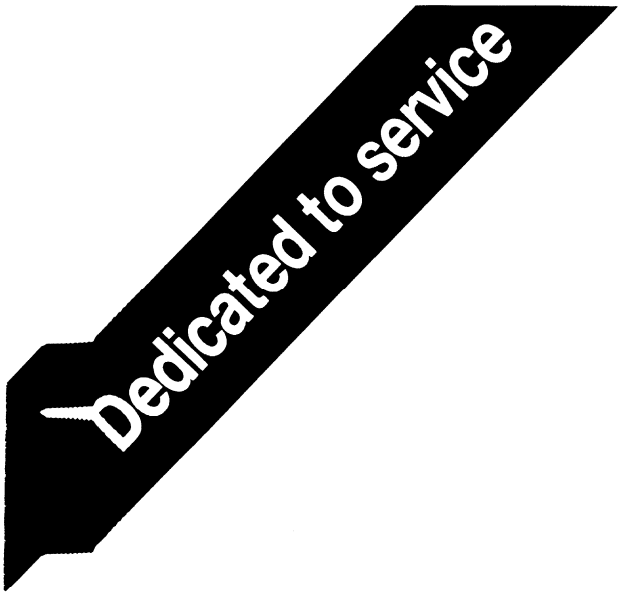
National Semiconductor

Semiconductor Master Selection Guide

1989

Including Products for Military/Aerospace Applications



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National Semiconductor is an industry leader in the manufacture of high quality, high reliability integrated circuits. We have been the leading proponent of driving down IC defects and extending product lifetimes. From raw material through product design, manufacturing and shipping, our quality and reliability is second to none.

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Charles E. Sporck
President, Chief Executive Officer
National Semiconductor Corporation

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National Semiconductor Corporation è un'industria al vertice nella costruzione di circuiti integrati di altà qualità ed affidabilità. National è stata il principale promotore per l'abbattimento della difettosità dei circuiti integrati e per l'allungamento della vita dei prodotti. Dal materiale grezzo attraverso tutte le fasi di progettazione, costruzione e spedizione, la qualità e affidabilità National non è seconda a nessuno.
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Charles E. Sporck
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Semiconductor Master Selection Guide

1989

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VR32TM
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XMOSTM
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TOUCH-TONE®
UNIXTM

CBS Labs
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DECTM
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IntellecTM
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Z80B®
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Introduction

National Semiconductor is dedicated to offering you high-quality, advanced IC products and support to help you meet the ever-changing demands of your marketplace.

This Master Selection Guide provides you with basic features and specifications on National's standard and semi-custom products. Many product families are available in surface-mount packages and in various military screening flows.

The Guide also includes a listing of sources for more detailed information on individual products.

If you have questions, please contact your local National Semiconductor sales office.

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a special selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD & JAN slash sheet numbers. It can also be used as a quick reference to cross-index National's generic part numbers with SMD & JAN slash sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

"When I'm looking for solutions . . .

ADVANCED PERIPHERALS

"I've got a great CPU design and National's high-quality peripheral ICs will help ensure its maximum performance."

COMMUNICATION SUPPORT
- IBM® data communications
- LOCAL AREA NETWORK
- network interface control
- serial network interface
- coaxial transceiver interface

GRAPHICS
- processors
- video DACs
- clock generators
- shift registers
- VRAM controller/drivers

MASS STORAGE
- floppy-disk control
- hard-disk control
- pulse detectors
- data synchronizers
- 2, 7 endec
- data separators

MEMORY MANAGEMENT
- DRAM controllers
- drivers
- error checking and correction circuits
- registers

INTERFACE

DISPLAY CONTROLLERS/ DRIVERS

PERIPHERAL POWER DRIVERS

BUS TRANSCEIVERS

TRANSMISSION LINE DRIVERS/ RECEIVERS

CRT CONTROLLERS

LEVEL TRANSLATORS/BUFFERS

FREQUENCY SYNTHESIS
- phase-locked-loop frequency synthesizers

MIL-AERO

"Our country has critical needs, and National combines the resources and responsiveness to meet them"

ASIC
- gate array

LOGIC
- FAST®
- FACT™
- F100K ECL
- Advanced Low-Power Schottky (ALS)
- High-Speed CMOS (HC/HCT)
- Low-Power Schottky
- Standard TTL
- Standard Schottky
- 54C CMOS
- CD400 CMOS
- Low-Power TTL
- DTL

GRAPHICS

LINEAR

HYBRIDS

MEMORY
- MOS & CMOS EPROM/SRAM

BIPOLAR MEMORY
- PROM and programmable logic (PAL®)

MICROPROCESSORS
- 8-, 16-, and 32-bit

MICROCONTROLLERS

VHSIC
- custom
- 64 kbit
- CMOS RAM

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"Reliable packaging is critical for my applications. So I call National."
- Small outline (SO) packages with 3 to 28 leads on 0.050-inch centers in gull-wing configuration
- Plastic pin-grid arrays (PPGA) with lead counts of 68 to 180
- Plastic quad flat packs (PQFP) with 100 to 196 leads on 0.025-inch centers
- Plastic leaded chip carrier (PLCC) with 20 to 84 leads on 0.050-inch centers in a J-bend configuration
- Leadless ceramic chip carrier (LCCC)
- Leaded ceramic chip carrier (LDCC)
- TapePak®—TAB bonded molded-plastic package with lead counts of 40 to 400 + and a patented protective carrier ring

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"National's brought its commitment to technical excellence and unmatched reliability to the board level."

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MICROCOMPUTER BOARDS
- analog I/O
- ancillary products
- controller boards
- CPU boards
- digital boards I/O
- expansion modules
- VME boards (Series 32000®)
- memory boards

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"Only one company has all the solutions to meet all my microprocessor and microcontroller needs: National"

MICROPROCESSORS 32-BIT (Series 32000)
- microprocessors (8-, 16- and 32-bit interface)
- peripherals
- development systems
- development software
- operating systems (UNIX® and real-time)

16-BIT (Bipolar)

F9450

MIL-STD 1750
- peripherals
- development board
- development software

8-BIT

(NSC800™ CMOS)
- evaluation board
- microprocessors
- peripherals
- 8-bit development systems

MICROCONTROLLERS 16-BIT (HPC™)
- MOLE™ development system
- terminal management processor (TMP)
- 16-bit microcontroller peripherals
- 16-bit ROM-less microcontrollers
- 16-bit piggyback microcontrollers
- 16-bit single-chip microcontroller

I look to National."

8-BIT (COP800)
- MOLE development system
- terminal management processor
- 8-bit ROM-less microcontrollers
- 8-bit piggyback microcontrollers
- 8-bit single-chip microcontrollers

4-BIT (COP400)
- MOLE development system
- microwire peripherals MICROWIRE™
- piggyback COPS™ microcontrollers
- ROM-less COPS microcontrollers
- single-chip COPS microcontrollers

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"The ASIC decision I make today will greatly affect the success of our products tomorrow. That's why I chose National."

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- foundry/customer-owned tooling

SEMI-CUSTOM

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- CMOS
- ECL/ASPECT™

Standard Cell
- CMOS
- mixed analog and digital
- ECL/ASPECT™

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- Faircad™
- Mentor
- Daisy
- FutureNet™

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LINEAR ASIC
- Linear/Digital
- Bipolar (L FAST)
- CMOS (C CMOS)
- Customer CAD

PROGRAMMABLE LOGIC

PAL® Devices
- ECL
- TTL

GAL® Devices
- EECMOS (Electrically-erasable CMOS)

FPLAs
- EECMOS

DIGITAL

"The digital world is rapidly evolving. And National's keeping pace—with new technologies and a growing product line to enhance today's systems and tomorrow's ideas."

FAST®

FACT™

F100K ECL

Advanced Low-Power Schottky (ALS)

Advanced Schottky (AS)

High-Speed CMOS (HC/HCT)

Low-Power Schottky (LS)

Standard TTL

Standard Schottky

54C/74C CMOS

CD4000 CMOS

LINEAR

"We may be in the middle of a digital revolution, but my designs require linear. And National comes through."

CONSUMER CIRCUITS
- audio
- automotive
- radio
- remote controllers
- video

CONVERTERS
- analog to digital
- digital to analog
- special converters

AMPLIFIERS
- buffers
- combined functions
- instrumentation
- operational
- power
- precision
- special
- video

ANALOG SWITCHES
- combined function
- standard

DISCRETE DEVICES
- PNP, NPN transistors
- JFETs, N-channel, P-channel, dual
- power MDS FETs
- rectifiers
- diodes, diode arrays
- small signal transistors
- quad transistor arrays

FILTERS
- monolithic

FREQUENCY SYNTHESIS
- phase-locked-loop frequency synthesizers

MOTOR CONTROLLERS
- H-switch
- servo-controllers

SAMPLE-AND-HOLD
- high-speed
- standard

SPECIAL ANALOG FUNCTIONS

TELECOMMUNICATIONS CIRCUITS
- ISDN
- SLIC
- COMBO™ circuits
- switching and transmission
- telephone components

VOLTAGE REFERENCES
- adjustable
- fixed
- precision

VOLTAGE REGULATORS
- dual tracking
- multi-tracking
- switch mode
- 3-terminal

MEMORY

"I want a memory device I can depend on. National makes that happen, applying the highest quality control standards to every phase of development. The result is superior products."

ECL I/O SRAMs
- 100K Series
- 10K Series
- BiCMOS
- modules

CMOS EPROMs

EEPROM
- CMOS
- NMOS

FLASH™ CMOS
- EEPROMs
- EPROMs

TTL FIFOs

For information about any of these products, call your local National sales office. Or write to us at MS23-200, P.O. Box 58090, Santa Clara, CA 95052-8090.

Table of Contents

Table of Contents (Continued)

Section 5 Interface

Section 6 Linear

Section 7 Memory

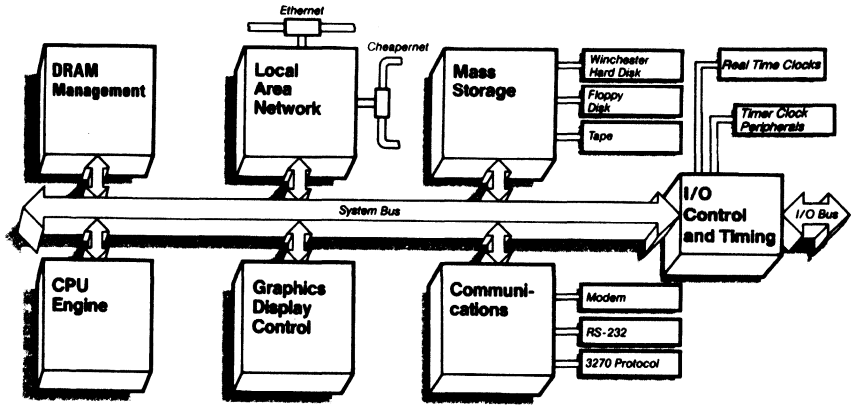
Section 8 Microcontrollers

Table of Contents (Continued)

Section 1
Advanced Peripherals

Section 1 Contents Advanced Peripherals

Advanced Peripherals



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National Semiconductor Advanced Peripherals products include complex VLSI peripheral circuits designed to serve a variety of applications. The Advanced Peripherals products are especially well suited for microcomputer and microprocessor systems such as graphics workstations, personal computers, and many others. National Semiconductor Advanced Peripherals devices are fully described in a series of databooks and handbooks.

Among the Advanced Peripherals books are the following titles:

Mass Storage

The National Semiconductor family of mass storage interface products offers the industry's highest performance and broadest range of products for Winchester hard disks and floppy disks. The Mass Storage Handbook includes complete product information and datasheets as well as a comprehensive design guide for disk controller systems.

DRAM Management

Today's large Dynamic Random Access Memory (DRAM) arrays require sophisticated high performance devices to provide timing access arbitration on board drive and control. National Semiconductor offers the broadest range of DRAM controllers with the highest "No-waitstate" performance available on the market. Controllers are available in Junction Isolated LS, Oxide Isolated ALS, and double metal CMOS for DRAMs from 64k bit through 4M bit devices, supporting memory arrays up to 64 Mbyte in size with only one LSI/VLSI device. For critical applications, National Semiconductor has developed several 16- and 32-bit Error Checking and Correction (ECC) devices to provide maximum data integrity. The Memory Support Handbook contains complete product information and several application notes detailing complete memory system design.

Local Area Networks and Data Communications

Today's computer systems have created a huge demand for data communications and Local Area Networks (LANs). National Semiconductor supplies a broad range of products to fill these needs. The IEEE 802.3 Standard for Ethernet LANs is one of the most popular solutions. National Semiconductor provides a complete three-chip solution for an entire 802.3 design. For IBM 370 class mainframe and system 34/36/38 peripheral connectivity, National offers a completely integrated solution for the physical layer front end transceiving and processing of the IBM 3270/3299 "coaxial" and IBM 5250 "twinaxial" protocols. To drive the communications lines, National Semiconductor has drivers and receivers designed to meet all the major standards such as RS-232, RS-422, and RS-485. Datasheets and applications information for all these products are in the LAN/DATA COMM Handbook.

Graphics

Sophisticated human interface is a mark of the newest computer systems designs. Today's personal computer may have better graphics display capability than engineering workstations of a few years ago. National Semiconductor has developed a new family of Advanced Graphics products to provide extremely high performance, high resolution color graphics displays. The graphics chip set is designed to provide the highest level of performance with minimum demands and loading on the system CPU. The graphics system may be expanded to any number of color planes with virtually unlimited resolution. The Graphics Databook lays it all out and makes the display system design easy.

Real Time Clocks

National offers a family of Real Time Clocks (RTCs) and advanced Timer Clock Peripherals (TCPs). The RTC family provides a simple μP bus compatible interface to any system requiring accurate, reliable, on-going real time and calander functions. The TCP family offers fast μP bus interface, select, RAM, and read and write handshaking controls. The Real Time Clock handbook includes complete product information and datasheets as well as comprehensive design guides.

Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

IEEE 802.3 (Ethernet) Local Area Network

The IEEE 802.3 Standards

The IEEE 802.3 standards have become the most widely accepted method for connecting personal computers and workstations together to form workgroup and corporate networks. These standards offer a variety of configurations and choice of media. The DP8390 Ethernet Chip Set is designed to interface to these standards, and allows partitioning of the individual chips to implement the interfaces to these standards or other 802.3 compatible networks.

The 802.3 standards are summarized in Table I. There are basically four standards. Two of these are bus and two are star topologies. All four networks utilize the same CSMA/CD (Carrier Sense Multiple Access with Collision Detection) cable access protocol, and the same basic data encoding and packet structure.

CSMA/CD protocol defines how a node will gain access to transmit over the cable. The node first monitors the cable to ensure no transmissions are in progress (Carrier Sense). Any node may then decide to transmit (Multiple Access). If more than one node decides to transmit then all nodes must be able to detect this condition (Collision Detection), stop their transmission and retry again.

The four standards differ primarily in the cabling scheme. Ethernet uses a thick double shielded coax for maximum distances. Thin-Ethernet maintains the same data rate but uses less expensive coax, sacrificing distance. StarLAN uses very inexpensive twisted pair phone cabling, a star network configuration, but at a slower data rate. The emerging twisted pair standard uses the same cable as StarLAN, but retains the 10 Mb/s data rate.

The DP8390 IEEE 802.3 chip set is designed to provide a simple high performance interface between the host system and any of the IEEE 802.3 standards. The chip set has been partitioned into three integrated circuits. This partitioning enables the greatest flexibility in implementing the various standards, and yet maintains the highest level of integration.

The DP8390 Network Interface Controller implements the Media Access Control (MAC) functions, and contains a 16 byte FIFO and dual DMA for easy system interface.

The DP8390 connects to either the DP8391 or DP83910 Serial Network Interface. Both these devices provide Manchester encoding/decoding, and connection to the drop cable. These devices are suitable for Ethernet, Thin-Ethernet and Twisted Pair Ethernet.

For Ethernet and Thin-Ethernet the interface to the Coax is handled by the DP8392. This device consists of a receiver, transmitter, jabber, and collision detection circuits.

IEEE Designation	Industry Name	Speed	Maximum Segment Length	Topology	Nodes per Segment	Media
10BASE5	Ethernet	10 Mbits/sec	500 Meters	Bus	100	Ethernet Coax
10BASE2	Thin-Wire Ethernet	10 Mbits/sec	185 Meters	Bus	30	RG-58 Coax
10BASET (Note 1)	Twisted Pair Ethernet	10 Mbits/sec	100 Meters (Note 2)	Star	1 (Note 2)	Unshielded Twisted Pair
1BASE5	StarLAN	1 Mbit/sec	500 Meters	Star	1 (Note 2)	Unshielded Twisted Pair

Note 1: Proposed Standard

Note 2: 10BASET and 1BASE5 are based on point to point links so a single link supports 1 DTE.

Table I. IEEE 802.3 Network Standards

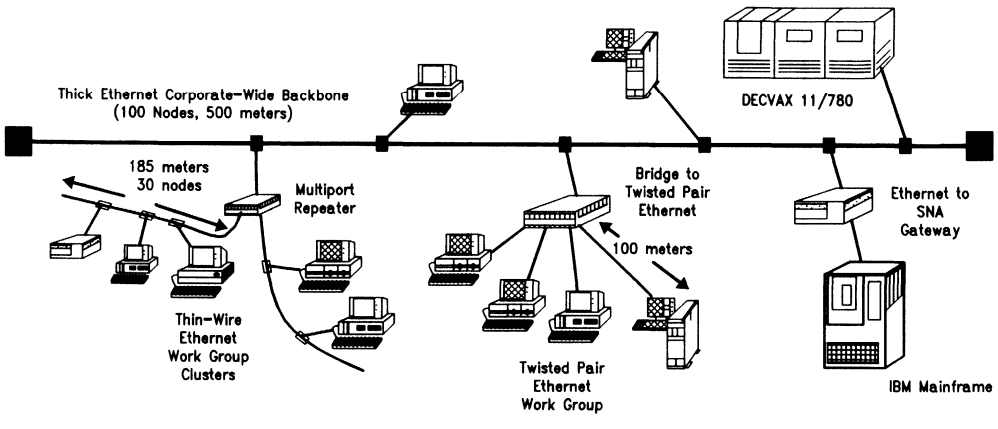


Figure 1. Typical Ethernet IEEE 802.3 Network Configuration

DP8390/NS32490 Network Interface Controller (NIC)

General Description

The DP8390/NS32490 Network Interface Controller (NIC) is a microCMOS VLSI device designed to ease interfacing with CSMA/CD type local area networks including Ethernet (10BASE5), Thin-Ethernet (10BASE2), StarLAN (1BASE5), and the emerging twisted pair (10BASET) standards. The NIC implements all Media Access Control (MAC) layer functions for transmission and reception of packets in accordance with the IEEE 802.3 Standards. This includes the collision backoff and retry algorithms.

In addition, unique dual DMA channels, internal programmable 16 byte FIFO for use with various bus latencies, and buffer management provide a simple efficient high performance packet control interface. To minimize system parts count and cost, bus arbitration and memory support logic are integrated into the NIC.

The local DMA channel can transfer data at a 10 MByte/sec rate when using a 20 MHz bus clock. This results in a bus utilization of 12%. The on-chip buffer management logic can maintain a receive buffer in local RAM. This eliminates CPU intervention in actual packet reception, and enables reception of back-to-back packets. The controller recovers buffer memory space when a bad packet is received. The chip will automatically retry a transmission if a collision occurs. Also on chip tally counters maintain network statics.

The NIC is the heart of a three chip set that implements the complete 802.3 node electronics as shown in Figure 2. The other two devices are the DP8391 Serial Network Interface (SNI) or the CMOS SNI, the DP83910, and the DP8392 Coaxial Transceiver Interface (CTI).

Features

- Compatible with all IEEE 802.3 Standards
- 8 or 16 bit data bus interfaces to 8, 16, 32 bit systems
- Versatile buffer management
- Single 5V supply
- Low power microCMOS
- Two DMA Channels with the Local DMA Channel capable of 10 Mbyte/sec transfer rates
- 16 byte FIFO with programmable thresholds
- Network Statistics Counters
- Supports Physical, Multicast, Broadcast addressing
- 3 levels of loopback
- Separate system & network clocks

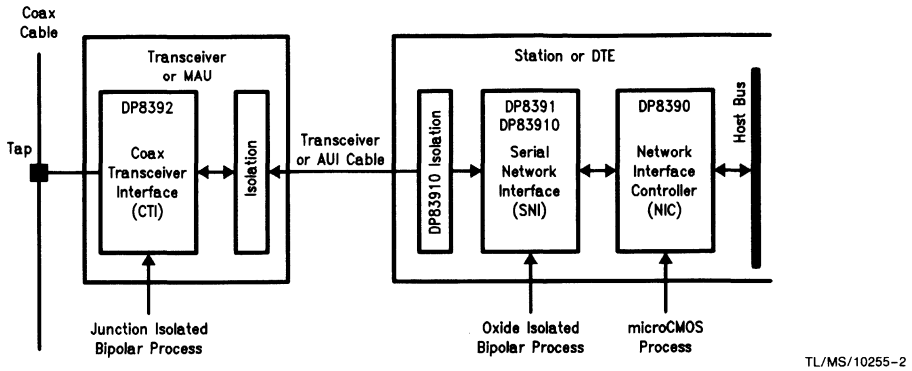


Figure 2. National's Ethernet Chip Set System Block Diagram for Ethernet (for Thin-Ethernet, the MAU and DTE are combined)

DP8391/NS32491 Serial Network Interface (SNI)

General Description

The DP8391/NS32491 Serial Network Interface (SNI) provides the Manchester data encoding and decoding functions for IEEE 802.3 Ethernet/Thin-Ethernet and Twisted Pair Ethernet networks. The SNI interfaces the DP8390 Network Interface Controller to the Ethernet transceiver cable. When transmitting, the SNI converts non-return-to-zero (NRZ) data from the controller and clock pulses into Manchester encoding and sends the converted data differentially to the transceiver. The opposite process occurs on the receive path, where a digital phase locked loop decodes 10 Mbit/sec signals with as much as ±20 ns of jitter.

The DP8391 SNI includes ECL like balanced driver and receivers, on board oscillator, collision signal translator, and diagnostic loopback.

The SNI is part of a three chip set that implements the complete IEEE compatible network node electronics as shown in Figure 2. The other two devices are the DP8392 Coax Transceiver, and the DP8390 Network Interface Controller.

Features

- Compatible with all IEEE 802.3 Standards
- 10 Mbit/sec encoding and decoding with clock recovery
- Patented digital PLL decoder requires no external components
- Decodes data with up to ±20 jitter
- Loopback capability for diagnostics
- Externally selectable half or full step modes of operation at transmit output.
- Squelch inputs at the receive and collision inputs
- High Voltage protection at transceiver interface (16V)
- Connects directly to the transceiver (AUI) cable

DP83910/NS324910 CMOS Serial Network Interface (CSNI)

General Description

The DP83910/NS324910 CMOS Serial Network Interface (SNI) is functionally compatible to the DP8391 SNI, but is implemented in microCMOS technology which provides a two-thirds reduction in operating power. Like the DP8391, the DP83910 provides the Manchester data encoding and decoding functions for Ethernet/Thin-Ethernet and Twisted Pair Ethernet. The CSNI interfaces the DP8390 Network Interface Controller to the Ethernet transceiver cable. When transmitting, the CSNI converts NRZ data from the controller and clock pulses into Manchester encoding and sends the data differentially to the transceiver. To receive data an analog phase locked loop decodes 10 Mbit/sec Manchester signals with as much as ±20 ns of jitter, and converts them to NRZ data and clock.

The DP83910 CSNI includes ECL like balanced driver and receivers, on board oscillator, collision signal translator, and diagnostic loopback.

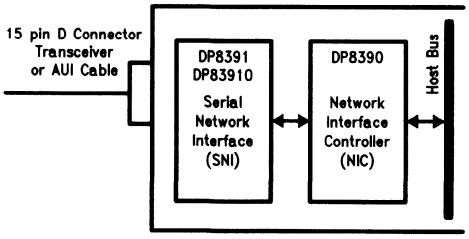
The CSNI is part of a three chip set that implements the IEEE 802.3 node electronics, Figure 2. The other two devices are the DP8392 Coax Transceiver, and the DP8390 Network Interface Controller.

Features

- Compatible with all IEEE 802.3 Standards
- Implemented in low power microCMOS technology
- 10 Mbit/sec encoding and decoding with clock recovery
- Precision Analog PLL decoder requires no external components
- Decodes data with up to ±20 jitter
- Loopback capability for diagnostics
- Externally selectable half or full step modes of operation at transmit output
- Squelch inputs at the receive and collision inputs
- Connects to the transceiver (AUI) cable through a pulse transformer

Local Area Network Chip Set (Continued)

10BASE5 (Ethernet)



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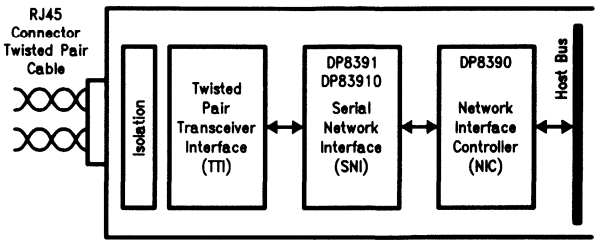
10BASET (Twisted Pair Ethernet)



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Note that the DP83910 requires isolation from the Transceiver cable, but the DP8391 does not.

10BASE2 (Thin-Ethernet)

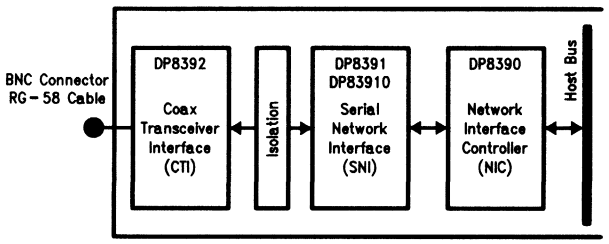

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Figure 3. Configurations for 10 Mbit/sec IEEE 802.3 Standards

DP8392/NS32492 Coaxial Transceiver (CTI)

General Description

The DP8392/NS32492 Coaxial Transceiver Interface (CTI) is used as a coaxial cable driver/receiver for Ethernet and Thin-Ethernet networks. The CTI is connected between the cable and the Data Terminal Equipment (DTE). In Ethernet applications the transceiver is usually mounted within its own enclosure and is connected to the DTE via a transceiver cable, Figure 4. In Thin-Ethernet applications, the CTI is typically located within the DTE and connects to the DTE through isolation transformers.

The CTI consists of a Receiver, Transmitter, Collision Detector, and a Jabber Timer. The Transmitter connects directly to a 50Ω coaxial cable. During transmission, a Jabber Timer is initiated to disable the CTI transmitter in the event of excessively long packets (>30 ms).

Collision Detection circuitry monitors the signals on the coax to determine the presence of colliding packets and signals the DTE in the event of a collision.

The CTI is part of a three chip set that implements the complete IEEE compatible network node electronics as shown in Figure 2. The other two devices are the DP8392 Coax Transceiver, and the DP8391 or DP83910 Serial Network Interface.

Features

- Integrates all Transceiver functions except power and signal isolation
- Jabber function integrated on chip
- Externally selectable CD Heatbeat
- Precision circuitry implement receive mode collision detection
- Designed for rigorous reliability requirements of IEEE 802.3
- Squelch circuitry on all inputs
- Standard 16 pin DIP uses special leadframe that reduces operating die temperature.

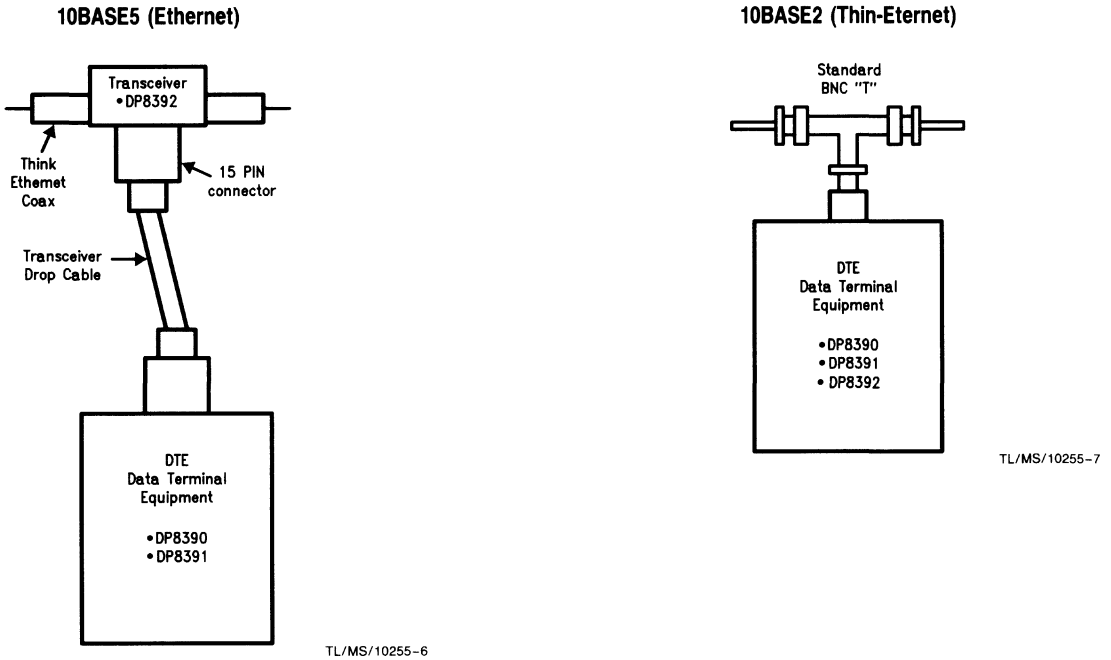


Figure 4. Typical Connection Diagram for an IEEE 802.3 Node

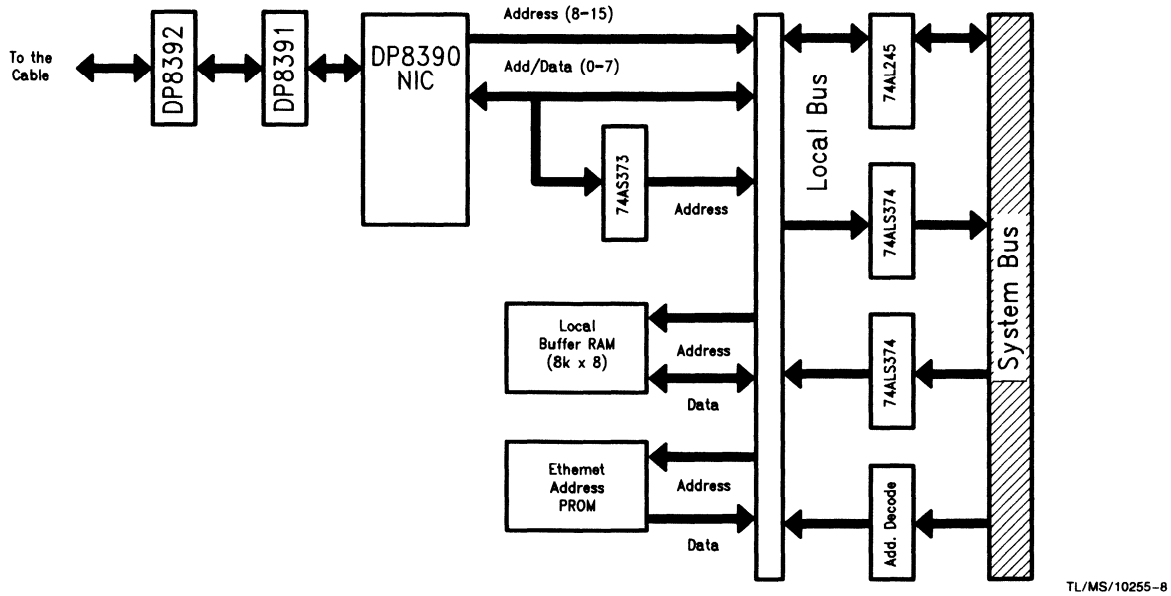


Figure 5. Functional Block Diagram for DP839EB LAN Evaluation Board

DP839EB LAN Evaluation Board

General Description

The DP839EB LAN Evaluation Board provides IBM PCs, IBM PC ATs and compatibles with Ethernet, Thin-Ethernet, Twisted Pair Ethernet and StarLAN connections. The DP839EB is compatible with the PC-bus and requires only a ½ size slot for installation.

The LAN Evaluation Board utilizes the National Semiconductor IEEE 802.3 chip set consisting of the DP8390 Network Interface Controller, the DP8391 Serial Network Interface Adapter, and the DP8392 Coaxial Transceiver Interface. The dual DMA capabilities of the DP8390, coupled with 8 kbytes of local buffer RAM allow the evaluation board to appear as an I/O port to the system.

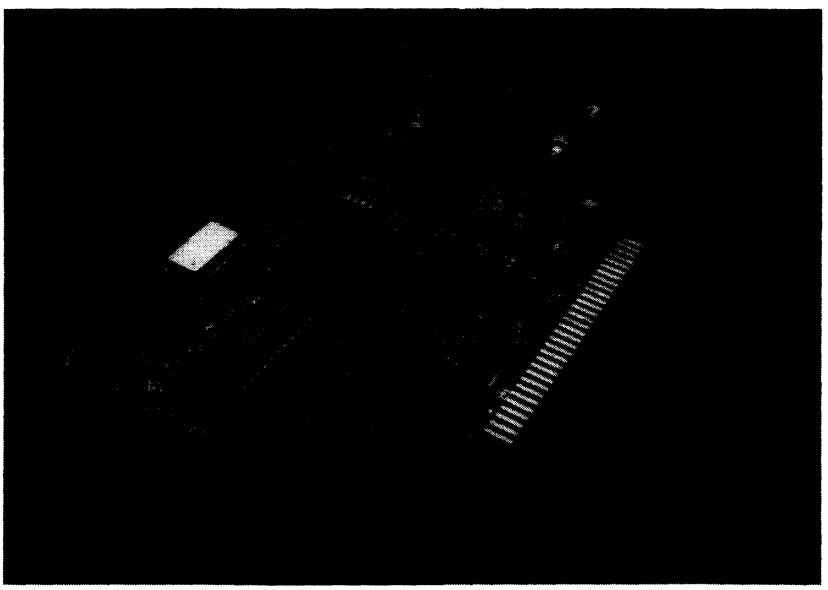
The Evaluation Board provides the designer with a good example of an 8 bit controller implementation, that can be extrapolated to 16 bit buses.

In addition, software is included with the board to facilitate low level functional check out of the board, and as a guide to programming the board. The source code is provided, and can serve as a model for additional software development.

Additionally the DP839EB is compatible with Novell NetWare™, and TCP/IP software support is available through third party developers.

Hardware Features

- Half-size IBM PC card form factor
- DP8390 IEEE 802.3 Chip Set utilizing dual DMA controller
- 8 kbyte on board packet buffer
- Interfaces to PC using DMA, or to an AT via string I/O instructions
- Ethernet connector (15 pin D), Thin-Ethernet connector (BNC)
- StarLAN and Twisted Pair Ethernet support with optional daughter card
- Low power operation
- Utilizes DP8390, DP8391, and DP8392



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High Speed Serial Data Communications

IBM 3270/3299 Protocol

The 3270/3299 serial communications protocol was developed by IBM for the controller-peripheral link in 370 class mainframe systems. These systems have large scale networking needs and often support thousands of terminals and printers. The 3270/3299 protocol has proved adaptable to the new directions in SNA and to the migration of the processing power out into the peripheral.

The 3270 protocol defines a point to point, deterministic connection between the host controller and the peripheral. Each peripheral is attached to the cluster controller through a dedicated cable, either RG62AU 93Ω coax or IBM type 3 media twisted pair. The 3270 protocol defines serial transmission using a Manchester encoding scheme with a 2.3587 Mb/sec data rate. All communication between the controller and peripheral is done in a controller initiated poll-response format. The response from the peripheral must begin 5.5 μsec after receiving the ending sequence from the controller.

The 3299 protocol is a variation of the 3270 protocol in that an 8 bit address byte is asserted between the starting sequence and the first word for each out board transmission from the controller. This was done to allow up to eight 3270 peripherals to be multiplexed and connected to the controller via a single coax cable, thus reducing cabling costs. The multiplexing and de-multiplexing is done with a 3299 terminal multiplexer.

IBM 5250 Protocol

The 5250 serial communications protocol was developed by IBM originally for the Series 3 and has become widely used in the mid-range System 3x line of computers. The System 3x line can vary from small office environment processors to more powerful processors with greatly enhanced networking facilities that rival the smaller 370 class mainframes.

The 5250 protocol defines a multi-drop topology in which up to seven 5250 peripherals can be attached to the System 3x controller via a single twinaxial cable. All of the devices are D.C. coupled to the line and must adhere to more stringent cabling requirements that the 3270 coax. The 5250 protocol defines a serial transmission using a Manchester encoding scheme with a 1 Mb/sec data rate. All communication between the controller and peripheral is done in a controller initiated poll-response format. The response from the peripheral must begin 45 ±15 microseconds after receiving the transmission which is much less stringent than the 3270 protocol.

NSC 8-Bit Protocol

As the requirements of distributed data communications have evolved and become more complex, the demand for a more sophisticated transmitting and receiving function has grown rapidly. Most approaches are designed for the transfer and receipt of varying size blocks of data at relatively high data rates coupled with a high degree of data integrity. To support these ever increasing number of applications National Semiconductor defined a generic 8-bit serial protocol. This protocol gives the designer the flexibility to customize this serial transmission scheme to meet the specific application. This protocol was designed to operate at up to 4 Mb/sec and be used with any of the major media options such as coax, twisted pair, fiber optic, etc. It is also well suited for the different network topologies such as star, ring, or multidrop.

DP834x Series

The DP834x series of devices were designed to provide the high speed serial communications solution for IBM and non-IBM peripheral communication.

The DP8344 Biphase Communications Processor (BCP) provides a total system solution for the IBM 3270/3299 and 5250 protocols plus the NSC 8-bit protocol. It combines a software configurable transmitter and receiver integrated on the same chip with a 20 MHz RISC processor customized for the communications environment.

The DP8340 IBM 3270 Protocol Transmitter/Encoder and the DP8341 IBM 3270 Protocol Receiver/Decoder are the transmitter and receiver pair that generate the complete encoding and decoding of data between parallel forms and the IBM 3270 information display system standard.

The DP8342 High Speed 8-Bit Serial Transmitter/Encoder and the DP8343 High Speed 8-Bit Serial Receiver/Decoder are the transmitter and receiver pair that implement the complete encoding and decoding of data between parallel form and the NSC general purpose 8-bit protocol.

Protocol	Speed	Max Length	Topology	Media	Device
IBM 3270	2.35 Mbits/sec	1500 Meters	Point to Point	Coax, Twisted Pair (Note 2)	8340/41, 8344
IBM 3299	2.35 Mbits/sec	3000 Meters (Note 1)	Point to Point	Coax, Twisted Pair (Note 2)	8344
IBM 5250	1 Mbits/sec	1500 Meters	Multi-Drop	Twinax	8344
NSC 8 Bit	3.5 Mbits/sec	User Defined	User Defined	User Defined	8342/43, 8344

Note 1: With multiplexer

Note 2: IBM type 3 media

Table 1. High Speed Serial Data Communications Standards

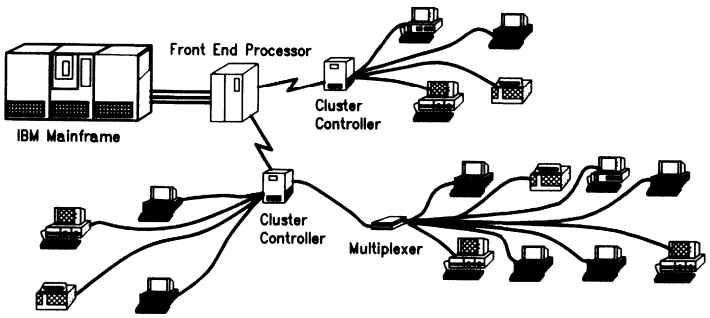

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Figure 1. Typical 3270 Environment

DP8344 Biphase Communications Processor (BCP®)

General Description

The DP8344 BCP is a communications processor designed to efficiently process IBM 3270, 3299 and 5250 communications protocols. The general purpose NSC 8-bit protocol is also supported. The BCP is easily integrated into cluster controllers, PCs, terminals and printers removing the difficulties in designing plug compatible peripherals for IBM mainframe and departmental processors. It is also well suited for gateways to local and wide area networks and for protocol converters to give inexpensive peripherals access to processing power of the mainframe.

The BCP integrates a 20 MHz, 8-bit Harvard architecture RISC processor, and an intelligent, software-configurable transceiver on the same low power micro-CMOS chip. The transceiver is mapped into the processor's register space, communicating with the processor via an asynchronous interface which enables both sections of the chip to run from different clock sources.

The BCP is designed to stand alone and is capable of implementing a complete communications interface, using the processor's spare power to control the complete system. Alternatively, the BCP can be interfaced to another processor with an on-chip interface controller arbitrating access to data memory.

A simple line interface connects the BCP to the communications line. The receiver includes an on-chip analog comparator, suitable for use in a transformer-coupled environment, although a TTL-level serial input is also provided for applications where an external comparator is preferred.

Features

Transceiver

- Software configurable for 3270, 3299, 5250 and general NSC 8 bit protocols
- Fully registered status and control
- On-Chip analog line receiver

Processor

- 20 MHz clock (50 ns T-states)
- Max, instruction cycle: 200 ns
- ALU and barrel shifter
- 64k x 16 program memory; 64k x 8 data memory (typical system requires < 2k program memory)
- Programmable wait states
- Soft-loadable program memory
- Interrupt and subroutine capability
- Stand alone or host operation
- Flexible bus interface with on-chip arbitration logic

General

- Low power CMOS
- 84 pin plastic leaded chip carrier (PLCC) package

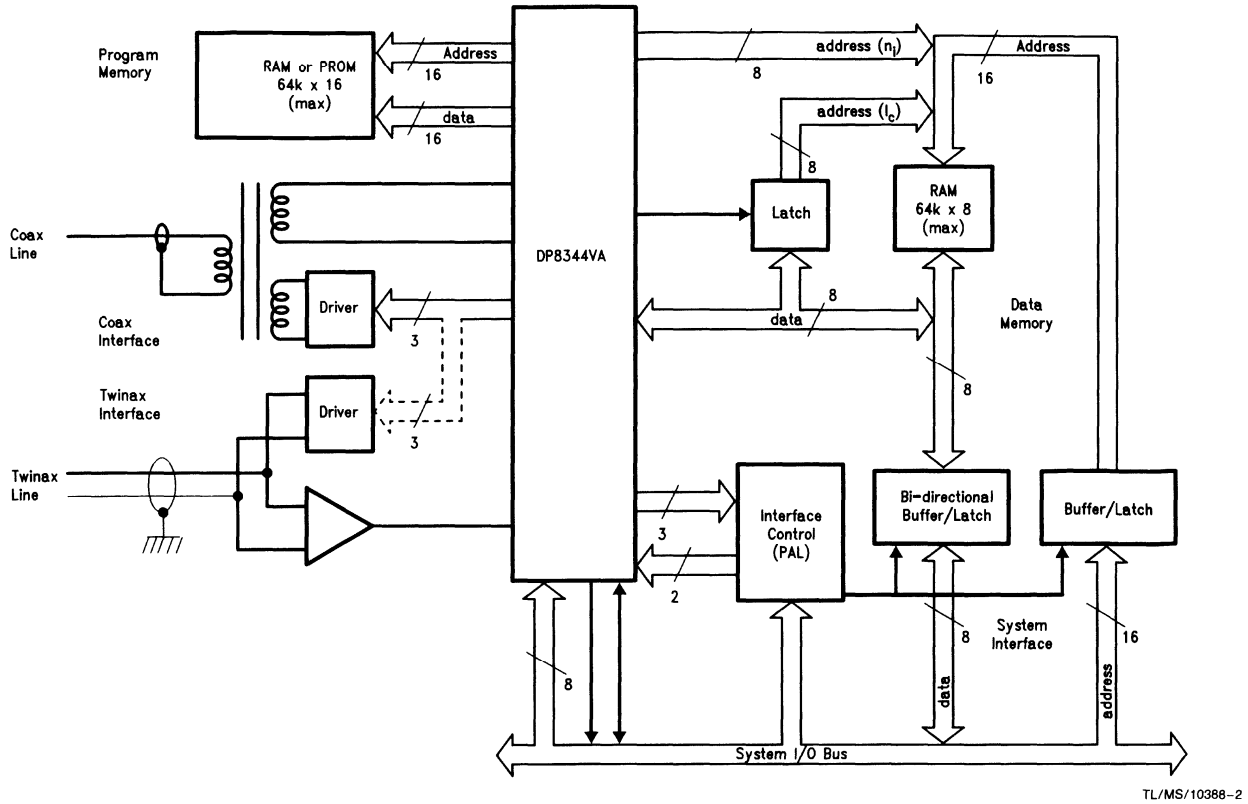

Figure 2. Block Diagram of Typical BCP System

DP8344 BCP Assembler System

General Description

To speed the development of peripheral and network interface designs based on the DP8344 Biphase Communications Processor, National offers a complete Assembly System containing a Macro Cross Assembler, Link Editor, and librarian that are uniquely tailored to the BCP's instruction set.

The Assembler provides nested macro definitions and expansions, source file inclusion nested conditional assembly, and complete expression syntax. Nested macro definitions and expansions enable the user to automate common instruction sequences to eliminate redundant coding. The nested conditional assembly feature allows the assembler to make intelligent decisions concerning instruction sequence based on user directives. For example, this feature allows the development of one basic source program to support both 3270 and 5250 protocol processing; the assembler optimizes its output based on the chosen protocol. Finally, the complete expression syntax feature allows the user to easily handle complex mathematical equations.

The Linker allows the user to link relocatable object sections in any desired order. It can also generate a load map which details each section's contribution to the linked module.

The Librarian speeds program development by allowing users to create libraries of frequently accessed object modules. This facilitates high-level-type programming.

The DP8344 BCP Assembler System includes the complete assembler software plus an easy-to-use, tabbed and indexed user's manual. The assembler system is currently available for PC-XT and PC-AT-type computers running MS-DOS™.

Features

- Nested macro definitions and expansions
- Nested conditional assembly
- Nested source file inclusion
- Up to 256 separately relocatable object sections
- Over 1700 external symbols per object file
- Complete expression syntax
- Large symbol table space
- Full assembly listing
- Symbol cross-reference listing

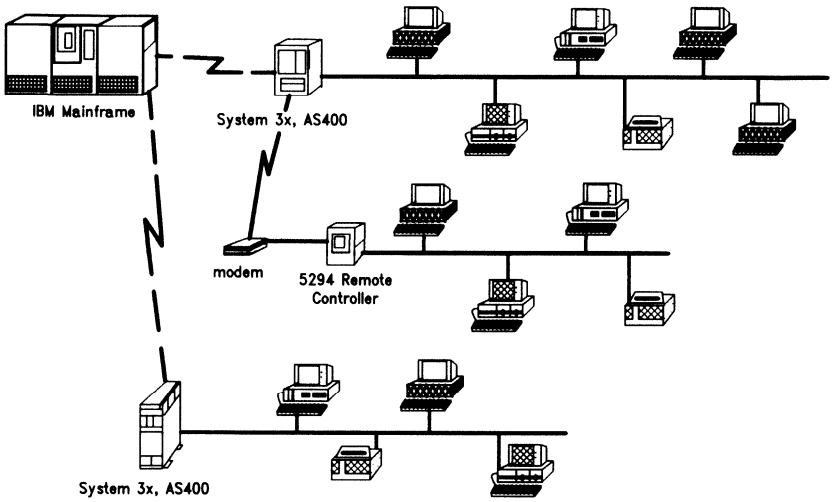

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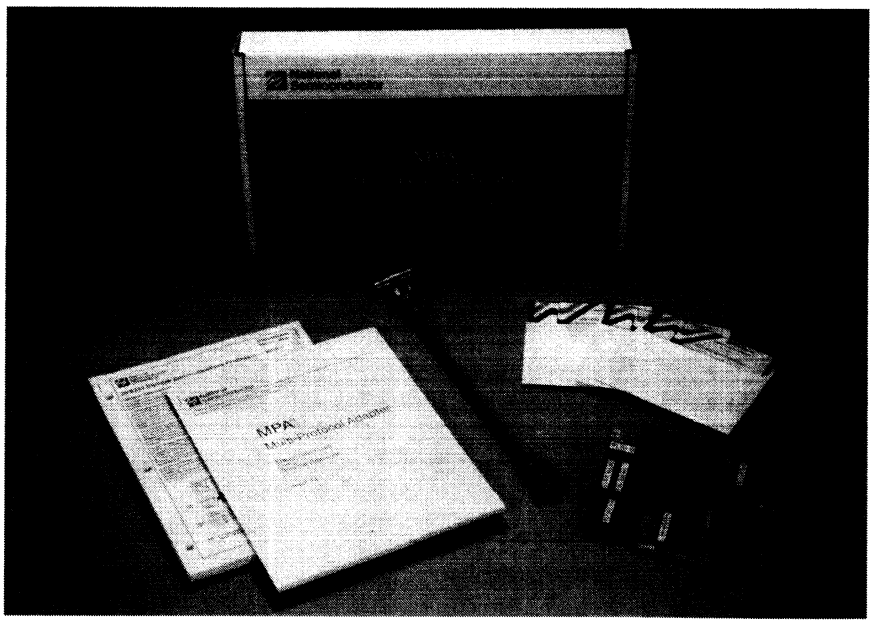
Figure 3. Typical 5250 Environment

The DP8344 BCP Multi-Protocol Adapter (MPA) Design/Evaluation Kit

The DP8344 BCP Multi-Protocol Adapter (MPA) is a PC expansion card that emulates a 3270 or 5250 display terminal and supports industry standard PC emulation software. The MPA comes in a design/evaluation kit that includes the hardware, with full schematics and PAL equations, and software including all the DP8344 source code. This kit was produced by National Semiconductor to provide a blueprint for PC emulation products and a cornerstone for all 3270 and 5250 product development using the DP8344. The code was developed in a modular fashion so it can be easily adapted to any 3270 or 5250 application. The MPA allows designers to accelerate the development of IBM peripheral devices and network interfaces based on the DP8344.

Features

- Standard half-size PC emulation board for IBM-PC/AT/XT
- Supports CUT and DFT 3270/3299 sessions and handles multiple 3299 and 5250 sessions
- Complete source code and design documentation
- Supports IRMA and IBM emulation software for 3270 terminal emulation
- Supports Smart Alec emulation software for 5250 terminal emulation



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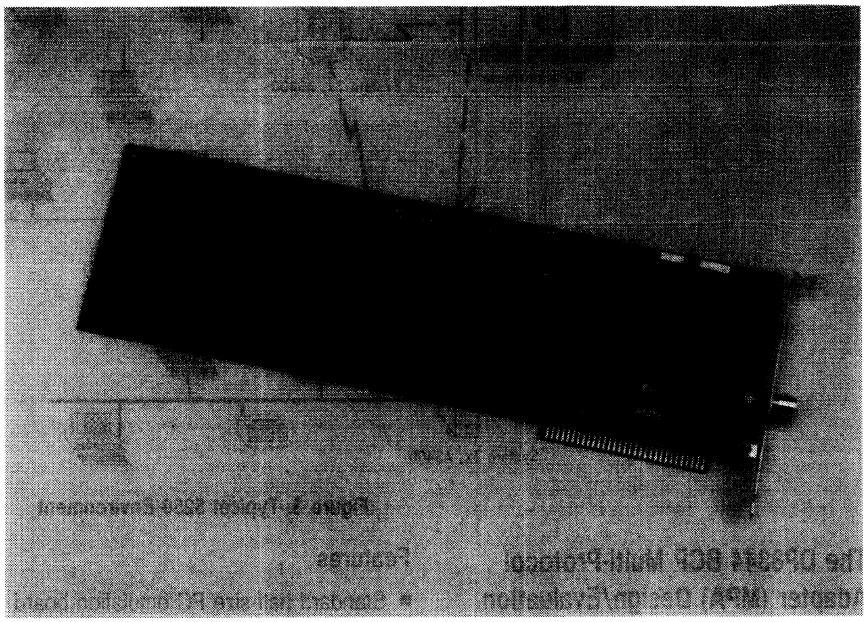
The CT-104 DP8344 BCP Demonstration/Development Kit

General Description

The DP8344 BCP Demonstration/Development kit is a cost effective development tool that performs functions similar to an in-circuit emulator to aid in the development of new products using National Semiconductor's DP8344 Biphase Communications Processor. The CT-104, developed by Capstone Technology, consists of a DP8344 based development board, a monitor/debugger software package, terminal emulation demo software, National Semiconductor's DP8344 video training tapes, and all required documentation. The development board is a full size PC card that features a 22 square inch area for logic prototype wiring. The full featured monitor/debugger lets users set breakpoints and perform single step execution of DP8344 programs. It also has a powerful macro command language and features a simple operator interface.



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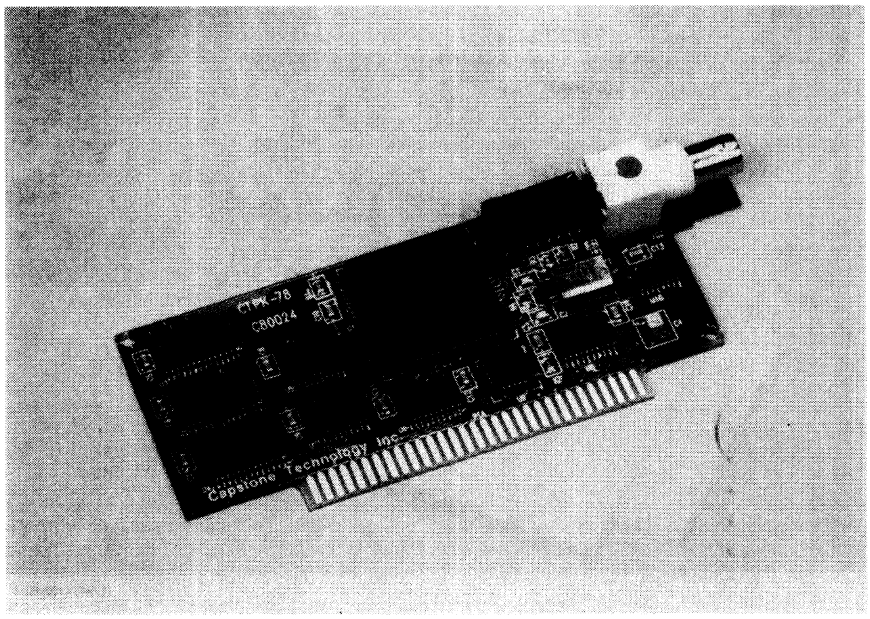

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The DP8344 BCP PocketLink Demonstration Kit

General Description

The DP8344 BCP PocketLink Demonstration kit is an entire 3270 Terminal Emulation Board in the size of a credit card. Capstone Technology, in a joint development effort with National Semiconductor and Pulse Engineering, provides in a very small size a platform for demonstrating two highly integrated technologies: the DP8344 Biphase Communications Processor for handling IBM's 3270 protocol and the PE-857623 for supporting the physical 3270 interface. The BCP PocketLink kit contains a pocket sized PC board with demonstration software for 3178/3278 terminal emulation.

DP8340 IBM 3270 Protocol Transmitter/Encoder

General Description

The DP8340 generates a complete encoding of parallel data for high speed serial transmission which conforms to the protocol as defined by the IBM 3270 information display system standard. The DP8340 converts parallel input data into a serial data stream. Although the IBM standard covers biphase serial data transmission over a coax line, the DP8340 also adapts to general high speed data transmission over other than coax lines, at frequencies either higher or lower than the IBM standard.

Features

- Transmission conforms to IBM 3270 protocol
- Internal parity generation (even or odd)
- Internal crystal controlled oscillator used for the generation of all required chip timing frequencies
- Clock output directly drives receiver (DP8341) clock input
- Input data holding register
- Automatic clear status response feature
- Line drivers at data outputs provide easy interface to biphase coax line or general transmission lines

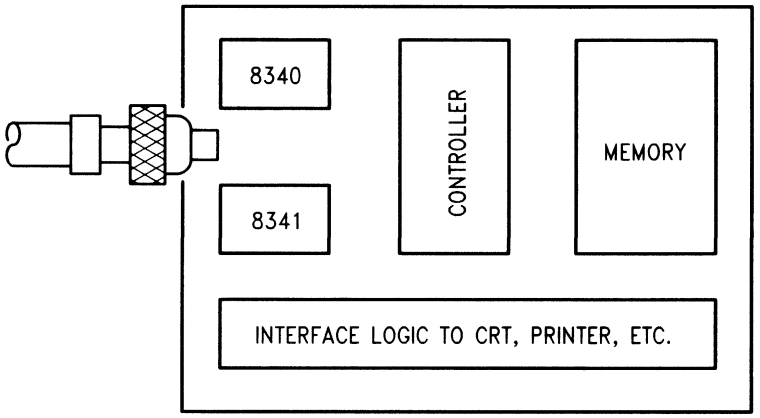

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Figure 4. 8340/41 System Diagram

DP8341 IBM 3270 Protocol Receiver/Decoder

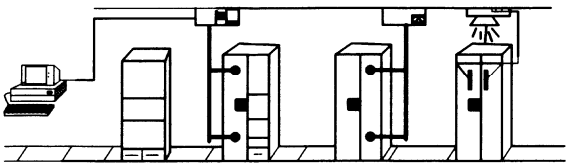
General Description

The DP8341 provides complete decoding of data for high speed serial data communications. In specific, the DP8341 recognizes serial data that conforms to the IBM 3270 information Display System Standard and converts it into ten (10) bits of parallel data.

The DP8341 receiver and its complementary chip, the DP8340 transmitter, are designed to provide maximum flexibility in system designs. The separation of transmitter and receiver functions allows addition of more receivers at one end of the biphase line without the necessity of adding unused transmitters. This is advantageous specifically in control units where typically biphase data is multiplexed over many biphase lines and the number of receivers generally outnumber the number of transmitters.

Features

- Conforms to the IBM 3270 protocol
- Even parity detection
- High sensitivity input on receiver easily interfaces to coax line
- Standard TTL data input on receiver provides generalized transmission line interface and also provides hysteresis
- Data holding register
- TRI-STATE receiver data outputs
- Data transmission error detection or receiver provides for both error detection and error type definition



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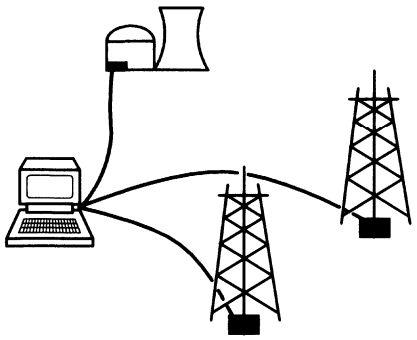
(a) Industrial Control



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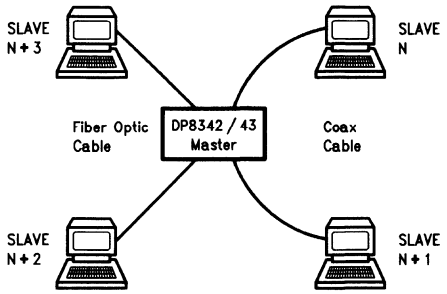
(b) Remote Data Acquisition



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(c)LAN Environment

Figure 5. NSC 8-Bit Applications

DP8342 High Speed 8-Bit Serial Transmitter/Encoder

General Description

The DP8342 generates a complete encoding of parallel data for high speed serial transmission. It generates five line quieses, a three bit time code violation, and a sync bit, followed by eight data bits, a parity bit and a two bit time ending sequence. A three-bit ending code signals the termination of the transmission. The DP8342 adapts to generalized high speed serial data transmission systems that operate at bit rates up to 3.5 MHz.

The DP8342 and its complementary chip, the DP8343 (receiver/decoder) have been designed to provide maximum flexibility in system designs. The separation of the transmitter receiver functions provides convenient addition of more receivers at one end of a biphase line without the need of unused transmitters. This is specifically advantageous in control units where typical biphase data is multiplexed over many biphase lines and the number of receivers generally exceeds the number of transmitters.

Features

- Internal parity generation (even or odd)
- Internal crystal controlled oscillator used for the generation of all required chip timing frequencies
- Clock output directly drives receiver (DP8343) clock input
- Input data holding register
- Automatic clear status response feature
- Line drivers at data outputs provide easy interface to biphase coax line or general transmission media

DP8343 High Speed 8-Bit Serial Receiver/Decoder

General Description

The DP8343 provides complete decoding of data for high speed serial data communications. In specific, the DP8343 receiver recognizes biphase serial data sent from its complementary chip, the DP8342 transmitter, and converts it into 8 bits of parallel data. These devices are easily adapted to generalized high speed serial data transmission systems that operate at bit rates up to 3.5 MHz.

The DP8343 receiver and the DP8342 transmitter are designed to provide maximum flexibility in system designs. The separation of transmitter and receiver function provides an additional advantage in flexibility of data bus organization. The data bus outputs of the receiver are TRI-STATE®, thus enabling the bus configuration to be organized as either a common transmit/receive (bi-directional) bus or as a separate transmit and receive bus for higher speed.

Features

- Even parity detection
- High sensitivity input on receiver easily interfaces to coax line
- Standard TTL data input on receiver provides generalized transmission line interface and also provides hysteresis
- Data holding register
- TRI-STATE receiver data outputs
- Data transmission error detection on receiver provides for both error detection and error type definition

High Speed Serial Data Communications (Continued)

Part No.	Pins	Description	Application
DP8340 N/J/V	24/28	2.3587 Mb/s serial biphase encoder/transmitter	IBM 3270 coax protocol
DP8341 N/J/V	24/28	2.3587 Mb/s serial biphase decoder/receiver	IBM 3270 coax protocol
DP8342 N/J/V	24/28	3.5 Mb/s serial biphase encoder/transmitter	NSC 8-bit general purpose Manchester data communication
DP8343 N/J/V	24/28	3.5 Mb/s serial biphase decoder/receiver	NSC 8-bit general purpose Manchester data communication
DP8344AV	84	0.2–4.0 Mb/s serial biphase encoder/transmitter-decoder/receiver with high-speed RISC processor	IBM 3270 coax protocol IBM 3299 coax protocol IBM 5250 twinax protocol NSC 8-bit general purpose Manchester data communications
DP8344 ASM-M5	N/A	DP8344 Assembler System	Software development for the DP8344
DP8344 MPA-EB	N/A	DP8344 Design/Evaluation Kit	Accelerate design of IBM 3270/3299, 5250 products using DP8344
DP8344CT-104	N/A	DP8344 Demonstration/Development Kit	Hardware/Software development tool
DP8344CT-PK78	N/A	DP8344 Demonstration Kit	3270 Terminal emulation demonstration of DP8344 and PE-857623

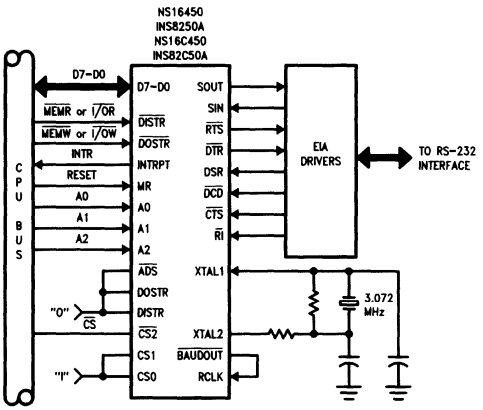
Table 2. High Speed Serial Data Communications Devices

Serial Communication—UARTs

National's family of UARTs provides high performance, low power serial data input/output interface. These UARTs are built using NMOS, CMOS and XMOS technologies. They provide buffered, full duplex receiver and transmitter functions along with a programmable baud rate generator and modem control functions. In systems interfacing to IBM PCs, the 8250, 16450 and 1655X are fully IBM compatible.

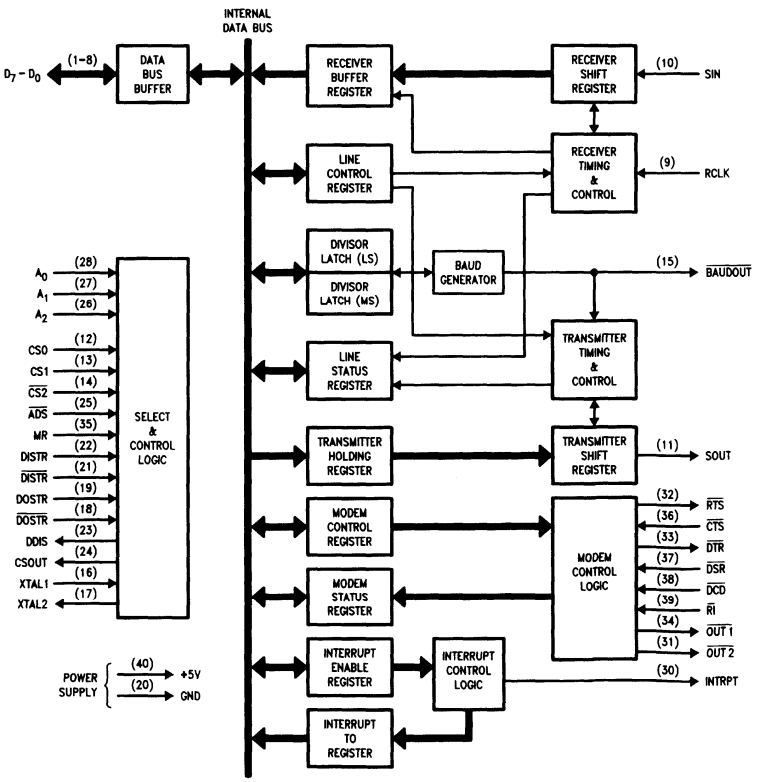
Part #	Baud Rate	Package	Process	Transmission	System Compatibility	Multiplexed Demultiplexed
NS8250N	DC to 56k	N	NMOS	Asynchronous	PCXT	Demultiplexed
NS8250N-B	DC to 56k	N, V	NMOS	Asynchronous	PCXT	Demultiplexed
NS8250A	DC to 56k	N, V	XMOS	Asynchronous	AT, Modems	Demultiplexed
NS82C50A	DC to 56k	N, V	CMOS	Asynchronous	Portable PC-AT	Demultiplexed
NS16450N	DC to 56k	N, V	XMOS	Asynchronous	PC-AT	Demultiplexed
NS16C450	DC to 56k	N, V	CMOS	Asynchronous	Portable PC-AT	Demultiplexed
NS16550AF	DC to 256k	N, V	XMOS	Asynchronous	PS/2, RT	Demultiplexed
NSC858V	DC to 1M	N, D	CMOS	Asynchronous	General Purpose	Multiplexed
NS16C552	DC to 21.5m	V	CMOS	Asynchronous	DUART, PS/2	Demultiplexed

Basic Configuration



TL/MS/10412-1

Block Diagram



TL/MS/10412-2

Graphics

Advanced Graphics Chip Set Offers:

Highest Graphics Performance in the Industry
- Resolutions to 16k x 16k
- Unlimited planes of color
- Color performance as fast as B/W

Partitioned Graphics Functions
- Provides highest performance
- Allows unlimited user flexibility
- Provides migration path to future requirements

Open Architecture
- Easy/cost effective system design
- Performance flexibility
- Allows use of the host CPU to help
- Allows growth in the family

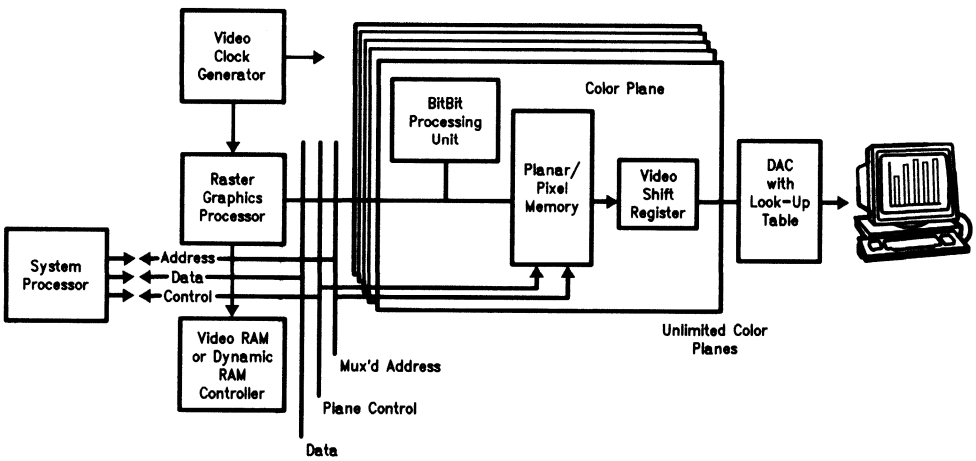
System Software Compatibility/Flexibility
- Programmable graphics processor
- Performance/operation "as you want it"

System Memory Compatibility
- Efficiently employs SRAM, DRAM, or VRAM

Device Number	Description	Packaging Information
DP8500	Raster Graphics Processor (RGP)	V68
†DP8510/11	BitBlt Processing Unit (BPU)	V44A
DP8512	Video Clock Generator (VCG) —up to 225 MHz	V44A
DP8513	Video Clock Generator	V44A
DP8514	Crystal Clock Generator	N16A
†DP8515, DP8515-350	Video Shift Register—10k ECL Outputs (VSR)	V44A
†DP8516 DP8516-350	Video Shift Register—100k ECL Outputs	V44A
DP8520	Video RAM Controller—256k Bits	V68
DP8521	Video RAM Controller—1M Bits	V68
DP8522	Video RAM Controller—4M Bits	V84
DP8530	Video Clock Generator—125 MHz	V28
DP85176/DA0630	35,50 MHz Triple 6-Bit VideoDAC with L.U.T.	28-pin DIP

†Available as military screened part.

Graphics Subsystem



TL/MS/10256-1

DP8500 Raster Graphics Processor

General Description

National's DP8500 Raster Graphics Processor (RGP) is a microprocessor specifically tuned for graphics applications. A member of the Advanced Graphics Chip Set, it provides the set of functions required for display buffer update and video refresh in mid-to-high-performance color or monochrome raster graphics systems employing both graphics primitives and text. The RGP combines the following elements: a general-purpose microcoded microprocessor, a programmable video refresh generator, a vector generator, a BitBlt controller and a rectangular clipper. As such, it may be used in standalone applications or as a dedicated graphics engine in conjunction with any general-purpose microprocessor.

The RGP supports a system architecture that features constant drawing speed, measured in pixels/second, independent of the depth (number of bits) of the pixel. The key feature arises from the RGP's use of an external data path device, the BitBlt Processing Unit (BPU), for all drawing functions. By employing a BPU on each plane of memory, the traditional "bottleneck" is removed from the data manipulation path. In effect, the data bus width (for drawing purposes) is made proportional to the pixel depth, thus preserving the drawing speed as pixel depth is increased from one bit to any number of bits.

During video refresh, the RGP produces all synchronization and blanking signals for CRT displays and generates memory cycles, appropriate for the type of memory used, on behalf of the video shift registers. Any type of memory may be used: SRAM, DRAM, or video RAM. In addition, the RGP supports the use of fast access modes in dynamic RAMS, such as page mode or static column mode.

Features

- 20 MHz operation
- Large uniform address space
  - 28-bit (pixel) address
  - 24-bit word address
  - 16-bit data bus
  - Program, data, and display memories can reside anywhere
- Flexible bus interface
  - Processor independent
  - Conventional HOLD/HLDA mechanism
- Large drawing space
  - Up to 16384 by 16384 pixels per bitmap
  - Pixels for any depth
- Dedicated graphics hardware
  - Vector generator
  - Line pattern generator
  - BitBlt controller
  - Rectangular clipper
- Efficient text support
  - Character size to 256 by 256 pixels
  - Multiple fonts/sizes
  - Proportional spacing
- Programmable video refresh
  - Can be disabled for laser printer applications
  - Pixel rates to 250 MHz and beyond
  - Display formats to 65536 pixels by 4095 scan lines
  - Interlaced or non-interlaced
  - Genlock support
- microCMOS technology
- 68-Lead PLCC package

DP8510 BitBlt Processing Unit

General Description

The DP8510 BitBlt Processing Unit (BPU) is a high-performance microCMOS device designed for use in raster graphics applications. It implements, in high-speed pipelined logic, the data operations which are fundamental to BitBlt (BIT boundary Block Transfer) graphics: shifting, masking, and bitwise logic operations. Under control of external hardware such as a state machine or a general-purpose microprocessor, it provides all necessary data path flow in the BPU. A single handshake scheme is used to interface the CPU, the BPU and the memory system.

The BPU provides both pixel level processing commonly used in image processing applications and extremely fast planar operations used most frequently in color graphics.

Features

- Supports all 16 classical BitBlt functions
- Flexible architecture allows BPU to be used with a state machine or processor
- Compatible with static or dynamic RAM, including Video RAMs
- Compatible with page mode, nibble mode and static column RAMs
- 20 MHz operation

DP8511 BitBlt Processing Unit (BPU)

General Description

The DP8511 BitBlt Processing Unit (BPU), a member of National Semiconductor's Advanced Graphics Chip Set (AGCS), is a high performance micro-CMOS device intended for use in raster graphics applications. Specifically designed to complement the DP8500 Raster Graphics Processor (RGP), the BPU performs data operations that are elementary to BitBlt (BIT boundary Block Transfer) graphic: shift, mask, and bitwise logical manipulation of memory. Under the control of the RGP, the BPU performs the necessary BitBlt data path operations at pipelined hardware speeds. A simple set of control lines interfaces the BPU to the RGP, CPU and to the system memory.

Features

- Interfaces directly to the DP8500 Raster Graphics Processor
- 20 MHz operation
- Supports all 16 classical BitBlt functions
- Compatible with static, dynamic RAMs, and Video RAMs
- Compatible with page mode, nibble mode and static column RAMs

DP8512 Video Clock Generator

General Description

The DP8512 is a clock generator intended for use in medium- to high-performance CRT graphics systems. The device simplifies timing and minimizes phase skew between the various signals involved in the transfer of DRAM (or VRAM) data into a DAC for display on a CRT. The device generates several synchronous clocks from a single crystal resonator input using digital phase locked loop (PLL) techniques. These clock signals include a graphics processor clock, a raster-scan pixel clock, and various gated TTL and ECL clocks required to transfer data from VRAM to video shift registers. Circuitry is also provided which enables the user to phase lock his graphics system to an external video source. The DP8512 is optimized for single-board graphics systems.

The DP8513 is a similar device intended for multiboard synchronous clock generation.

Features

- On-chip crystal oscillator and phase-locked-loop generate synchronized system clock, PCLK, and LCLK
- MOS-compatible single-phase or non-overlapping two-phase system clock output
- 225 MHz ECL differential output pixel clock (PCLK)
- Gated and non-gated load clock (LCLK) outputs ease VRAM-to-VSR synchronization
- Enables horizontal synchronization to an external source

DP8513 Multi-Board Video Clock Generator

General Description

The DP8513 is a clock generator indended for use in medium- to high-performance CRT graphics systems. The device simplifies timing and minimizes phase skew between the various signals involved in the transfer of DRAM (or VRAM) data into a DAC for display on a CRT. The DP8513 is used in conjunction with the DP8514 Crystal Clock Generator to simplify synchronization problems in multiboard systems. The device generates several synchronous clocks from a reference input using digital phase locked loop (PLL) techniques. These synchronous clocks include a graphics processor clock, a raster-scan pixel clock, and various gated TTL and ECL clocks required to transfer data from VRAM to video shift registers. Circuitry is also provided which enables the user to phase lock his graphics system to an external video source.

In a multiboard system the REFIN and REFCLK inputs enable the motherboard and the slave boards to be synchronously driven from a single master clock source such as the DP8514.

Features

- Phase-locked-loop generates synchronized system clock, PCLK, and LCLK
- MOS-compatible single-phase or non-overlapped two-phase system clock output
- 225 MHz ECL differential output pixel clock (PCLK)
- Gated and non-gated load clock (LCLK) outputs ease VRAM-to-VSR synchronization
- Enables horizontal synchronization from an external source

DP8514 Crystal Clock Generator

General Description

The DP8514 Crystal Clock Generator consists of a crystal or LC tank oscillator and a synchronizer/2-phase nonoverlapping MOS clock driver. It is designed to interface directly with the DP8513 Video Clock Generator in multiboard graphics applications. However, its features and flexible design allow it to be used in numerous other applications as well.

Features

- Pierce oscillator may be used with crystal, ceramic resonator, or LC tank circuit. External varactor allows VCO or VCXO mode.
- TTL-compatible oscillator and oscillator/2 outputs.
- Two-phase nonoverlapping MOS-compatible clock outputs drive 100 pF loads at 20 MHz.

DP8515/DP8515-350/DP8516/DP8516-350 Video Shift Register (VSR)

General Description

The DP8515/DP8515-350/DP8516/DP8516-350 Video Shift Register (VSR) provides the function of a high speed sixteen bit shift register and parallel data input latches/flipflops required in high performance raster scan video systems. Also on the VSR are four words of FIFO which by means of the mode control input pins M0 and M1 may be placed in front of the shift register if the user so desires.

Features

- Accepts inputs data at rates up to 20 MHz (30 MHz for -350)
- Tap at eighth bit allows use as 2 8-bit shift registers
- TTL to ECL conversion performed on chip
- Total chip Icc less than 200 mA

DP8520A/DP8521A/DP8522A microCMOS Programmable 256k/ 1M/4M Video RAM Controller/ Drivers

General Description

The DP8520A/21A/22A provide single chip interfaces between dual port video RAM (and/or conventional DRAM) and any 8-, 16-, and 32-bit microprocessor as well as any specialized graphics processor chip or system. The DP8520A/21A/22A perform all control and timing functions required by both video RAM (VRAM) and conventional DRAM.

DP8530 Video Clock Generator

General Description

The DP8530 is a clock generator intended for use in medium-performance CRT graphics systems. The device generates both ECL and TTL pixel and load clocks from a single crystal resonator using digital phase locked loop (PLL) techniques. The L counter inputs allow the pixel clock to be divided by 4 to 32 in increments of 4 to drive the LCLK. The S counter inputs allow the system clock (XOUT) to run up to four times the LCLK. Both free-running and gated (by ENIN) LCLK outputs are available.

Features

- On-chip crystal oscillator and phase-locked-loop generate TTL and ECL PCLK and LCLK outputs
- 125 MHz ECL differential output pixel clock (PCLK)
- Gated TTL and ECL load clock (LCLK) outputs

DP85176-50, DP85176-35, DAC0630, DAC0631 Triple 6-Bit Video DAC with Color Palette

General Description

The DP85176-50/DAC0630 and DP85176-35/DAC0631 are monolithic triple 6-bit video digital-to-analog converters with on-chip 256 x 18 bit color palette making possible the display of 256 colors selected from a total of 256k possible colors through the internal 6-bit video DACs. The DAC's are capable of driving 75Ω or 37.5Ω loads to normal video levels at pixel rates of 50 MHz (DP85176-50) and 35 MHz (DP85176-35). The DP85176-50 and DP85176-35 provide bidirectional microprocessor interface with TTL compatible inputs. The DP85176-50 and DP85176-35 are pin- and functionally-compatible with the Inmos IMS G171-50, IMS G171-35, IMS G176-50 and IMS G176-35.

Features

- Pixel rates of 50 MHz (DP85176-50) and 35 MHz (DP85176-35)
- 256 x 18 bit color palette
- 256k possible colors
- Three internal 6-bit DACs
- Directly drives (75Ω) video cable
- RGB analog output
- Composite blank
- Single +5V supply
- Lower power, high performance CMOS/ bipolar processing
- TTL compatible inputs
- Full asynchronous μP interface
- 28-pin package

DP850EB 4 Plane Evaluation System

General Description

The DP850EB is a four-plane evaluation system for the DP8500 Raster Graphics Processor. It offers a simple example of a planar architecture and demonstrates a system where the DP8500, D8511 BitBlt Processing Unit and DP8512 Video Clock Generator are used.

The DP850EB package includes, the board itself, a power supply, comprehensive documentation and an evaluation board software package. Included in the software package are an assembler, debugger, and demo source programs, which can be used for software development, such as for running benchmarks.

Features

- 640 x 480 resolution stand-alone PC board with large breadboard area for development
- Connect to an IBM PC AT/XT or compatible through RS232 serial port
- On-board connectors for power supply, multi-synch monitor and 25-pin RS232 cable
- Board design incorporates 16v8 GALs for reduced power consumption
- Design application documentation is complete with board schematic and programmable logic equations

Mass Storage/Disk Drive Support

The National Semiconductor family of mass storage interface products offers the industry's highest performance and broadest range of products for Winchester hard disks and floppy disks.

The disk data undergoes many transformations from the time the flux reversals on the disk platter are read by the head amplifier to the time the data can actually be used by the host system—whether it's a PC or main frame computer. With the exception of the preamplifier, National offers a complete integrated solution for this data path. Concentrating only on the data path portion of the disk system allows National to offer solutions for integration that are totally independent of the type of interface used. Shown in Figure 1 is a block diagram of a typical disk system. The first device in the data path is the pulse detector.

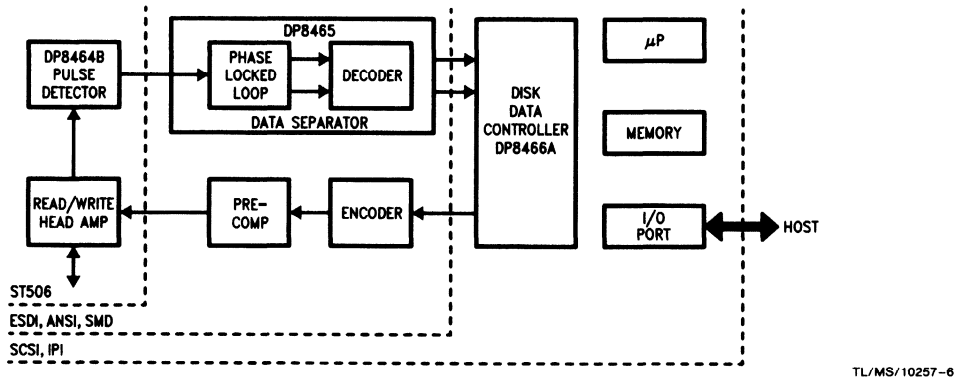


Figure 1. Typical Disk Drive Data Path

DP8464B Disk Pulse Detector

General Description

The DP8464B Disk Pulse Detector utilizes analog and digital circuitry to detect amplitude peaks of the signal received from the read/write amplifier of a disk head. The DP8464B produces a TTL compatible output which, on the positive leading edge, indicates a signal peak. Electrically, these peaks correspond to flux reversals on the magnetic medium. The signal from the read/write amplifier when reading a disk is, therefore, a series of pulses with alternating polarity. The disk pulse detector accurately replicates the time position of these pulse peaks.

The pulse detector is fabricated using an advanced oxide isolated Schottky process, and has been designed to function with data rates up to 15 Mbits/sec. The DP8464B is available in either a 300 mil wide 24-pin dual-in-line package or a surface mount 28-pin plastic chip carrier (PLCC).

Features

- Wide input signal amplitude range—from 20 mVpp to 660 mVpp
- Data rates up to 15 Mbits/sec 2,7 code or 10 Mbits/sec MFM
- On-chip differential gain controlled amplifier, differentiator, comparator gating circuitry, and output pulse generator
- Adjustable comparator hysteresis
- AGC and differentiator time constants set by external components

DP8468B Disk Pulse Detector + Embedded Servo Dector

General Description

The DP8468B is designed to meet the requirements of 3½- and 5¼-inch hard disk drives with storage capacities ranging from the low end to 200 megabytes. It can also be used in intelligent drives that employ run-length-limited (RLL) codes.

The DP8468B uses analog and digital circuitry to detect amplitude peaks of the signal received from the read/write amplifier of the disk drive head. Digital information is stored on disks as a series of pulses and, by replicating the time position of the pulse peaks, the disk pulse detector readies information for data separation devices.

The pulse detector has three main sections: the amplifier, the time channel and the gate channel. The amplifier consists of a wide-bandwidth differential amplifier with automatic gain control (AGC), which eliminates the need for factory gain adjustments. The time channel, comprised of a differentiator, changes state when the input signal changes direction. The gating channel, which is used to avoid problems that can be caused by false signals, features a differential comparator with hysteresis.

To provide maximum flexibility, users have direct control of the AGC level, AGC response times, differentiator response, hysteresis level, dynamic hysteresis and output pulse width.

The DP8468B has two gated detectors that detect embedded servo information used for disk head positioning. They are primarily designed to detect a burst-type servo pattern but, with external synchronization detection circuitry, they can also be used to detect a tri-bit-type servo pattern.

Two buffered low-impedance voltage outputs represent the peak detected level of each servo burst, and another low-impedance output represents the difference in voltage between the two servo channels. The latter voltage measurement is useful in servo systems using a linear voice coil for head positioning.

Features

- Wide input signal amplitude range—from 20 mVpp to 660 mVpp differential
- Data rates up to 15 Mbits/sec 2,7 code
- On-chip differential gain controlled amplifier, differentiator, comparator gating circuitry, and output pulse generator
- Adjustable comparator hysteresis
- Dynamic hysteresis tracks signal amplitude
- AGC and differentiator time constants set by external components
- Built in embedded servo detector
- On chip buffers provide low impedance servo output voltages
- User adjustable servo time constants

DP8465/61 Data Separator

General Description

The DP8465/61 Data Separators are designed for applications in disk drive memory systems, and depending on system requirements, may be located either in the drive or in the controller. They receive digital pulses from a pulse detector circuit (such as the DP8464B) if situated in the drive, or from an ST506 interface if situated in the controller. After locking to the frequency of these input pulses, they separate them into synchronized data and clock signals. While in the non-read mode, both of these circuits employ a phase-frequency comparator to keep the VCO locked to the 2F input (this signal may be derived from a crystal or a servo track). The DP8465 switches to a phase-only comparator when the read mode is entered. The DP8461 continues to use a phase-frequency comparator until the preamble detection circuit has detected two bytes of preamble. This feature thus restricts the DP8461 to use with codes employing the 1010 preamble. MFM and certain run length limited (RLL) codes such as 1,7 and 1,8 employ such a preamble. If RLL code is used or if the user wishes to do his own data separation, the synchronized data output is available to allow external circuitry to perform the data decoding function.

DP8455/51 Data Synchronizer

General Description

The DP8455/51 performs the same data synchronization function of the DP8465/61 with no MFM related circuitry. As with the DP8461, the DP8451 continues in the phase-frequency comparison mode until two bytes of preamble are detected. The DP8455/51, which are packaged in 20-pin DIPs, exclude the READ CLOCK generating circuitry along with the MFM Decoder, Missing Clock Detector, and Read Enable Delay. Users who do not need the functions and are only interested in using the SYNCHRONIZED DATA OUTPUT and VCO CLOCK OUTPUT can use the DP8455/51 as alternatives to the DP8465/61.

DP8462 2,7 Data Synchronizer

General Description

The DP8462 is similar to the DP8455/51 in that it is an all code synchronizer. It also has 2,7 code specific features and other enhancements which improve noise immunity and provide a higher maximum operating frequency. This is accomplished by having separate analog and digital V_{CC} and ground pins. A delay line trim option allows for an adjustable window margin to improve performance. Unlike the DP8465 and DP8461, the user can choose either mode for phase-frequency lock to synchronization fields which prevent false lock and harmonic lock.

Features

- Phase-frequency comparison in non-read mode (DP8465/55)
- Phase-frequency comparison in preamble (DP8461/51)
- 4-byte preamble-lock indication capability
- User-determined PLL loop filter network
- Standard narrow 24-pin DIP, 28-pin PLCC (DP8465/61/62) or 20-pin DIP, 20-pin PLCC (DP8455/51)

DP8459 All-Code Data Synchronizer

General Description

The DP8459 Data Synchronizer, an integrated phase locked loop (PLL) circuit that allows designers to reduce bit error rate through improved window accuracy. The device features precise synchronization window generation and a digital window strobe control with five-bit resolution. It is the only single-chip solution capable of addressing the full range of disk applications, including magnetic hard disk, flexible (floppy) disk, optical disk and tape-drive memory systems.

The DP8459 has an optional user-controlled synchronization field frequency-acquisition feature that guarantees lock; it accommodates the preamble types used with the Group Code Recording (GCR), Modified Frequency Modulation (MFM), the 1,7 run-length-limited (RLL) codes, and either of the standard 2,7 RLL codes.

The device employs a software-controlled window strobe feature, the highest-resolution windowing technique available today. This MICROWIRE™ bus-compatible strobe function replaces traditional hard-wiring, offering five-bit resolution that allows for margin testing, error-recovery routines and precise window calibration. The window can be easily shifted up to 15 steps early or late from its nominal position in the clock cycle, providing users with unmatched flexibility. Each step represents 1.8 percent of the voltage controlled oscillator (VCO) period. The industry-leading data rate range extends from 250 kilobits per second to 25 megabits per second with 2,7 code.

The DP8459 achieves precise synchronization window generation via an internal, self-aligning delay line which remains accurate regardless of temperature, power supply, external components and IC process variations.

An external PLL filter has two ports available to allow for significant design flexibility. Additional features include a free-run control which enables the DP8459 to coast over media flaws in optical-disk applications, while maintaining operating frequency. All digital input and output signals are TTL-compatible, and operation is from a single +5V power supply. Zero phase start is used during both data and reference clock-lock sequences for rapid acquisition of data.

Features

- Fully integrated dual-gain PLL
- Zero phase start lock sequence
- 250 kbit/sec—25 Mbit/sec data rate range
- Frequency lock capability (optional) for all standard recording codes
- Digital window strobe control, 5-bit resolution
- Two-port PLL filter network
- PLL free-run (Coast) control for optical disk defects
- Synchronization pattern (preamble lock) detection
- Non-glitching multiplexed read/write clock output
- +5V supply
- DP8459 supplied in 28-pin plastic leaded chip carrier (PLCC) package

DP8463B 2,7 Endec

General Description

To complete the 2,7 data separating function National offers the DP8463B 2,7 Endec. The 2,7 Endec performs the encoding and decoding for run length limited (RLL) codes for disk memory systems. When compared to MFM code, 2,7 gives a disk system the ability to record up to 50% more message data in the same media space without any increase in the flux density or flux changes per inch (FCI). The DP8463B also performs other functions of writing or reading format segments that can not be done by a disk data controller. These additional functions include the writing and reading of various address marks and preambles (PLL synchronization fields) that are compatible with RLL code. The user may also select different lengths of preamble to count before the DP8463B issues a lock detect signal.

The DP8463B is compatible with the Storage Module Drive (SMD) and Enhanced Small Device Interface (ESDI) functional specifications and has a format mode similar to the one used in ST506 devices.

Features

- Encodes and decodes using IBM 2,7 Message/Code Table
- Programmable formats
  Hard sector, soft sector with address mark preceding preamble, soft sector with address mark following preamble
- Programmable address marks
- Glitchless multiplexer is used to switch between read/reference clock sources
- Programmable preamble length counted before lock detected signal is issued
- Message data rate to 20 Mbits/sec
- 2-micron dual metal CMOS

DP8469 Synchronizer/2,7 Endec

General Description

The DP8469 data synchronizer/2,7 Endec is intended for use in magnetic disk, optical disk, or tape drives during reading and writing operations. The device utilizes a fully integrated PLL to synchronize 2,7 serial code and convert data between one of several hard and soft sectored versions of 2,7 RLL (Run Length Limited) and serial NRZ code formats. The DP8469 synchronizer/Endec incorporates both the DP8459 synchronizer and the DP8463 2,7 code Endec functions together in a 28-pin PCC package.

In the read mode, the device receives 2,7 RLL coded data from the drive's pulse detector, optionally compensates it for pulse pairing, resynchronizes it, and then decodes the data to NRZ format for output to the controller.

In the write mode, the device receives NRZ data from the disk controller, encodes it in one of nine different 2,7 RLL hard/soft sectored formats, and then sends the data out to the drive with optional 3T precompensation adjustments.

The synchronizer provides a dual gain phase locked loop which offers a high bandwidth mode for preamble lock acquisition and a low bandwidth mode for reading data. Two ports are provided for the PLL filter to enable use of higher order filter designs. The synchronizer has a Zero-Phase-Start feature which helps to minimize acquisition time in both read and write modes. A PHASE COMPARATOR TEST function is also provided for observation of PLL loop dynamics and determination of average media bit shift. The 2,7 OUTPUT pin provides the logical OR of the phase comparator's pump up and down outputs when programmed for test mode 4 operation.

A precise synchronization window is provided on chip using a self-aligned silicon delay line which remains accurate independent of temperature, power supply, external components and IC process variations. A strobe early/late function is provided which allows the synchronization window to be digitally adjusted to allow for error recovery or margin testing. The window can be shifted up to 20% in steps of 1.25% by 5 bits in a control register.

The synchronizer's data rate range is 1.5 Mbit/sec to 24 Mbit/sec. This range is divided into four operating regions each providing a 2 to 1 span in VCO frequency. Selection of one of the four data rate regions is controlled by two bits in a control register.

Features

- NRZ to 2,7 RZ RLL encoding/decoding
- 3T & 4T preamble generation/detection
- User specified preamble length
- 1.5 Mbits/sec to 24 Mbits/sec data rates
- ESDI, SMD, and ST506 soft sectoring
- Hard sectoring
- Fully integrated dual-gain PLL
- Zero-Phase-Start lock sequence
- Digitally controlled window strobe
- Digital write precompensation
- Digital pulse pairing compensation
- TTL compatible inputs & outputs
- +5V supply
- Packaging availability:
  28-pin Plastic Leaded Chip Carrier (PLCC)

DP5380 Asynchronous SCSI Interface (ASI)

General Description

The DP5380 ASI is a CMOS device designed to provide a low cost, high performance Small Computer Systems Interface. It complies with the ANS X3.131-1986 SCSI standard as defined by the ANSI X3T9.2 committee. It can act as both INITIATOR and TARGET, making it suitable for any application. The ASI supports selection, reselection, arbitration and all other bus phases. High-current open-drain drivers on chip reduce application chip count by interfacing direct to the SCSI bus. An on-chip oscillator provides all timing delays.

The ASI is intended to be used in a microprocessor based application, and achieves maximum performance with a DMA controller. The device is controlled by reading and writing several internal registers. A standard non-multiplexed address and data bus easily fits any μP environment. Data transfers can be performed by programmed-I/O, pseudo-DMA or via a DMA controller. The ASI easily interfaces to a DMA controller using normal or Block Mode. The ASI can be used in either a polled or interrupt-driven environment.

The DP5380 is pin and program compatible with the NMOS NCR5380 device. NCR5380 or AM5380 applications can use it with no changes to hardware or software. The DP5380 is available in a 40-pin DIP or a 44-pin PCC.

Features

SCSI Interface

- Supports TARGET and INITIATOR roles
- Parity generation with optional checking
- Arbitration support
- Direct control/monitoring of all SCSI signals
- High current outputs drive SCSI bus directly
- Faster and improved timing
- Very low SCSI bus loading

μP Interface

- Memory or I/O-mapped control transfers
- Programmed-I/O or DMA data transfers
- Normal or Block-mode DMA
- Fast DMA handshake timing

DP8490 Enhanced Asynchronous SCSI Interface (EASI)

General Description

The DP8490 EASI is a CMOS device designed to provide a low cost, high performance Small Computer Systems Interface. It complies with the ANS X3.131-1986 SCSI standard as defined by the ANSI X3T9.2 committee. It can act as both INITIATOR and TARGET, making it suitable for any application. The EASI supports selection, reselection, arbitration and all other bus phases. High-current open-drain drivers on chip reduce application chip count by interfacing direct to the SCSI bus. An on-chip oscillator provides all timing delays.

The DP8490 is pin and program compatible with the NMOS NCR5380 and CMOS DP5380 devices. NCR5380, DP5380 or AM5380 applications should be able to use with no changes to hardware or software. The DP8490 includes new features which make this part more attractive for new designs and performance upgrades. These new features include μP data bus parity, programmable parity for both SCSI and μP busses, loopback test mode, improved arbitration support, faster timing and extended interrupt control logic. The DP8490 is available in a 40-pin DIP or a 44-pin PLCC.

The EASI is intended to be used in a microprocessor based application, and achieves maximum performance with a DMA controller. The device is controlled by reading and writing several internal registers. A standard non-multiplexed address and data bus easily fits any μP environment.

Data transfers can be performed by programmed-I/O, psuedo-DMA or via a DMA controller. The EASI easily interfaces to a DMA controller using normal or Block Mode. The EASI can be used in either a polled or interrupt-driven environment. The EASI includes enhanced features for interrupt control.

Features

SCSI Interface

- Supports TARGET and INITIATOR roles
- Parity generation with optional checking
- Programmable parity polarity (ODD/EVEN)
- Arbitration support—can interrupt when done
- Direct control/monitoring of all SCSI signals
- High current outputs drive SCSI bus directly
- Faster and improved timing
- Very low SCSI bus loading

μP Interface

- Memory or I/O-mapped control transfers
- Programmed-I/O or DMA data transfers
- Normal or Block-mode DMA
- Fast DMA handshake timing
- Individually maskable interrupts
- Active interrupts identified in one register
- Optional data bus parity generation/checking
- Programmable parity polarity (ODD/EVEN)
- Loopback test mode

DP8466A Disk Data Controller

General Description

The DP8466A Disk Data Controller (DDC) is an intelligent peripheral which interfaces Winchester or floppy disk drives to microprocessor based systems. It transfers data between a buffer memory or host system and the serial bit data stream with disk rates up to 25 Mbits/sec. High speed system data transfer is possible with full on-chip DMA control of buffer or main memory. The 16-bit system I/O interface allows use with any popular 8-bit, 16-bit, or 32-bit microprocessor. Programmable track format enables reconfiguration of the DDC for different drive types in a multiple drive environment. Using other National DP8460 series disk data path chips, the DP8466A conforms to ST506, SMD and ESDI standard drive interfaces, as well as to intelligent standard interfaces such as SCSI (SASI) and IPI. The DDC is available in three performance versions: DP8466AN-12, DP8466AN-20, and DP8466AN-25.

Features

- Easily conforms to any standard drive interface
- Compatible with floppy, hard and optical disk drives
- Compatible with 8, 16, 32-bit microprocessor systems
- Programmable disk format
- Sector lengths up to 64 kbytes, with up to 255 sectors per track
- Programmable 32 or 48-bit ECC polynominal
- Internal ECC correction in less than a sector time
- Disk data rate to 25 Mbits/sec
- Multiple sector transfer capability
- 32-byte internal FIFO data buffer with interleavable burst capability
- 8 or 16-bit wide data transfers
- Single 32-bit or dual 16-bit DMA channel addresses
- Up to 10 Mbytes/sec DMA transfer rate

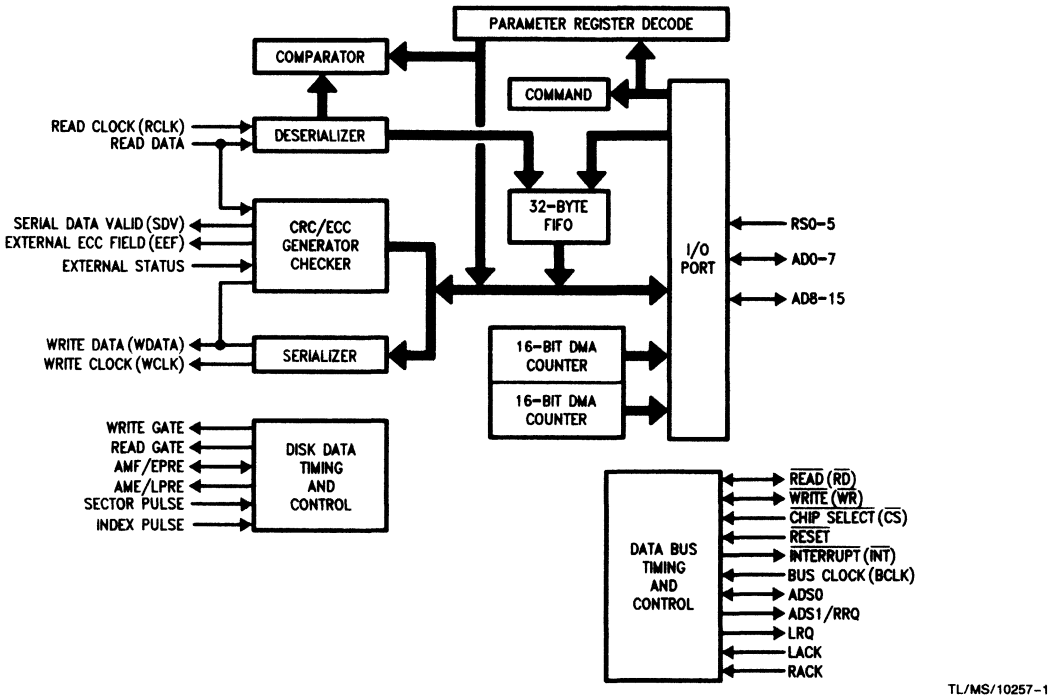


Figure 2. Disk Data Controller (DDC)

Floppy Disk Controllers: The Data Separator

The DP8473 incorporates a precision analog data separator for recovery of floppy disk data. The performance of the data separator is key to being able to correctly recover data from the disk. If the data cannot be read correctly the information is lost.

The serial data when written to the disk is distorted when read causing bit-shift. The data separator must be able to ignore this shift and determine the nominal pulse position to correctly recover the data.

The measure of the amount of shift tolerable by the data separator is called Window Margin. This is the maximum percentage of shift in the data that the data separator can tolerate. Figure 1 shows the performance of the DP8473 when all bits are shifted. This curve shows that the DP8473 can read data with typical 70% bit shift with drive motor speed variations of $> \pm 6\%$.

The DP8473 uses an analog PLL with a self calibrated VCO, and delay line (for bit centering), Figure 2, to yield excellent data recovery performance, typically much better than digital approaches.

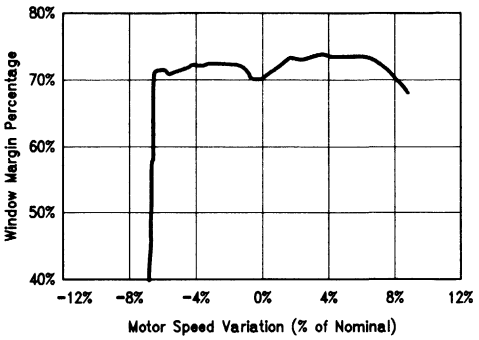


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Figure 1. Typical Window Margin Performance of the DP8473

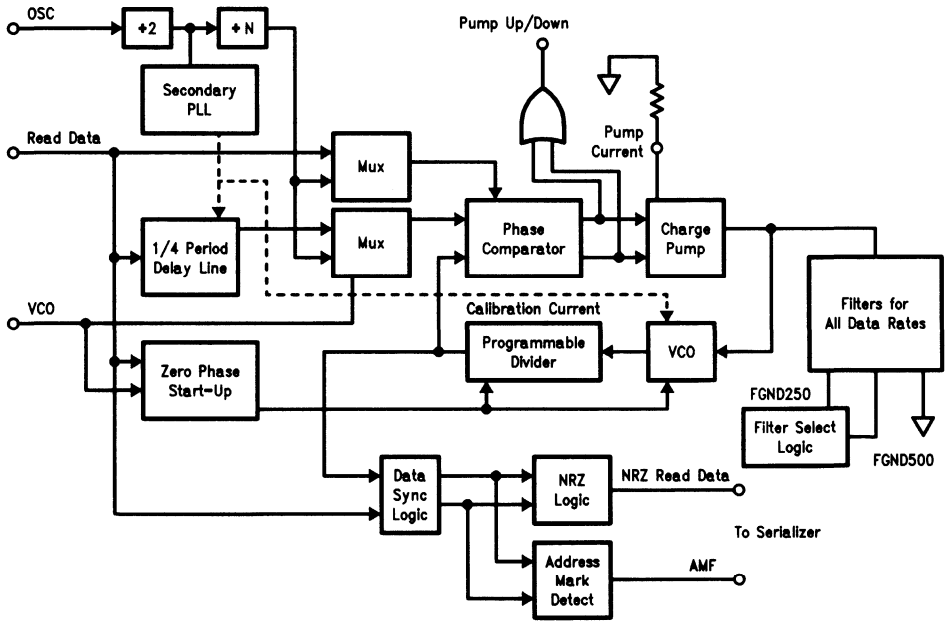

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Figure 2. Block Diagram of the DP8473's Precision Data Separator

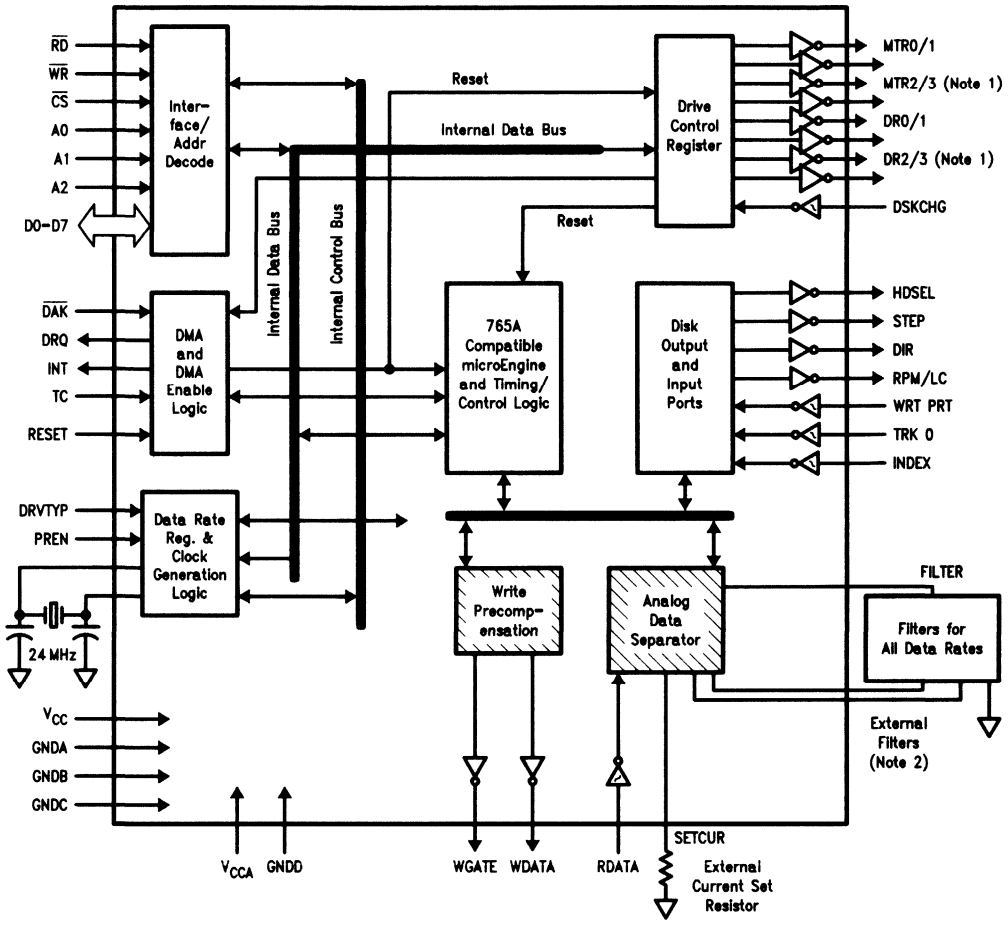

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Figure 3. Simplified Block Diagram for the DP8473 Floppy Disk Controller

DP8473 Floppy Disk Controller PLUS-2

General Description

The DP8473 is a fully integrated Floppy Disk Controller intended for use in IBM® Personal Computers, including the XT, AT and PS/2™'s. This controller is software compatible with the μPD765A, yet includes many enhancements that simplify design of PC compatible controllers to essentially a single chip.

This controller provides a high performance analog data separator, incorporating a self calibrating PLL, and delay line. Also provided is a programmable write precompensation circuit.

Specifically for the PC, the DP8473 contains internal data rate selection logic, supporting data rates up to 1 Mbit/sec MFM, PC compatible drive selection, and DMA enable logic. This includes μP and disk drive buffers, for direction connection of the DP8473 to the CPU and drive.

Software enhancements that are included simplify system software and enable use with new high density drives. These are Implied seeks (moving the head without the CPU issuing a separate seek command), and the extended track range for use with drives that have >256 tracks.

Features

- Internal precision analog data separator
- μPD765A software compatible
- Supports standard PC data rates of 250, 300, and 500 kbit/sec MFM
- Incorporates PC AT's "glue" logic
- Implied seeking, extended track

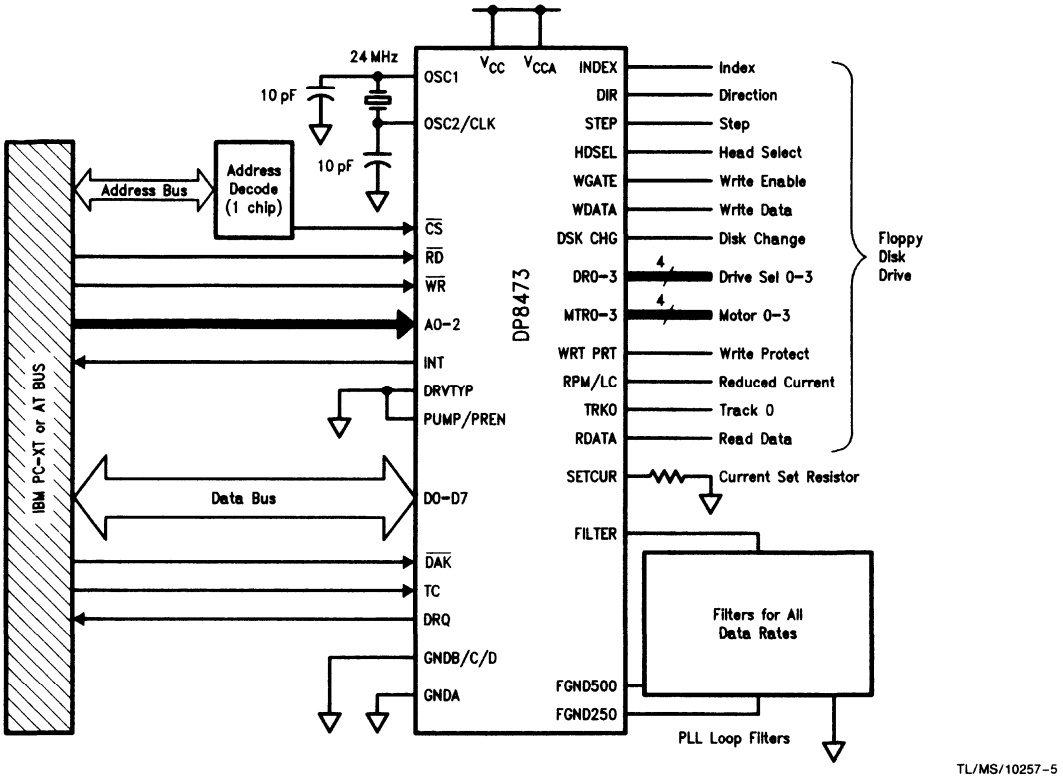

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Figure 4. Typical PC AT Floppy Disk Controller Design Using the DP8473

Winchester Disk Drives

The following products are supported by National's CLASIC division. All inquiries should be directed to CLASIC Marketing department.

Read/Write Products

Product Number	Description
μA117X, μA117XR	Read/Write Preamplifiers
μA501X, μ501XR	6–8 Channel Read/Write Circuits

Servo Products

Product Number	Description
μA24H80	Servo Preamplifier
μA2580	Low Noise Servo Preamplifier
μA2460, μA2461	Servo Controllers
μ2470	Servo Position Demodulator

Tape Drive Products

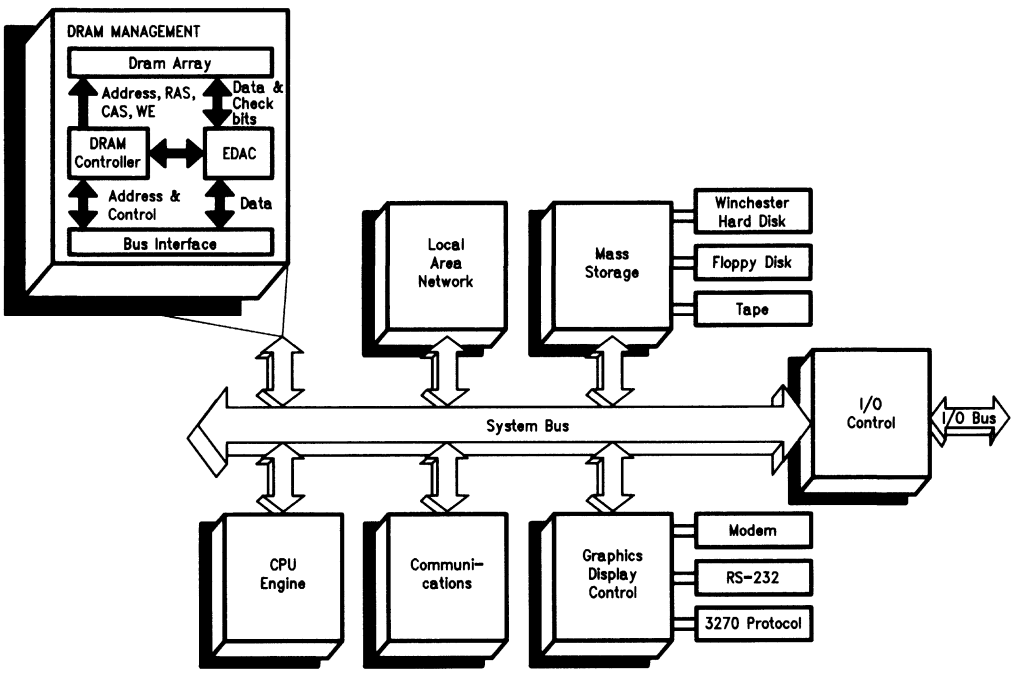
Product Number	Description
μA2440	2-channel Multiplexed Video Amplifier
μA2441	Tape Read Conditioner

DRAM Management

Today's Dynamic Random Access Memory (DRAM) arrays require sophisticated high performance devices to provide timing access arbitration on board drive and control. National Semiconductor offers the broadest range of DRAM controllers with the highest "No-Waitstate" performance available on the market. Controllers are available in Junction Isolated LS, Oxide Isolated ALS, FAST™ and double metal CMOS for DRAMs from 64k bit through 4M bit devices, supporting memory arrays up to 64 Mbyte in size with only one LSI/VLSI device. For critical applications, National Semiconductor has developed several 16- and 32-bit Error Checking and Correction (EC) devices to provide maximum data integrity.

Many of National Semiconductor's commercial ICs listed in this section are also offered as military qualified devices and are indicated by a "†" preceding the part number. Military products are offered in a variety of flows including MIL-STD-883, SMD (Standard Military Drawing), and MIL-M-38510. For more information, consult the 1989 Military/Aerospace Selection Guide.

Please note that National Semiconductor offers many commercial ICs which operate over the military temperature range (−55°C to +125°C). These devices are NOT military qualified products. Military devices are indicated by a "†" preceding the part number.



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DRAM Controllers Supporting 64k to 4M DRAMs and 8-Bit to 32-Bit CPU Interface

64k to 256k-Bit DRAM Controllers

DP8409A Multi Mode DRAM Controller/Driver

General Description

The DP8409A is capable of driving all 64k Dynamic RAMs (DRAMs) as well as 256k DRAMs. The DP8409A minimizes propagation delay skews, the major performance disadvantage of multiple-chip memory drive and control.

The DP8409A's 8 modes of operation offer a wide selection of DRAM control capabilities. Memory access may be controlled externally or on-chip automatically; an on-chip refresh counter makes refreshing (either externally or automatically controlled) less complicated; and automatic memory initialization is both simple and fast.

The DP8409A is a 48-pin DRAM Controller/Driver with 9 multiplexed address outputs and 6 control signals. It consists of two 9-bit address latches, a 9-bit refresh counter, and control logic. All output drivers are capable of driving 500 pF loads with propagation delays of 25 ns.

Operational Features

- All DRAM drive functions on one chip—minimizes skew on outputs, maximizes AC performance
- On-chip capacitive-load drives (specified to drive up to 88 DRAMs)
- Capable of addressing 64k, 256k, or 1M words
- Propagation delays of 25 ns typical at 500 pF load

DRAM Controllers Supporting 64k to 4M DRAMs and 8-Bit to 32-Bit CPU Interface (Continued)

DP8419 Family of 256k DRAM Controllers

General Description

The DP8417/8418/8419/8419X represent a family of 256k DRAM Controller/Drivers which are designed to provide "No-Waitstate" CPU interface to Dynamic RAM arrays of up to 2 Mbytes and larger.

Each device integrates the following critical 256k DRAM controller functions on a single monolithic device: ultra precise delay line; 9-bit refresh counter; fall-through row, column, and bank select input latches; Row/Column address muxing logic; on-board high capacitive-load RAS, CAS, and Write Enable & Address output drivers; and, precise control signal timing for all the above.

There are four device options of the basic DP8419 Controller. The DP8417 is pin and function compatible with the DP8419 except that its outputs are TRI-STATE®. The DP8418 changes one pin and is specifically designed to offer an optimum interface to 32 bit microprocessors. The DP8419X is functionally identical to the DP8419, but is available in a 52-pin DIP package which is upward pin compatible with National's new DP8429D 1 Mbit DRAM Controller/Driver.

Operational Features

- Specifically designed to eliminate CPU wait states up to 10 MHz or beyond
- Eliminates 15 to 20 SSI/MSI components for significant board real estate reduction, system power savings and the elimination of chip-to-chip AC skewing
- On-board ultra precise delay line
- On-board high capacitive RAS, CAS, WE, and address drivers (specified driving 88 DRAMs directly)
- AC specified for directly addressing up to 8 Megabytes
- Low power/high speed bipolar oxide isolated process

29F68A FAST™ DRAM Controller

General Description

The 29F68 is a high-performance memory controller, replacing many SSI and MSI devices by grouping several unique functions. It provides two 9-bit address latches and two 9-bit counters for row and column address generation during refresh. A 2-bit bank select latch for row and column address generation during refresh, and a 2-bit bank select latch for the two high order address bits are provided to select one of the four RAS and CAS outputs.

Operational Features

- Provides control for 16k, 64k, or 256k Dynamic RAM Systems
- Outputs directly drive up to 88 DRAMs
- Highest order two address bits select one of four banks of RAMs
- Chip select for easy expansion
- Provides memory scrubbing refresh function
- Functionally equivalent to AMD's Am2968 and Motorola's MC74F2968

DP8420A microCMOS Programmable DRAM Controller

General Description

The DP8420A dynamic RAM controller provides a low cost, single chip interface between dynamic RAM and all 8-, 16- and 32-bit systems. The DP8420A generates all the required access control signal timing for DRAMs. An on-chip refresh request clock is used to automatically refresh the DRAM array. Refreshes and accesses are arbitrated on chip.

The DP8420A is capable of directly driving up to 4 Mbytes of 256k-bit DRAMs. It can directly interface to all major microprocessors and application notes are available. The DP8420A is currently manufactured in a low cost 68 pin PLCC package.

Operational Features

- Allows zero wait state operation at CPU frequencies above 10 MHz
- On chip high precision delay line to guarantee critical DRAM access timing parameters
- CMOS process for low power
- High capacitance drivers for RAS, CAS, WE and DRAM address on chip
- On chip support for nibble, page and static column DRAMs
- Byte enable signals on chip allow byte writing in a word size up to 32 bits with no external logic
- Selection of controller speeds: 20 MHz and 25 MHz

1 Megabit DRAM Controllers

DP8428/NS32828, DP8429/NS32829

General Description

The DP8428 and DP8429 1M DRAM Controller/Drivers are designed to provide "No-Waitstate" CPU interface to Dynamic RAM arrays of up to 8 Mbytes and larger. The DP8428 and DP8429 are tailored for 32-bit and 16-bit system requirements, respectively. Both devices are fabricated using National's oxide isolated Advanced Low power Schottky (ALS) process and use design techniques which enable them to significantly out-perform other LSI or discrete alternatives in speed, level of integration, and power consumption.

Each device integrates the following critical 1M DRAM controller functions on a single monolithic device: ultra precise delay line; 9 bit refresh counter; fall-through row, column, and bank select input latches; Row/Column address muxing logic; on-board high capacitive-load RAS, CAS, Write Enable and Address output drivers; and, precise control signal timing for all the above.

Operational Features

- Specifically designed to eliminate CPU wait states up to 10 MHz or beyond
- Eliminates 20 discrete components for significant board real estate reduction, system power savings and the elimination of chip-to-chip AC skewing
- On-board ultra precise delay line
- On-board high capacitive RAS, CAS, WE and Address drivers (specified driving 88 DRAMs directly)

74F968 FAST™ DRAM Controller

General Description

The 'F968 is a high performance memory controller, replacing many SSI and MSI devices by grouping several unique functions. It provides two 10-bit address latches and two 10-bit counters for row and column address generation during refresh. A 2-bit bank select latch for row and column address generation during refresh and a 2-bit bank select latch for the two high order address bits are provided to select one of the four RAS and CAS outputs.

Operational Features

- Provides control for 16k, 64k, 256k, or 1 Mbit DRAM Systems
- Outputs directly drive up to 88 DRAMs
- Chip select for easy expansion
- Provides memory refresh with error correction mode
- 52-Pin Plastic Leaded Chip Carrier

DP8421A microCMOS Programmable DRAM Controller

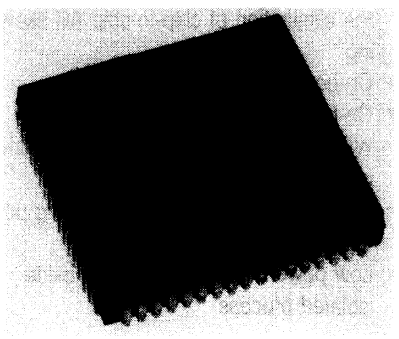
General Description

The DP8421A provides a low cost, single chip interface between dynamic RAM and all 8-, 16-, and 32-bit systems. It has the capability of directly driving up to 16 Mbytes of memory using 1 Mbit DRAMs. The DP8421A generates all the required access control signal timing for the DRAMs.

An on-chip refresh request clock is used to automatically refresh the DRAM array. Refreshes and accesses are arbitrated on chip.

Operational Features

- Allows zero wait state operation at CPU frequencies above 10 MHz
- On chip high precision delay line to guarantee critical DRAM access timing parameters
- microCMOS process for low power
- High capacitance drivers for RAS, CAS, WE and DRAM address on chip
- On chip support for nibble, page and static column DRAMs
- Byte enable signals on chip allow byte writing in a word size up to 32 bits with no external logic
- Selection of controller speeds: 20 MHz and 25 MHz
- 4 RAS and 4 CAS drivers (the RAS and CAS configuration is programmable)



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4 Megabit DRAM Controller

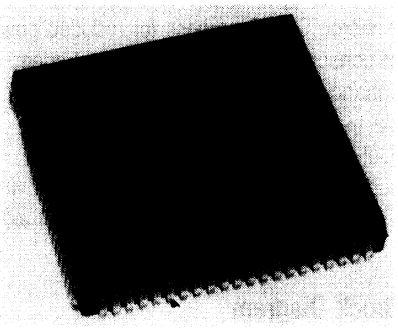
DP8422A microCMOS Programmable DRAM Controller

General Description

The DP8422A has all the same features as the DP8421 and it has the capability of directly driving up to 64 Mbytes of memory using 4 Mbit DRAMs. An additional feature of the DP8422A is the availability of two access ports to simplify dual CPU accessing. Arbitration among these ports and refresh is done on chip.

Operational Features

- Allows zero wait state operation at CPU frequencies above 10 MHz
- On chip high precision delay line to guarantee critical DRAM access timing parameters
- CMOS process for low power
- High capacitance drivers for RAS, CAS, WE and DRAM address on chip
- On chip support for nibble, page and static column DRAMs
- Byte enable signals on chip allow byte writing in a word size up to 32 bits with no external logic
- Selection of controller speeds: 20 MHz and 25 MHz
- On board Port A/Port B (DP8422A only)/refresh arbitration logic
- 4 RAS and 4 CAS drivers (the RAS and CAS configuration is programmable)



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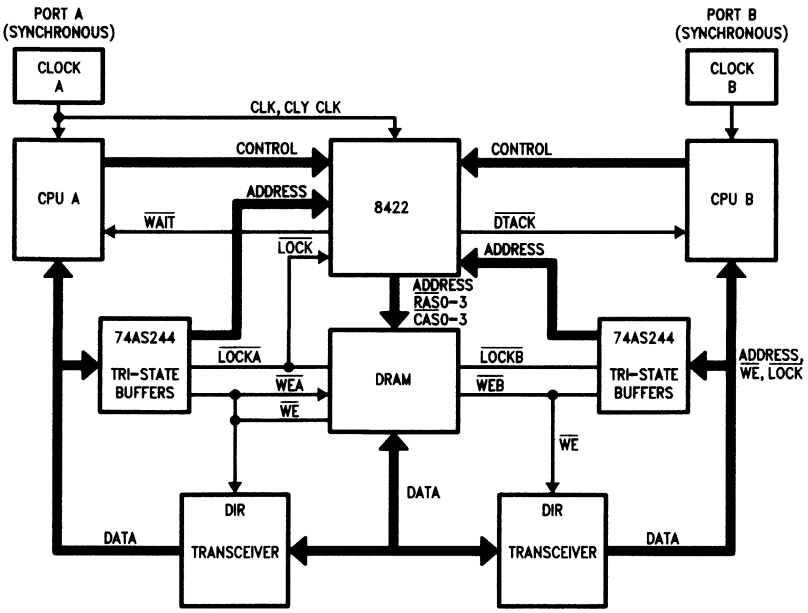
Dual Accessing with the DP8422



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National's microCMOS Programmable Family of Dynamic RAM Controller/Drivers

DP8420A/21A/22A

National's family of advanced CMOS programmable DRAM controllers are the best performing single chip solution on the market for any microprocessor interface with Dynamic RAMs.

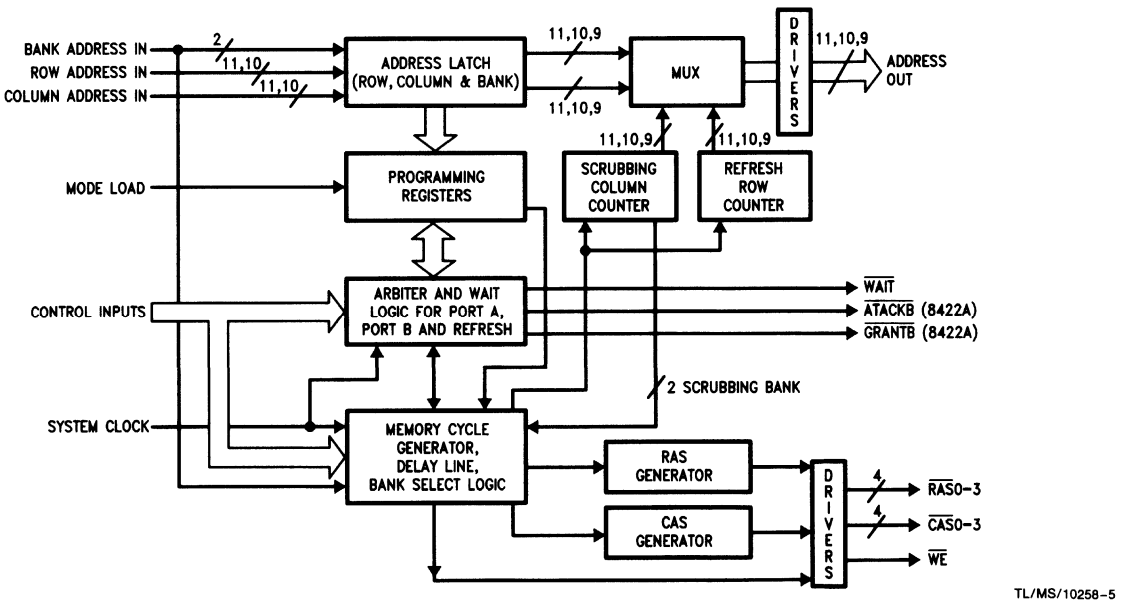
The family is fabricated with National's 2-micron CMOS process for reduced power consumption. However, several speed enhancing features, such as programmable t_{RAH} (Row Address Hold) and t_{ASC} (Column Address Setup) times and the support of memory interleaving (which virtually eliminates RAS precharge time) aid in the improved performance level of this CMOS device. In addition, a built-in, high precision, delay line that uses a high-speed Phase Lock Loop significantly enhances the family's performance by tightening critical timing parameters.

The integration of programmable, on-chip, waitstate logic and the elimination of external support logic also aids in the improved performance level.

The DP8420A/21A/22A can be easily programmed to work with a variety of applications, regardless of DRAM access type. Adjustable control signal pulse widths allows these products to be used with the full spectrum of microprocessor/CPU operating frequencies, as high as 25 MHz. In addition to the family's programmable t_{RAH} and t_{ASC} times, it also allows programmable selection of RAS low time during refresh, the refresh time span, RAS precharge time, and the RAS/CAS configuration. The DP8420A/21A/22A also supports a variety of refresh operations, including staggered and burst refresh, which are automatic and transparent to the system.

This family is very competitively priced with other alternative solutions on the market today.

Block Diagram



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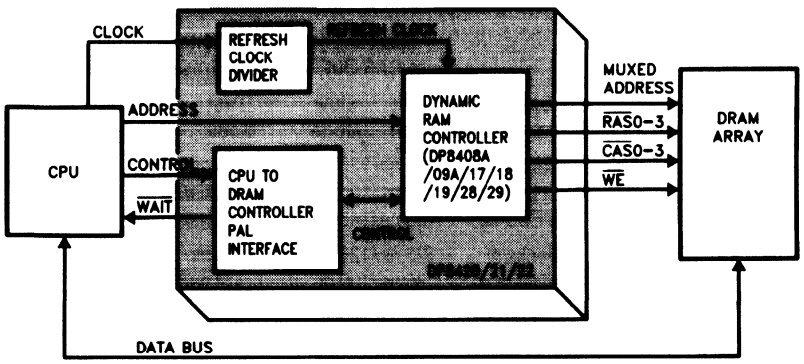
DRAM Controllers Supporting 64k to 4M DRAMs and 8-Bit to 32-Bit CPU Interface (Continued)

Interfacing the DP8420A/21A/22A with Major Microprocessors

We have developed a comprehensive series of application notes to assist you in designing the DP8420A/21A/22A with any of today's major microprocessors. These are now available in our current data book.

Single-Chip Microprocessor/DRAM Interface
Integrated into the DP8420A/21A/22A along with other Advanced Features



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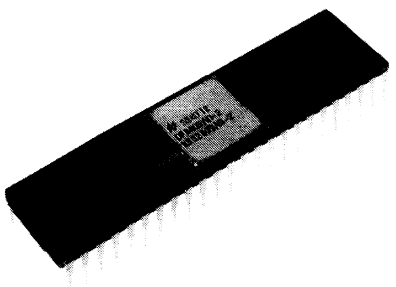
Application Notes:

Note	Microprocessor Interface
•AN-542	NS32009/NS32016/NS32C016 NS32032 and NS32132
•AN-543	NS32332
•AN-541	NS32532
•AN-540	NS32532 Dual Access, EDAC
•AN-538	68000/008/010
•AN-539	68020
•AN-537	68030
•AN-544	8086/186/88/188
•AN-545	80286
•AN-536	80386
•AN-546	Z280/Z80000/Z8000

DRAM Controller Master Selection Guide



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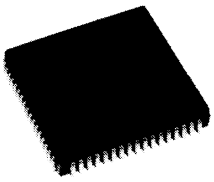

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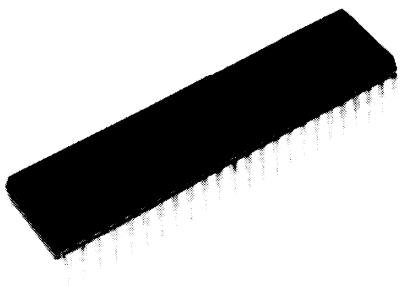

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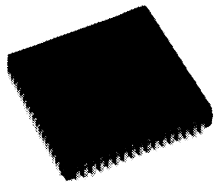

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Device # and Speed Options	DRAMs Supported	Process	Typ I_{CC}	A.C. Specified Word Width	Max RAS to CAS Out *Fast Mode	Max RAS to CAS Out Slow Mode	Guaranteed Row Address Hold *Fast Mode	Guaranteed Row Address Hold Slow Mode	V_{CC}	Operating Temp. Range (°C)	Package
DP8408A	16, 64k	Junction	210 mA	4 Banks of	105 ns	125 ns	20 ns	30 ns	+5V ±5%	0 to +70	48N
A-2		Isolated		16-Bit Data w/	85 ns	100 ns	12 ns	20 ns		0 to +85	48D
A-3		(S)		6-Bit ECC ea.	120 ns	145 ns	20 ns	30 ns			
DP8409A	16, 64, 256k	Junction	210 mA	4 Banks of	105 ns	125 ns	20 ns	30 ns	+5V ±5%	0 to +70	48N
A-2		Isolated		16-Bit Data w/	85 ns	100 ns	12 ns	20 ns		0 to +85	48D
A-3		(S)		6-Bit ECC ea.	120 ns	145 ns	20 ns	30 ns			68V
DP8417-80	16, 64, 256k	Oxide	150 mA	4 Banks of	63 ns	80 ns	15 ns	25 ns	+5V ±10%	0 to +70	48N
-70		Isolated		16-Bit Data w/	50 ns	72 ns	15 ns	25 ns		−40 to +85	48D
		(ALS)		6-Bit ECC ea.						−55 to +125	68V
DP8418-80	16, 64, 256k	Oxide	150 mA	2 Banks of	63 ns	80 ns	15 ns	25 ns	+5V ±10%	0 to +70	48N
-70		Isolated		32-Bit Data w/	50 ns	72 ns	15 ns	25 ns		−40 to +85	48D
		(ALS)		7-Bit ECC ea.						−55 to +125	68V
DP8419-80	16, 64, 256k	Oxide	150 mA	4 Banks of	63 ns	80 ns	15 ns	25 ns	+5V ±10%	0 to +70	48N
-70		Isolated		16-Bit Data w/	50 ns	72 ns	15 ns	25 ns		−40 to +85	48D
		(ALS)		6-Bit ECC ea.						−55 to +125	68V
DP8428-80	16, 64, 256k	Oxide	150 mA	2 Banks of	63 ns	80 ns	15 ns	25 ns	+5V ±10%	0 to +70	52D
-70	& 1 Mega-Bit	Isolated		32-Bit Data w/	50 ns	72 ns	15 ns	25 ns		−40 to +85	68V
		(ALS)		7-Bit ECC ea.						−55 to +125	
DP8429-80	16, 64, 256k	Oxide	150 mA	4 Banks of	63 ns	80 ns	15 ns	25 ns	+5V ±10%	0 to +70	52D
-70	& 1 Mega-Bit	Isolated		16-Bit Data w/	50 ns	72 ns	15 ns	25 ns		−40 to +85	68V
		(ALS)		6-Bit ECC ea.						−55 to +125	
29F68A	16, 64, 256k	FAST	200 mA	4 Banks of	80 ns**		15 ns**		+5V ±10%	0 to +70	48N
				16-Bit Data w/						−55 to +125	52V
				6-Bit ECC ea.							
74F968	16, 64, 256k	FAST	200 mA	4 Banks of	80 ns**		15 ns**		+5V ±10%	0 to +70	52D
	& 1 Mega-Bit			16-Bit Data w/						−55 to +125	52V
				6-Bit ECC ea.							
DP8420, 21	16, 64, 256K	2μ CMOS	5 mA	2 Banks of					+5V ±10%	0 to +70	52D
& DP8422	1 Mega-Bit,			32-Bit Data w/	53 ns	63 ns	15 ns	25 ns		−40 to +85	84V
	& 4 Mega-Bit			7-Bit ECC ea.						−55 to +125	

*All AC values shown factor in worst-case loading (including all outputs switching simultaneously), operating temperature and V_{CC} supply variables. All delays assume the use of National's on-board automatic delay line logic although external delay line control timing is allowed and supported.

**These values depend on external delay lines used to guarantee timing. Values listed are times attainable by device.

Error Detection and Correction (EDAC)

54F/74F420

Parallel Check Bit/Syndrome Bit Generator

General Description

The 'F420 is a parallel check bit/syndrome bit generator. The 'F420 utilizes a modified hamming code to generate 7 check bits from a 32-bit dataword, in 15 ns, when operated in the check bit generate mode. When operated in the syndrome generate mode, the check bits and data bits read from memory are utilized in a parity summer to generate syndrome bits upon error detection. The maximum error count detectable is 2.

16 Bit EDAC DP8400-2

General Description

For a 16-bit word, the DP8400-2 monitors data between the processor and memory with its 16-bit bidirectional data bus connected to the memory data bus. The DP8400-2 uses an encoding matrix to generate 6 check bits from the 16 bits of data. In a WRITE cycle, the data word and the corresponding check bits are written into memory. When the same location of memory is subsequently read, the EDAC generates 6 new check bits from the memory data and compares them with the 6 check bits read from memory to create 6 syndrome bits. If there is a difference (causing some syndrome bits to go high), then that memory location contains an error and the DP8400-2 indicates the type of error with 3 error flags. If the error is a single data-bit error, the DP8400-2 will automatically correct it.

The DP8400-2 expandable error checker/corrector offers a high degree of flexibility in applications which range from 8-bit to 80-bit data words. It is a 16-bit chip that is easily expandable with the simple addition of more DP8400s for each 16-bit word increment.

32 Bit EDAC DP8402A, 74F632

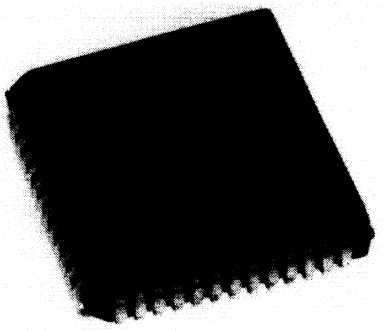
General Description

The DP8402A and 74F632 are 32-bit parallel error detection and correction circuits (EDAC). The EDACs use a modified Hamming code to generate a 7-bit check word from a 32-bit data word. This check word is stored along with the data word during the memory write cycle. During the memory read cycle, the 39-bit words from memory are processed by the EDAC to determine if errors have occurred in memory.

Single-bit errors in the 32-bit data word are flagged and corrected.

Single-bit errors in the 7-bit check word are flagged, and the CPU sends the EDAC through the correction cycle even though the 32-bit data word is not in error. The correction cycle will simply pass along the original 32-bit data word in this case and produce error syndrome bits to pinpoint the error-generating location.

Dual-bit errors are flagged but not corrected. These errors may occur in any two bits of the 39-bit word from memory (two errors in the 32-bit data word, two errors in the 7-bit check word, or one error in each word). The gross-error condition of all LOWs or all HIGHs from memo will be detected. Otherwise, errors in three or more bits of the 39-bit word are beyond the capabilities of these devices to detect.



TL/MS/10258–11

Features

Device	74F420	DP8400-2	DP8402A	74F632
Chip Package	48 Pin DIP 52 Pin PLCC	48 Pin DIP 68 Pin PLCC	48 Pin DIP 52 Pin DIP 68 Pin PLCC	52 Pin LCC 52 Pin PLCC
Data Bus Width Expandable	32 Bits No	16 Bits Yes, Above 64 Bits	32 Bits No	32 Bits No
Byte Write Capability	No	Yes	Yes	Yes
Detects and Corrects Single Bit Errors	Detects—Yes Corrects—No	Yes	Yes	Yes
Functionally Equivalent to TI 74ALS632A	No	No	Yes	Yes
Data in to Check Bits Valid	20 ns	40 ns	48 ns	25 ns
Data in to Error Flag Valid	24 ns	31 ns	40 ns	31 ns
Data in to Corrected Data Valid (Read Mode, with Single Bit Error)	N/A	61 ns	58 ns	28 ns

Real Time Clocks
The RTC Family—MM58167A, MM58174A, MM58274C

National's family of Real Time Clocks (RTCs) provides a simple microprocessor bus compatible interface to any system requiring accurate, reliable, on-going real time and calendar.

CMOS Technology—Low Power

Each device in the family develops real time from an on-chip 32.768 kHz crystal-controlled oscillator. All devices utilize metal-gate CMOS technology, which means extreme low power operation. National's CMOS allows the clock/calendar function to remain, with no time loss, on standby battery back-up when normal AC line power fails or is shut off. In power down mode these RTCs require 5 μA at 2.5V, typically.

Microprocessor Bus Compatible

The industry standard parallel address and data bus structures make National's RTC family compatible with all popular microprocessors, like NSC800™, COPS™, 8080 Series, 6800. Each device offers handshaking controls like Chip Select, Read and Write for simple interface to a microprocessor.

Event Interrupts

Each RTC in the family offers timed interrupts, 0.5, 10, 30 seconds, etc. These interrupts can be active in single or repeat modes to further simplify routine system timed events. The MM58167A extends this interrupt capability with an alarm-type feature, allowing a future and real-time comparison to initiate an interrupt, i.e., a system wake-up interrupt.

The MM58274C

The newest member of National's RTC family is the MM58274C. The MM58274 is pin-compatible to the industry-popular MM58174A. Easy system upgrade from the MM58174A to the MM58274C is possible with only a system software change. The MM58274C brings additional features to the family such as, a years counter, 12 or 24 hour timekeeping, extended interrupt event times, and buffered oscillator output for accurate oscillator timing. Of course, the MM58274C maintains the convenient 16-pin package and MM58174A pinouts, even with these additional features!

Family Comparison Guide

Check the RTC comparison guide for additional features, functions, and benefits of all the family members.

CMOS/LSI

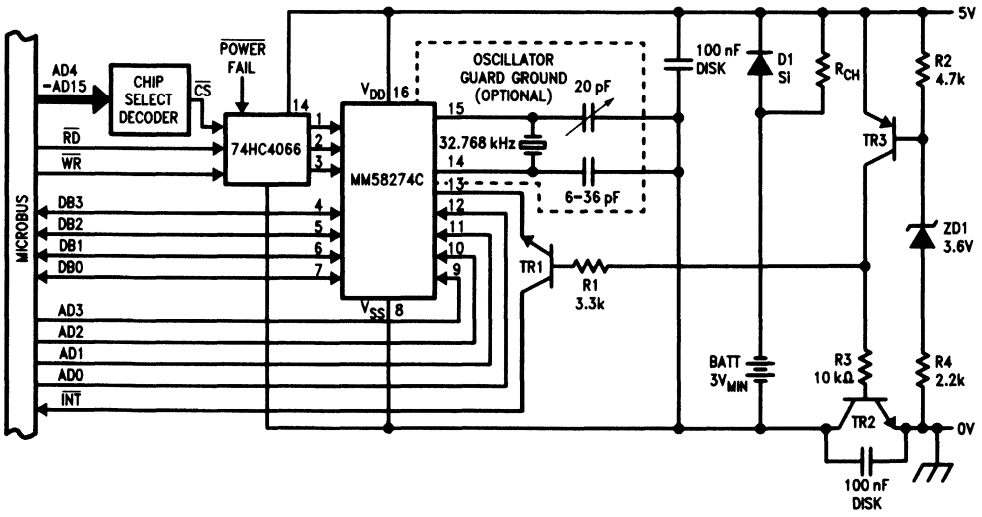
The Real-Time Clock family demonstrates National's capability and commitment to CMOS/LSI—the technology of the 90's.

RTC Family Comparison Guide

Features	MM58167A	MM58174A	MM58274C
Timekeeping			
Mode	24 Hour	24 Hour	12 or 24 Hour
Range	0.01 sec thru Months	0.1 sec thru Months	0.1 sec thru Years
Leap Year	No	Yes	Yes
Rollover	Status Bit	Data = F	Status Bit
Bus			
Mode	Parallel	Parallel	Parallel
Address (# Bits)	5	4	4
Data (# Bits)	8	4	4
Max Access Time (Address to Data Valid)	1050 ns	1850 ns	650 ns
RAM			
On-Chip	56 Bits (14×4)	No	No
Interrupts			
Programmable	0.1 sec thru Months	0.5, 5, 60 sec	0.1, 0.5, 1, 5, 10, 30 and 60 sec
Alarm Compare	Yes	No	No
Standby Mode	Yes	No	No
Status Register	Yes	No	Yes
Timebase			
Oscillator Frequency	32.768 kHz	32.768 kHz	32.768 kHz
Buffered Oscillator Output	No	No	Yes
Power Supply			
Voltage			
Operational	4.5–5.5V	4.5–5.5V	4.5–5.5V
Standby	2.2V min	2.2V min	2.2V min
Current			
Operational	5 mA	1 mA	1 mA
Standby (I_{DD} Max)	20 μA	10 μA	10 μA
Process Technology			
	CMOS	CMOS	CMOS
Packaging			
Pins/Type	24 DIP 28 PLCC	16* DIP	16* DIP 20 PLCC

*Same Pinouts

Typical MM58274C RTC System Diagram



TL/MS/10342-1

The TCP Family—DP8570A, DP8571A, DP8572A, DP8573A

National's family of Timer Clock Peripherals (TCPs) are truly advanced, next generation real time clocks (RTCs) *plus.* The TCP family offers a simple, *fast* microprocessor bus compatible interface, with valid data (150 ns max) after address valid. All offer chip select, read and write handshaking controls to complement this convenient high speed, RAM like, microprocessor bus interface.

Programmable Timers/Interrupts—On-Chip

Two members of the TCP family offer two independent multifunction programmable 10 MHz 16-bit timers. Each timer has its own prescaler and can select any of 8 possible clock inputs. In addition, each of the family members provides a flexible array of interrupts—periodic alarm, timer and powerfail (with time save) interrupts.

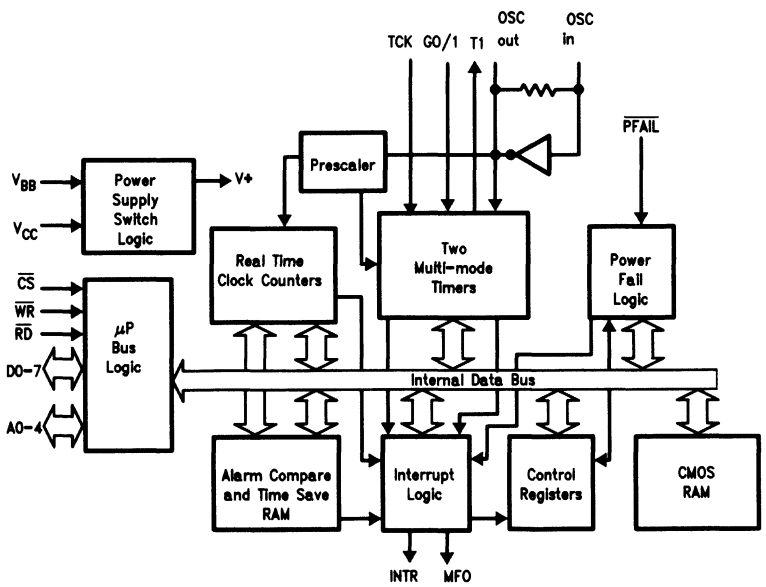
Powerfail Management and RAM—On-Chip

This advanced RTC family minimizes the complex external circuitry required for powerfail management by integrating auto power supply transition to external battery back-up on-chip. Many members provide up to 44 bytes of RAM to retain important system parameters during power down or for use as local memory during normal system operation.

Advanced CMOS Technology—Low Power

The TCP family utilizes National's advanced 2-micron dual metal CMOS process to continue the tradition of extreme low power down requirements established by our RTC family, 5 μA at 2.5V typical. Finally, all are software and hardware compatible for easy system migration from clock only product needs to advanced timer clock requirements. Three members, the DP8571A, DP8572A, and DP8573A, are socket compatible.

DP8570A Block Diagram



TL/MS/10342-2

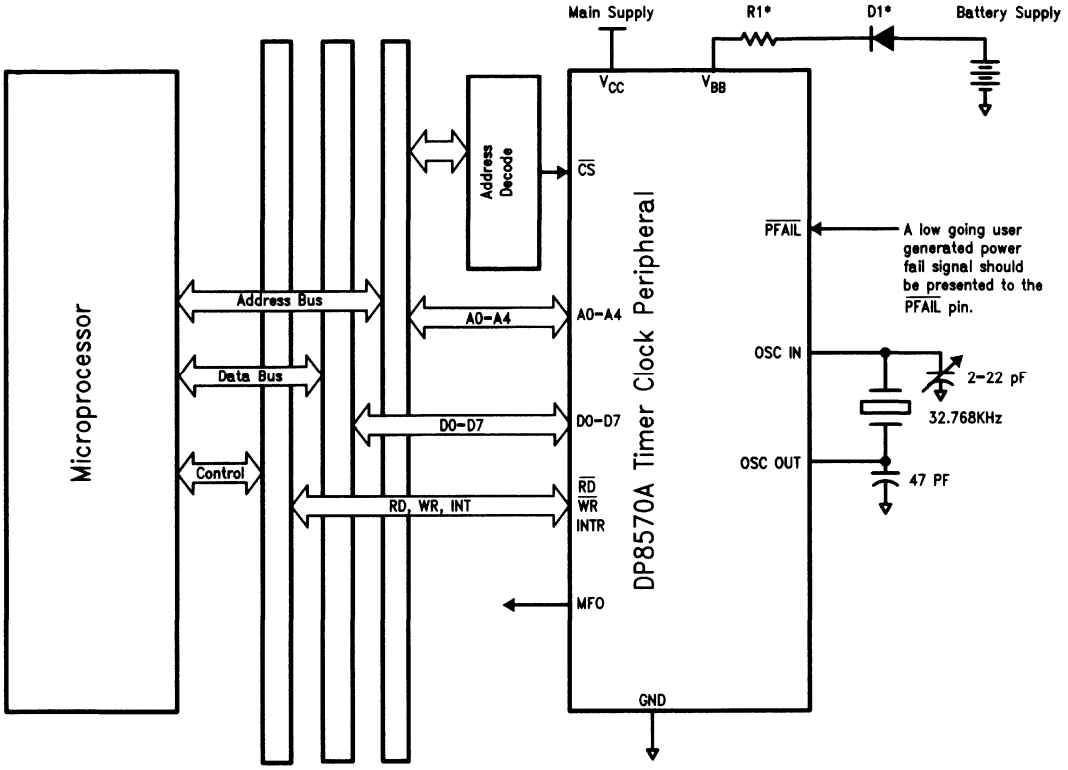
TCP Family Comparison Guide

Features	DP8570A	DP8571A	DP8572A	DP8573A
Timekeeping				
Mode	12 or 24 Hour	12 or 24 Hour	12 or 24 Hour	12 or 24 Hour
Range	0.01 sec thru Years	0.01 sec thru Years	0.01 sec thru Years	0.01 sec thru Years
Leap Year	Yes	Yes	Yes	Yes
Rollover	Status Bit	Status Bit	Status Bit	Status Bit
Bus				
Mode	Parallel	Parallel	Parallel	Parallel
Address (# Bits)	5	5	5	5
Data (# Bits)	8	8	8	8
Max Access Time (Address to Data Valid)	150 ns	150 ns	150 ns	150 ns
RAM				
On-Chip	44 Bytes	44 Bytes	44 Bytes	14 Bytes
Timer	2 16-Bit	2 16-Bit	No	No
Interrupts				
Programmable	0.01 sec thru 1 sec	0.01 sec thru 1 sec	0.01 sec thru 1 sec	0.01 sec thru 1 sec
Alarm Compare	Yes	Yes	Yes	Yes
Standby Mode	Yes	Yes	Yes	Yes
Status Register	Yes	Yes	Yes	Yes
Timer	Yes	Yes	No	No
Timebase				
Oscillator Frequency	4 Selectable (Note 1)	4 Selectable (Note 1)	4 Selectable (Note 1)	32.768 kHz
Buffered Oscillator Output	Yes	Yes	Yes	Yes
Power Supply				
Voltage				
Operational	4.5–5.5V	4.5–5.5V	4.5–5.5V	4.5–5.5V
Standby	2.0V min	2.0V min	2.0V min	2.0V min
Current (32.768 kHz)				
Operational	5 mA	5 mA	5 mA	5 mA
Standby (I_{DD} Max)	10 μA	10 μA	10 μA	10 μA
Process Technology				
	microCMOS	microCMOS	microCMOS	microCMOS
Packaging				
Pins/Type	28 DIP 28 PLCC (Note 2)	24 DIP (Note 2)	24 DIP (Note 2) 28 PLCC (Note 2)	24 DIP (Note 2) 28 PLCC (Note 2)

Note 1: 32 kHz, 32.768 kHz, 4.194304 MHz, 4.9152 MHz

Note 2: Socket equivalent pin outs

Typical Application



TL/MS/10342-3

These components may be necessary to meet UL requirements for lithium batteries. Consult battery manufacturer.

Section 2
Application Specific ICs

Section 2 Contents Application Specific ICs

ASIC

National Semiconductor's ASIC family covers a range of technologies and processes, including standard cells and gate arrays in CMOS and ECL processes available for both Commerical and Military/ Aerospace applications.

National Semiconductor supports a variety of design interfaces with Standard Cell and Gate Array technology. These range from producing integrated circuits from the user's schematic to accepting a database tape for mask generation. A large dedicated staff of integrated circuit design consultants are available at National's technology centers to help determine the most efficient and cost effective way to meet the user's semicustom integrated circuit requirements.

A well rounded package of easy-to-use design automation hardware and software is available to help the user quickly and easily implement and verify designs. These tools include workstation design kits, mainframe software for design integrity checks, logic simulation, timing verification, automatic cell placement and routing, IC layout design verification, and fault grading analysis to gauge testability.

A large selection of macros speeds up and simplifies the design process.

The system is tailored to allow the user to participate in the development of the circuit to the desired level.

ASIC—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

CMOS ASIC

2.0μ CMOS Product Features

- Available for both Commercial and Military/Aerospace applications
- N-well CMOS technology with 2-micron (drawn, 1.6 effective channel length) geometries, silicon gates and dual-metal layered interconnects
- Ultra-high performance; less than 1 ns typical gate delays
- Minimal power dissipation
- All inputs fully protected from over-voltage, latch-up, and static discharge
- A full range of I/O cells for a variety of off-chip interfaces and drive capabilities:
  - Bidirectional inputs/outputs
  - Inputs compatible with TTL, CMOS, or Schmitt trigger levels
  - Outputs compatible with CMOS and TTL and available in conventional, TRI-STATE®, or open drain configurations
- Common design tools for both gate arrays and standard cells
- National's standard cell library encompasses all functions available in National's Gate Array family, ensuring easy migration from gate arrays to more cost-efficient standard cells for high volume production
- Separate power supply traces for output drivers improve noise immunity
- A variety of packaging configurations up to 180 pins
- Alternately sourced

2.0μ CMOS Standard Cells Enchanced Product Features

- Available for both Commercial and Military/Aerospace applications
- High current output drivers available with 4, 8, 12, 24 and 48 mA drive capabilities
- Multiple cell families available
  - Large number of logic functions and I/O configurations
  - RAMs, PLAs, UART, 2901
- Complete software support
  - Schematic capture/netlist extraction for workstations
  - Remote dial-in facilities available
  - Easy-to-use menu-driven design system
  - Netlist translators for selected formats
  - Automated conversion of NSC gate array designs to standard cells
  - Design integrity check program
  - High accuracy timing delay calculator
  - Fully automated cell placement and routing
  - Pre- and post-layout logic/timing simulator
  - Design and layout verification
  - Automatic test conversion software
  - Fully integrated database manager
- In addition to standard SSI/MSI Functions, the standard cell library includes:
  - Single Port RAMs 256-2k bits
  - Dual Port RAMs 64-512 bits
  - Analog Comparator, Op Amp, Voltage Reference, Analog Switch, and resistors
  - 16-bit high performance controller HPC
  - 8-bit microcontroller COP8 core
  - RAM mega-cell 2k x 9
  - EEPROM 256 x 8
  - Microcontroller ROM

*For sizing and packaging, please contact your local design center.

2.0μ CMOS Gate Array Enhanced Product Features

- Available for both Commercial and Military/Aerospace applications
- Available from 600 gates to 8700 gates, with higher densities in design
- Full design automation support
  - — Schematic capture
  - — Logic simulator with timing information
  - — Fault grading
- Multiple power rail pin connections
- Multiple packaging options in both ceramic and plastic; DIPs, PGAs, leaded and leadless chip carriers
- Military performance
- Extensive library of SSI and MSI functions
- 100% auto-place-and-route at ≥ 95% utilization
- Design automation system supported on mainframe and workstations
- TTL and CMOS compatible I/O buffers, including Schmitt triggers
  - — Output drive selectable: 1, 2, or 4 mA
  - — Low power oscillator macros

Selectable Output Drive Capability

The enhanced I/O structure makes it possible to offer a variety of output drives for any given I/O location. Through implementation of I/O macro options, users can select output drives of 1, 2 or 4 mA for each output buffer.

Parallel I/O Buffers for High Drives

Output drive current in excess of 4 mA can be achieved by paralleling I/O buffers while maintaining individual input functions. For example, to achieve 24 mA, six 4 mA I/O buffers need to be paralleled up; one pin is needed to implement the output (which can be bidirectional) while 5 pins can still be used as inputs.

2.0μ Gate Array Product Configurations

Device	Equivalent 2-input NAND Gates*	Input Cells	I/O Cells	Signal Pins	Test Pin	Vdd Pins	Vss Pins
SCX6206	600	8	40	48	1	4	4
SCX6212	1200	17	42	59	1	4	4
SCX6218	1806	3	70	73	1	8	8
SCX6225	2430	11	76	88	1	6	6
SCX6232	3162	3	103	104	1	8	8
SCX6244	4380	3	112	113	1	8	8
SCX6287**	8736	0	155	155	1	8	8

***Note:** Input and I/O cells are not considered part of the internal cell count.

2.0 Micron Gate Array Package Availability Chart

Package Type	Pins	Code	6206	6212	6218	6225	6232	6244	6287
Plastic DIP	8	N11	A						
	14	N4	A						
(N)	16	N6	A						
	18	N7	A						
	20	N0	A						
	22	N8	A	A					
	24S	N9	A						
	24W	N2	A	A	A	A	A	A	
	28	N1	A	A	A	A	A	A	
	40	N3	A	A	A	A	A	A	
	48	N5	A	A	A	A	A	A	
Ceramic DIP	8	D11	A						
(D)	14	D4	A						
Side Braze	16	D6	A						
	18	D7	A						
	20	D0	A						
	22	D8	A	A					
	24S	D9	A						
	24W	D2	A	A	A	A			
	28	D1	A	A	A	A			
	40	D3	A	A	A	A	A	A	
	48	D5	A	A	A	A	A	A	
Small Outline	20	M4	P						
(SO)	24	M5	A	A					
Plastic Leaded	28	V0	A	A	A	A	A	A	
Chip Carrier	44	V2	A	A	A	A	A	A	
(PLCC)	68	V4	A	A	A	A	A	A	A
	84	V5				A	A	A	A
Plastic Quad	80	VF4		A	A	A	A	A	
Flat Pack	100	VF7			A	A	A	A	
EIAJ Std.	120	VF2						P	
Plastic Quad Flat Pack (P-QFP)	132	VF8			*A	*A	A	A	A
Ceramic Leadless	28	E0	A	A	A				
Chip Carrier	44	E2	A	A	A	A	A	A	
(LCC)	68	E4	A	A	A	A	A	A	A
	84	E5			A	A	A	A	
Ceramic Leaded	44	E1	A	A	A	A			
Chip Carrier	68	E19			A	A	A	A	E
(LDCC)	84	E20				E	A	E	E
	100	E22			E	E		E	
	132	E14				E	A	A	E
PPGA (Plastic)	124	NU6				A	A	A	A
Ceramic Pin 10 X 10	68	U0	A	A	A	A	A	A	
Array 11 X 11	68	U1	P	P	P	P	P	P	
PGA 10 X 10	84	U2			A	A	A	A	
11 X 11	84	U3			P	P	P	P	
13 X 13	124	U6				A	A	A	A
15 X 15	180	U9							A

A = Available Now; E = Prototypes Only

* = Only 100 pins internally connected; P = Contact Factory

ASIC Analog Cells

General Description

Analog cells will allow integrated-circuit designers to combine analog and digital functions on a single integrated circuit (IC), reducing manufacturing costs and improving system reliability.

The eight analog functions are two comparators, three operational amplifiers, a voltage reference, an analog switch and resistors. The functions have been optimized to operate with 5V power sources, based on National's proprietary M^2CMOS process.

These functions provide an effective and easy way of integrating analog and digital functions on a chip. These building blocks are the first of a powerful library of megacells for our standard cell products, which already include digital logic, memory and UARTs, thereby providing the user with the capability of integrating more of his system onto an integrated circuit.

Users of National Semiconductor's comprehensive analog and digital standard cell library will benefit primarily from the integration of both analog and digital functions on a single chip, which means that fewer components need to be used. This results in reduced board space, smaller systems, lower weights and increased system reliability. Using fewer components also means lower manufacturing costs, greater manufacturing productivity, and for both system vendors and end users, lower maintenance costs. And because such systems use less power, smaller power sources are needed, a key feature for portable systems.

Eight Analog Functions Added to National's ASIC Library

Analog and digital functions can now be combined on a single chip, reducing board space in systems designs.

National has placed eight analog functions into its standard cell library as a first step towards capturing a major share of the booming analog-digital standard cell IC market, which is expected to grow from $50 million in 1987 to over $2 billion by 1990. The analog cells are aimed at industrial controls, telecommunications, automotive applications and medical instrumentation.

True Single-Chip Solutions

Some 227 digital cells are already available in the library. With the new analog cells, National now offers a mixed analog-digital capability for true single-chip solutions.

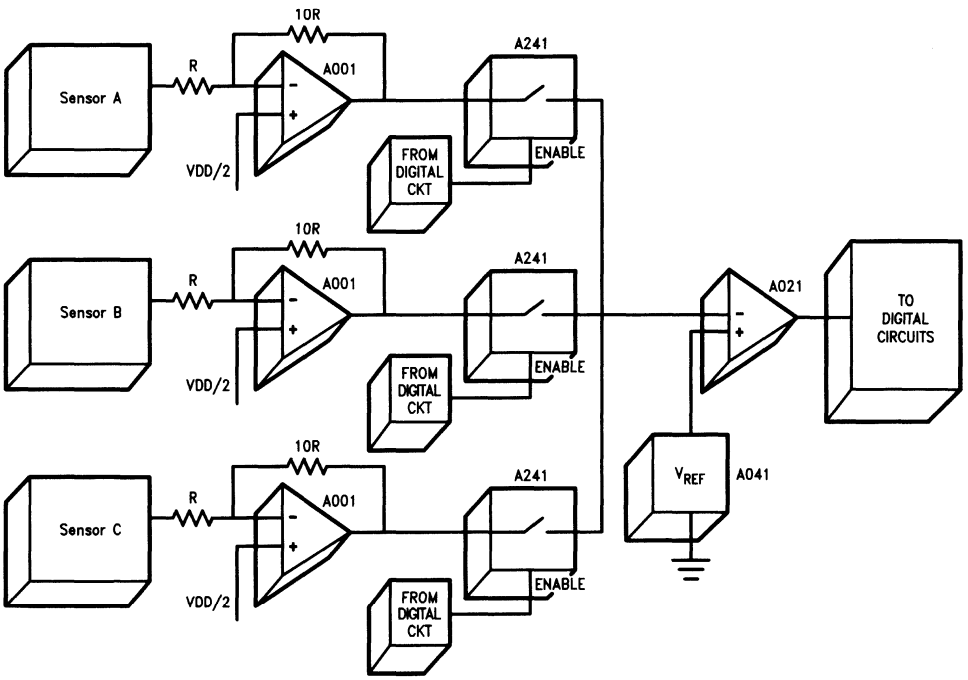
The eight analog functions include two comparators with different input common-mode ranges, three-operational amplifiers with different gain-bandwidth products, a voltage reference, an analog switch and resistors.

The functions are based on National's advanced 2-micron M^{2}CMOS process. This process is widely used across National's many product lines and has been optimized to operate from 5V supplies. Analog functions can amplify low-level signals from transducers and convert them to the voltage levels used by microprocessors.

Smaller Is Better

With combined analog and digital cells on the same chip, fewer components will be needed in systems designs, resulting in reduced board space, smaller power supplies and increased reliability. These attributes are essential to battery-powered portable systems. Additionally, the resulting smaller designs will allow more features to be packed into customer systems.

"These analog building blocks add a new dimension to our fast-growing library of digital cells," says Mike Bereziuk, director of marketing for National's ASIC Division. "They provide the designer with the capability of integrating more of a total system onto a single IC, thus gaining all the cost and performance advantages of a complete ASIC solution."



TL/MS/10259–1

Operational Amplifiers

Macro	Gain Bandwidth	Remarks
A001	0.75 MHz	VINCM: 0.3V
A002	1.5 MHz	to VDD − 1.5V
A003	0.3 MHz	

Comparators

Macro	Gain Bandwidth	Remarks
A021	250 ns with 10 MV Overdrive	VINCM: 1.5V to VDD − 0.5V
A022	180 ns with 10 MV Overdrive	VINCM: 0.3V to VDD − 1.5V

Resistors

A331 to A325	100Ω, 500Ω, 1 kΩ, 2 kΩ & 20 kΩ ±1% Match
A361 to A365	1kΩ, 3 kΩ, 5 kΩ, 6 kΩ, 100 kΩ ±5% Match

Voltage Reference

	Band Gap Reference
A041	2.5V

Analog Switch

A241	On Resistance = 100Ω
	T_{ON} = 30 ns, T_{OFF} = 30 ns

1.5μ CMOS Gate Array

General Description

National Semiconductor Corporation's new SCX6B00 CMOS Gate Array family complements the established SCX6200 family of gate arrays. With 1.5 micron drawn (1.1 micron effective) channel length, these arrays offer 20–30% higher performance than the 2 micron arrays and use the same macro library of 200+ functions.

The SCX6B00 family consists of 9 configurations, ranging from 400 to 15,000 gates and 28 to 200 pads. Every pad cell can be programmed as a power, input, output, or I/O pad and has from 1 mA to 24 mA output drive capability.

The arrays are fabricated with National's advanced dual-metal silicon gate CMOS process, are latch-up proof, and are protected against electrostatic discharge of $\geq$2,000V. Ample routing resources, in conjunction with NSC's sophisticated place-and-route software provide typical utilization factors of >95% for these channeled arrays.

Features

- Available for both Commercial and Military/Aerospace applications
- Latch-up proof, state-of-the-art, 1.5-Micron (drawn), dual-metal, silicon-gate microCMOS technology
- Ultra-high performance: 0.65 ns typical gate delays (2-input NAND, 2 loads, 5V, 25°C ambient)
- High ESD protection: 2,000V
- Complexity up to 15,000 gates and 200 selectable signal/power pads
- Wide range of high-density packages available
- Selectable Output Drive: 1 mA to 24 mA
- Inputs and I/Os: TTL, CMOS, Schmitt Trigger
- Any pad may be used as an Input, Output, I/O, or power pad
- Over 200 macros to choose from; compatible with 2.0 micron SCX6200 library
- Oscillator macros
- Power-On-Reset macro
- Scan path FFs to facilitate testability
- Auto place-and-route at greater than 95% utilization
- Fully integrated design automation system supported on mainframes and workstations: IBM AT/Futurenet, Mentor, Daisy, HP
- VHSIC Phase I Compatible AC Performance
- Separate Power Ring for Core and I/Os to minimize noise
- VLSI macros: Bit-Slice Family SM2901, SM2909, SM2911
- Static RAM Macros

Product Configurations

Device	Equivalent 2-Input NAND Gates	Total Pads*
SCX6B04	399	28
SCX6B10	1020	48
SCX6B21	2058	68
SCX6B31	3111	84
SCX6B48	4788	104
SCX6B64	6336	120
SCX6B86	8586	144
SCX6B120	11904	176
SCX6B150	14892	200

***Note:** Any pad may be used as an Input, Output, I/O, or Power Pad.

1.5 Micron Gate Array Package Availability Chart

Package Type	Pins	Code	6B04	6B10	6B21	6B31	6B48	6B64	6B86	6B120	6B150
Plastic DIP	8	N11	A								
	14	N4	A								
(N)	16	N6	A								
	18	N7	A								
	20	N0	A								
	22	N8	A	A							
	24S	N9	A	A							
	24W	N2	A	A	A	A	A	A			
	28	N1	A	A	A	A	A	A			
	40	N3		A	A	A	A	A			
	48	N5		A	A	A	A	A			
Ceramic DIP	8	D11	A								
(D)	14	D4	A								
Side Braze	16	D6	A								
	18	D7	A								
	20	D0	A								
	22	D8	A	A							
	24S	D9	E	A							
	24W	D2	A	A	A	A	A	A			
	28	D1	A	A	A	A	A	A			
	40	D3		A	A	A	A	A			
	48	D5		A	A	A	A	A			
Small Outline	20	M4	A								
(SO)	24	M5	A	A	A						
Plastic Leaded	20	V1	A	A	A	A					
Chip Carrier	28	V0	A	A	A	A	A	A			
(PLCC)	44	V2		A	A	A	A	A			
	68	V4			A	A	A	A	A	A	
	84	V5					A	A	A	A	P
Plastic Quad	80	VF4			P	P	P	P	P		
Flat Pack	100	VF7				A	A	A	A		
(EIAJ)	120	VF2					P	P	P	P	
	144	VF6							P	P	
Plastic Quad Flat Pack (PQFP)	132	VF8					*A	*A		A	A
Ceramic Leadless	20	E21	A	P							
Chip Carrier	28	E0	A	A	A						
(LCC)	44	E2		A	A	A	A	A			
	68	E4			A	A	A	A	A	A	
	84	E5				A	A	A	A	A	
Ceramic Leaded	44	E1		A	A	A	A	A			
Chip Carrier	68	E19				E	A	A	A	A	
(LDCC)	84	E20				E	E	E	E	E	E
	100	E22				E	E	E			
	132	E14					A	A	A	A	
PPGA (Plastic)	124	NU6					A	A	A	A	A
Ceramic Pin 10 X 10	68	U0			A	A	A	A	A		
Array 11 X 11	68	U1			P	P	P	P	P		
PGA 10 X 10	84	U2				A	A	A	A		
11 X 11	84	U3				P	P	P	P		
13 X 13	124	U6					A	A	A	A	A
15 X 15	144	U11							E	E	E
15 X 15	180	U9							P	P	P

A = Available Now; P = Planned, contact Factory; E = Prototype only

* = 100 pins internally connected

ECL ASIC

National's ASIC product line includes two ECL high-performance gate array families to speed turn-around.

ECL

The FGE Series ECL gate arrays range from 100 to 6,300 gates. Features include 600 MHz performance, ECL 100K and ECL 10K compatibility, user-selectable speed/power performance options, and TTL/ECL I/O choices with the FGE2500 and 2k RAM on the FGE6320R. These products are available for both Commercial and Military/Aerospace applications.

The FGA Series is a new family of ECL gate arrays, based on the ASPECT process, ranging from 600 to 15,000 gates., The arrays have speed and power options with propagation delays of 120 ps but using only 30% of the conventional ECL power.

ECL Gate Arrays

FGE Series

Device	Gate Equivalent	I/O Levels	Typical Internal Gate Delay(ns)	Typical Buffer Delay Input (ns)	Typical Buffer Delay Output (ns)	Typical Power (W)	Max. I/O	Package Codes	Availability
FGE0050	100	100K/10K ECL	0.225–0.57	0.0	0.45	0.1–0.4	21	24 FPK 24 CDIP	Now
FGE0500	680	100K/10K ECL	0.225–0.57	0.0	0.45	1.5–4.0	72	40 CDIP 44 LCC 84 LDCC 84 CPGA	Now
FGE2000	2500	100K/10K ECL	0.225–0.57	0.0	0.45	3.0–8.0	120	132 LDCC 132 CPGA	Now
FGE2500	2840	ECL/TTL Mix	0.225–0.57	0.0	0.45	3.0–8.0	120	156 CPGA	Now
FGE6300	6300	100K/10K ECL	0.250–0.62	0.0	0.45	4.5–10	220	301 CPGA	Now
FGE6320R	3500/ 2304 RAM	100K/10K ECL	0.250–0.62	0.0	0.45	4.5–10	220	301 CPGA	Now

FGA Series

Device	Gate Equivalent	I/O Levels	Typical Internal Gate Delay(ns)	Typical Buffer Delay Input (ns)	Typical Buffer Delay Output (ns)	Typical Power (W)	Max. I/O	Package Codes	Availability
FGA14000	15,400	10K/100K ECL	0.120–0.20	0.20	0.45	10–20	256	323 CPGA	Now
FGA14040R	7,390/ 4,600 RAM	10K/100K ECL	0.120–0.20	0.20	0.45	10–20	256	323 CPGA	2Q89
FGA4000	4,070	10K/100K TLL/ECL	0.120–0.20	0.20	0.45	3–6	128	172 CPGA	Now
FGA1300	1,445	10K/100K TLL/ECL	0.120–0.20	0.20	0.45	1–3	72	108 CPGA	Now
FGA600	605	10K/100K TLL/ECL	0.120–0.20	0.20	0.45	0.5–1.5	32	44 LDCC	2Q89

Design Automation

Overview

National Semiconductor's Design Automation Tools combine the benefits of state-of-the art proprietary tools with the flexibility of generic tools.

National's Design Automation Tools provide easy access to National's gate arrays and standard cells implemented in CMOS, ECL and ASPECT™ technologies.

The tools are integrated under a Rule-based design flow manager in a friendly and open design environment. The open system enables existing hardware and software to be integrated into the design environment, thus reducing ownership costs and user training.

These tools ensure a high success rate by addressing many of the problems faced by semicustom users, such as design integrity, design management, cost of ownership and development of time scales.

For the first time, you can complete all the steps involved in designing high-performance semicustom circuits. Available on many platforms including SUN® and VAX™ the tools enable you to complete schematic capture, simulation, automatic test vector generation, and place and route without the need for interaction with the semicustom vendor.

The result? National's Design Automation Tools are *the* choice for integrated high-density, high-performance semicustom products.

Features

- Open architecture
- Industry standards
  - — EDIF
  - — VHDL
  - — UNIX®
  - — X-windows
- Gate array and cell-based methodologies
- Support of National's high-performance technologies:
  - — ASPECT 1-2 GHz process
  - — ECL 660 MHz process
  - — CMOS 70 MHz process
- Common interface for all technologies
- User options:
  - — Schematic Capture
  - — ERC rule check (after Schematic Capture)
  - — Logic and timing simulation
  - — Auto/manual placement
  - — Auto/manual routing
  - — Post-route simulation
  - — Automatic test vector generation
- Menu-driven user interface
- Available on SUN, VAX and IBM platforms
- EDIF (Electronic Data Interchange Format) netlist interface option
- Integrated workstation support

Industry Standards

EDIF (Electronic Data Interchange Format) is a language that describes schematics, netlists and layouts in a ASCII file format. National uses EDIF as the standard for netlists and symbols when receiving or transmitting data between CAE tools.

VHDL (VHSIC Hardware Description Language) is a behavioral simulation language capable of describing large computer systems. Created by the Department of Defense, it has become IEEE standard 1076. VHDL is used as the source language for modeling National's libraries. These are automatically translated into the target simulators' behavioral languages.

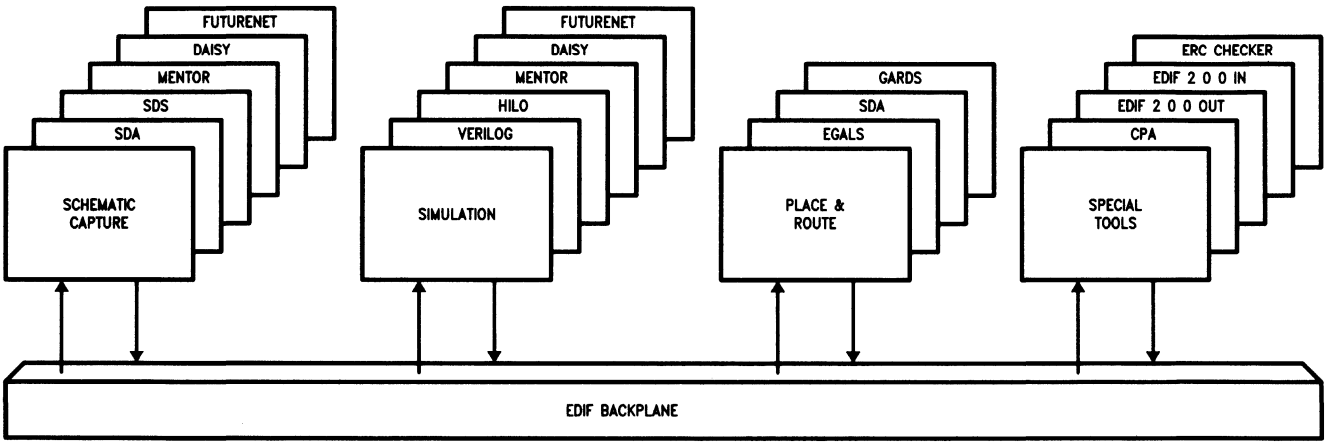
Other standards used by National include UNIX for operating systems and X-windows as the graphics interface.

Open Architecture

New technologies often demand new design automation tools—not with National's open-architecture approach. Using an EDIF compiler-post processor, National's libraries can be translated to your design environment. When the design is completed you can generate an EDIF netlist which would be accepted as input to the system. You can then complete placement, routing and final post-route simulation on National's mainframes or your own UNIX workstations. By plugging tools in and out of the EDIF back-plane, you can configure an environment that suits your needs.

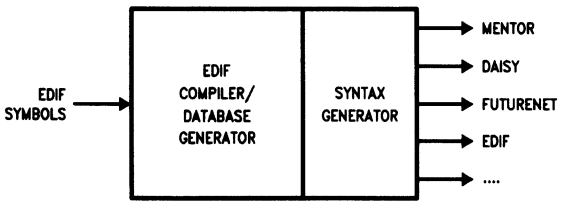
EDIF Compiler

The system is built around the EDIF Compiler, which accepts EDIF netlists and creates an object-oriented EDIF binary database. The binary EDIF database allows faster access to the data than would be possible by using EDIF in its ASCII format. To improve translation times between application tools, the compiler will incrementally compile only those elements that have changed since the last compilation. National's symbols are also created in EDIF format and translated into the various schematic capture systems, making the library highly portable. Another feature of the compiler is that it can accept EDIF netlists as input, and generate EDIF 200 netlists. This provides the means to port your design database to another design system.



EDIF provides a back-plane into which all application tools can be plugged.

TL/MS/10261-2



TL/MS/10261-3

The EDIF Compiler translates symbols from an EDIF source format into the target system's schematic format.

Design Flow

The design flow is controlled by RAIN, an interactive menu-driven monitor. All of the application tools can be executed from the menu, which minimizes training.

Schematic Capture is a multi-layer system that enables you to create high complexity designs quickly and easily.

Following Schematic Capture, the Design Checker™ is run to verify the design data-base. This application provides you with a detailed breakdown of your design, noting errors or places where technology rules may have been broken. If any errors are found at this stage, they must be corrected before the system will allow you to continue.

Once all the design-rule violations have been removed, the hierarchical Critical Path Analyzer can be run to produce pre-simulation timing information such as set-up and hold timing. CPA™ also creates a table of signal delays, with the longest delay typically listed first.

Logic and timing simulation can be performed at the switch, gate or behavioral level. The simulator, a 20-state system, mixed-level simulator, allows algorithm verification and ensures correctly functioning silicon in the end application. All simulation models are characterized over temperature and voltage, and then are translated automatically into simulation to guarantee accurate simulation results.

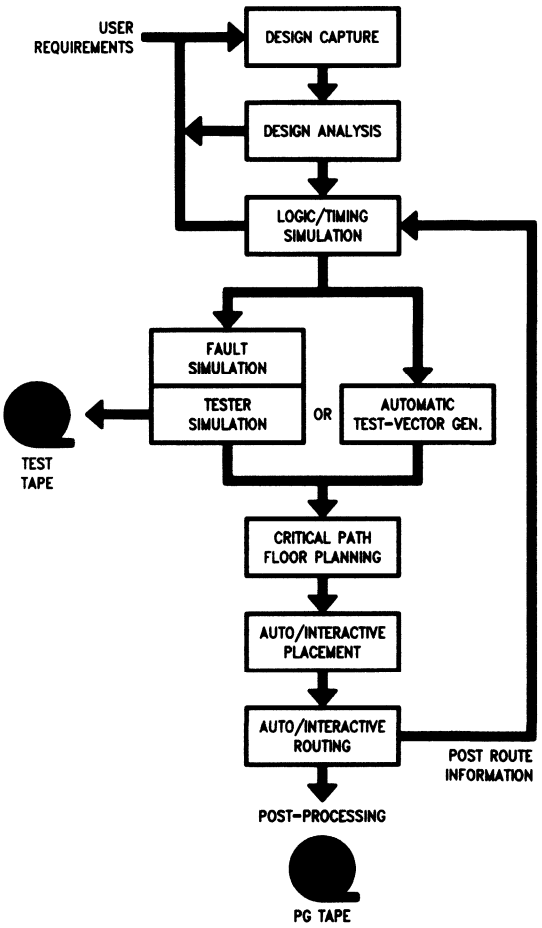
At this stage, you can either create your own test-vectors, using the high speed fault simulator, or you can use the automatic test vector generation tools.* The ATVG tools reduce design times by 10%–30% from traditional methods.

You can then use the automatic place and route tools to complete the layout and back-annotation.

***Note:** Available for ASPECT Technologies

Tools Available Under RAIN

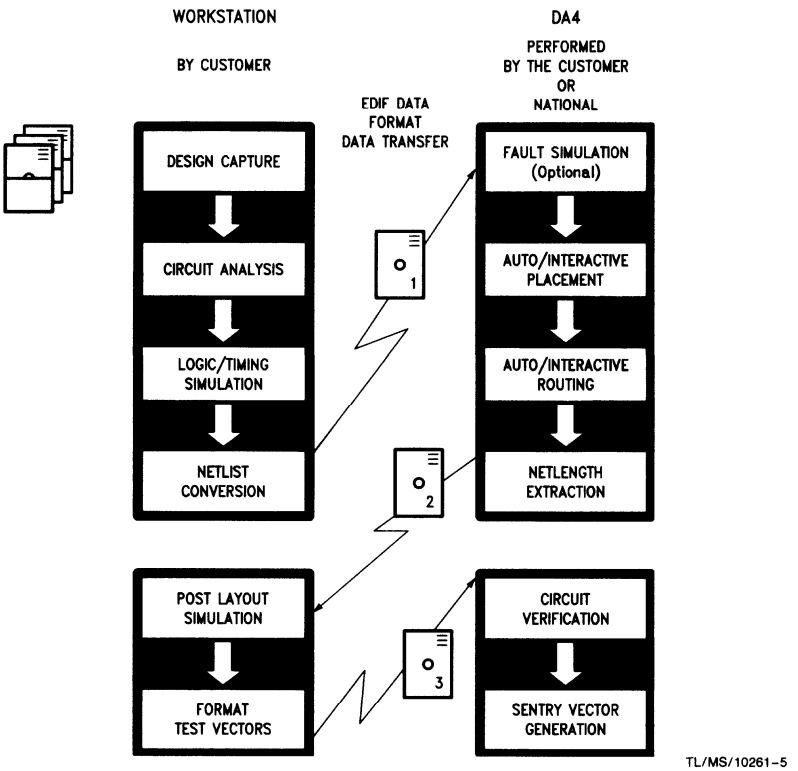
	UNIX
SCHEMATIC CAPTURE	✓
DESIGN ANALYSIS	✓
BEHAVIORAL SIMULATION	✓
LOGIC SIMULATION	✓
FAULT SIMULATION	✓
CRITICAL PATH ANALYSIS	✓
PLACEMENT	✓
ROUTING	✓
TEST VECTOR GENERATION	✓



TL/MS/10261–6

Workstation Support

National supports schematic capture, design analysis, simulation and test vector formatting on a number of engineering workstations including Daisy,® Mentor,® Valid,® and Cadence. Also included in the workstation Designer Kit is a communications program that provides seamless interface on NSC mainframes.



Workstation Design Flow

Advanced Technology Support

National's Design Automation Tools offer you access to National's high-performance, high-density semicustom products.

Fully integrated is National's ASPECT (Advanced Single Poly, Emitter Coupled Technology) series of Gate Arrays (FGA) and standard cells (FSA). The FGA family has gate complexities from 1,400 gates to 14,000 gates with typical internal delays of 120 ps. The FSA family will integrate up to 25,000 gates.

The CMOS product family is based on National's 2.0 μm and 1.5 μm M^{2}CMOS process. The CMOS product line contains three families: the SCX62XX family of 2.0 μm gate arrays, the SCX6B family of 1.5 μm gate arrays and the SCL family of CMOS standard cells. Gate array families range from 600 gates to 15,000 gates and the standard cell family up to 20,000 gates.

Design Automation

		Library Availability						
Library	**Description**	**DA4**	**Cadence**	**Verilog**	**Daisy**	**Mentor**	**Valid**	**Viewlogic**
SCX20	CMOS 2.0 μm Gate Array	■	■	■	●	●		
SCX15	CMOS 1.5 μm Gate Array	■	■	■	●	●	■	★
SCX10	CMOS 1.0 μm Poly Cell	▲						
SCL20	CMOS 2.0 μm Standard Cell	■	■	■	■	■		★
SCL10	CMOS 1.0 μm Standard Cell	▲						
FGE15	ECL 1.5 μm Gate Array				●	●		
FGA15	Aspect 1.5 μm Gate Array	●	●	●				★
FSA20	Aspect 2.0 μm Standard Cell	●						★

Release Now 89 = ● Release April 89 = ■ Release Sep 89 = ▲ Schematic Only = ★

Design Technology Center

Design Centers

Design Centers are state-of-the-art technology and design environments that provide the tools, service, and support you need to turn ideas into products. All National Semiconductor products, including programmable logic, semicustom (bipolar and CMOS gate arrays, and CMOS standard cells), LSI controllers, modems, microprocessors and microcontrollers, are supported by the Design Centers.

These Centers are the most up-to-date facilities of their kind in the world, and offer convenient locations in Burlington, Massachusetts; Bloomington, Minnesota; Richardson, Texas; and Tustin and Santa Clara, California.

The Right Tools for the Job

The time needed to implement your complex product and system designs decreases significantly as you gain ready access to training and design tools. Each Center is fully equipped with computer-aided design stations for gate array and standard cell—interactive systems that permit the designer to perform graphical schematic capture; logic, timing, and fault simulation; placement and routing; as well as post-layout timing verification. Workstations are linked via communications lines to a DEC® VAX 11/780 system and the IBM mainframe, which also enables design entry from your local facility.

Applications labs at the Center will help you evaluate the designs. These comprehensive resources include memory and logic programmers, logic analyzers, oscilloscopes, and hardware prototyping tools.

The Design Centers serve as a gateway to all of National's products and capabilities, as well as a resource for design assistance. The unique combinations of products and services offer cost-effective solutions to system development requirements:

- Semicustom products—ECL and CMOS gate arrays and CMOS standard cells.
- Programmable products—PROMs and FASTPLAs programmable logic devices.
- High-performance microprocessor products.
- Digital logic products—CMOS LSI, FAST LSI, and ECL.
- Memories—SRAMs, FIFO, register files, and controllers, in CMOS and bipolar technologies.
- Computer peripheral controllers—Winchester disk circuits.
- Telecommunications circuits—COMBOs and modems.
- Analog devices—interface circuits, power MOS, voltage regulators, transistors, and diodes.

Services that Make a Difference

Each Design Center is staffed by Technical Product Specialists who offer indepth knowledge of specific product lines and Applications Engineers who provide design support directly at your site. By providing fast and effective local support, we reduce your time to market and minimize your cost of ownership of National's products.

Support that Follows the Design

Design Centers exist to support your design needs—and will do whatever it takes to get the job done right. National's extensive customer communication network provides valuable feedback on such areas as software design tools, packaging, circuit testability, and other requirements for cost-effective system design. And each Center is equipped with a technical inquiry telephone line that represents immediate information, assistance, or answers to you.

The idea behind this comprehensive support program is to help you turn out a truly superior product. And Design Centers are the shortest distance between your idea and the marketplace.

Design Centers

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Suite 1
Bloomington, MN 55420
Phone (612) 854-8200

CLASIC

The National Customizable Linear Applications Specific Integrated Circuits (CLASIC) approach brings to the systems designer a level of sophistication that will enable VLSI solutions requiring analog and mixed analog/digital functions to be integrated cost effectively. The CLASIC approach offers:

- Bipolar and CMOS technologies
- Standard cell and array methodologies
- Customer CAD tools that allow design and simulation with higher level building blocks

The CLASIC system considerably reduces the time and the risks associated with VLSI designs by offering a cell library of such pre-designed, commonly identified function blocks as op amps, comparators, DACs, VCO, PLL, gates, flip-flops and counters, and the CAD tools to combine these blocks. The designer's task is somewhat more complicated, yet similar to designing a printed circuit board using standard ICs.

Most importantly, however, with the CLASIC approach, the customer can select the level of design participation desired. At the lowest level, the customer can simply provide a functional description of the desired design and a CLASIC applications engineer will translate this into a standard cell schematic. As the user gains experience and confidence with the CLASIC approach, any level of design up through layout can be accomplished with the appropriate CAD tools at the designer's facility, if desired. The designer can choose the options that best match both needs and experience.

The Cell Library

Contains the CLASIC library, a broad range of linear and digital functions, and cells are being added continually.

The linear performance offered by the Bipolar CLASIC cells is based on an NPN f_t of 2.5 GHz and a PNP f_t of 40 MHz. The logic cells are based on high-performance ECL technology, offering gate delays of 1.5 ns at fanouts of 3 and D flip-flop toggle frequencies of greater than 100 MHz.

The CMOS cell library is presently based on a 3-micron double-poly process that provides offset voltages of less than 5 mV, unity gain BW of 2 MHz, gate delays of 5 ns at fanouts of 3, and D flip-flop toggle frequencies greater than 50 MHz.

Semicustom Packaging

PLCC	Plastic Leaded (J-Bend) Chip Carrier
CLCC	Ceramic Leaded (J-Bend) Chip Carrier
CPGA	Ceramic Pin Grid Array
LDCC	Leaded Chip Carrier
LCC	Leadless Chip Carrier
FPK	Flatpak
CDIP	Ceramic Dual In-Line
PDIP	Plastic Dual In-Line

CLASIC Customer CAD Tools

A PC-based CAD system is CLASIC's main vehicle for extending access of National's technologies to the customer. CLASIC's macro cell library is supported on a number of popular and high performance CAD systems. The combination of CLASIC's macro cell library and the CAD software allow the system engineer to carry out an ASIC development project up to the layout stage. All necessary databases required for schematic capture, netlist translation, and simulation are included. The table summarizes CLASIC's library products.

Library maintenance service and training on the CAD systems are available. Training includes the use of the databases supplied, macro cell applications, and designing with CLASIC.

Instantaneous access to CLASIC's macro cells, reliable simulation models, and a direct tie-in to CLASIC's manufacturing facilities are the principal advantages to using CLASIC library products. Coupled with the PC CAD tools, CLASIC library products let you start designing ASIC almost immediately and, in the process, save a significant portion of the development charges by doing the design yourself.

CLASIC's macro cells encompass a wide range of commonly used system functions from op-amps and comparators, to high-level functional blocks such as DAC and a complete AGC subsystem. Similar to off-the-shelf products, CLASIC macro cells are supported with detailed data sheets and application notes. Unlike off-the-shelf products, however, parameters not specified in the data sheet can still be obtained by simulation without having to build special test circuits. Parasitics associated with high performance cells have been extracted and incorporated into the SPICE subcircuit file of the cell to insure correlation between simulation results and actual silicon performance. Fundamental to the reliability of any simulation result is the basic process model used to characterize the low level transistor and resistor devices. CLASIC's SPICE models are derived from extensive characterization efforts spanning many wafers and fabrication lots. Models are available for all standard geometry NPN and PNP transistors, Schottky transistors, resistors, and parasitic diodes. Simulation of circuit performance over manufacturing variations is also possible with worst-case models in the database.

Disk Drive Products

CLASIC supports a number of selected standard products used in Mass Storage Applications, built from our standard cell library. For more information on these products, please consult the Mass Storage Databook.

Read/Write Products

Product Number	Description
μA117X, μA117XR	Read/Write Preamplifiers
μA501X, μA501XR	6-8 Channel Read/Write Circuits

Servo Products

Product Number	Description
μA24H80	Servo Preamplifier
μA2580	Low Noise Servo Preamplifier
μA2460, μA2461	Servo Controllers
μA2470	Servo Position Demodulator

Tape Drive Products

Product Number	Description
μA2440	2-Channel multiplexed video amplifier
μ2441	Tape Read Conditioner

CLASIC Macro Cell Library Products

CLASIC Product No.	Computer Platform	CAD Software	Product Description
CCAT1-CT/A	PC AT	CASE Technology	• Run with CASE Technology CAD software
CCAT1-CT/S	PC AT	CT-1000, CT-2000	• Cell and component symbols
CCVX1-CT/A	VAX		• Cell subcircuit database (PSpice format)
CCVX1-CT/S	VAX		• Typical and worst-case SPICE models
CCAT1-VL/A	PC AT	ViewLogic's Workview	• Run with ViewLogic CAD software
CCAT1-VL/S	PC AT	CAD Products Running	• Cell and component symbols
CCVX1-VL/A	VAX	PSpice or SPICE	• Cell subcircuit database (PSpice format)
CCVX1-VL/S	VAX		• Typical and worst-case SPICE models
CCAT1-CD/A	PC AT	IBM CIEDS CAD	• Run with IBM's CIEDS CAD software
CCAT1-CD/S	PC AT	Software	• Cell and component symbols
CCVX1-CD/A	VAX		• Cell subcircuit database (PSpice format)
CCVX1-CD/S	VAX		• Typical and worst-case SPICE models

CLASIC Analog Cells

Operational Amplifiers

Cell Name	Description	Industry Std.	Area	Power
A2MX101	2-Input Analog Multiplexer/Amplifier	HA2400 Sim.	0.8 A	9.6 mW
AVID101	Video Amplifier—Differential Input/Output	LM733,592	1.3 A	144 mW
OPGM101	Transconductance Amplifier (No predistortion)	LM3080	0.5 A	4.3 mW
OPGP124	Ground Sensing—Single Supply Op Amp	LM124	0.7 A	5.4 mW
OPGP201	Compact General Purpose Op Amp	μA741	0.7 A	4.8 mW
OPLB102	Low Input Bias Current Op Amp	OP07 Input	1.3 A	12.0 mW
OPLB201	Low Input Bias Current Op Amp	OP07 Input	1.3 A	39.6 mW
OPHS101	High Speed/Fast Slew Op Amp	LM118	2.0 A	48.0 mW
OPLN102	Low Noise Op Amp—Minimum Gain of 5	OP27 Input	1.6 A	21.6 mW
OPLV101	Low Offset/Drift Amplifier	LM11	1.2 A	9.6 mW
OPNR101	Norton (Current Input) Amplifier	LM159	0.7 A	24.0 MW

Comparators

Cell Name	Description	Industry Std.	Area	Power
CMPEC101	High Speed (9 ns Prop Delay) ECL Output	AM685	0.8 A	44 mW
CMPEC301	Medium Speed/Power—ECL Output		1.25 A	6.6 mW
CMPGP101	Ground Sensing—Use with CMPLS101 Cell	LM139	0.8 A	5.5 mW
CMPGP201	Ground Sensing—Schottky Open Collector	LM393	0.65 A	5.3 mW
CMPGP202	High-Current O.C. Output CMPGP201		0.65 A	14 mW
CMPLS101	ECL Output Translator for CMPEC101		0.4 A	—
CMPHS101	High Speed (11 ns)—ECL Output		1.2 A	28.5 mW
CMPHS201	High Speed (13 ns)—ECL Output		1.2 A	28.5 mW
CMPHY201	Grnd. Sense/O.C. Output—Hysteresis 0–100 mV		0.9 A	52.8 mW
CMPHY501	ECL Output—Built-in Hysteresis ±0.7V		0.6 A	60 mW
CMPHY502	ECL Output—Positive Hysteresis +0.7V		0.6A	60 mW

Logic

Cell Name	Description	Industry Std.	Area	Power
ECTTL201	High Speed ECL to TTL Converter		2.25 D	6 mW
ECTTL401	Obsoleted—See Pad Cells		2.80 D	8 mW
ECTTL402	Obsoleted—See Pad Cells		2.80 D	11.0 mW
ED101	ECL Rising Edge Detector		1.60 D	3.5 mW
FFD101	D Flip Flop—Master with S/R		3.40 D	5 mW
FFD301	DD Flip Flop—No S/R			
GEXOR101	Exclusive OR/NOR Gate		1.40 D	1.7 mW
GEXOR201	Exclusive OR/NOR Gate—Differential Inputs		1.60 D	1.7 mW
GxOR101	2, 3, 4, or 5-input OR/NOR Gate		1–1.5 D	1.8 mW
GxORF101	2, 3, 4, or 5-input OR/NOR Gate—FAST		1–1.5 D	3.45 mW
GxORL101	2, 3, 4, or 5-input OR/NOR Gate—Lo Pwr		1–1.5 D	0.93 mW
MSEC101	ECL Delay Line—External RC—Retriggerable		3.6 D	3.8 mW

CLASIC Analog Cells (Continued)

Data Acquisition

Cell Name	Description	Industry Std.	Area	Power
DAC8B101	8-Bit Multiplying DAC	DAC08	3.3 A	24 mW
SH301	Fast Sample/Hold Amplifier		0.81 A	45.6 mW
SH401	Sample/Hold Amplifier		0.70 A	30 mW
SW101	Analog Switch—Diode Bridge—Fast		0.57 A	33.6 mW
SW201	Analog Switch—Diode Bridge—Low Power		0.43 A	16.8 mW

Bias and Voltage References

Cell Name	Description	Industry Std.	Area	Power
BIASA201	Analog Bias/Voltage Reference Cell		0.6A	32.4 mW
BIASD201	Digital Bias/Voltage Reference Cell		2.0 D	28.8 mW
BIASZ201	Peripheral Bias/Voltage Reference Cell		1.7 D	28.8 mW
UVD101	Digital Supply (5V) Undervoltage Detector		1.9 D	5 mW
UVD201	Analog Supply (12V) Undervoltage Detector		1.6 D	11 mW
VBG203	Precision 2.5 Voltage Reference—0.5%		0.8 A	4.0 mW

Peripheral Cells

Cell Name	Description	Industry Std.	Area	Power
ZAP101	Zenner Zap Cell (for VBG203)		5.6D	N/A
ZPAD*	Unprotected Pad Cell		1.8 D	N/A
ZPRT*	Analog, Digital and Mixed Protected Pad Cells		1.8 D	N/A
ZPIN201	Non-Inverting TTL to ECL Converter		3.0 D	4.0 mW
ZPOUT301	Differential ECL to TTL Converter		4.3 D	13.5 mW

Special Functions

Cell Name	Description	Industry Std.	Area	Power
CHGPM701	PLL Charge Pump—Programmable Gain		7.4 D	96 mW
TIME101	Timer/Multivibrator	NE555	1.0 A	36 mW
VCO701	Voltage Controlled Oscillator		6.4 D	50 mW

CLASIC Analog Cells (Continued)

Disk Drive Circuits

Cell Name	Description	Industry Std.	Area	Power
AGC101	Automatic Gain Control Subsystem (4 Cells)		2.30 A	180 mW
AGCB102	Bias Cell for GCA Amplifiers		0.35 A	18 mW
CONAM101	Error Amplifier—Current Output		0.30 A	20.4 mW
FWR101	Full Wave Rectifier—Common Emmitter		0.20 A	3.6 mW
FWR201	Full Wave Rectifier—Independent Biasing		0.35 A	40 mW
GCA101	Gain Controlled Amplifier—18 MHz BW		1.35 A	143 mW
GCA102	Gain Controlled Amplifier—Low Power		1.35 A	126 mW
GCA301	Gain Controlled Amplifier—20 MHz BW		1.20 A	192 mW
GCAOC101	Gain Controlled Amplifier—Low Noise		1.00 A	182 mW
PKBS101	Bias Cell for PKDET101		0.70 A	6 mW
PKDET101	Negative Peak Detector—Programmable Slew		1.10 A	12 mW
PKBS201	Bias Cell for PKDET201		0.8 A	33 mW
PKDET201	Negative Peak Detector—Selectable Base Line		1.60 A	48 mW

Discrete Components

Cell Name	Description	Industry Std.	Area	Power
NPN2	Single Base NPN Transistor—1 mA			
NPN4	Single Base NPN Transistor—2 mA			
NPN16	Single Base NPN Transistor—8 mA			
NPN2A	Double Base (Low Noise) NPN—1 mA			
NPN4A	Double Base (Low Noise) NPN—2 mA			
NPN16A	Double Base (Low Noise) NPN—8 mA			
PNP1	Lateral PNP—250 μA			
PNP2	Lateral PNP—500 μA			
PNP4	Lateral PNP—1 mA			
PNP8	Lateral PNP—2 mA			
PNPV1	Vertical PNP—250 μA			
PNPV2	Vertical PNP—500 μA			
PNPV4	Vertical PNP—1 mA			
PNPV8	Vertical PNP—2 mA			
RBSE	Base Diffused Resistor (See Design Manual)			
RIMP	Implant Resistor (See Design Manual)			
MCAP	MOS Capacitor (See Design Manual)			

Section 3
Digital Logic

Section 3 Contents Digital Logic

Digital Logic

Representing over twenty-five years of technology evolution and leadership, National's Digital Logic families provide SSI, MSI, and LSI Solutions in TTL, CMOS, and ECL technologies. Think National for all of your Logic applications—from mainframes and workstations to telecommunications to office automation, portable systems, Mil/Aero applications, and more—for new designs, systems upgrades, and as your Logic component in ASIC-based or other designs. When you buy from National, you receive superior product, service, applications support, and industry-standard packaging from the world's largest broad-line supplier of Digital Logic.

For advanced logic families, National products are unsurpassed. Offering undisputed leadership with FAST®, FACT™, ALS, AS, and F100K ECL, National's advanced-technology families provide you with the highest performance available in the industry to support your commercial and Mil/Aero designs.

TTL Families

Select from FAST, ALS, AS, Low Power Schottky, Schottky, and Standard TTL families.

Introduced by National Semiconductor, FAST (Fairchild Advanced Scottky TTL) logic is today's industry standard for new high-performance bipolar designs. FAST features a 30% speed improvement at one-fifth the power of Schottky TTL products, plus improved noise margins, lower input current, as well as superior capacitive and line driving characteristics.

For other applications demanding superior TTL speed/low power considerations, don't forget that there's ALS and AS, too. With FAST, ALS, and AS from National, you can select the Logic that's perfect for your system.

CMOS Families

National Semiconductor offers FACT, HC, HCT, 54C/74C, and CD4000 CMOS logic.

FACT (Fairchild Advanced CMOS Technology) is the industry's high-performance standard ACMOS logic family, setting the next-generation standard for high-speed and low-power applications. FACT's advanced design features 1ns internal gate delays with a full 24 mA drive capability.

ECL Families

National's high-performance ECL products encompass the most popular industry standards available today. For Digital Logic users, there's F100K ECL and 11C.

The logic of choice for new designs is F100K ECL, providing: fast gate speeds with moderate edge rates, low power consumption, full voltage and temperature compensation, extremely small parasitic capacitances, complementary outputs, and Mil/Aero processing, too. F100K pin assignments minimize crosstalk, noise coupling, and feedthrough, making this the industry's easiest system design upgrade from TTL.

Digital Logic—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide," please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements.

The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

Package Code Key—Digital Logic

Product Flow	PDIP	CDIP	SO	PCC
Commercial	PC	DC	SC*	QC
	SPC	SDC	—	—
	N	—	M**	—
	—	—	WM**	—

*SCX is the designator for SO tape and reel.

**"M Flow 563" or "WM Flow 63" is the designator for SO tape and reel.

Mil/Aero

Product Flow	DIP	Flatpak	Leadless Chip Carrier
JAN S	SCA	SDA	—
	SEA	SFA	—
	SRA	SSA	—
JAN B	BCA	BDA	B2A
	BEA	BFA	—
	BJA	—	—
	BRA	BSA	—
	BLA	BKA	—
DESC SMD	CA	DA	2A
	EA	FA	—
	RA	SA	—
MIL-STD-883	DMQB	FMQB	LMQB
	SDMQB	—	—
	J/883	W/883	E/883
DM	DM	—	—
	SDM	—	—

Digital Logic Functional Availability Guide

	Bipolar						CMOS						ECL	
Device	**FAST®**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Arithmetic Functions														
83				A		M					A			
85				A		A			A		A			
97						A								
148	C					A			C					
180						A								
181	A		C	A	A	A			C					
182	A		C		A				C					
264			C											
280	A		C		A				A					
282			C											
283	A			A	A	A			A					
286			C											
322	A			A										
381	C				C									
382	C													
385	A													
401	C													
402	A													
420	C													
518		C												
519		C												
520		C												
521	A	C							C	C				
522		C												
524	C													
582	C													
583	A													
632	C	C												
688									A	A				
689		C												
909											C			
932											C			
1010									C					
1016								C						
CD4008												C		
F100158													C	
F100160													C	
F100166													A	
F100179													C	
F100180													C	
F100181													C	
F100182													C	
F100183													C	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Buffers														
34			C						C	C				
95				C		A					C			
96				C										
97				C		A					C			
98				C										
125	C			A		A			A					
126				A					A					
365	A			A		A			A					
367				A		A			A					
368						A			C					
465		C												
467		C												
540	A	C		C			A		C	C				
541	C	C					A		C	C	C			
827	A													
901											A			
902											A			
903											C			
904											C			
906											A			
907											A			
941											A			
1034		C	C	C										
1035		C												
2241	A													
2244	A													
2541		C												
4049									A					
4050									A	C				
CD4009												A		
CD4010												C		
CD4041												A		
CD4048												A		
CD4049												A		
CD4050												A		
CD4093												A		
CD40106												A		
CD4503												A		
CD4512												A		
CD4584												C		
F100122													A	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Inverters														
04	A	A	C	A	A	A	A		A	C	A			
05		C		A		C			C	C				
96											C			
98											C			
366	C			A					M	C				
368	C			A		A			M	C				
466		C												
468		C												
828	A													
914											A			
1004		C	C											
1005		C												
F100121													C	
Counters, Binary Count Up														
93				C		A					C			
161	A	A	C	A	A	A	A	C	A		A			
162	A	C	C	A					A		A			
163	A	A	C	A	A	A	A	C	A		A			
197				C		C								
293				C										
393				C					A					
CD4518												C		
CD4520												A		
Counters, Binary Count Up/Down														
169	A	C	C	A			A							
191	A			A		A	A		C	C				
193	A			A		A			A	C	A			
269	C													
569	C													
915											C			
4020									A					
4040									A					
4060									C					
CD4029												A		
CD40193												A		
CD4510												C		
CD4516												C		

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Counters, Decade														
90				C		A					A			
160	A	C	C	A		M			A		A			
162	A	C	C	A					A		A			
168	C	C	C	M										
190	A			A					C	C				
192	A			A					A	C	A			
196				C										
290				C										
390				C					A					
490				A										
568	C													
569	C													
925											C			
926											C			
927											C			
928											C			
945											C			
946											C			
947											C			
4017									A					
CD4017												A		
CD40160												A		
CD40162												A		
CD40192												A		
Counters, Other														
525	C													
CD4018												A		
CD4020												A		
CD4022												A		
CD4024												A		
CD4040												A		
CD4060												A		
CD40161												A		
CD40163												A		
CD4522												C		
CD4526												C		
CD4527												C		
CD4541												C		
F100136													A	
11C05														A

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Decoders/Encoders														
19											C			
42				A		A			A		A			
45						A								
46						C								
47				A		A								
48				A							A			
49				M										
131		C												
137		C							C					
138	A	A		A	A		A	A	A	A				
139	A			A	A		A	A	A	C				
145						A								
147									A	C				
148						A			C	C				
149									C	C				
154				A		A			A		A			
155				A		A			C	C				
156				A										
237									C					
247				A										
248				A										
249				A										
347				A										
447				A										
537	C													
538	C													
539	C													
547	A													
548	A													
4514									A					
CD4028												A		
CD4511												A		
CD4514												C		
CD4515												C		
CD4529												C		
CD4543												A		
F100165													C	
F100170													A	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Drivers														
06						A								
07						A								
16						A								
17						A								
26				A		C								
29											C			
140					A									
240	A	A	C	A	A		A	A	A	C	C			
241	A	C	C	A	A		A	C	A	C				
244	A	A	C	A	A		A	A	A	C	A			
366	C			A					A					
367				A		A			A					
804		C	C											
805		C	C											
808		C	C											
832		C	C											
1034			C											
1036			C											
1804			C											
1805			C											
1808			C											
1832			C											
4511									A					
4543									A					
F100112													C	
F100113													A	
F100123													C	
F100126													A	
Flip-Flops, D-Type														
74	A	C	C	A	A	A	A	A	A	C	A			
173				A		A			A		A			
174	A	A	C	A	A	A	A	A	A		A			
175	A	A	C	A	A	A	A	A	A		A			
273		A		A			A		A	C				
374	A	A	C	A	C		A	A	A	A	A			
377				A			A	A						
378	A			A										
379	A			A										
534	A	C	C	C				A	C	C				
564	A	C		C				A	A					
574	A	C	C	C			C	A	A					
575			C											
576		C	C											
577			C											

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Flip-Flops, D-Type (Continued)														
821	A						C	A						
823	A							A						
825	A							A						
874		C	C											
876		C	C											
878			C											
879			C											
CD4013												A		
CD4076												A		
CD40174												A		
CD40175												A		
F100131													A	
F100151													A	
11C06														C
11C70														C
Flip-Flops, JK-Type														
73				A		A			A		C			
76						A			A	C	A			
107				A		A			A		A			
109	A	C	C	A	C	A	A	A	A	C				
112	C			A	A				A	C				
113	C			M	A				A					
114	C			A										
CD4027												A		
F100135													A	
Gates, AND														
08	A	A	C	A	A	A	A		A	C	A			
09		C		A	C	A								
11	A	A	C	A	A	C	A		A					
15		C		A										
21		A	C	A										
576		C	C											
808		C	C											
1008		C	C											
1011		C												
1808			C											
CD4073												A		
CD4081												A		
CD4082												C		
F100104													A	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Gates, NAND														
00	A	A	C	A	A	A	A	A	A	C	A			
01		C				A								
03		C		A	C	A			A	C				
10	A	A	C	A	A	A	A		A		A			
12		C		C										
13	A	C		A										
20	A	A	C	A	A	A	A		A		C			
22		C		A										
26				A		C								
30	C	A	C	A	A	A			A		A			
37	C	C		A		A								
38	A	C		A		A								
39						C								
40	C	C		A	A	A								
132	A	C		A	C	A			A					
133		C		A	A				A					
1000		C	C											
1003		C												
1010		C												
1020		C												
1804			C											
CD4011												A		
CD4012												A		
CD4023												A		
F100104													A	
Gates, AND-OR, AND-OR-INVERT														
04	A	A	C	A	A	A	A		A	C	A			
05		C		A	C	A			C	C				
14	A	C		A		A	A		A		A			
51	C			A	C	A			A					
54				A										
55				A										
58									A					
64	A				A									
CD4007												A		
CD4019												A		
CD4069												A		
CD4519												C		
F100117													A	
F100118													C	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Gates, OR														
32	A	A	C	A	A	A	A		A	C	A			
405									C					
832		C	C											
1032		C	C											
1832			C											
4075									M					
4078									A					
CD4071												A		
CD4072												C		
CD4075												A		
F100101													A	
F100102													A	
11C01														C
Gates, NOR														
02	A	A	C	A	A	A	A		A		A			
25						A								
27	C	A	C	A		C			A					
28		C		A										
33		C		A										
260				A										
1002		C												
1036			C											
4002									A					
CD4001												A		
CD4002												A		
CD4025												A		
F100101													A	
F100102													A	
11C01														C
Gates, Exclusive-OR/NOR														
86	A	C	C	A	A	A	A		A		A			
136		C	C	A										
266				A					A					
386				C										
810		C	C											
811		C	C											
4075									C					
7266									A					
CD4030												A		
CD4070												A		
F100107													A	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Latches														
75				A		A			A					
256				A										
259				A					A					
279				A		A								
373	A	C	C	A	C		A	A	A	A	A			
375				A										
377				A			A	A						
412	C													
432	C													
533	A	C	C	C					A	C				
563	A	C		C				A	A					
564	A	C		C				A	A					
573	A	C	C	C				A	A					
580		C	C											
841	C							C						
843	C							C						
845	C							C						
873		C	C											
880		C	C											
CD4042												C		
CD4043												C		
CD4044												C		
CD4099												A		
CD4723												C		
CD4724												A		
F100130													C	
F100150													A	
F100155													C	
F100156													C	
F100175													C	
Memory														
89						C					A			
170				A		A								
189	A				M									
200											C			
219	A													
403	A													
407	A													
410	A													
413	A													
433	C													

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Memory (Continued)														
670				A										
910											C			
968	C													
989											C			
2708							C	C						
29F68	C													
F100142													C	
F100145													C	
F100402													C	
Multiplexers														
150						A					C			
151	A	A		A	A	A	A	A	A	C	A			
152				M										
153	A	A		A	A	A	A	A	A	C				
155				A		A			C	C				
156				A										
157	A		C	A	A	A	A	A	A	C	A			
158	A		C	A	A		A	A	A	C				
251	A	A		A	A		A	A	A	C				
253	A	A		A	A		A	A	A	C				
257	A	C	C	A	A		A	A	A	C				
258	A	C	C	A	A		A	A	C	C				
298				A		M			A					
350	C													
352	A	C		A										
353	A	C		A										
354									A					
356									C					
398	A													
399	A							A						
4051										C				
4052										C				
4053										C				
CD4016												A		
CD4051												A		
CD4052												A		
CD4053												A		
CD4066												A		
CD4089												C		
F100155													C	
F100163													C	
F100164													A	
F100171													C	

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Multivibrators														
121						A								
122				C		A								
123				C		A			A					
221				C					A		M			
423									C					
4538									A					
96LS02				A										
96S02					C									
CD4046												C		
CD4047												A		
CD4528												A		
CD4538												C		
Registers														
95				A		A					C			
164	A			A		A			A	C	A			
165				A		A			A		A			
166		C		C		A			C					
194	A			A	A	A			A					
195				A	A				A		A			
279						M								
295				A										
299	C			A	C		A	A	A					
322	A			A										
323	C			A				A						
395				A										
399								A						
502				A										
503				A										
589									C					
595									C					
597									C	C				
673	C													
675	C													
676	A													
818								C						
905											M			
952				C										
962				C										
CD4006												A		
CD4014												A		
CD4015												A		

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Registers (Continued)														
CD4021												M		
CD4031												A		
CD4034												A		
CD4035												C		
CD4094												C		
CD40195												C		
F100136													A	
F100141													A	
F100145													C	
F100402													C	
Transceivers/Receivers														
230			C											
231			C											
242		C	C						A					
243	A	C	C	C					A					
245	A	C	C	A			A	A	A	A				
540	A	C		C			A		C	C				
541	C	C					A		C	C				
543	C													
544	A													
545	A													
550	C													
551	C													
552	C													
588	C													
620			C						C					
623									C					
640			C						A	C				
643									A	C				
645		C	C	C										
646	A	C	C				A		C					
648	A	C	C				C		C					
651	A		C											
652	A	C	C											
657	A													
1240		C												

Digital Logic Functional Availability Guide (Continued)

	Bipolar						CMOS						ECL	
Device	**FAST**	**ALS**	**AS**	**LS**	**S**	**TTL**	**AC**	**ACT**	**HC**	**HCT**	**C**	**CD4000**	**F100K**	**11C**
Transceivers/Receivers (Continued)														
1241		C												
1242		C												
1243		C												
1244		C												
2243	C													
2620			C											
29F52	C													
F100114													A	
F100250													C	
Translators														
F100124													A	
F100125													A	
F100128													A	
11C90														A
11C91														A
Miscellaneous														
221											C			
905											C			
908											C			
911											C			
912											C			
914											C			
917											C			
918											C			
922											A			
923											A			
942									C					
943									C					
949											C			
956											C			
4016									C					
4046									C					
4316									C					

Other Bipolar Families

Device	9300	9600	93L	DTL	54/74L	96L	8xxx
Gates							
54/74L00					A		
54/74L02					A		
54/74L10					A		
54/74L20					C		
54/74L86					C		
930				M			
932				M			
944				M			
946				M			
949				M			
962				M			
96101		C					
Inverters							
54/74L04					A		
936				M			
937				M			
Flip-Flops							
54/74L72					A		
54/74L73					A		
54/74L74					A		
9093				M			
9099				M			
945				M			
948				M			
Registers							
54/74L95					A		
54/74L98					A		
9300/93L00	A		M				
9328/93L28	A		M				
9338/93L38	A		M				

Device	9300	9600	93L	DTL	54/74L	96L	8xxx
Latches							
9308/93L08	A		M				
9314/93L14	A		M				
9334/93L34	A		M				
Multiplexers/Demultiplexers/Encoders/Decoders							
8123							C
9301/93L01	A		M				
9309/93L09	A		M				
9311	A						
9312/93L12	A		M				
9318	A						
9321/93L21	A		M				
9322/93L22	A		M				
Counters							
54/74L93					A		
8556							C
93L10			M				
9316	A						
Comparators							
8130							C
8131							C
8136							C
8160							C
9324/93L24	A		M				
Checker/Generator							
9348	M						
Monostables (One-Shots)							
9601		A					
9602/96L02		A				M	

FAST® (54/74Fxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND/NAND Buffer					
54F/74F00	Quad 2-Input	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F10	Triple 3-Input	3	3	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F13	Dual 4-Input (Schmitt Trigger)	4	2	14	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F20	Dual 4-Input	4	2	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A
54F/74F30	8-Input	8	1	14	PC, DC, SC
54F/74F37	Quad 2-Input Buffer	2	4	14	PC, DC, SC
54F/74F38	Quad 2-Input Buffer	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A
54F/74F40	Dual 4-Input Buffer	4	2	14	PC, DC, SC
54F/74F132	Quad 2-Input Schmitt Trigger	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB
AND					
54F/74F08	Quad 2-Input	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F11	Triple 3-Input	3	3	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
OR/NOR, Exclusive-OR					
54F/74F02	Quad 2-Input NOR	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F27	Triple 3-Input NOR	3	3	14	PC, DC, SC
54F/74F32	Quad 2-Input OR	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F86	Quad 2-Input Exclusive-OR	2	4	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
AND/OR-Invert					
54F/74F04	Hex Inverter	1	6	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F14	Hex Schmitt Trigger Inverted	1	6	14	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F51	AND/OR-Invert	3/3/2/2		14	PC, DC, SC
54F/74F64	AND/OR-Invert	4/2/3/2		14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA

Flip-Flops/Registers

Device	Type	Flip-Flop Type	Pins	Package Codes
54F/74F74	Dual Positive Edge-Trigger	D	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F109	Dual Positive Edge-Trigger	JK	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F112	Dual Negative Edge-Trigger	JK	16	PC, DC, SC
54F/74F113	Dual Edge-Trigger	JK	14	PC, DC, SC
54F/74F114	Dual Negative Edge-Trigger	JK	14	PC, DC, SC
54F/74F174	Hex Master Reset	D	16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F175	Quad Master Reset	D	16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F374	Octal, TRI-STATE® Outputs	D	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F378	Parallel w/Enable	D	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F379	Quad Parallel w/Enable	D	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F398	Quad Register	2-Port	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F399	Quad Register	2-Port	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F407	Data Access Register		24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F410	Register Stack		18	DC, SC, DM, DMQB
54F/74F534	Octal, TRI-STATE Outputs	D	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F564	Octal, TRI-STATE Outputs	D	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F574	Octal, TRI-STATE Outputs	D	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F821	10-Bit Master Reset	D	24	SPC, SDC, QC, SDM, SDMQB, FMQB, LMQB
54F/74F823	9-Bit Master Reset	D	24	SPC, SDC, QC, SDM, SDMQB, FMQB, LMQB
54F/74F825	8-Bit Master Reset	D	24	SPC, SDC, QC, SDM, SDMQB, FMQB, LMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FAST® (54/74Fxxx) (Continued)

Latches

Device	Broadside Pinout	Inverting	Transparent	TRI-STATE Outputs	No. of Bits	Pins	Package Codes
54F/74F373			x	x	8	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F412			x	x	8	24	SPC, SDC, SC
54F/74F432		x	x	x	8	24	SPC, SDC, SC
54F/74F533		x	x	x	8	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F563	x	x	x	x	8	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F573	x		x	x	8	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F841	x		x	x	10	24	SPC, SDC, SC
54F/74F843	x		x	x	9	24	SPC, SDC, SC
54F/74F845	x		x	x	8	24	SPC, SDC, SC

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
54F/74F160A	4-Bit BCD Decade		Async	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F161A	4-Bit Binary		Async	16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F162A	4-Bit BCD Decade		Sync	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F163A	4-Bit Binary		Sync	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F168	4-Bit BCD Decade	x		16	PC, DC, SC
54F/74F169	4-Bit Binary	x		16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB
54F/74F190	4-Bit BCD Decade	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F191	4-Bit Binary	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F192	4-Bit BCD Decade	x	Async	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F193	4-Bit Binary	x	Async	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F269	8-Bit Binary	x		24	SPC, SDC, SC
54F/74F525	16-Stage Programmable		Async	28	DC, SC, QC
54F/74F568	4-Bit BCD Decade, TRI-STATE	x	Sync/Async	20	PC, DC, SC
54F/74F569	4-Bit Binary, TRI-STATE	x	Sync/Async	20	PC, DC, SC, QC

Shift Registers

Device	Type	Serial Inputs	Parallel Inputs	TRI-STATE Outputs	Pins	Package Codes
54F/74F164	8-Bit	2			14	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F194	4-Bit Bidirectional	2	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F299	8-Bit Octal Storage	2	x	x	20	PC, DC, SC
54F/74F322	8-Bit Parallel	2	x	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F323	8-Bit Storage	2	x	x	20	PC, DC, SC
54F/74F673A	16-Bit Serial/Parallel Out	1		x	24	SPC, SDC
54F/74F675A	16-Bit Serial/Parallel Out	1			24	SPC, SDC
54F/74F676	16-Bit Serial Out	1	x		24	SPC, SDC, SDM, SDMQB, FMQB, LMQB

Microprocessor Support

Device	Type	Pins	Package Codes
54F/74F148	8-Line to 3-Line Priority Encoder	16	PC, DC, SC, QC

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FAST® (54/74Fxxx) (Continued)

ALUs

Device	Arithmetic Functions	Logic Functions	Features	Pins	Package Codes
54F/74F181	16	16	Carry Generate/Propagate Outputs	25	SPC, SDC, SDM, SDMQB, FMQB, LMQB, BLA, BKA
54F/74F381	3	3	Carry Generate/Propagate Outputs	20	PC, DC, SC
54F/74F382	3	3	Ripple Carry Expansion	20	PC, DC, SC
54F/74F582	2		Lookahead and Ripple Carry Expansion	24	SPC, SDC

ALU Support

Device	Type	Pins	Package Codes
54F/74F182	Carry Lookahead Generator	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F350	4-Bit Shifter	16	PC, DC, SC

Adders/Subtractors

Device	Type	Pins	Package Codes
54F/74F283	Binary Full Adder w/Carry Lookahead	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F385	Quad Adder/Subtractor w/Master Reset	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F583	BCD Full Adder w/Carry Lookahead	16	PC, DC, SC, DM, DMQB, FMQB, LMQB

Comparators

Device	Type	No. of Bits	Features	Pins	Package Codes
54F/74F521	Identity	8	Expandable	20	PC, DC, SC, DM, DMQB, FMQB, BRA, BSA, SRA, SSA
54F/74F524	Magnitude OR Complement	8	Expandable, Registered	20	PC, DC, SC

Divider

Device	Type	Features	Pins	Package Codes
54F/74F525	16-Stage Programmable	Crystal Oscillator Circuit	28	DC, SC, QC

Buffers/Line Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
54F/74F125	4		x	14	PC, DC, SC
54F/74F240	8	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F241	8		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F244	8		x	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F365	6		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54F/74F366	6	x		16	PC, DC, SC
54F/74F368	6	x		16	PC, DC, SC
54F/74F540	8	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F541			x	20	PC, DC, SC
54F/74F827	10		x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F828	10	x		24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F2241	8			20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F2244	8			20	PC, DC, SC, DM, DMQB, FMQB, LMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FAST® (54/74Fxxx) (Continued)

Transceivers/Registered Transceivers

Device	Transceivers	Registered	Features	TRI-STATE Outputs	Pins	Package Codes
54F/74F243	4			x	14	DC, DM, DMQB, FMQB, LMQB
54F/74F245	8			x	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A
54F/74F543	8	x		x	24	SPC, SDC, SC, QC
54F/74F544	8	x	Inverting	x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB, BLA, BKA
54F/74F545	8			x	20	PC, DC, SC
54F/74F550	8	x	Status Flags	x	28	DC
54F/74F551	8	x	Status Flags, Inverting	x	28	DC
54F/74F552	8	x	Parity and Flag	x	28	DC, QC
54F/74F588	8		GPIB Compatible	x	20	PC, DC, SC
54F/74F646	8	x		x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F648	8	x	Inverting	x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F651	8	x	Inverting	x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F652	8	x		x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F657	8		Parity	x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F2243	4			x	14	DC, SC
29F52	8	x		x	24	SDC, QC

Multiplexers

Device	Type	Outputs True	Outputs Complement	Pins	Package Codes
54F/74F151A	8-Input	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F153	Dual 4-Input	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F157A	Quad 2-Input	x		16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F158A	Quad 2-Input		x	16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F251A	8-Input	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F253	Dual 4-Input	x		16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F257A	Quad 2-Input	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F258A	Quad 2-Input		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F350	4-Input w/Shift	x		16	PC, DC, SC
54F/74F352	Dual 4-Input		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, SEA, SFA
54F/74F353	Dual 4-Input		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F398	Quad 2-Port w/Flip-Flop	x	x	20	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BRA, BSA, B2A, SRA, SSA
54F/74F399	Quad 2-Port w/Flip-Flop	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FAST® (54/74Fxxx) (Continued)

Decoders/Demultiplexers

Device	Type	TRI-STATE Outputs	Latched Input	Acknowledge Output	Pins	Package Codes
54F/74F138	1-of-8				16	PC, DC, SC, QC, DM, DMQB, FMQB, LMBQ, BEA, BFA, B2A, SEA, SFA
54F/74F139	Dual 1-of-4				16	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54F/74F537	1-of-10	x			20	PC, DC, SC
54F/74F538	1-of-8	x			20	PC, DC, SC
54F/74F539	Dual 1-of-4	x			20	PC, DC, SC
54F/74F547	3-to-8		x	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F548	3-to-8			x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB

Memory

Device	Type	Pins	Package Codes
54F/74F189	16 x 4 RAM	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F219	16 x 4 RAM	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54F/74F403	16 x 4 FIFO	24	SPC, SDC, SCS, DMS, DMQB, FMQB, LMQB
54F/74F413	64 x 4 FIFO	16	PC, DC, DM, DMQB
54F/74F433	64 x 4 FIFO	24	SPC, SDC

Memory Support

Device	Type	Features	Pins	Package Codes
54F/74F407	Data Access Register	TRI-STATE Outputs	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54F/74F410	Register Stack	TRI-STATE Outputs	18	DC, SC, DM, DMQB
54F/74F420	Parallel Check Bit/ Syndrome Bit Generator	TRI-STATE Outputs	48	QC
54F/74F632	32-Bit Error Detection & Correction	Latched TRI-STATE Outputs	52	DC, QC
54F/74F968	1 M-Bit Dynamic RAM Controller	TRI-STATE Outputs	52	QC
29F68	Dynamic RAM Controller	TRI-STATE Outputs	48	QC

Cyclic Redundancy Checker-Generator

Device	Polynomial Length	Expandable	Pins	Package Codes
54F/74F401	16		14	PC, DC, SC
54F/74F402	64	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB

Parity Generator/Checker

Device	Features	Pins	Package Codes
54F/74F280	Odd/Even Outputs, 9 Bits In	14	PC, DC, SC, QC, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54F/74F420	Parallel Check Bit/Syndrome Bit Generator	48	QC

Error Detection and Correction

Device	Features	Pins	Package Codes
54F/74F632	32-Bit Error Detection and Correction	52	DC, QC

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

ALS (54ALSxxx, DM74ALSxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND/NAND Buffer					
54ALS/DM74ALS00A	Quad 2-Input	2	4	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS01	Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS03B	Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS10A	Triple 3-Input	3	3	14	M, N, E/883, J/883, W/883
54ALS/DM74ALS12A	Triple 3-Input	3	3	14	M, N
54ALS/DM74ALS13	Dual 4-Input Schmitt Trigger	4	2	14	M, N
54ALS/DM74ALS20A	Dual 4-Input	4	2	14	M, N, E/883, J/883, W/883, DA
54ALS/DM74ALS22B	Dual 4-Input	4	2	14	M, N
54ALS/DM74ALS30A	8-Input	8	1	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS37A	Quad 2-Input Buffer	2	4	14	M, N
54ALS/DM74ALS38A	Quad 2-Input Buffer	2	4	14	M, N
54ALS/DM74ALS40A	Dual 4-Input Buffer	4	2	14	M, N
54ALS/DM74ALS132	Quad 2-Input Schmitt Trigger	2	4	14	M, N
54ALS/DM74ALS133	13-Input	13	1	16	M, N
54ALS/DM74ALS1000A	Buffered Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS1003A	Buffered Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS1010A	Buffered Triple 3-Input	3	3	14	M, N
54ALS/DM74ALS1020A	Buffered Dual 4-Input	4	2	14	M, N
AND					
54ALS/DM74ALS08	Quad 2-Input	2	4	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS09	Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS11A	Triple 3-Input	3	3	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS15A	Triple 3-Input	3	3	14	M, N
54ALS/DM74ALS21A	Dual 4-Input	4	2	14	M, N, E/883, J/883, W/883, CA, DA, 2A
54ALS/DM74ALS1008A	Buffered Quad 2-Input	2	4	14	M, N
54ALS/DM74ALS1011A	Buffered Triple 3-Input	3	3	14	M, N
OR/NOR, Exclusive-OR					
54ALS/DM74ALS02	Quad 2-Input NOR	2	4	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS27	Triple 3-Input NOR	3	3	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS28A	Quad 2-Input NOR	2	4	14	M, N
54ALS/DM74ALS32	Quad 2-Input OR	2	4	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS33A	Quad 2-Input NOR	2	4	14	M, N
54ALS/DM74ALS86	Quad 2-Input Exclusive-OR	2	4	14	M, N
54ALS/DM74ALS136	Quad 2-Input Exclusive-OR	2	4	14	M, N
54ALS/DM74ALS810	Quad 2-Input Exclusive-OR	2	4	14	M, N
54ALS/DM74ALS811	Quad 2-Input Exclusive-OR	2	4	14	M, N
54ALS/DM74ALS1002A	Buffered Quad 2-Input NOR	2	4	14	M, N
54ALS/DM74ALS1032A	Buffered Quad 2-Input OR	2	4	14	M, N
AND/OR-Invert					
54ALS/DM74ALS04B	Hex Inverter	1	6	14	M, N, E/883, J/883, W/883, DA, 2A
54ALS/DM74ALS05A	Hex Inverter	1	6	14	M, N
54ALS/DM74ALS14	Hex Schmitt Trigger Inverter	1	6	14	M, N
54ALS/DM74ALS1004	Buffered Hex Inverter	1	6	14	M, N
54ALS/DM74ALS1005	Buffered Hex Inverter	1	6	14	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

ALS (54ALSxxx, DM74ALSxxx) (Continued)

Flip-Flops

Device	Type	Flip-Flop Type	Pins	Package Codes
54ALS/DM74ALS74A	Dual Positive Edge-Trigger	D	14	M, N
54ALS/DM74ALS109A	Dual Positive Edge-Trigger	JK	16	M, N
54ALS/DM74ALS174	Hex Master Reset	D	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS175	Quad Master Reset	D	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS273	Octal D		20	M, N, E/883, J/883, W/883, RA, SA, 2A
54ALS/DM74ALS374	Octal, TRI-STATE Outputs	D	20	M, N, E/883, J/883, W/883, RA, SA, 2A
54ALS/DM74ALS534	Octal, TRI-STATE Outputs	D	20	M, N
54ALS/DM74ALS564A	Octal, TRI-STATE Outputs	D	20	M, N
54ALS/DM74ALS574A	Octal, TRI-STATE Outputs	D	20	M, N
54ALS/D74ALS576A	Octal D	D	20	M, N
54ALS/DM74ALS874B(NT)	Dual 4-Bit D	D	24	M, N
54ALS/DM74ALS876A(NT)	Dual 4-Bit D	D	24	M, N

Latches

Device	Broadside Pinout	Inverting	Transparent	TRI-STATE® Outputs	No. of Bits	Pins	Package Codes
54ALS/DM74ALS373			x	x	8	20	M, N
54ALS/DM74ALS533		x	x	x	8	20	M, N
54ALS/DM74ALS563A	x	x	x	x	8	20	M, N
54ALS/DM74ALS573B	x		x	x	8	20	M, N
54ALS/DM74ALS580A					8	20	M, N
54ALS/DM74ALS873B(NT)					4	24	M, N
54ALS/DM74ALS880A(NT)					4	24	M, N

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
54ALS/DM74ALS160B	4-Bit BCD Decade		Async	16	M, N
54ALS/DM74ALS161B	4-Bit Binary		Async	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS162B	4-Bit BCD Decade		Sync	16	M, N
54ALS/DM74ALS163B	4-Bit Binary		Sync	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS168B	4-Bit BCD Decade	x		16	M, N
54ALS/DM74ALS169B	4-Bit Binary	x		16	M, N

Comparators

Device	Type	No. of Bits	Features	Pins	Package Codes
54ALS/DM74ALS518		8		20	M, N
54ALS/DM74ALS519		8		20	M, N
54ALS/DM74ALS520		8		20	M, N
54ALS/DM74ALS521	Identity	8	Expandable	20	M, N
54ALS/DM74ALS522		8		20	M, N
54ALS/DM74ALS689		8		20	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

ALS (54ALSxxx, DM74ALSxxx) (Continued)

Buffers/Line Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
54ALS/DM74ALS240A	8	x		20	M, N, E/883, J/883, W/883, SA
54ALS/DM74ALS241A	8		x	20	M, N
54ALS/DM74ALS244A	8		x	20	M, N, E/883, J/883, W/883, SA, 2A
54ALS/DM74ALS465A	8		x	20	M, N
54ALS/DM74ALS466A	8	x		20	M, N
54ALS/DM74ALS467A	8		x	20	M, N
54ALS/DM74ALS468A	8	x		20	M, N
54ALS/DM74ALS540A	8	x		20	M, N
54ALS/DM74ALS541			x	20	M, N
54ALS/DM74ALS804A				20	M, N
54ALS/DM74ALS805A				20	M, N
54ALS/DM74ALS808A				20	M, N
54ALS/DM74ALS832A				20	M, N
54ALS/DM74ALS1034				14	M, N
54ALS/DM74ALS1035				14	M, N
54ALS/DM74ALS2541			x	20	M, N

Transceivers/Registered Transceivers

Device	Transceivers	Registered	Features	TRI-STATE Outputs	Pins	Package Codes
54ALS/DM74ALS242C				x	14	M, N
54ALS/DM74ALS243A	4			x	14	M, N
54ALS/DM74ALS245A	8			x	20	M, N
54ALS/DM74ALS645A	8				20	M, N
54ALS/DM74ALS646(NT)	8	x		x	24	M, N
54ALS/DM74ALS648(NT)	8	x	Inverting	x	24	M, N
54ALS/DM74ALS652(NT)	8	x	Noninverting	x	24	M, N
54ALS/DM74ALS1240A			Inverting	x	20	M, N
54ALS/DM74ALS1241A			Noninverting	x	20	M, N
54ALS/DM74ALS1242A			Inverting	x	14	M, N
54ALS/DM74ALS1243A			Noninverting	x	14	M, N
54ALS/DM74ALS1244A			Inverting	x	14	M, N

Multiplexers

Device	Type	Outputs		Pins	Package Codes
		True	Complement		
54ALS/DM74ALS151	2-Input	x	x	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS153	Dual 4-Input	x		16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS251	8-Input	x	x	16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS253	Dual 4-Input	x		16	M, N, E/883, J/883, W/883, EA, FA, 2A
54ALS/DM74ALS257	Quad 2-Input	x		16	M, N
54ALS/DM74ALS258	Quad 2-Input		x	16	M, N
54ALS/DM74ALS352	Dual 4-Input		x	16	M, N
54ALS/DM74ALS353	Dual 4-Input		x	16	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

ALS (54ALSxxx, DM74ALSxxx) (Continued)

Decoder/Demultiplexers

Device	Type	Pins	Package Codes
54ALS/DM74ALS131	3-of-8	16	M, N
54ALS/DM74ALS137	3-of-8	16	M, N
54ALS/DM74ALS138	1-of-8	16	M, N, E/883, J/883, W/883, DA, 2A

Memory Support/Error Detection and Correction

Device	Type	Features	Pins	Package Codes
54ALS/DM74ALS632	32-Bit Error Detection and Correction	Latched, TRI-STATE Outputs	52	D,V

Shift Register

Device	Type	Pins	Package Codes
54ALS/DM74ALS166	8-Bit Shift Register	16	M,N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

AS (DM74ASxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND/NAND Buffers					
DM74AS00	Quad 2-Input	2	4	14	M, N
DM74AS10	Triple 3-Input	3	3	14	M, N
DM74AS20	Dual 4-Input	4	2	14	M, N
DM74AS30	8-Input	8	1	14	M, N
AND					
DM74AS08	Quad 2-Input	2	4	14	M, N
DM74AS11	Triple 3-Input	3	3	14	M, N
DM74AS21	Dual 4-Input	4	2	14	M, N
OR/NOR, Exclusive-OR					
DM74AS02	Quad 2-Input NOR	2	4	14	M, N
DM74AS27	Triple 3-Input NOR	3	3	14	M, N
DM74AS32	Quad 2-Input OR	2	4	14	M, N
DM74AS86	Quad 2-Input Exclusive-OR	2	4	14	M, N
DM74AS136	Quad 2-Input Exclusive-OR	2	4	14	N
DM74AS810	Quad 2-Input Exclusive-OR	2	4	14	N
DM74AS811	Quad 2-Input Exclusive-OR	2	4	14	N
AND/OR-Invert					
DM74AS04	Hex Inverter	1	6	14	M, N
DM74AS34	Hex Non-Inverter	1	6	14	N
DM74AS1004	Hex Inverter	1	6	14	N

Flip-Flops/Registers

Device	Type	Flip-Flop Type	Pins	Package Codes
DM74AS74	Dual Positive Edge-Trigger	D	14	M, N
DM74AS109	Dual Positive Edge-Trigger	JK	16	N
DM74AS174	Hex Master Reset	D	16	N
DM74AS175	Quad Master Reset	D	16	N
DN74AS374	Octal, TRI-STATE® Outputs	D	20	N
DN74AS534	Octal, TRI-STATE Outputs	D	20	N
DN74AS574	Octal, TRI-STATE Outputs	D	20	M, N
DN74AS575(NT)	Octal, TRI-STATE Outputs	D	24	N
DM74AS576	Octal, TRI-STATE Outputs	D	20	N
DM74AS577(NT)	Octal, TRI-STATE Outputs	D	24	N
DM74AS874(NT)	Dual 4-Bit, TRI-STATE Outputs	D	24	N
DM74AS876(NT)	Dual 4-Bit, TRI-STATE Outputs	D	24	N
DM74AS878(NT)	Dual 4-Bit, TRI-STATE Outputs	D	24	N
DM74AS879(NT)	Dual Quad	D	24	M

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

AS (DM74ASxxx) (Continued)

Latches

Device	Broadside Pinout	Inverting	Transparent	TRI-STATE Outputs	No. of Bits	Pins	Package Codes
DM74AS373			x	x	8	20	M, N
DM74AS533		x	x	x	8	20	N
DM74AS573	x		x	x	8	20	M, N
DM74AS580		x		x	8	20	N
DM74AS873(NT)				x	4	24	N
DM74AS880(NT)		x		x	4	24	N

Counters

Device	Type	Up/Down	Reset	Pins	Package Codes
DM74AS160	4-Bit BCD Decade		Async	16	N
DM74AS161	4-Bit Binary		Async	16	M, N
DM74AS162	4-Bit BCD Decade		Sync	16	N
DM74AS163	4-Bit Binary		Sync	16	M, N
DM74AS168	4-Bit BCD Decade	x		16	N
DM74AS169A	4-Bit Binary	x		16	M, N

ALUs/ALU Support

Device	Arithmetic Functions	Logic Functions	Features	Pins	Package Codes
DM74AS181B(NT)	16	16	Carry Generate/Propagate Outputs	24	N
DM74AS182			Carry Lookahead Generator	16	N
DM74AS264			Counter Lookahead	16	N
DM74AS282			Carry Lookahead Generator	20	M, N

Buffers/Line Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
DM74AS230	8		x	20	M, N
DM74AS231	8	x		20	N
DM74AS240	8	x		20	M, N
DM74AS241	8		x	20	M, N
DM74AS244	8		x	20	N
DM74AS804B				20	N
DM74AS805B				20	N
DM74AS808B				20	N
DM74AS832B				20	N
DM74AS1000A				14	N
DM74AS1008A				14	N
DM74AS1032A				14	N
DM74AS1034A				14	N
DM74AS1036A				14	N
DM74AS1804				20	N
DM74AS1805				20	N
DM74AS1808				20	N
DM74AS1832				20	N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

AS (DM74ASxxx) (Continued)

Transceivers/Registered Transceivers

Device	Transceivers	Registered	Features	TRI-STATE Outputs	Pins	Package Codes
DM74AS242				x	14	N
DM74AS243	4			x	14	N
DM74AS245	8			x	20	M, N
DM74AS620			Inverting	x	20	M, N
DM74AS640			Inverting	x	20	M, N
DM74AS645			Noninverting	x	20	N
DM74AS646(NT)	8	x		x	24	N
DM74AS648(NT)	8	x	Inverting	x	24	N
DM74AS651(NT)	8	x	Inverting	x	24	N
DM74AS652(NT)	8	x	Noninverting	x	24	N
DM74AS2620					20	N

Multiplexers

Device	Type	Outputs		Pins	Package Codes
		True	Complement		
DM74AS157	Quad 2-Input	x		16	N
DM74AS158	Quad 2-Input		x	16	N
DM74AS257	Quad 2-Input	x		16	N
DM74AS258	Quad 2-Input		x	16	N

Parity Generator/Checker

Device	Features	Pins	Package Codes
DM74AS280	Odd/Even Outputs, 9 Bits In	14	M, N
DM74AS286		14	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS)

Gates

Device	Type	Open Collector	Pins	Package Codes
NAND				
54LS/DM54LS/DM74LS00	Quad 2-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS03	Quad 2-Input	x	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS04	Hex Inverter		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A, SCA, SDA
54LS/DM54LS/DM74LS05	Hex Inverter	x	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A, SCA, SDA
54LS/DM54LS/DM74LS10	Triple 3-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS12	Triple 3-Input		14	M, N
54LS/DM54LS/DM74LS13	Dual 4-Input Schmitt		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS14	Hex Schmitt Trigger Inverter		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS20	Dual 4-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A
54LS/DM54LS/DM74LS22	Dual 4-Input	x	14	M, N, DM, DMQB, FMQB, BCA, BDA, B2A
54LS/DM54LS/DM74LS26	Quad 2-Input (12V)		14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS30	8-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS37	Quad 2-Input Buffer		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS38	Quad 2-Input (48 mA)	x	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A
54LS/DM54LS/DM74LS40	Dual 4-Input Buffer		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS132	Quad 2-Input Schmitt		14	M, N, J/883
54LS/DM54LS/DM74LS133	13-Input		16	M, N, DM, DMQB, FMQB, LMQB
NOR				
54LS/DM54LS/DM74LS02	Quad 2-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A, SCA, SDA
54LS/DM54LS/DM74LS27	Triple 3-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA
54LS/DM54LS/DM74LS28	Quad 2-Input		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS33	Quad 2-Input	x	14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS260	Dual 5-Input		14	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS266	Quad 2-Input	x	14	M, N, DM, DMQB, FMQB, BCA, BDA, B2A
AND				
54LS/DM54LS/DM74LS08	Quad 2-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A
54LS/DM54LS/DM74LS09	Quad 2-Input	x	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS11	Triple 3-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A, SCA, SDA
54LS/DM54LS/DM74LS15	Triple 3-Input	x	14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS21	Dual 4-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A, SCA, SDA
OR				
54LS/DM54LS/DM74LS32	Quad 2-Input		14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS) (Continued)

Gates (Continued)

Device	Type	Open Collector	Pins	Package Codes
Exclusive-OR				
54LS/DM54LS/DM74LS86	Quad 2-Input		14	M, N, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS136	Quad 2-Input	x	14	M, N, DM, DMQB, FMQB, J/883
54LS/DM54LS/DM74LS386	Quad 2-Input		14	M, N
AND/OR-Invert				
54LS/DM54LS/DM74LS51	Quad 2-2 Input		14	M, N, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A
54LS/DM54LS/DM74LS54	4-Wide, 2-Input		14	M, N, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A
54LS/DM54LS/DM74LS55	2-Wide, 4-Input		14	M, N, DM, DMQB, FMQB

Buffer Gates and Drivers

Device	Type	TRI-STATE®	Pins	Package Codes
54LS/DM54LS/DM74LS125A	Quad Buffer	x	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS126	Quad Buffer	x	14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS365A	Hex	x	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS366A	Hex Inverter	x	16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54LS/DM54LS/DM74LS367A	Hex	x	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS368A	Hex Inverter	x	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
DM81LS95	Octal Buffer	x	20	M, N
DM81LS96	Octal Buffer	x	20	M, N
DM81LS97	Octal Buffer	x	20	M, N
DM81LS98	Octal Buffer	x	20	M, N

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/DM54LS/DM74LS73	Dual JK	J, K		x	15	14	M, N, J/883, W/883
54LS/DM54LS/DM74LS74A	Dual D	D	x	x	30	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, B2A
54LS/DM54LS/DM74LS107	Dual JK	J, K		x	15	14	M, N, J/883, W/883
54LS/DM54LS/DM74LS109A	Dual JK	J, K	x	x	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS112	Dual JK	J, K	x	x	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS113	Dual JK					14	DM, DMQB, FMQB, LMQB, BCA, BDA, B2A, SCA, SDA
54LS/DM54LS/DM74LS114	Dual JK	J, K	x	x	30	14	M, N, DM, DMQB, FMQB, LMQB, BCA, BDA, B2A
54LS/DM54LS/DM74LS174	Hex D	D		x	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS175	Quad	D		x	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS374	Octal D	D			35	20	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS377	Octal D	D			30	20	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS574	Octal D	D			35	20	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS) (Continued)

Latches

Device	Type	Data Inputs	Common Clear	Enable Inputs (Level)	Min. Enable Pulse Width (ns)	Max. Delay Enable to Outputs (ns)	Pins	Package Codes
54LS/DM54LS/DM74LS75	Quad	1		1(L)	20	30	16	M, N, J/883, W/883
54LS/DM54LS/DM74LS170	16-Bit D	4		2	25	35	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS256	Dual 4-Bit Addressable	8	L	2(L)	17	27	16	N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS259	8-Bit Addressable	1	L	1(L)	17	27	16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54LS/DM54LS/DM74LS279	4-Bit Set-Reset	4					16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS373	8-Bit D	8		1(H)	15	30	20	M, N, J/883, W/883
54LS/DM54LS/DM74LS375	4-Bit D	4		2(H)	20	30	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS533	8-Bit D	8		1(H)	15	30	20	M, N
54LS/DM54LS/DM74LS563	8-Bit D	8		1(H)	15	30	20	M, N
54LS/DM54LS/DM74LS573	8-Bit D	8		1(L)	15	30	20	M, N
54LS/DM54LS/DM74LS670	16-Bit D	4		2	25	35	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/DM54LS/DM74LS174	6-Bit D	6	L	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS175	4-Bit D	4	L	30	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS374	8-Bit D	8		35	20	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS534	8-Bit D	8		35	20	M, N
54LS/DM54LS/DM74LS564	8-Bit D	8		35	20	M, N

Multiplexers

Device	Type	Enable Inputs	Outputs		Pins	Package Codes
			True	Complement		
54LS/DM54LS/DM74LS151	8-Input	1	x	x	16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS153	Dual 4-Input	2	x		16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS157	Quad 2-Input	1	x		16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS158	Quad 2-Input	1		x	16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS251	8-Input	1	TRI-STATE	TRI-STATE	16	M, N, J/883, W/883, BEA, BFA, SEA
54LS/DM54LS/DM74LS253	Dual 4-Input	2	TRI-STATE		16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS257A	Quad 2-Input	1	TRI-STATE		16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS258A	Quad 2-Input	1		TRI-STATE	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS298	Quad 2-Port	Clock Edge-Trigger	Latched		16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS352	Dual 4-Input	2		x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS353	Dual 4-Input	2		TRI-STATE	16	M, N, DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS) (Continued)

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low Enable	Active Low Outputs	Open Collector Output Voltage (V)	Pins	Package Codes
54LS/DM54LS/DM74LS42	1-of-10	4(BCD)		10		16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS138	1-of-8	3	2	8		16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS139	Dual 1-of-4	2 + 2	1 + 1	4 + 4		16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS154	4-of-16	4				24	M, N, J/883
54LS/DM54LS/DM74LS155	Dual 1-of-4	2	2 + 1	4 + 4		16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS156	Dual 1-of-4	2	2 + 1	4 + 4	5.5	16	M, N, DM, DMQB, FMQB, J/883, W/883
54LS/DM54LS/DM74LS259	1-of-8	3	1	8H		16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/DM54LS/DM74LS95B	Right/Left Shift	4	D	4S	30	14	M, N, DM, DMQB, FMQB, BCA, BDA
54LS/DM54LS/DM74LS164	Serial-In/Parallel-Out Shift	8	2D		25	14	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BCA, BDA, SCA, SDA
54LS/DM54LS/DM74LS165	Parallel/Serial-In Serial-Out Shift	8	D	8A	30	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS166	Parallel-In/Serial-Out	8		8S	25	16	M, N
54LS/DM54LS/DM74LS170	Register File (OC)	4 x 4		4A		16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS173	Quad D (TRI-STATE)	4		4S	30	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS194A	Bidirectional Universal	4	DR, DL	4S	30	16	M, N, DM, DMQB, FMQB, LMQB, BEA, BFA, B2A
54LS/DM54LS/DM74LS195A	Universal Shift	4	J, K	4S	30	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS273	Octal D	8		8S	30	20	M, N, DM, DMQB, DMQB, FMQB, BRA, BSA
54LS/DM54LS/DM74LS295A	Shift (TRI-STATE)	4	D	4S	30	14	N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS298	Quad 2-Port	4		2D (Mux)	30	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS299	Universal Shift/Storage	8	DR, DL	8S	35	20	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS322	Serial/Parallel (TRI-STATE)	4	D	4S	30	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS323	Universal Shift/Storage	8	DR, DL	8S	35	20	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS378	Parallel D	6		6S	30	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS379	Quad D	4		4S	30	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS395	Parallel Shift Right (TRI-STATE)	4	D	4S	30	16	M, N, DM, DMQB, FMQB, LMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS) (Continued)

Registers (Continued)

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/DM54LS/DM74LS502	Successive Approximation	8	D		15	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS503	Successive Approximation	8	D		15	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS670	Register File (TRI-STATE)	4 x 4		4A		16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA
54LS/DM54LS/DM74LS952	Shift Register	8			25	18	N
54LS/DM54LS/DM74LS962	Shift Register	8			25	18	N

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/DM54LS/DM74LS90	Decade	2 x 5		32	14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS93	Divide-by-16	2 x 8		32	14	M, N
54LS/DM54LS/DM74LS160A	BCD Decade	10P	Sync	25	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS161A	Binary	16P	Sync	25	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS162A	BCD Decade	10P	Sync	25	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS163A	Binary	16P	Sync	25	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883
54LS/DM54LS/DM74LS168	Bidirectional BCD Decade		Sync		16	DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS169	Up/Down	16P	Sync	25	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA
54LS/DM54LS/DM74LS190	Up/Down Decade	10	Async	20	16	M, N, J/883, W/883
54LS/DM54LS/DM74LS191	Up/Down Binary	16	Async	20	16	M, N, J/883, W/883
54LS/DM54LS/DM74LS192	Up/Down Decade	10	Async	30	16	M, N, DM, DMQB, FMQB, LMQB
54LS/DM54LS/DM74LS193	Up/Down Binary	16	Async	30	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A, SEA, SFA
54LS/DM54LS/DM74LS196	Decade	2 x 5	Async	45	14	M, N
54LS/DM54LS/DM74LS197	Binary	2 x 8	Async	50	14	M, N
54LS/DM54LS/DM74LS290	BCD Decade	2 x 5		32	14	M, N
54LS/DM54LS/DM74LS293	Binary	2 x 8		32	14	M, N
54LS/DM54LS/DM74LS390	Dual Decade	2 x 5		40	16	M, N
54LS/DM54LS/DM74LS393	Dual Modulo 16	2 x 8		40	14	M, N
54LS/DM54LS/DM74LS490	Dual Decade	2 x 5		40	16	M, N, DM, DMQB, FMQB

Display Decoder/Drivers

Device	Type	Output Current (mA)	Output Voltage (V)	Active High/Low	Ripple Blanking	Pins	Package Codes
54LS/DM54LS/DM74LS47	BCD to 7 Segment	24.0	15.0	L	x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS48	BCD to 7 Segment	1.3	5.5	H	x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS247	BCD to 7 Segment	24.0	15.0	L	x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS248	BCD to 7 Segment	1.3	5.5	H	x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS249	BCD to 7 Segment	8.0	5.5	H	x	16	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS347	BCD to 7 Segment	24.0	7.0	L	x	14	M, N, DM, DMQB, FMQB
54LS/DM54LS/DM74LS447	BCD to 7 Segment	24.0	7.0	L	x	16	M, N, DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power Schottky (54LS, DM54LS, DM74LS, DM81LS, DM96LS) (Continued)

Monostables (One Shots)

Device	Type	Pulse Width Variations (%) vs. Temp	Pulse Width Variations (%) vs. Vcc	No. of Inputs Pos.	No. of Inputs Neg	Min. Outputs (tw) (ns)	Pins	Package Codes
54LS/DM54LS/DM74LS122	Single, Retriggerable	±3.0	±2.0			40	14	M, N
54LS/DM54LS/DM74LS123	Dual, Retriggerable	±2.0	±1.0			40	16	M, N
54LS/DM54LS/DM74LS221	Dual	±1.0	±1.0			40	16	M, N
DM96LS02	Dual Retriggerable Resettable	±1.0	±0.8	1	1	35	16	M, N, DM, DMQB, FMQB

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min I_{OS} (mA)	Pins	Package Codes
54LS/DM54LS/DM74LS240	Octal Inverting Bus Driver, TRI-STATE	Any TTL	64	−40	20	M, N, DM, DMQB, FMQB, LMQB, J/883, BRA, BSA, B2A
54LS/DM54LS/DM74LS241	Octal Noninverting Bus Driver TRI-STATE	Any TTL	64	−40	20	M, N, DM, DMQB, FMQB, LMQB, J/883, BRA, BSA, B2A, SRA, SSA
54LS/DM54LS/DM74LS243	Octal Bus Transceiver	Any TTL	24	−40	20	M, N
54LS/DM54LS/DM74LS244	Octal Noninverting Bus Driver TRI-STATE	Any TTL	64	−40	20	M, N, DM, DMQB, FMQB, LMQB, BRA, BSA, SSA
54LS/DM54LS/DM74LS245	Octal Bus Transceiver	Any TTL	24	−40	20	M, N, DM, DMQB, FMQB, J/883
54LS/DM54LS/DM74LS645	Octal Bus Transceiver	Any TTL	24	−40	20	M, N

Arithmetic Operators, 4-Bit

Device	Type	Features	Pins	Package Codes
54LS/DM54LS/DM74LS83A	Adder	Full Binary 4-Bit with Carry	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS85	Comparator	4-Bit Magnitude with Expander	16	M, N, DM, DMQB, FMQB, J/883, W/883, BEA, BFA, B2A
54LS/DM54LS/DM74LS181	Arithmetic Logic	External Carry Lookahead	24	N, DM, DMQB, LMQB
54LS/DM54LS/DM74LS283	Adder	Full Binary 4-Bit with Carry	16	M, N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA, B2A

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Schottky (DM54Sxx, DM74Sxx, DM93Sxx, DM96Sxx)

Gates

Device	Type	Open Collector	Pins	Package Codes
NAND				
DM54S/DM74S00	Quad 2-Input		14	M, N, J/883, W/883
DM54S/DM74S03	Quad 2-Input	x	14	N
DM54S/DM74S04	Hex Inverter		14	M, N, J/883, W/883
DM54S/DM74S05	Hex Inverter	x	14	M, N
DM54S/DM74S10	Triple 3-Input		14	N, J/883, W/883
DM54S/DM74S20	Dual 4-Input		14	N, J/883, W/883
DM54S/DM74S30	8-Input		14	N, J/883, W/883
DM54S/DM74S40	Dual 4-Input Buffer		14	N, J/883, W/883
DM54S/DM74S132	Quad 2-Input Schmitt		14	N
DM54S/DM74S133	13-Input		14	M, N, J/883
AND				
DM54S/DM74S07	Quad 2-Input	x	14	N
DM54S/DM74S08	Quad 2-Input		14	N, J/883, W/883
DM54S/DM74S11	Triple 3-Input		14	N, J/883, W/883
NOR				
DM54S/DM74S02	Quad 2-Input		14	N, J/883, W/883
OR				
DM54S/DM74S32	Quad 2-Input		14	N, J/883, W/883
Exclusive-OR				
DM54S/DM74S86	Quad 2-Input		14	M, N, J/883, W/883
AND/OR-Invert				
DM54S/DM74S51	Quad 2-2 Input		14	N
DM54S/DM74S64	4-2-3-2 Input		14	N, J/883, W/883

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
DM54S/DM74S74	Dual D	D	x	x	75	14	M, N, J/883, W/883
DM54S/DM74S109	Dual J-K	J, K	x	x	75	16	N
DM54S/DM74S112	Dual J-K	J, K	x	x	80	16	M, N, J/883
DM54S/DM74S113	Dual J-K	J, K	x		80	14	N, J/883
DM54S/DM74S174	Hex D	D		x	75	16	N, J/883
DM54S/DM74S175	Quad D	D		x	75	16	N, J/883, W/883
DM54S/DM74S374	Octal D	D			75	20	M, N

Latches

Device	Type	Data Inputs	Pins	Package Codes
DM54S/DM74S373	Octal D	D	20	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Schottky (DM54Sxx, DM74Sxx, DM93Sxx, DM96Sxx) (Continued)

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
DM54S/DM74S174	6-Bit D	6	L	75	16	N, J/883
DM54S/DM74S175	4-Bit D	4	L	75	16	N, J/883, W/883

Multiplexers

Device	Type	Enable Inputs	Outputs		Pins	Package Codes
			True	Complement		
DM54S/DM74S151	8-Input	1	x	x	16	M, N, J/883, W/883
DM54S/DM74S153	Dual 4-Input	2	x		16	N, J/883
DM54S/DM74S157	Quad 2-Input	1	x		16	N, J/883, W/883
DM54S/DM74S158	Quad 2-Input	1		x	16	N, J/883, W/883
DM54S/DM74S251	8-Input	1	x	x	16	N, J/883
DM54S/DM74S253	Dual 4-Input	2	TRI-STATE		16	N, J/883, W/883
DM54S/DM74S257	Quad 2-Input	1	TRI-STATE		16	N, J/883, W/883
DM54S/DM74S258	Quad 2-Input	1		TRI-STATE	16	N, J/883

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low		Pins	Package Codes
			Enable	Outputs		
DM54S/DM74S138	1-of-8	3	2	8	16	N, J/883, W/883
DM54S/DM74S139	Dual 1-of-4	3	2	8	16	N, J/883, W/883

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
DM54S/DM74S194	Bidirectional Universal	4	DR, DL	4 Sync	70	16	N, J/883
DM54S/DM74S195	Parallel Shift	4	J, K	4	70	16	N, J/883
DM54S/DM74S299	Universal Shift	8		8	50	20	N
DM93S00	Universal Shift	4	J, K	4 Sync	70	16	N

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
DM54S/DM74S10	BCD Decade	10 Presettable	Sync	70	16	N, J/883, W/883
DM54S/DM74S16	4-Bit Binary	16 Presettable	Sync	70	16	N
DM54S/DM74S161	4-Bit Binary	16 Presettable	Sync	40	16	N, J/883, W/883
DM54S/DM74S163	4-Bit Binary	16 Presettable	Sync	40	16	N, J/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Schottky (DM54Sxx, DM74Sxx, DM93Sxx, DM96Sxx) (Continued)

Monostables (One-Shots)

Device	Type	Pulse Width Variation (%) vs. Temp	Pulse Width Variation (%) vs. Vcc	No. of Inputs Pos.	No. of Inputs Neg.	Min. Output (tw) (ns)	Pins	Package Codes
DM96S02	Dual Retriggerable, Resettable	±1.0	±1.0	1	1	27	16	N

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min. I_{OS} (mA)	Pins	Package Codes
DM54S/DM74S40	Dual 4-Input NAND Buffer	Any TTL	60	−50	14	N, J/883, W/883
DM54S/DM74S140	Dual 4-Input NAND Line Driver	Any TTL	60	−50	14	N, J/883
DM54S/DM74S240	Octal Line Driver	Any TTL	64	−50	20	M, N, J/883
DM54S/DM74S241	Octal Line Driver	Any TTL	64	−50	20	N, J/883
DM54S/DM74S244	Octal Line Driver	Any TTL	64	−50	20	M, N, J/883, W/883

Arithmetic Operators

Device	Type	Features	No. of Bits	Pins	Package Codes
DM54S/DM74S181	ALU		4	24	N, J/883
DM54S/DM74S182	Lookahead Carry			16	N, J/883
DM54S/DM74S280	Parity	9-Bit Generator/Checker	9	14	M, N, J/883, W/883
DM54S/DM74S283	Binary Adder	4-Bit	4	16	N, J/883
DM54S/DM74S381	ALU		4	20	N
DM93S41	Arithmetic Logic	External CLA	4	24	N
DM93S43	Multiplier	Twos Complement	4 x 2	24	N
DM93S46	Comparator	6-Bit Identity w/Expander	6	16	N
DM93S47	Comparator, High-Speed	16-Bit Identity, Open Collector	6	16	N
DM93S62	Parity	9-Bit Parity Generator	9	14	N

Memory

Device	Type	No. of Bits	Pins	Package Codes
DM54S/DM74S189	16 x 4 BIP RAM	64	16	J/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Standard TTL (54xx, DM54xx, DM74xx, DM93xx, DM96xx, DM8xxx)

Gates

Device	Type	Open Collector	Pins	Package Codes
NAND				
54/DM54/DM7400	Quad 2-Input		14	M, N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7401	Quad 2-Input	x	14	N, J/883, W/883, BCA, BDA
54/DM54/DM7403	Quad 2-Input	x	14	N, J/883, BCA
54/DM54/DM7404	Hex Inverter		14	M, N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7405	Hex Inverter	x	14	N, J/883, W/883, BCA, BDA
54/DM54/DM7406	Hex Inverter (30V)	x	14	M, N, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7410	Triple 3-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, SCA
54/DM54/DM7414	Hex Schmitt Trigger		14	N, J/883, W/883, BCA, BDA
54/DM54/DM7416	Hex Inverter (15V)	x	14	N, J/883, W/883, BCA, BDA
54/DM54/DM7420	Dual 4-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
54/DM54/DM7426	Quad 2-Input (15V)	x	14	N
54/DM54/DM7430	8-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, SCA
54/DM54/DM7437	Quad 2-Input Buffer		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7438	Quad 2-Input (48 mA)	x	14	M, N, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7439	Quad 2-Input NAND Buffer	x	14	N
54/DM54/DM7440	Dual 4-Input Buffer		14	N, DM, DMQB, FMQB, BCA, BDA
54/DM54/DM74132	Quad 2-Input Schmitt		14	N, J/883, W/883
DM96101	Quad 2-Input NAND Buffer	x	14	N
NOR				
54/DM54/DM7402	Quad 2-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7425	Dual 4-Input w/Strobe		14	N, DM, DMQB, FMQB
54/DM54/DM7427	Triple 3-Input		14	N
AND				
54/DM54/DM7407	Hex Buffer (30V)	x	14	M, N, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7408	Quad 2-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7409	Quad 2-Input	x	14	N, DM, DMQB, FMQB, BCA, BDA
54/DM54/DM7411	Triple 3-Input		14	N
54/DM54/DM7417	Hex Buffer (15V)	x	14	N, J/883, W/883, BCA, BDA
OR				
54/DM54/DM7432	Quad 2-Input		14	N, DM, DMQB, FMQB, J/883, W/883
Exclusive-OR				
54/DM54/DM7486	Quad 2-Input		14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
AND/OR-Invert				
54/DM54/DM7450	Quad 2-2 Input Expandable		14	N
54/DM54/DM7451	Dual 2-2 Input		14	N, DM, DMQB, FMQB

Buffers/Line Drivers

Device	Type	TRI-STATE®	Pins	Package Codes
54/DM54/DM74125	Quad Bus Buffer	x	14	N, DM, DMQB, FMQB, J/883, W/883
54/DM54/DM74365	Hex	x	16	N, J/883, W/883
54/DM54/DM74367	Hex	x	16	N, J/883, W/883
54/DM54/DM74368	Hex	x	16	N, J/883, W/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Standard TTL (54xx, DM54xx, DM74xx, DM93xx, DM96xx, DM8xxx) (Continued)

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/DM54/DM7473	Dual J-K	J, K		x	15	14	N, DM, DMQB, FMQB, J/883, W/883
54/DM54/DM7474	Dual D	D	x	x	15	14	M, N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7476	Dual J-K	J, K	x	x	15	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74107	Dual J-K	J, K		x	15	14	N, J/883, BCA, BDA
54/DM54/DM74109	Dual J-K	J, K	x	x	30	16	N, J/883, W/883
54/DM54/DM74174	Hex D				25	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74175	Quad D				25	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
DM9093	Dual J-K					14	DMQB, FMQB
DM9099	Dual J-K					14	DMQB, FMQB

Latches

Device	Type	Data Inputs	Common Clear	Enable Inputs (Level)	Min. Enable Pulse Width (ns)	Max. Delay Enable to Output (ns)	Pins	Package Codes
54/DM54/DM7475	4-Bit D	4		2(H)	20	30	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74170	16-Bit D	4		2	25	45	16	N, DM, DMQB, FMQB
54/DM54/DM74279	4-Bit RS	4					16	N, DM, DMQB, FMQB
DM9308	Dual 4-Bit D	8	2 x L	2 x 2 AND	18	30	24	N, DM, DMQB, FMQB
DM9314	Quad 4-Bit, D, RS	4	L	1(L)	18	24	16	N, DM, DMQB, FMQB
DM9334	8-Bit Addressable	1	L	1(L)	17	24	16	N, DM, DMQB, FMQB, J/883

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/DM54/DM74174	6-Bit D	6	L	25	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74175	4-Bit D	4	L	25	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
DM9338	8-Bit Multiple Port Registers	1		27	16	N, DM, DMQB, FMQB

Multiplexers

Device	Type	Enable Inputs	Outputs		Pins	Package Codes
			True	Complement		
54/DM54/DM74150	16-Input	1		x	24	N, DM, DMQB, FMQB, J/883, BJA
54/DM54/DM74151A	8-Input	1	x	x	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74153	Dual 4-Input	2	x		16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM74157	Quad 2-Input	1	x		16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
DM9309	Dual 4-Input		x	x	16	N, DM, DMQB, FMQB, BEA, BFA
DM9312	8-Input	1	x	x	16	N, DM, DMQB, FMQB
DM9322	Quad 2-Input	1	x		16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
DM8123	Quad 2-Input	1	x		16	N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Standard TTL (54xx, DM54xx, DM74xx, DM93xx, DM96xx, DM8xxx) (Continued)

Decoders/Demultiplexers/Encoders

Device	Type	Address Inputs	Active Low		OC Output Voltage (V)	Pins	Package Codes
			Enable	Outputs			
54/DM54/DM7442A	1-of-10	4(BCD)		10		16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM7445	1-of-10	4(BCD)		10	30	16	N, J/883, W/883
54/DM54/DM74145	1-of-10	4(BCD)		10	15	16	N, J/883, W/883
54/DM54/DM74148	8-of-3					16	N, J/883, W/883
54/DM54/DM74154	1-of-16	4	2	16		24	N, DM, DMQB, FMQB, J/883
54/DM54/DM74155	Dual 1-of-4	2	2 + 1	4 + 4		16	N, J/883, W/883
DM9301	1-of-10	4(BCD)		10		16	N, DM, DMQB, FMQB
DM9311	1-of-16	4	2	16		24	N, DM, DMQB, FMQB, J/883
DM9318		8 (BCD)				16	J/883, W/883
DM9321	Dual 1-of-4	2 + 2	1 + 1	4 + 4		16	N, DM, DMQB, FMQB
DM9334	1-of-8	3	1	8		16	N, DM, DMQB, FMQB

Comparators

Device	Type	Features	Pins	Package Codes
DM8130	Magnitude	Compares 2 10-Bit Words	24	N
DM8131	Unified Bus	Compares 2 6-Bit Words	16	N
DM8136	Unified Bus	Compares 2 6-Bit Words	16	N
DM8160	Magnitude	Compares 2 6-Bit Words	16	N

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
DM2502C	Successive Approximation Register				15	16	N
DM2503C	Successive Approximation Register				15	16	N
DM2504C	Successive Approximation Register				15	24	N
54/DM54/DM7495A	Right/Left Shift	4	D	4 Sync	25	14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
54/DM54/DM74164	Serial-In/Parallel-Out Shift	8	2D		25	14	N, DM, DMQB, FMQB
54/DM54/DM74165	Parallel to Serial Converter	8	D	8 Async	25	16	N, DM, DMQB, FMQB
54/DM54/DM74166	Parallel-In/Serial-Out	8	D		25	16	N, J/883
54/DM54/DM74170	Register File, Open Collector	4 x 4		4 Async		16	N, DM, DMQB, FMQB
54/DM54/DM74173	Quad D, TRI-STATE	4		4 Sync	25	16	N, DM, DMQB, FMQB, J/883, W/883
54/DM54/DM74194	Universal Shift	4		4 Sync	25	16	N, J/883, W/883, BEA
54/DM54/DM74279	Quad 2-Port					16	N, DM, DMQB, FMQB
DM9300	Universal Shift	4	J, K	4 Sync	30	16	N, DM, DMQB, FMQB
DM9328	Shift	2 x 8	2 x 2D		20	16	N, DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Standard TTL (54xx, DM54xx, DM74xx, DM93xx, DM96xx, DM8xxx) (Continued)

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/DM54/DM7490A	Decade	2 x 5		32	14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
54/DM54/DM7493A	Divide-by-16	2 x 8		32	14	N, J/883, W/883, BCA, BDA
54/DM54/DM7497	Rate Multiplier	64		25	16	N, DM, DMQB, FMQB
54/DM54/DM74161	Binary	16 Presettable	Sync	25	16	N, DM, DMQB, FMQB, J/883, W/883, BEA, SEA
54/DM54/DM74163	Binary	16 Presettable	Sync	25	16	N, J/883, W/883, BEA
54/DM54/DM74191	Up/Down Binary	16	Async	20	16	N, DM, DMQB, FMQB, J/883, W/883
54/DM54/DM74193	Up/Down Binary	16	Sync	20	16	N, J/883, W/883
54/DM54/DM74197	Binary	2 x 8 Presettable	Async	50	14	N
DM8556	Binary			25	16	N
DM9316	Binary	16 Presettable	Sync	30	16	N, DM, DMQB, FMQB, J/883, W/883

Display Decoder/Drivers

Device	Type	Open Collector	Output Current (mA)	Output Voltage (V)	Active High/ Low	Ripple Blanking	Blanking Above BCD 9-Input	Pins	Package Codes
54/DM54/DM7445	1-of-10 Driver	x	80	30.0	L		x	16	N, J/883, W/883
54/DM54/DM7446	BCD-to-7 Segment	x	40	30.0	L	x		16	N
54/DM54/DM7447A	BCD-to-7 Segment	x	40	15.0	L	x		16	N, J/883, BEA
54/DM54/DM74145	1-of-10 Driver	x	80	15.0	L		x	16	N, J/883, W/883
DM9368	7-Segment LED Driver, Common Cathode		20	1.7	H	x		16	N
DM9370	7-Segment LED Driver, Common Anode	x	20	1.7	H	x		16	N
DM9374	7-Segment LED Driver, Common Anode		15	10.0	L	x		16	N

Monostables (One-Shots)

Device	Type	Pulse Width Variation (%) vs. Temp	Pulse Width Variation (%) vs. Vcc	No. of Inputs Pos.	No. of Inputs Neg.	Min. Output (tw) (ns)	Pins	Package Codes
54/DM54/DM74121	Single Non-Retriggerable	±0.25	±0.15	1	2	40	14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
54/DM54/DM74122	Single Retriggerable, Resettable	±2.7	±1.0	2	2	45	14	N, DM, DMQB, FMQB, BCA, BDA
54/DM54/DM74123	Dual Retriggerable Resettable	±2.7	±1.0	1	1	45	16	N, DM, DMQB, FMQB, BEA, BFA
DM9601	Single Retriggerable	±2.7	±1.0	2	2	50	14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA
DM9602	Dual Retriggerable	±1.5	±1.5	1	1	72	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Standard TTL (54xx, DM54xx, DM74xx, DM93xx, DM96xx, DM8xxx) (Continued)

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min. I_{OS} (mA)	Pins	Package Codes
54/DM54/DM7437	Quad 2 NAND Buffer	Any TTL	48	−20	14	N, DM, DMQB, FMQB, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7438	Quad 2 NAND Buffer	96106	48	Open Collector	14	N, J/883, W/883, BCA, BDA, SCA, SDA
54/DM54/DM7440	Dual 2 NAND Buffer	Any TTL	48	−20	14	N, DM, DMQB, FMQB, BCA, BDA

Arithmetic Operators

Device	Type	Features	No. of Bits	Pins	Package Codes
54/DM54/DM7483	Adder	4-Bit Full Binary w/Carry		16	DM, DMQB, FMQB, BEA, BFA
54/DM54/DM7485	Comparator	Magnitude w/Expander	4	16	N, DM, DMQB, FMQB, LMQB, J/883, W/883, BEA, BFA
54/DM54/DM7497	64-Bit Rate Multiplier	Cascadable	64	16	DM, DMQB, FMQB
54/DM54/DM74180	Parity	Generator/Checker	8	14	N, J/883, W/883, BCA, BDA
54/DM54/DM74181	ALU	16 Operations on 2 4-Bit Words	4	24	N, J/883, BJA
54/DM54/DM74283	Adder	Full Binary w/Carry	4	16	N, DM, DMQB, FMQB
DM9318	Encoder	Priority w/Expander	8	16	N, J/883, W/883
DM9324	Comparator	Magnitude	5	16	N, DM, DMQB, FMQB
DM9386	Comparator	Identity Exclusive-NOR, Open Collector	5	16	N

Parity Checker/Generator

Device	Features	Pins	Package Codes
9348	12-Input	16	DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Low Power TTL (DM54Lxx, 93Lxx, 96Lxx)

Gates

Device	Type	Pins	Package Codes
NAND			
DM54L00	Quad 2-Input	14	J/883, W/883, BCA, BDA, SCA, SDA
DM54L04	Hex Inverter	14	J/883, W/883, BCA, BDA, SCA, SDA
DM54L10	Triple 3-Input	14	J/883, W/883, BCA, BDA, SCA, SDA
NOR			
DM54L02	Quad 2-Input	14	J/883, W/883, BCA, BDA, SCA, SDA
Flip-Flops			
DM54L72	JK	14	J/883, W/883
DM54L73	Dual JK	14	J/883, W/883, BCA, BDA, SCA, SDA
DM54L74	Dual D Positive Edge-Triggered	14	J/883, W/883, BCA, BDA, SCA, SDA
Latches			
93L08	Dual D 4-Bit	24	DM, DMQB, FMQB
93L14	Quad	16	DM, DMQB, FMQB
93L34	8-Input Addressable	16	DM, DMQB, FMQB
Multiplexers			
93L09	Dual 4-Input	16	DM, DMQB, FMQB
93L12	8-Input	16	DM, DMQB, FMQB
93L22	Quad 2-Input	16	DM, DMQB, FMQB
Decoders			
93L01	1-of-10	16	DM, DMQB, FMQB
93L21	Dual 1-of-4	16	DM, DMQB, FMQB
Registers			
DM54L95	4-Bit Right/Left Shift	14	J/883, W/883, BCA, BDA, SCA, SDA
DM54L98	4-Bit Storage	16	J/883, W/883
93L00	4-Bit Universal Shift	16	DM, DMQB, FMQB
93L28	Dual 8-Bit Shift	16	DM, DMQB, FMQB
93L38	8-Bit Multiple Port	16	DM, DMQB, FMQB
Counters			
DM54L93	Divide-by-16	14	J/883, W/883, BCA, BDA, SCA, SDA
93L10	BCD Decade/4-Bit Binary	16	DM, DMQB, FMQB
Comparators			
93L24	5-Bit	16	DM, DMQB, FMQB
Multivibrators			
96L02	Dual Retriggerable Resettable Monostable Vibrator	16	DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

DTL (9xx)

NAND Gates

Device	Type	Pins	Package Codes
930	Dual 4-Input Extendable	14	DM, DMQB, FMQB, BCA, BDA
932	Dual 4-Input Extendable Buffer	14	DM, DMQB, FMQB
936	Hex Inverter	14	DM, DMQB, FMQB, BCA, BDA
937	Hex Inverter	14	DM, DMQB, FMQB
944	Dual 4-Input Extendable Buffer	14	DM, DMQB, FMQB
946	Quad 2-Input	14	DM, DMQB, FMQB, BCA, BDA
949	Quad 2-Input	14	DM, DMQB, FMQB
962	Triple 3-Input	14	DM, DMQB, FMQB, BCA, BDA

Flip-Flops

Device	Type	Pins	Package Codes
945	Set/Reset	14	DM, DMQB, FMQB
948	Set/Reset	14	DM, DMQB, FMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FACT™ (54AC/74ACxxxx, 54ACT/74ACTxxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND/NAND Buffer					
54/74AC00	Quad 2-Input	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74ACT00	Quad 2-Input	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC10	Triple 3-Input	3	3	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC20	Dual 4-Input	4	2	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
AND					
54/74AC08	Quad 2-Input	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC11	Triple 3-Input	3	3	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
OR/NOR, Exclusive-OR					
54/74AC02	Quad 2-Input NOR	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC32	Quad 2-Input OR	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC86	Quad 2-Input Exclusive OR	2	4	14	PC, DC, SC, DM, DMQB, FMQB, LMQB
AND/OR-Invert					
54/74AC04	Hex Inverter	1	6	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC14	Hex Schmitt Trigger	1	6	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A

Dual Edge-Triggered Flip-Flops

Device	Type	Clock Edge	Direct Set	Direct Clear	Pins	Package Codes
54/74AC74	D	Positive	x	x	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74ACT74	D	Positive	x	x	14	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A
54/74AC109	JK	Positive	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT109	JK	Positive	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, CA, DA, 2A

Multiple Flip-Flops

Device	Type	Master Reset	TRI-STATE® Outputs	Pins	Package Codes
54/74AC174	Hex D	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT174	Hex D	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74AC175	Quad D	x		16	PC, DC, SC, DM, DMQB, LMQB
54/74ACT175	Quad D	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC273	Octal D	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC374	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT374	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC377	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT377	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT534	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT564	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC574	Octal D		x	20	PC, DC, SC
54/74ACT574	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC821	Octal D		x	24	SPC, SDC
54/74ACT821	Octal D		x	24	SPC, SDC, SC, SDM, SDMQB
54/74ACT823	9-Bit D		x	24	SPC, SDC, SC, SDM, SDMQB
54/74ACT825	Octal D		x	24	SPC, SDC, SC, SDM, SDMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FACT™ (54AC/74ACxxxx, 54ACT/74ACTxxxx) (Continued)

Shift Register

Device	Type	Serial Inputs	Parallel Inputs	TRI-STATE Outputs	Pins	Package Codes
54/74AC299	8-Bit Octal Storage	2	x	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT299	8-Bit Octal Storage	2	x	x	20	PC, DC, SC, DM
54/74ACT323	8-Bit Octal Storage	2	x	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT399	Quad 2-Port				20	PC, DC, SC, DM, DMQB, FMQB, LMQB

Latches

Device	Type	Enable Inputs (Level)	TRI-STATE Outputs	Pins	Package Codes
54/74AC373	Octal	1(H)	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT373	Octal	1(H)	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT563	Octal D		x	20	PC, DC, SC, DM, DMQB, LMQB
54/74ACT573	Octal D		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT841	10-Bit Transparent			24	SPC, SDC, SC
54/74ACT843	9-Bit Transparent			24	SPC, SDC, SC
54/74ACT845	8-Bit Transparent			24	SPC, SDC, SC

Counters

Device	Type	Parallel Entry	Reset	Up/ Down	Pins	Package Codes
54/74AC161	4-Bit Binary	Sync	Async		16	PC, DC, DM, DMQB, FMQB, LMQB
54/74ACT161	4-Bit Binary	Sync	Async		16	PC, DC, SC
54/74AC163	4-Bit Binary	Sync	Sync		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT163	4-Bit Binary	Sync	Sync		16	PC, DC, SC
54/74AC169	4-Bit Binary	Sync		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC191	4-Bit Decade	Async		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB

Octal Buffers/Line Drivers

Device	Enable Inputs (Level)	Inverting	Noninverting	Pins	Package Codes
54/74AC240	2(L)	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT240	2(L)	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC241	1(L), 1(H)		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT241	1(L), 1(H)		x	20	PC, DC, SC, DM
54/74AC244	2(L)		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT244	2(L)		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC540	2(L)	x		20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC541	1(L), 1(H)		x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB

Transceivers

Device	Type	Enable Inputs (Level)	TRI-STATE Outputs	Pins	Package Codes
54/74AC245	Octal Bus	1(L)	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74ACT245	Octal Bus	1(L)	x	20	PC, DC, SC, DM, DMQB, FMQB, LMQB, RA, SA, 2A
54/74AC646	Octal Bus w/Register	1(L), 1(H)	x	24	SPC, SDC, SC, SDM, SDMQB, FMQB, LMQB
54/74AC648	Octal Bus w/Register	1(L), 1(H)	x	24	SPC, SDC, SC

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

FACT™ (54AC/74ACxxxx, 54ACT/74ACTxxxx) (Continued)

Multiplexers

Device	Type	Enable Inputs (Level)	Outputs		Pins	Package Codes
			True	Complement		
54/74AC151	8-Input	1(L)	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT151	8-Input	1(L)	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC153	Dual 4-Input	2(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT153	Dual 4-Input	2(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC157	Quad 2-Input	1(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT157	Quad 2-Input	1(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC158	Quad 2-Input	1(L)		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT158	Quad 2-Input	1(L)		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC251	8-Input	1(L)	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT251	8-Input	1(L)	x	x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74AC253	Dual 4-Input	2(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT253	Dual 4-Input	2(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74AC257	Quad 2-Input	1(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT257	Quad 2-Input	1(L)	x		16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74AC258	Quad 2-Input	1(L)		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB
54/74ACT258	Quad 2-Input	1(L)		x	16	PC, DC, SC, DM, DMQB, FMQB, LMQB

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low Enable	Active High Enable	Active Low Outputs	Pins	Package Codes
54/74AC138	1-of-8	3	2	1	8	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT138	1-of-8	3	2	1	8	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74AC139	Dual 1-of-4	2,2	1,1		4,4	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A
54/74ACT139	Dual 1-of-4	2,2	1,1		4,4	16	PC, DC, SC, DM, DMQB, FMQB, LMQB, EA, FA, 2A

Specialized LSI

Device	Type	Pins	Package Codes
54/74ACT818	Diagnostic Register, 8-bit	24	SPC, SDC
54/74ACT1016	16 x 16 Multiplier (55 ns)	64	PC, DC
54/74ACT1016	16 x 16 Multiplier (65 ns)	64	PC, DC
54/74AC2708	64 x 9 FIFO Memory	28	PC, DC
54/74ACT2708	64 x 9 FIFO Memory	28	PC, DC

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HC (MM54HCxxx, MM74HCxxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND					
MM54HC/MM74HC00	Quad 2-Input	2	4	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC03	Quad 2-Input	2	4	14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC10	Triple 3-Input	3	3	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC20	Dual 4-Input	4	2	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC30	8-Input	8	1	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC132	Quad 2-Input Schmitt Trigger	2	4	14	M, N, E/883, J/883, BCA
MM54HC/MM74HC133	13-Input	13	1	16	M, N, E/883, J/883, W/883
AND					
MM54HC/MM74HC08	Quad 2-Input	2	4	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC11	Triple 3-Input	3	3	14	M, N, E/883, J/883, W/883, CX
OR/NOR, Exclusive-OR/NOR					
MM54HC/MM74HC02	Quad 2-Input NOR	2	4	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC27	Triple 3-Input NOR	3	3	14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC32	Quad 2-Input OR	2	4	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC86	Quad 2-Input Exclusive-OR	2	4	14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC266A	Quad 2-Input Exclusive-OR	2	4	14	M, N, J/883
MM54HC/MM74HC4002	Dual 4-Input NOR	4	2	14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC4075	Triple 3-Input OR	3	3	14	M, N, E/883, J/883, W/883
MM54HC/MM74HC4078	8-Input NOR/OR	8	1	14	M, N, E/883, J/883, W/883
MM54HC/MM74HC7266	Quad 2-Input Exclusive-NOR	2	4	14	M, N, J/883
AND/OR-Invert					
MM54HC/MM74HC04	Hex Inverter	1	6	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HCU04	Hex Inverter	1	6	14	J/883, W/883, CX
MM54HC/MM74HC05	Hex Inverter	1	6	14	N
MM54HC/MM74HC14	Hex Schmitt Trigger Inverter	1	6	14	M, N, E/883, J/883, W/883, CX, BCA
MM54HC/MM74HC51	Dual AND/OR-Invert		2	14	M, N, E/883, J/883
MM54HC/MM74HC58	Dual AND/OR	4	2	14	M, N, E/883, J/883

Flip-Flops

Device	Type	Flip-Flop Type	Pins	Package Codes
MM54HC/MM74HC73	Dual	JK	14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC74A	Dual Positive Edge-Trigger	D	16	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC76	Dual	JK	16	M, N, E/883, J/883, W/883
MM54HC/MM74HC107	Dual	JK	14	N, E/883, J/883, W/883, CX
MM54HC/MM74HC109A	Dual Positive Edge-Trigger	JK	16	N, E/883, J/883, W/883, EX
MM54HC/MM74HC112	Dual Negative Edge-Trigger	JK	14	N, E/883, J/883, W/883, EX
MM54HC/MM74HC113	Dual Edge-Trigger	JK	14	N, E/883, J/883, W/883
MM54HC/MM74HC173	4-Bit	D	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC174	Hex Master Reset	D	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC175	Quad Master Reset	D	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC273	Octal	D	20	M, N, E/883, J/883
MM54HC/MM74HC374	Octal, TRI-STATE® Outputs	D	20	M, N, E/883, J/883, RX, BRA
MM54HC/MM74HC534	Octal, TRI-STATE Outputs	D	20	M, N
MM54HC/MM74HC564	Octal, TRI-STATE Outputs	D	20	M, N, E/883, J/883
MM54HC/MM74HC574	Octal, TRI-STATE Outputs	D	20	M, N, J/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HC (MM54HCxxx, MM74HCxxxx) (Continued)

Latches

Device	Broadside Pinout	Inverting	Transparent	TRI-STATE® Outputs	No. of Bits	Pins	Package Codes
MM54HC/MM74HC75					4	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC259					8	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC373			x	x	8	20	M, N, E/883, J/883, RX, BRA
MM54HC/MM74HC533		x	x	x	8	20	M, N, E/883, J/883, RX
MM54HC/MM74HC563	x	x	x	x	8	20	M, N, E/883, J/883
MM54HC/MM74HC564					8	20	M, N, E/883, J/883
MM54HC/MM74HC573	x		x	x	8	20	M, N, E/883, J/883

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
MM54HC/MM74HC160	4-Bit BCD Decade		Async	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC161	4-Bit Binary		Async	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC162	4-Bit BCD Decade		Sync	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC163	4-Bit Binary		Sync	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC190	Decade	x	Sync	16	N
MM54HC/MM74HC191	Decade	x	Sync	16	N
MM54HC/MM74HC192	4-Bit BCD Decade	x	Async	16	N, E/883, J/883, W/883, EX
MM54HC/MM74HC193	4-Bit Binary	x	Async	16	N, E/883, J/883, W/883
MM54HC/MM74HC390	Dual 4-Bit Decoder			16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC393	Dual 4-Bit Binary			14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC4017	Decade Divider			16	M, N, E/883, J/883, EX
MM54HC/MM74HC4020	14-Stage Binary			16	M, N, E/883, J/883, W/883
MM54HC/MM74HC4040	12-Stage Binary			16	M, N, E/883, J/883, W/883
MM54HC/MM74HC4060	14-Stage Binary			16	M, N

Shift Registers

Device	Type	Serial Inputs	Parallel Inputs	TRI-STATE Outputs	Pins	Package Codes
MM54HC/MM74HC164	8-Bit	2			14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC165	8-Bit				16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC166	8-Bit				16	M, N
MM54HC/MM74HC194	4-Bit Bidirectional	2	x		16	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC195	Universal 4-Bit				16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC299	8-Bit Octal Storage	2	x	x	20	M, N, E/883, J/883, W/883
MM54HC/MM74HC589	8-Bit				16	M, N
MM54HC/MM74HC595	8-Bit				16	M, N
MM54HC/MM74HC597	8-Bit				16	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HC (MM54HCxxx, MM74HCxxxx) (Continued)

Buffers/Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
MM54HC/MM74HC34				14	N
MM54HC/MM74HC125				14	M, N, E/883, J/883, W/883
MM54HC/MM74HC126				14	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC240	8	x		20	M, N, E/883, J/883
MM54HC/MM74HC241	8		x	20	M, N, E/883, J/883, BRA
MM54HC/MM74HC244	8		x	20	M, N, E/883, J/883, RX, BRA
MM54HC/MM74HC365	6		x	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC366				16	M, N, E/883, J/883, W/883
MM54HC/MM74HC367				16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC368				16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC540	8	x		20	M, N
MM54HC/MM74HC541			x	20	M, N
MM54HC/MM74HC4049		x		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC4050				16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC4511				16	M, N, E/883, J/883
MM54HC/MM74HC4543				16	M, N, E/883, J/883, W/883

Transceivers

Device	Transceivers	Registered	Features	TRI-STATE Outputs	Pins	Package Codes
MM54HC/MM74HC242			Inverting		14	M, N, E/883, J/883, W/883
MM54HC/MM74HC243	8	x		x	24	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC245A	8			x	20	M, N, E/883, J/883
MM54HC/MM74HC540	8		Inverting	x	20	M, N
MM54HC/MM74HC541	8			x	20	M, N
MM54HC/MM74HC620	8			x	20	M, N
MM54HC/MM74HC623	8				20	M, N
MM54HC/MM74HC640			Inverting		20	M, N, E/883, J/883
MM54HC/MM74HC643	8		Inverting		20	M, N, E/883, J/883
MM54HC/MM74HC646	8	x		x	24	M, N
MM54HC/MM74HC648	8				24	M, N

Multiplexers

Device	Type	Outputs		Pins	Package Codes
		True	Complement		
MM54HC/MM74HC151	8-Input	x	x	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC153	Dual 4-Input	x		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC157	Quad 2-Input	x		16	M, N, E/883, J/883, W/883
MM54HC/MM74HC158	Quad 2-Input		x	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC251	8-Input	x	x	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC253	Dual 4-Input	x		16	M, N, E/883, J/883, W/883
MM54HC/MM74HC257	Quad 2-Input	x		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC258	Quad 2-Input			16	M, N
MM54HC/MM74HC298	Quad w/Storage			16	M, N, E/883, J/883
MM54HC/MM74HC354	Transparent			20	M, N, E/883, J/883
MM54HC/MM74HC356	8-Channel, TRI-STATE			20	M, N
MM54HC/MM74HC4051	8-Channel Analog			16	M, N
MM54HC/MM74HC4052	Dual 4-Channel Analog			16	M, N
MM54HC/MM74HC4053	Triple 2-Channel Analog			16	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HC (MM54HCxxx, MM74HCxxxx) (Continued)

Decoders/Demultiplexers/Encoders

Device	Type	Latched Input	Pins	Package Codes
MM54HC/MM74HC42	BCD-to-Decimal		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC137	3-of-8		16	M, N
MM54HC/MM74HC138	1-of-8		16	M, N, E/883, J/883, W/883, EX, BEA
MM54HC/MM74HC139	Dual 1-of-4		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC147	10-of-4		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC154	4-of-6		24	M, N, J/883
MM54HC/MM74HC155	Dual 2-of-4		16	N
MM54HC/MM74HC237	3-of-8		16	M, N
MM54HC/MM74HC4514	4-of-16	x	24	M, N, J/883

Multivibrators

Device	Type	Pulse Width Variation (%) vs. Temp	Pulse Width Variation (%) vs. V_{CC}	No. of Inputs Pos.	No. of Inputs Neg.	Min. Output (tw)(ns)	Pins	Package Codes
MM54HC/MM74HC123A	Dual Retriggerable, Resettable	±2.7	±1.0	1	1	45	16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC221A	Dual Non-Retriggerable						16	M, N, E/883, J/883
MM54HC/MM74HC423A	Dual Retriggerable						16	M, N
MM54HC/MM74HC4538	Dual Retriggerable						16	M, N, E/883, J/883, W/883

Arithmetic Functions

Device	Type	Features	Pins	Package Codes
MM54HC/MM74HC85	4-Bit Magnitude Comparator		16	M, N, E/883, J/883, W/883, EX
MM54HC/MM74HC181	ALU	Function Generator	24	M, N
MM54HC/MM74HC182	Carry Lookahead Generator		16	M, N
MM54HC/MM74HC280	9-Bit Parity Generator/Checker		14	M, N, E/883, J/883, W/883, CX
MM54HC/MM74HC283	4-Bit Binary Adder		16	M, N, E/883, J/883
MM54HC/MM74HC521	8-Bit Magnitude Comparator	Equality Detector	20	M, N
MM54HC/MM74HC688	8-Bit Magnitude Comparator		20	M, N, E/883, J/883

Miscellaneous

Device	Type	Features	Pins	Package Codes
MM54HC/MM74HC148	8-to-3 Line Priority Encoder		16	M, N
MM54HC/MM74HC149	8-to-8 Line Priority Encoder		20	M, N
MM54HC/MM74HC942	300 Baud Modem		20	N
MM54HC/MM74HC943	300 Baud Modem		20	N
MM54HC/MM74HC4016	Quad Analog Switch		14	M, N
MM54HC/MM74HC4046	CMOS Phase Lock Loop		16	M, N
MM54HC/MM74HC4066	Quad Analog Switch		14	M, N
MM54HC/MM74HC4316	Quad Analog Switch	Level Translator	16	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HCT (MM54HCTxxxx, MM74HCTxxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND					
MM54HCT/MM74HCT00	Quad 2-Input	2	4	14	M, N
MM54HCT/MM74HCT03	Quad 2-Input	2	4	14	N
AND					
MM54HCT/MM74HCT08	Quad 2-Input	2	4	14	N
OR/NOR, Exclusive-OR/NOR					
MM54HCT/MM74HCT32	Quad 2-Input OR	2	4	14	N
Inverter					
MM54HCT/MM74HCT04	Hex Inverter	1	6	14	M, N
MM54HCT/MM74HCT05	Hex Inverter			14	M, N

Flip-Flops

Device	Type	Flip-Flop Type	Pins	Package Codes
MM54HCT/MM74HCT74	Dual Positive Edge-Trigger	D	14	M, N
MM54HCT/MM74HCT76	Dual Negative Edge-Trigger	JK	16	N
MM54HCT/MM74HCT109	Dual Positive Edge-Trigger	JK	16	N
MM54HCT/MM74HCT112	Dual Negative Edge-Trigger	JK	16	N
MM54HCT/MM74HCT273	Octal	D	20	M, N
MM54HCT/MM74HCT374	Octal, TRI-STATE® Outputs	D	20	M, N, E/883, J/883
MM54HCT/MM74HCT534	Octal, TRI-STATE Outputs	D	20	M, N

Latches

Device	Inverting	Transparent	TRI-STATE Outputs	No. of Bits	Pins	Package Codes
MM54HCT/MM74HCT373		x	x	8	20	M, N, E/883, J/883
MM54HCT/MM74HCT533	x	x	x	8	20	M, N

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
MM54HCT/MM74HCT190	Decade	x	Sync	16	N
MM54HCT/MM74HCT191	Binary	x	Sync	16	N
MM54HCT/MM74HCT192	Decade			16	M, N
MM54HCT/MM74HCT193	Binary			16	M, N

Shift Registers

Device	Type	Serial Inputs	Pins	Package Codes
MM54HCT/MM74HCT164	8-Bit	2	14	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

HCT (MM54HCTxxxx, MM74HCTxxxx) (Continued)

Buffers/Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
MM54HCT/MM74HCT34				14	M, N
MM54HCT/MM74HCT240	8	x		20	M, N
MM54HCT/MM74HCT241	8		x	20	M, N
MM54HCT/MM74HCT244	8		x	20	M, N
MM54HCT/MM74HCT540	8	x		20	M, N
MM54HCT/MM74HCT541				20	M, N

Transceivers

Device	Transceivers	Features	TRI-STATE Outputs	Pins	Package Codes
MM54HCT/MM74HCT245	8		x	20	M, N, E/883, J/883
MM54HCT/MM74HCT540	8	Inverting	x	20	M, N
MM54HCT/MM74HCT541	8		x	20	M, N
MM54HCT/MM74HCT640		Inverting		20	M, N
MM54HCT/MM74HCT643	8	Inverting		20	M, N

Multiplexers

Device	Type	Outputs		Pins	Package Codes
		True	Complement		
MM54HCT/MM74HCT151	8-Input	x	x	16	M, N,
MM54HCT/MM74HCT153	Dual 4-Input	x		16	M, N
MM54HCT/MM74HCT157	Quad 2-Input			16	M, N
MM54HCT/MM74HCT158	Quad			16	M, N
MM54HCT/MM74HCT251	8-Input	x	x	16	M, N
MM54HCT/MM74HCT253	Dual 4-Input	x		16	M, N
MM54HCT/MM74HCT257	Quad 2-Input			16	M, N
MM54HCT/MM74HCT258	Quad 2-Input			16	M, N

Decoders/Encoders

Device	Type	Pins	Package Codes
MM54HCT/MM74HCT138	1-of-8	16	M, N, J/883
MM54HCT/MM74HCT139	1-of-8	16	N
MM54HCT/MM74HCT147	10-to-4	16	M, N
MM54HCT/MM74HCT148	8-to-3	16	M, N
MM54HCT/MM74HCT155	2-to-4	16	N

Arithmetic Functions

Device	Type	Features	Pins	Package Codes
MM54HCT/MM74HCT521	8-Bit Magnitude Comparator	Equality Detector	20	M, N
MM54HCT/MM74HCT688	8-Bit Magnitude Comparator		20	M, N, J/883

Miscellaneous

Device	Type	Pins	Package Codes
MM54HCT/MM74HCT149	8-to-8 Line Priority Encoder	20	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

C (MM54Cxxx, MM74Cxxx)

Gates

Device	Type	Inputs/ Gate	No. of Gates	Pins	Package Codes
NAND					
MM54C/MM74C00	Quad 2-Input	2	4	14	M, N, J/883, W/883
MM54C/MM74C10	Triple 3-Input	3	3	14	N, J/883, W/883
MM54C/MM74C20	Dual 4-Input	4	2	14	N
MM54C/MM74C30	8-Input	8	1	14	N, J/883, W/883
AND					
MM54C/MM74C08	Quad 2-Input	2	4	14	N, J/883, W/883
OR/NOR, Exclusive-OR/NOR					
MM54C/MM74C02	Quad 2-Input NOR	2	4	14	N, J/883, W/883
MM54C/MM74C32	Quad 2-Input OR	2	4	14	M, N, J/883, W/883
MM54C/MM74C86	Quad 2-Input Exclusive-OR	2	4	14	N, J/883, W/883
AND/OR-Invert					
MM54C/MM74C04	Hex Inverter	1	6	14	N, J/883, W/883
MM54C/MM74C14	Hex Schmitt Trigger Inverter	1	6	14	M, N, J/883, W/883

Flip-Flops

Device	Type	Flip-Flop Type	Pins	Package Codes
MM54C/MM74C73	Dual	JK	14	N
MM54C/MM74C74	Dual Positive Edge-Trigger	D	14	M, N, J/883, W/883
MM54C/MM74C76	Dual	JK	16	N, J/883, W/883
MM54C/MM74C107	Dual	JK	14	N, J/883
MM54C/MM74C173	4-Bit	D	16	M, N, J/883, W/883
MM54C/MM74C174	Hex Master Reset	D	16	N, J/883, W/883
MM54C/MM74C175	Quad Master Reset	D	16	N, J/883, W/883
MM54C/MM74C374	Octal, TRI-STATE® Outputs	D	20	M, N, J/883

Latches

Device	Broadside Pinout	Transparent	TRI-STATE Outputs	No. of Bits	Pins	Package Codes
MM54C/MM74C373	x	x	x	8	20	M, N, J/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

C (MM54Cxxx, MM74Cxxx) (Continued)

Counters

Device	Type	Down	Up/ Reset	Pins	Package Codes
MM54C/MM74C90	Decade			14	N, J/883, W/883
MM54C/MM74C93	4-Bit Binary			14	N
MM54C/MM74C160	4-Bit BCD Decade		Async	16	N, J/883, W/883
MM54C/MM74C161	4-Bit Binary		Async	16	N, J/883, W/883
MM54C/MM74C162	4-Bit BCD Decade		Sync	16	N, J/883, W/883
MM54C/MM74C163	4-Bit Binary		Sync	16	N, J/883, W/883
MM54C/MM74C192	4-Bit BCD Decade	x	Async	16	N, J/883, W/883
MM54C/MM74C193	4-Bit Binary	x	Async	16	M, N, J/883, W/883
MM54C/MM74C915	7-Segment-to-BCD			18	N
MM54C/MM74C925	4-Digit Counter/Driver			16	N
MM54C/MM74C926	4-Digit Counter/Driver			18	N
MM54C/MM74C927	4-Digit Counter/Driver			18	N
MM54C/MM74C928	4-Digit Counter/Driver			18	N
MM54C/MM74C945	4 ½-Digit Counter/Driver			40	N
MM54C/MM74C946	4-Digit Counter/Driver			40	N
MM54C/MM74C947	4-Digit Up/Down Counter			40	N

Shift Registers

Device	Type	Serial Inputs	Pins	Package Codes
MM54C/MM74C95	4-Bit		14	N
MM54C/MM74C164	8-Bit	2	14	N, J/883
MM54C/MM74C165	8-Bit		16	N, J/883, W/883
MM54C/MM74C195	Universal 4-Bit		16	N, J/883, W/883

Buffers/Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
MM54C/MM74C240	8	x		20	M, N
MM54C/MM74C244	8		x	20	M, N, J/883
MM54C/MM74C901	6	x		14	M, N, J/883, W/883
MM54C/MM74C902	6		x	14	N, J/883, W/883
MM54C/MM74C903	6	x		14	N
MM54C/MM74C904	6			14	N
MM54C/MM74C906	6			14	M, N, J/883, W/883
MM54C/MM74C907	6			14	N, J/883, W/883
MM54C/MM74C941	8			20	N, J/883
MM54C/MM80C95	6			16	N
MM54C/MM80C96	6			16	N
MM54C/MM80C97	6			16	N
MM54C/MM80C98	6			16	N
MM54C/MM88C29	4			14	N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

C (MM54Cxxx, MM74Cxxx) (Continued)

Multiplexers

Device	Type	Outputs		Pins	Package Codes
		True	Complement		
MM54C/MM74C150	1-of-16			24	N
MM54C/MM74C151	8-Input	x	x	16	N, J/883, W/883
MM54C/MM74C157	Quad 2-Input	x		16	N, J/883, W/883

Decoders/Demultiplexers

Device	Type	Pins	Package Codes
MM54C/MM74C42	BCD-to-Decimal	16	N, J/883, W/883
MM54C/MM74C48	BCD-to-7 Segment	16	N, J/883, W/883
MM54C/MM74C154	4-to-16	24	M, N, J/883
MM54C/MM82C19	1-to-16	24	N

Memory/Memory Support

Device	Type	Pins	Package Codes
MM54C/MM74C89	16 x 4 RAM	16	N, J/883, W/883
MM54C/MM74C200	Random Access Read/Write	16	N
MM54C/MM74C910	Random Access Read/Write	18	N
MM54C/MM74C989	16 x 4 RAM	16	N

Arithmetic Functions

Device	Type	Pins	Package Codes
MM54C/MM74C83	4-Bit Binary Adder	16	N, J/883, W/883
MM54C/MM74C85	4-Bit Magnitude Comparator	16	N, J/883, W/883
MM54C/MM74C909	Quad Comparator	14	N
MM54C/MM74C932	Phase Comparator	8	N

Miscellaneous

Device	Type	Features	Pins	Package Codes
MM54C/MM74C221	One-Shot Multivibrator		16	N, J/883, W/883
MM54C/MM74C905	12-Bit S.A.R.		24	N, J/883
MM54C/MM74C908	Dual H.V. Driver		8	N
MM54C/MM74C911	Display Controller		28	N
MM54C/MM74C912	Display Controller		28	N
MM54C/MM74C914	Hex Schmitt Triggers	Extended Input Voltage	14	M, N, J/883, W/883
MM54C/MM74C917	Display Controller		28	N
MM54C/MM74C918	Dual H.V. Driver		14	N
MM54C/MM74C922	16-Key Keyboard Encoder		18	N, J/883
MM54C/MM74C923	20-Key Keyboard Encoder		20	N, J/883
MM54C/MM74C956	4-Digit LED Display Driver		40	N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

CD4000

Gates

Device	Type	Buffered	Pins	Package Codes
NAND				
CD4011	Quad 2-Input	x	14	M, N, J/883, W/883, BCA, BDA
CD4012	Dual 4-Input	x	14	N, J/883, W/883, BCA, BDA
CD4023	Triple 3-Input	x	14	M, N, J/883, W/883, BCA, BDA
AND				
CD4073	Triple 3-Input	x	14	M, N, J/883, W/883
CD4081	Quad 2-Input	x	14	M, N, J/883, W/883
CD4082	Dual 4-Input		14	N
OR/NOR, Exclusive-OR				
CD4001	Quad 2-Input NOR	x	14	M, N, J/883, W/883, BCA, BDA
CD4002	Dual 4-Input NOR	x	14	M, N, J/883, W/883, BCA, BDA
CD4025	Triple 3-Input NOR	x	14	M, N, J/883, W/883, BCA, BDA
CD4030	Quad Exclusive-OR		14	N, J/883, W/883, BCA, BDA
CD4070	Quad 2-Input Exclusive-OR		14	M, N, J/883, W/883
CD4071	Quad 2-Input OR	x	14	M, N, J/883, W/883
CD4072	OR		14	N
CD4075	Triple 3-Input OR	x	14	N, J/883, W/883
AND/OR-Invert				
CD4007	Dual Complementary Pair		14	M, N, J/883, W/883, BCA, BDA
CD4019	Quad Select		16	N, J/883, W/883, BEA
CD4069	Hex Inverter		14	M, N, J/883, W/883
CD4519	4-Bit		16	N

Flip-Flops

Device	Type	Flip-Flop Type	Pins	Package Codes
CD4013	Dual	D	14	M, N, J/883, W/883, BCA, BDA
CD4027	Dual	JK	16	M, N, J/883, W/883, BEA
CD4076	Quad	D	16	M, N, J/883, W/883
CD40174	Hex	D	16	N, J/883, W/883
CD40175	Quad	D	16	N, J/883, W/883

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

CD4000 (Continued)

Latches

Device	TRI-STATE® Outputs	No. of Bits	Pins	Package Codes
CD4042		4	16	M, N
CD4043	x	4	16	M, N
CD4044	x	4	16	M, N
CD4099		8	16	N, J/883, W/883
CD4723		4	16	M, N
CD4724		8	16	N, J/883, W/883

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
CD4017	Decade Counter/Divider			16	M, N, J/883, W/883, BEA
CD4018	Presettable Divide-by-N			16	N, J/883, W/883, BEA
CD4020	14-Stage Ripple Carry Binary			16	M, N, J/883, W/883, BEA
CD4022	Divide-by-8 Counter/Divider			16	N, BEA
CD4024	7-Stage Ripple Carry Binary Counter/Divider			14	M, N, BCA, BDA
CD4029	Presettable Binary/Decade	x		16	N, J/883, W/883
CD4040	12-Stage Binary Ripple			16	M, N, J/883, W/883
CD4060	14-Stage Binary Ripple			16	M, N, J/883, W/883
CD40160	Decade		Async	16	N, J/883, W/883
CD40161	Binary		Async	16	N, J/883, W/883
CD40162	Decade		Sync	16	N, J/883, W/883
CD40163	Binary		Sync	16	N, J/883, W/883
CD40192	4-Bit Decade	x	Sync	16	N, J/883, W/883
CD40193	4-Bit Binary	x	Sync	16	M, N, J/883, W/883
CD4510	BCD	x		16	N
CD4516	Binary	x		16	M, N
CD4518	Dual		Sync	16	N
CD4520	Dual		Sync	16	M, N, J/883, W/883
CD4522	Programmable Divide-by-N 4-Bit Binary			16	N
CD4526	Programmable Divide-by-N 4-Bit Binary			16	N
CD4527	BCD Rate Multiplier			16	N
CD4541	Programmable Timer			14	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

CD4000 (Continued)

Shift Registers

Device	Type	TRI-STATE Outputs	Pins	Package Codes
CD4006	18-Stage Static		14	N, J/883, W//883, BCA, BDA
CD4014	8-Stage Static		16	M, N, J/883, W/883,BEA
CD4015	Dual 4-Bit Static		16	N, BEA
CD4021	8-Stage Static		16	BEA
CD4031	64-Bit Static		16	N, J/883, W/883
CD4034	8-Stage Bidirectional Bus		24	N, J/883, W/883
CD4035	4-Bit Parallel-In/Parallel-Out		16	N
CD4094	8-Bit	x	16	M, N
CD40195	4-Bit		16	N

Buffers/Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
CD4009	6	x		16	N, J/883, W/883
CD4010	6		x	16	M, N
CD4041	4			14	M, N, J/883, W/883
CD4048				16	N, J/883, W/883
CD4049		x		16	M, N, BEA
CD4049U		x		16	J/883, W/883
CD4050				16	M, N, J/883, W/883, BEA
CD4093				14	M, N, J/883, W/883
CD40106				14	M, N, J/883, W/883
CD4503				16	N, J/883, W/883
CD4512				16	M, N, J/883, W/883
CD4584				14	M, N

Multiplexers

Device	Type	Pins	Package Codes
CD4016	Quad Bilateral	14	M, N, J/883, W/883
CD4051	Single 8-Channel	16	M, N, J/883, W/883
CD4052	Dual 4-Channel	16	M, N, J/883, W/883
CD4053	Triple 2-Channel	16	M, N, J/883, W/883
CD4066	Quad Bilateral	16	M, N, J/883, W/883
CD4089	Binary Rate	16	N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

CD4000 (Continued)

Decoders

Device	Type	Pins	Package Codes
CD4028	BCD-to-Decimal	16	N, J/883, W/883
CD4511	BCD to 7-Segment	16	M, N, J/883, W/883
CD4514	4-to-16 Line	24	M, N
CD4515	4-to-16 Line	24	M, N
CD4529	8-Channel	16	N
CD4543	BCD-to-7-Segment	16	N, J/883, W/883

Artihmetic Functions

Device	Type	Pins	Package Codes
CD4008	4-Bit Full Adder	16	N

Multivibrators

Device	Type	Pins	Package Codes
CD4046	Micropower Phase-Locked Loop	16	M, N
CD4047	Monostable/Astable	14	M, N, J/883, W/883
CD4528	Dual Monostable	16	M, N, J/883, W/883
CD4538	Dual Precision Monostable	16	M, N

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

F100K ECL (100XXX)

Gates and Buffers

Device	Type	No. Inputs/ Gate	Propagation Delay* (ns)	Pins	Package Codes
F100101	Triple OR/NOR	5	0.95	24	DC, FC, J-MIL, W-MIL
F100102	Quint OR/NOR	2	0.95	24	DC, FC, J-MIL, W-MIL
F100104	Quint AND/NAND	2	1.40	24	DC, FC, J-MIL, W-MIL
F100107	Quint Exclusive-OR/NOR	2	1.40	24	DC, FC, J-MIL, W-MIL
F100117	Triple 2-Wide OA/OAI	5	2.30	24	DC, FC, J-MIL, W-MIL
F100118	5-Wide 5, 4, 4, 4, 2, OA/OAI	19	3.00	24	DC, FC
F100121	9-Bit Inverter	1	1.25	24	DC, FC
F100122	9-Bit Buffer	1	1.25	24	DC, FC, J-MIL, W-MIL

*Maximum propagation delay at 25°C in flatpak.

Flip-Flops/Latches

Device	Type	Toggle Frequency Propagation Delay*	Pins	Package Codes
F100130	Triple D Latch	1.50 ns	24	DC, FC
F100131	Triple D Flip-Flop	350 MHz	24	DC, FC, J-MIL, W-MIL
F100135	Triple J-K Flip-Flop	650 MHz	24	DC, FC, J-MIL, W-MIL
F100150	Hex D Latch	1.20 ns	24	DC, FC, J-MIL, W-MIL
F100151	Hex D Flip-Flop	375 MHz	24	DC, FC, J-MIL, W-MIL
F100175	Quint 100K/10K Latch	2.75 ns	16	DC, SDC

*Minimum f_{MAX} for flip-flops; maximum propagation delay for latches.

Multiplexers/Demultiplexers

Device	Type	Propagation Delay* (ns)	Pins	Package Codes
F100155	Quad Multiplexer/Latch	1.65	24	DC, FC
F100163	Dual 8-Input Multiplexer	1.50	24	DC, FC
F100164	Single 16-Input Multiplexer	2.15	24	DC, FC, J-MIL, W-MIL
F100170	Dual 1-of-4 or Single 1-of-8 Demultiplexer/Decoder	2.50	24	DC, FC, J-MIL, W-MIL
F100171	Triple 4-Input Multiplexer	1.40	24	DC, FC

*Maximum propagation delay at 25°C in flatpak.

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

F100K ECL (100XXX) (Continued)

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Propagation Delay* (ns)	Pins	Package Codes
F100112	Quad Driver	1.20	24	DC, FC
F100113	Quad Line Driver	1.15	24	DC, FC, J-MIL, W-MIL
F100114	Quint Differential Line Receiver	1.80	24	DC, FC, J-MIL, W-MIL
F100123	Hex Bus Driver	2.2/4.10	24	DC, FC
F100126	9-Bit Backplane Driver	2.55	24	DC, FC, J-MIL, W-MIL
F100250	Quint Line Transceiver	4.10	24	DC, FC

*Maximum propagation delay at 25°C in flatpak.

Shift Registers/Counters

Device	Type	Shift Frequency** (MHz)	Pins	Package Codes
F100136	4-Bit Bidirectional Shift Register or Modulo 16 Up/Down Counter	250	24	DC, FC, J-MIL, W-MIL
F100141	8-Bit Bidirectional Shift Register	300	24	DC, FC, J-MIL, W-MIL

**Minimum f_{SHIFT} at 25°C in flatpak.

Arithmetic Operators

Device	Type	Propagation Delay† (ns)	Pins	Package Codes
F100156	Mask-Merge Latch	1.60	24	DC, FC
F100158	8-Bit Shift Matrix	2.50	24	DC, FC
F100160	Dual Parity Checker/Generator	3.90	24	DC, FC
F100165	Universal Priority Encoder	3.90	24	DC, FC
F100166	9-Bit Comparator	3.30	24	DC, FC, J-MIL, W-MIL
F100179	Carry Lookahead Generator	2.70	24	DC, FC
F100180	High-Speed 6-Bit Adder	4.40	24	DC, FC
F100181	4-Bit Binary/BCD ALU	6.60	24	DC, FC
F100182	9-Bit Wallace Tree Adder	7.00	24	DC, FC
F100183	2 x 8-Bit Recode Multiplier	3.60	24	DC, FC

†Maximum propagation delay at 25°C in flatpak.

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

F100K ECL (100XXX) (Continued)

Translators

Device	Type	Propagation Delay* (ns)	Pins	Package Codes
F100124	Hex TTL-to-ECL	2.70	24	DC, FC, J-MIL, W-MIL
F100125	Hex ECL-to-TTL	3.50	24	DC, FC, J-MIL, W-MIL
F100128	ECL/TTL Bidirectional Translator	3.70	24	DC

*Maximum propagation delay at 25°C in flatpak.

Special Functions

Device	Type	Pins	Package Codes
F100142	4 x 4 Content-Addressable Memory	24	DC, FC
F100145	16 x 4 Register File	24	DC, FC
F100402	16 X 4 Register File	16	DC, FC

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

11C ECL (11CXX)

Device	Type	Complementary Outputs	Pins	Package Codes
11C01	Dual 5–4 Input OR/NOR Gate	X	16	DC, FC
11C05	1 GHz Divide-by-4 Counter	X	14	DC, DMQB
11C06	750 MHz D-Type Flip-Flop	X	16	DC, FC
11C70	Master/Slave D-Type Flip-Flop	X	16	DC
11C90	650 MHz Prescaler	X	16	DC, DMQB
11C91	650 MHz Prescaler	X	16	DC, DMQB

Note: For additional information on Military/Aerospace products, please refer to National Semiconductor's separate Selection Guide "Semiconductors for Military/Aerospace Applications" or to National's Table 1's.

Section 4
Discretes

Section 4 Contents Discretes

Discrete

For many years National Semiconductor has been a major supplier of discrete semiconductor devices for the wide ranging consumer, automotive, computer and industrial marketplaces. And now . . . the acquisition of Fairchild by National Semiconductor has heralded in a new era for the NSC Discrete Product Line. The combined product lines have greatly magnified the product depth and has now also made Mil-Aero versions available.

This section catalogs the many new discrete products that were previously sold by Fairchild along with the NSC bi-polar and JFET transistors. These include:

- Commercial and Mil-Aero versions of small signal diodes
- Commercial and Mil-Aero versions of metal can, small signal bipolar transistors
- The combined Fairchild and NSC lines of general purpose, switching and power transistors in plastic encapsulated packages
- Commercial and Mil-Aero versions of monolithic diode arrays
- Quad transistor arrays
- N-Channel, P-Channel and Dual JFET transistors
- Power MOSFETs and ultrafast rectifiers
- Many of the above devices are also available in surface mount packages:
  - — Leadless glass diodes
  - — SOT diodes and transistors
  - — SOIC quad transistor and diode arrays

The selection guides in this catalog are designed to provide an easy reference to the many standard parts offered by NSC. If your needs are not satisfied by any of the devices listed, please contact your local NSC Sales Office or the factory for lead form options and for other special selections that are available.

Discrete—Military/ AeroSpace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

Military qualified products are indicated by a † preceding the part number. For more information, please refer to the military portion of this section or the 1989 Military/Aerospace Selection Guide.

Diode Products by Ascending V_{RRM} and t_{rr}

Part No.	V_{RRM} (V)	I_{RRM} (nA)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Package
BA316	10	200	0.85	10	4.0	DO-35
BAY82	15	100	1.0	20	0.75	DO-7
FD777	15	100	1.0	20	0.75	DO-7
†1N4376	20	100	1.1	50	0.75	DO-7
1N4244	20	100	1.0	20	0.75	DO-7
FJT1101	20	0.005	1.10	50		DO-35
BAV17	25	100	1.0	100	50	DO-35
BA317	30	200	0.85	10	4.0	DO-35
FD700	30	50	1.1	50	0.70	DO-7
FDSO1700	30	50	1.1	50	0.7	TO-236
1N625	30	1000	1.5	4.0	4.0	DO-35
FDLL625	30	1000	1.5	4.0	50	LL-34
FJT1100	30	0.01	1.05	10		DO-35
1N456A	30	25	1.0	100		DO-35
1N456	30	25	1.0	40		DO-35
1N461A	30	500	1.0	100		DO-35
BA217	30	50	1.0	10		DO-35
BA130	30	100	1.0	10		DO-35
FDLL456A	30	25	1.0	100		LL-34
FDLL456	30	25	1.0	40		LL-34
FDLL461A	30	500	1.0	100		LL-34
1N4154	35	100	1.0	30	2.0	DO-35
BAW75	35	100	1.0	30	2.0	DO-35
FDLL4154	35	100	1.0	30	2.0	LL-34
1N4009	35	100	1.0	30	4.0	DO-35
FDLL4009	35	100	1.0	30	4.0	LL-34
FDH999	35	1000	1.0	10	5.0	DO-35
1N4152	40	50	0.88	20	2.0	DO-35
FDLL4152	40	50	0.88	20	2.0	LL-34
FDH666	40	100	1.0	100	4.0	DO-35
1N4450	40	50	1.0	200	4.0	DO-35
FDLL666	40	100	1.0	100	4.0	LL-34
FDLL4450	40	50	1.0	200	4.0	LL-34
1N482B	40	25	1.0	100		DO-35
FDLL482B	40	25	1.0	100		LL-34
FDH900	45	500	1.1	100	4.0	DO-35
BA318	50	200	0.85	10	4.0	DO-35
BAY71	50	100	1.0	20	2.0	DO-35
BAX13	50	200	1.0	20	4.0	DO-35
BAY74	50	100	1.1	300	4.0	DO-35
BAV74	50	100	1.0	100	4.0	TO-236
1N626	50	1000	1.5	4.0	1000	DO-35
FDLL626	50	1000	1.5	4.0	1000	LL-34
1S920	50	100	1.2	200		DO-35
BA218	50	50	1.0	10		DO-35
1S44	50	50	1.0	10	8.0	DO-35
FDLL920	50	100	1.2	200		LL-34

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

Diode Products by Ascending V_{RRM} and t_{rr} (Continued)

Part No.	V_{RRM} (V)	I_{RRM} (nA)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Package
1N659	60	5000	1.0	6.0		DO-35
BAV18	60	100	1.0	100	50	DO-35
FDLL659	60	5000	1.0	6.0		LL-34
BAV70	70	5000	1.1	50	6.0	TO-236
BAV99	70	2500	1.1	50	6.0	TO-236
BAW56	70	2500	1.1	50	6.0	TO-236
†1N457	70	25	1.0	100		DO-35
†1N457A	70	25	1.0	100		DO-35
1N462A	70	500	1.0	100		DO-35
FDLL457	70	25	1.0	20		LL-34
FDLL457A	70	25	1.0	100		LL-34
FDLL462A	70	500	1.0	100		LL-34
1N4153	75	50	0.66	20	2.0	DO-35
1N4151	75	50	1.0	50	2.0	DO-35
1N4305	75	100	0.85	10	2.0	DO-35
FDH600	75	100	1.0	200	4.0	DO-35
FDLL4153	75	50	0.88	20	2.0	LL-34
FDLL4151	75	50	1.0	50	2.0	LL-34
FDLL4305	75	100	0.85	10	2.0	LL-34
†1N3600	75	100	1.0	200	4.0	DO-35
†1N3064	75	100	1.0	10	4.0	DO-35
†1N4150	75	100	1.0	200	4.0	DO-35
†1N4454	75	100	1.0	10	4.0	DO-35
FDLL3600	75	100	1.0	200	4.0	LL-34
FDLL600	75	100	1.0	200	4.0	LL-34
FDLL3604	75	100	1.0	10	4.0	LL-34
FDLL4150	75	100	1.0	200	4.0	LL-34
FDLL4454	75	100	1.0	10	4.0	LL-34
BAW62	75	25	1.0	100	4.0	DO-35
BAS16	75	1000	1.1	50	6.0	TO-236
FDH1000	75	50	1.0	500	100	DO-35
BA128	75	100	1.0	50		DO-35
BAW76	75	100	1.0	100	2.0	DO-35
1N5194	80	25	1.0	100		DO-35
1N5282	80	100	1.3	500	2.0	DO-35
†1N483B	80	25	1.0	100		DO-35
FDLL483B	80	25	1.0	100		LL-34
BAS29	90		0.84	50		TO-236
BAS31	90		0.84	50		TO-236
BAS35	90		0.84	50		TO-236
†1N914	100	25	1.0	10	4.0	DO-35
1N914A	100	25	1.0	20	4.0	DO-35
1N914B	100	25	1.0	100	4.0	DO-35
1N916	100	25	1.0	10	4.0	DO-35
1N916A	100	25	1.0	20	4.0	DO-35
1N916B	100	25	1.0	30	4.0	DO-35
†1N4148	100	25	1.0	10	4.0	DO-35
1N4149	100	25	1.0	10	4.0	DO-35
1N4446	100	25	1.0	20	4.0	DO-35
1N4447	100	25	1.0	20	4.0	DO-35
1N4448	100	25	1.0	100	4.0	DO-35
1N4449	100	25	1.0	30	4.0	DO-35

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Diode Products by Ascending V_{RRM} and t_{rr} (Continued)

Part No.	V_{RRM} (V)	I_{RRM} (nA)	V_{FM} @ I_F (V)	V_{FM} @ I_F (mA)	t_{rr} (ns) Max	Package
FDLL914	100	25	1.0	10	4.0	LL-34
FDLL914A	100	25	1.0	20	4.0	LL-34
FDLL914B	100	25	1.0	100	4.0	LL-34
FDLL916	100	25	1.0	10	4.0	LL-34
FDLL916B	100	25	1.0	30	4.0	LL-34
FDLL4148	100	25	1.0	10	4.0	LL-34
FDLL4149	100	25	1.0	10	4.0	LL-34
FDLL4446	100	25	1.0	20	4.0	LL-34
FDLL4447	100	25	1.0	20	4.0	LL-34
FDLL4449	100	25	1.0	30	4.0	LL-34
FDSO1200	100	25	1.0	200	4.0	TO-236
BAS19	100	100	1.0	100	50	TO-236
1N627	100	1000	1.5	4.0	1000	DO-35
FDLL627	100	1000	1.5	4.0	1000	LL-34
1S921	100	100	1.2	200		DO-35
FDLL921	100	100	1.2	200		LL-34
BAV19	120	100	1.0	100	50	DO-35
1N658	120	50	1.0	100	300	DO-35
1N660	120	5000	1.0	6.0	300	DO-35
1N660	120	5000	1.0	6.0	300	DO-35
FDLL658	120	50	1.0	100	300	LL-34
FDLL660	120	5000	1.0	6.0	300	LL-34
BAY80	120	100	1.0	150		DO-35
BAY72	125	100	1.0	100	50	DO-35
BAY73	125	1.0	1.0	200		DO-35
BAS20	150	100	1.0	100	50	TO-236
FDH444	150	50	1.1	200	60	DO-35
BAX16	150	100	1.0	1.0	120	DO-35
1N628	150	1000	1.5	4.0	1000	DO-35
FDLL628	150	1000	1.5	4.0	1000	LL-34
FDH300	150	1.0	1.0	200		DO-35
†1N3595	150	1.0	1.0	200		DO-35
1N6099	150	1.0	1.0	200		DO-35
FDH333	150	3.0	1.05	200		DO-35
1N484B	150	25	1.0	100		DO-35
†1N458	150	25	1.0	7.0		DO-35
1S922	150	100	1.2	200		DO-35
FDLL300	150	1.0	1.0	200		LL-34
FDLL3595	150	1.0	1.0	200		LL-34
FDLL6099	150	1.0	1.0	200		LL-34
FDLL333	150	3.0	1.05	200		LL-34
FDLL485A	150	5.0	1.0	100		LL-34
FDLL484B	150	25	1.0	100		LL-34
FDLL458	150	25	1.0	7.0		LL-34
FDLL922	150	100	1.2	200		LL-34
FDLL916A	200	25	1.0	20	4.0	LL-34
FDLL4448	200	25	1.0	200	4.0	LL-34
FDSO1400	200	100	1.0	200	4.0	TO-236
BAS21	200	100	60	100	50	TO-236
FDH400	200	100	1.0	200	50	DO-35
†1N3070	200	100	1.0	100	50	DO-35
†1N4938	200	100	1.0	100	50	DO-35

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Diode Products by Ascending V_{RRM} and t_{rr} (Continued)

Part No.	V_{RRM} (V)	I_{RRM} (nA)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Package
BAV20	200	100	1.0	100	50	DO-35
FDLL400	200	100	1.0	200	50	LL-34
FDLL3070	200	100	1.0	100	50	LL-34
BAX17	200	25	1.2	200	120	DO-35
1N5195	200	25	1.0	100		DO-35
1N629	200	1000	1.5	4.0	1000	DO-35
FDLL629	200	1000	1.5	4.0	1000	LL-34
†1N485B	200	25	1.0	100		DO-35
†1N459	200	25	1.0	3.0		DO-35
1N459A	200	25	1.0	100		DO-35
1S923	200	100	1.2	200		DO-35
1N463A	200	500	1.0	100		DO-35
FDLL459A	200	25	1.0	100		LL-34
FDLL485B	200	25	1.0	100		LL-34
FDLL459	200	25	1.0	3.0		LL-34
FDLL923	200	100	1.2	200		LL-34
FDLL463A	200	500	1.0	100		LL-34
FDSO1500	200	1.0	1.0	200		TO-236
1N661	240	10000	1.0	6.0	300	DO-35
FDLL661	240	10000	1.0	6.0		LL-34
BAV21	250	100	1.0	100	50	DO-35
1N5196	250	25	1.0	100		DO-35

Diode Arrays by V_{RRM} and t_{rr}

Part Type	V_{RRM} (V)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Configuration	Package
FASO2501	60	1.0	100	10	M16S	14-SOIC
FASO2503	60	1.0	100	10	2M8	14-SOIC
FASO2509	60	1.3	500	10	2M8	14-SOIC
FASO2510	60	1.3	500	10	M16S	14-SOIC
FASO2563	60	1.3	500	10	CC8S	14-SOIC
FASO2564	60	1.3	500	10	CA8S	14-SOIC
FSA2002M	60	1.0	100	10	CC8	TO-85
FSA2003M	60	1.0	100	10	CA8	TO-85
FSA2500M	60	1.0	100	10	M16	TO-85
FSA2501M	60	1.0	100	10	M16S	TO-116-2
FSA2501P	60	1.0	100	10	M16M	TO-116
FSA2502M	60	1.0	100	10	M16	TO-96
FSA2503M	60	1.0	100	10	2M8	TO-116-2
FSA2503P	60	1.0	100	10	2M8	TO-116
FSA2504M	60	1.0	100	10	2M8	TO-86
FSA2508P	60	1.3	500	10	2M8	9B
FSA2509M	60	1.3	500	10	2M8	TO-116-2
FSA2509P	60	1.3	500	10	2M8	TO-116
FSA2510M	60	1.3	500	10	M16S	TO-116-2
FSA2510P	60	1.3	500	10	M16S	TO-116
FSA2563M	60	1.3	500	10	CC8S	TO-116-2
FSA2563P	60	1.3	500	10	CC8S	TO-116
FSA2564M	60	1.3	500	10	CA8S	TO-116-2
FSA2564P	60	1.3	500	10	CA8S	TO-116
FSA2565M	60	1.3	500	10	CC13	TO-116-2

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

Diode Arrays by V_{RRM} and t_{rr} (Continued)

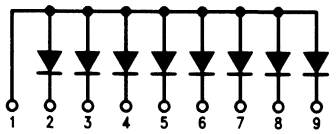
Part Type	V_{RRM} (V)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Configuration	Package
FSA2565P	60	1.3	500	10	CC13	TO-116
FSA2566M	60	1.3	500	10	CA13	TO-116-2
FSA2566P	60	1.3	500	10	CA13	TO-116
1N5768JAN	60	1.0	100	20	CC8	TO-85
1N5768JANTX	60	1.0	100	20	CC8	TO-85
1N5768JANTXV	60	1.0	100	20	CC8	TO-85
1N5770JAN	60	1.0	100	20	CA8	TO-85
1N5770JANTX	60	1.0	100	20	CA8	TO-85
1N5770JANTXV	60	1.0	100	20	CA8	TO-85
1N5772JAN	60	1.0	100	20	M16N	TO-85
1N5772JANTX	60	1.0	100	20	M16N	TO-85
1N5772JANTXV	60	1.0	100	20	M16N	TO-85
1N5774JAN	60	1.0	100	20	2M8	TO-86
1N5774JANTX	60	1.0	100	20	2M8	TO-86
1N5774JANTXV	60	1.0	100	20	2M8	TO-86
FASO5774	60	1.0	100	20	2M8	14-SOIC
1N6100JAN	75	1.0	100	5.0	S7	TO-86
1N6100JANTX	75	1.0	100	5.0	S7	TO-86
1N6100JANTXV	75	1.0	100	5.0	S7	TO-86
1N6101JAN	75	1.0	100	5.0	S8	6B
1N6101JANTX	75	1.0	100	5.0	S8	6B
1N6101JANTXV	75	1.0	100	5.0	S8	63
FASO6101	75	1.0	100	5.0	S7	14-SOIC
FASO2719	75	1.0	10	6.0	S8	16-SOIC
FASO2720	75	1.0	10	6.0	S7	14-SOIC
FSA2719M	75	1.0	10	6.0	S8	6B
FSA2719P	75	1.0	10	6.0	S8	9B
FSA2720M	75	1.0	10	6.0	S7	TO-116-2
FSA2720P	75	1.0	10	6.0	S7	TO-116
FSA2721M	75	1.0	10	6.0	S7	TO-86
FASO2619	100	1.0	10	5.0	S8	16-SOIC
FASO2620	100	1.0	10	5.0	S7	14-SOIC
FSA2619M	100	1.0	10	5.0	S8	6B
FSA2619P	100	1.0	10	5.0	S8	9B
FSA2620M	100	1.0	10	5.0	S7	TO-116-2
FSA2620P	100	1.0	10	5.0	S7	TO-116
FSA2621M	100	1.0	10	5.0	S7	TO-86
FSA2621P	100	1.0	10	5.0	S7	TO-116

Note 1: Package code 6B = 16 lead ceramic DIP.

Note 2: Package code 9B = 16 lead plastic DIP.

Configurations

CA8



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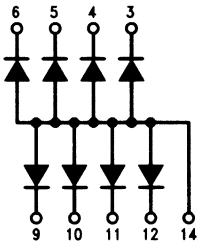
CA8S



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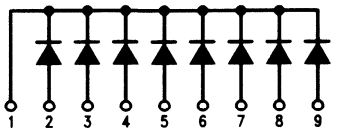
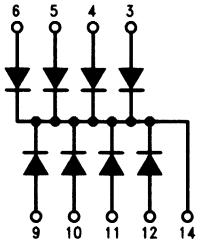
CC8



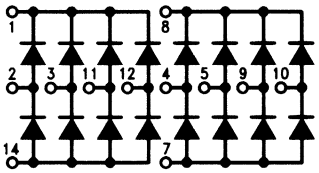
TL/MS/10322-3

CC8S



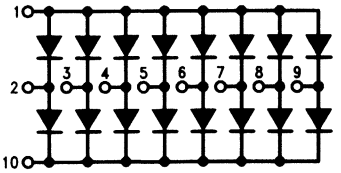
TL/MS/10322-4

2M8



TL/MS/10322-5

M16



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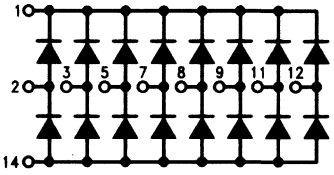
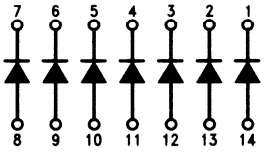


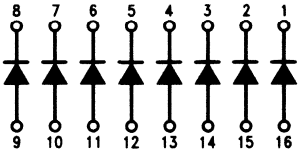
TL/MS/10322-7

S7



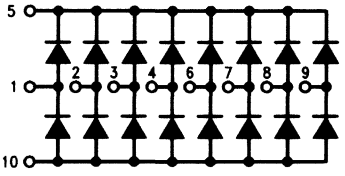
TL/MS/10322-8

S8



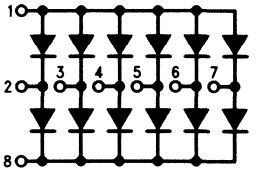
TL/MS/10322-9

M16M



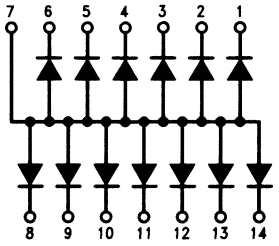
TL/MS/10322-10

M16N



TL/MS/10322-11

CA13



TL/MS/10322-12

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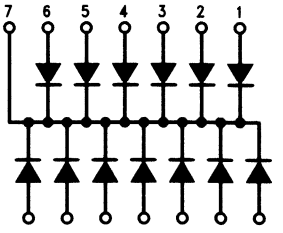


TL/MS/10322-13

Military Diode Products in Numerical Order by Part Number

Part No.	V_{RRM} (V)	I_{RRM} (nA)	V_{FM} @ I_F (V)	(mA)	t_{rr} (ns) Max	Package
1N3064JAN	75	100	1.0	10	4.0	DO-7
1N3064JANTX	75	100	1.0	10	4.0	DO-7
1N3595JAN	150	1.0	1.0	200	3000	DO-7
1N3595JANTX	150	1.0	1.0	200	3000	DO-7
1N3595JANTXV	150	1.0	1.0	200	3000	DO-7
1N3600JAN	75	100	1.0	200	4.0	DO-7
1N3600JANTX	75	100	1.0	200	4.0	DO-7
1N3600JANTXV	75	100	1.0	200	4.0	DO-7
1N3070JAN	200	100	1.0	100	50	DO-35
1N3070JANTX	200	100	1.0	100	50	DO-35
				50	4.0	DO-7
1N4148-1JAN	100	25	1.0	10	4.0	DO-35
1N4148-1JANTX	100	25	1.0	10	2.0	DO-35
1N4148-1JANTXV	100	25	1.0	10	4.0	DO-35
1N4150-1JAN	75	100	1.0	200	4.0	DO-35
1N4150-1JANTX	75	100	1.0	200	4.0	DO-35
1N4150-1JANTXV	75	100	1.0	200	4.0	DO-35
1N4306JAN	75	50	1.0	50	4.0	DO-7
1N4306JANTX	75	50	1.0	50	4.0	DO-7
1N4306JANTXV	75	50	1.0	50	4.0	DO-7
1N4307JAN	75	50	1.0	50	4.0	DO-7
1N4307JANTX	75	50	1.0	50	4.0	DO-7
1N4307JANTXV	75	50	1.0	50	4.0	DO-7
1N4376JAN	20	100	1.1	50	0.75	DO-7
1N4376JANTX	20	100	1.1	50	0.75	DO-7
1N4376JANTXV	20	100	1.1	50	0.75	DO-7
1N4454-1JAN	75	100	1.0	10	4.0	DO-35
1N4454-1JANTX	75	100	1.0	10	4.0	DO-35
1N4454-1JANTXV	75	100	1.0	10	4.0	DO-35
1N457JAN	70	25	1.0	100		DO-35
1N458JAN	150	25	1.0	7.0		DO-35
1N459JAN	200	25	1.0	3.0		DO-35
1N483BJAN	80	25	1.0	100		DO-35
1N483BJANTX	80	25	1.0	100		DO-35
1N483BJANTXV	80	25	1.0	100		DO-35
1N485BJAN	200	25	1.0	100		DO-35
1N485BJANTX	200	25	1.0	100		DO-35
1N485BJANTXV	200	25	1.0	100		DO-35
1N486BJAN	250	25	1.0	100		DO-35
1N486BJANTX	250	25	1.0	100		DO-35
1N486BJANTXV	250	25	1.0	100		DO-35
1N4938-1JAN	200	100	1.0	50		DO-35
1N4938-1JANTX	200	100	1.0	50		DO-35
1N914JAN	100	25	1.0	10	4.0	DO-35
1N914JANTX	100	25	1.0	10	4.0	DO-35

Zener Diodes by Ascending Zener Voltage

Device No.	V_Z (V) Nom	Z_Z (Ω) @ I_Z Max	mA	P_D (mW) (25°C)	Package
1N5226B	3.3	28	20	500	DO-35
1N746A	3.3	28	20	500	DO-35
1N4728A	3.3	10	7.6	1000	DO-41
1N5227B	3.6	24	20	500	DO-35
1N747A	3.6	24	20	500	DO-35
1N4729A	3.6	10	69	1000	DO-41
1N5228B	3.9	23	20	500	DO-35
1N748A	3.9	23	20	500	DO-35
1N4730A	3.9	9.0	64	1000	DO-41
1N5229B	4.3	22	20	500	DO-35
1N749A	4.3	22	20	500	DO-35
1N4731A	4.3	9.0	58	1000	DO-41
1N5230B	4.7	19	20	500	DO-35
1N750A	4.7	19	20	500	DO-35
1N4732A	4.7	8.0	53	1000	DO-41
1N5231B	5.1	17	20	500	DO-35
1N751A	5.1	17	20	500	DO-35
1N4733A	5.1	7.0	49	1000	DO-41
1N5232B	5.6	11	20	500	DO-35
1N752A	5.6	11	20	500	DO-35
1N4734A	5.6	5.0	45	1000	DO-41
1N5233B	6.0	7.0	20	500	DO-35
1N5234B	6.2	7.0	20	500	DO-35
1N753A	6.2	7.0	20	500	DO-35
1N4735A	6.2	2.0	41	1000	DO-41
1N5235B	6.8	5.0	20	500	DO-35
1N754A	6.8	5.0	20	500	DO-35
1N957B	6.8	4.5	18.5	500	DO-35
1N4736A	6.8	3.5	37	1000	DO-41
1N5236B	7.5	6.0	20	500	DO-35
1N755A	7.5	6.0	20	500	DO-35
1N958B	7.5	5.5	16.5	500	DO-35
1N4737A	7.5	4.0	34	1000	DO-41
1N5237B	8.2	8.0	20	500	DO-35
1N756A	8.2	8.0	20	500	DO-35
1N959B	8.2	6.5	15	500	DO-35
1N4738A	8.2	4.5	34	1000	DO-41
1N5238B	8.7	8.0	20	500	DO-35
1N5239B	9.1	10	20	500	DO-35
1N757A	9.1	10	20	500	DO-35
1N960B	9.1	7.5	14	500	DO-35
1N4739A	9.1	5.0	8	1000	DO-41
1N5240B	10	17	20	500	DO-35
1N758A	10	17	20	500	DO-35
1N961B	10	8.5	12.5	500	DO-35
1N4740A	10	7.0	25	1000	DO-41
1N5241B	11	22	20	500	DO-35
1N962B	11	9.5	11.5	500	DO-35
1N4741A	11	8.0	23	1000	DO-41
1N5242B	12	30	20	500	DO-35

Zener Diodes by Ascending Zener Voltage (Continued)

Device No.	V_Z (V) Nom	Z_Z (Ω) @ I_Z Max	mA	P_D (mW) (25°C)	Package
1N759A	12	30	20	500	DO-35
1N963B	12	11.5	10.5	500	DO-35
1N4742A	12	9.0	21	1000	DO-41
1N5243B	13	13	9.5	500	DO-35
1N964B	13	13	9.5	500	DO-35
1N4743A	13	10	19	1000	DO-41
1N5244B	14	15	9.0	500	DO-35
1N5245B	15	16	8.5	500	DO-35
1N965B	15	16	8.5	500	DO-35
1N4744A	15	14	17	1000	DO-41
1N5246B	16	17	7.8	500	DO-35
1N966B	16	17	7.8	500	DO-35
1N4745A	16	16	15.5	1000	DO-41
1N5247B	17	19	7.4	500	DO-35
1N5248B	18	21	7.0	500	DO-35
1N967B	18	21	7.0	500	DO-35
1N4746A	18	20	14	1000	DO-41
1N5249B	19	23	6.5	500	DO-35
1N5250B	20	25	6.2	500	DO-35
1N968B	20	25	6.2	500	DO-35
1N4747A	20	22	12.5	1000	DO-41
1N5251B	22	29	5.6	500	DO-35
1N969B	22	29	5.6	500	DO-35
1N4748A	22	23	11.5	1000	DO-41
1N5252B	24	33	5.2	500	DO-35
1N970B	24	33	5.2	500	DO-35
1N4749A	24	25	10.5	1000	DO-41
1N5253B	25	35	5.0	500	DO-35
1N5254B	27	41	4.6	500	DO-35
1N971B	27	41	4.6	500	DO-35
1N4750A	27	35	9.5	1000	DO-41
1N5255B	28	44	4.5	500	DO-35
1N5256B	30	49	4.2	500	DO-35
1N972B	30	49	4.2	500	DO-35
1N4751A	30	40	8.5	1000	DO-41
1N5257B	33	58	3.8	500	DO-35
1N973B	33	58	3.8	500	DO-35
1N4752A	33	45	7.5	1000	DO-41

Diode Pro Electron Series

Part No.	V_{rrm} (V) Min	I_{rrm} (nA) Max	V_{fm} (V) Max	@	I_f (mA)	t_{rr} (ns) Max	Package
BA128	75	100	1.0		50		DO-35
BA129	200	50	1.0		100		DO-35
BA130	30	100	1.0		10		DO-35
BA217	30	50	1.0		10		DO-35
BA218	50	50	1.0		10		DO-35
BA316	10	200	0.85		10	4.0	DO-35
BA317	30	200	0.85		10	4.0	DO-35
BA318	50	200	0.85		10	4.0	DO-35
BAS16	75	1000	1.1		50	6.0	TO-236
BAS19	100	100	1.0		100	50	TO-236
BAS20	150	100	1.0		100	50	TO-236
BAS21	200	100	1.0		100	50	TO-236
BAS29	90		0.84		50		TO-236
BAS31	90		0.84		50		TO-236
BAS35	90		0.84		50		TO-236
BAV17	25	100	1.0		100	50	DO-35
BAV18	60	100	1.0		100	50	DO-35
BAV19	120	100	1.0		100	50	DO-35
BAV20	200	100	1.0		100	50	DO-35
BAV21	250	100	1.0		100	50	DO-35
BAV70	70	5000	1.1		50	6.0	TO-236
BAV74	50	100	1.0		100	4.0	TO-236
BAV99	70	2500	1.1		50	6.0	TO-236
BAW56	70	2500	1.1		50	6.0	TO-236
BAW62	75	25	1.0		100	4.0	DO-35
BAW75	35	100	1.0		30	2.0	DO-35
BAW76	75	100	1.0		100	2.0	DO-35
BAX13	50	200	1.0		20	4.0	DO-35
BAX16	180	100	1.5		200	120	DO-35
BAY19	120	100	1.0		100	50	DO-35
BAY71	50	100	1.0		20	2.0	DO-35
BAY72	125	100	1.0		100	50	DO-35
BAY73	125	1.0	1.0		200	3.0	DO-35
BAY74	50	100	1.1		300	4.0	DO-35
BAY80	150	100	1.0		150	50	DO-35
BAY82	15	100	1.0		20	0.75	DO-7

NPN General Purpose Transistors by Ascending V_{ceo}

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MPS3721			60	660	2/10		TO-92
MMBT5134	10	20	20	150	10/1.0	250	TO-236
MMBT4274	12	30	35	120	10/1.0	350	TO-236
MMBT5128	12	15	35	350	50/10	200	TO-236
PN5127	12	20	15	300	2/10	150	TO-92
PN5128	12	15	35	350	50/10	200	TO-92
PN5129	12	15	35	350	50/10	800	TO-92
2N5132	15	20	35	500	2/10	150	TO-92
2N5220	15	15	30	600	50/10	100	TO-92
MMBT5220	15	15	30	600	50/10	100	TO-236
MMBT5770	15		50	200	8/1.0	800	TO-236
PN5131	15	20	35	500	10/1.0	100	TO-92
2N2712	18	18	75	225	2/4.5	80	TO-92
2N2714	18	18	75	225	2/4.5	300	TO-92
2N2926	18	18	35	470	2/10		TO-92
2N3721	18	18	60	660	2/10		TO-92
2N3900	18	18	250	500	2/4.5	12	TO-92
MMBT5133	18	20	60	1000	1.8/5.0	40	TO-236
MPS2712	18	18	75	225	2/4.5		TO-92
MPS2716	18	18	75	225	2/4.5		TO-92
MPS711	18	18	30	90	2/4.5		TO-92
PN5133	18	20	60	1000	1.8/5.0	40	TO-92
2N3706	20	40	30	600	50/2.0	100	TO-92
2N3794	20	40	100	600	10/10	600	TO-92
2N5223	20	25	50	800	2/10	150	TO-92
BCW32	20	30	200	450	2/5.0		TO-236
BCW33	20	30	420	800	2/5.0		TO-236
MMBT5136	20	30	20	400	150/1.0	40	TO-236
MMBT5137	20	30	20	400	150/1.0	40	TO-236
MMBT5223	20	25	50	800	2/10	150	TO-236
MMBT6561	20	20	50	200	350/1.0	60	TO-126
MMBT6571	20	25	250	100	0.1/5.0	50	TO-236
MPS6561	20	20	50	200	350/1.0		TO-92
MPS6571	20	25	250	100	0.1/5.0		TO-92
PN3691	20	35	40	160	10/1.0	500	TO-92
PN3692	20	35	100	400	10/1.0	500	TO-92
PN5132	20	20	30	400	10/10	200	TO-92
PN5136	20	30	20	400	150/1.0	150/15	TO-92
PN5137	20	30	20	400	150/1.0	150/15	TO-92
2N2923	25	25	90	180	2/10		TO-92
2N2924	25	25	150	300	2/10		TO-92
2N2925	25	25	235	470	2/10		TO-92
2N3390	25	25	400	800	2/4.5		TO-92
2N3391	25	25	250	500	2/4.5		TO-92
2N3391A	25	25	250	500	2/4.5		TO-92
2N3392	25	25	150	300	2/4.5		TO-92
2N3393	25	25	90	180	2/4.5		TO-92
2N3394	25	25	55	110	2/4.5		TO-92
2N3395	25	25	150	500	2/4.5		TO-92
2N3396	25	25	90	500	2/4.5		TO-92
2N3397	25	25	55	500	2/4.5		TO-92
2N3398	25	25	55	800	2/4.5		TO-92
2N3414	25	25	75	225	2/4.5		TO-92
2N3415	25	25	180	540	2/4.5		TO-92

NPN General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
2N4124	25	30	120	360	2/1.0	300	TO-92
2N5089	25	30	400	120	0.1/5.0	50	TO-92
2N5172	25	25	100	500	10/10		TO-92
2N5225	25	25	30	600	50/10	50	TO-92
MMBT2924	25	25	150	300	2/10		TO-236
MMBT3392	25	25	150	300	2/4.5		TO-236
MMBT3393	25	25	90	180	2/4.5		TO-236
MMBT3565	25	30	150	600	1.0/10	40	TO-236
MMBT4124	25	30	120	360	2/1.0	300	TO-236
MMBT5089	25	30	400	120	0.1/5.0	50	TO-236
MMBT5135	25	30	50	600	10/10	40	TO-236
MMBT5172	25	25	100	500	10/10		TO-236
MMBT5225	25	25	30	600	50/10	50	TO-236
MMBT6514	25	40	150	200	2/1.0		TO-236
MMBT6515	25	40	250	500	2/1.0		TO-236
MMBT6520	25	40	200	400	2/1.0		TO-236
MMBT6521	25	40	300	600	2/1.0		TO-236
MPS172	25	25	100	500	10/10		TO-92
MPS2923	25	25	90	180	2/10		TO-92
MPS2924	25	25	150	300	2/10		TO-92
MPS2925	25	25	235	470	2/10		TO-92
MPS2926	25	25	35	470	2/10		TO-92
MPS3392	25	25	150	300	2/4.5		TO-92
MPS3393	25		90	180	2/4.5		TO-92
MPS3394	25		55	110	2/4.5		TO-92
MPS3395	25		150	500	2/4.5		TO-92
MPS3396	25		90	500	2/4.5		TO-92
MPS3397	25		55	500	2/4.5		TO-92
MPS3398	25		55	800	2/4.5		TO-92
MPS5172	25	25	100	500	10/10		TO-92
MPS6515	25	40	250	500	2/10		TO-92
MPS6520	25		200	400	2/10		TO-92
MPS6521	25		200	600	2/10		TO-92
MPS6522	25		200	400	2/10		TO-92
MPS6560	25	25	50	200	500/1.0	60	TO-92
PE4010	25	30	200	100	1.0/10		TO-92
PE8050	25	30	65	200	100/1.0	100	TO-92
PN3565	25	30	150	600	1.0/10	40	TO-92
PN5135	25	30	50	600	10/10	40	TO-92
2N2218	30	60	40	120	150/10	250	TO-39
2N2219	30	60	100	300	150/10	250	TO-39
2N2221	30	60	40	120	150/10	250	TO-18
2N2222	30	60	100	300	150/10	250	TO-18
2N3704	30	50	100	300	50/2.0	100	TO-92
2N3705	30	50	50	150	50/2.0	100	TO-92
2N3858	30	30	60	120	2/4.5	250	TO-92
2N3859	30	30	100	200	2/4.5	250	TO-92
2N3860	30	30	150	300	2/4.5	250	TO-92
2N4123	30	40	50	150	2/1.0	250	TO-92
2N4951	30	60	60	200	150/10	250	TO-92
2N4952	30	60	100	300	150/10	250	TO-92
2N4953	30	60	200	600	150/10	250	TO-92
2N4954	30	40	60	600	150/10	250	TO-92

NPN General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
2N4970	30	50	100	350	150/10	200	TO-92
2N5088	30	35	300	900	0.1/5.0	50	TO-92
BSR13	30	60	100	300	150/10	250	TO-236
MMBT2218	30	60	40	120	150/10	250	TO-236
MMBT2219	30	60	100	300	150/10	250	TO-236
MMBT2221	30	60	40	120	150/10	250	TO-236
MMBT2222	30	60	100	300	150/10	250	TO-236
MMBT3566	30	40	150	600	10/10	40	TO-236
MMBT3641	30	60	40	120	150/10	150	TO-236
MMBT3643	30	60	100	300	150/10	250	TO-236
MMBT3704	30	50	100	300	50/1.0	100	TO-236
MMBT3705	30	50	50	150	50/20	100	TO-236
MMBT4123	30	40	5	150	2/1.0	250	TO-236
MMBT5088	30	35	300	900	0.1/5.0	50	TO-236
MPS3704	30	50	100	300	50/20	100	TO-92
MPS3705	30	50	50	150	50/20	100	TO-92
MPS6512	30	40	50	180	2/10		TO-92
MPS6513	30	40	90	180	2/10		TO-92
MPS6532	30	50	30		100/1.0		TO-92
PN2218	30	60	40	120	150/10	250	TO-92
PN2219	30	60	100	300	150/10	250	TO-92
PN2221	30	60	40	120	150/10	250	TO-92
PN2222	30	60	100	300	150/10	250	TO-92
PN3566	30	40	150	600	10/10	700	TO-92
PN3641	30	60	40	120	150/10	250	TO-92
PN3643	30	60	100	300	150/10	250	TO-92
PN4141	30	60	40	120	150/10	250	TO-92
PN4142	30	60	100	300	150/10	250	TO-92
PN5449	30	50	100	300	50/2.0	100	TO-92
TN2219	30	60	100	300	150/10	50	TO-237
†2N1613	32	75	40	120	150/10	60	TO-39
BCW60A	32	32	120	200	2.0/5.0	125	TO-236
BCW65A	32	60	100	250	100/1.0	100	TO-236
MPS6573	35		100	500	10/5.0	300	TO-92
MPS6574	35		100	300	1/5.0	300	TO-92
†2N2218A	40	75	40	120	150/10	250	TO-39
†2N2219A	40	75	100	300	150/10	300	TO-39
†2N2221A	40	75	40	120	150/10	250	TO-18
†2N2222A	40	74	100	300	150/10	300	TO-18
2N3109	40	80	100	300	150/1.0	70	TO-39
2N3903	40	60	50	150	10/1.0	250	TO-92
2N3904	40	60	100	300	10/1.0	200	TO-92
2N3946	40	60	59	150	10/1.0	250	TO-18
2N4400	40	60	50	150	150/1.0	200	TO-92
2N4401	40	60	100	300	150/1.0	250	TO-92
2N4424	40	40	180	540	2/4.5		TO-92
2N4944	40	80	40	120	150/1.0	900	TO-92
2N4946	40	80	100	300	150/1.0	900	TO-92
2N697	40	60	40	120	150/10	50	TO-39
BSR14	40	75	100	300	150/10	300	TO-236
BSR17	40	60	50	150	10/1.0	250	TO-236
BSS79B	40	75	40	120	150/10	250	TO-236
BSS79C	40	75	100	300	150/10	250	TO-236

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

NPN General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MMBT2218A	40	75	40	120	150/10	250	TO-236
MMBT2219A	40	75	100	300	150/10	300	TO-236
MMBT2221A	40	75	40	120	150/10	250	TO-236
MMBT2222A	40	75	100	300	150/10	300	TO-236
MMBT3569	40	80	100	300	150/10	60	TO-236
MMBT3903	40	60	50	150	10/0.1	250	TO-236
MMBT3904	40	60	100	300	10/0.1	300	TO-236
MMBT3926	40	60	59	150	10/0.1	250	TO-236
MMBT4400	40	60	50	150	150/1.0	200	TO-236
MMBT4401	40	60	100	300	150/1.0	250	TO-236
MMBTA20	40		40	400	5/10	125	TO-236
MPS3903	40	60	20		0.1/1.0	200	TO-92
MPS6514	40		150	300	2/10		TO-92
MPS6530	40	60	40	120	100/1.0		TO-92
MPS6531	40	60	90	270	100/1.0		TO-92
MPSA10	40		40	400	5/10	50	TO-92
MPSA20	40		40	400	5/10	125	TO-92
PN2218A	40	75	40	120	150/10	250	TO-92
PN2219A	40	75	100	300	150/10	300	TO-92
PN2221A	40	75	40	120	150/10	250	TO-92
PN2222A	40	45	100	300	150/10	300	TO-92
PN222A	40	75	100	300	150/10	300	TO-92
PN3567	40	80	40	120	30/1.0	900	TO-92
PN3569	40	80	100	300	150/1.0	900	TO-92
PN5816	40	50	100	200	2/2.0	100	TO-92
TIS90	40	40	100	300	50/2.0		TO-92
TIS92	40	40	100	300	50/2.0		TO-92
TIS97	40		250	700	0.1/5.0		TO-92
TN2218A	40	75	40	120	150/10	250	TO-237
TN2219A	40	75	100	300	150/10	60	TO-237
2N2270	45	60	50	200	150/10	100	TO-39
2N2586	45	60	120	360	0.01/5.0	45	TO-18
2N3827	45	60	100	400	10/10	800	TO-92
2N5962	45	45	600	1400	10/5.0	100	TO-92
†2N930	45	45	100	300	0.01.5.0	30	TO-18
2N930A	45	60	100	300	0.01.5.0	45	TO-18
BCF81	45	50	420	800	2/5.0		TO-236
BCW66F	45	75	100	250	100/1.0	100	TO-236
BCW72	45	50	200	450	2/5.0		TO-236
BCW81	45	50	420	800	2/5.0		TO-236
BCX70G	45	45	120	220	2/5.0	125	TO-236
BCX70H	45	45	180	310	2/5.0	125	TO-236
BCX70J	45	45	250	460	2/5.0	125	TO-236
MMBT100	45	75	100	450	10/1.0	250	TO-236
MMBT100A	45	75	300	600	10/1.0	250	TO-236
MMBT3642	45	60	40	120	150/10	150	TO-236
MMBT3693	45	45	40	160	10/10	200	TO-236
MMBT3694	45	45	100	400	10/10	200	TO-236
MMBT5962	45	45	600	1400	0/5.0	100	TO-236
MMBT930A	45	60	100	300	0.01/5.0	45	TO-236
MMBTA18	45		500	1500	10/5.0	100	TO-236
MPS3693	45	45	40	160	10/10	200	TO-92
MPS3694	45	45	100	400	10/10	200	TO-92

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

NPN General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MPS3826	45	60	40	160	10/10	800	TO-92
MPS3827	45	60	100	400	10/10	800	TO-92
MPS6564	45		25		10/5		TO-92
MPS6565	45	60	40	160	10/10		TO-92
MPS6566	45	60	100	400	10/10	200	TO-92
MPS6575	45		200	500	10/5.0	300	TO-92
MPS6576	45		100	300	1/5.0	300	TO-92
MPSA18	45	45	500	1500	10/5.0	100	TO-92
PN100	45	75	100	45	10/1.0	250	TO-92
PN100A	45	75	300	600	10/1.0	250	TO-92
PN3642	45	60	40	120	150/10	250	TO-92
PN3693	45	45	40	160	10/10	200	TO-92
PN3694	45	45	100	400	10/1.0	200	TO-92
PN930	45	45	100	300	0.01/5.0	30	TO-92
2N3053	50	60	50	250	150/10	100	TO-39
2N3416	50	50	75	225	2/4.5		TO-92
2N3417	50	50	180	540	2/4.5		TO-92
2N4409	50	80	60	400	10/1.0	60	TO-92
2N5209	50	50	100	300	0.1/5.0	30	TO-92
2N5210	50	50	200	600	0.1/5.0	30	TO-92
MMBT4409	50	80	60	400	10/1.0	60	TO-236
MMBT5209	50	50	100	300	0.1/5.0	30	TO-236
MMBT5210	50	50	200	600	0.1/5.0	30	TO-236
2N1890	60	100	100	300	150/10	60	TO-39
†2N2484	60	60	100	500	0.01/5.0	60	TO-18
2N3107	60	100	100	300	150/10	70	TO-39
2N3108	60	100	40	120	150/10	60	TO-39
2N3117	60	60	150	500	0.01/5.0	60	TO-18
2N5961	60	60	150	700	10/5.0	100	TO-92
MMBT2484	60	60	100	500	0.01/5.0	60	TO-236
MMBT3117	60	60	250	500	0.01/5.0	60	TO-236
MMBT5961	60	60	150	700	10/5.0	100	TO-236
MMBTA05	60		50		100/1.0	50	TO-236
MPS8098	60	60	100	300	1/5.0	150	TO-92
PE4020	60	60	150	950	10/5.0	100	TO-92
PN2484	60	60	100	500	0.01/5.0	60	TO-92
TIS98	60		100	300	1/5.0	2	TO-92
MMBT101	65	100	75	375	10/1.0		TO-236
PN101	65	100	75	375	10/1.0		TO-92
TIS99	65		55	300	100/5.0	2	TO-92
2N1893	80	120	150	10	5.0	50	TO-39
†2N3019	80	140	100	300	150/10	100	TO-39
2N3020	80	140	40	120	150/10	80	TO-39
†2N3700	80	140	100	300	150/10	100	TO-18
2N3701	80	140	40	120	150/10	80	TO-18
2N4410	80	120	60	400	10/1.0	69	TO-92
BSS64	80	120	20		1.0/10	50	TO-236
MMBT3567	80	40	40	120	150/1.0	56	TO-236
MMBT4410	80	120	60	400	10/1.0	60	TO-236
MMBTA06	80		50		100/1.0	50	TO-236
MPS8099	80	80	100	300	1/5.0	150	TO-92

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

NPN General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
2N2405	90	120	60	200	150/10		TO-39
2N5830	100	120	80	500	10/5.0	100	TO-92
MMBT5830	100	120	80	500	10/5.0	100	TO-236
MMBTL01	120	140	50	300	10/5.0	60	TO-236
MPSL01	120	140	50	300	10/5.0	60	TO-92
2N5550	140	160	60	250	10/5.0	300	TO-92
2N5831	140	160	80	250	10/5.0	100	TO-92
MMBT5550	140	160	60	250	10/5.0	100	TO-236
MMBT5831	140	160	80	250	10/5.0	100	TO-236
2N5551	160	180	80	250	10/5.0	300	TO-92
MMBT5551	160	180	80	250	10/5.0	100	TO-236
MPS5551	160	180	80	250	10/5.0	100	TO-92
2N5833	180	200	50	250	10/5.0	100	TO-92
MMBT5833	180	200	5	250	10/5.0	100	TO-236
MMBT5965	180	200	50	250	10/5.0	100	TO-236
PN965	180	200	50	250	10/5.0	100	TO-92
MMBTA43	200	200	50	200	30/10	50	TO-236
MSPA43	200	200	50	200	30/10	50	TO-92
PE7058	220	220	40		30/20	40	TO-92
MMBTA42	300	300	40		30/10	50	TO-236
MPSA42	300	300	40		30/10	50	TO-92
PE7059	300	300	40		30/20	40	TO-92

PNP General Purpose Transistors by Ascending V_{ceo}

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MPS6562			50	200	500/1.0	60	TO-92
MPS6563			50	200	350/1.0	60	TO-92
2N5221	15	15	30	600	50/10	100	TO-92
MMBT5771	15		50	120	10/1.0	850	TO-236
2N4290	20	30	50	300	100/10	100	TO-92
BCW29	20	30	120	360	2/5.0	7.0	TO-236
BCW30	20	30	215	500	2/5.0		TO-236
MMBT5142	20	20	30		50/1.0	100	TO-236
MMBT5143	20	20	15		300/10	100	TO-236
MMBT5239	20	20	40		10/1.0	300	TO-236
PN5139	20	20	40		10/1.0	300	TO-92
PN5142	20	20	30		50/1.0	100	TO-92
PN5143	20	20	30		50/1.0	100	TO-92
2N3702	25	40	60	300	50/5.0	100	TO-92
2N4126	25	25	120	360	2/1.0	250	TO-92
2N5226	25	25	30	600	50/10	50	TO-92
2N5354	25	25	40	120	50/1.0		TO-92
2N5355	25	25	100	300	50/1.0		TO-92
2N5447	25	40	60	300	50/5.0	100	TO-92
2N6076	25	25	100	500	10/10		TO-92
MMBT3638	25	25	30		50/1.0	100	TO-236
MMBT3638A	25	25	100		50/1.0	150	TO-236
MMBT3702	25	40	60	300	50/5.0	100	TO-236
MMBT4126	25	25	120	360	2/1.0	250	TO-236
MMBT5226	25	25	0	600	50/20	50	TO-236

PNP General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MMBT6562	25	25	50	200	500/1.0	60	TO-236
MPS3702	25	40	60	300	50/5.0	100	TO-92
PN3638	25	25	30		10/10	100	TO-92
PN3638A	25	25	100		50/1.0	150	TO-92
PN5447	25	40	60	300	50/5.0	100	TO-92
2N3703	30	50	30	150	50/5.0	100	TO-92
2N4125	30	30	50	150	2/1.0	200	TO-92
2N4291	30	40	100	300	100/10	100	TO-92
2N5227	30	90	50	700	2/10	100	TO-92
2N5448	30	50	30	150	50/5.0	100	TO-92
FTSP4125	30	30	50	150	2/1.0	200	TO-236
MMBT3703	30	50	30	150	50/5.0	100	TO-236
MMBT3704	30	50	100	300	50/2.0	100	TO-236
MMBT3705	30	50	50	150	50/2.0	100	TO-236
MMBT4125	30	30	50	150	2/1.0	200	TO-236
MMBT4916	30	30	70	200	10/1.0	400	TO-236
MMBT4917	30	30	150	300	10/1.0	450	TO-236
MMBT5138	30	30	50	800	0.1/10	30	TO-236
MMBT5227	30	30	50	700	2/10	100	TO-236
MPS3703	30	50	30	150	50/5.0	100	TO-92
MPS6535	30	30	30		100/1.0		TO-92
PN4916	30	30	70	200	10/1.0	400	TO-92
PN4917	30	30	150	300	10/1.0	400	TO-92
PN5138	30	30	50	800	0.1/10	30	TO-92
PN917	30	30	150	300	10/1.0	450	TO-92
BCF29	32	32	120	260	2/5.0		TO-236
BCF30	32	32	215	500	2/5.0		TO-236
BCW61A	32	32	120	220	2/5.0		TO-236
2N1132A	40	60	30	90	150/10	60	TO-39
2N2904	40	60	40	120	150/10	200	TO-39
2N2905	40	60	100	300	150/10	200	TO-39
2N2906	40	60	40	120	150/10	200	TO-18
2N2907	40	60	100	300	150/10	200	TO-18
2N3905	40	40	50	150	10/1.0	200	TO-92
2N3906	40	40	100	300	10/1.0	250	TO-92
2N4037	40	60	50	250	150/10	60	TO-39
2N4402	40	40	50	150	500/2	100	TO-92
2N4403	40	40	100	300	150/2	200	TO-92
2N5365	40	40	40	120	50/1.0		TO-92
2N5366	40	40	100	300	50/1.0		TO-92
2N5817	40	50	100	200	2/2.0	100	TO-92
BCW80C	40		100	300	150/10	210	TO-236
BSR15	40	60	100	300	150/10	200	TO-236
BSS80B	40	75	40	120	150/10	250	TO-236
BSS80C	40	60	100	300	150/10	210	TO-236
MMBT2904	40	60	40	120	150/10	200	TO-236
MMBT2905	40	60	100	300	150/10	200	TO-236
MMBT2906	40	60	40	120	150/10	200	TO-236
MMBT2907	40	60	100	300	150/10	200	TO-236
MMBT3251	40	50	100	300	10/1.0	300	TO-236
MMBT3905	40	40	50	150	10/1.0	200	TO-236
MMBT3906	40	40	100	300	10/1.0	250	TO-236
MMBT4121	40	40	70	200	10/1.0	400	TO-236
MMBT4122	40	40	150	300	10/1.0	450	TO-236

PNP General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MMBT4248	40	40	50		0.1/5.0		TO-236
MMBT4250	40	40	250	700	0.1/5.0		TO-236
MMBT4402	40	40	50	150	150/2.0	150	TO-236
MMBT4403	40	40	100	300	150/2.0	200	TO-236
MMBT6518	40	40	150	300	2/10		TO-236
MMBTA70	40		40	400	5/10	125	TO-236
MPS3905	40	40	50	150	10/1.0	200	TO-92
MPS3906	40	40	100	300	10/1.0	250	TO-92
MPS6516	40	40	50	100	2/10		TO-92
MPS6517	40	40	90	180	2/10		TO-92
MPS6518	40		150	300	2/10		TO-92
MPS6533	40	40	40	120	100/1.0		TO-92
MPS6534	40	40	90	270	100/1.0		TO-92
PN2904	40	60	40	120	150/10	200	TO-92
PN2905	40	60	100	300	150/10	200	TO-92
PN2906	40	60	40	120	150/10	200	TO-92
PN2907	40	60	100	300	150/10	200	TO-92
PN3251	40	50	100	300	10/1.0	300	TO-92
PN4121	40	40	70	200	10/1.0	400	TO-92
PN4122	40	40	150	300	10/1.0	450	TO-92
PN4142	40	60	40	120	150/10	200	TO-92
PN4143	40	60	100	300	150/10	200	TO-92
PN4248	40	40	50		0.1/5.0		TO-92
PN4250	40	40	250	700	0.1/5.0		TO-92
TIS91	40	40	100	300	50/2.0		TO-92
TIS93	40	40	100	300	50/2.0		TO-92
TN4037	40	60	50	250	150/10	200	237
BCF70	45	50	215	500	2/5.0	200	TO-236
BCW69	45	50	120	260	2/5.0		TO-236
BCW70	45	50	215	500	2/5.0		TO-236
BCX71H	45	45	180	310	2/5.0		TO-236
BCX71J	45	45	250	460	2/5.0		TO-236
BCX71K	45	45	380	630	2/5.0		TO-236
MMBT200	45	60	100	450	10/1.0	250	TO-236
MMBT200A	45	60	300	600	10/1.0	250	TO-236
MMBT3644	45	45	100	300	150/10	200	TO-236
PN200	45	60	100	450	10/1.0	250	TO-92
PN200A	45	60	300	600	10/1.0	250	TO-92
PN3644	45	45	100	300	150/10	200	TO-92
2N5086	50	50	250	800	0.1/5.0	40	TO-92
2N5087	50	50	250	800	0.1/5.0	40	TO-92
MMBT5086	50	50	250	800	0.1/5.0	40	TO-236
MMBT5087	50	50	250	800	0.1/5.0	40	TO-236
†2N2904A	60	60	40	120	150/10	200	TO-39
†2N2905A	60	60	100	300	150/10	200	TO-39
†2N2906A	60	60	40	120	150/10	200	TO-18
†2N2907A	60	60	100	300	150/10	200	TO-18
2N3962	60	60	100	450	1/5.0	40	TO-18
2N4030	60	60	40	120	100/5.0	100	TO-39
2N4032	60	60	100	300	100/5.0	150	TO-39
BSR16	60	60	100	300	150/10	200	TO-236
MMBT2904A	60	60	40	120	150/10	200	TO-236
MMBT2905A	60	60	100	300	150/10	200	TO-236
MMBT2906A	60	60	40	120	150/10	200	TO-236

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

PNP General Purpose Transistors by Ascending V_{ceo} (Continued)

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} Min	H_{fe} Max	I_c/V_{ce} (mA/V)	Ft (MHz) Min	Package
MMBT2907A	60	60	100	300	150/10	200	TO-236
MMBT3645	60	60	100	300	150/10	200	TO-236
MMBT3962	60	60	100	450	1.0/5.0	40	TO-236
MMBT4249	60	60	100	300	0.1/5.0		TO-236
MMBT4354	60	60	50	500	10/10	100	TO-236
MMBT4355	60	60	100	400	10/10	100	TO-236
MMBT5855	60	60	50	300	150/10	100	TO-236
MMBTA55	60	60	50		100/1.0	100	TO-236
MPSA55	60		50		100/1.0	50	TO-92
PN2904A	60	60	40	120	150/10	200	TO-92
PN2905A	60	60	100	300	150/10	200	TO-92
PN2906A	60	60	40	120	150/10	200	TO-92
PN2907A	60	60	100	300	150/10	200	TO-92
PN3645	60	60	100	300	150/10	200	TO-92
PN4249	60	60	100	300	0.1/5.0		TO-92
PN4250A	60	60	250	700	0.1/5.0		TO-92
PN4354	60	60	50	500	10/10	500	TO-92
PN4355	60	60	100	400	10/10	500	TO-92
PN5855	60	60	50	300	150/10	100	TO-92
TN2904A	60	60	40	120	150/10	200	TO-237
TN2905	60	60	100	300	150/10	200	TO-237
TN2905A	60	60	100	300	150/10	200	TO-237
2N4036	65	90	20	200	150/2.0	60	TO-39
TN4036	65	90	40	140	150/10	60	TO-237
2N4031	80	80	40	120	100/5.0	100	TO-39
2N4033	80	80	100	300	100/5.0	150	TO-39
MMBT201	80	100	75	375	10/1.0		TO-236
MMBT4356	80	80	50	250	10/10	100	TO-236
MMBT5857	80	80	50	300	150/10	100	TO-236
MMBTA56	80	80	50		100/10	100	TO-236
MPSA56	80		50		100/1	50	TO-92
PN201	80	100	75	375	10/1.0		TO-92
PN4356	80	80	50	250	10/10	500	TO-92
BSS63	100	110	30		10/1.0	50	TO-236
MMBTL51	100	100	40	250	50/5.0	100	TO-236
MPSL51	100	100	40	250	50/5	60	TO-92
2N5400	120	130	40	180	10/5	400	TO-92
MMBT5400	120	130	40	180	10/5.0	100	TO-236
2N5401	150	160	60	240	10/5	300	TO-92
MMBT4888	150	150	40	400	10/10	30	TO-236
MMBT4889	150	150	80	300	10/10	40	TO-236
MMBT5401	150	160	60	240	10/5.0	100	TO-236
PN4888	150	150	40	400	10/10	30	TO-92
PN4889	150	150	80	300	10/10	40	TO-92
MMBTA93	200		30	150	30/A0	50	TO-236
MPSA93	200	200	30	150	30/10	50	TO-92
MMBTA92	300		25		30/10	50	TO-236
MPSA92	300	300	25		30/10	50	TO-92

NPN Switching Transistors by Ascending V_{ceo}

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	$V_{ce\ (sat)}$ (V) Max	@ I_c/I_b (mA)	C_{ob} (pF) Max	Ft (MHz) Max	t_{off} (ns) Max	Package
MMBT5134	10	20	0.25	10/1.0	4.0	250	18	TO-236
PN5134	10	20	0.25	10/1.0	4.0	250	18	TO-92
2N5224	12	25	0.35	10/3.0	4.0	250	60	TO-92
BSV52	12		0.25	10/1.0	4.0	400	18	TO-236
MMBT4274	12	30	0.20	30/3.0	5.0	350	25	TO-236
MMBT5224	12	25	0.35	10/3.0	4.0	250	60	TO-236
PN4274	12	30	0.20	30/3.0	5.0	350	25	TO-92
BSX39	14		0.25	10/1.0			18	TO-236
2N2369	15	40	0.25	10/1.0	4.0	400	18	TO-18
†2N2369A	15	40	0.2	10/1.0	4.0	500	18	TO-18
2N3013	15	40	0.18	30/3.0	5.0	350	25	TO-52
2N5769	15	40	0.2	10/1.0	4.0	500	18	TO-92
2N5772	15	40	0.2	30/3.0	5.0	350	25	TO-92
2N706	15	25	0.6	10/1.0	6.0	200	75	TO-18
MMBT2369	15	40	0.25	10/1.0	4.0	400	18	TO-236
MMBT2369A	15	40	0.2	10/1.0	4.0	500	18	TO-236
MMBT3013	15	40	0.18	30/3.0	5.0	350	25	TO-236
MMBT3646	15	40	0.20	30/3.0	5.0	350	28	TO-236
MMBT4275	15	40	0.20	30/3.0	5.0	350	28	TO-236
MMBT5769	15	40	0.2	10/1.0	4.0	500	18	TO-236
MMBT5772	15	40	0.2	30/3.0	5.0	350	28	TO-236
MMBT706	15	25	0.6	10/1.0	6.0	200	75	TO-236
MMBT706A	15	25	0.69	10/1.0	6.0	200	75	TO-236
MPS2369	15	40	0.25	10/1.0	4.0	500	18	TO-92
MPS3646	15	40	0.20	30/3.0	5.0	350	28	TO-92
MPS706	15	25	0.6	10/1.0	6.0	200	75	TO-92
MPS706A	15	25	0.6	10/1.0	6.0	200	75	TO-92
PN2369	15	40	0.25	10/1.0	4.0	400	12	TO-92
PN2369A	15	40	0.20	10/1.0	4.0	400	12	TO-92
PN3646	15	40	0.20	10/1.0	4.0	500	18	TO-92
PN4275	15	40	020	30/3.0	5.0	350	28	TO-92
2N2710	20	40	0.25	10/1.0	4.0	400	35	TO-18
2N3014	20	40	0.18	30/3.0	5.0	350	25	TO-52
MMBT2710	20	40	0.25	10/1.0	4.0	500	35	TO-236
MMBT3014	20	40	0.18	30/3.0	5.0	350	25	TO-236
2N3724	30	50	0.20	10/1.0	4.0	300	35	TO-39
2N4013	30	50	0.2	100/10	10	300	60	TO-18
2N3253	40	75	0.6	500/50	12	175	70	TO-39
2N3725	50	80	0.26	10/1.0	4.0	300	35	TO-39
2N4014	50	80	0.26	100/108	10	300	60	TO-18

† Also offered as a military device. Please refer to 1989 Military/Aerospace Selection Guide.

PNP Switching Transistors by Ascending V_{ceo}

Part No.	V_{ceo} (V) Min	V_{cbo} (V) Min	$V_{ce(sat)}$ (V) Max	@ I_C/V_{ce} (mA/V)	C_{ob} (pF) Max	Ft MHz Min	t(off) (ns) Max	Package
MMBT5228	5	5	0.4	10/0.3	5.0	300	140	TO-236
2N5228	6	5	0.4	10/0.3	5.0	300	140	TO-92
MMBT3639	6	6	0.16	10/0.3	3.5	500	60	TO-236
MPS3639	6	6	0.16	10/0.3	3.5	500	60	TO-92
PN3639	6	6	0.16	10/0.3	3.5	500	60	TO-92
2N4208	12	12	0.15	10/0.3	3.0	700	20	TO-18
MMBT3640	12	12	0.20	10/0.3	3.5	500	75	TO-236
MMBT4208	12	12	0.15	10/0.3	3.0	700	20	TO-236
MMBT4258	12	12	0.15	10/0.3	3.0	700	20	TO-236
MPS3640	12	12	0.20	10/0.3	3.5	500	75	TO-92
PN3640	12	12	0.20	10/0.3	3.5	500	75	TO-92
PN4258	12	12	0.15	10/0.3	3.0	700	20	TO-92
2N4209	15	15	0.18	10/0.3	3.0	850	20	TO-18
2N5771	15	15	0.18	10/0.3	3.0	850	20	TO-92
MMBT5771	15	15	0.18	10/0.3	3.0	850	20	TO-237

NPN RF Amplifiers and Oscillators by Ascending V_{ceo}

Part No.	V_{ceo} (V) Min	V_{ces}* V_{cbo} (V)	H_{fe} @ I_C/V_{ce} Min	Max	(mA/V)	C_{ob} (pF) Max	Ft (MHz) Min	Max	Package
2N3662	12	18	20		8/10	1.7	700	2100	TO-92
2N3663	12	30	20		8/10	1.7	700	2100	TO-92
PN5130	12	30	15	250	8/10	1.7	450		TO-92
PN5179	15	20	25	250	3/1	1.0	900	2000	TO-92
2N3825	15	30	20		2/10	3.5	200	800	TO-92
2N4292	15	30	20		3/1	3.5	600		TO-92
2N4293	15	30	20		3/1	3.5	600		TO-92
PN918	15	30	20		3/10	1.7	600		TO-92
PN3563	15	30	20	200	8/10	1.7	600	1500	TO-92
PN3564	15	30	20	500	15/10	3.5	400	1200	TO-92
PN5770	15	30	50	200	8/10	1.1	900	1800	TO-92
MMBT5770	15	30	50	200	8/10	1.1	900	1800	TO-236
MPS6539	20		20		4/10	0.7	500		TO-92
MPS6507	20	30*	25		2/10	2.5	700		TO-92
MPS6511	20	30*	25		10/10	2.5			TO-92
MPS6541	20	30*	25		4/10	1.7	600	1500	TO-92
MPS6568A	20	20	20	200	4/5	0.65	375	800	TO-92
MPS6569	20	20	20	200	4/5	0.5	300	800	TO-92
MPS6570	20	20	20	200	4/5	0.5	300	800	TO-92
MPSH30	20	20	20	200	4/5	0.85	300	800	TO-92
MPSH31	20	20	20	200	4/5	0.65	300	800	TO-92
MPS6542	20	30*	25		2/10	1.5	700		TO-92
MPS6543	20	35	25		4/10	1.0	750		TO-92
MPSTH30	20	20	20	200	4/5	0.85	300	800	TO-236
MPS6548	25	30	25		4/10	0.7	650		TO-92
MPSH10	25	30	60		4/10	0.35	650		TO-92
MPS6546	25	35	20		2/10	0.45	600		TO-92
MPS6547	25	35	20		2/5	0.35	600		TO-92
MPSH11	25	30	60		4/10	0.9	650		TO-92
MPSH19	25	30	45		4/10	0.65	300		TO-92
MMBTH10	25	30	60		4/10	0.35	650		TO-236
MMBTH11	25	30	60		4/10	0.9	650		TO-236

NPN RF Amplifiers and Oscillators by Ascending V_{ceo} (Continued)

Part No.	V_{ceo} (V) Min	V_{ces}* V_{cbo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	C_{ob} (pF) Max	Ft (MHz) Min	Max	Package
MPSH32	30	30	27	200	4/5	0.22	300		TO-92
MPSH24	30	40	30		8/10	0.36	400		TO-92
PE3100	30	30*	30	225	5/10	0.8	500		TO-92
PE5029	30	30	30	225	5/10	0.4	500		TO-92
PE5031	30	40	30	180	5/10	0.4	500		TO-92
TIS86	30	30	40	200	4/10	0.45	500		TO-92
MPS6540	30	30	25		2/10	0.65	350		TO-92
MPSH20	30	40	25		4/10	0.65	400		TO-92
PE5025	30	30	20	100	10/10	1.0	300	700	TO-92
MMBTH20	30	40	25		4/10	0.65	400		TO-236
MMBTH24	30	40	30		8/10	0.36	400		TO-236
PE5030B	40	45	45	150	7/15	0.4	600		TO-92
MPS6567	40		25		10/5	0.7			TO-92
MPSH37	40		25		5/10	0.7	300		TO-92
MPSH34	45	45	15		20/2	0.32	500		TO-92
TIS87	45	45	30	150	12/12	0.45	500		TO-92
MPS6544	45	60	20		30/10	0.65			TO-92
MMBTH34	45	45	15		20/2	0.32	500		TO-236
MMBTH81	65	100	60		10/10	0.85	600		TO-236

NPN Low Level Transistors by Ascending V_{ceo}

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	C_{ob} (pF) Max	Ft (MHz) Min	Max	NF (db) Max	Package
2N3900A	18	250	500	2/4.5	12			5	TO-92
2N3901	18	350	700	2/4.5	12			5	TO-92
2N5133	18	60	1000	1/5	5				TO-92
2N4286	25	150	600	1/5	6	40			TO-92
2N4968	25	40	200	0.01/5	6	40			TO-92
PE4010	25	200	1000	1/10	4	20			TO-92
2N3707	30	100	400	0.1/5				5	TO-92
2N3708	30	45	660	1.0/5					TO-92
2N3709	30	45	165	1.0/5					TO-92
2N3710	30	90	330	1.0/5					TO-92
2N3711	30	180	660	1.0/5					TO-92
MPS3708	30	45	660	1/5					TO-92
MPS3707	30	100	400	0.1/5				5	TO-92
MPS3709	30	45	165	1/5					TO-92
MPS3710	30	90	330	1/5					TO-92
MPS3711	30	100	660	1/5	6	40			TO-92
2N4966	40	40	200	0.1/5	6	40			TO-92
2N4967	40	100	600	0.01/5	6	40			TO-92
2N4287	45	150	600	1/5	6	40			TO-92
2N5232	50	250	500	2/5	4				TO-92
2N5232A	50	250	500	2/5	4			5	TO-92
MPSA09	50	100	600	0.1/5	5	600			TO-92
2N3858A	60	60	120	10/1	4.0	90	250		TO-92
2N3859A	60	100	200	10/1	4.0	90	250		TO-92
2N3877	70	20	250	2/4.5					TO-92
2N3877A	85	20	250	2/4.5					TO-92

PNP Low Level Transistors by Ascending V_{ceo}

Part No.	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} @ I_c/V_{ce} Min	Max	(mA/mV)	C_{ob} (pF) Max	Ft (MHz) Min	Max	NF (db) Max	Package
2N4288	25	30	150	600	1/5	1	8	40		TO-92
2N4289	25	30	150	600	1/5	1	8	40	4	TO-92
MPS6523	25		300	600	2/10	50	4			TO-92
2N4058	30	30	100	400	0.1/5	10			5	TO-92
2N4059	30	30	45	660	1/5	10				TO-92
2N4061	30	30	90	330	1/5	10				TO-92
2N4062	30	30	180	660	1/5	10				TO-92
2N5227	30	30	50	700	2/10	10	5	100		TO-92
MPSA70	40		40	400	5/10	10	4	125		TO-92
PN4248	40	40	50		0.1/5	10	6			TO-92
PN4250	40	40	250	700	0.1/5	10	6		2	TO-92
2N5086	50	50	150	500	0.1/5	10	4	40	3	TO-92
2N5087	50	50				10	4	40	2	TO-92
PN4249	60	60	100	300	0.1/5	10	6			TO-92
PN4250A	60	60	250	700	0.1/5	10	6		2	TO-92

NPN Darlington Transistors by V_{ceo}

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	$V_{ce\,(sat)}$ @ I_c (V) Max	(mA)	Package
2N5305			2000	20,000	2/5	1.4	2	TO-92
2N5306			7000	70,000	2/5	1.4	2	TO-92
2N5307			2000	20,000	2/5	1.4	2	TO-92
2N5308			7000	70,000	2/5	1.4	2	TO-92
MPSA12		20	20,000		10/5	1.0		TO-92
MPSA14		30	20,000		100/5	1.5	10	TO-92
MPSA13		30	10,000		100/5	1.5	10	TO-92
NSD152			10,000	25,000	100/5	1.5	10	TO-202
NSD153			20,000		10/5	1.5	10	TO-202
NSD154			20,000		10/5	1.5	10	TO-202
NSDU45		50	25,000	150,000	200/5	1.0	200	TO-202
NSDU45A		60	25,000	150,000	200/5	1.0	200	TO-202
D40C1	30		10,000	60,000	200/5	1.5		TO-202
D40C2	30		40,000		200/5	1.5		TO-202
D40C3	30		90,000		200/5	1.5		TO-202
D40C8	30		40,000		200/5	1.5		TO-202
D40K1	30		10,000		200/5			TO-202
D40K3	30		10,000		200/5			TO-202
NSD151	30		10,000	100,000	100/5	1.5	10	TO-202
D40C5	40		40,000		200/5	1.5		TO-202
D40C7	40		10,000	60,000	200/5	1.5		TO-202
D40K4	40		10,000		200/5			TO-202
2N6426	40	40	30,000	300,000	100/5	1.5	10	TO-92
2N6427	40	40	20,000	200,000	100/5	1.5	10	TO-92
2N6548	40	50	25,000	150,000	200/5		200	TO-202
2N6549	40	50	15,000	150,000	200/5		200	TO-202
D40K2	50		10,000		200/5			TO-202
2N7051	100	100	20,000		100/5	1.4	100	TO-226AA
2N7052	100	100	10,000		100/5	1.4	100	TO-226AA
2N7053	100	100	10,000		100/5	1.5	100	TO-226AE

PNP Darlington Transistors by V_{ceo}

Part Type	V_{ceo} (V) Min	V_{cbo} (V) Min	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)		$V_{ce\ (sat)}$ @ I_c (V) Max	(mA)	Package
MPSA62	20		20,000	10/5	1.0		TO-92		
D41K1	30		10,000	0.2/5		1.5	0.02	TO-202	
D41K3	30		10,000	0.2/5		1.5	0.02	TO-202	
MPSA63	30		10,000	0/5		1.5	0.01	TO-92	
MPSA64	30		20,000	100/5		1.5	0.01	TO-92	
MPSA65	30		20,000	0.1/5		1.5	0.01	TO-92	
MPSA66	30		40,000	0.1/5		1.5	0.01	TO-92	
D41K2	50		10,000	0.2/5		1.5	0.02	TO-202	
D41K4	50		10,000	0.2/5		1.5	0.02	TO-202	
NSDU95	50	60	25,000	0.2/5		1.5	0.02	TO-202	
NSDU95A	50	60	25,000	0.2/5		1.5	0.02	TO-202	

NPN Medium Power Transistors by Ascending V_{ceo}

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	$V_{ce\ (sat)}$ (V) Max	I_c/I_b (mA)/(mA)	Package
NSE871		50		25/20			TO-202
TN1711		40	300	500/10	1.5	150	TO-237
MPS6561	20	50	200	500/1	0.5	350	TO-92
MSP6560	25	50	200	500/1	0.5	500	TO-92
2N5449	30	100	300	50/2	0.6	100	TO-92
2N6714	30	50	250	1A/1	0.5	100	TO-237
92PU01	30	50		1A/1	0.5	1A	TO-237
D40D1	30	50	150	100	0.5	500	TO-202
D40D2	30	120	360	100	0.5	500	TO-202
D40D3	30	290		100		500	TO-202
D40E1	30	50		100/2	1.0	1A	TO-202
D42C1	30	25		200/1	0.5	1A	TO-202
D42C2	30	40	120	200/1	0.5	1A	TO-202
D42C3	30	40		200/1	0.5	1A	TO-202
NSDU01	30	60		100/1	0.5	1A	TO-202
TN3252	30	30	90	500/1	0.5	500	TO-237
TN3724	30	60	150	150/1	0.25	10	TO-237
2N4237	40	30	150	250/1	0.6	1A/0.1A	TO-39
2N6715	40	50	250	1A/1	0.5	1A	TO-237
92PU01A	40	50		1A/1	0.5	1A	TO-237
NCBV14	40	75		50/1	1.4	500	TO-202
NSDU01A	40	60		100/1	0.5	1A	TO-202
NSDU02	40	50	300	150/10	0.4	150	TO-202
NSE180	40	50	250	100/1	0.9	1.5A	TO-202
TN3053	40	50	250	150/10	1.4	150	TO-237
TN3253	40	25	75	375/1	1.35	150	TO-237
2N6705	45	40	250	250/2	1.0	1A	TO-237
92PE37B	45	40		250/2	1.0	1A	TO-237
D40D4	45	50	150	100	0.5	500	TO-202
D40D5	45	120	360	100	0.5	500	TO-202
D40D6	45	50	150	100	1.0	500	TO-202
D42C4	45	25		200/1	0.5	1A	TO-202
D42C5	45	40	120	200/1	0.5	1A	TO-202
D42C6	45	40		200/1	0.5	1A	TO-202
NSD102	45	50	150	100/5	0.4	500	TO-202

NPN Medium Power Transistors by Ascending V_{ceo} (Continued)

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	H_{fe} @ I_c/V_{ce} Max	H_{fe} @ I_c/V_{ce} (mA/V)	$V_{ce\ (sat)}$ (V) Max	I_c/I_b (mA)/(mA)	Package
NSD103	45	120	300	100/5	0.4	500	TO-202
TN2270	45	50	200	150/10	0.9	150	TO-202
NSD6179	50	40	250	500/2	0.5	500	TO-202
TN3444	50	20	60	500/1	0.6	500	TO-237
2N4238	60	30		500/4	0.6	1A/0.1A	TO-39
2N4896	60	100	300	2A/2	1.0	5A/0.5A	TO-39
2N4945	60	40	120	150/1	0.25	150	TO-92
2N6551	60	80	250	50/1	1.0	1A	TO-202
2N6706	60	40	250	250/2	1.0	1A	TO-237
2N6716	60	50	250	250/1	0.35	250	TO-237
D40D7	60	50	150	100	1.0	500	TO-202
D40D8	60	120	360	100/2	1.0	500	TO-202
D40E5	60	50		100/2	1.0	1A	TO-202
MPSA05	60	50		100/1	0.25	100	TO-92
NSDU05	60	50		250/1	0.35	250	TO-202
NSE181	60	50	250	10/1	0.9	1.5A	TO-202
PN3568	60	40	120	150/1	0.25	150	TO-92
TN2017	60	50	200	200/10			TO-237
TN2102	65	40	120	150/10	0.5	150	TO-237
2N5321	75	40	250	500/4.0	0.8	500/50	TO-39
D40D10	75	50	150	100/2	1.0	500	TO-202
D40D11	75	120	360	100/2	1.01	500	TO-202
D40D13	75	50	150	100/2	1.0	500	TO-202
D40D14	75	120	360	100/2	1.0	500	TO-202
NSD6178	75	40	250	500/2	0.5	500	TO-202
2N4239	80	15		1A/1.0	0.6	1A/0.1A	TO-39
2N5336	80	30	120	2A/2.0	1.2	5A/0.5A	TO-39
2N6552	80	80	250	50/1	1.0	1A	TO-202
2N6707	80	40	120	250/2	1.0	1A	TO-237
2N6717	80	50	250	250/1	0.35	250	TO-237
2N6731	80	100	300	350/2	0.35	350	TO-237
92PE37C	80	40		250/2	1.0	1A	TO-237
92PU100	80	50	100	100/5	0.35	250	TO-237
D40E7	80	50		100/2	1.0	1A	TO-202
MPSA06	80	50		100/1	0.25	100	TO-92
NSD104	80	50	150	100/2	0.5	500	TO-202
NSD105	80	120	360	100/5	0.5	500	TO-202
NSDU06	80	20		500/1	0.35	250	TO-202
TN3019	80	100	300	150/10	0.5	500	TO-237
TN3020	80	30	100	500/10	0.5	500	TO-237
2N5320	100	30	130	500/4.0	0.5	500/50	TO-39
2N5338	100	30	120	2A/2.0	1.2	5A/0.5A	TO-39
2N5681	100	40	150	250/2.0	1.0	500/50	TO-39
2N6553	100	80	250	50/1	1.0	1A	TO-202
2N6718	100	50	250	250/1	0.35	350	TO-237
92PU05	100	80		50/1	0.35	250	TO-237
92PU06	100	20	500	500/1	0.35	250	TO-237
92PU07	100	20		500/1	0.35	250	TO-237
NSD106	100	50	150	100/5	0.5	500	TO-202
NSDU07	100	20		500/1	0.35	250	TO-202
2N5682	120	40	150	250/2.0	1.0	500/50	TO-39
D40P1	120	40	80	10	1.0	100	TO-202

NPN Medium Power Transistors by Ascending V_{ceo} (Continued)

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	$V_{ce\ (sat)}$ (V) Max	I_c/I_b (mA)/(mA)	Package
2N6591	150	40	200	100/10	0.8	200	TO-202
2N6720	150	10	50	500/10	0.5	100	TO-237
NSD36	150	30	300	100/10	0.5		TO-202
2N6711	160	30	200	30/10			TO-237
92PE487	160	15		10/10	1.0	30	TO-237
NSD457	160	25		30/10	1.0	30	TO-202
NSE457	160	25		30/10	1.0	30	TO-202
D40P3	180	40	80	10	1.0	100	TO-202
2N6592	200	40	200	100/10	0.8	200	TO-202
2N6721	200	10	50	500/10	0.5	100	TO-237
2N6733	200	40	200	10/10	2.0	20	TO-237
MPSA43	200	50	200	30/10	0.4	20	TO-92
NSD36A	200	30	300	100/10	0.5		TO-202
PN7055	220	40		10/20	1.0	20	TO-92
D40P5	225	40	80	10	1.0	100	TO-202
2N3440	250	40	160	20/10	0.5	50/4.0	TO-39
2N6593	250	30	200	100/10	0.8	200	TO-202
2N6712	250	30	200	30/10			TO-237
2N6722	250	10	50	500/10	0.5	100	TO-237
2N6734	250	40	200	10/10	2.0		TO-237
92PE488	250	15		10/10	1.0	30	TO-237
D40N1	250	30	90	20/10			TO-202
D40N2	250	60	180	20/10			TO-202
NSD131	250	30	90	30/10	1.0	20	TO-202
NSD132	250	60	180	30/10	1.0	20	TO-202
NSD3440	250	40	160	20/10	0.5	50	TO-202
NSD36B	250	30	300	100/10	0.5		TO-202
NSD458	250	25		30/10	1.0	30	TO-202
NSE458	250	25		30/10	1.0	30	TO-202
TN3440	250	40	160	20/10	0.5	50	TO-237
2N5416	300	30	120	50/10	2.0	50/5.0	TO-39
2N6719	300	40	200	30/10			TO-237
2N6713	300	30	200	30/10			TO-237
2N6723	300	10	50	500/10	0.5	100	TO-237
2N6735	300	40	200	10/10			TO-237
92PE489	300	15		10/10	1.0	30	TO-237
92PU10	300	40		10/10	0.75	30	TO-237
D40N3	300	30	90	20/10			TO-202
D40N4	300	80		20/10			TO-202
MPSA42	300	40		10/10	0.5	20	TO-92
NSD133	300	30	90	30/10	1.0	20	TO-202
NSD134	300	60	180	30/10	1.0	20	TO-202
NSD36C	300	30	300	100/10	0.5		TO-202
NSD459	300	25		30/10	1.0	30	TO-202
NSDU10	300	40		10/15	1.5	20	TO-202
NSE459	300	25		30/10	1.0	30	TO-202
SV7056	300	40		30/20	1.0	20	TO-202
TN3742	300	20	200	10	1.0	30	TO-237
2N3439	350	40	160	20/10	0.5	50/4.0	TO-39
NSD3439	350	40	160	20/10	0.5	50	TO-202
NSD135	375	30		10/10	1.0	20	TO-202

PNP Medium Power Transistors by Ascending V_{ceo}

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	$V_{ce\ (sat)}$ (V) Max	I_c/I_b (mA)/(mA)	Package
2N6726	30	55		10/1	0.5	1000	TO-237
92PU51	30	60		100/1	0.5	1A	TO-237
D41D1	30	50	150	100/2	0.5	500	TO-202
D41D2	30	120	300	100/2	0.5	500	TO-202
NSDU51	30	50		1A/1	0.7	1000	TO-202
TN5023	30	40	100	500/1	0.7	1000	TO-237
2N4234	40	30	150	250/1.0	0.6	1000/125	TO-39
2N6727	40	55		10/1	0.5	1000	TO-237
92PU51A	40	60		100/1	0.5	1A	TO-237
NSDU51A	40	50		1A/1	0.7	1000	TO-202
NSDU52	40	50	300	150/10	0.4	150	TO-202
NSE170	40	50	250	100/1	0.3	500	TO-202
TN3467	40	40	120	500/1	1.0	1000	TO-237
TN4234	40	30	150	250/1		1000	TO-237
2N6706	45	40	250	250/2	0.5	500	TO-237
2N6708	45	40	250	250/2	1.0	1000	TO-237
92PE77A	45	25		500/2	1.0	1000	TO-237
D41D	45	50	150	100/2	0.5	500	TO-202
D41D5	45	120	360	100/2	0.5	500	TO-202
NSD202	45	50	100	100/5	0.4	500	TO-202
NSD203	45	120	300	100/5	0.4	500	TO-202
2N5323	50	40	250	500/4.0	1.2	500/50	TO-39
NSD6181	50	40	120	500/2	0.5	500	TO-202
TN3245	50	30	90	500/1	1.2	1000	TO-237
TN5022	50	25	100	500/1	0.8	1000	TO-237
2N4235	60	30	150	250/1.0	0.6	1000/125	TO-39
2N6554	60	80	300	50/1	0.5	250	TO-202
2N6555	60	80	300	50/1	0.5	250	TO-202
2N6709	60	40	250	250/2	0.5	500	TO-237
2N6728	60	50	250	250/1	0.35	250	TO-237
92PE77B	60	25		500/2	1.0	1000	TO-237
92PU55	60	50		250/1	0.35	250	TO-237
D41D7	60	50	150	100/2	1.0	500	TO-202
D41D8	60	120	360	100/2	1.0	500	TO-202
D41E5	60	10		1A/1	1.0	1000	TO-202
D41E5	60	10		1A/2	1.0	1000	TO-202
D43C7	60	10		1A/2	0.5	1000	TO-202
D43C8	60	40	120	200/1	0.5	1000	TO-202
D43C9	60	20		2A/1	0.5	1000	TO-202
NSDU55	60	20		500/1	0.35	250	TO-202
NSE171	60	50	250	100/1	0.3	500	TO-202
TN4030	60	40	120	100/5	1.0	1000	TO-237
TN4235	60	30	150	250/1		1000	TO-237
TN4314	65	50	250	150/10	1.4	150	TO-237
2N5322	75	30	130	500/4.0	0.7	500/50	TO-39
D41D10	75	50	150	100/2	1.01	500	TO-202
D41D11	75	120	360	100/2	1.0	500	TO-202
D41D13	75	50	150	100/2	1.0	500	TO-202
D41D14	75	120	360	100/2	1.0	500	TO-202
NSD6180	75	40	250	500/2	0.5	200	TO-202

PNP Medium Power Transistors by Ascending V_{ceo} (Continued)

Part No.	V_{ceo} (V)	H_{fe} @ I_c/V_{ce} Min	Max	(mA/V)	$V_{ce\ (sat)}$ (V) Max	I_c/I_b (mA)/(mA)	Package
2N4236	80	30	150	250/1.0	0.6	1000/125	TO-39
2N6710	80	40	250	250/2	0.5		TO-237
2N6729	80	50	250	250/1	0.35	250	TO-237
2N6732	80	100	300	350/2	0.35	350	TO-237
92PE77C	80	25		500/2	0.5	500	TO-237
92PU56	80	50		250/1	0.35	250	TO-237
D41E7	80	10		1A/2	1.0	1000	TO-202
D43C10	80	10		1A/1	0.5	1000	TO-202
D43C11	80	40	120	200/1	0.5	1000	TO-202
D43C12	80	40	120	200/1	0.5	1000	TO-202
NSD204	80	50	150	100/5	0.5	500	TO-202
NSD205	80	120	360	100/5	0.5	500	TO-202
NSDU56	80	20		500/1	0.35	250	TO-202
TN4033	80	100	300	100/5	0.5	500	TO-237
TN4236	80	30	150	250/1		1000	TO-237
2N5679	100	40	150	250/2.0	2.0	1000/20	TO-39
2N6556	100	80	300	50/1	0.5	250	TO-202
2N6730	100	50	200	250/1	0.35	250	TO-237
92PU57	100	50		250/1	0.35	250	TO-237
NSD206	100	50	150	100/5	0.5	500	TO-202
NSDU57	100	20		500/1	0.35	250	TO-202
2N5680	120	40	150	250/2.0	2.0	1000/200	TO-39
2N5415	250	30	150	50/10	2.5	50/5.0	TO-39
2N5416	300	30	120	50/10	2.0	50/5.0	TO-39
NSE872	300	50		25/20			TO-202

Military Qualified Transistors (Numeric Order)

Part Type	Polarity	V_{ceo} (V) Min	H_{fe} @ Min	H_{fe} @ Max	I_c/V_{ce} (mA)/(V)	Package	MIL STD 19500 Slash No.
2N1613JAN	NPN	30	40	120	150/10	TO-39	181
2N1613JANTX	NPN	30	40	120	150/10	TO-39	181
2N1613JANTXV	NPN	30	40	120	150/10	TO-39	181
2N2060JAN	NPN	60	50	150	10/5.0	TO-78	270
2N2060JANTX	NPN	60	50	150	10/5.0	TO-78	270
2N2060JANTXV	NPN	60	50	150	10/5.0	TO-78	270
2N2218AJAN	NPN	50	40	120	150/10	TO-39	251
2N2218AJANTX	NPN	50	40	120	150/10	TO-39	251
2N2218AJANTXV	NPN	50	40	120	150/10	TO-39	251
2N2219AJAN	NPN	50	100	300	150/10	TO-39	251
2N2219AJANTX	NPN	50	100	300	150/10	TO-39	251
2N2219AJANTXV	NPN	50	100	300	150/10	TO-39	251
2N2221AJAN	NPN	50	40	120	150/10	TO-18	255
2N2221AJANTX	NPN	50	40	120	150/10	TO-18	255
2N2221AJANTXV	NPN	50	40	120	150/10	TO-18	255
2N2222AJAN	NPN	50	100	300	150/10	TO-18	255
2N2222AJANTX	NPN	50	100	300	150/10	TO-18	255
2N2222AJANTXV	NPN	50	100	300	150/10	TO-18	255
2N2369AJAN	NPN	15	40	120	10/0.35	TO-18	317
2N2369AJANTX	NPN	15	40	120	10/0.35	TO-18	317
2N2369AJANTXV	NPN	15	40	120	10/0.35	TO-18	317
2N2484JAN	NPN	60	200	500	0.01/1.0	TO-18	376
2N2484JANTX	NPN	60	200	500	0.01/1.0	TO-18	376
2N2484JANTXV	NPN	60	200	500	0.01/1.0	TO-18	376
2N2906AJANTXV	NPN	60	40	120	150/10	TO-18	291
2N2920JAN	NPN	60	300	1000	1.0/5.0	TO-78	355
2N2920JANTX	NPN	60	300	1000	1.0/5.0	TO-78	355
2N2920JANTXV	NPN	60	300	1000	1.0/5.0	TO-78	355
2N3019JAN	NPN	80	100	300	150/10	TO-39	391
2N3019JANTX	NPN	80	100	300	150/10	TO-39	391
2N3019JANTXV	NPN	80	100	300	150/10	TO-39	391
2N3700JAN	NPN	80	100	300	150/10	TO-18	391
2N3700JANTX	NPN	80	100	300	150/10	TO-18	391
2N3700JANTXV	NPN	80	100	300	150/10	TO-18	391
2N718AJAN	NPN	30	40	120	150/10	TO-18	181
2N718AJANTX	NPN	30	40	120	150/10	TO-18	181
2N718AJANTXV	NPN	30	40	120	150/10	TO-18	181
2N930JAN	NPN	45	100	300	10/5.0	TO-18	253
2N930JANTX	NPN	45	100	300	10/5.0	TO-18	253
2N2904AJAN	PNP	60	40	120	150/10	TO-39	290
2N2904AJANTX	PNP	60	40	120	150/10	TO-39	290
2N2904AJANTXV	PNP	60	40	120	150/10	TO-39	290
2N2905AJAN	PNP	60	100	300	150/10	TO-39	290
2N2905AJANTX	PNP	60	100	300	150/10	TO-39	290
2N2905AJANTXV	PNP	60	100	300	150/10	TO-39	290
2N2906AJAN	PNP	60	40	120	150/10	TO-18	291
2N2906AJANTX	PNP	60	40	120	150/10	TO-18	291
2N2907AJAN	PNP	60	100	300	150/10	TO-18	291
2N2907AJANTX	PNP	60	100	300	150/10	TO-18	291
2N2907AJANTXV	PNP	60	100	300	150/10	TO-18	291

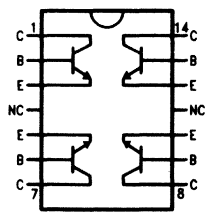
Quad Transistors

Device No.	Type	V_{ceo} (V) Min	H_{fe} @ Min	I_C/V_{ce} (mA/V)	$V_{ce\,(sat)}$ (V) Max	@ I_C/I_b (mA/mA)	Configuration	Package
MMPQ2222	NPN	40	100	150/10	0.4	150/15	CD5	16-SOIC
MMPQ3724	NPN	40	30	500/1.0	0.5	500/50	CD5	16-SOIC
MMPQ3725	NPN	50	20	500/1.0	0.5	500/50	CD5	16-SOIC
MMPQ3904	NPN	40	100	10/1.0	0.2	10/1.0	CD5	16-SOIC
MMPQ6426	NPN	40	10000	100/5.0	1.5	100/0.1	CD4	16-SOIC
MMPQ6502	*	40	100	150/10	0.4	150/15	CD7	16-SOIC
MMPQ6700	*	40	70	10/1.0	0.25	10/1.0	CD7	16-SOIC
MPQ2222	NPN	40	100	150/10	0.4	150/15	CD1	TO-116
MPQ3724	NPN	40	30	500/1.0	0.5	500/50	CD1	TO-116
MPQ3725	NPN	50	20	500/1.0	0.5	500/50	CD1	TO-116
MPQ3904	NPN	40	100	10/1.0	0.2	10/1.0	CD1	TO-116
MPQ6426	NPN	40	10000	100/5.0	1.5	100/0.1	CD4	TO-116
MPQ6502	*	40	100	150/10	0.4	150/15	CD3	TO-116
MPQ6700	*	40	100	10/1.0	0.25	10/1.0	CD3	TO-116
MMPQ2907	PNP	40	100	150/10	0.4	150/15	CD6	16-SOIC
MMPQ3906	PNP	40	100	10/1.0	0.25	10/1.0	CD6	16-SOIC
MPQ2907	PNP	40	100	150/10	0.4	150/15	CD2	TO-116
MPQ3906	PNP	40	100	10/1.0	0.25	10/1.0	CD2	TO-116

*Complementary Pairs.

Connection Diagrams (Top View)

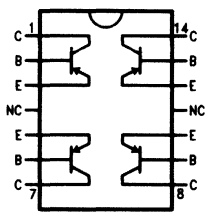
NPN



TL/MS/10323-1

CD1

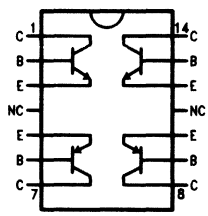
PNP



TL/MS/10323-2

CD2

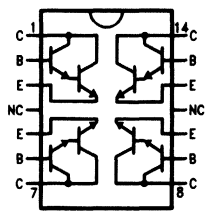
Complementary



TL/MS/10323-3

CD3

NPN Darlington



TL/MS/10323-4

CD4

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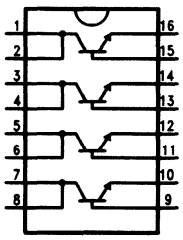

TL/MS/10323-5

CD5

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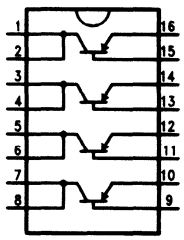
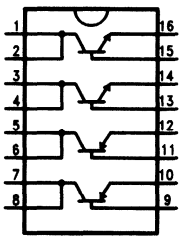


TL/MS10323-6

CD6



TL/MS10323-7

CD7

Bipolar Pro Electron Series

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC327	50*	45	5	100*	45	40		300	1	0.7			500					TO-92
						100	600	100	1			1.2*	300					
BC327A	60*	60	5	100*	45	40		300	1	0.7			300					TO-92
						100	400	100	1			1.2*	500					
BC327-10	50*	45	5	100*	45	40		300	1	0.7			500					TO-92
						63	160	100	1			1.2*	300					
BC327-16	50*	45	5	100*	45	40		300	1	0.7			500					TO-92
						100	250	100	1			1.2*	300					
BC327-25	50*	45	5	100*	45	40		300	1	0.7			500					TO-92
						160	400	100	1			1.2*	300					
BC328	30*	25	5	100*	25	40		300	1	0.7			500					TO-92
						100	600	100	1			1.2	300					
BC328-10	30*	25	5	100*	25	40		300	1	0.7			500					TO-92
						63	160	100	1			1.2	300					
BC328-16	30*	25	5	100*	25	40		300	1	0.7			500					TO-92
						100	250	100	1			1.2	300					
BC328-25	30*	25	5	100*	25	40		300	1	0.7			500					TO-92
						160	400	100	1			1.2	300					
BC337	50*	45	5	100	20	100	600	100	1	0.7			500					TO-92
						40		500	1									
BC337A	60*	60	5	100	20	100	400	100	1	0.7			500					TO-92
						40		500	1									
BC337-16	50*	45	5	100	20	100	250	100	1	0.7			500					TO-92
						40		500	1									
BC337-25	50*	45	5	100	20	160	400	100	1	0.7			500					TO-92
						40		500	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC338	30*	20	5	100	20	100	600	100	1	0.7			500					TO-92
						40		500	1									
BC338-16	30*	20	5	100	20	100	250	100	1	0.7			500					TO-92
						40		500	1									
BC338-25	30*	20	5	100	20	100	250	100	1	0.7			500					TO-92
						40		500	1									
BC368	25*	20	5	10 μA	25	60		5	10	0.5			1A					TO-92
						85	375	500	1									
						60		1A	1									
BC369	25*	20	5	10 μA	25	50		5	10	0.5			1A					TO-92
						85	375	500	1									
						60		1A	1									
BC546	80	65	6	15	30	110	800	2	5	0.25							10	TO-92
										0.6			100					
BC546A	80	65	6	15	30	110		0.01	5	0.25			10				10	TO-92
							220	2	5	0.6			100					
BC546B	80	65	6	15	30	200		0.01	5	0.25			10				10	TO-92
							450	2	5	0.6			100					
BC547	50	45	6	10	20					0.25		0.77*	10	4.5			10	TO-92
										0.6			100					
						125	900*	2	5		0.55	0.70*	2					
BC547A	50	45	6	10	20					0.25		0.77*	10	4.5			10	TO-9210
										0.6			100					
						125	260*	2	5		0.55	0.70*	2					
BC547B	50	45	6	10	20					0.25		0.77*	10	4.5			10	TO-92
										0.6			100					
						240	500*	2	5		0.55	0.70*	2					
BC547C	50	45	5	15	30					0.25		0.77*	10	4.5			10	TO-92
										0.6			100					
						420	900	2	5		0.55	0.70*	2					

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC548	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			10	TO-92
						125	900*	2	5			0.55	0.70*	2					
BC548A	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			10	TO-92
						125	260*	2	5			0.55	0.70*	2					
BC548B	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			10	TO-92
						240	500*	2	5			0.55	0.70*	2					
BC548C	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			10	TO-92
						450	900*	2	5			0.55	0.70*	2					
BC549	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			4	TO-92
						240	900*	2	5			0.55	0.70*	2					
BC549B	30	20	5	10	20					0.25 0.6			0.77*	10 100	4.5			4	TO-92
						240	500*	2	5			0.55	0.70*	2					
BC549C	30	20	5	10	20					0.25			0.77*	10 100	4.5			4	TO-92
						450	900*	2	5			0.55	0.70*	2					
BC550	50	45	5	10	45					0.25 0.6			0.77*	10 100				3	TO-92
						240	900*	2	5			0.55	0.70*	2					
BC550B	50	45	5	10	45					0.25 0.6			0.77*	10 100				3	TO-92
						240	500*	2	5			0.55	0.70*	2					
BC556	80	65	5	15	30	75	475	2	5	0.3 0.65				10 100				10	TO-92

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC556A		80	65	5	15	30	125	250	2	5		0.3			10			10	TO-92
										0.65					100				
BC556B		80	65	5	15	30	220	475	2	5		0.3			10			10	TO-92
										0.65				100					
BC557	50	45	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						75	900*	2	5			0.6	0.75*	2					
BC557A	50	45	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						125	260*	2	5			0.6	0.75*	2					
BC557B	50	45	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						240	500*	2	5			0.6	0.75*	2					
BC558	30	25	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						75	500*	2	5			0.6	0.75*	2					
BC558A	30	25	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						125	260*	2	5			0.6	0.75	2					
BC558B	30	25	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						240	500*	2	5			0.6	0.75	2					
BC558C	30	25	5	100	20					0.3			0.82*	10				10	TO-92
										0.65				100					
						450	900*	2	5			0.6	0.75	2					
BC559	25	20	5	100	20					0.3			0.82*	10				4	TO-92
										0.65				100					
						125	500*	2	5			0.6	0.75*	2					

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC559B	25	20	5	100	20					0.3 0.65		0.82*	10 100					TO-92
						240	500*	2	5		0.6	0.75*	2					
BC559C	25	20	5	100	20					0.3 0.65		0.82*	10 100				4	TO-92
						450	900*	2	5		0.6	0.75*	2					
BC560	50	45	5	100	45					0.3 0.65		0.82*	10 100				3	TO-92
						125	500*	2	5		0.6	0.75*	2					
BC560B	50	45	5	100	45					0.3 0.65		0.82*	10 100				3	TO-92
						240	500*	2	5		0.6	0.75*	2					
BC635	45 (94)	45	5			25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC636	45 (94)	45	5	100	30	25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC637	60 (94)	60	5			25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC638	60 (94)	60	5	100	30	25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC639	100 (94)	80	5			25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC640	100 (94)	80	5	100	30	25 40 25	250	5 150 500	2 2 2	0.5			500					TO-92
BC807	50*	45	5	100	20	100 40	600	100 500	1 1	0.7			500					TO-92

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC807-16	50*	45	5	100	20	100	250	100	1	0.7			500					TO-236
						40		500	1									
BC807-25	50*	45	5	100	20	160	400	100	1	0.7			500					TO-236
						40		500	1									
BC807-40	50*	45	5	100	20	250	600	100	1	0.7			500					TO-236
						40		500	1									
BC808	30*	25	5	100	20	100	600	100	1	0.7			500					TO-236
						40		500	1									
BC808-16	30*	25	5	100	20	100	250	100	1	0.7			500					TO-236
						40		500	1									
BC808-25	30*	25	5	100	20	160	400	100	1	0.7			500					TO-236
						40		500	1									
BC808-40	30*	25	5	100	20	250	600	100	1	0.7			500					TO-236
						40		500	1									
BC817	30*	25	5	100	20	100	600	100	1	0.7			500					TO-236
						40		500	1									
BC817-16	30*	25	5	100	20	100	250	100	1	0.7			500					TO-236
						40		500	1									
BC817-25	30*	25	5	100	20	160	400	100	1	0.7			500					TO-236
						40		500	1									
BC817-40	30*	25	5	100	20	250	600	100	1	0.7			500					TO-236
						40		500	1									
BC818	30*	25	5	100	20	100	600	100	1	0.7			500					TO-236
						40		500	1									
BC818-16	30*	25	5	100	20	100	250	100	1	0.7			500					TO-236
						40		500	1									
BC818-25	30*	25	5	100	20	160	400	100	1	0.7			500					TO-236
						40		500	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC818-40	30*	25	5	100	20	250	600	100	1	0.7			500					TO-236
						40		500	1									
BC846	80	65	6	15	30	110		0.01	5	0.25			10				10	TO-236
							800	2	5	0.6			100					
BC846-A	80	65	6	15	30	110		0.01	5	0.25			10				10	TO-236
							220	2	5	0.6			100					
BC846-B	80	65	6	15	30	200		0.01	5	0.25			10				10	TO-236
							450	2	5	0.6			100					
BC847	50	45	6	15	30	110		0.01	5	0.25			10				10	TO-236
							800	2	5	0.6			100					
BC847-A	50	45	6	15	30	110		0.01	5	0.25			10				10	TO-236
							220	2	5	0.6			100					
BC847-B	50	45	6	15	30	200		0.01	5	0.25			10				10	TO-236
							450	2	5	0.6			100					
BC848	30	30	5	15	30	110		0.01	5	0.25			10				10	TO-236
							800	2	5	0.6			100					
BC848-A	30	30	5	15	30	110		0.01	5	0.25			10				10	TO-236
							220	2	5	6			100					
BC848-B	30	30	5	15	30	200		0.01	5	0.25			10				10	TO-236
							450	2	5	6			100					
BC848-C	30	30	5	15	30	420		0.01	5	0.25			10				10	TO-236
							800	2	5	6			100					

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC849	30	30	5	15	30	200		0.01	5	0.25				10				4	TO-236
							800	2	5	6				100					
BC849B	30	30	5	15	30	200		0.01	5	0.25				10				4	TO-236
							450	2	5	0.6				100					
BC849C	30	30	5	15	30	420		0.01	5	0.25				10				4	TO-236
							800	2	5	0.6				100					
BC850	50	45	5	15	30	200		0.01	5	0.25				10				3	TO-236
							800	2	5	0.6				100					
BC850-B	50	45	5	15	30	200		0.01	5	0.25				10					TO-236
							450	2	5	6				100					
BC856	80	65	5	15	30	75	475	2	5	0.3				10				10	TO-236
										0.65				100					
BC856-A	80	65	5	15	30	125	250	2	5	0.3				10				10	TO-236
										0.65				100					
BC856-B	80	65	5	15	30	220	475	2	5	0.3				10				10	TO-236
										0.65				100					
BC857	50	45	5	15	30	75	475	2	5	0.3				10				10	TO-236
										0.65				100					
BC857-A	50	45	5	15	30	125	250	2	5	0.3				10				10	TO-236
										0.65				100					

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BC857-B	50	45	5	15	30	220	475	2	5	0.3 0.65			10 100				10	TO-236
BC858	30	30	5	15	30	75	800	2	5	0.3 0.65			10 100				10	TO-236
BC858-B	30	30	5	15	30	220	475	2	5	0.3 0.65			10 100				10	TO-236
BC858-C	30	30	5	15	30	420	800	2	5	0.3 0.65			10 100				10	TO-236
BC859	30	30	5	15	30	220	800	2	5	0.65			100				4	TO-236
BC859-A	30	30	5	15	30	125	250	2	5	0.65			100				4	TO-236
BC859-B	30	30	5	15	30	220	475	2	5	0.65			100				4	TO-236
BC859-C	30	30	5	15	30	420	800	2	5	0.65			100				4	TO-236
BC860	50	45	5	15	30	220	800	2	5	0.3 0.65			10 100				3	TO-236
BC860-B	50	45	5	15	30	220	475	2	5	0.3 0.65			10 100				3	TO-236
BCF29	32	32	5	100	32	120	260	0.01 2	5 5	0.3			10				4	TO-236
BCF30	32	32	5	100	32	200	450	0.01 2	5 5	0.25			10				4	TO-236
BCF32	50	45	5	100	20	215	500	0.01 2	5 5	0.3			10				4	TO-236

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BCF33	50	45	5	100	20	200		0.01	5	0.3				10				4	TO-236
							450	2	5										
BCF70	50	45	5	100	20	215		0.01	5	0.3				10				4	TO-236
							500	2	5										
BCV26	40	30	10	100	30	4,000		1	5	1.0			1.5	100					TO-236
						10,000		10	5										
						20,000		100	5										
BCV27	40	30	10	100	30	4,000		1	5	1.0			1.5	100					TO-236
						10,000		10	5										
						20,000		100	5										
BCV71	80	60	5	100	20	110	220	2	5	0.25				10				10	TO-236
BCV72	80	60	5	100	20	200	450	2	5	0.25				10				10	TO-236
BCW29	32	32	5	100	32	120		0.01	5	0.3				10				10	TO-236
							260	2	5										
BCW30	32	32	5	100	32	215		0.01	5	0.3				10				10	TO-236
							500	2	5										
BCW31	32	32	5	100	32	150		0.01	5	0.25				10				10	TO-236
							270	2											
BCW32	32	32	5	100	32	200		0.01	5	0.25				10				10	TO-236
							420	2											
BCW33	32	32	5	100	32	450		0.01	5	0.25				10				10	TO-236
							800	2											
BCW60	32*	32	5	20	32	50		50	1	0.35		0.6	0.85	50		125		6	TO-236
						120	630	2	5										
BCW61	32*	32	5	20	32	50		50	1	0.25		0.6	0.85	50				6	TO-236
						120	630	2	5										
BCW65	60	32	5	20*	32	35		0.1	10				2.0	500	12	100		10	TO-236
						75	220	10	1										
						100	250	100	1										
						35		500	1										

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BCW66	75	45	5	20*	45	35		0.1	10				2.0	500	12	100		10	TO-236
						75		10	1										
						100	250	100	1										
						35		500	1										
BCW68	75	45	5	20*	45	35		0.1	10				2.0	500	12	100		10	TO-236
						75		10	1										
						100	250	100	1										
						35		500	1										
BCW69	50	45	5	100	20	120	260	2	5	0.3				10				10	TO-236
BCW70	50	45	5	100	20	215	500	2	5	0.3				10				10	TO-236
BCW71	50	45	5	100	20	110	220	2	5	0.25				10				10	TO-236
BCW72	50	45	5	100	20	200	450	2	5	0.25				10				10	TO-236
BCW81	50	45	5	100	20	420	800	2	5	0.25				10				10	TO-236
BCW89	80	60	5	100	20	120	260	2	5	0.3				10				10	TO-236
BCX17	50*	45	5	100	20	100	600	100	1	0.62				500					TO-236
						70		300	1										
						40		500	1										
BCX18	30*	25	5	100	20	100	600	100	1	0.62				500					TO-236
						70		300	1										
						40		500	1										
BCX19	50*	45	5	100	20	100	600	100	1	0.62			1.2	500					TO-236
						70		300	1										
						40		500	1										
BCX20	30*	25	5	100	20	100	600	100	1	0.62			1.2	500					TO-236
						70		300	1										
						40		500	1										

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BCX58		32	7	10	32	120	630	2	5						125	800	6	TO-92
						80	1000	10	1									
						40		100	1									
BCX58-7		32	7	10	32	120	220	2	5						125	800	6	TO-92
						80		10	1									
						40		100	1									
BCX58-8		32	7	10	32	20		0.01	5						125	800	6	TO-92
						180	310	2	5									TO-92
						120	400	10	1									
						45		100	1									
BCX58-9		32	7	10	32	40		0.01	5						125	800	6	TO-92
						250	460	2	5									
						160	630	10	1									
						60		100	1									
BCX58-10		32	7	10	32	100		0.01	5						125	800	6	TO-92
						380	630	2	5									
						240	1000	10	1									
						60		100	1									
BCX59		45	7			120	630	2	5	0.5		1.0	100		125	800		TO-92
						80	1000	10	1									
						40		100	1									
BCX59-7		45	7			120	220	2	5	0.5		1.0	100		125	800		TO-92
						80		10	1									
						40		100	1									
BCX59-8		45	7			20		0.01	5	0.5		1.0	100		125	800		TO-92
						180	310	2	5									
						120	400	10	1									
						45		100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BCX59-9		45	7			40		0.01	5	0.5		1.0	100		125	800		TO-92
						250	460	2	5									
						160	630	10	1									
						60		100	1									
BCX59-10		45	7			100		0.01	5	0.5		1.0	100		125	800		TO-92
						380	630	2	5									
						240	1000	10	1									
						60		100	1									
BCX70G	45	45	5	20	32	120	220	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						60		50	1									
BCX70H	45	45	5	20	32	180	310	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						70		50	1									
						20		0.01	5									
BCX70J	45	45	5	20	32	250	460	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						90		50	1									
						40		0.01	5									
BCX71G	45	45	5	20	32	120	220	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						60		50	1									
BCX71H	45	45	5	20	32	180	310	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						70		50	1									
						20		0.01	5									
BCX71J	45	45	5	20	32	250	460	2	5	0.55	0.7	1.05	50	4.5	125	800	6	TO-92
						90		50	1									
						40		0.01	5									
BCX78		32	5			120	630	2	5	0.6		1.0	100	4.5	200		6	TO-92
						80	1000	10	1									
						40		100	1									
BCX78-7		32	5			120	220	2	5	0.6		1.0	100	4.5	200		6	TO-92
						80		10	1									
						40		100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BCX78-8		32	5			30		0.01	5	0.6		1.0	100	4.5	200		6	TO-92
						180	310	2	5									
						120	400	10	1									
						45		100	1									
BCX78-9		32	5			40		0.01	5	0.6		1.0	100	4.5	200		6	TO-92
						250	460	2	5									
						160	630	10	1									
						60		100	1									
BCX78-10		32	5			100		0.01	5	0.6		1.0	100	4.5	200		6	TO-92
						380	630	2	5									
						240	1000	10	1									
						60		100	1									
BCX79		45	5			80	1000	10	1	0.6		1.0	100	4.5	200		6	TO-92
						40		100	1									
						120	630	2	5									
BCX79-7		45	5			120	220	2	5	0.6		1.0	100	4.5	200		6	TO-92
BCX79-8		45	5			120	400	10	1	0.6		1.0	100	4.5	200		6	TO-92
						45		100	1									
						30		0.01	5									
						180	310	2	5									
BCX79-9		45	5			160	630	10	1	0.6		1.0	100	4.5	200		6	TO-92
						60		100	1									
						40		0.01	5									
						250	460	2	5									
BCX79-10		45	5			240	1000	10	1	0.6		1.0	100	4.5	200		6	TO-92
						60		100	1									
						100		0.01	5									
						380	630	2	5									
BD370A	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BD370A-10	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD370A-16	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD370A-25	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD370B	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD370B-10	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD370B-16	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD370B-25	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD370C	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD370C-6	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD370C-10	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD370C-16	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD370D	80	100		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD370D-6	80	100		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD370D-10	80	100		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD371A	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* / V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* / I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} / h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ / $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BD371A-10	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD371A-16	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD371A-25	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						180	400	100	1									
BD371B	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD371B-10	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD371B-16	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD371B-25	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100										
BD371C	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD371C-6	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD371C-10	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD371C-16	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD371D	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD371D-6	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD371D-10	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD372A	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BD372A-10	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD372A-16	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD372A-25	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD372B	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD372B-10	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD372B-16	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD372B-25	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD372C	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD372C-6	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD372C-10	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD372C-16	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD372D	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD372D-6	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD372D-10	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD373A	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BD373A-10	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD373A-16	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD373A-25	80	45		100	45	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD373B	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD373B-10	80	60		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD373B-16	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD373B-25	80	60		100	60	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						160	400	100	1									
BD373C	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD373C-6	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD373C-10	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BD373C-16	80	80		100	80	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						100	250	100	1									
BD373D	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	400	100	1									
BD373D-6	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						40	100	100	1									
BD373D-10	80	100		100	100	25		500	2	0.7		1.2*	1A	30	50	420	6	TO-237
						63	160	100	1									
BF240	40	40	4	100	20	65	225	1	10		0.65	0.74*	1	0.34			3.5	TO-237
						6		12	7									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	& $V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BF241	40	40	4	100	20	35	125	1	10		0.65	0.74*	1	0.34			3.5	TO-92
						6		12	7									
BF494	30	20	5			65	220	1	10									TO-92
BF495	30	20	5			35	250	1	10									TO-92
BF536	30	30	4	50	20	25		1	10									TO-236
BF840	40	40	4	100	20	65	220	1	10									TO-236
BF841	40	40	4	100	20	35	125	1	10									TO-236
BF936	30	20	4	50	20	25		1	10								6	TO-92
BFS18	30	30	5	100	20	35	125	1	10									TO-236
BFS19	30	30	5	100	25	65	225	1	10									TO-236
BSR13	60	30	5	30	50	35		0.1	10	0.4		1.3	150	8	250			TO-236
						50		1	10									
						75		10	10									
						100	300	150	10	1.6		2.6	500					
						50		150	1									
						30		500	10									
BSR14	75	40	6	10	60	35		0.1	10	0.3	0.6	1.2	150	8	300			TO-236
						50		1	10									
						75		10	10	1.0		2.0	500					
						100	300	150	10									
						50		150	1									
						40		500	10									

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BSR15	60	40	5	20	50	35		0.1	10	0.4			1.3	150	8	200	100		TO-236
						50		1	10										
						75		10	10	1.6			2.6	500					
						100	300	150	10										
						30		500	10										
BSR16	60	60	5	10	50	75		0.1	10	0.4			1.3	150	8	200	100		TO-236
						100		1	10										
						100		10	10	1.6			2.6	500					
						100	300	150	10										
						50		500	10										
BSR17	60	40	6	5 μA	50	20		0.1	1	0.2		0.65	0.85	10		250	250		TO-236
						35		1	1										
						50	150	10	1										
						30		50	1										
						15		100	1	0.3			0.95	50					
BSR18	60	40	6	5 μA	50	20		0.1	1	0.2		0.65	0.85	10		200	300		TO-236
						35		1	1										
						50	150	10	1										
						30		50	1										
						15		100	1	0.3			0.95	50					
BSR19	160	140	6	100	100	60		1	5	0.15			1.0	10	6	100	300	10	TO-236
						60		10	5										
						20	250	50	5	0.25			1.2	50					
BSR20	130	120	5	100	100	30				0.2			1.0	10	6	100		8	TO-236
						40	180	10	5										
						40		50	5	0.5			1.0	50					
BSS38	120	100	5	200	90	20		4	1	0.7				4		60	1000		TO-236
										3.0			1.2	50					
BSS63	110	100	6	100	90	30		10	1	0.25			0.9	25		50			TO-236
						30		25	1										
BSS64	120	80	5	100	90	20		10	1	0.15			1.2	4		60	1000		TO-236
										0.2				50					

Bipolar Pro Electron Series (Continued)

Type No.	V_{CES}* V_{CBO} (V) Min	V_{CEO} (V) Min	V_{EBO} (V) Min	I_{CES}* I_{CBO} (nA) Max	@ V_{CB} (V)	H_{FE} h_{fe} 1 kHz* Min	Max	@ I_C (mA)	V_{CE} (V)	$V_{CE(SAT)}$ (V) Max	&	$V_{BE(SAT)}$ $V_{BE(ON)}$* (V) Min	Max	@ I_C (mA)	C_{ob} (pF) Max	f_T (MHz) Min	t_{off} (ns) Max	NF (dB) Max	Pkg Type
BSS79-B	60	40	5	10	50	40	120	150	10	0.4				150	6	200			TO-236
										1.6				500					
BSS79-C	60	40	5	100	50	100	300	150	10	0.4				150	6	200			TO-236
										1.6				500					
BSS80-B	60	40	5	10	50	40	120	150	10	0.4				150	8	200			TO-236
										1.6				500					
BSS80-C	60	40	5	100	50	100	300	150	10	0.4				150	8	200			TO-236
										1.6				500					
BSV52	20	12	5	100	10	25		1	1	0.3				10		400	18		TO-236
						40	120	10	1	0.25		0.7	0.85	10					
							25	50	1	0.4			1.2	50					
BSX39		14		100	12	25		1	1	0.25		0.7	0.85	10			18		TO-236
						40	200	10	1										
						25		50	1	0.4			1.2	5					

TEST CONDITIONS:

Note 1: I_C = 200 μA, V_{CE} = 5V, f = 1 kHz.
Note 2: I_C = 100 mA, V_{CC} = 20V, $I_B{}^1 = I_B{}^2$ = 5 mA.
Note 3: I_C = 200 μA, V_{CE} = 2V, f = 1 kHz.
Note 4: I_C = 100 mA, V_{CC} = 10V, $I_B{}^1 = I_B{}^2$ = 10 mA.
Note 5: I_C = 10 mA, V_{CC} = 3V, $I_B{}^1 = I_B{}^2$ = 1 mA.
Note 6: I_C = 100 μA, V_{CE} = 5V, f = 1 kHz.
Note 7: I_C = 1 mA, V_{CE} = 10V, f = 200 MHz.
Note 8: I_C = 1 mA, V_{CE} = 5V, f = 1 kHz.
Note 9: I_C = 150 mA, V_{CC} = 6V, $I_B{}^1 = I_B{}^2$ = 15 mA.
Note 10: I_C = 10 μA, V_{CE} = 5V, f = WB.
Note 11: I_C/I_B = 20.
Note 12: I_C = 200 μA, V_{CE} = 5V, f = 30 Hz to 15 kHz.
Note 13: I_C/I_B = 40.
Note 14: I_C/I_B = 1000.
Note 15: I_C/I_B = 33.
Note 16: I_C = 250 μA, V_{CE} = 5V, f = 10 Hz to 15.7 kHz.
Note 17: I_C = 15 mA, $I_B{}^1 = I_B{}^2$ = 1 mA.
Note 18: I_C/I_B = 3.3.
Note 19: I_{CE} = 200 μA, V_{CE} = 5V, f = 200 Hz.

General Purpose N-Channel JFETs by BV_{gss}

Type No.	BV_{gss} (V)	V_p (V) @ V_{ds}			I_d	G_{fs} @ (ms)		C_{iss} (pF)	C_{rss} (pF)	e_n @ F (Hz)		Package
	Min	Min	Max	(V)	(nA)	Min	Max	Max	Max			
MPF110	20	0.5	10	10	1	0.5						TO-92
MPF111	20	0.5	10	10	1000	0.5						TO-92
2N5103	25	0.5	4	15	1	2	8	5	1	100	10	TO-72
2N5104	25	0.5	4	15	1	3.5	7.5	5	1	50	10	TO-72
2N5105	25	0.5	4	15	1	5	10	5	1			TO-72
2N5457	25	0.5	6	15	10	2	5	7	3			TO-92
2N5458	25	1	7	15	10	1.5	5.5	7	3			TO-92
2N5459	25	2	8	15	10	2	6	7	3			TO-92
J210	25	1	3	15	1	4	12	15	11.5	110	999	TO-92
J211	25	2.5	4.5	15	1	7	12	15	11.5	110	999	TO-92
J212	25	4	6	15	1	7	12	15	11.5	110	999	TO-92
MPF103	25		6	15	1	1	5	7	3			TO-92
MPF104	25		7	15	1	1.5	5.5	7	3			TO-92
MPF105	25		8	15	1	2	6	7	3			TO-92
MPF109	25	0.2	8	15	10	0.8	6	7	3	115	999	TO-92
MPF112	25	0.5	10	10	1000	1	7.5					TO-92
PN5163	25	0.4	8	15	1000	2	9	12	3	50	999	TO-92
TIS58	25	0.5	5	15	20	1.3	4	6	3			TO-92
TIS59	25	1	9	15	20	1.3		6	3			TO-92
2N3967	30	2	5	20	1	2.5		5	1.3	84	100	TO-72
2N3967A	30	2	5	20	1	2.5		5	1.3	160	10	TO-72
2N3968	30		3	20	1	2		5	1.3	84	100	TO-72
2N3968A	30		3	20	1	2		5	1.3	160	10	TO-72
2N3969	30		1.7	20	1	1.3		5	1.3	84	100	TO-72
2N3969A	30		1.7	20	1	0.3		5	1.3	160	10	TO-72
2N4220	30		4	15	0.1	1	4	6	2			TO-72
2N4220A	30		4	15	0.1	1	4	6	2	115	100	TO-72
2N4221	30		6	15	0.1	2	5	6	2			TO-72
2N4221A	30		6	15	0.1	2	5	6	2	115	100	TO-72
2N4222	30		8	15	0.1	2.5	6	6	2			TO-72
2N4222A	30		8	15	0.1	2.5	6	6	2	115	100	TO-72
2N5556	30	0.2	4	15	1	1.5	6.5	6	3	35	10	TO-72
2N5557	30	0.8	5	15	1	1.5	6.5	6	3	35	10	TO-72
2N5558	30	1.5	6	15	1	1.5	6.5	6	3	35	10	TO-72
PN4220	30		4	15	1	1	4	6	2			TO-92
PN4221	30		6	15	1	2	5	6	2			TO-92
PN4222	30		8	15	1	2.5	6	6	2			TO-92
PN4302	30		4	20	10	1		6	3	100	999	TO-92
PN4303	30		6	20	10	2		6	3	100	999	TO-92
PN4304	30		10	20	10	1		6	3	125	999	TO-92
2N3369	40		6.5	20	1000	0.6	2.5	20	3			TO-18
2N3370	40		3.2	20	1000	0.3	2.5	20	3			TO-18
2N5358	40	0.5	3	15	100	1	3	6	2	115	100	TO-72
2N5359	40	0.8	4	15	100	1.2	3.6	6	2	115	100	TO-72
2N5360	40	0.8	4	15	100	1.4	4.2	6	2	115	100	TO-72
2N5361	40	1	6	15	100	1.5	4.5	6	2	115	100	TO-72
2N5362	40	2	7	15	100	2	5.5	6	2	115	100	TO-72
2N5363	40	2.5	8	15	100	2.5	6	6	2	115	100	TO-72
2N5364	40	2.5	8	15	100	2.7	6.5	6	2	115	100	TO-72
J201	40	0.3	1.5	20	10	0.5		15	12	110	999	TO-92
J202	40	0.8	4	20	10	1		15	12	110	999	TO-92
J203	40	2	10	20	10	1.5		15	12	110	999	TO-92

General Purpose N-Channel JFETs by BV_{gss} (Continued)

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{ds} Min	V_p (V) @ V_{ds} Max	V_{ds} (V)	I_d (nA)	G_{fs} @ (ms) Min	G_{fs} @ (ms) Max	C_{iss} (pF) Max	C_{rss} (pF) Max	e_n @ F (Hz)		Package
2N3458	50		7.8	20	1000	2.5	10	18	5	225	20	TO-18
2N3459	50		3.4	20	1000	1.5	6	18	5	155	20	TO-18
2N3460	50		1.8	20	1000	0.8	4.5	18	5	155	20	TO-18
2N3684	50	2	5	20	1	2	3	4	1.2	150	100	TO-72
2N3685	50	1	3.5	20	1	1.5	2.5	4	1.2	150	100	TO-72
2N3686	50	0.6	2	20	1	1	2	4	1.2	150	100	TO-72
2N3687	50	0.3	1.2	20	1	0.5	1.5	4	1.2	150	100	TO-72
2N3821	50		4	15	0.5	1.5	4.5	6	3	200	10	TO-72
2N3822	50		6	15	0.5	3	6.5	6	31	200	10	TO-72
2N4338	50	0.3	1	15	100	0.6	1.8	7	3	68	999	TO-18
2N4339	50	0.6	1.8	15	100	0.8	2.4	7	3	68	999	TO-18
2N4340	50	1	3	15	100	1.3	3	7	3	68	999	TO-18
2N4341	50	2	6	15	100	2	4	7	3	68	999	TO-18
PN3684	50	2	5	20	1	2	3	4	1.2	150	20	TO-92
PN3685	50	1	3.5	20	1	1.5	2.5	4	1.2	150	20	TO-92
PN3686	50	0.6	2	20	1	1	2	4	1.2	150	20	TO-92
PN3687	50	0.3	1.2	20	1	0.5	1.5	4	1.2	150	20	TO-92

N-Channel JFET Switches by BV_{gss}

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	R_{ds} (on) @ I_d (Ω) Max	R_{ds} (on) @ I_d (mA)	t_{on} (ns) Max	t_{off} (ns) Max	Package
2N5432	25	4	10	5	3	5	10	5	36	TO-52
2N5433	25	3	9	5	3	7	10	5	36	TO-52
2N5434	25	1	4	5	3	10	10	5	36	TO-52
2N5555	25		(10)			150		10	25	TO-92
2N5654	25		(8)			100	1	14	30	TO-92
J105	25	4.5	10	5	0.001	3		15	20	TO-92
J106	25	2	6	5	0.001	6		15	20	TO-92
J107	25	0.5	4.5	5	0.001	6		15	20	TO-92
J108	25	3	10	5	1000	8	10	15	136	TO-92
J109	25	2	6	5	1000	12	10	15	136	TO-92
J110	25	0.5	4	5	1000	18	10	15	136	TO-92
J114	25	3	10	5	1000	150	1	16	120	TO-92
PN5432	25	4	10	5	3	5	10	5	36	TO-92
PN5433	25	3	9	5	3	7	10	5	36	TO-92
PN5434	25	1	4	5	3	10	10	5	36	TO-92
2N3966	30	4	6	10	10	220				TO-72
2N4859	30	4	10	15	0.5	25		9	25	TO-18
2N4859A	30	4	10	15	0.5	25		8	20	TO-18
2N4860	30	2	6	15	0.5	40		10	50	TO-18
2N4860A	30	2	6	15	0.5	40		10	40	TO-18
2N4861	30	0.8	4	15	0.5	60		20	100	TO-18
2N4861A	30	0.8	4	15	0.5	60		16	80	TO-18
2N5638	30		(12)			30	1			TO-92
2N5639	30		(8)			60	1			TO-92
2N5640	30		(6)			100	1			TO-92
2N5653	30		(12)			50	1	9	5	TO-92

N-Channel JFET Switches by BV_{gss} (Continued)

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	R_{ds} (on) (Ω) Max	R_{ds} (on) @ I_d (mA)	t_{on} (ns) Max	t_{off} (ns) Max	Package
MMBF4860	30	2	6	15	0.5	40		10	50	TO-236AB
MMBF4861	30	0.8	4	15	0.5	60		20	100	TO-236AA
PN4859	30	4	10	15	0.5	25		9	25	TO-92
PN4860	30	2	6	15	0.5	40		10	50	TO-92
PN4861	30	0.8	4	15	0.5	60		20	100	TO-92
TIS73	30	4	10	15	4	25		9	250	TO-92
TIS74	30	2	6	15	4	40		10	50	TO-92
TIS75	30	0.8	4	15	4	60		20	100	TO-92
J111	35	3	10	5	1000	30	1	113	135	TO-92
J112	35	1	5	5	1000	50	1	113	135	TO-92
J113	35	0.5	3	5	1000	100	1	113	135	TO-92
MMBFJ111	35	3	10	5	1000	30	1	113	135	TO-236AB
MMBFJ112	35	1	5	5	1000	50	1	113	135	TO-236AB
MMBFJ113	35	0.5	3	5	1000	100	1	113	135	TO-236AB
2N3970	40	4	10	20	1	30	1	20	30	TO-18
2N3971	40	2	5	20	1	60	1	130	60	TO-18
2N3972	40	0.5	3	20	1	100	1	80	100	TO-18
2N4092	40	2	7	20	1	50	1	35	60	TO-18
2N4093	40	1	5	20	1	80	1	60	80	TO-18
2N4391	40	4	10	20	1	30	1	20	35	TO-18
2N4392	40	2	5	20	1	60	1	20	55	TO-18
2N4393	40	0.5	3	20	1	100	1	20	80	TO-18
2N4856	40	4	10	15	0.5	25		9	25	TO-18
2N4856A	40	4	10	15	0.5	25		8	20	TO-18
2N4857	40	2	6	15	0.5	40		10	50	TO-18
2N4857A	40	2	6	15	0.5	40		10	40	TO-18
2N4858	40	0.8	4	15	0.5	60		20	100	TO-18
2N4858A	40	0.8	4	15	0.5	60		16	80	TO-18
MMBF4391	40	4	10	20	1	30	1	20	35	TO-236AB
MMBF4392	40	2	5	20	1	60	1	20	55	TO-236AB
MMBF4393	40	0.5	3	20	1	100	1	20	80	TO-236AB
PN4091	40	5	10	20	1	30		25	40	TO-92
PN4092	40	20	7	20	1	50		35	60	TO-92
PN4093	40	1	5	20	1	80		60	80	TO-92
PN4391	40	4	10	20	1	30		20	35	TO-92
PN4392	40	2	5	20	1	60		40	80	TO-92
PN4393	40	0.5	3	20	1	100		55	130	TO-92
PN4856	40	4	10	15	0.5	25		9	25	TO-92
PN4857	40	2	6	15	0.5	40		10	50	TO-92
PN4858	40	0.8	4	15	0.5	60		20	100	TO-92
U1897	40	5	10	20	1	30	1	25	40	TO-92
U1898	40	2	7	20	1	50	1	35	60	TO-92
U1899	40	1	5	20	1	80	1	60	80	TO-92
2N3824	50		8			250				TO-72

N-Channel JFETs for RF, VHF & UHF Amplifiers

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	R_e (ms) Min	Y_{fs} @Freq (MHz)	C_{iss} (pF) Max	C_{rss} (pF) Max	NF (db) Max	Package
2N3819	25		8	15	2	1.6		8	4.0		TO-92
2N3823	30		8	15	4	3.2	200	6	2.0	2.5	TO-72
2N4223	30	0.1	8	15	0.25	2.7	200	6	2.0	5.0	TO-72
2N4224	30	0.1	8	15	0.50	1.7	200	6	2.0		TO-72
2N4416	30		6	15	1	4.0	400	4	0.8	4	TO-72
2N4416A	30	2.5	6	15	1	4.0		4	0.8	4	TO-72
2N4416A	30	2.5	6	15	1	4.0		4	0.8	4	TO-72
2N5078	30	0.5	8	15		4.0	200	6	2.0	3	TO-72
2N5245	30	1	6	15	10	4.0	400	4.5	1.0	4	TO-92
2N5246	30	0.5	4	15	10	2.5	400	4.5	1.0		TO-92
2N5247	30	1.5	8	15	10	4.0	400	4.5	1.0		TO-92
2N5248	30	1	8	15	10	3.0	400	6	2.0		TO-92
2N5397	25	1	6	10	1	5.5	450	5	1.2	3.5	TO-72
2N5398	25	1	6	10	1	5	450	5.5	1.3	3.2	TO-72
2N5484	25	0.3	3	15	10	2.5	100	5	1	3	TO-92
2N5485	25	2	6	15	10	3.5	400	5	1	4	TO-92
2N5486	25	2.0	6	15	10	3.5	400	5	1	4	TO-92
2N5668	25	0.2	4	15	10	1	100	7	3	2.5	TO-92
2N5669	25	1	6	15	10	1.6	100	7	3	2.5	TO-92
2N5670	25	2	8	15	10	2.5	100	7	3	2.5	TO-92
2N5949	30	3	7	15	100	3.0	100	6	2	5	TO-92
2N5950	30	2.5	6	15	100	3.0	100	6	2	5	TO-92
2N5951	30	2	5	15	100	3.0	100	6	2	5	TO-92
2N5952	30	1.3	3.5	15	100	3.0	100	6	2	5	TO-92
2N5953	30	0.8	3.0	15	100	1.0	100	6	2	5	TO-92
J300	25	1	6	10	1.0	4.5	0.001	5.5	1.7	t2	TO-92
J304	30	2	6	15	1.0	t4.2	40	t3	t0.8	t4	TO-92
J305	30	0.5	3	15	1.0	13	400	t3	t0.8	t4	TO-92
J308	25	1	6.5	10	1.0	8	0.001	7.5	2.5	t1.5	TO-92
J309	25	1	4	10	1.0	10	0.001	7.5	2.5	11.5	TO-92
J310	25	2	6.5	10	1	8	0.001	7.5	2.5	11.5	TO-92
MMBF4416	30		6	15	1	4.0		15	15	4	TO-236AB
MMBF5484	25	0.3	3	15	10	2.5	100	5	1	3	TO-236AB
MMBF5485	25	2	6	15	10	3.5	400	5	1	4	TO-236AB
MMBF5486	25	2.0	6	15	10	3.5	400	5	1	4	TO-236AB
MMBFJ309	25	1	4	10	1.0	10	0.001	7.5	2.5	11.5	TO-236AB
MMBFJ310	25	2	6.5	10	1	8	0.001	7.5	2.5	11.5	TO-236AB
MPF102	25		8	15	2.0	1.6	100	7	3		TO-92
MPF106	25	0.5	4	15	0.5	2.5	0.001	5	2	4	TO-92
MPF107	25	2.0	6	15	0.5	4	0.001	5	1.2	4	TO-92
MPF108	25	0.5	8	15	10	1.6	100	6.5	2.5	3	TO-92
MPF256	25	0.5	7.5	15	0.2	6	0.001			2	TO-92
MPF820	25		5	15	0.2					4	TO-92
PN4223	30	0.1	8	15	1	2.7	200	6	2.0	5.0	TO-92
PN4224	30	0.1	8	15	5	1.7	200	6	2.0		TO-92
PN4416	30		6	15	1	4.0	400	4	0.8	4	TO-92
U308	25	1	6	10	1.0	10	0.001	5	2.5	t3	TO-52
U309	25	1	4	10	1.0	10	0.001	5	2.5	3	TO-52
U310	25	0.15	15	10	1	10	0.001	5	2.5	3	TO-52
U312	25	1	6	10	1.0	6	0.001	3.8	1.2	t3.5	TO-52

t = typical

N-Channel JFETs by BV_{gss} for Ultra-Low Input Current Amplifiers

Type No.	BV_{gss} (V) Min	I_{gss} (pA) Max	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	G_{fs} @ I_d (ms) Min	G_{fs} @ I_d (ms) Max	C_{iss} (pF) Max	C_{rss} (pF) Max	Package
2N4117	40	10	0.6	1.8	10	1	20	210	3	1.5	TO-72
2N4117A	40	1	0.6	1.8	10	1	20	210	3	1.5	TO-72
2N4118A	40	1	1.0	3.0			80	250	3	1.5	TO-72
2N4118	40	10	1.0	3.0			80	250	3	1.5	TO-72
2N4119	40	10	2	6	10	1	100	330	3	1.5	TO-72
2N4119A	40	1	2	6	10	1	100	330	3	1.5	TO-72
NF5301	30	1	0.6	3	10	1	70	300	3	1.5	TO-72
NF5301-1	30	1	0.6	1.8	10	1	70	300	3	1.5	TO-72
NF5301-2	30	1	1.7	3.0	10	1	70	300	3	1.5	TO-72
PF5301	30	1	0.6	3	10	1	70	300	3	1.5	TO-92
PF5301-1	30	1	0.6	1.8	10	1	70	300	3	1.5	TO-92
PF5301-2	30	1	1.7	3.0	10	1	70	300	3	1.5	TO-92
PN4117	40	10	0.6	1.8	10	1	20	210	3	1.5	TO-92
PN4117A	40	1	0.6	1.8	10	1	20	210	3	1.5	TO-92
PN4118A	40	1	1.0	3.0			80	250	3	1.5	TO-92
PN4118	40	10	1.0	3.0			80	250	3	1.5	TO-92
PN4119	40	10	2	6	10	1	100	330	3	1.5	TO-92
PN4119A	40	1	2	6	10	1	100	330	3	1.5	TO-92

N-Channel JFETs by BV_{gss} for Low Frequency and Low Noise Amplifiers

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	G_{fs} (ms) Min	G_{fs} (ms) Max	C_{iss} (pF) Max	C_{rss} (pF) Max	en @ Max	Freq (Hz)	Package
2N4393	40	0.5	3.0	20	1.0	12		14	3.5	18	10	TO-18
2N5556	30	0.2	4.0	15	1.0	1.5	6.5	6	3	3	10	TO-72
NF5101	40	0.5	1.1	15	1.0	3.5		112	14	3.5	1000	TO-72
2N5557	30	0.8	5.0	15	1.0	1.5	6.5	6	3.0	35	10	TO-72
2N5558	30	1.5	6.0	15	1.0	1.5	6.5	6	3	35	10	TO-72
NF5102	40	0.7	1.6	15	1.0	7.5		112	14	3.5	1000	TO-72
NF5103	40	1.2	2.7	15	1.0	7.5		112	14	3.5	1000	TO-72
PN4393	40	0.5	3.0	20	1.0	12		14	3.5	18	10	TO-92
PF5101	40	0.5	1.1	15	1.0	3.5		112	14	3.5	1000	TO-92
PF5102	40	0.7	1.6	15	1.0	7.5		112	14	3.5	1000	TO-92
PF5103	40	1.2	2.7	15	1.0	7.5		112	14	3.5	1000	TO-92
MMBF4393	40	0.5	3.0	20	1.0	12		14	3.5	18	10	TO-236

General Purpose P-Channel JFETs by BV_{gss}

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (nA)	G_{fs} (ms) Min	G_{fs} (ms) Max	C_{iss} (pF) Max	C_{rss} (pF) Max	en @ Max	Freq (Hz)	Package
2N3329	20		5	15	10	1	2	20		125	1000	TO-72
2N3330	20		6	15	10	1.5	3	20		125	1000	TO-72
2N3331	20		8	15	10	2	4	20		155	1000	TO-72
2N3332	20		6	15	10	1	2.2	20		65	1000	TO-72
2N3820	20		8.0	10	10	0.8	5	32	16			TO-92
PN4360	20	0.7	10	10	1	2	8	20	5	190	100	TO-92
PN5033	20	0.3	2.5	10	1	1	5	25	7	100	1000	TO-92
2N4381	25	1	5	15	1	2	6	20	5	20	1000	TO-18
2N5020	25	0.3	1.5	15	1	1	3.5	25	7	30	1000	TO-18
2N5021	25	0.5	2.5	15	1	1.5	6	25	7	30	1000	TO-18
PN4342	25		5.5	10	1	2	6	20	5	80	100	TO-92
2N2608	30	1	4	5	1	1		17		125	1000	TO-18
2N2609	30	1	4	5	1	2.5		30		125	1000	TO-18
J270	30	0.5	2.0	15	0.001	6.0	15	120	15	110	1000	TO-92
J271	30	1.5	4.5	15	0.001	8.0	18	120	15	110	1000	TO-92
2N5460	40	0.75	6	15	1	1	4	7	2	115	100	TO-92
2N5461	40	1	7.5	15	1	1.5	5	7	2	115	100	TO-92
2N5462	40	1.8	9	15	1	2	6	7	2	115	100	TO-92

P-Channel JFET Switches by BV_{gss}

Type No.	BV_{gss} (V) Min	V_p (V) @ V_{dp} Min	V_p (V) @ V_{dp} Max	V_{dp} (V)	I_d (mA)	R_{ds} (on) @ I_d (Ω) Max	R_{ds} (on) @ I_d (mA)	t_{on} (ns) Max	t_{off} (ns) Max	Package
2N5018	30		10	15	1	75		35	65	TO-18
2N5019	30		5	15	1	150		90	125	TO-18
2N5114	30	5	10	15	0.001	75	1	16	21	TO-18
2N5115	30	3	6	15	0.001	100	1	30	38	TO-18
2N5116	30	1	4	15	0.001	150	1	42	61	TO-18
J174	30	5	10	15	0.001	85	1	2	5	TO-92
J175	30	3	6	15	0.001	125	0.5	5	10	TO-92
J176	30	1	4	15	0.001	250	0.25	15	15	TO-92
J177	30	0.8	2.25	15	0.001	300	0.1	20	20	TO-92
P1086	30		10	15	1	75	1	35	65	TO-92
P1087	30		5	15	1	150	1	90	125	TO-92
MMBFJ174	30	5	10	15	0.001	85	1	2	5	TO-236AB
MMBFJ175	30	3	6	15	0.001	125	0.5	10	10	TO-236AB
MMBFJ176	30	1	4	15	0.001	250	0.25	15	15	TO-237AB
MMBFJ177	30	0.8	2.25	15	0.001	300	0.1	20	20	TO-236AB

N-Channel Dual JFETs

Type No.	V_p (V) Min	V_p (V) Max	G_{fs} Min	G_{fs} Max	G_{fs} Match %	$\|V_{gs1-2}\|$ (mV) Max	Drift (μV/C) Max	I_{dss} Match %	Package
2N3921		3.0	1.5	7.5	5	5	10		TO-71
2N3922		3.0	1.5	7.5	5	5	10		TO-71
2N3954	1	4.5	1	3	3	5	10	5	TO-71
2N3954A	1	4.5	1	3	3	5	5	5	TO-71
2N3955	1	4.5	1	3	5	10	25	5	TO-71
2N3955A	1	4.5	1	3	3	5	15	5	TO-71
2N3956	1	4.5	1	3	5	15	50	5	TO-71
2N3957	1	4.5	1	3	10	20	75	10	TO-71
2N3958	1	4.5	1	3	15	25	100	15	TO-71
2N4084		3	1.5	7.5	5	15	10		TO-71
2N4085		3	1.5	7.5	5	15	25		TO-71
2N5045	0.5	4.5	1.5	6		5.0	67		TO-71
2N5046	0.5	4.5	1.5	6		10	133		TO-71
2N5047	0.5	4.5	1.5	6		15	200	20	TO-71
2N5196	0.7	4.5	1	4	3	5	5	5	TO-71
2N5197	0.7	4.5	1	4	3	5	10	5	TO-71
2N5198	0.7	4.5	1	4	5	10	20	5	TO-71
2N5199	0.7	4.5	1	4	5	15	40	5	TO-71
2N5452	1	4.5	1	3	3	5	5	5	TO-71
2N5453	1	4.5	1	3	3	10	10	5	TO-71
2N5454	1	4.5	1	3	5	15	25	5	TO-71
2N5515	0.7	4	1	4	3	5	5	5	TO-71
2N5516	0.7	4	1	4	3	5	10	5	TO-71
2N5517	0.7	4	1	4	5	10	20	5	TO-71
2N5518	0.7	4	1	4	5	15	40	5	TO-71
2N5519	0.7	4	1	4	10	15	80	10	TO-71
2N5520	0.7	4	1	4	3	5	5	5	TO-71
2N5521	0.7	4	1	4	3	5	10	5	TO-71
2N5522	0.7	4	1	4	3	10	20	5	TO-71
2N5523	0.7	4	1	4	5	15	40	5	TO-71
2N5524	0.7	4	1	4	10	15	80	10	TO-71
2N5545	0.5	4.5	1.5	6	3	5	10	5	TO-71
2N5546	0.5	4.5	1.5	6	5	10	20	10	TO-71
2N5547	0.5	4.5	1.5	6	10	15	40	10	TO-71
2N5561	0.8	3			3	5	5	5	TO-71
2N5562	0.8	3			3	10	10	5	TO-71
2N5563	0.8	3			3	15	25	5	TO-71
2N5564	0.5	3	7.5		5	5	10	5	TO-71
2N5565	0.5	3	7.5		10	10	25	5	TO-71
2N5566	0.5	3	7.5		10	20	50	5	TO-71
2N5902	0.6	4.5	0.07			5	5		TO-78
2N5903	0.6	1.5	0.07			5	10		TO-78
2N5904	0.6	4.5	0.07			10	20		TO-78
2N5905	0.6	4.5	0.07			15	40		TO-78
2N5906	0.6	4.5	0.07			5	5		TO-78
2N5907	0.6	4.5	0.07			5	10		TO-78
2N5908	0.6	4.5	0.07			10	20		TO-78
2N5909	0.6	4.5	0.07			15	40		TO-78

N-Channel Dual JFETs (Continued)

Type No.	V_p (V) Min	V_p (V) Max	G_{fs} Min	G_{fs} Max	G_{fs} Match %	$\|V_{gs1-2}\|$ (mV) Max	Drift (μV/C) Max	I_{dss} Match %	Package
2N5911	1	5	5	10	5	10	20	5	TO-78
2N5912	1	5	5	10	5	10	40	5	TO-78
2N6483	0.7	4	1	4	3	5	5	5	TO-71
2N6484	0.7	4	1	4	3	10	10	5	TO-71
2N6485	0.7	4	1	4	5	15	25	5	TO-71
J401	0.5	2.5	2	7		5	10		MINI-DIP
J402	0.5	2.5	2	7		10	10		MINI-DIP
J403	0.5	2.5	2	7		10	25		MINI-DIP
J404	0.5	2.5	2	7		15	25		MINI-DIP
J405	0.5	2.5	2	7		20	40		MINI-DIP
J406	0.5	2.5	2	7		40	80		MINI-DIP
J410	0.5	3.5	1	4		10	10		MINI-DIP
J411	0.5	3.5	1	4		25	25		MINI-DIP
J412	0.5	3.5	1	4		40	80		MINI-DIP
NDF9406	0.5	4	0.7	1.8	3	5	5	5	TO-71
NDF9407	0.5	4	0.7	1.8	3	5	10	5	TO-71
NDF9408	0.5	4	0.7	1.8	5	10	10	5	TO-71
NDF9409	0.5	4	0.7	1.8	5	15	10	5	TO-71
NDF9410	0.5	4	0.7	1.8	10	25	25	10	TO-71
NPD5564	0.5	3	7.5		5	5	10	5	MINI-DIP
NPD5565	0.5	3	7.5		10	10	25	5	MINI-DIP
NPD5566	0.5	3	7.5		10	20	50	5	MINI-DIP
NPD8301	0.5	3.5	1	4		5	10		MINI-DIP
NPD8302	0.5	3.5	1	4		10	15		MINI-DIP
NPD8303	0.5	3.5	1	4		15	25		MINI-DIP
U257	1	5	5	10	15	100		15	TO-78
U401	0.5	2.5	2	7		5	10		TO-71
U402	0.5	2.5	2	7		10	10		TO-71
U403	0.5	2.5	2	7		10	25		TO-71
U404	0.5	2.5	2	7		15	25		TO-71
U405	0.5	2.5	2	7		20	40		TO-71
U406	0.5	2.5	2	7		40	80		TO-71

JFET Pro Electron Series

Type No.	BV_{gss} BV_{gdo} (V) @ I_g Min	(μA)	I_{gss} I_{dgd} (nA)@V_{gd} Max	(V)	V_p (V) @ Min	Max	V_{ds} (V)	I_d (nA)	V_{gs} (V) @ Min	Max	V_{gs} (V)	I_d (μA)	I_{dss} (mA) Min	Max	@V_{ds} (V)	$R_e(Y_{fs})$ (mmho) @ f Min	Max	(MHz)	C_{iss} (pF) Typ	@V_{ds} (V)	V_{gs} (V)	C_{rss} (pF)@V_{ds} Typ	(V)	V_{gs} (V)
BF244A	30	1	5	20	0.5	8	15	10	0.4	2.2	15	200	2	6.5	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF244B	30	1	5	20	0.5	8	15	10	1.6	3.8	15	200	6	15	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF244C	30	1	5	20	0.5	8	15	10	3.2	7.5	15	200	12	25	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF245A	30	1	5	20	0.5	8	15	10	0.4	2.2	15	200	2	6.5	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF245B	30	1	5	20	0.5	8	15	10	1.6	3.8	15	200	6	15	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF245C	30	1	5	20	0.5	8	15	10	3.2	7.5	15	200	12	25	15	3	6.5	0.001	4	20	−1	1.1	20	−1
BF246A	25	1	5	15	0.6	14.5	15	10	1.5	4.0	15	200	30	80	15	8		0.001	11	5	0	3.5	15	0
BF246B	25	1	5	15	0.6	14.5	15	10	3.0	7.0	15	200	60	140	15	8		0.001	11	5	0	3.5	15	0
BF246C	25	1	5	15	0.6	14.5	15	10	5.5	12	15	200	110	250	15	8		0.001	11	5	0	3.5	15	0
BF247A	25	1	5	15	0.6	14.5	15	10	1.5	4.0	15	200	30	80	15	8		0.001	11	5	0	3.5	15	0
BF247B	25	1	5	15	0.6	14.5	15	10	3.0	7.0	15	200	60	140	15	8		0.001	11	5	0	3.5	15	0
BF247C	25	1	5	15	0.6	14.5	15	10	5.5	12	15	200	110	250	15	8		0.001	11	5	0	3.5	15	0
BF256A	30	1	5	20					0.5	7.5	15	200	3	7	15	4.5		0.001				0.7	20	−1
BF256B	30	1	5	20					0.5	7.5	15	200	6	13	15	4.5		0.001				0.7	20	−1
BF256C	30	1	5	20					0.5	7.5	15	200	11	18	15	4.5		0.001				0.7	20	−1
BSR56	40	1	1	20	4	10	15	1					50		15						5		10	0
BSR57	40	1	1	20	2	6	15	1					20	100	15							5	10	0
BSR58	40	1	1	20	0.8	4	15	1					8	80	15							5	10	0

Ultra-Fast Reverse Recovery Rectifiers

Part Number	V_{RSM} (V)	$I_{F(AVG)}$ (A)	t_{rr} (ns) (Note 1)	V_F (V) (Note 2)	Package Style
SINGLE RECTIFIER PER PACKAGE					
FRP805	50	8	50	0.95	TO-220AC
FRP810	100	8	50	0.95	TO-220AC
FRP815	150	8	50	0.95	TO-220AC
FRP820	200	8	50	0.95	TO-220AC
FRP840	400	8	75	1.50	TO-220AC
FRP850	500	8	75	1.50	TO-220AC
FRP860	600	8	75	1.50	TO-220AC
FRP1005	50	10	50	0.95	TO-220AC
FRP1010	100	10	50	0.95	TO-220AC
FRP1015	150	10	50	0.95	TO-220AC
FRP1020	200	10	50	0.95	TO-220AC
FRP1605	50	16	50	0.95	TO-220AC
FRP1610	100	16	50	0.95	TO-220AC
FRP1615	150	16	50	0.95	TO-220AC
FRP1620	200	16	50	0.95	TO-220AC
DUAL RECTIFIERS, COMMON CATHODE					
FRP1605CC	50	16	50	0.95	TO-220AB
FRP1610CC	100	16	50	0.95	TO-220AB
FRP1615CC	150	16	50	0.95	TO-220AB
FRP1620CC	200	16	50	0.95	TO-220AB
FRP1640CC	400	8	75	1.50	TO-220AB
FRP1650CC	500	8	75	1.50	TO-220AB
FRP1660CC	600	8	75	1.50	TO-220AB
FRP2005CC	50	20	50	0.95	TO-220AB
FRP2010CC	100	20	50	0.95	TO-220AB
FRP2015CC	150	20	50	0.95	TO-220AB
FRP2020CC	200	20	50	0.95	TO-220AB
FRK3205CC	50	32	50	0.95	TO-3P
FRK3210CC	100	32	50	0.95	TO-3P
FRK3215CC	150	32	50	0.95	TO-3P
FRK3220CC	200	32	50	0.95	TO-3P

Note 1: $I_F = I_{F(AVG)}$; $dI_F/dt = 100\ A/\mu s$; $T_J = 25°C$.

Note 2: V_F measured at $I_{F(AVG)}$.

Plastic Encapsulated TO-220AB/TO-3P Power MOSFETs

Part Number	V_{DSS} (V)	$R_{DS(on)}$ (Ω)	I_{DR} (A)	Package Style
IRFP450CF	500	0.320	15.5	TO-3P
IRFP450	500	0.400	14.0	TO-3P
IRF840CF	500	0.680	8.9	TO-220AB
IRFP440CF	500	0.680	10.5	TO-3P
IRF840	500	0.850	8.0	TO-220AB
IRFP440	500	0.850	8.8	TO-3P
IRF842	500	1.100	7.0	TO-220AB
IRF830CF	500	1.200	5.0	TO-220AB
IRF830	500	1.500	4.5	TO-220AB
MTP4N50	500	1.500	4.0	TO-220AB
IRF832	500	2.200	4.0	TO-220AB
IRF820CF	500	2.400	2.8	TO-220AB
IRF820	500	3.000	2.5	TO-220AB
IRF822	500	4.000	2.0	TO-220AB
MTP2N50	500	4.000	2.5	TO-220AB
IRFP451CF	450	0.320	15.5	TO-3P
IRFP451	450	0.400	14.0	TO-3P
IRFP441CF	450	0.680	10.5	TO-3P
IRF841	450	0.850	8.0	TO-220AB
IRFP441	450	0.850	8.8	TO-3P
IRF843	450	1.100	7.0	TO-220AB
MTP4N45	450	1.500	4.0	TO-220AB
IRF831	450	1.500	4.5	TO-220AB
IRF833	450	2.000	4.0	TO-220AB
IRF821	450	3.000	2.5	TO-220AB
IRF823	450	4.000	2.0	TO-220AB
MTP2N45	450	4.000	2.5	TO-220AB
IRFP350CF	400	0.240	18.0	TO-3P
IRFP350	400	0.300	16.2	TO-3P
IRF740CF	400	0.440	11.0	TO-220AB
IRFP340CF	400	0.440	12.0	TO-3P
IRF740	400	0.550	10.0	TO-220AB
IRFP340	400	0.550	11.0	TO-3P
IRF742	400	0.800	8.0	TO-220AB
IRF730CF	400	0.800	6.2	TO-220AB
IRF730	400	1.000	5.5	TO-220AB
MTP5N40	400	1.000	5.0	TO-220AB
IRF720CF	400	1.440	3.8	TO-220AB
IRF732	400	1.500	4.5	TO-220AB
IRF720	400	1.800	3.0	TO-220AB
IRF722	400	2.500	2.5	TO-220AB
MTP3N40	400	3.300	3.0	TO-220AB
IRF710	400	3.600	1.5	TO-220AB
IRF712	400	5.000	1.3	TO-220AB
MTP2N40	400	5.000	2.0	TO-220AB

Part Number	V_{DSS} (V)	$R_{DS(on)}$ (Ω)	I_{DR} (A)	Package Style
IRFP351CF	350	0.240	18.0	TO-3P
IRFP351	350	0.300	16.2	TO-3P
IRFP341CF	350	0.440	12.0	TO-3P
IRF741	350	0.550	10.0	TO-220AB
IRFP341	350	0.550	11.0	TO-3P
IRF743	350	0.800	8.0	TO-220AB
IRF731	350	1.000	5.5	TO-220AB
MTP5N35	350	1.000	5.0	TO-220AB
IRF733	350	1.500	4.5	TO-220AB
IRF721	350	1.800	3.0	TO-220AB
IRF723	350	2.500	2.5	TO-220AB
MTP3N35	350	3.300	3.0	TO-220AB
IRF711	350	3.600	1.5	TO-220AB
IRF713	350	5.000	1.3	TO-220AB
MTP2N35	350	5.000	2.0	TO-220AB
IRFP250CF	200	0.068	35.9	TO-3P
IRFP250	200	0.085	32.5	TO-3P
IRF640CF	200	0.144	20.0	TO-220AB
IRFP240CF	200	0.144	22.0	TO-3P
IRF640	200	0.180	18.0	TO-220AB
IRFP240	200	0.180	19.8	TO-3P
IRF642	200	0.220	16.0	TO-220AB
IRF630CF	200	0.320	10.0	TO-220AB
MTP12N20	200	0.350	12.0	TO-220AB
IRF630	200	0.400	9.0	TO-220AB
IRF632	200	0.500	8.0	TO-220AB
IRF620CF	200	0.640	5.6	TO-220AB
MTP7N20	200	0.700	7.0	TO-220AB
IRF620	200	0.800	5.0	TO-220AB
IRF622	200	1.200	4.0	TO-220AB
IRF610	200	1.500	2.5	TO-220AB
MTP2N20	200	1.800	3.5	TO-220AB
IRF612	200	2.400	2.0	TO-220AB
MTP12N18	180	0.350	12.0	TO-220AB
MTP7N18	180	0.700	7.0	TO-220AB
MTP2N18	180	1.800	3.25	TO-220AB
IRFP251CF	150	0.068	35.9	TO-3P
IRFP251	150	0.085	32.5	TO-3P
IRFP241CF	150	0.144	22.0	TO-3P
IRF641	150	0.180	18.0	TO-220AB
IRFP241	150	0.180	19.8	TO-3P
IRF643	150	0.220	16.0	TO-220AB
IRF631	150	0.400	9.0	TO-220AB
IRF633	150	0.500	8.0	TO-220AB
IRF621	150	0.800	5.0	TO-220AB

Plastic Encapsulated TO-220AB/TO-3P Power MOSFETs (Continued)

Part Number	V_{DSS} (V)	$R_{DS(on)}$ (Ω)	I_{DR} (A)	Package Style
IRF623	150	1.200	4.0	TO-220AB
IRF611	150	1.500	2.5	TO-220AB
IRF613	150	2.400	2.0	TO-220AB
IRFP150CF	100	0.044	47.5	TO-3P
IRFP150	100	0.055	43.0	TO-3P
IRF540CF	100	0.068	30.0	TO-220AB
IRFP140CF	100	0.068	33.0	TO-3P
IRF540	100	0.085	27.0	TO-220AB
IRFP140	100	0.085	29.5	TO-3P
IRF542	100	0.110	24.0	TO-220AB
IRF530CF	100	0.144	16.0	TO-220AB
MTP20N10	100	0.150	20.0	TO-220AB
IRF530	100	0.180	14.0	TO-220AB
IRF520CF	100	0.240	9.1	TO-220AB
IRF532	100	0.250	12.0	TO-220AB
IRF520	100	0.300	8.0	TO-220AB
MTP10N10	100	0.330	10.0	TO-220AB
IRF522	100	0.400	7.0	TO-220AB
IRF510	100	0.600	4.0	TO-220AB
IRF512	100	0.800	3.5	TO-220AB
MTP4N10	100	0.800	5.0	TO-220AB
MTP20N08	80	0.150	20.0	TO-220AB
MTP10N08	80	0.330	10.0	TO-220AB
MTP4N08	80	0.800	5.0	TO-220AB
IRFP151CF	60	0.044	47.5	TO-3P
IRFP151	60	0.055	43.0	TO-3P
IRFP141CF	60	0.068	33.0	TO-3P
IRF541	60	0.085	27.0	TO-220AB
IRFP141	60	0.085	29.5	TO-3P
FMP20N06	60	0.085	20.0	TO-220AB
FMP18N06	60	0.100	18.0	TO-220AB
IRF543	60	0.110	24.0	TO-220AB
IRF531	60	0.180	14.0	TO-220AB
IRF533	60	0.250	12.0	TO-220AB
IRF521	60	0.300	8.0	TO-220AB
IRF523	60	0.400	7.0	TO-220AB
IRF511	60	0.600	4.0	TO-220AB
IRF513	60	0.800	3.5	TO-220AB
FMP20N05	50	0.085	20.0	TO-220AB
FMP18N05	50	0.100	18.0	TO-220AB

Section 5
Interface

Section 5 Contents Interface

Interface

Since its creation in 1973, National Semiconductor's Interface design and production teams have produced technically advanced products unparalleled in the semiconductor industry.

Growing from a line of early drivers and receivers, which pioneered the introduction of the TRI-STATE® function, National Semiconductor's Interface product line today is the most comprehensive available—with over 200 devices in a variety of product categories.

Based on its advanced design and process capabilities, National's Interface product line includes:

- The industry's most advanced RS-232 drivers and receivers
- The industry's most advanced RS-422 drivers, receivers and transceivers
- The industry's most advanced RS-485 drivers, receivers and transceivers
- The industry's only offering of over 16 devices incorporating power up/down glitch-free protection
- The industry's first Trapezoidal™ bus transceiver
- The industry's first transceivers for the Future Bus standard
- The industry's first fault protected peripheral driver incorporating a major breakthrough in current sensing and shutdown circuitry.

Interface—Military

Many of National Semiconductor's commercial ICs listed in this section are also offered as military qualified devices and are indicated by a "†" preceding the part number. Military products are offered in a variety of flows including MIL-STD-883, SMD (Standard Military Drawing), and MIL-M-38510. For more information, consult the 1989 Military/Aerospace Selection Guide.

Please note that National Semiconductor offers many commercial ICs which operate over the military temperature range (−55°C to +125°C). These devices are NOT military qualified products. Military devices are indicated by a "†" preceding the part number.

Transmission Line Drivers/ Receivers

The common purpose of transmission line drivers and receivers is to transmit data quickly and reliably through a variety of environments over electrically long distances. This task is complicated by the fact that externally introduced noise and ground shifts can severely degrade the data.

The connection between two elements in a system should be considered a transmission line if the transmitted signal takes longer than twice its rise or fall time to travel from the driver to the receiver.

Single-Ended Data Transmission

In data processing systems today there are two basic means of communicating between components. One method is single-ended, which uses one signal line for data transmission, and the other is differential, which uses two signal lines.

The Electronics Industry Association (EIA) has developed several standards to simplify the interface in data communications systems.

RS-232

The first of these, RS-232, was introduced in 1962 and has been widely used throughout the industry. RS-232 was developed for single-ended data transmission at relatively slow data rates (20 kbaud) over short distances (up to 50 ft.).

RS-423

With the need to transmit data faster and over longer distances, RS-423, a newer standard for single-ended applications, was established. RS-423 extends the maximum data rate to 100 kbaud (up to 30 ft.) and the maximum distance to 4000 feet (up to 1 kbaud). RS-423 also requires high impedance driver outputs with power off so as not to load the transmission line.

Differential Data Transmission

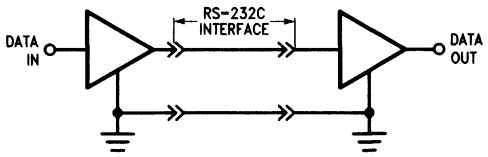
When transmitting at very high data rates, over long distances and through noisy environments, single-ended transmission is often inadequate. In these applications, differential transmission nullifies the effects of ground shifts and noise signals which appear as common-mode voltages on the transmission line.

RS-422

RS-422 was defined by the EIA for this purpose and allows data rates up to 10 Mbaud (up to 40 ft.) and line lengths up to 4000 feet (up to 100 kbaud).

Drivers designed to meet this standard are well suited for party-line type applications where only one driver is connected to, and transmits on, a bus and up to 10 receivers can receive the data. While a party-line type of application has many uses, RS-422 devices cannot be used to construct a truly multipoint bus. A multipoint bus consists of multiple drivers and receivers connected to a single bus, and any one of them can transmit or receive data.

RS-232C Application



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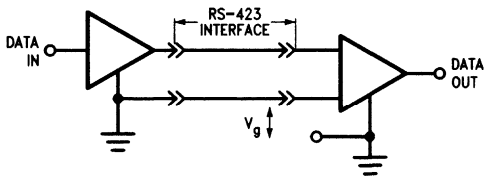
EIA RS-423 Application



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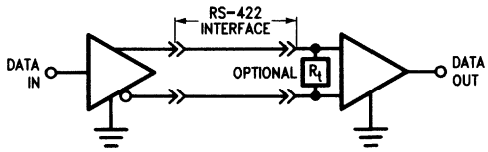
EIA RS-422 Application



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RS-485

To meet the need for truly multipoint communications, the EIA established RS-485 in 1983. RS-485 meets all the requirements of RS-422, but in addition, this new standard allows up to 32 drivers and 32 receivers to be connected to a single bus—thus allowing a truly multipoint bus to be constructed.

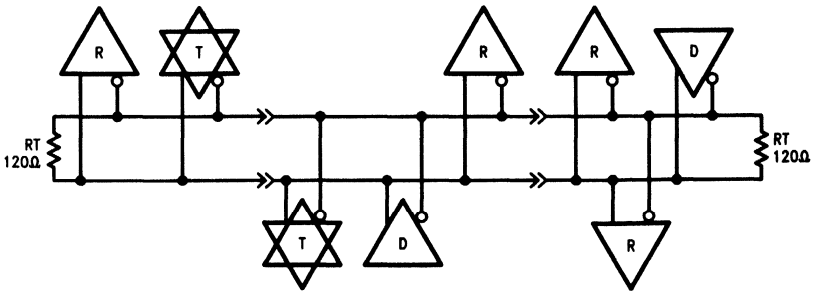
The key features of RS-485:

- Implements a truly multipoint bus consisting of up to 32 drivers and 32 receivers
- An extended common-mode range for both drivers and receivers in TRI-STATE® and with power off (−7V to +12V)
- Drivers can withstand bus contention and bus faults

National Semiconductor produces a variety of drivers, receivers, and transceivers for these four very popular transmission standards and numerous other data transmission requirements.

Shown below is a table that highlights key aspects of the EIA Standards.

RS-485 Application



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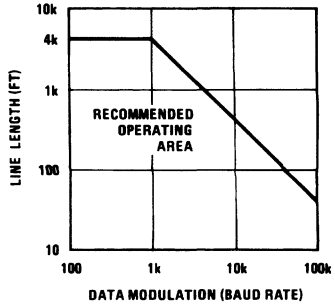
Specification		RS-232C	RS-423	RS-422	RS-485
Mode of Operation		Single-Ended	Single-Ended	Differential	Differential
Number of Drivers and Receivers Allowed on One Line		1 Driver, 1 Receiver	1 Driver, 10 Receivers	1 Driver, 10 Receivers	32 Drivers, 32 Receivers
Maximum Cable Length		50 feet	4000 feet	4000 feet	4000 feet
Maximum Data Rate		20 kb/s	100 kb/s	10 Mb/s	10 Mb/s
Driver Output Maximum Voltage		±25V	±6V	−0.25V to +6V	−7V to +12V
Driver Output Signal Level	Loaded Unloaded	±5V ±15V	±3.6V ±6V	±2V ±5V	±1.5V ±5V
Driver Load Impedance		3 kΩ to 7 kΩ	450 Ω min	100Ω	54Ω
Maximum Driver Output Current (High Impedance State)	Power On Power Off	— V_{MAX}/300Ω	— ±100 μA	— ±100 μA	±100 μA ±100 μA
Slew Rate		30V/μs max	Controls Provided	—	—
Receiver Input Voltage Range		±15V	±12V	−7V to +7V	−7V to +12V
Receiver Input Sensitivity		±3V	±200 mV	±200 mV	±200 mV
Receiver Input Resistance		3 kΩ to 7 kΩ	4 kΩ min	4 kΩ min	12 kΩ min

Unbalanced Single-Ended Transmission Line Drivers and Receivers

Line length is a function of data rate (baud) and slew rate. The recommended safe operating area (line length vs baud rate) is shown below for 24 AWG wire. It assumes that a differential line receiver is used which is referenced at the driver ground. Also, it assumes that the driver slew rate is between 0.1 to 0.3 times the reciprocal of the baud rate (minimum unit interval). Otherwise, line lengths greater than 50 feet are not recommended. The exception to line length is the 360 I/O coaxial interface. The coaxial provides improved grounding and eliminates crosstalk.



TL/MS/10275–6

Unbalanced Drivers

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Open-Collector/ Open-Emitter TRI-STATE	Party-Line Application	Slew Rate Control	Output Current (mA)	Output Voltage (V)	Propagation Delay (ns)	Comments	Package Type
RS-232	DS1488		4	±9 or ±15			IOS/C	±6	±6 or ±9	200		J, M, N
RS-232	DS14C88			±9 or ±15			Internal	±6	±7 or ±11			J, M, N
RS-232	DS75150		2	±12			IOS/C	±10	±5	60		J, M, N
RS-232		†DS9616/μA9616	3	±12			Internal		+7, −5	320		J
RS-423	DS3691	†DS1691A	4	+5 or ±5	TRI-STATE	Yes	CEXT	±20	±2	200		J, M, N
RS-423	DS9636AC/ μA9636AC	†DS9636AM/ μA9636AM	2	±12			Yes	±60	±6	1400		J, N
MIL-188-114	DS3692	DS1692	4	+5 or ±5	TRI-STATE	Yes	CEXT	±20	±2	200	±10V Common-Mode Range	J, N
360 I/O	DS75121	DS55121	2	5	Emitter	Yes		−100	2.4	10	50Ω Coax Driver	J, N
360 I/O	DS75123		2	5	Emitter	Yes		−100	2.4	10	50Ω Coax Driver (IBM)	J, N
	DS75450		2	5	Emitter and Collector	Yes		300	0.7	20		J, N
	DS75451	†DS55451	2	5	Collector	Yes		300	0.7	18		J, M, N
	DS75452	†DS55452	2	5	Collector	Yes		300	0.7	26		J, M, N
	DS75453	†DS55453	2	5	Collector	Yes		300	0.7	18		J, M, N
	DS75454	DS55454	2	5	Collector	Yes		300	0.7	27		J, M, N
	DS75110A/ μA75110A	†DS55110A/ μA55110A	2	±5	Constant Current	Yes		12		15		J, M, N

† Part available with military screening

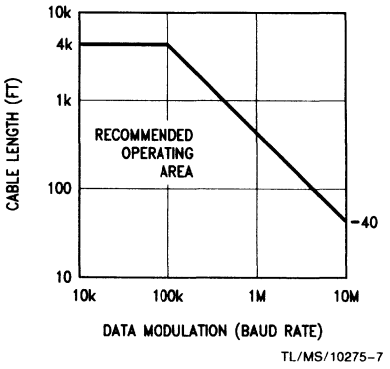
Unbalanced Single-Ended Transmission Line Drivers and Receivers (Continued)

Unbalanced Receivers

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Strobed or TRI-STATE	Response Control	Hysteresis (mV)	Input Range (V)	Threshold Sensitivity (V)	Propagation Delay (ns)	Comments	Package Type
RS-232	DS1489		4	5		CEXT	250	±25	3	30		J, M, N
RS-232	DS1489A		4	5		CEXT	1150	±25	3	30	Preferential in Applications to DS1489	J, M, N
RS-232	DS14C89A		4	5				±25	3			J, M, N
RS-232	DS75154		4	5 or 15		CEXT	800	±25	3	22		J, M, N
RS-232 MIL-STD 188C		†DS9627/ μA9627	2	±12	Strobed				±3	250	Variable Hysteresis Rim Control	J
RS-423	DS26C32A		4	5	TRI-STATE							J, M, N
RS-423	DS26F32C	†DS26F32M	4	5	TRI-STATE		30	±7	±0.2	22		J
RS-423	DS26LS32C	†DS26LS32M	4	5	TRI-STATE		100	±7	±0.2	17		J, M, N
RS-423	DS26LS32AC		4	5	TRI-STATE		100	±7	±0.2	23	Fail-Safe	J, M, N
RS-423	DS3486		4	5	TRI-STATE		100	±15	±0.2	25		J, M, N
RS-423	DS34C86		4	5	TRI-STATE							J, M, N
RS-423	DS34F86	DS35F86	4	5	TRI-STATE			±7	±0.2	22		J
RS-423	DS88C20	†DS78C20	2	5	Strobed	CEXT	50	±25	±0.2	50		J, N
RS-423	DS88C120	†DS78C120	2	5	Strobed	CEXT	50	±25	±0.2	50	Fail-Safe	J, N
RS-423	DS88LS120	†DS78LS120 †DS9622/μA9622	2 2	5 to 15 +5, −10	Strobed	CEXT	50	±25	±0.2	50 50	Fail-Safe	J, N J
RS-423	DS9637AC/ μA9637AC	†DS9637AM/ μA9637AM	2	5								J, M, N
RS-423	DS9639AC/ μA9639AC		2	5								N
RS-423	DS96F173C	†DS96F173M	4	5	TRI-STATE		50	+12/−7	±0.2	22		J
RS-423	DS96173C/ μA96173C		4	5	TRI-STATE		50	+12/−7	±0.2	25		J, N
RS-423	DS96F175C	†DS96F173M	4	5	TRI-STATE		50	+12/−7	±0.2	22		J
RS-423	DS96175C/ μA96175C		4	5	TRI-STATE		50	+12/−7	±0.2	25		J, N
360 I/O	DS75124		3	5	Strobed		400	7	0.8 to 2	20	50Ω Coax. Receiver (IBM)	J, N
360 I/O	DS75125		7	5				−2/7	0.7 to 1.7	16	IBM Coax. Receiver	J, N
360 I/O	DS75127		7	5				−2/7	0.7 to 1.7	16	IBM Coax. Receiver	J, N
360 I/O	DS75128		8	5	Strobed			−2/7	0.7 to 1.7	16	IBM Coax. Receiver	J, N
360 I/O	DS75129		8	5	Strobed			−2/7	0.7 to 1.7	16	IBM Coax. Receiver	J, N
	DS26LS33C	DS26LS33M	4	5	TRI-STATE		200	±15	±0.5	17		J, N
	DS26LS33AC		4	5	TRI-STATE		200	±15	±0.5	23	Fail-Safe	J, N
		†DS9615/μA9615	2	5		Yes		±15	±0.5	75		J
		†DS9622/μA9622	2	+5 −10	Strobed			±10		50		J

Balanced Differential Transmission Line Drivers and Receivers

The balanced or differential scheme of data transmission is preferred for applications incorporating high data rates and long transmission lines in the presence of high common-mode noise. Induced signals appear as common-mode levels and are rejected by the differential line receiver.



TL/MS/10275–7

Balanced Drivers

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Open Collector	Party-Line Application	TRI-STATE	V_{OH} (V) I_{OH} (mA)	V_{OL} (V) I_{OL} (mA) (V)	Propagation Delay (ns)	Comments	Package Information
RS-422	DS26C31C											J, M, N
RS-422	DS26F31C	†DS26F31M	4	5		Yes	Yes	2.5/−20	0.5/20	15		J
RS-422	DS26LS31C	†DS26LS31M	4	5		Yes	Yes	2.5/−20	0.5/40	12		J, M, N
RS-422	DS3487	DS3587	4	5		Yes	Yes	2.0/−50	0.5/48	15		J, M, N
RS-422	DS34C87											J, M, N
RS-422	DS34F87	DS35F87	4	5		Yes	Yes	2.5/−20	0.5/48	15		J
RS-422	DS3691	†DS1691A	2	+5 or ±5		Yes	Yes	2/−20	−2/20	200		J, M, N
RS-422	DS8921, DS8921A		1	5		No	No	2.5/−20	0.5/20	12	Transceiver	J, M, N
RS-422	DS8922 DS8922A		2	5		Yes	Yes	2.5/−20	0.5/20	12	Dual Transceiver with Driver/Receiver Pair Disable	J, M, N
RS-422	DS8923 DS8923A		2	5		Yes	Yes	2.5/−20	0.5/20	12	Dual Transceiver with Separate Driver and Receiver Disables	J, M, N
RS-422	DS9638C/ μA9638C	†DS9638M/ μA9638M	2	5				2.0/−40	0.5/40	20		J, M, N
RS-485	DS3695		1	5		Yes	Yes			15	Transceiver	M, N
RS-485	DS36F95	†DS16F95	1	5		Yes	Yes			16		J
RS-485	DS3696		1	5		Yes	Yes			15	Transceiver with Line Fault Reporting	N
RS-485	DS3697		1	5		Yes	Yes			15	Repeater	N
RS-485	DS3698		1	5		Yes	Yes			15	Repeater with Line Fault Reporting	N
RS-485	DS75176B		1	5		Yes	Yes				Transceiver	J, M, N

Balanced Differential Transmission Line Drivers and Receivers (Continued)

Balanced Drivers (Continued)

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Open Collector	Party-Line Application	TRI-STATE	V_{OH} (V) I_{OH} (mA)	V_{OL} (V) I_{OL} (mA) (V)	Propagation Delay (ns)	Comments	Package Information
RS-485	DS96F172C	†DS96F172M	4	5		Yes	Yes			16		J
RS-485	DS96172/ μA96172		4	5		Yes	Yes			20		J, N
RS-485	DS96F174C	†DS96F174M	4	5		Yes	Yes			16		J
RS-485	DS96174/ μA96174		4	5		Yes	Yes			20		J, N
RS-485	DS96176/ μA96176		1	5		Yes	Yes			20	Transceiver	J, N
RS-485	DS96177/ μA96177		1	5		Yes	Yes			20	Repeater	J, N
	DS8830	†DS7830	2	5		No	No	1.8/−40	0.5/40	10		J, N
	DS8831	†DS7831	2	5		Yes	Yes	1.8/−40	0.5/40	10		J, N
	DS8832	†DS7832	2	5		Yes	Yes	1.8/−40	0.5/40	10	DS8831 without V_{CC} Clamp Diode	J, N
	DS8924		4	5		Yes	Yes	2.0/−48	0.5/48	12		J, N
	DS75113	†DS55113	2	5	Optional	Yes	Yes	2.0/−40	0.4/40	13		J, M, N
	DS75114	DS55114	2	5	Optional			2.0/−40	0.4/40	15		J, N
		†DS9614M/ μA9614M	2	5							See DS55114	J
	MM88C29	MM78C29	2	5 or 15				2.9/−57	0.4/11	100		J, N
	MM88C30	MM78C30	2	5 or 15				2.9/−57	0.4/11	100		J, N

Balanced Differential Transmission Line Drivers and Receivers (Continued)

Balanced Receivers

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Strobed or TRI-STATE	Response Control	Hysteresis (mV)	Common Mode Range (V)	Threshold Sensitivity (V)	Propagation Delay (ns)	Comments	Package Type
RS-422	DS26C32A		4		TRI-STATE							J, M, N
RS-422	DS26F32C	†DS26F32M	4	5	TRI-STATE		30	±7	±0.2	22		J
RS-422	DS26LS32C	†DS26LS32M	4	5	TRI-STATE		100	±7	±200	17		J, M, N
RS-422	†DS26LS32AC		4	5	TRI-STATE		100	±7	±200	17	Fail-Safe	J, M, N
RS-422	DS3486		4	5	TRI-STATE		80	±10	±200	17		J, M, N
RS-422	DS34C86		4	5	TRI-STATE							J, M, N
RS-422	DS34F86	DS35F86	4	5	TRI-STATE			±7	±0.2	22		J
RS-422	DS88C20	†DS78C20	2	5 to 15	Strobed	Yes	50	±10	±200	60	Fail-Safe CMOS Compatible	J, N
RS-422	DS88C120	†DS78C120	2	5 to 15	Strobed	Yes	50	±10	±200	60		J, N
RS-422	DS88LS120	†DS78LS120	2	5	Strobed	Yes	50	±10	±200	50		J, N
RS-422	DS8921		1	5			50	±7	±200			J, M, N
RS-422	DS8921A		1	5			50	±7	±200		Low Skew	J, M, N
RS-422	DS8922		2	5	TRI-STATE		50	±7	±200			J, M, N
RS-422	DS8922A		2	5	TRI-STATE		50	±7	±200		Low Skew	J, M, N
RS-422	DS8923		2	5	TRI-STATE		50	±7	±200			J, M, N
RS-422	DS8923A		2	5	TRI-STATE		50	±7	±200		Low Skew	J, M, N
RS-422	DS9637AC/ μA9637AC	†DS9637AM/ μA9637AM	2	5				±7	±0.2	25		J, M, N
RS-422	DS9639A/ μA9639A		2	5				±7	±0.2	85		N
RS-485	DS3695		1	5	TRI-STATE		70	+12/−7	±200	22	Transceiver	M, N
RS-485	DS36F95	†DS16F95	1	5	TRI-STATE		50	+12/−7	±0.2	16	Transceiver	J
RS-485	DS3696		1	5	TRI-STATE		70	+12/−7	±200	22	Transceiver with Line Fault Reporting	N

Balanced Differential Transmission Line Drivers and Receivers (Continued)

Balanced Receivers (Continued)

Standard	Device Number and Temperature Range: Commercial 0°C to +70°C	Device Number and Temperature Range: Military −55°C to +125°C	Circuits Per Package	Power Supplies (V)	Strobed or TRI-STATE	Response Control	Hysteresis (mV)	Common Mode Range (V)	Threshold Sensitivity (V)	Propagation Delay (ns)	Comments	Package Type
RS-485	DS3697		1	5	TRI-STATE		70	+12/−7	±200	22	Repeater	N
RS-485	DS3698		1	5	TRI-STATE		70	+12/−7	±200	22	Repeater with Line Fault Reporting	N
RS-485	DS75176B		1	5	TRI-STATE		70	+12/−7	±200		Transceiver	J, M, N
RS-485	DS96F173C	†DS96F173M	4	5	TRI-STATE		50	+12/−7	±0.2	22		J
RS-485	DS96173/ μA96173		4	5	TRI-STATE		50	+12/−7	±0.2	25		J, N
RS-485	DS96F175C	†DS96F175M	4	5	TRI-STATE		50	+12/−7	±0.2	22		J
RS-485	DS96175/ μA96175		4	5	TRI-STATE		50	+12/−7	±0.2	25		J, N
RS-485	DS96176/ μA96176		1	5	TRI-STATE		50	+12/−7	±0.2	25	Transceiver	J, N
	DS3603	†DS1603	2	±5	TRI-STATE			±3	±25	17		J, N
	DS3650	DS1650	4	±5	TRI-STATE			±3	±25	10		J, M, N
	DS3652	†DS1652	4	±5	Strobed			±3	±25	10		J, M, N
	DS8820	†DS7820	2	5	Strobed	Yes		±15	±1000	40		J, N
	DS8820A	†DS7820A	2	5	Strobed	Yes		±15	±1000	30		J, N
	DS75107	†DS55107	2	±5	Strobed			±3	±25	17		J, N
	DS75108	DS55108	2	±5	Strobed			±3	±25	17		J, N
	DS75115	DS55115	2	5	Strobed	Yes		±15	±500	20		J, N
	DS75208		2	±5	Strobed			±3	±10	17		J, N
		†DS9615/ μA9615	2	5		Yes		±15	±0.5	75	See DS55115	J
		†DS9622/ μA9622	2	+5/−10	Strobed			±10		50		J

Bus Transceivers

A bus is a common communication medium, such as a cable or a printed circuit trace, that is time shared by several elements of a system. Single-ended bus circuits are listed in this section and these may be further categorized into open-collector circuits and TRI-STATE® circuits.

When not transmitting, a bus driver should be capable of presenting a high impedance output in order to allow other drivers to freely use the bus. This is achieved by using either an open-collector or TRI-STATE output.

Open-collector drivers may be connected in a wired-OR configuration which is very useful for polling and bus arbitration. These devices require pull-up resistors, which can also serve as bus terminators.

TRI-STATE drivers, on the other hand, do not require bus termination for short bus runs on PC boards. In addition, TRI-STATE devices provide improved rise time characteristics with low power dissipation. Hence, they are popular in high-speed microcomputer systems.

A single-ended bus is highly susceptible to noise, including ground noise and cross-talk. For this reason the bus should not be extended beyond the subsystem's enclosure without special care. Line lengths in excess of 10 feet are not recommended without the use of noise reduction techniques, such as slew rate control, high receiver thresholds and noise filtering. Devices such as National Semiconductor's DS3662 and DS3882 Trapezoidal Bus Transceivers and DS3896 and DS3897 Futurebus Transceivers are specifically designed for reducing crosstalk and noise susceptibility on high-speed buses.

Futurebus Transceivers

The DS3896 and DS3897 are the first two devices designed for driving high-speed microcomputer backplane buses. Both devices meet the proposed IEEE-P896 Futurebus standard and incorporate low output capacitance (<5 pF) with the ability to drive a bus with a loaded impedance of less than 18Ω. This excellent drive capability is achieved while still maintaining high levels of noise immunity.

Power Up/Down Glitch Free Protection

Powering a device up or down, or simply connecting or disconnecting a device from an active bus, has frequently presented the design engineer with the problem of invalid data glitches being transmitted onto the bus. National Semiconductor is the industry leader in offering bus transceivers incorporating glitch-free power up/down protection. For more detailed information on National Semiconductor's line of bus transceivers, refer to the following selection guide.

Bus Circuits

Data bus circuits are not transmission line circuits in the normal interpretation where the transmission line is electrically long (1/4 wavelength) with respect to the baud rate. Like unbalanced transmission lines, the data transmission is susceptible to common-mode noise, such as ground IR noise and induced reactive noise from crosstalk. A bus is a communications method where many elements of a system time share the same signal (address or data) bus. A bus shouldn't extend out of its sub-system's electronic enclosure without special care. Line length in excess of 10 feet is not recommended without slew rate control. Cables should be in the form of twisted pair or flat cable where a signal wire is alternated with a ground wire.

Open-Collector Bus Circuits

Device Number and Temperature Range				Bus Driver		Bus Receiver					
Commercial 0°C to +70°C	Military −55°C to +125°C	Circuits/ Package	Driver/ Receiver/ Transceiver	Propagation Delay (ns)	V_{OL} (V)/ I_{OL} (mA)	Propagation Delay (ns)	V_{IL} (V)/ I_{IL} (μA)	V_{IH} (V)/ I_{IH} (μA)	Hysteresis (V)	Comments	Packaging Type
DM8131	DM7131	1	Receiver			30	0.95/50	2/50	0.65	1-Bit Bus Comparator	J, N
DM8136	DM7136	1	Receiver			30	0.95/50	2/50	0.65	1-Bit Bus Comparator	J, N
DS26S10	DS26S10M	4	Transceiver	10	0.8/100	10	1.75/−100	2.25/100			J, N
DS26S11	DS26S11M	4	Transceiver	10	0.8/100	10	1.75/−100	2.25/100		Input to Bus is Non-Inverting	J, N
DS3662		4	Transceiver	30	0.9/100	40	1.50/400	1.9/100		Trapezoidal Transceiver	J, N
DS3862		8	Transceiver							Trapezoidal Transceiver	N
DS3890		8	Driver	15						Futurebus Driver	J, N
DS3892		8	Receiver			18				Futurebus Receiver	J, N
DS3893A		4	Transceiver	7		8				TURBOTRANSCEIVER	V
DS3896		8	Transceiver							Futurebus Transceiver	J, M, N
DS3897		4	Transceiver							Futurebus Transceiver	J, M, N
DS3898		8	Repeater	30						Futurebus Repeater	J, N
DS75450		2	Driver	20	0.7/300					AND Separate Output Transistors	J, N
DS75451	†DS55451	2	Driver	18	0.7/300					AND	J, M, N
DS75452	†DS55452	2	Driver	26	0.7/300					NAND	J, M, N
DS75453	†DS55453	2	Driver	18	0.7/300					OR	J, M, N
DS75454	DS55454	2	Driver	27	0.7/300					NOR	J, N
DS8640	†DS7640	4	Receiver			23	1.2/−50	1.8/50		Quad NOR Receiver	J, N
DS8641	DS7641	4	Transceiver	30	0.7/50	30	1.2/−100	1.8/100			J, N
DS8836	†DS7836	4	Receiver			20	1.05/−50	2.65/50	1	Quad NOR Receiver	J, N
DS8837	†DS7837	6	Receiver			20	1.05/−50	2.65/50	1		J, M, N
DS8838	†DS7838	4	Transceiver	25	0.8/50	30	1.05/−100	2.65/100	1		J, M, N

† Part available with military screening.

TRI-STATE Bus Circuits

Device Number and Temperature Range				Bus Driver			Bus Receiver					
Commercial 0°C to +70°C	Military −55°C to +125°C	Circuits/ Package	Driver/ Receiver/ Transceiver	Propagation Delay Typ (ns)	V_{OL} (V)/ I_{OL} (mA)	V_{OH} (V)/ I_{OH} (mA)	Propagation Delay Typ (ns)	V_{IL} (V) I_{IL} (μA)	V_{IH} (V) I_{IH} (μA)	Hysteresis (mV)	Comments	Packaging Type
DM74S240	DM54S240	4 or 8	Transceiver	4.5	0.55/64	2.4/−3	4.5	0.8/−400	2/50	400	Non-Inverting	J, N
DM74S241	DM54S241	4 or 8	Transceiver	6	0.55/64	2.4/−3	6	0.8/−400	2/50	400	Inverting	J, N
DM74S940	DM54S940	8	Transceiver	4.5	0.55/64	2.4/−3	4.5	0.8/−400	2/50	400	Non-Inverting	J, N
DM74S941	DM54S941	8	Transceiver	6	0.55/64	2.4/−3	6	0.8/−400	2/50	400	Inverting	J, N
DP8212	DP8212M	8	Driver	20	0.45/15	3.6/−1					8080 MPU Data Latch and Service Request f/t	J, N
DP8216	†DP8216M	4	Transceiver	20	0.6/55	3.6/−1	15	0.95/−250	2/10		8080 MPU Non-Inverting	J, N
DP8226	DP8226M	4	Transceiver	16	0.6/50	3.6/−1	15	0.95/−250	2/10		8080 MPU Inverting	J, N
DP8228	†DP8228M	8	Transceiver	30	0.45/10	2.4/−1	20	0.8/−250	2/20		8080 MPU System Bus Controller and Bus Driver	J, N
DP8238	†DP8238M	8	Transceiver	30	0.45/10	2.4/−1	20	0.8/−250	2/20		8080 MPU System Bus Controller and Bus Driver	J, N
DP8303A		8	Transceiver	10	0.5/50	3.6/−5	10	0.8/−250	2/80		Bidirectional Inverting	J, N
DP8304B	†DP7304B	8	Transceiver	10	0.5/50	3.6/−5	15	0.8/−250	2/80		Bidirectional Non-Inverting IEEE 488	J, N, M
DP8307A		8	Transceiver	10	0.5/50	3.6/−5	10	0.8/−250	2/80		Bidirectional Inverting	J, N
DP8308	DP7308	8	Transceiver	11	0.5/50	3.6/−5	15	0.8/−250	2/80		Bidirectional Non-Inverting	J, N
DS3647		4	Transceiver	8	0.5/50	2.4/−5	7	0.8/−500	2/100		Quad Bidirectional I/O Register	N
DS3667		8	Transceiver	20	0.5/48	2.5/−5.2	20	0.8/−100	2/20	400		
DS75160A		8	Transceiver	20	0.5/48	2.5/−5.2	20	0.8/−100	2/20	400	IEEE 488 GPIB	N
DS75161A		8	Transceiver	20	0.5/48	2.5/−5.2	20	0.8/−100	2/20	400	IEEE 488 GPIB	N
DS75162A		8	Transceiver	20	0.5/48	2.5/−5.2	20	0.8/−100	2/20	400	IEEE 488 GPIB	N
DS8T26A	DS8T26AM	4	Transceiver	14	0.5/48	2.4/−10	14	0.85/−200	2/20		Inverting	J, N
DS8T28	DS8T28M	4	Transceiver	17	0.5/48	2.4/−10	17	0.85/−200	2/20		Non-Inverting	J, N
DS8833	†DS7833	4	Transceiver	14	0.5/50	2.4/−10	20	0.8/−40	2/80	400	Non-Inverting TRI-STATE Receiver	J, N
DS8834	†DS7834	4	Transceiver	14	0.5/50	2.4/−10	20	0.8/−40	2/80	400	Inverting	J, N
DS8835	†DS7835	4	Transceiver	14	0.5/50	2.4/−10	20	0.8/−40	2/80	400	Non-Inverting TRI-STATE Receiver	J, N
DS8839	DS8739	4	Transceiver	14	0.5/50	2.4/−10	20	0.8/−40	2/80	400	Non-Inverting	J, N

Note: Unless otherwise specified, bus circuits listed above are TTL compatible and use 5V supplies.

† Part available with military screening.

Peripheral/Power Drivers

Peripheral/power drivers is a broad definition given to interface power devices. The devices generally have open-collector output transistors that can switch hundreds of milliamps at high voltage and are driven by standard logic gates. They serve many applications including relay drivers, printer hammer drivers, lamp drivers, bus drivers, core memory drivers, voltage level translators, stepper motor drivers and solenoid drivers.

Unlike standard logic devices, peripheral drivers have many varied load situations depending on the application. This requires the design engineer to interpret device specifications in greater detail. Designers at National Semiconductor have incorporated many technically advanced and useful features into their broad line of peripheral driver devices.

Some of these features include:

- Short circuit protection at individual outputs
- Glitch-free power up/down
- Fail-safe operation
- Inductive fly-back protection
- Negative transient protection
- High input impedance for CMOS/NMOS compatibility

For further information on National Semiconductor's broad line of peripheral drivers, refer to the following selection guide.

Peripheral/Power Drivers

Device Number and Temperature Range		Drivers/ Package	Logic Function (Driver On)	Input Compatibility (Logic)	Output High Voltage (V)	Latch-Up Voltage (Note 3) (V)	Output Low Voltage (V)	Output Low Current (mA)	Propagation Delay Typ (ns)	On Power Supply Current (mA)
0°C to +70°C	−55°C to +125°C									
DP8310	DP7310	8	(Note 5)	TTL	30		0.5	100	40	152
DP8311	†DP7311	8	(Note 6)	TTL	30		0.5	100	40	125
DS2001C/ μA9665C		7	NAND	TTL	50		1.6	350	5000	
DS2002C/ μA9666C	DS2002M/ μA9666M	7	NAND	PMOS	50		1.6	350	5000	
DS2003C/ μA9667C	DS2003M/ †μA9667M	7	NAND	TTL/CMOS	50		1.6	350	5000	
DS2004C/ μA9668C	DS2004M/ μA9668M	7	NAND	CMOS/PMOS	50		1.6	350	5000	
DS3631	†DS1631	2	AND	CMOS	56	40	1.4	300	150	8
DS3632	†DS1632	2	NAND	CMOS	56	40	1.4	300	150	8
DS3633	DS1633	2	OR	CMOS	56	40	1.4	300	150	8
DS3634	†DS1634	2	NOR	CMOS	56	40	1.4	300	150	8
DS3654		10	(Note 2)	(Note 2)	(Note 1)	45	1.6	250	1000	70
DS3656		4	NAND	TTL/LS	65	30	1.5	600		65
DS3658		4	NAND	TTL/LS	70	35	0.7	600	2430	65
DS3668		4	NAND	TTL/LS	70	(Note 7)	1.5	600	2000	80
DS3669		4	AND	TTL/LS	70	35	0.7	600		65
DS3680		4	(Note 4)	TTL/CMOS	−2.1	−60	−60	−50	10,000	4.4
DS3686		2	NAND	TTL/CMOS	(Note 1)	56	1.3	300	1000	28
DS3687	†DS1687	2	NAND	TTL/CMOS	(Note 1)	−56	−1.3	300	1000	2.8

† Part available in military screening.

Peripheral/Power Drivers (Continued)

Device Number and Temperature Range		Drivers/ Package	Logic Function (Driver On)	Input Compatibility (Logic)	Output High Voltage (V)	Latch-Up Voltage (Note 3) (V)	Output Low Voltage (V)	Output Low Current (mA)	Propagation Delay Typ (ns)	On Power Supply Current (mA)
0°C to +70°C	−55°C to +125°C									
DS75450		2	AND	TTL	30	20	0.7	300	31	55
DS75451	†DS55451	2	AND	TTL	30	20	0.7	300	31	55
DS75452	†DS55452	2	NAND	TTL	30	20	0.7	300	31	55
DS75453	†DS55453	2	OR	TTL	30	20	0.7	300	31	55
DS75454	DS55454	2	NOR	TTL	30	20	0.7	300	31	55
DS75461	†DS55461	2	AND	TTL	35	30	0.7	300	33	55
DS75462	†DS55462	2	NAND	TTL	35	30	0.7	300	33	55
DS75463	†DS55463	2	OR	TTL	35	30	0.7	300	33	55
DS75464	†DS55464	2	NOR	TTL	35	30	0.7	300	33	55
MM74C908, MM74C918		2	AND		13.5	15	$V_{CC} - 1.8$	300	150	0.015

Note 1: The DS3686, DS3687 and DS3654 contain an internal inductive fly-back clamp circuit connected from the output to ground. As an example, DS3686 driving a relay solenoid connected to 28V would clamp the output voltage fly-back transient at 56V caused by the solenoid's stored inductive current. This clamp protects the circuit output and quenches the fly-back.

Note 2: The DS3654 is a 10-bit shift register followed by 10 enabled drivers. The input circuit is equivalent to a 4k resistor to ground, and the logic input thresholds are 2.8V and 0.8V. The recommended power supply voltage is 7.5V to 9.5V. The circuit can be cascaded to be a 20 or 30-bit shift register.

Note 3: Latch-up voltage is the maximum voltage the output can sustain when switching an inductive load.

Note 4: DS3680 has a differential input circuit.

Note 5: DS8310 inverting, positive edge latching.

Note 6: DS8311 inverting, fall through latch.

Note 7: DS3668 35V, latch-up with output fault protection.

† Part available in military screening.

Display Drivers

MOS/LSI Display Drivers

National's comprehensive family of display drivers provides direct interface to all of the common display technologies—light-emitting diode (LED), liquid crystal display (LCD), and vacuum fluorescent (VF).

Function Similar Family

Each driver utilizes a simple serial-data input channel, on-chip shift register, latches and buffer/driver outputs. The serial input channel allows direct interface to most microprocessors, including COPS™, NSC800™, 8080 series, and TMS1000 series. Besides a serial-data input, each driver requires a clock input. Some offer a latch (data) input and/or data output for easy cascade interconnect of additional drivers.

Once loaded, the shift register data can be transferred to the on-chip latches, which then output to the buffer/driver and respective display. This buffer/driver is where each provides the unique driver interface desired by the particular display technology—LED, LCD, or VF.

The MM58241 Series—VF

Each of the products in the MM58241 series provides high-voltage (several up to 60V) drive of VF displays. All are ideal for direct or multiplexed interface to large complex VF panel arrays or 5 × 7 (or larger) dot-matrix character strings. Each of the drivers are cascadable for further expansion. Application note AN-371 provides further details and other application information.

The MM5450 Series—LED

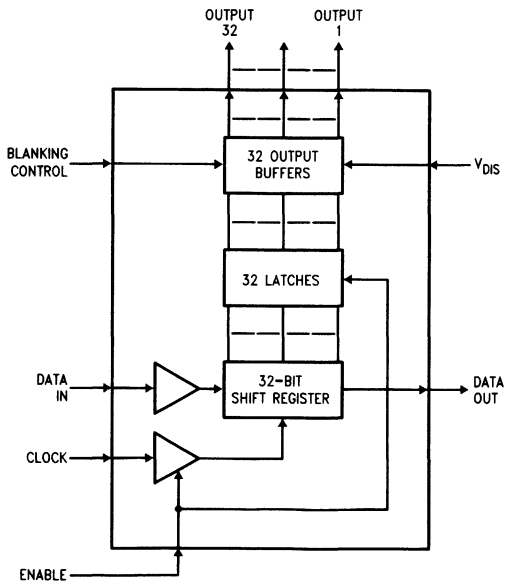
National's MM5450 series of LED display drivers rounds out this comprehensive product family. This popular series offers direct drive of LED displays by providing up to 25 mA of current drive per LED segment.

CMOS/LSI

Many of the products in the display driver family utilize CMOS technology and are further evidence of National's capabilities and commitment to CMOS/LSI—the technology of the '80s.

In addition, National offers a line of bipolar segment and digit drivers with a broad range of output sink and source currents.

Detailed features/functions of the 16-member display driver family are highlighted in the following product guide.



TL/MS/10278–1

Figure 1. Typical Block Diagram

LSI Display Driver Selection Guide

Display Technology	Product Number	Features
Vacuum Fluorescent (VF)	MM58241	32-segment, direct/multiplexed drive to 60V, data enable, brightness control, cascadable, 40-pin DIP or 44-pin PCC package.
VF	MM58242	20-digit, direct/multiplexed drive to 60V, data enable, brightness control, cascadable, 28-pin DIP or PCC package.
VF	MM58248	35-segment, direct/multiplexed drive to 60V, pin-compatible to MM5448, 40-pin DIP or 44-pin PCC package.
VF	MM58341	32-segment, direct/multiplexed drive to 35V, data enable, brightness control, cascadable, 40-pin DIP or 44-pin PCC package.
VF	MM58342	20-digit, direct/multiplexed drive to 35V, data enable, brightness control, cascadable, 28-pin DIP or PCC package.
VF	MM58348	35-segment, direct/multiplexed drive to 35V, pin-compatible to MM5448, 40-pin DIP or 44-pin PCC package.
Liquid Crystal (LCD)	MM5452	32-segment, direct drive, serial-data input, data enable, on-chip backplane (B/P) oscillator, 40-pin DIP or 44-pin PCC package.
LCD	MM5453	33-segment, direct drive, serial-data input, B/P oscillator, 40-pin DIP or 44-pin PCC package.
LCD	MM5483	31-segment, direct drive, serial-data input/output, latch (data) control, 40-pin DIP or 44-pin PCC package.
LCD	MM58201	Multiplexed drive, 192 segments (8 backplanes, 24 segments), 192-bit RAM, cascadable, R/C oscillator, serial-data input/output, 40-pin DIP or 44-pin PCC package.
Light-Emitting Diode (LED)	MM5450	34-segment, direct drive up to 25 mA, brightness control, data enable, 40-pin DIP or 44-pin PCC package.
LED	MM5451	35-segment, direct drive up to 25 mA, brihtness control, 40-pin DIP or 44-pin PCC package.
LED	MM5480	23-segment, direct drive up to 25 mA, serial-data input, brightness control, 28-pin DIP package.
LED	MM5481	14-segment, direct drive up to 25 mA, serial-data input, brightness control, 20-pin DIP package.
LED	MM5484	16-segment, direct drive up to 10 mA, serial-data input/output, cascadable, 22-pin DIP package.
LED	MM5486	33-segment, direct drive up to 25 mA, serial-data input/output, brightness control, latch (data) control, 40-pin DIP package.

Bipolar Display Driver Selection Guide

LED Display Segment Drivers

Device Number and Temperature Range		Drivers/ Package	I_O/Segment (mA)		V_{MAX}(V)		Comments
			Sink* (Common Anode)	Source (Common Cathode)	Input	Supply	
0°C to +70°C	−55°C to +125°C						
DS75491		4	50	50	15	10	
DS75493	DS55493	4		30	10	10	Programmable Constant Current
DS8654		8		50	36	36	

*Digit drivers with output sink capability may be used to drive segments of "common anode" displays.

LED Display Digit Drivers

Device Number and Temperature Range		Drivers/ Package	I_O/Digit (mA)		V_{MAX}(V)		Comments
			Sink* (Common Anode)	Source (Common Cathode)	Input	Supply	
0°C to +70°C	−55°C to +125°C						
DS75491		4		50	10	10	
DS75494	†DS55494	6	150		10	10	Enable Control
DS75492		6	250		10	10	
DS8870		6	350		10	10	DS75492 Pinout, Darlington Output
DS8863		8	500		15	10	
DS8963			500		23	18	
DS8654				50	36	36	
DS8874			50		10	10	Serial Shift Register Input
DS8973			100		10	10	3-Cell Operation—Low Battery Indicator
DS3654		10	400		9.5	45	Serial Input

Gas Discharge Display Drivers

Device Number and Temperature Range		Device Type	Drivers/ Package	Comments
0°C to +70°C	−55°C to +125°C			
DS8880	DS7880	Cathode Drivers	7	BCD to 7-Segment
DS8884A			7	BCD to 7-Segment with Comma and DP

Vacuum Fluorescent Display Drivers

Device Number and Temperature Range		Device Type	Drivers/ Package	Comments
0°C to +70°C	−55°C to +125°C			
DS8654		Ground Driver (segments)	8	7-Segment plus DP
DS8654		Anode Driver (digit)	8	

Memory Support

MOS memory devices today can be found in a variety of configurations, giving design engineers more flexibility than ever before. National Semiconductor offers a variety of key devices that will allow a user to easily implement memory designs which meet his or her particular requirements.

National's memory support circuits include clock drivers, 4k and 16k RAM address drivers, data I/O circuits, and timing and control drivers. Further information on the specific device types may be found in application note AN-76, "Applying Modern Clock Drivers to MOS Memories".

In addition to memory support applications, this family of products provides the versatility of general use in typical applications including level translation of TTL/CMOS input levels to high voltage (24V) outputs with high capacitive (1000 pF) drive, power drivers, relay driver and sense amplifier. Detailed features/function of this series of drivers are highlighted in the following product guide.

Memory Support Circuits

Temperature Range		Driver/ Package	TRI-STATE®/ Strobed	Output High Voltage (V)	Propagation Delay Typ. (ns)	Capacitive Load (PS)	Supply Current (mA)
0°C to +70°C	−55°C to +125°C						
DP84240		8	TRI-STATE	5.5	20	500	125
DP84244		8	TRI-STATE	5.5	20	500	150
DS0025C		2		20	25	1000	
DS0026C	†DS0026	2		20	7.5	1000	80
DS0056C	†DS0056	2		20	7.5	1000	80
DS3245		4	STROBED	12	11	200	30
DS3628	DS1628	8	TRI-STATE	5.5	6.5	500	120
DS3647A		4	TRI-STATE	5.5	8	50	140
DS3648	DS1648	4	TRI-STATE	5.5	9	500	60
DS3678	DS1678	4	TRI-STATE	5.5	9	500	60
DS3649	†DS1649	6	TRI-STATE	5.5	8	500	75
DS3679	DS1679	6	TRI-STATE	5.5	8	500	75
DS3651	DS1651	4	STROBED	5.5	23	50	60
DS36149	DS16149	6	STROBED	5.5	13	500	60
DS36179	†DS16179	6	STROBED	5.5	13	500	60
DS75325	DS55325	4		24	25	25	70
DS75361		2	STROBED	24	11	390	24
DS75365		4	STROBED	24	31	200	47
DS9643/μA9643		2	STROBED	12	9	300	19

† Part available with military screening

Microprocessor Support

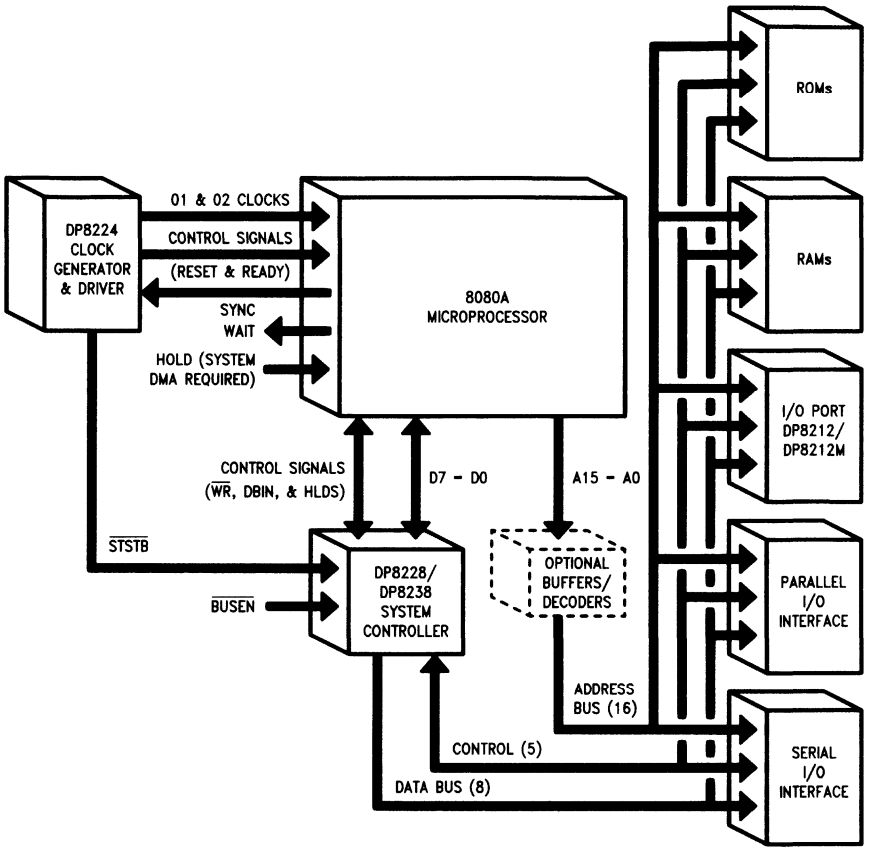
National offers a selection of high quality circuits designed specifically to interface with, and support, the very popular 8-bit 8080A microprocessor. National's family of 8080A support circuits includes clock/generator driver, system controller, I/O port and databus transceivers, all of which make it easy to add microprocessor capability to any system design. For further information on these devices, refer to the enclosed selection guide.

Microprocessor Support Circuits

Temperature Range		8080	General	
0°C to +70°C	−55°C to +125°C	CPU	Purpose	Description
DP8212	DP8212M	•	•	8-Bit I/O Port
DP8216	†DP8216M	•	•	4-Bit Parallel Receiver/Driver
DP8226	DP8226M			
DP8224		•		Clock Generator/Driver
DP8228	†DP8228M	•		System Controller Bus Driver
DP8238	†DP8238M			
DP8303A			•	8-Bit 48 mA Bus Transceiver
DP8304B	DP7304B		•	8-Bit 48 mA Bus Transceiver
DP8307A			•	8-Bit 48 mA Bus Transceiver
DP8308	DP7308		•	8-Bit 48 mA Bus Transceiver
MM74C373	MM54C373		•	Octal D-Type Latch
MM74C374	MM54C374		•	Octal D-Type Flip-Flop
MM74C922	MM54C922		•	16-Key Encoder
MM74C923	MM54C923		•	20-Key Encoder
DM74LS373	DM54LS373		•	Octal Transparent D Latch
DM74LS374	DM54LS374		•	Octal Edge-Triggered D Flip-Flop

† Part available with military screening.

National's 8080A Support Circuits



TL/MS/10280-1

Level Translators/Buffers

Several different families of logic circuits are available today, each offering advantages in certain applications. This wide selection of circuit types allows the design engineer to more easily construct functions and systems which meet his specific requirements.

Each of these logic "families", however, is produced using different processes, and their specific electrical characteristics are almost always different. Interfacing between these logic families can, at times, be difficult.

National Semiconductor offers a selection of level translators which can greatly simplify this task. The following selection guide outlines the level translator circuits available.

Device Number					
0°C to +70°C	−55°C to +125°C	Logic Function	Output Characteristics	Output	Input
DP8480A		Inverting	TRI-STATE Fall Through Latch	TTL	10k ECL
DP8481		Inverting	Gated Fall Through Latch	10k ECL	TTL
DP8482A		Inverting	TRI-STATE Fall Through Latch	TTL	10k ECL
DP8483		Inverting	Gated Fall Through Latch	100k ECL	TTL
DS3630	DS1630	Hex Buffer	50 ns Prop. Delay at 500 pF	CMOS	CMOS
DS8800	†DS7800	Dual 2-Input Gate	Open-Collector −30V to +30V	PMOS	TTL
DS88L12	DS78L12	Hex Inverter	Active Pull-Up 0.4V to 14V	MOS	TTL
MM74C901	†MM54C901	Hex Inverter	Active Pull-Up 0.4V @ 2.6 mA	TTL	CMOS
MM74C902	†MM54C902	Hex Buffer	Active Pull-Up 0.4V @ 3.2 mA	TTL	CMOS
MM74C903	MM54C903	Hex Inverter	Active Pull-Up 0V to 15V	PMOS	CMOS
MM74C904	MM54C904	Hex Buffer	Active Pull-Up 0V to 15V	PMOS	CMOS
MM74C906	†MM54C906	Hex Buffer	Open Drain 0V to 15V	NMOS	CMOS
MM74C907	†MM54C907	Hex Buffer	Open Drain V_{CC} to V_{CC} − 15V	PMOS	CMOS

† Part available with military screening.

Frequency Synthesis

Frequency synthesis is the process of generating a multitude of different frequencies from one reference frequency. A common application where the frequency synthesis concept is used is in electronically tuned radios and televisions.

Digital tuning systems are fast replacing the conventional mechanical systems in AM, FM and television receivers. The digital approach encompasses the following operational features:

- Precise tuning of station frequencies
- Exact digital frequency display
- Keyboard entry of desired frequency
- Virtually unlimited station memory
- Up/down scanning through the band
- Station "search" (stop on next active station)
- Power-on to the last station
- Easy option for time-of-day clock

In addition, recent developments in large-scale integrated circuit technology and new varactor diodes for the AM band have made the cost-benefit picture for digital tuning very attractive.

The heart of any digital tuning system is, of course, the phase locked loop (PLL) synthesizer. The basic subcomponents of a digital system are: a voltage controlled oscillator (VCO), a phase comparator and some programmable and fixed dividers. The PLL's basic function is to take two input signals and match them as illustrated in Figure 1. The output of the phase comparator of the PLL is an error signal which is filtered and fed back to the VCO as a DC control voltage. The DC control voltage adjusts the VCO until it causes the phase comparator's two inputs to match one another.

The weak point of this simple illustration is that many PLLs are fabricated using MOS processes which make them relatively incapable of receiving high frequency signals. In fact, state-of-the-art microCMOS devices are usually limited to 100 MHz operation. Even the FM band exceeds this limitation. As a result, a prescaler is almost always used in PLL tuning applications such as FM radios, police scanning radios, aircraft radios, etc. The prescaler is specifically designed to divide high frequency AC input signals down to a usable frequency for the PLL. The prescaler becomes an extension of the PLL's programmable counter as illustrated in Figure 2.

For less sophisticated tuning applications, a fixed division prescaler will make the VCO signal palatable to the PLL and be sufficient for general tuning characteristics. However, in some applications, a fixed division prescaler can cause significant undesirable side effects such as:

1. Increased channel spacing (step size) at the output of the PLL's counter; or
2. A forced decrease of the fixed oscillator reference frequency, to obtain specific channel spacing which can lead to
   A. increased lock-on time
   B. decreased scanning rates, and
   C. sidebands at undesirable frequencies

AN-335 in the Interface databook explains in detail how these two shortcomings of fixed division prescaling are alleviated by using a dual modulus prescaler. A dual modulus prescaler is substituted for the fixed prescaler and is controlled by programmable counters in the dual modulus PLL, as illustrated by the dotted line in Figure 2.

In order to address the requirements of digital frequency synthesis applications, National has introduced a growing family of PLL synthesizers and prescalers. The DS8906, DS8907 and DS8908 are complete PLL synthesizers with features that go beyond those illustrated in Figure 2.

Highlights

- The DS8908 integrates a reference oscillator, phase comparator, charge pump, operational amplifier, 120 MHz ECL/I^2L dual modulus programmable divider, and a shift register/latch for serial data entry.
- The DS8614, DS8615, DS8616, DS8617, DS8627, and DS8628 represent a broad family of single and dual modulus prescalers for use in conjunction with other manufacturers' NMOS or CMOS PLLs. These low-power/high-speed prescalers are available with division ratios ranging from a fixed $\div 20$ up to a dual modulus $\div 64/65$. This array of products allows for the choice of a division ratio which is virtually tailored to the speed and tuning requirements of a particular frequency synthesis application.

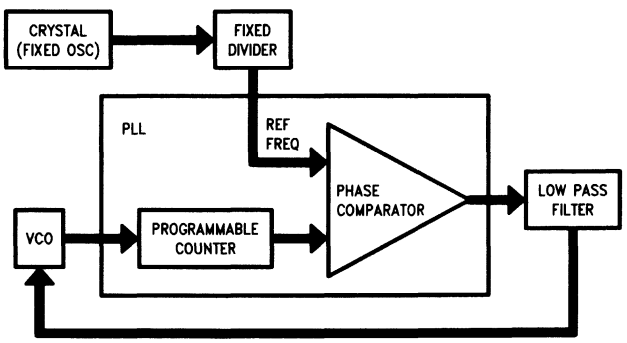


Figure 1

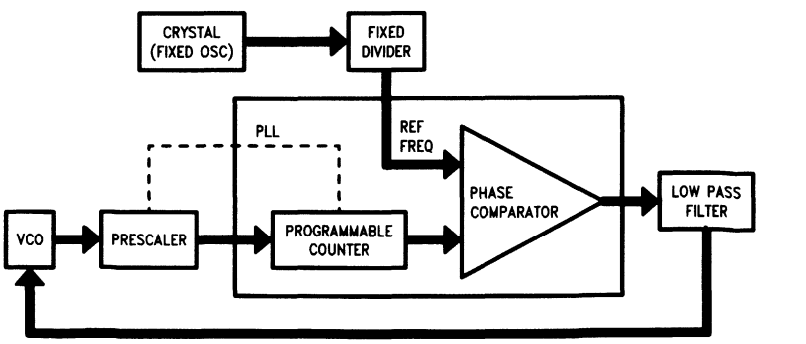


Figure 2

Frequency Synthesizers Selection Guide

PLL Frequency Synthesizers

Product Type	Frequency Bands	Power (mA)	Tuning Resolution
DS8906	AM/FM	160	500 Hz/12.5 kHz
DS8907	AM/FM	160	10 Hz/25 kHz
DS8908	AM/FM	160	1 kHz, 9 kHz, 10 kHz, 20 kHz
DS8911	AM/FM/VHF TV	35	FM; 10, 12.5, 25, 100 kHz AM; 1, 1.25, 2.5, 10 kHz

High Frequency Prescalers

Product Type	Divide Modulus	Power (mA)	f_{MAX}
Single (Fixed) Modulus Dividers			
DS8627	÷ 24	7/10	130/225 MHz
DS8628	÷ 20	7/10	130/225 MHz
DS8629	÷ 100	135	30/120 MHz
Dual-Modulus Dividers			
DS8614	÷ 20/21	7/10	130 MHz
DS8615	÷ 32/33	7/10	130 MHz
DS8616	÷ 40/41	7/10	130 MHz
DS8617	÷ 64/65	7/10	130 MHz

Section 6
Linear

Section 6 Contents Linear

Linear

National Semiconductor and Linear ICs are synonymous. Why do so many people associate Linear with National Semiconductor?

One reason is the large number of Linear ICs we ship every year. Another reason is the large number of Linear ICs that were designed and brought into production by National Semiconductor, such as the LM324, LM358, LM311, LM317 and many others.

The total market for Linear ICs continues to grow in spite of digital designs replacing many analog systems. The reason for the growing Linear market is the pervasiveness of ICs into all product areas and new innovative Linear circuits that allow an increasingly digital electronic world to interface with the real world, which is analog.

Linear—Military/AeroSpace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Application Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN slash sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN slash sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

Many of National Semiconductor's commercial linear ICs listed in the following pages are also offered as military qualified devices and are indicated by a "†" preceding the part number. Military products are offered in a variety of flows including MIL-STD-883, SMD (Standard Military Drawing), and MIL-M-38510. For more information, consult the 1989 Military/Aerospace Selection Guide.

Please note that National Semiconductor offers many commercial linear ICs which operate over the military temperature range (−55°C to +125°C). These devices are NOT military quality products. Military devices are indicated by a "†" preceding the part number.

Series Regulators

Voltage Regulators

Adjustable Positive Voltage Regulators

Amps	Device	Output Voltage	Package
10.0	LM196K	1.25V–15V	TO-3
	LM396K	1.25V–15V	TO-3
5.0	†LM138K	1.2V–32V	TO-3
	LM338K, T	1.2V–32V	TO-3, TO-220
3.0	†LM150K	1.2V–33V	TO-3
	LM350K, T	1.2V–33V	TO-3, TO-220
1.5	†LM117K	1.2V–37V	TO-3
	†LM117HVK	1.2V–57V	TO-3
	LM317K, T	1.2V–37V	TO-3, TO-220
	LM317HVK	1.2V–57V	TO-3
1.0	LM78GCT*	5V–30V	TO-220 (4 Pin)
0.5	†LM117H	1.2V–37V	TO-39
	†LM117HVH	1.2V–57V	TO-39
	LM317H	1.2V–57V	TO-39
	LM317HVH	1.2V–37V	TO-39
	LM317MP	1.2V–37V	TO-202
	LM78MGCT*	5V–30V	TO-220 (4-Pin)
0.2	†LH0075G, CG	0–27V	TO-8
0.1	LM317LZ, M	1.2V–37V	TO-92, SO-8
	LM2931CT	3.0V–24V	TO-220, 5-LEAD
	†LP2951CN, J, H, M	1.24V–29V	DIP, CERDIP, HEADER, SO-8

Adjustable Negative Voltage Regulators

Amps	Device	Output Voltage	Package
3.0	LM133K	−1.2V – −32V	TO-3
	LM333K, T	−1.2V – −32V	TO-3, TO-220
1.5	†LM137K	−1.2V – −37V	TO-3
	†LM137HVK	−1.2V – −47V	TO-3
	LM337K, T	−1.2V – −37V	TO-3, TO-220
	LM337HVK	−1.2V – −47V	TO-3
1.0	LM79GCT*	−2.2V– −30V	TO-220 (4-Pin)
	†LM137H	−1.2V – −37V	TO-39
	†LM137HVH	−1.2V – −47V	TO-39
	LM337H	−1.2V – −37V	TO-39
	LM337HVH	−1.2V – −47V	TO-39
	LM337MP	−1.2V – −37V	TO-202
0.5	LM79MGCT*	−2.2V– −30V	TO-224 (4 Pin)
0.2	†LH0076G, CG	0–27V	TO-8
0.1	LM337LZ, M	−1.2V – −37V	TO-92, SO-8

*These products were formerly manufactured by Fairchild Semiconductor Corporation. The prefixes have been changed from μA to LM and may be found with the former prefix as well as the latter.

†Military qualified device. More more information, consult the 1989 Military/Aerospace Selection Guide.

Voltage Regulators (Continued)

Fixed Positive Voltage Regulators

Amps	Device	Output Voltage	Package
3.0	†LM123K	5V	TO-3
	LM323K	5V	TO-3
1.0	†LM109K	5V	TO-3
	†LM140AK	5V, 12V, 15V	TO-3
	†LM140K	5V, 12V, 15V	TO-3
	†LM2940T	5V, 8V, 10V, 12V	TO-220
	LM2940CT	5V, 12V, 15V	TO-220
	LM309K	5V	TO-3
	LM340AK, T	5V, 12V, 15V	TO-3, TO-220
	LM340K, T	5V, 12V, 15V	TO-3, TO-220
	LM78xxCK, T**	5V, 6V, 8V, 12V, 15V, 18V, 24V	TO-3, TO-220
0.5	LM2984CT	5V, 12V, 15V	TO-220, TO-202
	LM341T, P	5V, 12V, 15V	TO-220, TO-202
	LM78MxxCT, H**	5V, 6V, 8V, 12V, 15V, 24V	TO-220, TO-39
0.2	†LM109H	5V	TO-39
	LM309H	5V	TO-39
	LM342P	5V, 12V, 15V	TO-202
0.15	LM2930T	5V, 8V	TO-220
0.1	†LM140LAH	5V, 12V, 15V	TO-39
	LM2931Z, T	5V	TO-92, TO-220
	LM340LZ, H	5V, 12V, 15V	TO-92, TO-39
	LM78LxxACZ, H, M**	5V, 6.2V, 8.2V, 9V, 12V, 15V	TO-92, TO-39, SO-8
	LP2950CZ	5V	TO-92
0.05	LM2936Z	5V	TO-92

Fixed Negative Voltage Regulators

Amps	Device	Output Voltage	Package
3.0	†LM145K	−5V, −5.2V	TO-3
	LM345K	−5V, −5.2V	TO-3
1.5	†LM120K	−5V, −12V, −15V	TO-3
	LM320K, T	−5V, −12V, −15V	TO-3, TO-220
	LM79xxCT, K**	−5V, −8V, −12V, −15V	TO-220, TO-3
0.5	LM320MP	−5V, −12V, −15V	TO-220
	LM79MxxCT, H**	−5V, −8V, −12V, −15V	TO-220, TO-39
0.2	†LM120H	−5V, −12V, −15V	TO-39
	LM320H	−5V, −12V, −15V	TO-39
0.1	LM320LZ	−5V, −12V, −15V	TO-92
	LM79LxxACZ, M	−5V, −12V, −15V	TO-92, SO-8

*The LM320 has better electrical characteristics than the LM79xx.

LM100 Series +55°C to +150°C

LM300 Series 0°C to +125°C

**These products were formerly manufactured by Fairchild Semiconductor Corporation. The prefixes have been changed from μA to LM and may be found with the former prefix as well as the latter.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Voltage Regulators (Continued)

Low Dropout Regulators

Amps	Device	Output Voltage	Package
0.050	LM2936Z	5V	TO-92
0.100	LM2931T, Z	5V, ADJ	TO-220, TO-92
	LP2950CZ	5V	TO-92
	LP2951N, J, H	ADJ	DIP, CERDIP, HEADER
0.150	LM2930T	5V, 8V	TO-220
0.500	LM2984CT	TRIPLE 5V + WATCHDOG	TO-220, 11-LEAD
0.750	LM2925T	5V WITH DELAYED RESET	TO-220, 5-LEAD
	LM2935T	DUAL 5V	TO-220, 5-LEAD
1.0	†LM2940T	5V, 8V, 10V, 12V	TO-220
	LM2940CT	5V, 12V, 15V	TO-220

*Future Product

Shunt Regulators

Amps	Device	Output Voltage	Package
0.15	LM431ACZ, M	2.5V–36V	TO-92, SO-8

Switching Regulators

Amps	Device	Operation Modes	V_{IN} Range	Package
7.0	†HS7107CK	Step-Down, Invert, Flyback	10V–100V	TO-3
	†HS7067CK	Step-Down, Invert, Flyback	10V–60V	TO-3
5.0	LH1605CK	Step-Down		TO-3
1.5	†LM78S40CN	Step-Up, Step-Down, Invert	2.5V–40V	16-Pin DIP
0.75	†LM1578H LM2578H LM3578N, H	Step-Up, Step-Down, Invert, Flyback	2V–40V	TO-39, 8-Pin DIP
0.05	LMC7660IN	Invert	1.5V–10V	8-Pin DIP

Switching Controllers

Device	Title	Package
LM1524/2524/3524	Swithing Regulator	16-Pin Plastic DIP, SO-16 16-Pin Ceramic DIP
LM1525A/3525A	Switching Regulator	16-Pin Plastic DIP 16-Pin Ceramic DIP
LM1527A/3527A	Switching Regulator	16-Pin Plastic DIP 16-Pin Ceramic DIP
LM494	Pulse Width Modulated Control Circuit	16-Pin Plastic and Ceramic DIP

Building Block Regulators

Device	Title	Package
†LM104/204/304	Negative Regulator	TO-39
†LM105/205/305	Voltage Regulator (Positive)	TO-39
LM376	Voltage Regulator (Positive)	8-Pin Plastic DIP
†LM723	Voltage Regulator	14-Pin DIP, TO-39

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Amplifiers

General Purpose Operational Amplifier

Part #	V_{OS} mV (Max)	I_B nA (Max)	GBW MHz (Typ)	Slew Rate V/μs (Typ)	Supply Current (Note 3) mA (Max)	Supply Voltage Min V	Supply Voltage Max V	Special Features
Military Temperature Range (−55°C to +125°C) Specs at T_A = 25°C (Note 1)								
†LH0044A	0.025	15	0.4	0.06	3	±3	±20	
LM607A	0.025	2	1.8	0.7	1.5	*	±22	Improved OP-07
†LH0044	0.05	30	0.4	0.06	4	±3	±20	
LM607B	0.05	3	1.8	0.7	1.5	*	±22	Improved OP-07
†μA714/LM714**	0.075	3	0.6	0.17	4	±3	±22	OP-07 Replacement
†LM11	0.3	0.05	*	0.3	0.6	*	±20	
LF411A	0.5	0.2	4	15	2.8	±6	±22	
LF441A	0.5	0.05	1	1	0.2	±6	±22	
†LH0052	0.5	0.003	1	3	3.5	±5	±22	
†LM108A	0.5	2	1	0.3	0.4	±2	±20	
LF412A	1	0.2	4	15	5.6	±6	±22	Dual BI-FET™
LF442A	1	0.05	1	1	0.4	±6	±22	Dual BI-FET™
†LH0004	1	100	*	*	0.15	±5	±45	
LM604A	1	40	7	2	8	4	36	Multiplexed Op Amp
†LF155A	2	0.05	2.5	5	4	±5	±22	
†LF156A	2	0.05	5	12	7	±5	±22	
†LF157A	2	0.05	25	50	7	±5	±22	Minimum Gain of 5
†LF411	2	0.2	4	15	3.4	±6	±18	
LMC660A	2	0.02	1.5	1.7	2.2	5	15	Quad CMOS
†LM10	2	20	*	*	0.4	(Note 4)		Op Amp + Reference
†LM101A	2	75	1	0.5	3	±3	±22	
†LM107	2	75	1	0.5	3	±3	±22	
†LM108	2	2	1	0.3	0.4	±2	±20	
†LM112	2	2	1	0.2	0.6	±2	±20	Compensated LM108
†LM124A	2	50	*	*	3	3	32	Quad
†LM158A	2	50	*	*	1.2	3	32	Dual
LP124	2	4	0.1	0.05	0.13	3	32	Quad
LH0020	2.5	250	*	*	5	±5	±22	
†LM6165	3	3,000	725	300	6.5	4.75	32	MILTEMP VIP, AV = 25
†LF412	3	0.2	4	15	6.8	±6	±22	Dual
†LM741A	3	80	1.5	0.7	2.8	±3	±22	
†LH0022	4	0.01	1	3	3.5	±5	±22	
†LF155	5	0.1	2.5	5	4	±5	±22	
†LF156	5	0.1	5	12	7	±5	±22	
†LF157	5	0.1	20	50	7	±5	±22	Minimum Gain of 5
†LF147	5	0.2	4	13	11	±6	±22	Quad BI-FET™
†LF412	5	0.2	4	15	6.8	±6	±18	Dual BI-FET™

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

General Purpose Operational Amplifier (Continued)

Part #	V_{OS} mV (Max)	I_B nA (Max)	GBW MHz (Typ)	Slew Rate V/μs (Typ)	Supply Current (Note 3) mA (Max)	Supply Voltage Min V	Supply Voltage Max V	Special Features
Military Temperature Range (−55°C to +125°C) Specs at T_A = 25°C (continued)								
†LF442	5	0.1	1	1	0.5	±6	±18	Dual BI-FET™
LF444A	5	0.1	1	1	0.80	±6	±22	Quad BI-FET™
LH0086	5	0.5	3	10	15.5	±8	±18	Programmable Gain OA
μA776/LM776**	5	50	*	0.8	0.18	±1.2	±18	Programmable
†LM124	5	150	*	*	3	3	32	Quad
†LM143	5	20	1	2.5	4	±4	±40	
†LM144	5	20	1	2.5	4	±4	±40	Minimum Gain of 10
†LM146	5	100	1.2	0.4	2	±1.5	±22	(Note 5)
†LM148	5	100	1	0.5	3.6	±5	±22	Quad
†LM149	5	100	4	2	3.6	±5	±22	Minimum Gain of 5, Quad
†LM158	5	150	*	*	1.2	3	32	Dual
LM192	5	150	*	*	2	3	32	Comparator + Op Amp
†LM741	5	500	*	0.5	2.8	±3	±22	
†LM1558	5	500	*	*	5	±3	±22	Dual
†LM4250	5	50	0.2	0.2	0.1	±1	±18	(Note 5)
†LH0042	20	0.025	1	3	3.5	±5	±22	
Automotive Temperature Range (−40°C to +85°C)								
LM604	3	60	7	3	9	4	36	Multiplexed Op Amp
LP2902	4	20	0.1	0.05	0.15	3	26	Quad
LM2902	7	250	*	*	3	3	26	Quad
LM2904	7	250	*	*	2	3	26	Quad
LM2924	7	250	*	*	2	3	26	Comparator + Op Amp
Industrial Temperature Range (−25°C to +85°C) (Note 1)								
LM637	0.025	10	65	14	4.5	±3.5	±18	Improved OP-37
LM627	0.025	10	14	4.5	4.5	±3.5	±18	Improved OP-27
LMC669B	0.025	0.1	*	*	6	±8	±22	Autozero Block
LH0044B	0.05	30	0.4	0.06	4	±3	±20	
LH0044C	0.05	30	0.4	0.06	4	±3	±20	
LMC669C	0.05	0.1	*	*	6	±8	±22	Autozero Block
LM208A	0.5	2	1	0.3	0.6	±2	±20	
LH0052C	1	0.005	1	3	3.8	±5	±22	
LMC660A	2	0.02	1.5	1.7	2.2	5	15	Quad CMOS
LM10B(L)	2	20	*	*	0.4	(Note 4)		Op Amp + Reference
LM201A	2	75	1	0.5	3	±3	±22	
LM207	2	75	1	0.5	3	±3	±22	
LM208	2	2	1	0.3	0.6	±2	±20	
LM212	2	2	1	0.3	0.6	±2	±20	Compensated LM208
LM224A	3	80	*	*	2	3	32	Quad

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

General Purpose Operational Amplifier (Continued)

Part #	V_{OS} mV (Max)	I_B nA (Max)	GBW MHz (Typ)	Slew Rate V/μs (Typ)	Supply Current (Note 3) mA (Max)	Supply Voltage Min V	Supply Voltage Max V	Special Features
Industrial Temperature Range (−25°C to +85°C) (continued)								
LM258A	3	80	*	*	1.2	3	32	Dual
LF255	5	0.1	2.5	5	4	±5	±22	
LF256	5	0.1	5	12	7	±5	±22	
LF257	5	0.1	20	50	7	±5	±22	Minimum Gain of 5
LM224	5	150	*	*	2	3	32	Quad
LM258	5	150	*	*	1.2	3	32	Dual
LM292	5	250	*	*	2	3	32	Comparator + Op Amp
LH0020C	6	500	*	*	6	±5	±22	
LH0022C	6	0.025	1	3	4	±5	±22	
LM246	6	250	0.5	0.4	2.5	±2	±18	(Note 5)
LM248	6	200	1	0.5	4.5	±5	±18	Quad
LM249	6	200	4	2	4.5	±5	±18	Minimum Gain of 5, Quad
LH0086C	10	0.5	3	10	15.5	±8	±18	Programmable Gain 1 to 200
LH0042C	20	0.05	1	3	4	±5	±22	
Commercial Temperature Range (0°C to +70°C) (Notes 1 and 2)								
LMC669B	0.025	0.1	*	*	6	±8	±22	Autozero Block
LM607A	0.025	2	1.8	0.7	1.5	*	±22	Improved OP-07
LMC669C	0.05	0.1	*	*	6	±8	±22	Autozero Block
LM607B	0.05	3	1.8	0.7	1.5	*	±22	Improved OP-07
μA714/LM714**	0.075	5.5	0.6	0.17	4	±3	±22	OP-07 Replacement
LM607	0.15	10	1.8	0.7	1.8	*	±22	Improved OP-07
LF411A	0.5	0.2	4	15	2.8	±6	±22	
LF441A	0.5	0.05	1	1	0.2	±6	±22	
LM308A	0.5	7	1	0.3	0.8	±2	±20	
LM11C	0.6	0.1	*	0.3	0.8	*	±20	
LF412A	1	0.2	4	15	5.6	±6	±22	Dual
LF442A	1	0.05	1	1	0.4	±6	±22	Dual
LM604A	1	40	5	3	9	4	36	Multiplexed Op Amp
LF355A	2	0.05	2.5	5	4	±5	±22	
LF356A	2	0.05	5	12	10	±5	±22	
LF357A	2	0.05	20	50	10	±5	±22	Minimum Gain of 5
LF411	2	0.2	4	15	3.4	±6	±22	
LF412	3	0.2	4	15	6.8	±6	±22	Dual
LM324A	3	100	*	*	3	3	32	Quad
LM358A	3	100	*	*	2	3	32	Dual
LM604	3	60	5	7	9	4	36	Multiplexed Op Amp
LM741E	3	80	1.5	0.7	2.8	±3	±22	
LMC662	3	0.02	1.4	1.1	1.3	4.75	15.5	Dual CMOS

General Purpose Operational Amplifier (Continued)

Part #	V_{OS} mV (Max)	I_B nA (Max)	GBW MHz (Typ)	Slew Rate V/μs (Typ)	Supply Current (Note 3) mA (Max)	Supply Voltage Min V	Supply Voltage Max V	Special Features
Commercial Temperature Range (0°C to +70°C) (continued)								
LM10C(L)	4	30	*	*	0.5	(Note 4)		Op Amp + Reference
LP324	4	10	0.1	0.05	0.15	3	32	
LF347B	5	0.2	4	13	11	±6	±22	Quad
LF355B	5	0.1	2.5	5	4	±5	±22	
LF356B	5	0.1	5	12	4	±5	±22	
LF357B	5	0.1	20	50	7	±5	±22	
LF441	5	0.1	1	1	0.25	±6	±22	
LF442	5	0.1	1	1	0.5	±6	±22	Dual
LM11CL	5	0.2	*	0.3	0.8	*	±20	
LM392	5	250	*	*	2	3	32	
LF451	5	0.02	4	13	3.4	10	32	SO Pkg BI-FET™
LF453	5	0.02	4	13	6.5	10	32	SO Pkg Dual BI-FET™
LM611	5	35	1.4	0.7	0.3	3	36	Single Supply Amp + Ref
LM613	5	35	0.8	0.7	1	3	36	20 Op Amps + 2 Comparators + Ref
LM614	5	35	0.79	0.74	1	3	36	Quad Op Amp + Ref
LM833	5	1000	10	5	8	*	±18	Dual Low Noise
LMC660	6	0.02	1.5	1.7	2.7	5	15	Quad CMOS
μA776/LM776**	6	50	*	0.8	0.19	±1.2	±18	Programmable
LM346	6	250	0.5	0.4	2.5	±1.5	±22	(Note 5)
LM348	6	200	1	0.5	4.5	±5	±18	
LM349	6	200	4	2	4.5	±5	±18	
LM741C	6	500	1.5	0.5	2.8	±3	±18	
†μA4136/LM4136**	6	500	3	1	11.3		±18	Quad
LM1458	6	500	*	*	5.6	±3	±18	
LM4250C	6	75	0.2	0.2	0.1	±1	±18	(Note 5)
LM324	7	250	*	*	3	3	32	
LM358	7	250	*	*	2	3	32	
LM301A	7.5	250	1	0.5	3	±3	±18	
LM307	7.5	250	1	0.5	3	±3	±18	
LM308	7.5	7	1	0.3	0.8	±2	±18	
LM312	7.5	7	1	0.2	0.8	±2	±18	Compensated LM308
LM343	8	40	1	2.5	5	±4	±34	
LM344	8	40	1	2.5	5	±4	±34	Minimum Gain of 10
LF347	10	0.2	4	13	11	±6	±18	Quad BI-FET™
LF351	10	0.2	4	13	3.4	±6	±18	
LF353	10	0.2	4	13	6.8	±6	±18	Dual BI-FET™
LF355	10	0.2	2.5	5	4	±5	±18	

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

General Purpose Operational Amplifier (Continued)

Part #	V_{OS} mV (Max)	I_B nA (Max)	GBW MHz (Typ)	Slew Rate V/μs (Typ)	Supply Current (Note 3) mA (Max)	Supply Voltage Min V	Supply Voltage Max V	Special Features
LF356	10	0.2	5	12	10	±5	±18	
LF357	10	0.2	20	50	10	±5	±18	Minimum Gain of 5
LF444	10	0.1	1	1	1	±6	±18	Quad BI-FET™
LF13741	15	0.2	1	0.5	4	*	±18	
TL081C	15	0.2	4	13	2.8	±6	±18	
TL082C	15	0.2	4	13	5.6	±6	±18	Dual BI-FET™

*Not Specified.

**Fairchild Op Amps.

Note 1: Datasheet should be referred to for test conditions and more detailed information.

Note 2: Those looking for a commercial part should also look at the Industrial Temp Range guide as many Hybrids are listed there.

Note 3: Supply current is for all amplifiers in a package.

Note 4: The LM10 has 2 versions: one a high voltage part, good to 45V and a low voltage part, good to 7V. Refer to the datasheet for more information.

Note 5: The LM146 and LM4250 are programmable amplifiers. The data shown is for $V_S = \pm 15V$ and $I_{SET} = 10\ \mu A$. Refer to the datasheets for more information.

Low I_{BIAS} Selection Guide

≤5 pA	≤20 pA	≤50 pA	≤100 pA	≤200 pA	≤500 pA	≤1 nA
$T_A = 25°C$						
†LH0022	LMC668	LH0032A	†LH0032	LF401A	LH4101	†LH4104
LH0022C	LMC660	†LF155A/156A	†LF155/156	LF401	LH0032C	
†LH0042	LMC662	†LF157A	†LF157	LF400A	LH0086	
LH0042C		LF355A/356A	LF255/256	LF400	LH0086C	
LH0052		LF357A	LF257	TL081		
LH0052C		LF441A	LF355B/356B	LH0032AC		
†LH0062		LF442A	LF357B	LF351		
		LF444A	†LF441	†LF411A/411		
		†LM11	†LF442	LF355/356		
			†LF444	LF357		
			LM11C	†LF147/347B/347		
			LH0062C	LF353		
				†LF412A/412		
				LF13741		
				LM11CL		
				LF451		
				LF453		

Note: Datasheet should be referred to for conditions and more detailed information.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

High Speed Operational Amplifier Selection Guide

Part #	Slew Rate V/μs (Typ)	GBW MHz (Typ)	V_{OS} mV (Max)	I_S mA (Max) (Note 1)	Notes
GBW ≥ 4 MHz, T_A = 25°C					
†LH0024	500	70	4	15	
†LH0032	500	70	2	20	FET Input
†LM6161	300	50	7	6.8	Unity Gain Stable, VIP™
†LM6164	300	175	4	6.8	Min Gain of 5, VIP™
†LM6165	300	725	3	6.8	Min Gain of 25, VIP™
LH4161	300	50	1	6.5	Precision VIP™
LH4162	300	50	2	13	Dual Precision VIP™
LH4101	250	45	15	40	Medium Power JFET
LH4106	170	34	15	20	VIP™ Op Amp + Buffer
μA715/LM715**	100	65	5	7	
LF400	70	16	0.5	12	Fast Settling JFET
LF401	70	16	0.2	12	Precision Fast Settling JFET
†LH0003	70	30	3	3	
†LH0062	70	15	5	8	FET Input
LM118	70	15	4	7	
LF157	50	20	2	7	Min Gain of 5, JFET
†LH4104	40	18	5	25	Medium Power Fast Settling JFET
LM359	30	30	*	22	Dual Current Mode (Norton) Amp
†LF411	15	4	0.5	2.8	JFET
†LF412	15	4	1.0	5.6	Dual JFET
LM637	14	65	0.025	4.5	Improved OP-37
LF147	13	4	5	11	Quad JFET
LF351	13	4	10	3.4	JFET
LF353	13	4	10	6.5	Dual JFET
LF451	13	4	5	3.4	BI-FET in SO Pkg
LF453	13	4	5	6.5	Dual BI-FET in SO Pkg
LF156	12	4.5	2	7	JFET
LM833	7	15	5	8	Dual Low Noise
LM627	4.5	14	0.025	4.5	Improved OP-27

*Not specified.

Note 1: Supply current is for all amplifiers in a package.

†Military qualified devices. For more information, consult the 1989 Military/Aerospace Selection Guide.

Medium and High Power Operational Amplifier Selection Guide (≥ 0.1A Output)

Part #	I_{OUT} A (Typ)	V_{OS} mV (Max)	I_S mA (Max)	Slew Rate V/μS (Typ)	PBW kHz (Typ)
†LH4104	0.1	5	25	40	*
LH4101	0.1	15	40	250	*
†LH0041	0.2	3	3.5	3	20
†μA759/LM759**	0.325	3	18	0.6	*
LH0061	0.5	4	10	25	1000
†LH0021	1.0	3	3.5	3	20
†LH0101	2	3	35	10	300
†LH0101	2	10	35	10	300
LM675	3	10	50	8	*
LM12	10	7	80	9	60

*Not Specified

Note 1: Refer to Datasheet for conditions and more detailed information.

†Military qualified product. For more information, consult the 1989 Military/Aerospace Selection Guide.

Buffers (Notes 1 and 2)

Device Type	−3 dB MHz (Typ)	V_{OS} mV (Max)	I_S mA (Max)	Voltage Gain (Typ)	V_{OUT} V (Min)	S. R. V/μs (Typ)	I_{OUT} mA (Typ)
†LM110	20	4	5.5	0.9999	±10	3.0	10
LH4001	25	50	10	0.97	±10	125	200
†LH0002	30	30	10	0.97	±10	200	100
LM6121/LM6125	50	30	16	0.99	±13.3	800	300
†LH0033	100	5	22	0.98	±9	1500	90
LH4009	150	25	60	0.92	±10	10,000	200
LH4011	150	25	68	0.95	±10	5,000	200
LH4008	180	25	68	0.95	±10	10,000	200
†LH4002	200	50	35	0.85	±3	1250	40
†LH0063	200	25	65	0.93	±10	2400	250
LH4012	490	50	75	0.98	±10	11,500	200

†Military qualified product. For more information consult the 1989 Military/Aerospace Selection Guide.

*Not specified

Note 1: Datasheet should be referred to for test conditions and more detailed information.

Note 2: 200°C Temp Range Parts are available. Consult local sales office for information.

Voltage Comparators Selection Guide

	Response Time (Typ) ns	V_{OS} mV(Max)	I_S mA(Max)	I_B nA(Max)	Comments
T_A = 25°C (Notes 1 and 2)					
μA6685/LM6685*	2.7	3	48	13,000	Ultra Fast
μA6687/LM6687*	2.7	2	76	10,000	Ultra Fast
μA685/LM685*	6.5	2	48	13,000	Latch Comparator
μA687/LM687*	8	3	83	10,000	Dual Comparator
†LM361	12	5	25	30,000	High Speed w/Strobes
†LM360	16	5	32	20,000	High Speed, Complementary Outputs
†μA760/LM760*	25	6	48	60,000	Diff High Speed
†LM306	40	5	10	25,000	High Speed, High Drive
†μA710/LM710*	40	2	16	20,000	High Speed Diff
†LM319	80	8	12.5	1000	High Speed Dual
†LF311	200	10	7.5	0.15	FET Input
†LM311	200	10	7.5	300	General Purpose Single
†LM339	1300	5	2	400	General Purpose Quad
LM392	1300	10	1	400	One Comparator Plus One Op Amp
†LM393	1300	5	2.5	250	General Purpose Dual
LM2903	1300	5	2.5	250	Automotive Dual
LM2901	1300	7	2	400	Automotive Quad
LP365	4000	9	0.30	200	Programmable Quad
LP311	4000	10	0.3	150	Low Power Single
LP339	5000	9	0.1	40	Low Power Quad

*Former Fairchild Comparators

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Note 1: Datasheet should be referred to for test conditions and more detailed information.

Note 2: This selection guide should be used to select for Response Time required. Industrial and Military Temperature Range types are available. The DC specs are for the lowest Commercial Grade available.

Instrumentation Amplifiers

Part Number	Gain Error (Max)	Gain Linearity (Typ)	CMRR dB (Min)	I_B nA (Max)
		$T_A = 25°C$		
†LH0036 μ Power	3%	0.03%	46	125
LH0038	3%	0.0001%	86	100
LH0084	0.3%	0.005%	80	0.500
LM363	2.5%	0.01%	90	10

Note 1: Datasheet should be referred to for test conditions and more detailed information.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Analog To Digital Converter

Part No.	Resolution (Bits)	Absolute Accuracy (Max)	Conversion Time	Input Voltage Range	Output Logic Levels	Supplies (V)	Temperature Range* M	I	C	Package	Comments
Analog To Digital Converter											
ADC0800	8	±2 LSB	50 μs	±5V	TTL, TRI-STATE	+5, −12	•		•	18-Pin DIP	
ADC0801	8	±¼ LSB	110 μs	5V	TTL, TRI-STATE	+5	•	•		20-Pin DIP	Differential Input
†ADC0802	8	±½ LSB	110 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin SO 20-Pin PCC	Differential Input
ADC0803	8	±½ LSB	110 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin SO 20-Pin PCC	Differential Input
ADC0804	8	±1 LSB	110 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP 20-Pin SO 20-Pin PCC	Differential Input
ADC0805	8	±1 LSB	110 μs	5V	TTL, TRI-STATE	+5		•		20-Pin DIP	Ratiometric Operation
ADC0808	8	±½ LSB	100 μs	5V	TTL, TRI-STATE	+5	•	•		28-Pin DIP 28-Pin PCC	8-Channel MUX
ADC0809	8	±1 LSB	100 μs	5V	TTL, TRI-STATE	+5		•		28-Pin DIP 28-Pin PCC	8-Channel MUX
ADC0811B	8	±½ LSB	32 μs	5V	TTL	+5		•	•	20-Pin DIP 20-Pin PCC	11-Channel Serial I/O
ADC0811C	8	±1 LSB	32 μs	5V	TTL	+5		•	•	20-Pin DIP 20-Pin PCC	11-Channel Serial I/O
ADC0816	8	±½ LSB	100 μs	5V	TTL, TRI-STATE	+5	•	•		40-Pin DIP	16-Channel MUX
ADC0817	8	±1 LSB	100 μs	5V	TTL, TRI-STATE	+5		•		40-Pin DIP	16-Channel MUX
ADC0819B	8	±½ LSB	16 μs	5V	TTL	+5		•	•	28-Pin DIP 28-Pin PCC	19-Channel Serial I/O
ADC0819C	8	±1 LSB	16 μs	5V	TTL	+5		•	•	28-Pin DIP 28-Pin PCC	19-Channel Serial I/O
ADC0820B	8	±½ LSB	1.2 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin SO 20-Pin PCC	Built-In Track and Hold Function
ADC0820C	8	±1 LSB	1.2 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin SO 20-Pin PCC	Built-In Track and Hold Function

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Analog To Digital Converter (Continued)

Part No.	Resolution (Bits)	Absolute Accuracy (Max)	Conversion Time	Input Voltage Range	Output Logic Levels	Supplies (V)	Temperature Range* M	I	C	Package	Comments
Analog To Digital Converter (Continued)											
ADC0829B	8	±½ LSB	100 μs	5V	TTL, TRI-STATE	+5		•		28-Pin DIP	Additional Digital Input Capability
ADC0829C	8	±1 LSB	100 μs	5V	TTL, TRI-STATE	+5		•		28-Pin DIP	Additional Digital Input Capability
ADC0831B	8	±½ LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	8-Pin DIP	Serial I/O
ADC0831C	8	±1 LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	8-Pin DIP	Serial I/O
ADC0832B	8	±½ LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	8-Pin DIP	2-Channel Serial I/O
ADC0832C	8	±1 LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	8-Pin DIP	2-Channel Serial I/O
ADC0833B	8	±½ LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	14-Pin DIP	4-Channel Serial I/O
ADC0833C	8	±1 LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	14-Pin DIP	4-Channel Serial I/O
ADC0834B	8	±½ LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	14-Pin DIP	4-Channel Serial I/O
ADC0834C	8	±1 LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	14-Pin DIP	4-Channel Serial I/O
ADC0838B	8	±½ LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP 20-Pin PCC	8-Channel Serial I/O
ADC0838C	8	±1 LSB	32 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP 20-Pin PCC	8-Channel Serial I/O
ADC0841B	8	±½ LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP 20-Pin PCC	Differential Input, Internal Clock
ADC0841C	8	±1 LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP 20-Pin PCC	Differential Input, Internal Clock
ADC0844B	8	±½ LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP	4-Channel MUX, Internal Clock
ADC0844C	8	±1 LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP	4-Channel MUX, Internal Clock
ADC0848B	8	±½ LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	28-Pin DIP 28-Pin PCC	8-Channel MUX, Internal Clock
ADC0848C	8	±1 LSB	40 μs	5V	TTL, TRI-STATE	+5		•	•	28-Pin DIP 28-Pin PCC	8-Channel MUX, Internal Clock
ADC1001C	10	±1 LSB	200 μs	5V	TTL, TRI-STATE	+5		•	•	20-Pin DIP	8-Bit Bus Compatible, Differential Input
ADC1005B	10	±½ LSB	50 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin PCC	8-Bit Bus Compatible, Differential Input

Analog To Digital Converter (Continued)

Part No.	Resolution (Bits)	Absolute Accuracy (Max)	Conversion Time	Input Voltage Range	Output Logic Levels	Supplies (V)	Temperature Range* M	I	C	Package	Comments
Analog To Digital Converter (Continued)											
ADC1005C	10	±1 LSB	50 μs	5V	TTL, TRI-STATE	+5	•	•	•	20-Pin DIP 20-Pin PCC	8-Bit Bus Compatible, Differential Input
ADC1021C	10	±1 LSB	200 μs	5V	TTL, TRI-STATE	+5		•	•	24-Pin DIP	Differential Input 16-Bit Bus Compatible
ADC1025B	10	±½ LSB	50 μs	5V	TTL, TRI-STATE	+5	•	•	•	24-Pin DIP 28-Pin PCC	Differential Input 16-Bit Bus Compatible
ADC1025C	10	±1 LSB	50 μs	5V	TTL, TRI-STATE	+5	•	•	•	24-Pin DIP 28-Pin PCC	Differential Input 16-Bit Bus Compatible
ADC1205B	12+sign	±½ LSB	100 μs	5V or ±5V	TTL, TRI-STATE	+5 to ±5		•	•	24-Pin DIP	8-Bit Bus Compatible, Differential Input
ADC1205C	12+sign	±1 LSB	100 μs	5V or ±5V	TTL, TRI-STATE	+5 to ±5		•	•	24-Pin DIP	8-Bit Bus Compatible, Differential Input
ADC1210	12	±¾ LSB	200 μs	10.2V	CMOS	+5 to ±15	•	•		24-Pin DIP	
ADC1211	12	±2 LSB	200 μs	10.2V	CMOS	+5 to ±5	•	•		24-Pin DIP	
ADC1225B	12+sign	±½ LSB	100 μs	5V or ±5V	TTL, TRI-STATE	+5 or ±5		•	•	28-Pin DIP	16-Bit Bus Compatible Differential Input
ADC1225C	12+sign	±1 LSB	100 μs	5V or ±5V	TTL, TRI-STATE	+5 or ±5		•	•	28-Pin DIP	16-Bit Bus Compatible Differential Input
ADC3511	3½-Digit	0.05%	200 ms	2V	TTL, TRI-STATE	+5			•	24-Pin DIP	Integrating μP Compatible
ADC3711	3¾-Digit	0.05%	400 ms	2V	TTL, TRI-STATE	+5			•	24-Pin DIP	Integrating μP Compatible
†LM131	V-F	0.01%	N/A	V_{CC} − 2V	Open Collector	+5 to +40	•	•	•	8-Pin DIP or TO-99 Can	Voltage-to-Frequency Converter 100 kHz Max
DIGITAL VOLTMETER											
ADD3501	3½-Digit	0.05%	200 ms	2V	7-Segment LED Drive	+5			•	28-Pin DIP	3½-Digit LED DVM
ADD3701	3½-Digit	0.05%	400 ms	2V	7-Segment LED Drive	+5			•	28-Pin DIP	3¾-Digit LED DVM

*Temperature ranges: "M" is −55°C to +125°C ambient; "I" is −40°C to +85°C or −25°C to +85°C; "C" is 0°C to +70°C.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Digital to Analog Converter

Part No.	Resolution (Bits)	Linearity @ 25°C % (Max)	Settling Time (+ ½ LSB)	Supplies (V)	Temperature Range* M	I	C	Package	Comments
DAC0630	6	0.5	20 ns	5			•	28-Pin DIP	Triple 6-Bit, 50 MHz Video DAC Internal Palette RAM
DAC0631	6	0.5	28 ns	5			•	28-Pin DIP	Triple 6-Bit, 35 MHz Video DAC Internal Palette RAM
ADC0852	8	0.19		5		•	•	8-Pin DIP	DAC/Comparator, Serial Input, 2 Channels
ADC0854	8	0.19		5		•	•	14-Pin DIP	DAC/Comparator, Serial Input, 4 Channels
DAC0800	8	0.19	100 ns	±5 to ±15	•		•	16-Pin DIP 16-Pin S.O.	High-Speed Multiplying
DAC0801	8	0.39	100 ns	±5 to ±15	•		•	16-Pin DIP 16-Pin S.O.	High-Speed Multiplying
DAC0802	8	0.10	100 ns	±5 to ±15	•		•	16-Pin DIP 16-Pin S.O.	High-Speed Multiplying
DAC0806	8	0.78	150 ns	±5 to ±15			•	16-Pin DIP 16-Pin S.O.	Multiplying
DAC0807	8	0.39	150 ns	±5 to ±15			•	16-Pin DIP 16-Pin S.O.	Multiplying
DAC0808	8	0.19	150 ns	±5 to ±15	•		•	16-Pin DIP 16-Pin S.O.	Multiplying
DAC0830	8	0.05	1 μs	5 to 15	•	•	•	20-Pin DIP 20-Pin S.O. 20-Pin PCC	μP Compatible 4-Quadrant Multiplying
DAC0831	8	0.10	1 μs	5 to 15			•	20-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC0832	8	0.20	1 μs	5 to 15		•	•	20-Pin DIP 20-Pin S.O. 20-Pin PCC	μP Compatible 4-Quadrant Multiplying
DAC1000	10	0.05	500 ns	5 to 15	•	•	•	24-Pin DIP	μP Compatible Double Buffered
DAC1001	10	0.1	500 ns	5 to 15			•	24-Pin DIP	μP Compatible Double Buffered
DAC1002	10	0.2	500 ns	5 to 15	•	•	•	24-Pin DIP	μP Compatible Double Buffered
DAC1006	10	0.05	500 ns	5 to 15	•	•	•	20-Pin DIP	μP Compatible Double Buffered
DAC1007	10	0.1	500 ns	5 to 15		•	•	20-Pin DIP	μP Compatible Double Buffered
DAC1008	10	0.2	500 ns	5 to 15	•	•	•	20-Pin DIP	μP Compatible Double Buffered

Digital to Analog Converter (Continued)

Part No.	Resolution (Bits)	Linearity @ 25°C % (Max)	Settling Time (+ ½ LSB)	Supplies (V)	Temperature Range*			Package	Comments
					M	I	C		
DAC1020	10	0.05	500 ns	5 to 15	•	•	•	16-Pin DIP	4-Quadrant Multiplying
DAC1021	10	0.1	500 ns	5 to 15	•	•	•	16-Pin DIP	4-Quadrant Multiplying
DAC1022	10	0.2	500 ns	5 to 15	•	•	•	16-Pin DIP	4-Quadrant Multiplying
DAC1208	12	0.012	1 μs	5 to 15		•	•	24-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1209	12	0.024	1 μs	5 to 15		•	•	24-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1210	12	0.05	1 μs	5 to 15		•	•	24-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1218	12	0.012	1 μs	5 to 15		•	•	18-Pin DIP	4-Quadrant Multiplying
DAC1219	12	0.024	1 μs	5 to 15		•	•	18-Pin DIP	4-Quadrant Multiplying
DAC1220	12	0.05	500 ns	5 to 15	•	•	•	18-Pin DIP	4-Quadrant Multiplying
DAC1221	12	0.1	500 ns	5 to 15			•	18-Pin DIP	4-Quadrant Multiplying
DAC1222	12	0.2	500 ns	5 to 15	•	•	•	18-Pin DIP	4-Quadrant Multiplying
DAC1230	12	0.012	1 μs	5 to 15		•	•	20-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1231	12	0.024	1 μs	5 to 15		•	•	20-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1232	12	0.05	1 μs	5 to 15		•	•	20-Pin DIP	μP Compatible 4-Quadrant Multiplying
DAC1265A	12	0.006	200 ns	±15	•		•	24-Pin DIP	High-Speed, Internal Reference
DAC1265	12	0.012	200 ns	±15	•		•	24-Pin DIP	High-Speed, Internal Reference
DAC1266A	12	0.006	200 ns	±12 to ±15	•		•	24-Pin DIP	High-Speed
DAC1266	12	0.012	200 ns	±12 to ±15	•		•	24-Pin DIP	High-Speed

*Ambient temperature range for "M" is −55°C to +125°C, "I" is −25°C to +85°C or −40°C to +85°C, "C" 0°C to +70°C.

Voltage Reference

Shunt Type

Reverse Breakdown Voltage (V_R)	Device	Operating Temp. Range*	Voltage Tolerance Max, T_A = 25°C	Temperature Drift ppm/°C (Max)	Operating Current Range, I_R
1.22	†LM113-2	M	±1%	50 (Typ)	500 μA to 20 mA
1.22	†LM113-1	M	±2%	50 (Typ)	500 μA to 20 mA
1.22	†LM113	M	±5%	100 (Typ)	500μA to 20 mA
1.22	LM313	C	±5%	100 (Typ)	500 μA to 20 mA
1.235	LM185BX-1.2	M	±1%	30	10 μA to 20 mA
1.235	†LM185BY-1.2	M	±1%	50	10 μA to 20 mA
1.235	†LM185-1.2	M	±1%	150	10 μA to 20 mA
1.235	LM285BX-1.2	I	±1%	30	10 μA to 20 mA
1.235	LM285BY-1.2	I	±1%	50	10 μA to 20 mA
1.235	LM285-1.2	I	±1%	150	10 μA to 20 mA
1.235	LM385A-1.2	C	±0.32%	150	15 μA to 20 mA
1.235	LM385BX-1.2	C	±1%	30	15 μA to 20 mA
1.235	LM385BY-1.2	C	±1%	50	15 μA to 20 mA
1.235	LM385B-1.2	C	±1%	150	15 μA to 20 mA
1.235	LM385-1.2	C	+2%, −2.4%	150	15 μA to 20 mA
1.24 to 5.3 (Adj.)	†LM185B	M	±1%	150	10 μA to 20 mA
1.24 to 5.3 (Adj.)	LM185BX	M	±1%	50	10 μA to 20 mA
1.24 to 5.3 (Adj.)	†LM185BY	M	±1%	50	10 μA to 20 mA
1.24 to 5.3 (Adj.)	LM285BX	I	±1%	30	10 μA to 20 mA
1.24 to 5.3 (Adj.)	LM285BY	I	±1%	50	10 μA to 20 mA
1.24 to 5.3 (Adj.)	LM285	I	±2%	150	10 μA to 20 mA
1.24 to 5.3 (Adj.)	LM385BX	C	±1%	30	13 μA to 20 mA
1.24 to 5.3 (Adj.)	LM385BY	C	±1%	50	13 μA to 20 mA
1.24 to 5.3 (Adj.)	LM385	C	±2%	150	13 μA to 20 mA
2.49	†LM136A	M	±1%	72	400 μA to 10 mA
2.49	†LM136	M	±2%	72	400 μA to 10 mA
2.49	LM236A	I	±1%	72	400 μA to 10 mA
2.49	LM236	I	±2%	72	400 μA to 10 mA
2.49	LM336	I	±4%	54	400 μA to 10 mA
2.49	LM336B	C	±2%	54	400 μA to 10 mA
2.5	†LM185BX-2.5	M	±1.5%	30	20 μA to 20 mA
2.5	†LM185BY-2.5	M	±1.5%	50	20 μA to 20 mA
2.5	†LM185B-2.5	M	±1.5%	150	20 μA to 20 mA
2.5	LM285BX-2.5	I	±1.5%	30	20 μA to 20 mA
2.5	LM285BY-2.5	I	±1.5%	50	20 μA to 20 mA
2.5	LM285-2.5	I	±1.5%	150	20 μA to 20 mA
2.5	LM385A-2.5	C	±0.8%	150	20 μA to 20 mA
2.5	LM385BX-2.5	C	±1.5%	30	20 μA to 20 mA
2.5	LM385BY-2.5	C	±1.5%	50	20 μA to 20 mA
2.5	LM385B-2.5	C	±1.5%	150	20 μA to 20 mA
2.5	LM385-2.5	C	±3%	150	20 μA to 20 mA

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Shunt Type (Continued)

Reverse Breakdown Voltage (V_R)	Device	Operating Temp. Range*	Voltage Tolerance Max, T_A = 25°C	Temperature Drift ppm/°C (Max)	Operating Current Range, I_R
5.0	†LM136A	M	±1%	72	400 μA to 10 mA
5.0	†LM136	M	±2%	72	400 μA to 10 mA
5.0	LM236A	I	±1%	72	400 μA to 10 mA
5.0	LM236	I	±2%	72	400 μA to 10 mA
5.0	LM336B	C	±2%	54	400 μA to 10 mA
5.0	LM336	C	±4%	54	400 μA to 10 mA
6.9	†LM129A	M	+3%, −2%	10	600 μA to 15 mA
6.9	LM129B	M	+3%, −2%	20	600 μA to 15 mA
6.9	LM129C	M	+3%, −2%	50	600 μA to 15 mA
6.9	LM329B	C	±5%	50	600 μA to 15 mA
6.9	LM329C	C	±5%	20	600 μA to 15 mA
6.9	LM329D	C	±5%	100	600 μA to 15 mA
6.95	†LM199A	M	±2%	0.5	500 μA to 10 mA
6.95	†LM199A-20	M	Same as LM199A with 20 ppm guaranteed long term drift.		
6.95	†LM199	M	±2%	1.0	500 μA to 10 mA
6.95	LM299A	I	±2%	0.5	500 μA to 10 mA
6.95	LM299A-20	I	Same as LM299A with 20 ppm guaranteed long term drift.		
6.95	LM299	I	±2%	1	500 μA to 10 mA
6.95	LM399A	C	±5%	1	500 μA to 10 mA
6.95	LM399A-50	C	Same as LM399A with 50 ppm guaranteed long term drift.		
6.95	LM399	C	±5%	2	500 μA to 10 mA
6.95	LM3999	C	±5%	5	600 μA to 10 mA

*C (Commercial) = 0°C to 70°C, I (Industrial) = −25°C to +85°C for the LM236 and LM299, I = −40°C to +85°C for all others.
M (Military) = −55°C to +125°C

Current References

Output Current Range	Device	Operating Temperature Range	Set Current Error			Operating Voltage Range	Set Current Temperature Dependence*
			2 μA to 10 μA	10 μA to 1 mA	1 mA to 5 mA		
2 μA to 10 mA	LM134	−55°C to +125°C	±8%	±3%	±5%	1V to 40V	0.96T to 0.104T
2 μA to 10 mA	LM134-3	−55°C to +125°C	N/A	±1%	N/A	1V to 40V	0.98T to 0.102T
2 μA to 10 mA	LM134-6	−55°C to +125°C	N/A	±2%	N/A	1V to 40V	0.97T to 0.103T
2 μA to 10 mA	LM234	−25°C to +100°C	±8%	±3%	±5	1V to 40V	0.96T to 0.104T
2 μA to 10 mA	LM234-3	−25°C to +100°C	N/A	±1%	N/A	1V to 40V	0.98T to 0.102T
2 μA to 10 mA	LM234-6	−25°C to +100°C	N/A	±2%	N/A	1V to 40V	0.97T to 0.103T
2 μA to 10 mA	LM334	0°C to +70°C	±12%	±6%	±8%	1V to 40V	0.96T to 0.104T

*Set current changes linearly with temperature at a rate of 0.33%/°C.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Series Type (Buffered Output)

Output Voltage	Device	Oper Temp. Range*	Voltage Tolerance Max, T_A = 25°C	Temperature Drift ppm/°C (Max)	Load Reg. ppm/mA	Rated Load Current	Quiescent Current (mA)
2.5	LM368Y-2.5	C	±0.2%	20	25	0 mA to +10 mA	0.55
2.5	LM368-2.5	C	±0.2%	30	25	0 mA to +10 mA	0.55
5.0	LM168BY-5.0	M	±0.05%	10	10	−10 mA to +10 mA	0.35
5.0	LM268BY-5.0	I	±0.05%	15	10	−10 mA to +10 mA	0.35
5.0	LM368BY-5.0	C	±0.1%	20	10	−10 mA to +10 mA	0.35
5.0	LM368-5.0	C	±0.1%	30	10	−10 mA to +10 mA	0.35
10	LM169B	M	±0.05%	3	8	−10 mA to +10 mA	1.8
10	LM168BY-10	M	±0.05%	10	10	−10 mA to +10 mA	0.35
10	†LH0070-2	M	±0.05%	8	60	0 to 5 mA	5
10	LM169	M	±0.05%	5	8	−10 mA to +10 mA	1.8
10	†LH0070-0	M	±0.1%	40	60	0 mA to 5 mA	5
10	†LH0070-1	M	±0.1%	20	60	0 mA to 5 mA	5
10	LM268BY-10	I	±0.05%	15	10	−10 mA to +10 mA	0.35
10	LM369C	C	±0.05%	10	8	−10 mA to +10 mA	1.8
10	LM369	C	±0.05%	5	8	−10 mA to +10 mA	1.8
10	LM369B	C	±0.05%	3	8	−10 mA to +10 mA	1.8
10	LM368Y-10	C	±0.1%	20	10	−10 mA to +10 mA	0.35
10	LM368-10	C	±0.1%	30	10	−10 mA to +10 mA	0.35
10	LM369D	C	±0.1%	30	8	−10 mA to +10 mA	2
10.24	†LH0071-2	M	±0.05%	8	60	0 mA to 5 mA	5
10.24	†LH0071-1	M	±0.1%	20	60	0 mA to 5 mA	5
10.24	†LH0071-0	M	±0.1%	30	60	0 mA to 5 mA	5

*C (Commercial) = 0°C to 70°C, I (Industrial) = −40°C to +85°C, M (Military) = −55°C to +125°C

Low Current Reference Diodes

Output Voltage	Device	Operating Temp. Range*	Voltage Tolerance Max, T_A = 25°C	Temperature Drift ppm/°C (Max)	Operating Current Range, I_R
3.0	†LM103-3.0	M	±10%	−1700	10 μA to 10 mA
3.3	†LM103-3.3	M	±10%	−1500	10 μA to 10 mA
3.6	†LM103-3.6	M	±10%	−1400	10 μA to 10 mA
3.9	†LM103-3.9	M	±10%	−1300	10 μA to 10 mA

*M (Military) = −55°C to +125°C

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

"Reference Grade" Voltage Regulators*

Output Voltage	Device	Operating Temperature Range	Voltage Tolerance Max, T_A = 25°C	Output Variation Over Operating Range	Load Reg. ppm/mA	Line Reg. ppm/V	Output Current (Max)	Quiescent Current
Adjustable:	†LP2951	−55°C to +150°C	±0.5%	±0.5%	100	42	100 mA	120 μA
1.235V to 30V	LP2951AC	−40°C to +125°C	±0.5%	±0.5%	100	42	100 mA	120 μA
	LP2951C	−40°C to +125°C	±1%	±1%	200	83	100 mA	120 μA
Programmable:	†LH0075	−55°C to +125°C	±0.5%	±0.14% (Typ)	15	200	200 mA	8 mA
5V, 6V, 10V, 12V, 15V	LH0075C	0°C to +70°C	±1%	±0.3% (Typ)	25	400	200 mA	10 mA
Programmable								
−5V, −6V, −10V	†LH0076	−55°C to +125°C	±0.5%	±0.14% (Typ)	15	200	200 mA	15 mA
−10V, −15V	LH0076C	0°C to +70°C	±1%	±0.3% (Typ)	25	400	200 mA	15 mA
5V	LP2950AC	−40°C to +125°C	±0.5%	±0.5%	100	42	100 mA	120 μA
5V	LP2950C	−40°C to +125°C	±1%	±1%	200	83	100 mA	120 μA

*For more information on these circuits, refer to the Voltage Regulator section of the Databook.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Temperature Sensor

Part	Temp. Range	*Accuracy	Output Scale
LM34A	−50°F to +300°F	±2.0°F	10 mV/°F
LM34	−50°F to +300°F	±3.0°F	10 mV/°F
LM34CA	−40°F to +230°F	±2.0°F	10 mV/°F
LM34C	−40°F to +230°F	±3.0°F	10 mV/°F
LM34D	+32°F to +212°F	±4.0°F	10 mV/°F
LM35A	−55°C to +150°C	±1.0°C	10 mV/°C
LM35	−55°C to +150°C	±1.5°C	10 mV/°C
LM35CA	−40°C to +110°C	±1.0°C	10 mV/°C
LM35C	−40°C to +110°C	±1.5°C	10 mV/°C
LM35D	0°C to +100°C	±2.0°C	10 mV/°C
LM134-3	−55°C to +125°C	±3.0°C	$I_{SET} \propto$ °k
LM134-6	−55°C to +125°C	±6.0°C	$I_{SET} \propto$ °k
LM234-3	−25°C to +100°C	±3.0°C	$I_{SET} \propto$ °k
LM234-6	−25°C to +100°C	±6.0°C	$I_{SET} \propto$ °k
LM135A	−55°C to +150°C	±1.3°C	10 mV/°k
†LM135	−55°C to +150°C	±2.0°C	10 mV/°k
LM235A	−40°C to +125°C	±1.3°C	10 mV/°k
LM235	−40°C to +125°C	±2.0°C	10 mV/°k
LM335A	−40°C to +100°C	±2.0°C	10 mV/°k
LM335	−40°C to +100°C	±4.0°C	10 mV/°k
LM3911	−25°C to +85°C	±10.0°C	10 mV/°k (or °F)

***Note:** Accuracy is measured over T(Min) to T(Max) uncalibrated

Note: The LM134/234/334 3-Terminal Adjustable current sources Datasheet can be found in Linear 1, Section 1.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Active Filter

Device #	Type	Function	Max Order	Max Freq Accuracy	Freq Range	Typ. Q Accuracy	Max F_O x Q
MF10 (S)	Universal	Universal	4th	± 0.6%	0.1–30 kHz	± 2%	200 kHz
MF8	Bandpass	Chebyshev Butterworth	4th	± 1.0%	0.1–20 kHz	± 2%	5 MHz
MF6 (S)	Lowpass	Butterworth	6th	± 1.0%	0.1–20 kHz	N/A	N/A
MF5 (S)	Universal	Universal	2nd	± 1.0%	0.1–30 kHz	± 6%	200 kHz
MF4 (S)	Lowpass	Butterworth	4th	± 0.6%	0.1–20 kHz	N/A	N/A
LMF60 (S)	Lowpass	Butterworth	6th	± 1%	0.1–30 kHz	N/A	N/A
LMF90 (S)	Notch	Elliptic	4th	± 1.5%	0.1–30 kHz	*	N/A
LMF100 (S)	Universal	Universal	4th	± 0.6%	100 kHz	± 0.5%	1.5 MHz
LMF120 (S)(M)	Universal	Universal	12th	± 1.5%	0.1–100 kHz	± 2%	1 MHz
AF100	Universal	Universal	2nd	1%	10 kHz	7.5%	50 kHz
AF150	Universal	Universal	2nd	1%	100 kHz	7.5%	200 kHz
AF151	Universal	Universal	4th	1%	10 kHz	7.5%	50 kHz

S Surface Mount Available

M Mask-Programmable Filter

*Notch Bandwidth 0.127%, 0.25%, 0.55%

Analog Switch/Multiplexer

Part Number	Function	Logic Input	V_S (Typ)	T_{ON}/T_{OFF} ns (Typ)	R_{ON} Ω
AH5011	QUAD SPST	TTL, CMOS	—	150/300	100
AH5012		TTL, CMOS	—	150/300	150
CD4016		CMOS	±7.5	20/40	850
CD4066		CMOS	±7.5	25/50	280
†LF11201/LF13201		TTL	±15	90/500	200
†LF11202/LF13202		TTL	±15	90/500	200
†LF11331/LF13331		TTL	±15	90/500	200
†LF11332/LF13332		TTL	±15	90/500	200
†LF11333/LF13333		TTL	±15	90/500	200
MM74HC4016		CMOS	±12	5/8	40
AH5020	DUAL SPDT	TTL, CMOS	—	150/300	150
CD4053	TRIPLE SPDT	CMOS	±7.5	160/75	300
MM74HC4053		CMOS	±6.0	15/16	40
AH5009	4-CHANNEL	TTL, CMOS	—	150/300	100
AH5010		TTL, CMOS	—	150/300	150
CD4052	4-CHANNEL	CMOS	±7.5	160/75	300
CD4529B	DIFFERENTIAL	CMOS	±7.5	50	350
LF13509		TTL, CMOS	±18	1600/200	350
MM74HC4052		CMOS	±6.0	15/16	40
CD4051	8-CHANNEL	CMOS	±7.5	160/75	300
CD4529B		CMOS	±7.5	50	350
LF13508		TTL, CMOS	±18	1600/200	350
MM74HC4051		CMOS	±6.0	15/16	40

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Sample and Hold

	LF198A	LF398A	LF198	LF398	LF298	Units
Accuracy Gain/Offset Error	0.01	0.01	0.02	0.02	0.02	% Max
Offset Voltage	2	3	5	10	5	mV Max
Droop Rate (25°C)						
C_S = 1000 pF	30	30	30	30	30	mV/sec
C_S = 10000 pF	3	3	3	3	3	
Acquisition Time (25°C)						
C_S = 1000 pF	4	4	4	4	4	μs
C_S = 10000 pF	20	20	20	20	20	
Aperture Time (25°C)	25	25	25	25	25	ns
Temperature Range	−55 to +125	0 to +70	−55 to +125	0 to +70	−25 to +85	°C
Comment	Low Drift	Low Drift	General Purpose	General Purpose	Low Drift	

	Acquisition Time	Aperture Time	Droop Rate	Gain Accuracy	V_{OS}	Temp. Range*		
						M	I	C
LF198A/398A	4 μs	25 ns	30 mV/sec	0.01%	2 mV	•		•
†LF198/298/398	4 μs	25 ns	30 mV/sec	0.02%	5 mV	•	•	•
†LH0023	50 μs	150 ns	0.5 mV/sec	0.01%	20 mV	•	•	
†LH0043	10 μs	20 ns	1 mV/sec	0.1%	40 mV	•	•	
†LH0053	4 μs	25 ns	50 mV/sec	0.2%	7 mV	•	•	
LH4860	90 ns	6 ns	1 V/sec	0.05%	5 mV	•	•	

M (Military) = −55°C to +125°C, I (Industrial) = −40°C or 25°C to +85°C, C (Commercial) = 0°C to +70°C.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Audio Circuits

Preamplifiers/Systems

	Application			Package	Voltage Range	Equivalent Input Noise	THD	PSR	Input Coupling	Notes
	Portable	Home	Auto							
LM381	•	•		14 Pin DIP	9V–40V	0.5 μV	0.1%	120 dB	AC	Stereo; See AN-64
LM382	•	•	•	14 Pin DIP	9V–40V	0.8 μV	0.1%	120 dB	AC	Stereo
LM387	•	•	•	8 Pin DIP	9V–30V	1.0 μV	0.1%	110 dB	AC	Stereo
LM1818	•	•	•	20 Pin DIP	3.5V–18V	0.85 μV	0.05%	85 dB	AC	Tape System
LM1837	•	•	•	18 Pin DIP	4V–18V	0.6 μV†	0.03%	95 dB	DC	Autoreverse Tapedecks
LM1897	•	•	•	16 Pin DIP	4V–18V	0.6 μV†	0.03%	105 dB	DC	Tape Playback
LM833 (Note 1)		•	•	8 Pin DIP 8 Pin SO	±5V–±15V	0.5 μV	0.002%	100 dB	DC	Low Noise Dual Op Amp
LM837 (Note 1)		•	•	14 Pin DIP 14 Pin SO	±5V–±15V	0.5 μV	0.002%	100 dB	DC	Low Noise Quad Op Amp Drives 600Ω Load

†CCIR/ARM in DIN circuit referred to unity gain at 2 kHz.

Note 1: Data sheet in Linear 1.

Audio Power Amplifiers

	Application			Package	Power*			@ Voltage	Bridgeable	THD*	Input Noise*	Single/ Dual	Notes
	Portable	Home	Auto		8Ω	4Ω	2Ω						
LM380		•		8 Pin DIP 14 Pin DIP	2.5W			18V		0.2%		Single	See AN-69 Fixed Gain
LM383	•		•	5 Pin TO-220		5.5W	8.6W	14.4V	Yes	0.2%	2 μV	Single	Protected
LM384		•		14 Pin DIP	5.5W			22V	Yes	0.25%		Single	Fixed Gain
LM386	•	•		8 Pin DIP 8 Pin SO	0.33W			6V		0.2%		Single	4V Operation 20 mW Quiescent
LM388	•			14 Pin DIP	2.2W			12V	Yes	0.1%		Single	4V Operation Min Externals
LM389	•			18 Pin DIP	0.33W			6V		0.2%		Single	Includes Transistor Array
LM390	•			14 Pin DIP		1W		6V	Yes	0.2%		Single	Battery Operation
LM391		•		16 Pin DIP	10–100W			60V–100V	Yes	0.01%	3 μV	Single	Shutdown Pin, Thermal Protected Power Driver
LM1877	•	•	•	14 Pin DIP	3W			20V		0.05%	2.5 μV	Dual	6V–24V
LM2877	•	•	•	11 Pin SIP	4.5W			20V		0.07%	2.5 μV	Dual	Flexible Application
LM1895	•	•	•	8 Pin DIP		1.1W		6V		0.2%	1.4 μV	Single	Low AM Radiation 3V Op
LM2895	•	•	•	11 Pin SIP		4.3W		12V		0.15%	1.4 μV	Single	3V–15V

Audio Power Amplifiers (Continued)

	Application				Power*			@			Input	Single/	
	Portable	Home	Auto	Package	8Ω	4Ω	2Ω	Voltage	Bridgeable	THD*	Noise*	Dual	Notes
LM1896	•	•	•	14 Pin DIP		1.1W		6V	Yes	0.1%	1.4 μV	Dual	Low AM Radiation, 3V Op
LM2896	•	•	•	11 Pin SIP		2.5W		9V	Yes	0.1%	1.4 μV	Dual	No Pops, 3–15V Op
LM2002			•	5 Pin TO-220		5.2W	8W	14.4V	Yes	0.1%	2 μV	Single	Well-Protected
LM2878		•		11 Pin SIP	5.5W			22V	Yes	0.15%	2.5 μV	Dual	6V–32V
LM831	•			16 Pin DIP	0.44W	0.22W		3V	Yes	0.25%	1.3 μV	Dual	1.8V–6V
LM12 (Note 1)		•		4-Pin TO-3	50W	85W		±30V	Yes	0.01%	9 μV	Single	Power Op Amp; See AN-446
LM675 (Note 1)		•		5 Pin TO-220	25W			±25V		0.03%	3 μV	Single	Power Op Amp
LM1875		•		5 Pin TO-220	25W			±25V		0.015%	3 μV	Single	Low Distortion At H. Power
LM2005			•	11 Pin TO-220		20W		14.4V	Yes	0.3%	1.5 μV	Dual	Well-Protected
LM2879		•		11 Pin TO-220	8W			28V	Yes	0.05%	2.5 μV	Dual	6V–32V

*Note that all values shown are typical. Please refer to data sheets for test conditions.

Note 1: Data sheet in Linear 1.

Audio Controls

	Application				Voltage	Volume	Signal to			
	Portable	Home	Auto	Package	Range	Control Range	Noise	THD	Separation	Notes
LM1035/ LM1036		•	•	20 Pin DIP	8V–18V	80 dB	80 dB	0.05%	75 dB	Dual DC Controlled Tone/Volume/Balance
LM1037	•	•	•	18 Pin DIP	5V–25V		100 dB	0.04%	100 dB	DC Audio Switch
LM1038	•	•	•	18 Pin DIP	5V–25V		100 dB	0.04%	100 dB	BCD Logic Control
LM13600 (Note 1)	•	•	•	16 Pin DIP 16 Pin SO	±2V–±18V			0.5%	100 dB	Dual Transconductance Amplifiers
LM13700 (Note 1)	•	•	•	16 Pin DIP 16 Pin SO						
LM3080 (Note 1)	•	•	•	8 Pin DIP	±2V–±18V					Transconductance Amplifier
LM1040		•	•	24 Pin DIP	9V–16V	75 dB	80 dB	0.06%	75 dB	Dual DC Controlled Tone/Volume/Balance Stereo Enhancement
LMC835	•	•	•	28 Pin DIP	±2.5V–±8V	±12 dB/Band	114 dB	*		Stereo 7 Band Graphic Equalizer MICROWIRE™ Controlled; See AN-435
LMC1992		•	•	28 Pin DIP	7V–15V	80 dB	105 dB	0.03%	95 dB	Stereo Volume/ Tone/Fade/Select MICROWIRE™ Controlled

*Distortion determined by external op amps.

Note 1: Data sheet in Linear 1.

Noise Reduction

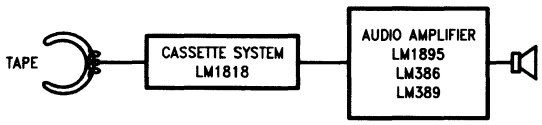
	Application			Package	Voltage Range	NR Type	NR Effect*	Encoding Required	Single/ Dual/	Decode S/N*	Notes
	Portable	Home	Auto								
LM1131	•	•	•	18 Pin DIP	5V–20V	Dolby®	10 dB	Yes	Dual	90 dB	DC Switched
LM1894	•	•	•	14 Pin DIP, SO	4.5V–18V	DNR®	12 dB	No	Dual	76 dB	NSC System See AN-384, 386, 390
LM1112	•	•	•	16 Pin DIP	6V–20V	Dolby®	10 dB	Yes	Single	83 dB	
LM1141	•	•	•	28 Pin DIP, Quad	5V–16V	Dolby®		Yes	Single	76/66 dB	Dolby B/C
LM832	•			14 Pin DIP, SO	1.5V–9V	DNR®	12 dB	No	Dual	68 dB	NSC System See AN-384, 386, 390

*Note that all values shown are typical. Please refer to data sheets for test conditions.

DNR® is a registered trademark of National Semiconductor Corporation.

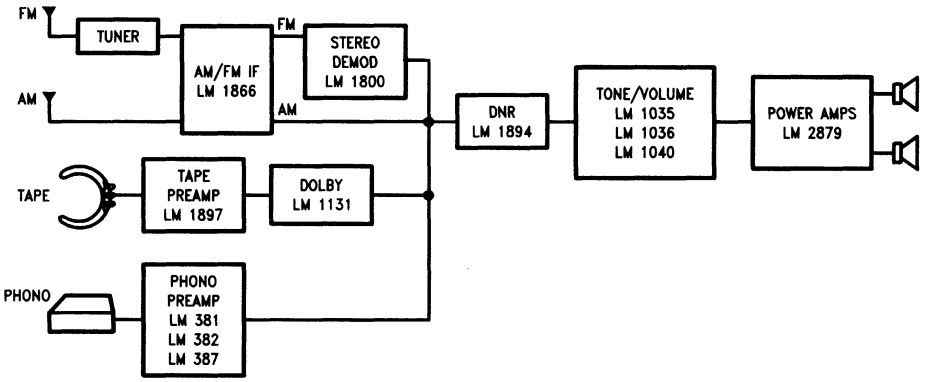
Dolby® is a registered trademark of Dolby Laboratories Licensing Corporation.

Monaural Cassette Player



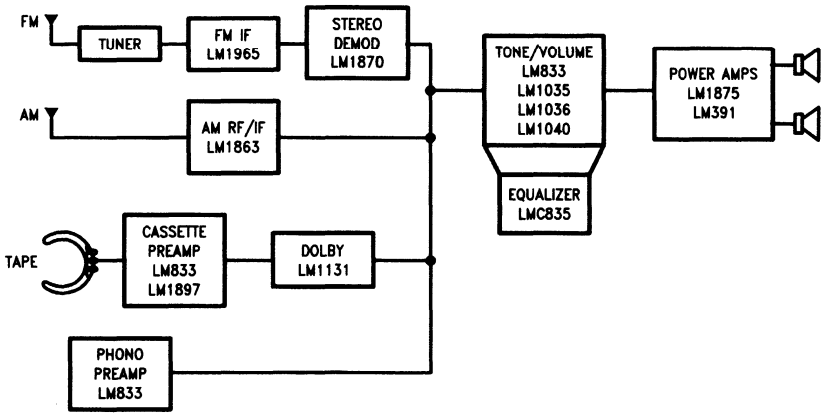
TL/MS/10296-1

Home Stereo System (Audio Power < 10W)



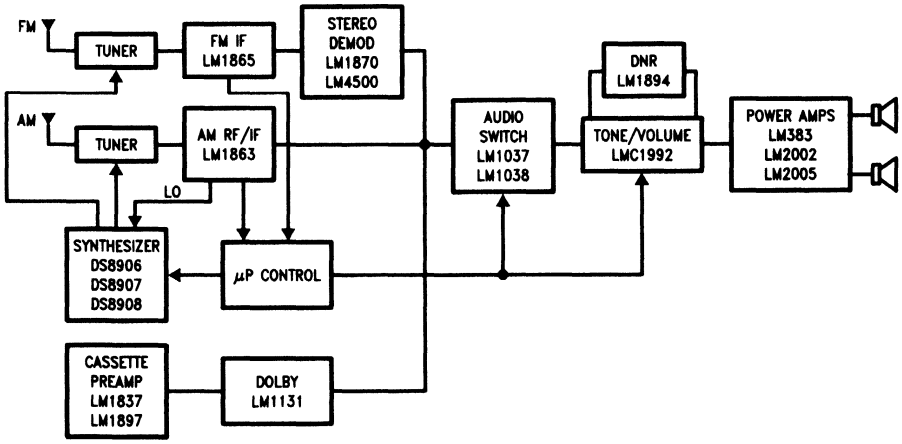
TL/MS/10296-2

Home Component Stereo (Audio Power > 10W)



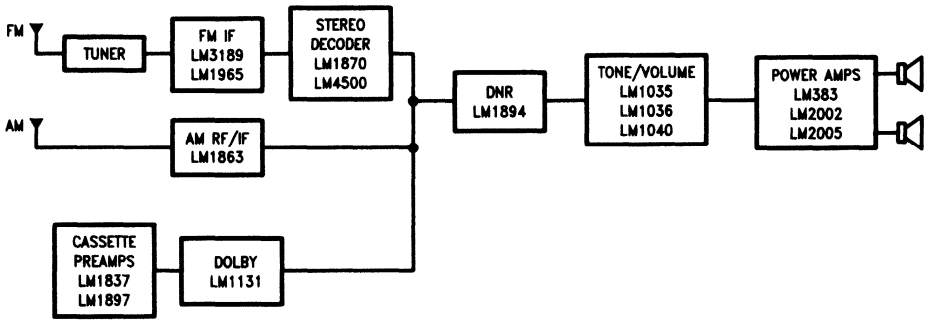
TL/MS/10296-3

Automotive Radio (Electronically Tuned)



TL/MS/10296–4

Auto Radio (Manually Tuned)



TL/MS/10296–5

Radio Circuits

AM RF/IF Detector

	Portable	Home	Auto	Synthesized	Pin Count (Dip Package)	Supply Range	Max Input Sensitivity for 20 dB S/N Ratio	AM and FM IF	Audio Power Amplifier	Internal Detector	Output	Meter
LM1863	•	•	•	•	20*	7-16V	30 μV			•	•	
LM1866	•	•			20	3-15V	25 μV	•		•	•	
LM1868	•	•			20	4.5-15V	12 μV	•	•	•		
LM3820	•	•	•		14	4.5-16V	35 μV					

*SO Surface Mount Package Only

Stereo Decoder

	Portable	Home	Auto	Pin Count Dip Package	Supply Range	THD	Separation	Blend	High Cut	Lamp Driver	Output Buffer	ARI Interference Rejection
LM1800		•		16	10-18V	0.4%	45 dB			•	•	
LM1870	•	•	•	20	7-15V	0.05%	45 dB	•	•	•	•	
LM1884*		•		16	8-16V	0.1%	—			•	•	
LM4500A	•	•	•	16	8-16V	0.1%	40 dB			•	•	•

*TV Stereo Decoder

Radio Remote Control

	Function	Pin Count (Dip Package)	Supply Range	Channels		Frequency Range
				Analog	Digital	
LM1871	Encoder/Transmitter	18	4.5-15V		2	up to 72 MHz
LM1872	Decoder/Receiver	18	2.5-7V	2	2	up to 72 MHz

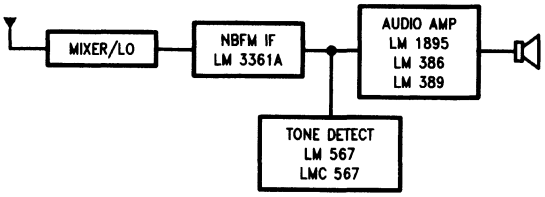
FM IF/Detector

	Portable	Home	Auto	Synthesized	Pin Count Dip	Pin Count S.O.	Supply Range	−3 dB Limiting Sensitivity	THD	Mute	AGC Outputs	AFC	Meter Output	AM/ FM IF
LM1865		•	•	•	20	20	7.3-16V	60 μV*	0.1%	•	Reverse	•	•	
LM1965		•	•		20		7.3-16V	60 μV*	0.1%	•	Reverse	•	•	
LM2065		•	•	•	20		7.3-16V	60 μV*	0.1%	•	Forward	•	•	
LM1866	•	•			20		3-15V	20 μV	0.5%	•	•	•	•	•
LM1868	•	•			20		4.5-15V	15 μV	1.1%					•
LM3089		•	•		16		8-16V	12 μV	0.5%	•	•	•	•	
LM3189		•	•		16		8-16V	12 μV	0.5%	•	•	•	•	
LM3361A**	•		•		16	16	2-9V	2 μV	-		•			
TBA1205	•	•			14		6-18V	30 μV	0.2%				•	

*Exclusive of 22 dB Buffer

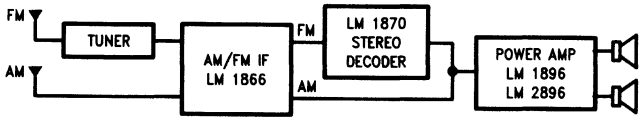
**Narrow-Band FM-IF

Cordless Telephone Receiver



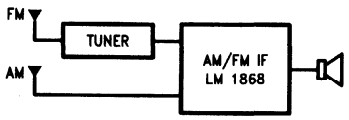
TL/MS/10297–1

Portable Radio (Stereo)



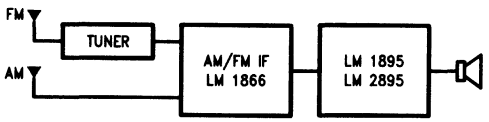
TL/MS/10297–2

Portable Radio (Monaural)



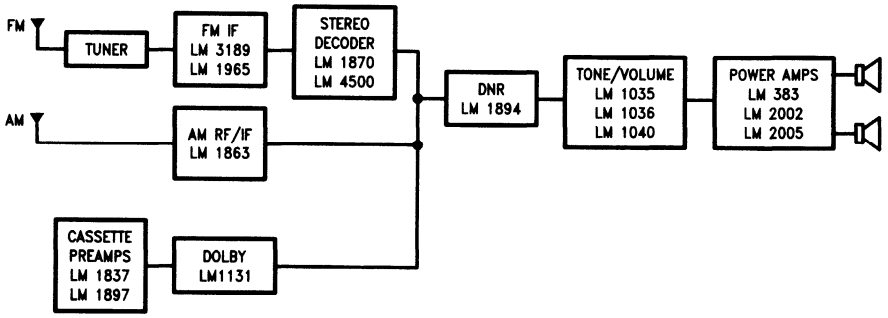
TL/MS/10297–3

Table/Clock Radio



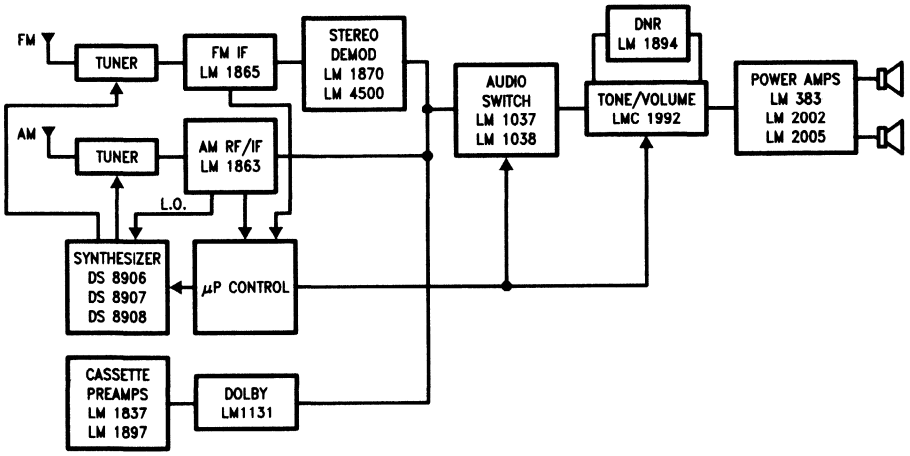
TL/MS/10297–4

Auto Radio (Manually Tuned)



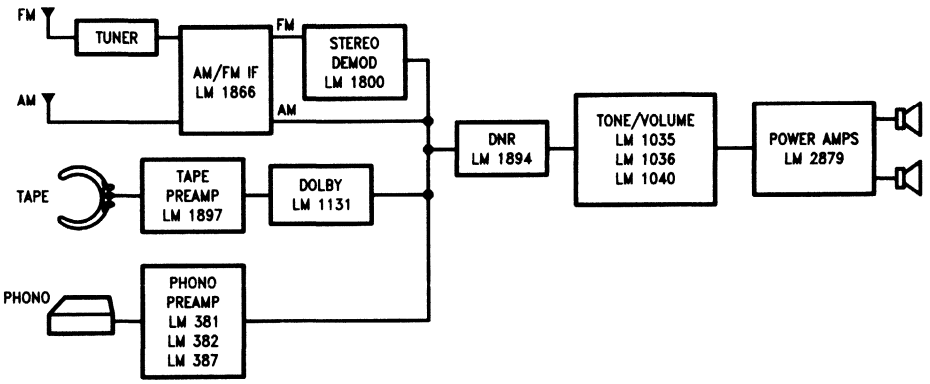
TL/MS/10297–5

Automotive Radio (Electronically Tuned)



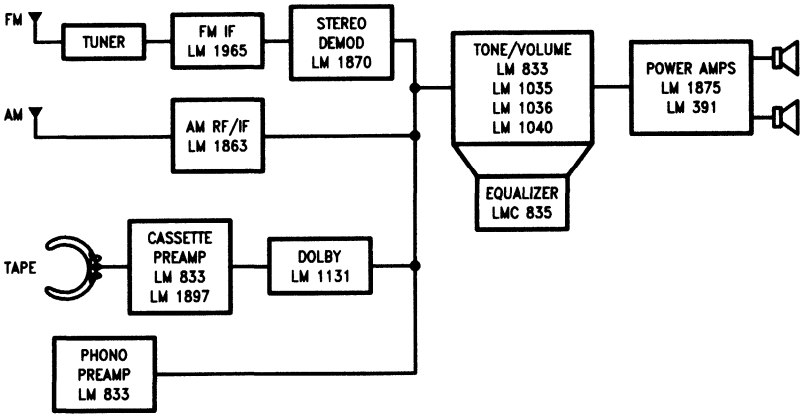
TL/MS/10297–6

Home Stereo System (Audio Power < 10W)



TL/MS/10297–7

Home Component Stereo (Audio Power > 10W)



TL/MS/10297–8

Video Circuits

Video Amplifiers

	Bandwidth	Gain	Package	Supply Voltage	Comments
LM592	90 MHz	100, 400	14 Pin DIP 14 PIN SO	±3V–±6V	Differential IN, Differential OUT
†LM733	120 MHz	10, 100, 400	14 Pin DIP 10-Pin CAN	±3V–±6V	Differential IN, Differential OUT
LM1201	200 MHz	4–10	16 Pin DIP	+12V	Single Amplifier with Black Level and Contrast Control
LM1203	70 MHz	4–10	28 Pin DIP	+12V	Triple Amplifier System with Black Level and Balanced Contrast Control
LM359 (Note 1)	400 MHz GBW 30 MHz @ $A_V = 1$		14 Pin DIP	5V–22V	Dual Norton Amplifiers

Video Timing

	Function	Package	Supply Voltage	Comments
LM1391	Low-Freq PLL	8 Pin DIP	Internally Regulated	For Horizontal Section
LM1880	No-Holds Vert/Horiz	14 Pin DIP	Internally Regulated	Eliminates Hold Controls
LM1881	Sync Separator	8 Pin DIP 8 Pin SO	5V–12V	Outputs Provided: Composite Sync Vertical Burst Gate Odd/Even Field

Video Modulators/Demodulators

	Function	Package	Comments
LM1496 (Note 2)	Balanced Modulator-Demodulator (Modulator—Suppressed Carrier, AM Demodulator—Synchronous, FM Phase Detection)	14 Pin DIP 10 Pin TO-5 14 Pin SO	Operating Frequency to 100 MHz Balanced Inputs and Outputs
LM1889	Modulates Color Difference, Luminance, Audio onto Low-VHF Channels	18 Pin DIP	DC Channel Switching Chroma Reference
LM2889	Modulates Composite Video, Audio onto Low-VHF Channels	14 Pin DIP	DC Channel Switching, Low Distortion FM Sound Modulator, Video Clamp

Note 1: Data sheet in Linear 1.

Note 2: Data sheet in Linear 3—Special Functions Chapter 5.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Video IFs

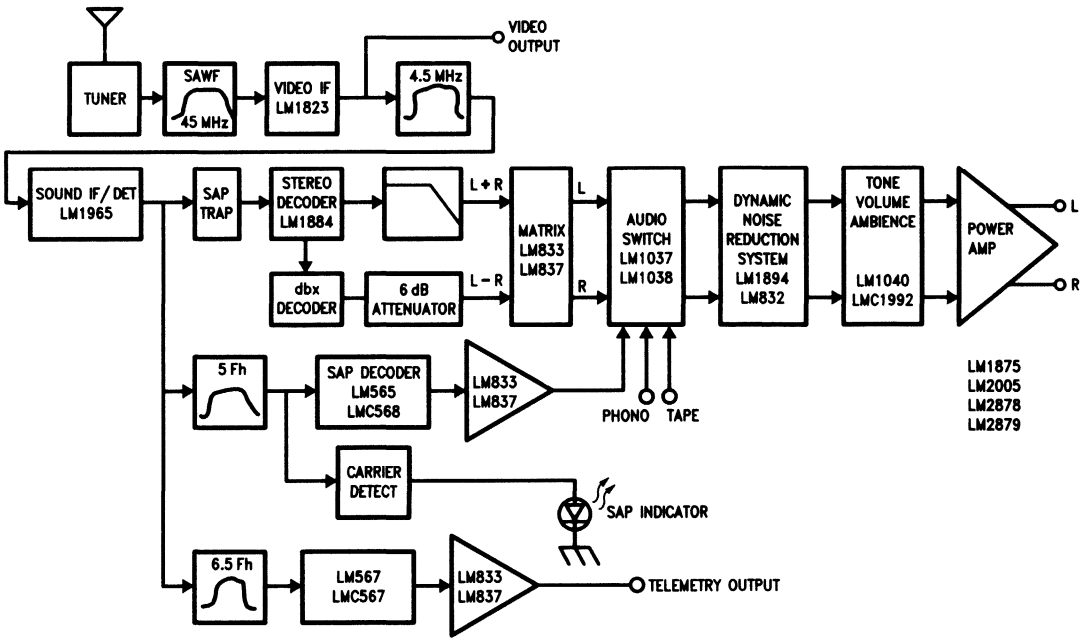
	Application	Package	Comments
LM1211 (Note 3)	Broadband Demodulator Date or Video Recovery from LANs, Other Comm. Systems	20 Pin DIP	Operating Range 20 MHz–80 MHz Quasi-Synchronous Detector 25 MHz Output Amplifier
LM1823	Video IF Signal Processing	28 Pin DIP	Operating Range 20 MHz–70 MHz Synchronous Detector using PLL 9 MHz Output Amplifier

Other Video Products

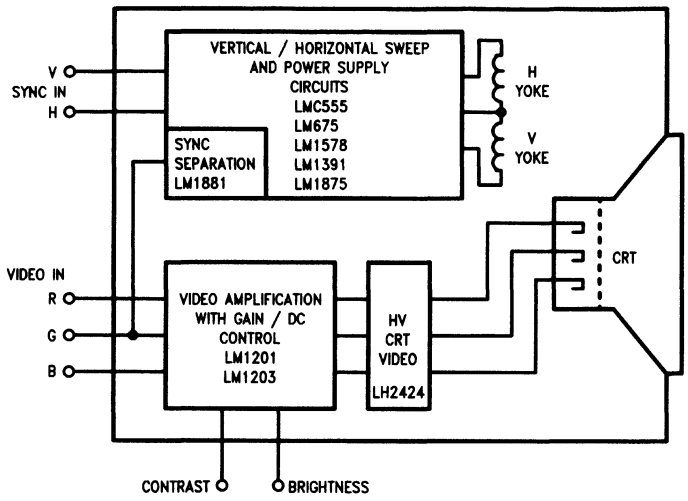
	Function	Package	Supply Voltage	Comments
LM1044	Video Switch	24 Pin DIP	8V–16V	• DC Switch between 3 Composite Video Channels or 2 RGB Channels • 60 dB Channel Separation
LM1884 (Note 4)	TV Stereo Decoder	16 Pin DIP	9V–15V	Provides L − R, L + R Outputs from Composite Input
LM1886	Color TV Video Matrix DAC	20 Pin DIP	+5V, +12V	Encodes Luminance and Color Difference Signals from 3-Bit RGB Inputs
DAC0630	RAM Pallette Triple-6 Bit Video DAC	28 Pin DIP	+4.5–+5.5V	Triple 6-Bit DACs On-Band 256 x 18 Bit Color Pallette Replaces 1MSG171/176

Note 3: Data Sheet in Linear 3.

Note 4: Data Sheet in Linear 3.



TL/MS/10298–1



TL/MS/10298–2

Figure 1. Typical RGB Color Monitor Block Diagram

Application Notes* Cross Reference

Device	AN #
LM359	AN-278, AB-24
LM1823	AN-391
LM1886	AN-402
LM1889	AN-402
LM2889	AN-391, AN-402

*National Semiconductor Corporation Linear Application Notes

† Military qualified device. For more information, consult the 1989 Military/Areospace Selection Guide.

Motion Control

Dedicated Motor Control Functions

Part Number	Function	Features
LM621	Brushless D.C. Motor Commutator	Directly interfaces to PWM outputs On-chip dead-time generator Compatible with 3 ϕ and 4 ϕ motors (ϕ = Phase)
LM628/LM629	High Performance Motion Controller for D.C. and Brushless D.C. Motors	On Board 32-Bit Incremental Shaft Encoder Interface 256 μs Sampling Interval Automatic Trajectory Generator Target Position and Velocity Programmable "On-the-Fly" Easily Programmable PID Filter Convenient 8-Bit Host Interface 8-Bit or 12-Bit Port to DAC (LM628) 8-Bit PWM Output (LM629)

H-Switches

Output Current (Amps)			Supply	Full Current Saturation Voltage				
Peak (Typical)	Continuous (Max)	Device	Voltage (Max)	Source (Max)	Sink (Max)	Operating Temp. Range	Package	Description
2	1	LM18293	36	1.8	1.8	−40°C to +125°C	16-Pin DIP	Quad ½ H Switch
3	2	LM18298	50	2.8	2.6	−40°C to +150°C	15-Pin TO-220	Dual Full H Switch

Power Op-Amps*

Output Current Amps			Supply	Input Offset		Slew	Operating		
Peak (Typical)	Continous (Max)	Device	Voltage (Max)	Voltage (Max)	Quiescent Current	Rate (Typical)	Temp. Range	Package	Features
3	1.5	LM675	60	10 mV	50 mA	8 V/μs	0°C to +70°C	5-Pin TO-220	Thermal Parole
15	10	LM12L	60	15 mV	80 mA	9 V/μs	−55°C to +125°C	4-Pin TO-3	Fully Protected
15	10	LM12CL	60	20 mV	120 mA	9 V/μs	0°C to +70°C	4-Pin TO-3	Fully Protected
15	10	LM12	80	15 mV	80 mA	9 V/μs	−55°C to +125°C	4-Pin TO-3	Fully Protected
15	10	LM12C	80	20 mV	120 mA	9 V/μs	0°C to +70°C	4-Pin TO-3	Fully Protected
1	0.5	LM18272	28	100 mV	15 mA (Typ)	0.5 V/μs	0°C to +85°C	8-Pin DIP	Dual (Bridge)

*For more information on Power Amps, see the Amplifier section of the Linear Databook. For more High Power Amplifiers, refer to the Audio Amplifier section.

Communication Circuits

Communications-Related Building Blocks

Modulators & Demodulators Selection Guide

	LM1211	LM1496	LM1889	LM2889
Typical Application	Broadband Demodulator	Balanced Modulator-Demodulator	TV Video Modulator	TV Video Modulator
Key Features	• Configurable for AM or FM Based Signals • 20 MHz–80 MHz Operating Frequency Range • 25 MHz Detector Output Bandwidth • Linear Output Phase Response	• Wide Frequency Response to 100 MHz • Fully Balanced Inputs and Outputs • Adjustable Gain and Signal Handling	• Input Signals —Audio Modulation —Color Difference —Luminance • Channel 3 (61.25 MHz) or Channel 4 (67.25 MHz) Output • Companion Circuit to LM1886 TV Video Matrix D to A	• Input Signals —Audio —Composite Video • Channel 3 (61.25 MHz) or Channel 4 (67.25 MHz) Output • Video DC Restoration

PLL's and Tone Decoders

General purpose PLL's and tone decoders are available for applications that include FSK demodulation, tone decoding, SAP and SCA demodulation, and telemetry reception. Both bipolar and CMOS devices are offered. Special purpose PLL's for TV synchronization and FM stereo demodulation are also available for use in other low frequency signal processing applications.

PLL and Tone Decoder Selection Guide

	LM565	†LM567	LMC567* (CMOS LM567)	LMC568	LM1391	LM1800, LM1870, LM4500A
Typical Application	PLL	Tone Decoder	Tone Decoder	PLL	TV—Horizontal PLL	FM Stereo Demodulator PLL
Center Frequency Range	15 Hz–500 kHz	0.01 Hz–500 kHz	0.01 Hz–500 kHz	0.01 Hz–500 kHz	15 kHz–63 kHz	
VCO Control Range	±30%	±7%	±7%	±30%	±300 Hz	
Supply Voltage	±5V to ±12V	4.75V–9V	2V–9V	2V–9V	8V–9.2V	Lowest: 7V Highest: 16V (See Datasheets)
Supply Current (Typ)	8 mA	12 mA	0.8 mA	1.2 mA	20 mA	Lowest: 21 mA Highest: 45 mA (See Datasheet)

*The CMOS LMC567 oscillator runs at twice the frequency of the bipolar LM567 oscillator. Refer to the datasheets for additional information.

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Communications-Related Building Blocks (Continued)

Power Line Carrier

The LM2893/LM1893 Carrier-Current Transceiver performs as a power line interface for half-duplex (bi-directional) communication of serial bit streams of virtually any coding. Applications include energy management systems, inter-office control, fire alarm systems, security systems, telemetry, and remote meter reading.

Timers

General purpose timers are available for generating accurate time delays or oscillation. Both bipolar and CMOS devices are offered.

Timer Selection Guide

	LM322	LM2905	†LM555	LMC555* (CMOS LM555)	†LM556 (Dual LM555)
Trigger Pulse Relative to Output Pulse	Can Be Longer	Can Be Longer	Must Be Shorter	Must Be Shorter	Must Be Shorter
Typical Application	Monostable	Monostable	Astable	Astable	Astable
Supply Voltage	4.5V–40V	4.5V–40V	4.5V–15V	1.2V–12V	4.5V–15V
Supply Current (Typical)	2.5 mA	2.5 mA	10 mA	0.15 mA	10 mA (Each Timer Section)

*The CMOS LMC555 can handle −10 mA to +50 mA of output current and the bipolar LM555 can handle up to ±200 mA of output current.

VCO and Function Generator

The LM566 is a general purpose voltage controlled oscillator which may be used to generate square and triangle waves. Typical applications include FM modulation, signal generation, function generation, frequency shift keying, and tone generation. The LM566 has very linear modulation characteristics.

Drive-Related Building Blocks

Display Drivers

LED flasher/oscillator and dot/bar display drivers are offered.

Display Driver Selection Guide

	LM3909	LM3914	LM3915	LM3916
Typical Application	Flasher/ Oscillator	Dot/Bar Display Driver	Dot/Bar Display Driver	Dot/Bar Display Driver
Display Scale	N/A	Linear	Log	VU Meter
Display Type	LED, Incandescent	LED, LCD, Vacuum Fluorescent	LED, LCD, Vacuum Fluorescent	LED, LCD, Vacuum Fluorescent

Meter Drivers

The LM1819 Air-Core Meter Driver is a function generator/driver for air-core (moving-magnet) meter movements in tachometers and ruggedized instruments. Driver outputs are self-centering and better than 2% linearity is guaranteed over a full 305° deflection range. Signal conditioning circuitry is included on chip.

Temperature Controller

The LM3911 (Note 1) is a temperature controller containing a precision temperature sensor, op amp, and reference. It is designed for temperature sensing and closed loop temperature control applications over the −25°C to +85°C range.

Note 1: See Linear 2 for datasheet.

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Precision-Related Building Blocks

Chopper Block

The LMC669 Auto Zero Block (Note 1) is a universal commutating auto-zero block that can be used with any operational amplifier to correct offset voltage.

Note 1: See Linear 2 for datasheet.

Transistor Arrays

A variety of matched and power transistors are offered.

Transistor Array Selection Guide

	†LM394	†LM395	LM3046	LM3146
Description	NPN Transistor Pair	Power Transistor	5 NPN Transistors	5 NPN Transistors
Key Features	• Emitter-Base Voltage Matched to 50 μV • Current Gain Matched to 2%	• Collector Current: 1A • Quiescent Current: 10 mA • Switching Time: 2 μs • Current Limit • Thermal Limit • Safe Area Protection	• Emitter-Base Voltage Matched to ±5 mV • Breakdown Voltages $-V_{(BR)(CBO)}$: 20V $-V_{(BR)(CEO)}$: 15V $-V_{(BR)(CIO)}$: 20V $-V_{(BR)(EBO)}$: 5V • DC—120 MHz	• Emitter-Base Voltage Matched to ±5 mV • Breakdown Voltages $-V_{(BR)(CBO)}$: 40V $-V_{(BR)(CEO)}$: 30V $-V_{(BR)(CIO)}$: 40V $-V_{(BR)(EBO)}$: 5V • DC—120 MHz

Sensing-Related Building Blocks

Liquid Level Sensors

A variety of liquid level sensing circuits are offered.

Liquid Level Sensor Selection Guide

	LM903	LM1042	LM1812	LM1830
Output Type	Digital HI/LO	Analog	Pulse-Echo Timing	Digital HI/LO
Operation Method	Thermoresistive Probe	Thermoresistive Probe	Acoustic Transducer	Conductive Liquid

† Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Special Functions

A variety of special sensor amplifiers are offered.

Special Amplifiers Selection Guide

	LM1815	LM1964
Typical Application	Adaptive Sense Amplifier	Sensor Interface Amplifier
Sensor	Inductive Pickup	Lambda Sensor
Key Features	• Operates from 2.5V to 12V Supply • Adaptive Hysteresis • True Zero Crossing Timing Reference	• Normal Operation Guaranteed with Inputs up to 3V Below Ground on a Single Supply • Fully Protected Inputs • Input Open Circuit Detection

Special Comparator

The LM1801 Battery Operated Power Comparator is an extremely low power comparator with a high current, open collector output stage. Typical applications include intrusion alarms, water leak detectors, gas leak detectors, overvoltage crowbars and battery operated monitors. The LM1801 is designed to operate in a standby mode for 1 year, powered by a 9V alkaline battery.

Special Converters

A variety of special converters for signal transformation applications are offered.

Special Converters Selection Guide

	LH0091 (Note 1)	LH0094 (Note 1)	†LM331 (Note 1)	LM2907, LM2917
Converter Type	True RMS-to-DC	Multifunction	Voltage-to-Frequency	Frequency-to-Voltage
Key Features	• 0.1% Accuracy with External Trim • Uncommitted Amplifier for Filtering, Gain or High Crest Factor Configuration • True RMS Conversion	• $OUT = IN_y\left(\frac{IN_Z}{IN_X}\right)^m$, $0.1 \leq m \leq 10$, m Continuously Adjustable • Applications —Precision Divider, Multiplier —Square Root —Square —Trigonometric Function Generator —Companding —Linearization —Control Systems —Log Amp	• 1 Hz to 100 kHz Frequency Range • Split or Single Supply Operation	• Operates Relay, Lamp or Other Load when Input Exceeds a Selected Rate • Ground Referenced Tachometer Fully Protected from Damage Due to Swings Above Supply or Below Ground

Note 1: See Linear 2 for datasheets.

†Military qualified device. For more information, consult the 1989 Military/Aerospace Selection Guide.

Ultrasonic Transceiver

The LM1812 Ultrasonic Transceiver is a general purpose ultrasonic transceiver designed for use in a variety of ranging, sensing, and communications applications. Typical uses include liquid level measurement, sonar, surface profiling, data links, hydroacoustic communications, non-contact sensing and industrial process control. Depending on the acoustic transducer, typical performance capabilities include 5 feet to 100 feet in water and 4 inches to 35 feet in air.

Section 7
Memory

Section 7 Contents Memory

Memory

When it comes to the business of meeting your memory needs, no other U.S. manufacturer meets them as fully as National.

We continue to expand our leadership in mainstream, high-performance memory applications by combining industry-standard architectures with advanced process technologies.

Our revolutionary one-micron BiCMOS III process, for example, combines the speed of pure bipolar with the high density, low power and manufacturability of CMOS. Which translates into the best possible ratio of speed, power and cost-per-bit.

Taken together, our product lines comprise the broadest array of memory product families of any domestic supplier.

Our CMOS EPROM family is ideal for systems that require non-volatile memory with low power consumption and microprocessor speeds.

For applications in which in-circuit, remote-programmable memory promotes design flexibility and end-use advantages, we offer a family of low density serial EEPROM's.

And when true high-performance volatile memory is essential, our ultra-high-speed BiCMOS ECL I/O, high-speed CMOS, and TTL I/O static RAMs are designed to meet your density and speed requirements.

With our company-wide processes and design platform, our standard memory products are designed from the beginning for smooth migration into our ASIC standard cell library as customer demand requires. Which means our products are far more than simple socket solutions. They're created to provide systems solutions. Now and in the future.

As for packaging, the plain truth is that no one offers you as many packaging options, from DIPs to surface-mount devices.

And for on-time delivery of reliable, high-quality devices, National is second to none.

Simply put, no one is doing more to fully satisfy your memory requirements. And that's what meeting the memory challenge is all about.

National Memories

Non-Volatile		Volatile	
EPROM	Serial EEPROM	BiCMOS ECL I/O SRAM	TTL I/O SRAM
✓	✓	✓	✓

Memory—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

BiCMOS ECL I/O SRAMs

With the introduction of the first family of high-performance 15-ns 256-kbit x 1 static RAMs, National offers you devices truly optimized for speed and density.

Based on our proprietary one-micron BiCMOS III process, our ECL I/O SRAMs combine the speed advantages of ECL with the high density and low power of CMOS technology to bring a new level of system performance to your application.

With a 262, 144-bit x 1 organization, our devices offer four times the density of 64-kbit ECL chips in one-fourth the space. Which means you can boost system performance significantly.

Our 15-ns BiCMOS SRAMs are available in two voltage-supply versions. The NM5100 version operates from a −5.2V ±5 percent supply and offers 100k-compatible, temperature compensated I/O. The NM100500 version operates from a −4.2V to −4.5V supply. Industry-standard pin-outs ensure multiple sourcing. In addition to our high-performance SRAMs, National is also developing a family of specialty ECL I/O RAMs (e.g., self-timed RAMs, FIFO's) and ECL RAMs in advanced packaging (e.g., Modules, Tape-Pak) for your system needs.

BiCMOS ECL I/O Static RAM Selection Guide

Part Number	Organization	Pins	Access (ns)	Temperature Range
STATIC RAMs				
NM100500/5100	256k x 1	24	15	0°C to +85°C
NM100504/5104	64k x 4	28	15	0°C to +85°C
NM100494/4494	16k x 4	28	12	0°C to +85°C
ADVANCED SELF-TIMED STATIC RAMS				
NM100492	2k x 9	64	7, 10	0°C to +85°C

TTL I/O SRAM

National is the largest supplier of low-density bipolar TTL I/O SRAMs in both commercial and military applications. We offer a range of reliable, high-speed, low-power devices, from 64 bits to 2 kbits.

We're also one of the only bipolar TTL I/O RAM suppliers that offer MIL-STD-883 specs. We offer a full range of JAN- qualified 1k TTL I/O SRAMs, too. And while other manufacturers are abandoning their customers in this important product category, we continue to improve speed, ESD and soft-error rate characteristics for improved system performance.

TTL I/O Static RAM Selection Guide

Part Number	Organization	Outputs	Pins	Access Time	Temperature Range
CMOS TTL I/O STATIC RAMS					
1600ADMQB30	64k x 1	TS	22	30	−55°C to +125°C
1600ADMQB35	64k x 1	TS	22	35	−55°C to +125°C
1600ADMQB45	64k x 1	TS	22	45	−55°C to +125°C
1600ADMQB55	64k x 1	TS	22	55	−55°C to +125°C
1600ADMQB70	64k x 1	TS	22	70	−55°C to +125°C
1600ALMQB30	64k x 1	TS	22	30	−55°C to +125°C
1600ALMQB35	64k x 1	TS	22	35	−55°C to +125°C
1600ALMQB45	64k x 1	TS	22	45	−55°C to +125°C
1600ALMQB55	64k x 1	TS	22	55	−55°C to +125°C
1600ALMQB70	64k x 1	TS	22	70	−55°C to +125°C
1601ADMQB30	64k x 1	TS	22	30	−55°C to +125°C
1601ADMQB35	64k x 1	TS	22	35	−55°C to +125°C
1601ADMQB45	64k x 1	TS	22	45	−55°C to +125°C
1601ADMQB55	64k x 1	TS	22	55	−55°C to +125°C
1601ADMQB70	64k x 1	TS	22	70	−55°C to +125°C
1601ALMQB30	64k x 1	TS	22	30	−55°C to +125°C
1601ALMQB35	64k x 1	TS	22	35	−55°C to +125°C
1601ALMQB45	64k x 1	TS	22	45	−55°C to +125°C
1601ALMQB55	64k x 1	TS	22	55	−55°C to +125°C
1601ALMQB70	64k x 1	TS	22	70	−55°C to +125°C
1620DMQB30	16k x 4	TS	22	30	−55°C to +125°C
1620DMQB35	16k x 4	TS	22	35	−55°C to +125°C
1620DMQB45	16k x 4	TS	22	45	−55°C to +125°C
1620DMQB55	16k x 4	TS	22	55	−55°C to +125°C
1620DMQB70	16k x 4	TS	22	70	−55°C to +125°C
1620LMQB30	16k x 4	TS	22	30	−55°C to +125°C
1620LMQB35	16k x 4	TS	22	35	−55°C to +125°C
1620LMQB45	16k x 4	TS	22	45	−55°C to +125°C
1620LMQB55	16k x 4	TS	22	55	−55°C to +125°C
1620LMQB70	16k x 4	TS	22	70	−55°C to +125°C
1621DMQB30	16k x 4	TS	22	30	−55°C to +125°C
1621DMQB35	16k x 4	TS	22	35	−55°C to +125°C
1621DMQB45	16k x 4	TS	22	45	−55°C to +125°C
1621DMQB55	16k x 4	TS	22	55	−55°C to +125°C
1621DMQB70	16k x 4	TS	22	70	−55°C to +125°C
1621LMQB30	16k x 4	TS	22	30	−55°C to +125°C
1621LMQB35	16k x 4	TS	22	35	−55°C to +125°C
1621LMQB45	16k x 4	TS	22	45	−55°C to +125°C
1621LMQB55	16k x 4	TS	22	55	−55°C to +125°C
1621LMQB70	16k x 4	TS	22	70	−55°C to +125°C

TTL I/O Static RAM Selection Guide (Continued)

Part Number	Organization	Outputs	Pins	Access Time	Temperature Range
CMOS TTL I/O STATIC RAMS (Continued)					
1624DMQB30	16k x 4, OE	TS	24	30	−55°C to +125°C
1624DMQB35	16k x 4, OE	TS	24	35	−55°C to +125°C
1624DMQB45	16k x 4, OE	TS	24	45	−55°C to +125°C
1624DMQB55	16k x 4, OE	TS	24	55	−55°C to +125°C
1624DMQB70	16k x 4, OE	TS	24	70	−55°C to +125°C
1624LMQB30	16k x 4, OE	TS	28	30	−55°C to +125°C
1624LMQB35	16k x 4, OE	TS	28	35	−55°C to +125°C
1624LMQB45	16k x 4, OE	TS	28	45	−55°C to +125°C
1624LMQB55	16k x 4, OE	TS	28	55	−55°C to +125°C
1624LMQB70	16k x 4, OE	TS	28	70	−55°C to +125°C
1625DMQB30	16k x 4, OE	TS	24	30	−55°C to +125°C
1625DMQB35	16k x 4, OE	TS	24	35	−55°C to +125°C
1625DMQB45	16k x 4, OE	TS	24	45	−55°C to +125°C
1625DMQB55	16k x 4, OE	TS	24	55	−55°C to +125°C
1625DMQB70	16k x 4, OE	TS	24	70	−55°C to +125°C
1625LMQB30	16k x 4, OE	TS	28	30	−55°C to +125°C
1625LMQB35	16k x 4, OE	TS	28	35	−55°C to +125°C
1625LMQB45	16k x 4, OE	TS	28	45	−55°C to +125°C
1625LMQB55	16k x 4, OE	TS	28	55	−55°C to +125°C
1625LMQB70	16k x 4, OE	TS	28	70	−55°C to +125°C
NMOS TTL I/O STATIC RAMS					
NMC2147H	4k x 1	TS	18	70	0°C to +70°C
NMC2147H-3	4k x 1	TS	18	55	0°C to +70°C
NMC2147H-2	4k x 1	TS	18	45	0°C to +70°C
NMC2147H-1	4k x 1	TS	18	35	0°C to +70°C
NMC2147H-3L	4k x 1	TS	18	55	0°C to +70°C
NMC2148H	1k x 4	TS	18	70	0°C to +70°C
NMC2148H-3	1k x 4	TS	18	55	0°C to +70°C
NMC2148H-2	1k x 4	TS	18	45	0°C to +70°C
NMC2148H-1	1k x 4	TS	18	70	0°C to +70°C
NMC2148H-3L	1k x 4	TS	18	55	0°C to +70°C

TTL I/O Static RAM Selection Guide (Continued)

Part Number	Organization	Outputs	Pins	Access Time	Temperature Range
BIPOLAR TTL I/O STATIC RAMS					
DM54S189J/883	16 x 4	TS	16	50	−55°C to +125°C
DM74S189	16 x 4	TS	16	35	0°C to +70°C
DM74S189A	16 x 4	TS	16	25	0°C to +70°C
DM74S289	16 x 4	OC	16	35	0°C to +70°C
93L415A	1k x 1	OC	16	25	0°C to +70°C
93L415DMQB	1k x 1	OC	16	40	−55°C to +125°C
93L422A	256 x 4	TS	22	25	0°C to +70°C
93L422DMQB	256 x 4	TS	22	35	−55°C to +125°C
93L425A	1k x 1	TS	16	25	0°C to +70°C
93L425DMQB	1k x 1	TS	16	35	−55°C to +125°C
93479A	256 x 9	TS	22	35	0°C to +70°C
93479DMQB	256 x 9	TS	22	45	−55°C to +125°C
EDGE-TRIGGERED REGISTERS					
DM75S68	16k x 4	TS	16	55	−55°C to +125°C
DM75S68A	16k x 4	TS	16	45	−55°C to +125°C
DM85S68	16k x 4	TS	16	40	0°C to +70°C
DM85S68A	16k x 4	TS	16	24	0°C to +70°C
FIFO's					
DM75X431	64 x 8	TS	24		−55°C to +125°C
DM85X431	64 x 8	TS	24		0°C to +70°C
DM75X432	128 x 4	TS	18		−55°C to +125°C
DM85X432	128 x 4	TS	18		0°C to +70°C
DM85X433	128 x 5	TS	20		−55°C to +125°C
DM85X433	128 x 5	TS	20		0°C to +70°C

CMOS EPROMS

In 1981, National was the first manufacturer to introduce a 16-kbit EPROM in CMOS. Today, we offer the most complete CMOS EPROM family, ranging from 16 kbit to 1 Mbit.

Our high-performance 512-kbit devices post access times of 90 ns. Our 1 Mbit devices run at 120 ns.

All devices consume extremely low levels of power and can be operated with a single 5V power supply. Devices are available in both extended and mil temperature ranges, and are compliant with MIL-STD-883C and applicable standard military drawings.

CMOS EPROMs

Part No.	Org.	No. of Pins	Access Time	Temp. Range
NMC27C16Q	2k x 8	24	300, 350, 450, 550	0°C to +70°C
NMC27C16QE	2k x 8	24	450	−40°C to +85°C
NMC27C16Q45/883	2k x 8	24	450	−55°C to +125°C
NMC27C16Q55/883	2k x 8	24	550	−55°C to +125°C
NMC27C32Q	4k x 8	24	300, 350, 450, 550	0°C to +70°C
NMC27C32QE	4k x 8	24	450	−40°C to +85°C
NMC27C32Q45/883	4k x 8	24	450	−55°C to +125°C
NMC27C32BQ	4k x 8	24	120, 150, 200, 250	0°C to +70°C
NMC27C32BQE	4k x 8	24	200, 250	−40°C to +85°C
NMC27C64BQ/BN	8k x 8	28	120, 150, 200, 250	0°C to +70°C
NMC27C64BQE	8k x 8	28	120, 150, 200	−40°C to +85°C
27C64Q350/883	8k x 8	28	350	−55°C to +125°C
27C64Q250/883	8k x 8	28	250	−55°C to +125°C
27C64Q200/883	8k x 8	28	200	−55°C to +125°C
27C64E350/883	8k x 8	32	350	−55°C to +125°C
27C64E250/883	8k x 8	32	250	−55°C to +125°C
27C64E200/883	8k x 8	32	200	−55°C to +125°C
NMC27C128BQ/BN	16k x 8	28	120, 150, 200, 250	0°C to +70°C
NMC27C128BQE	16k x 8	28	120, 150, 200	−40°C to +85°C
27CP128Q350/883	16k x 8	28	350	−55°C to +125°C
27CP128Q300/883	16k x 8	28	300	−55°C to +125°C
27CP128Q250/883	16k x 8	28	250	−55°C to +125°C
27CP128E350/883	16k x 8	32	350	−55°C to +125°C
27CP128E300/883	16k x 8	32	300	−55°C to +125°C
27CP128E250/883	16k x 8	32	250	−55°C to +125°C
NMC27C256BQ/BN	32k x 8	28	90, 100, 120, 150, 200, 250	0°C to +70°C
NMC27C256BQE	32k x 8	28	120, 150, 200	−40°C to +85°C
27C256Q350/883	32k x 8	28	350	−55°C to +125°C
27C256Q300/883	32k x 8	28	300	−55°C to +125°C
27C256Q250/883	32k x 8	28	250	−55°C to +125°C
27C256E350/883	32k x 8	32	350	−55°C to +125°C
27C256E300/883	32k x 8	32	300	−55°C to +125°C
27C256E250/883	32k x 8	32	250	−55°C to +125°C
NMC27C512AQ/AN	64k x 8	28	90, 100, 120, 150, 200, 250	0°C to +70°C
NMC27C512AQE	64k x 8	28	120, 150, 200	−40°C to +85°C
NMC27C010Q	128k x 8	32	120, 150, 170, 200, 250	0°C to +70°C
NMC27C010QE	128k x 8	32	150, 170, 200	−40°C to +85°C
NMC27C1024Q	64k x 16	40	120, 150, 170, 200, 250	0°C to +70°C
NMC27C1024QE	64k x 16	40	150, 170, 200	−40°C to +85°C

EEPROM

National pioneered the low-density serial 256-bit EEPROM in 1981. Since then, we've added 14 more serial products and three parallel-format products, all available in commercial, industrial and military temperature ranges. Most are available in both conventional dual-in-line and space-saving small-outline packages.

All told, we offer far more low-density EEPROMs than any other manufacturer in the world. More importantly, we ship more EEPROMs, regardless of density, than any manufacturer in the world. And that number promises to grow as we add application-specific EEPROMs to the family.

In addition to our existing family of NMOS EEPROMs, we have developed a CMOS family of non-volatile serial-interface EEPROMs that offer higher endurance, lower power consumption, and faster operation while retaining user-friendly features of the NMOS devices.

What's more, these 2-micron N-well CMOS devices incorporate several unique features that add significant performance value:

Write protection allows you to transform the entire memory, or a portion of it, into ROM.

Sequential register read automatically cycles the memory to the next register during a READ operation to produce a serial data stream. In this way the entire memory can be read in one continuous data stream or as registers of varying length which means the EEPROM can be used as a non-volatile shift register.

You'll also reduce programming time and system complexity because, unlike earlier versions of these memories in which each register must be erased before being written, the new memories do not require a separate ERASE cycle before a WRITE cycle.

These new devices are clocked at 1 MHz and require only 1.8 μA typical of I_{CC} current in the active mode and only 10 μA typical in the standby mode.

The write cycle time is only 5 ms typical and 10 ms maximum.

The family is also offered in an extended voltage range of 3.0V to 5.5V for battery-operated applications.

EEPROM Selection Guide

Part Number	Organization	Pins	Access Time (ns)	Operating Temperature
SERIAL				
NMOS EEPROM				
NMC9306	16 x 16	8	2	C, E, M
NMC9307		8	2	
NMC9313B		8	2	C
NMC9346	64 x 16	8	2	C, E, M
NMC9314B		8	2	C
CMOS EPROM				
NMC9306 NMC93CS06*	16 x 16 Serial	8	500	C, E, M
NMC93C26 NMC93CS26*	32 x 16 Serial	8	500	
NMC93C46 NMC93CS46*	64 x 16 Serial	8	500	
NMC93C56 NMC93CS56*	128 x 16 Serial	8	500	
NMC93C66 NMC93CS66*	256 x 16 Serial	8	500	

C = 0°C to +70°C

E = −40°C to +85°C

M = −55°C to +125°C

Bipolar PROM Selection Guide

Non-Registered PROMs

Part Number	Organization	Output	Pins (DIP)	Access Time (ns)	Temperature Range
DM54S188J/883	32 x 8	OC	16	45	−55°C to +125°C
DM74S188	32 x 8	OC	16	35	0°C to +70°C
DM54S288J/883	32 x 8	TS	16	45	−55°C to +125°C
DM74S288	32 x 8	TS	16	35	0°C to +70°C
DM74S188A	32 x 8	OC	16	25	0°C to +70°C
DM74S288A	32 x 8	TS	16	25	0°C to +70°C
PL87X288B	32 x 8	TS	16	15	0°C to +70°C
DM54S387J/883	256 x 4	OC	16	60	−55°C to +125°C
DM74S387	256 x 4	OC	16	50	0°C to +70°C
DM54S287J/883	256 x 4	TS	16	60	−55°C to +125°C
DM74S287	256 x 4	TS	16	50	0°C to +70°C
DM74S387A	256 x 4	OC	16	30	0°C to +70°C
DM74S287A	256 x 4	TS	16	30	0°C to +70°C
DM54S570J/883	512 x 4	OC	16	65	−55°C to +125°C
DM74S570	512 x 4	OC	16	55	0°C to +70°C
DM54S571J/883	512 x 4	TS	16	65	−55°C to +125°C
DM74S571	512 x 4	TS	16	55	0°C to +70°C
DM74S570A	512 x 4	OC	16	45	0°C to +70°C
DM74S571A	512 x 4	TS	16	45	0°C to +70°C
DM74S571B	512 x 4	TS	16	35	0°C to +70°C
DM74LS471	256 x 8	TS	20	60	0°C to +70°C
DM54S473J/883	512 x 8	OC	20	75	−55°C to +125°C
DM74S473	512 x 8	OC	20	60	0°C to +70°C
DM54S472J/883	512 x 8	TS	20	75	−55°C to +125°C
DM74S472	512 x 8	TS	20	60	0°C to +70°C
DM74S473A	512 x 8	OC	20	45	0°C to +70°C
DM74S472A	512 x 8	TS	20	45	0°C to +70°C
DM74S472B	512 x 8	TS	20	35	0°C to +70°C
DM54S475J/883	512 x 8	OC	24	75	−55°C to +125°C
DM74S475	512 x 8	OC	24	65	0°C to +70°C
DM54S474J/883	512 x 8	TS	24	75	−55°C to +125°C
DM74S474	512 x 8	TS	24	65	0°C to +70°C
DM74S475A	512 x 8	OC	24	45	0°C to +70°C
DM74S474A	512 x 8	TS	24	45	0°C to +70°C
DM74S474B	512 x 8	TS	24	35	0°C to +70°C
DM54S572/883	1024 x 4	OC	18	75	−55°C to +125°C
DM74S572	1024 x 4	OC	18	60	0°C to +70°C
DM54S573J/883	1024 x 4	TS	18	75	−55°C to +125°C
DM74S573	1024 x 4	TS	18	60	0°C to +70°C
DM74S572A	1024 x 4	OC	18	45	0°C to +70°C
DM74S573A	1024 x 4	TS	18	45	0°C to +70°C
DM74S573B	1024 x 4	TS	18	35	0°C to +70°C
DM87S180	1024 x 8	OC	24	55	0°C to +70°C
DM87S280	1024 x 8	OC	24	55	0°C to +70°C

Bipolar PROM Selection Guide (Continued)

Non-Registered PROMs (Continued)

Part Number	Organization	Output	Pins (DIP)	Access Time (ns)	Temperature Range
DM87S181	1024 x 8	TS	24	55	0°C to +70°C
DM87S281	1024 x 8	TS	24	55	0°C to +70°C
DM87S181A	1024 x 8	TS	24	45	0°C to +70°C
DM77S184J/883	2048 x 4	OC	18	70	−55°C to +125°C
DM87S184	2048 x 4	OC	18	55	0°C to +70°C
DM77S185J/883	2048 x 4	TS	18	70	−55°C to +125°C
DM87S185	2048 x 4	TS	18	55	0°C to +70°C
DM87S185A	2048 x 4	TS	18	45	0°C to +70°C
DM87S185B	2048 x 4	TS	18	35	0°C to +70°C
DM87S195A	4096 x 4	TS	20	45	0°C to +70°C
DM87S195B	4096 x 4	TS	20	35	0°C to +70°C

Registered PROMs

Part Number	Organization	Pins	t_{SA} (Min) In ns	Temperature Range
DM87SR474	512 x 8	24	50	0°C to +70°C
DM87SR474B	512 x 8	24	35	0°C to +70°C
DM87SR476	512 x 8	24	50	0°C to +70°C
DM87SR476B	512 x 8	24	35	0°C to +70°C
DM87SR27	512 x 8	24	50	0°C to +70°C
DM87SR27B	512 x 8	24	35	0°C to +70°C
DM87SR181	1024 x 8	24	40	0°C to +70°C
DM87SR183	1024 x 8	24	40	0°C to +70°C
DM87SR183B	1024 x 8	24	35	0°C to +70°C
DM87SR191	2048 x 8	24	18	0°C to +70°C
DM87SR193	2048 x 8	24	18	0°C to +70°C

Section 8
Microcontrollers

Section 8 Contents Microcontrollers

Microcontroller

Practical Solutions to Real Problems

Microcontrollers have always been driven by customer need rather than technological capability.

They were designed to meet specific needs with specific performance in specific applications with specific cost.

That also meant, however, that your choices were limited to what was available on the market—which meant possibly having to compromise your design objectives because you couldn't get exactly the microcontroller you needed.

No more.

Now you can get a microcontroller from National that spans a wide range of system solutions—to go almost anywhere your design imagination takes you.

Whether you need a low-cost 4-bit workhorse or a 16-bit 30 MHz powerhouse, whether you want ½ kbyte of ROM or over 64 kbytes, whether you're building a simple singing greeting card or a complex telecommunications network, we have a microcontroller for the job.

With on-board CPU, memory, internal logic, and I/Os, National microcontrollers are helping more and more designers lower system costs and shrink system size.

And as technology brings more peripheral functions onto the chip, including user-programmable memory, fast SRAM, timers, UARTs, comparators, A/D converters, and LAN interfaces, the microcontroller will become the cost-efficient choice for even such real-time "microprocessor" applications as laser printers, ISDN, and digital signal processing.

That's why National continues to lead the industry in the development of microcontroller technology.

That's why we're including our 8-bit and 16-bit controller cores in our standard-cell library.

That's why we're scaling our common M²CMOS™ process for submicron feature sizes, hypermegahertz frequencies, and unparalleled performance levels.

That's why we offer you "Hot-Line" applications support and a 24-hour-a-day digital information service.

That's why we offer you IBM®-PC and DEC™- VAX™-based development tools and high-level-language (C) compilers

And that's why we've committed the full resources of our company to provide you with the most complete, most reliable, most cost-effective systems solution for all your needs.

This databook is a reflection of that committment.

It will give you an overview of microcontrollers in general and of National's microcontrollers in particular.

It will help you evaluate your microcontroller options from both a business perspective and an engineering perspective.

It will help you make reasoned judgements about selecting the best microcontroller for your needs.

And it will show you what the microcontroller future holds in store for all of us.

If you'd like more information, or you'd like to find out how to put a icrocontroller to work in your own application, just contact your local National Semiconductor Sales Office.

Microcontroller—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

How to Select a Microcontroller

Microcontrollers have evolved far beyond their origins as control chips in calculators.

Today, microcontrollers can be the perfect solution for simplifying a wide range of designs. And for giving those designs a clear competitive advantage in the marketplace.

Whether used for simple logic replacement or as an integral part of a high performance system, a microcontroller can reduce system costs, shrink system size, and shorten system design cycles. And yet deliver performance often superior to "traditional" digital solutions.

Still, all microcontrollers are not created equal. And it's important to consider a number of factors before committing to a particular device:

1. Is the microcontroller optimized for your specific application in terms of speed, performance, features, and cost?
2. Is it code-efficient, and based on a true microcontroller architecture for the highest performance and efficiency?
3. Is it fabricated in the most advanced CMOS process technology, and is it fully scalable to maintain its performance edge in the future?
4. Is it supported by a comprehensive family of development tools that run on standard platforms such as the IBM-PC and DEC VAX?
5. Is it backed by a dedicated team of professionals who are available not only to provide expert training for new users, to get them on-line quickly and efficiently, but also to provide technical guidance for even the most experienced user?
6. Is it designed for the future, with the capability of on-chip gate arrays and with the planned implementation of the controller core as a standard-cell functional block?

If you answered "yes" to all these questions, then you already know that there's only one company with the product depth and technology capability to provide you with a microcontroller optimized for your specific application.

National Semiconductor.

You'll find National Microcontrollers in:
Laser Printers
Disc Controllers
Telecommunications Systems
Keyboards
Airplane Multiplex Systems
Car Radios
Engine Control Systems
Anti-Skid Brake Systems
Armaments
Factory Automation
Medical Equipment
Fuses
Scales
Refrigerators
Security Systems
Garage Door Openers
Camera Aperture Controls
Office Copiers
Cable TV Converters
Televisions
Video Recorders
Solar Heating Controls
Thermostats
Climate Control Systems
Intelligent Toys
Kitchen Timers

Why Select a National Microcontroller

National has created the most complete selection of 4-, 8-, and 16-bit microcontrollers of any company in the industry.

Which means that no matter what the specific needs of your application are, you can find a National microcontroller to meet them.

Our COP400 family offers the lowest-cost, 4-bit solutions for timing, counting, and control functions.

Our COP800 family offers low-cost, feature-rich, 8-bit solutions.

And our High Performance microController (HPC™) family offers the highest performance with the world's fastest 16-bit CMOS solution.

1.0 Common Features for a Custom Fit

All our microcontrollers are designed to provide not just a one-time-only solution, but a continuum of solutions to meet the changing demands of your product and the marketplace.

Our COP400 family, for example, which consists of over 60 devices, is designed with a common instruction set, so you can migrate from one member of the family to others without having to recode, so you can take efficient advantage of the application-specific flexibility of the COP400 family's programmable I/O options.

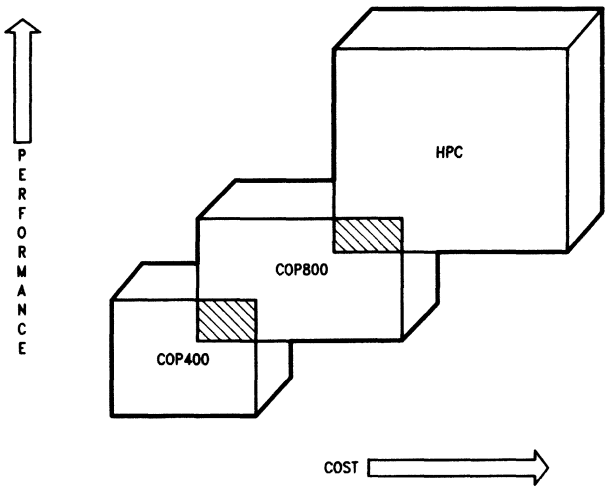
Our COP800 and HPC families, on the other hand, are each designed around a common CPU core that then can be surrounded by a variety of standard functional building blocks such as RAM, ROM, user programmable memory, fast SRAM, DMA, UART, comparator, A/D, HDLC, and I/O.

This unique core approach allows us to offer you a microcontroller with the exact combination of CPU power and peripheral function you need for your specific application. So you don't have to compromise your design parameters by using an inappropriate device, and you don't have to compromise your cost parameters by paying for performance and features you don't need.

This core concept also allows us to bring new microcontroller products to market fast and at a lower cost to help you keep pace with the rapidly changing conditions in your own market.

And it allows us to implement both the COP800 and the HPC cores as standard cells, for the highest levels of integration and flexibility in your own proprietary design.

Microcontroller Family of Products



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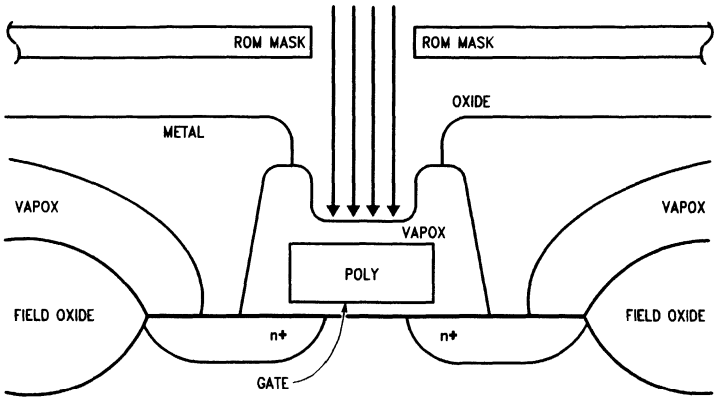
With a full range of performance- and feature-options, National's microcontroller families can be customized to meet the needs of your specific application.

COP400 Post-Metal ION Implant



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2.0 True Microcontroller Architecture

Our microcontrollers are designed as true controllers, not modified microprocessors.

The COP400 family is designed with a two-bus Harvard architecture; the COP800 family with a memory-mapped, modified Harvard architecture, and the HPC family with a memory-mapped, von Neumann architecture.

All three control-oriented families, however, are optimized for high code efficiency. Most instructions are only 1 byte long—yet each can typically execute several functions. This "function-dense" code provides a substantial increase in memory efficiency and processing speed.

3.0 Advanced Process and Packaging Technologies

National offers you not only the right microcontroller for your needs, but also the right process technology for your microcontroller.

COP400 devices are available in both high-speed NMOS and low-power CMOS fabrications, while the higher-performance COP800 and HPC families are both fabricated in National's advanced M^{2}CMOS process.

M^{2}CMOS. This double-metal CMOS process offers significant design advantages. It combines the speed of NMOS, the ruggedness of bipolar, and the low power consumption of bulk CMOS to produce fast, dense, highly efficient, highly scalable devices for a wide variety of integrated-circuit designs.

It's for these reasons that M^{2}CMOS has become the standard process technology for all of National's advanced-technology LSI and VLSI products, including microprocessors, gate arrays, standard cells, telecommunications devices, linear devices and, of course, microcontrollers.

Post-Metal Programming (PMP). This is a new process technology available from no other semiconductor manufacturer in the world. It offers the fastest, guaranteed prototype programmed-ROM turntime in the industry.

PMP is a high-energy implantation process that allows microcontroller ROM to be programmed **after** final metallization.

This is a true innovation, because ROM is usually implemented in the second die layer, with nine or ten other layers then added on top. And that means the ROM pattern must be specified early in the production process, and completed prototype devices won't be available typically for six weeks.

With PMP, however, dice can be fully manufactured through metallization and electrical tests (only the passivation layers need to be added), and held in inventory. Which means ROM can be programmed late in the production cycle, **making prototypes available in only two weeks!**

And production parts can follow in as little as four weeks.

PMP allows you to adapt to fast-changing market conditions and to take maximum advantage of narrow windows of opportunity.

And shorter production lead times can simplify your inventory control and reduce safety stock by up to 20%, giving you significant cost reductions.

Currently, Post-Metal Programming is available for selected members of the COP400 family, and will be expanded to the COP800 and HPC familes in the near future.

Military versions. All National microcontrollers have CMOS parts available in the full military temperature range (−55°C to +125°C). Each of these parts is a candidate for qualification to MIL-STD-883C and/or DESC specifications. Many of the parts in both the COP and HPC families have already been certified as being Mil. Spec. Compliant. When the COP or HPC is a solution to a military application, introduce the part to the customer. Mil/Aero, working with Microcontrollers, will support the venture.

Packaging. One major reason that National microcontrollers demonstrate such consistently high levels of reliability is that we've developed special advanced packaging processes to protect the die.

For example, we've designed a unique leadframe with "locking holes" that helps block any penetrating moisture from reaching the die itself.

And the leadframes themselves are made of an unusual high-strength copper alloy that has a lower thermal resistance (θ_{JA}) than typical Alloy 42-leadframes.

We've also employed a unique low-stress, high-purity epoxy molding compound for our packages, which gives them a coefficient of expansion that nearly matches that of the leadframes. As a result, many of our microcontrollers are also offered in plastic packages for military-temperature-range operation.

Reliability is built-in at the die level as well. Our M²CMOS microcontrollers are fabricated on dedicated lines at our world-class, six-inch wafer-fab facility in Arlington, Texas. With its Class-10 clean rooms and automated-handling system, Arlington has set a standard of reliability equalled by few other companies in the industry.

And this reliability is available to you in a wide variety of microcontroller packages, ranging in size from 20 to 84 pins.

Package types include plastic and ceramic DIPs, small outline (S.O.) surface mounts, plastic and ceramic leaded chip carriers, and pin grid arrays.

Or, you can select the world's most advanced, high-density packaging option, TapePak™.

TapePak combines the advantages of an automated tape-and-reel-type delivery system with built-in testing pads for reliability and a unique plastic package carrier. The result is a surface-mounted package that can be as small as 1/10 the size of conventional surface mounts, with lead spacings of 20 mils.

4.0 Full Development Support

Even the right microcontroller, of course, is useless without the right development tool to put that controller to work in your application.

That's why National offers you a full range of development support. Ready-to-run evaluation boards. Emulators. Software. Prototyping devices. Training and seminars for beginning and advanced users. Everything you need to take your design from concept to reality.

And you don't need an expensive development environment to do it. With our exclusive Microcontroller On-Line Emulator (MOLE™), a standard IBM PC or DEC VAX becomes a full-featured platform.

And with our comprehensive library of prewritten routines, from keyboard scanners to Fast Fourier Transforms, you can reduce software programming to a minimum. This "user-friendly" service can help you bring your design to market quickly and cost-effectively.

5.0 Full Applications Support

At National, we believe that applications support should be immediate and "hands-on".

That's why we established the unique Dial-A-Helper program.

With a computer, modem, and telephone, you can tie directly into our Microcontroller Applications Group for fast, direct assistance in developing your design.

You can leave messages on our electronic bulletin board for our Applications Engineers, who will respond to you directly.

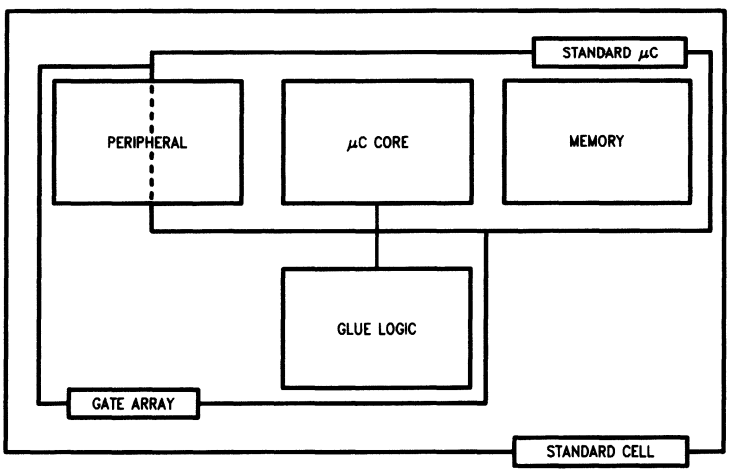
You can access applications files.

You can download those files for later reference.

Or, if you're having a real problem, you can actually turn the control of your Microcontroller On-Line Emulator development system over to our engineering staff, who can perform remote diagnostic routines to locate and eliminate any bugs.

The point is, when you buy a microcontroller from National, you're buying more than silicon—you're buying the commitment of an entire company of dedicated professionals who share a single goal: to help you put that silicon to **work**.

Systems in the Future—Integration Path



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6.0 The ASIC Future

National's microcontrollers were designed to meet two objectives: to adapt to your evolving needs, and to adapt to evolving technology.

Both "evolutions," however, are leading to the same goal: the complete "system-on-chip" solution. Already, the glue logic that ties a microcontroller to its peripheral functions can be replaced with a gate array. And soon, all three functions (microcontroller "core", logic, and peripherals) will be available as a single standard-cell functional block.

The key to achieving this goal, of course, is a common, advanced, scalable process technology.

That's why both the COP800 and HPC families are fabricated in our high-performance double-metal CMOS process. This is a highly scalable technology that can accommodate die shrinks to submicron feature sizes, increasing performance and cutting power consumption with each step.

Moreover, because M^2CMOS is now the standard process technology for all new National LSI and VLSI devices, the COP800 and HPC cores will not only be available as part of our standard-cell library, but will also be able to support one of the broadest range of functional blocks available from any semiconductor manufacturer—all aligned on the same set of design rules.

So you can standardize your designs on just one or two core processors, and, as we introduce new technologies and functions, you can maintain that design knowledge base while taking advantage of these new, higher levels of functional integration.

And because National (and **only** National) gives you the option of using standard parts or designing your own customized solutions—both supported by common design tools and a common process—you can create highly competitive, highly secure, highly optimized solutions in minimal space at minimal cost in minimal time.

And that's the name of the game.

The 16-Bit HPC™ Family: Optimized for Performance

Key Features

- World's first 16-bit CMOS microcontroller
- World's fastest CMOS microcontroller
- 134 ns instruction-cycle time at 30 MHz
- Full 16-bit architecture and implementation
- 64 kbyte address space
- High code efficiency with single-byte, multiple-function instructions
- 16 x 16-bit multiply, 32 x 16-bit divide
- Eight vectored interrupt sources
- Watchdog logic monitors
- 16-bit timer/counters
- Up to 52 general-purpose high-speed I/O lines
- On-chip ROM to 16 kbytes
- On-chip RAM to 512 bytes
- On-chip peripherals
  - — DMA
  - — HDLC
  - — Timers
  - — Input-capture registers
  - — A/D converter
  - — UART
  - — User-programmable memory
  - — High speed SRAM
- M²CMOS fabrication
- MICROWIRE/PLUS™ serial interface
- ROMless versions available
- Military temp range available (−55°C to +125°C)
- MIL-STD-883C qualified
- 68-pin PGA, PLCC, LDCC, LCC and 84-pin/TapePak® packages

National's High Performance Controller (HPC) family is not only the world's first 16-bit CMOS microcontroller family, but also the world's fastest.

Currently operating at a clock rate of 30 MHz, the HPC's 2-micron geometry is fabricated in scalable M²CMOS, allowing die-shrinks to 1.25 microns and, ultimately, to submicron levels. Meaning the HPC will be operating at much higher frequencies in the future.

The HPC is designed for high-performance applications. With its 134 ns instruction cycle and its 16 x 16-bit multiply and 32 x 16-bit divide, the HPC is appropriate for compute-intensive environments that used to be the sole domain of the microprocessor.

The HPC is ideal, for example, for signal conditioning applications. The HPC's high throughput helps eliminate external components from typical signal processing/control circuits, and allows key parts of the application to be implemented in software rather than hardware.

This not only reduces system cost and development time, but also increases the flexibility and market life of the product.

At the same time, because the HPC has a control-oriented architecture, important functions are still implemented in hardware, providing critical performance advantages unavailable in a pure-software solution, such as a general microprocessor-based design.

It is this powerful performance capability that, when combined with the wide range of peripheral functions that are available (such as UARTs, A/D converters, and HDLC protocol controllers), make the HPC a true systems solution on a chip.

The Powerful HPC Core

The HPC is an "application-specific" microcontroller.

Based on a common, high-performance CPU "core", each HPC family member can be "customized" to meet the exact needs of a particular application.

The core, based on a microprocessor-like von Neumann architecture, contains seven key functional elements:

1. Arithmetic Logic Unit (ALU)
2. 6 working registers
3. 8 interrupts
4. 3 timers
5. Control logic
6. Watchdog circuitry
7. MICROWIRE/PLUS interface

The internal data paths, registers, timers, and ALU are all 16 bits wide.

So the HPC can directly address up to 64 kbytes of "external" memory.

The external data bus, however, is dynamically configurable as 8 or 16 bits, allowing it to efficiently interface with a variety of peripheral devices.

Flexible Peripheral Support

The HPC core can support a full range of peripheral functions:

- High-level Data Link Control (HDLC) for ISO-standard data communications
- Universal Asynchronous Receiver/Transmitters (UARTs) for full-duplex, 300/1200/2400/9600-baud serial communications
- High-Speed Outputs and Pulse-Width Modulated (PWM) timers for efficient external interfaces
- User-programmable memory
- Analog-to-Digital (A/D) converters for interfacing "real-world" inputs

Plus:

- Up to 64 kbytes of direct-addressable memory
- Up to 52 I/O ports on a 68-pin package

Efficient Instruction Set

The HPC family achieves much of its performance through its unique, highly optimized instruction set. Unlike the instruction set of a typical microprocessor, the HPC instruction set is designed for maximum code efficiency. Because ROM-space is necessarily limited on a single-chip solution, programs must be compact and economical.

The HPC instruction set supports nine addressing modes, like a high-performance 16-bit microprocessor. And each instruction in the set is designed to execute a number of individual functions, so the same operations can be executed with tighter code.

As a result, the typical HPC instruction cycle is only 134 ns at 30 MHz. And the typical HPC 16-bit multiply or divide takes less than 4 μs.

To achieve the same level of performance in other 16-bit and high-end 8-bit microcontrollers, as indicated by recent benchmark studies, would require up to *two times the memory space* as the HPC.

Low Power Operation

The HPC uses power as efficiently as it uses memory space.

The HPC draws only 20 mA of current at 17 MHz. And its even less at lower clock rates.

The HPC can also operate effectively at input voltages as low as +3.0V, which further reduces power consumption.

In addition, the HPC has two software-selectable power-down modes:

1. IDLE, which stops all operations except for the oscillator and one timer, thereby maintaining all RAM, registers, and I/O in a static state, cuts current drain to 2 mA.

2. HALT, which stops all operations including the oscillator and timers, but holds RAM, registers, and I/O stable, cuts current drain to only 20 μA.

Key Applications

- Signal conditioning/processing/control
- Automotive systems
- Data processing
- Telecommunications
- Military
- Embedded controllers
- Medical
- Factory automation
- Industrial control
- Compute-intensive environments
- High-end control
- Tape and disk drives
- Security systems
- Laser printers
- SCSI control

High Level Language Support

A C compiler is already available for software development on standard platforms: the IBM PC running DOS or UNIX® or the DEC™ VAX™ running VMS™ or UNIX.

With powerful tools such as these, the HPC can be quickly and efficiently programmed for any high-performance application.

HPC Family of Microcontrollers

Commercial Temp Version 0°C to +70°C	Industrial Temp Version −40°C to +85°C	Military Temp Version −55°C to +125°C	Memory ROM (Bytes)	Memory RAM (Bytes)	I/O I/O Pins	I/O Serial I/O	Features Interrupt	Features Stack	Timer Base Counters	Size (Pins)	Other*
HPC46003	HPC36003	HPC16003†	ROMless	256	52	YES	8 Sources	In RAM	8	68	4 ICR's
HPC46004	HPC36004	HPC16004	ROMless	512	52	YES	8 Sources	In RAM	8	68	4 ICR's
HPC46064	HPC36064	HPC16064	16.0k	512	52	YES	8 Sources	In RAM	8	68	4 ICR's
HPC46083	HPC36083	HPC16083†	8.0k	256	52	YES	8 Sources	In RAM	8	68	4 ICR's
HPC46104	HPC36104	HPC16104	ROMless	512	52	YES	8 Sources	In RAM	8	68	4 ICR's & 8 CH A/D
HPC46164	HPC36164	HPC16164	16.0k	512	52	YES	8 Sources	In RAM	8	68	4 ICR's & 8 CH A/D
HPC46400	HPC36400	HPC16400	N/A	256	56	YES	8 Sources	In RAM	4	68	HDLC & DMA

*ICR = Input Capture Registers

HDLC = High-Level Data Link Control

PEARL = Port Expanded and Recreation Logic

† MIL-STD-883C Qualified

The 8-Bit COP800 Family: Optimized for Value

National's COP800 family provides cost-effective solutions for feature-rich, 8-bit microcontroller applications.

Key Features

- High-performance 8-bit microcontroller
- Full 8-bit architecture and implementation
- 1 μs instruction-cycle time
- High code efficiency with single-byte, multiple-function instructions
- UART
- A/D converter
- Watchdog logic monitor
- On-chip ROM to 4 kbytes
- On-chip RAM to 192 bytes
- EEPROM
- M²CMOS™ fabrication
- MICROWIRE/PLUS™ serial interface
- ROMless versions available
- Wide operating voltage range: +2.5V to +6V
- Military temp range available: −55°C to +125°C
- MIL-STD-883C versions available
- 20- to 44-pin packages (DIP and SMD)

The COP800 combines a powerful single-byte, multiple-function instruction set with a memory-mapped core architecture similar to the HPC™.

And like the HPC, the COP800 family supports a wide variety of ROM, RAM, I/O and peripheral functions.

The COP800 has an instruction-cycle time of only 1 μs, and because over 70% of its instruction set is composed of single-cycle, single-byte instructions, the COP800 can deliver exceptional performance for an 8-bit engine.

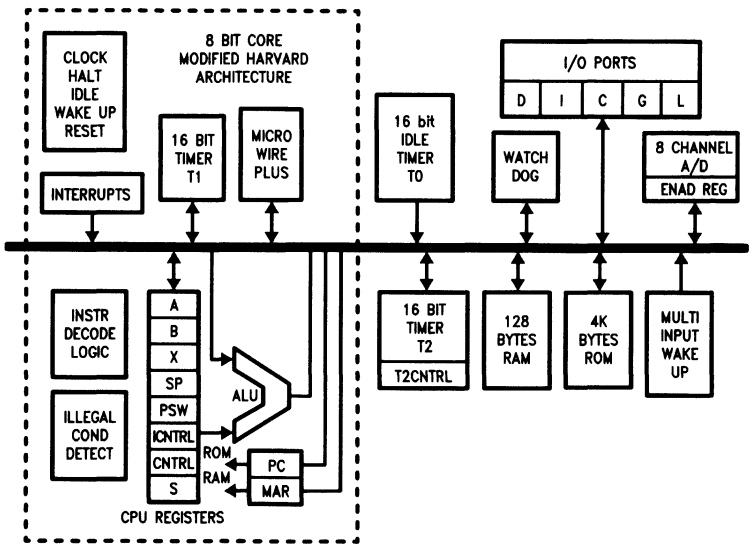
And since it's fabricated in National's advanced M²CMOS process, the COP800 has low current drain, low heat dissipation, and a wide operating voltage range.

Key Applications

- Automotive systems
- Process control
- Robotics
- Telecommunications
- AC-motor control
- DC-motor control
- Keyboard controllers
- Modems
- RS232C controllers

The COP800 family offers high performance in a low-cost, easy-to-design-in package.

COP888CF Block Diagram



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COP800 Family of Microcontrollers

Commercial Temp Version 0°C to +70°C	Industrial Temp Version −40°C to +85°C	Military Temp Version −55°C to +125°C	Memory ROM (Bytes)	Memory RAM (Bytes)	Features I/O I/O Pins	Features I/O Serial I/O	Features Interrupt	Features Stack	Features Timer Base Counters	Features Size (Pins)	Features Other*
	COP820C	COP620C	1.0k	64	24	Yes	3 Sources	In RAM	1	28	
	COP821C	COP621C	1.0k	64	20	Yes	3 Sources	In RAM	1	24	
	COP822C	COP622C	1.0k	64	16	Yes	3 Sources	In RAM	1	20	
	COP8720C		1.0k EE	64	24	Yes	3 Sources	In RAM	1	28	64 x 8 EEPROM in RAM
	COP8721C		1.0k EE	64	20	Yes	3 Sources	In RAM	1	24	64 x 8 EEPROM in RAM
	COP8722C		1.0k EE	64	16	Yes	3 Sources	In RAM	1	20	64 x 8 EEPROM in RAM
	COP840C	COP640C	2.0k	128	24	Yes	3 Sources	In RAM	1	28	
	COP841C	COP641C	2.0k	128	20	Yes	3 Sources	In RAM	1	24	
	COP842C	COP642C	2.0k	128	16	Yes	3 Sources	In RAM	1	20	
	COP8640C		2.0k	64	24	Yes	3 Sources	In RAM	1	28	64 x 8 EEPROM in RAM
	COP8641C		2.0k	64	20	Yes	3 Sources	In RAM	1	24	
	COP8642C		2.0k	64	21	Yes	3 Sources	In RAM	1	20	
	COP884CF	COP684CF	4.0k	128	21	Yes	10 Sources	In RAM	2	28	2 PWM & A/D
	COP884CG	COP684CG	4.0k	192	23	Yes	14 Sources	In RAM	3	28	3 PWM & UART
	COP884CL	COP684CL	4.0k	128	23	Yes	10 Sources	In RAM	2	28	2 PWM
	COP888CF	COP688CF	4.0k	128	33/37	Yes	10 Sources	In RAM	2	40/44	2 PWM & A/D
	COP888CG	COP688CG	4.0k	192	35/39	Yes	14 Sources	In RAM	3	40/44	3 PWM & UART
	COP888CL	COP688CL	4.0k	128	33/39	Yes	10 Sources	In RAM	2	40/44	2 PWM

*PWM = Pulse Width Modulated

The 4-Bit COP400 Family: Optimized for Low-Cost Control

National's COP400 family offers the broadest range of low-priced, 4-bit microcontrollers on the market.

Key Features

- High-performance 4-bit microcontroller
- 4 μs–16 μs instruction-cycle time
- ROM-efficient instruction set
- On-chip ROM from 0.5k to 2k
- On-chip RAM from 32 x 4 to 160 x 4
- More than 60 compatible devices in family
- Common pin-outs
- NMOS and P²CMOS™
- MICROWIRE™ serial interface
- Wide operating voltage range: +2.4V to +9V
- Military temp range available: −55°C to +125°C
- 20- to 28-pin packages (incl. 20-, 24-pin SO and 28-pin PLCC)

And far from being "old technology," 4-bit microcontrollers are meeting significant market needs in more applications than ever before. In fact, National shipped more than 40 million 4-bit devices last year alone. The reason for the continuing strength of the COP400 family is its versatility. You can select from over 60 different, compatible devices. You can select devices with unit costs **below 50 cents**—the lowest-priced microcontrollers in the world. You can select devices with a wide variety of ROM and RAM combinations, from 0.5k ROM and 32 x 4 RAM to 2k ROM and 160 x 4 RAM.

And every COP400 family member shares the same powerful, ROM-efficient instruction set and the same pin-out, so you can migrate between devices without re-engineering.

And like all of National's microcontrollers, the COP400 can be optimized to meet your specific application needs, with a variety of I/O options, pin-outs, and package types, from DIPs to SMDs.

COPS™ microcontrollers can be used to replace discrete logic in high-volume consumer products and low-volume industrial products allowing you to add features, miniaturize and reduce component count.

Key Applications

- Consumer electronics
- Automotive
- Industrial control
- Toys/games
- Telephones

Wide Acceptance

COPS wide acceptance comes from innovative products. National has built on this established family with continued and enhanced devices.

- The first under-a-dollar microcontroller led to a broader range of automotive and consumer applications.
- The first high-speed, low-power CMOS microcontroller with 0.5k ROM provides design flexibility at low cost.
- The first microcontroller implementing MICROWIRE/PLUS™ allowing two-way communication across only three lines.
- The first under $.50 microcontroller providing excellent cost/performance benefits for applications impossible before.
- The first microcontroller implementing Post-Metal Programming (PMP™) for quick turns prototyping and production.

PMP

Post-Metal Programming (PMP), another NSC microcontroller first. Takes advantage of:

- Seasonal or volatile market demand
- Narrow windows of opportunity in highly competitive markets
- Simplified inventory control
- Reduced safety stock

Get all the advantages of custom-programmed microcontrollers with all the business advantages of low cost, quick-turn prototyping and production.

The secret is an entirely new process technology called Post-Metal Programming.

Inside PMP

Post-Metal Programming is a high energy implantation process that allows the ROM layer of a microcontroller to be programmed after final metallization. That means every die layer can be fully fabricated, except for the passivation layers, and held in inventory. Then when you request a ROM pattern, a ROM implant mask is generated and the buried ROM layer is programmed with an ion beam.

The wafer is passivated and cut into dice which are then packaged on a quick-turn line.

So in only two weeks, you've got prototypes.

4-Week Production Quantities

Wafer fab accounts for the majority of prototyping and production time for integrated circuits.

With PMP, however, the dice are essentially complete and in inventory.

So we can take your approved prototypes right into full production in as little as four weeks.

Winning The Time-To-Market Race

The electronics market won't wait for anyone. If your competitors make a move, you've got to respond now.

You can't wait around for proof-of-design prototypes. Even a week can make a difference between success or failure. Between gaining market share or losing it. Between staying ahead of the other guys or falling behind. With PMP, you can stretch that lead by *weeks*. In fact, if you compare the quick-turn PMP process to conventional prototype-and-production timetables, you'll see that *you can actually gain as much as 3½ months over your competitors!*

No Extra Cost

PMP is available at *no extra cost.*

That means, for example, that National's COP413L, the world's lowest-priced microcontroller at $.49 in quantity, is available in the PMP process for . . . $.49 in quantity.

Compare that with the traditional "alternative" for quick-turn prototyping of user-programmable ROM. EPROM and EEPROM can easily drive your unit costs up to as much as $6!

And when you consider the additional cost-savings of being able to reduce your safety stock in inventory, knowing you can get quick-turns in a few weeks, the PMP process and National Semiconductor microcontrollers not only make good *engineering* sense, they make good *business* sense.

System Solutions

The COP400 family provides a flexible, cost-effective system solutions to all applications requiring timing, counting, or control functions.

And, bottom line, if a 4-bit controller can do the job, why pay more?

COP400 Family of Microcontrollers

Commercial Temp Version 0°C to +70°C	Industrial Temp Version −40°C to +85°C	Military Temp Version −55°C to +125°C	Technology	Description: Memory ROM (Bytes)	Description: Memory RAM (Digits)	Features: I/O I/O Pins	Features: I/O Serial I/O	Features: Time Interrupt	Features: Time Stack	Features: Base Counter	Features: Typ. 5V Micro Bus	Features: Max Operat. Power	Features: Standby at 3.3V	Features: Size (Pins)	Development Tools: ROMless Device	Development Tools: Piggyback
COP413L*	COP313L		NMOS Low Power	0.5k	32	15	Yes	No	2 Level	No	No	15 mW	7.5 mW	20	COP401L-X13/R13	
COP414L*	COP314L		NMOS Low Power	0.5k	32	15	Yes	No	2 Level	No	No	15 mW	7.5 mW	20	COP401LN	
COP410L	COP310L		NMOS Low Power	0.5k	32	19	Yes	No	2 Level	No	No	15 mW	7.5 mW	24	COP401LN	
COP411L	COP311L		NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	15 mW	7.5 mW	20	COP401LN	
COP413C	COP313C		CMOS Low Power	0.5k	32	15	Yes	No	2 Level	No	No	1 mW	0.1 mW	20	COP404CN	COP444CP
COP413CH	COP313CH		CMOS Hi Speed	0.5k	32	15	Yes	No	2 Level	No	No	1 mW	0.1 mW	20	COP404CN	COP444CP
COP410C	COP310C	COP210C	CMOS Hi Speed	0.5k	32	19	Yes	No	2 Level	No	No	1 mW	0.1 mW	24	COP404CN	COP444CP
COP411C	COP311C	COP211C	CMOS Hi Speed	0.5k	32	16	Yes	No	2 Level	No	No	1 mW	0.1 mW	20	COP404CN	COP444CP
COP420	COP320		NMOS Hi Speed	1.0k	64	23	Yes	1 Source	3 Level	Yes	Yes	100 mW	N/A mW	28	COP402N	COP420P
COP421	COP321		NMOS Hi Speed	1.0k	64	19	Yes	No	3 Level	Yes	No	100 mW	N/A mW	24	COP402N	COP420P
COP422	COP322		NMOS Hi Speed	1.0k	64	16	Yes	No	3 Level	Yes	No	100 mW	N/A mW	20	COP402N	COP420P
COP424C*	COP324C	COP224C	CMOS Hi Speed	1.0k	64	23	Yes	1 Source	3 Level	Yes	Yes	1 mW	0.1 mW	28	COP404CN	COP444CP
COP425C*	COP325C	COP225C	CMOS Hi Speed	1.0k	64	19	Yes	No	3 Level	Yes	No	1 mW	0.1 mW	24	COP404CN	COP444CP
COP426C*	COP326C	COP226C	CMOS Hi Speed	1.0k	64	16	Yes	No	3 Level	Yes	No	1 mW	0.1 mW	20	COP404CN	COP444CP
COP420L*	COP320L		NMOS Low Power	1.0k	64	23	Yes	1 Source	3 Level	Yes	No	45 mW	9.9 mW	28	COP404LSN-5	COP444LP
COP421L*	COP321L		NMOS Low Power	1.0k	64	19	Yes	No	3 Level	Yes	No	45 mW	9.9 mW	24	COP404LSN-5	COP444LP
COP422L*	COP322L		NMOS Low Power	1.0k	64	16	Yes	No	3 Level	Yes	No	45 mW	9.9 mW	20	COP404LSN-5	COP444LP
COP440	COP340		NMOS Hi Speed	2.0k	160	35	Yes	4 Sources	4 Level	Yes	Yes	205 mW	9.9 mW	40	COP404N	COP440R
COP441	COP341		NMOS Hi Speed	2.0k	160	23	Yes	4 Sources	4 Level	Yes	Yes	205 mW	9.9 mW	28	COP404N	COP440R
COP442	COP342		NMOS Hi Speed	2.0k	160	19	Yes	2 Sources	2 Level	Yes	No	205 mW	9.9 mW	24	COP404N	COP440R
COP444C*	COP344C	COP244C†	CMOS Hi Speed	2.0k	128	23	Yes	1 Source	3 Level	Yes	Yes	1 mW	0.1 mW	28	COP404CN	COP444CP
COP445C*	COP345C	COP245C	CMOS Hi Speed	2.0k	128	19	Yes	No	3 Level	Yes	No	1 mW	0.1 mW	24	COP404CN	COP444CP
COP444L	COP344L		NMOS Low Power	2.0k	128	23	Yes	1 Source	3 Level	Yes	No	65 mW	9.9 mW	28	COP404LSN-6	COP444LP
COP445L	COP345L		NMOS Low Power	2.0k	128	19	Yes	No	3 Level	Yes	No	65 mW	9.9 mW	24	COP404LSN-6	COP444LP

*Microcontrollers available with Quick-Turns Post-Metal Programming (PMP).

†Mil-Std 883C Qualified

COPS Family Development Tools

Commercial Temp Version 0°C to +70°C	Technology	Description: Memory ROM (Bytes)	Description: Memory RAM (Digits)	Features: I/O I/O Pins	Features: I/O Serial I/O	Features: Interrupt	Features: Stack	Features: Time Base Counter	Features: Micro Bus	Features: Typ. 5V Operat. Power	Features: Max Standby at 3.3V	Features: Size (Pins)	Supplementary Description
ROMless													
COP401L-X13	NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	100 mW	7.5 mW	40	Has XTAL Oscillator Option
COP401L-R13	NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	100 mW	7.5 mW	40	Has RC Oscillator Option
COP401L	NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	100 mW	7.5 mW	40	ROMless Version of COP410L
COP402	NMOS Hi Speed	1.0k	63	20	Yes	1 Source	3 Level	Yes	No	50 mW	N/A mW	40	Has Interrupt, No Microbus
COP402M	NMOS Hi Speed	1.0k	63	16	Yes	Yes	3 Level	Yes	Yes	125 mW	N/A mW	40	No Interrupt, Has Microbus
COP404LSN-5	NMOS Low Power	1.0k	128	20	Yes	1 Source	3 Level	Yes	No	125 mW	N/A mW	40	W/Push-Pull Mem Interface
COP404	NMOS Hi Speed	2.0k	160	23	Yes	4 Sources	4 Level	Yes	Yes	35 mW	15 mW	48	ROMless Version of COP440
COP404C	CMOS Hi Speed	2.0k	128	23	Yes	1 Source	3 Level	Yes	Yes	1 mW	0.1 mW	48	CMOS ROMless Device
PIGGYBACK													
COP420P	NMOS Hi Speed	1.0k	64	23	Yes	3 Sources	3 Level	Yes	No	50 mW	N/A mW	28	Includes: CPU, RAM, I/O
COP444LP	NMOS Low Power	2.0k	128	23	Yes	3 Sources	3 Level	Yes	No	125 mW	N/A mW	28	and EPROM Socket
COP444CP	CMOS Hi Speed	2.0k	128	23	Yes	1 Source	1 Level	Yes	Yes	1 mW	1 mW	28	Will Accept Standard EPROM

Mole™ Development Tools

The Microcontroller On Line Emulator (MOLE) system is designed to support the development of NSC Microcontroller products. These include COPS™ family, and the HPC™ family of products. The MOLE provides effective support for the development of both software and hardware in Microcontroller-based applications.

The purpose of the MOLE is to provide the tools required to write and assemble code for the target microcontroller and assist in the debugging of both the hardware and software.

A MOLE system consists of three components: a MOLE Brain Board, a MOLE Personality Board, and software for a host computer. The host may be an IBM®-PC, or one of a number of inexpensive PC compatibles. The cross-assemblers and cross-compilers provided by National Semiconductor will run under control of the host computer MS-DOS operating system.

The Brain Board provides the MOLE system with the capability of communicating with the user's Host CPU. Resident firmware on the Brain Board allows the user to download assembled load modules over the RS-232 link from the host computer, display and alter code in both hex and mnemonic format, initiate Breakpoints, Traces, and timing on addresses and external events, examine and modify the internal resources of the Microcontroller being emulated. The Brain Board also provides all the hardware and firmware to program standard EPROMs up to 27256's (32k x 8).

Development system flexibility is provided by the Personality board. This component tailors the system to emulate a single microcontroller family or device. For instance, one Personality Board supports the COP400 CMOS and NMOS family. This Personality Board provides emulation capability for 42 Microcontroller device types.

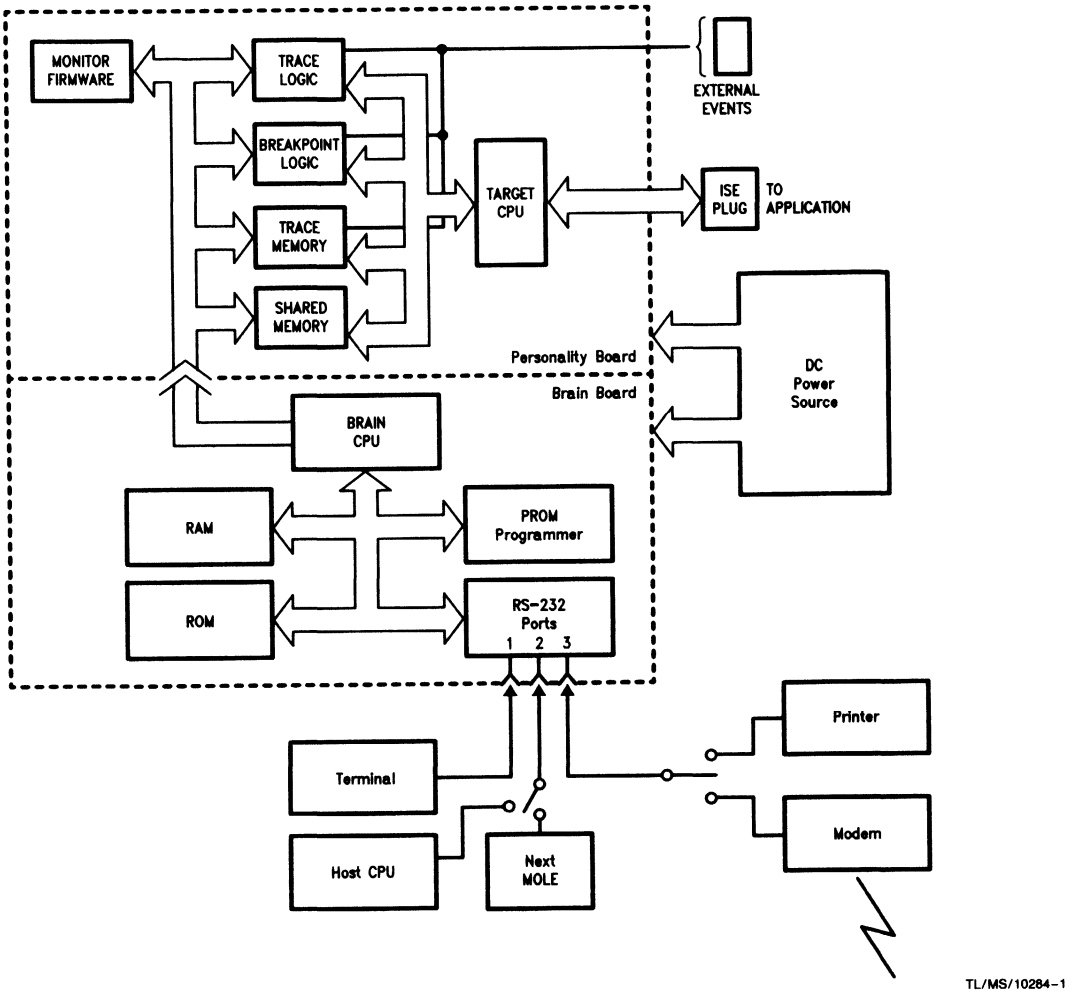
Personality boards are also available for the HPC and COPS family of M²CMOS products.

The host CPU contributes cost effective bulk storage and high speed processing. Disk editing and assembly operations are controlled by the host CPU. The results are down loaded to the Brain Board over the RS-232 link.

Once the application program has been completely debugged, the code may be submitted to National Semiconductor for use in creating the tooling necessary for manufacturing the masked Microcontroller device.

The MOLE concept provides the user with a powerful development system based around a familiar host. The Brain Board/Personality Board/Host combination provides FULL emulation capability. This modular design provides maximum flexibility and maximum utility for the development of Microcontroller based systems.

MOLE System Block Diagram



Mole Systems

MOLE systems are available for a variety of microcontrollers. To order a complete development package, select the section for the microcontroller to be developed and order the parts listed.

Included, along with the cross assembler, in the software package are two file conversion routines to convert the assembler output (LM) to HEX and to convert HEX to LM. Also included in the software package is a COMM program which facilitates the downloading and uploading between the host and the MOLE, and adds the capability to make the host act as a terminal.

Development Tools Selection Table

Microcontroller	Order Part Number	Description	Includes	Manual Number
HPC	MOLE-BRAIN	Brain Board	Brain Board Users Manual	420408188-001
	MOLE-HPC-PB1	Personality Board	HPC Personality Board Users Manual	420410477-001
	MOLE-HPC-IBMR	Relocatable Assembler Software for IBM	HPC Software Users Manual and Software Disk PC-DOS Communications Software Users Manual	424410836-001 420040416-001
	MOLE-HPC-IBM-CR	C Compiler for IBM	HPC C Compiler Users Manual and Software Disk Assembler Software for IBM MOLE-HPC-IBM	424410883-001
	MOLE-HPC-VMS-C	C Compiler/Relocatable Assembler/Linker for VAX/VMS	Manuals and Software	424410883-001
	MOLE-HPC-UNX-C	C Compiler/Relocatable Assembler/Linker for VAX/UNIX	Manuals and Software	Future Product
	424410897-001	Users Manual		424410897-001
COP820/840	MOLE-BRAIN	Brain Board	Brain Board Users Manual	420408188-001
	MOLE-COP8-PB1	Personality Board	COP820/840 Personality Board Users Manual	420410806-001
	MOLE-COP8-IBM	Assembler Software for IBM	COP800 Software Users Manual and Software Disk PC-DOS Communications Software Users Manual	424410527-001 420040416-001
	420410703-001	Users Manual		420410703-001
COP888	MOLE-BRAIN	Brain Board	Brain Board Users Manual	420408188-001
	MOLE-COP8-PB2	Personality Board	COP888 Personality Board Users Manual	420420084-001
	MOLE-COP8-IBM	Assembler Software for IBM	COP800 Software Users Manual and Software Disk PC-DOS Communications Software Users Manual	424410527-001 420040416-001
	420411060-001	Users Manual		420411060-001
COP400	MOLE-BRAIN	Brain Board	Brain Board Users Manual	420408188-001
	MOLE-COPS-PB1	Personality Board	COP400 Personality Board Users Manual	420408189-001
	MOLE-COPS-IBM	Assembler Software for IBM	COP400 Software Users Manual and Software Disk PC-DOS Communications Software Users Manual	424409479-002 420040416-001
	424410284-001	Users Manual		424410284-001

Designer Kits

Designer Kits are self contained development systems that contain all of the components, manuals and software to design a microcontroller based system. Just add an IBM-PC or compatible PC, + 5V DC 1.5 Amps power supply and RS232 cables.

Several different kits are offered. The Evaluation package contains evaluation software that allows limited code to be developed. The Development package has no restrictions on the assembler software.

Microcontroller	Order Part Number	Description	Includes	Manual Number
HPC 17 MHz	MOLE-HPC-EVAL0	HPC Designer's Kit Evaluation Version	HPC-DB1 Board Evaluation Compiler, Assembler/Linker, Manuals	420410901-1
	MOLE-HPC-DEVL0	HPC Designer's Kit Development Version	HPC-DB1 Board Evaluation Compiler, FULL Assembler/Linker, Manuals	420410901-1

MICROWIRE™ and MICROWIRE/PLUS™: 3-Wire Serial Interface

National's MICROWIRE and MICROWIRE/PLUS provide for high-speed, serial communications in a simple 3-wire implementation.

Originally designed to interface COP400 microcontrollers to peripheral devices, the MICROWIRE protocol has been extended to both the COP800 and HPC™ families with the enhanced version, MICROWIRE/PLUS.

Because the shift clock in MICROWIRE/PLUS can be internal or external, the interface can be designated as either bus master or slave, giving it the flexibility necessary for distributed and multiprocessing applications.

With its simple 3-wire interface, MICROWIRE/PLUS can connect a variety of nodes in a serial-communication network.

This simple 3-wire design also helps increase system reliability while reducing system size and development time.

MICROWIRE/PLUS consists of an 8-bit serial shift register (SIO), serial data input (SI), serial data output (SO), and a serial shift clock (SK).

Because the COP800 and HPC families have memory-mapped architectures, the contents of the SIO register can be accessed through standard memory-addressing instructions.

The control register (CNTRL) is used to configure and control the mode and operation of the interface through user-selectable bits that program the internal shift rate. This greatly increases the flexibility of the interface.

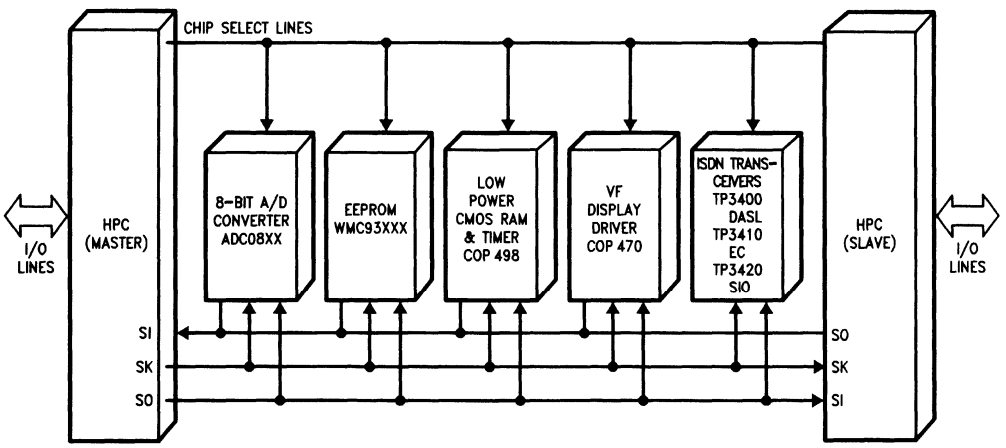
MICROWIRE/PLUS can also provide additional I/O capability for COP800 and HPC microcontrollers by connecting, for example, external 8-bit parallel-to-serial shift registers to 8-bit serial-to-parallel shift registers.

And it can interface a wide variety of peripherals:

- Memory (CMOS RAM and EEPROM)
- A/D converters
- Timers/counters
- Digital phase locked-loops
- Telecom peripherals
- Vacuum fluorescent display drivers
- LED display drivers
- LCD display drivers

Both MICROWIRE and MICROWIRE/PLUS give all the members of National's microcontroller families the flexibility and design-ease to implement a solution quickly, simply, and cost-effectively.

MICROWIRE/PLUS System Block



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MICROWIRE and MICROWIRE/PLUS Peripherals

Part Number	Description
A/D CONVERTERS AND COMPARATORS	
ADC0811	11 Channel 8-Bit A/D Converter with Multiplexer
ADC0819	19 Channel 8-Bit A/D Converter with Multiplexer
ADC0831	1 Channel 8-Bit A/D Converter with Multiplexer
ADC0838	8 Channel 8-Bit A/D Converter with Multiplexer
ADC0832	2 Channel 8-Bit A/D Converter with Multiplexer
ADC0833	4 Channel 8-Bit A/D Converter with Multiplexer
ADC0834	4 Channel 8-Bit A/D Converter with Multiplexer
ADC0852	Multiplexed Comparator with 8-Bit Reference Divider
ADC0854	Multiplexed Comparator with 8-Bit Reference Divider
DISPLAY DRIVERS	
COP470	4 Digit by 8 Segment Expandable V.F. Display Driver
COP472-3	3 x 12 Multiplexed Expandable LCD Display Driver
MM5450	35 Output LED Display Driver
MM5451	34 Output LED Display Driver
MM5483	31 Segment LCD Display Driver
MM5484	16 Segment LED Display Driver
MM5486	33 Output LED Display Driver
MM58201	8 Backplane and 24 Segment Multiplexed LCD Driver
MM58241	32 Output High Voltage Display Driver
MM58242	20 Output High Voltage Display Driver
MM58248	35 Output High Voltage Display Driver
MM58341	32 Output High Voltage Display Driver
MM58342	20 Output High Voltage Display Driver
MM58348	35 Output High Voltage Display Driver
MEMORY DEVICES	
COP498	4 x 64 Low Power CMOS RAM and Timer with "Wake-Up"
COP499	4 x 64 Low Power CMOS RAM
NMC9306	16 x 16 NMOS EEPROM
NMC9313B	16 x 16 NMOS EEPROM
NMC9314B	64 x 16 NMOS EEPROM
NMC9346	64 x 16 NMOS EEPROM
NMC93C06	16 x 16 CMOS EEPROM
NMC93C26	32 x 16 CMOS EEPROM
NMC93C46	64 x 16 CMOS EEPROM
NMC93C506	16 x 16 CMOS EEPROM with Write Protect
NMC93C526	32 x 16 CMOS EEPROM with Write Protect
NMC93C546	64 x 16 CMOS EEPROM with Write Protect
NMC93C556	128 x 16 CMOS EEPROM with Write Protect
NMC93C56	128 x 16 CMOS EEPROM
NMC93C566	256 x 16 CMOS EEPROM with Write Protect
NMC93C66	256 x 16 CMOS EEPROM

MICROWIRE and MICROWIRE/PLUS Peripherals (Continued)

Part Number	Description
TELECOM DEVICES	
TP3400	Digital Adapter for Subscriber Loops (DASL)
TP3410	Echo Canceller (EC)
TP3420	S Interface Device (SID)
AUDIO AND RADIO DEVICES	
DS8906	AM/FM Digital PLL Synthesizer
DS8907	AM/FM Digital PLL Frequency Synthesizer
DS8908	AM/FM Digital PLL Frequency Synthesizer
DS8911	AM/FM/TV Sound Up-Conversion Frequency Synthesizer
LMC1992	Stereo Volume/Tone/Fade with Source Select
LMC1993	Stereo Volume/Tone/Fade/Loudness with Source Select
LMC835	7 Band Graphic Equalizer
SPECIAL FUNCTIONS	
COP452L	Frequency Generator and Counter

Section 9
Microprocessors

Section 9 Contents Microprocessors

† = **Note:** These products are highlighted as available or soon to be available with full Military Quality inspection.

‡ Military Applications only.

Microprocessors

In 1983, National Semiconductor released the first full 32-bit microprocessor, years ahead of the closest competition.

Now, Series 32000®, the only complete family of 32-bit microprocessors, offers clear advantages to the designer: Better price/performance ratios, architecture with a clear migration path and a complete hardware/software solution.

Designed from the top down, it began as a true 32-bit solution, rather than having evolved from more primitive 8-bit and 16-bit architectures. The CPUs, for example, all have a 32-bit arithmetic logic unit (ALU), 32-bit dedicated and general-purpose registers and 32-bit internal data paths.

And the CPU coprocessors are exact architectural complements of each other, operating efficiently, effectively and more compactly.

This is true of the complete Series 32000 computing cluster: Memory Management, Floating Point, Interrupt Control, Timing Control and DMA Control.

Series 32000 includes development systems, evaluation boards, software programs and engineering support. Also peripherals: DRAM controllers, advanced graphics support, LAN interface chips, data communications, disk control and interface.

The software you write for one Series 32000 microprocessor is compatible with every other microprocessor in the family. And because the migration path has been so well planned, you have complete upward and downward software compatibility. The architectural continuity National provides allows for a totally transparent user interface.

Best of all, Series 32000 is supported by the manufacturing strength and capacity to deliver high-quality, high-reliability devices at a reasonable cost. As a leader in 32-bit technology, stable and committed to the 32-bit market, National Semiconductor assures you availability of parts, now and in the future.

Currently, Series 32000 is the only 32-bit family that offers complete programs for military and other high-reliability applications, including: MIL-STD-883, JAN 38510, spaced qualified versions and Ada® development support.

The net of this is that designers get flexibility and completeness, while drastically cutting development times. So you can concentrate on designing systems, rather than trying to overcome limited hardware solutions. And your software investment is protected.

No one has more experience in the 32-bit market. And no one does more—with an integrated family of devices, development tools, and software—to put that experience to work for you.

Microprocessors—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry, National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide", please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross reference National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

Series 32000® Components

Device	Description	Bus Width			Process	Package Type
		Internal	External Address	External Data		
CENTRAL PROCESSING UNITS						
†NS32532	Central Processing Unit—High performance 32-bit CPU. Supports 4-Gbyte uniform address space on chip memory management unit with 64-entry translation look-aside buffer. Incorporates 512-Byte on-chip instruction cache and 1024-Byte on-chip data cache and four stage instruction pipeline. High performance bus with separate 32-bit address and data lines with dynamic bus sizing and burst mode memory access. Software compatible with the Series 32000 family.	32	32	32	M²CMOS	175-pin PGA
NS32332	Central Processing Unit—Second generation 32-bit CPU with enhanced internal micro-architecture. Supports 4 Gbyte uniform address space. Extensive support for cache memories and multiprocessing. Features burst mode memory access and dynamic bus configuration to 8, 16 and 32 bits.	32	32	32	XMOS™ (NMOS)	84-pin PGA Pin-Grid Array
†NS32C032	CMOS CPU Central Processing Unit—CMOS version of NS32032. Internal and external architecture the same as NS32032. Pin compatible with the NS32032 processed in XMOS.	32	24	32	CMOS	68-pin LCC Leadless
NS32032	Central Processing Unit—CPU with 32-bit architecture and 32-bit data bus supporting a large address space. The 16 Mbyte uniform address space, powerful two-address instruction set and symmetrical addressing modes support both assembly and high level language code generation. NS32032 is upward and downward compatible to 8, 16 and 32-bit Series 32000 microprocessors. The architecture provides full virtual memory capabilities using the NS32082 MMU. High performance floating-point instructions are provided with NS32081 FPU.	32	24	32	XMOS (NMOS)	68-pin LCC Leadless
†NS32C016	CMOS CPU Central Processing Unit—CMOS version of NS32016. Internal and external architecture the same as NS32016. Pin compatible with NS32016 processed in XMOS.	32	24	16	CMOS	48-pin DIP Dual-In-Line Package
NS32016	Central Processing Unit—CPU functionally the same as NS32032 with 16-bit data bus.	32	24	16	XMOS (NMOS)	48-pin DIP Dual-In-Line Package
NS32008	Central Processing Unit—CPU functionally the same as NS32032 with 8-bit data bus.	32	24	8	XMOS (NMOS)	48-pin DIP Dual-In-Line Package
†NS32GX32	Central Processing Unit—High performance 32-bit CPU optimized for Embedded System Applications. Has a 4 Gigabyte linear address space and incorporates a 1024 byte 2-way Set Associative Data Cache and a direct mapped 512 byte Instruction Cache. BitBLT functions are supported: line drawing primitives, barrel shifter, bit field instructions, and binary data compression/expansion. Separate high performance 32-bit Address and Data busses with dynamic bus sizing and burst mode memory access. High performance real time features. Software compatible with Series 32000 family.	32	32	32	M²CMOS	175 PGA
†NS32CG16	CMOS Central Processing Unit—32 Bit CPU which provides special features for graphics applications. Software compatible with the Series 32000 family. Has a 16 Mbyte linear address space. Incorporates 18 graphics instructions for bit-aligned block transfers (BitBLT), line drawing, pattern drawing, replication and filling, pattern magnification and binary data compression/expansion. On-chip clock generator and programmable power-down modes.	32	24	16	CMOS	PLCC

†**Note:** These products are highlighted as available or soon to be available with full Military Quality inspection. Products not highlighted may also be available with military quality.

Series 32000 Components (Continued)

Device	Description	Bus Width			Process	Package Type
		Internal	External Address	External Data		
SLAVE PROCESSORS						
NS32382	Memory Management Unit—Second generation MMU works in conjunction with NS32332. Full 32-bit architecture and supports 4 Gbyte address space. Supports enhanced slave protocol.	32	32	32	XMOS	125-pin PGA Pin-Grid Array
NS32082	Memory Management Unit—MMU provides hardware support for demand-paged virtual memory. Supports fast dynamic two-level address translation and protection on individual 512-byte pages. Manages up to 32 Mbytes of physical storage. High speed address translation performed on-chip through 32-entry associative cache. Memory protection supports access-level checking and dual address maps.	32	24	16	XMOS (NMOS)	48-pin DIP Dual-In-Line Package
†NS32081	Floating Point Unit—FPU provides high-speed floating point instructions for single (32-bit) and double (64-bit) precision. Supports IEEE standard for binary floating point arithmetic.	64	—	16	XMOS (NMOS)	24-pin DIP Dual-In-Line Package
‡†NS32C081	Floating Point Unit—Second Generation FPU. Provides high-speed floating point instructions for single and double precision math. Supports IEEE standard for binary floating point arithmetic. Compatible with NS32C016, NS32CG16, and NS32C032. CMOS replacement for NS32081.	64	—	16	CMOS	44-pin DIP Dual-In-Line Package
†NS32381	Floating Point Unit—Second generation FPU. Provides high-speed floating point instructions for single (32-bit) and double (64-bit) precision. Supports IEEE standard for binary floating point arithmetic. Compatible with NS32016, NS32C016, NS32008, NS32C032, NS32032, NS32332 and NS32532 CPUs.	64	—	32	CMOS (NMOS)	68-pin PGA
NS32580	Floating Point Controller—FPC is an interface controller designed to couple the NS32532 with the Weitek WTL 3164 Floating-Point Data Path (FPDP). 15 Mflops peak performance for single and double precision ADD,SUB, MUL and MAC instructions with the FPDP. Conforms to IEEE 754-1985 standard for Binary Floating-Point-Arithmetic. Upward compatible with existing NS32081 software base. Supports single (32-bit) and double (64-bit) precision operations.	64	—	16 or 32	M^2CMOS	172-pin PGA
PERIPHERALS						
†NS32C201	CMOS TCU Timing Control Unit—NS32C201 CMOS TCU fabricated using NSC microCMOS technology with TTL compatible inputs.	—	—	—	CMOS	24-pin DIP Dual-In-Line Package
NS32202	Interrupt Control Unit—ICU minimizing the software and real-time overhead required to handle multi-level, prioritized interrupts. Single ICU manages up to 16 interrupt sources and resolves interrupt priorities. Expandable up to 256 interrupts using multiple ICUs.	32	—	16	XMOS (NMOS)	40-pin DIP Dual-In-Line Package
NS32203	Direct Memory Access Controller—DMA relieves CPU of data transfers between memory and I/O devices. Transfer rates up to 5 Mbytes per second. Performs memory to memory, I/O to I/O, or memory to I/O transfers. Interfaces with Series 32000 microprocessors.	—	—	16	XMOS (NMOS)	49-pin DIP Dual-In-Line Package

†**Note:** These products are highlighted as available or soon to be available with full Military Quality inspection. Products not highlighted may also be available with military quality.

‡Military Applications Only

Series 32000 Development Products

Device	Description	RAM Memory
DEVELOPMENT SYSTEMS		
SYS32/30	The SYS32/30 is a high performance package that converts an IBM PC/AT or compatible system into an ideal development environment for Series 32000 based applications. The SYS32/30 is based on the NS32332 CPU, the NS32382 memory management unit and the NS32081 floating point unit. The SYS32/30 gives 2 to 3 VAX MIP system performance. The SYS32/30 complements the NS32032 based SYS32/20. The SYS32/30 base unit kit consists of a single add in board to install in the IBM PC/AT or compatible systems and comes with the Opus5 operating system. This operating system is a port of AT&T's UNIX System V.3, and is derived from GENIX V.3, National Semiconductor's port of UNIX System V.3. The base unit kit includes the GNX Version 3 assembler, linker, debuggers, monitors and an extensive selection of utilities including Tools For Documenters (derived from AT&T DWB 2.0) and various bsd 4.2 utilities including C Shell. All software is on high density disks. Order as NSS-SYS30-KITX.	4, 8 or 16 Mbyte

Device	Description	Devices Supported
IN SYSTEM EMULATOR		
NS32CG16 ISE	The ISE for the NS32CG16 32-bit Printer/Display Processor is a hardware and software emulator that interfaces to a PC AT through a SCSI port provided by an add-in board. The NS32CG16 ISE features emulation function. 512 Kbytes of emulation memory (expandable to 1 Mbyte) and a trace function. Order as NSS-ISE-CG16.	NS32CG16
SPLICE		
SPLICE	Splice development tool provides a communication link between a Series 32000 target and a development host. This connection allows users to download and map their software onto target memory and debug this software using NSC debuggers. Order as NSV-SPLXXX-XXX.	NS32008 NS32016 NS32CG16 NS32032 NS32332 NS32382

Device	Description
EVALUATION BOARD	
NS32GX32EB	Evaluation Board for the NS32GX32. Fully configured 30 MHz Board level computer based on the NS32GX32. Includes the NS32GX32, 8–128 Kbytes of ROM, 128K of 0 wait state RAM, 2 RS232 serial ports, one parallel printer port, and PAL address decoder and wire wrap area for board customization. MONGX32 monitor and cables provided for interface to National's GNX development environment. Sockets are provided for an NS32381 Floating Point Unit and an NS32202 Interrupt Control Unit. Order as NSV-GX32EB-AI30
DESIGNER KIT	
NS32532DK	The kit contains a 25 MHz NS32532 CPU, NS32202 ICU, PC board, RAMless monitor, TDS (Tiny Development Systems) monitor, decode PAL, delay line and a complete documentation package. Memory size options range from 8 to 128 kbytes of ROM and 128 kbytes of user supplied zero-wait-state RAM. Order as NSV-532DK

Series 32000 Software

Device	Description	Host Systems
GENIX V.3 Operating System	Certified port of AT&T UNIX System V.3 Operating System providing features of V.2 plus shared libraries and networking capabilities; C and FORTRAN 77 compilers included. Order as NSW-GV3-XXXX.	SYS32/20 SYS32/30 VAX/UNIX
GNX Tools	A set of Language Tools packaged for native and cross environments. ASSEMBLER includes assembler, linkers, libraries, debuggers, monitors, etc. for development of Series 32000 code. This is the prerequisite for related compilers. Order as NSW-ASM-3-XXXX. C COMPILER used with Assembler to do Series 32000 code development. Order as NSW-C-3-XXXX. FORTRAN 77 COMPILER used with Assembler to do Series 32000 code development. Order as NSW-F77-3-XXXX. PASCAL COMPILER used with Assembler to do Series 32000 code development. Order as NSW-PAS-3-XXXX.	SYS32/XX SYS32/20 SYS32/30 VAX/UNIX VAX/VMS MicroVAX/ULTRIX MicroVAX/VMS (for all GNX Packages)
ADA	Series 32000 ADA cross-support development. Order as NSW-ADA-XXXX.	SYS32/20 SYS32/30 VAX/VMS

16-Bit Military Microprocessors

F9450

National's focus is on high-performance embedded controller applications based on the F9450 16-bit microprocessor. These applications are typically driven by a fixed program. The controller is incorporated within a system that surrounds it, making its functions largely invisible to the outside world.

The F9450 is a monolithic implementation of the MIL-STD-1750A instruction set architecture, mandated for use in many military applications. All F9450s pass the U.S. Air Force SEAFAC VSW test, Version 2.1 + 2, 2.1 + 12 and all military-grade products fully comply with the requirements of MIL-STD-883C and Military DESC Drawing 84169.

The attraction of the F9450 in the commercial market is its raw speed and fast context switching, its on-chip floating-point capability, and its interrupt and fault handling capabilities. Current designs include graphics workstations.

Various support tools are available for the F9450. To assist in your software development efforts, National provides MACRO-50, a macro-assembler for the F9450 and a C compiler.

Third party support for the F9450 includes Ada, JOVIAL, FORTRAN, CMS-2 compilers. Ada, JOVIAL and CMS-2 compilers are available from DoD as well as mainstream software houses. Both Tektronix and Hewlett Packard provide in-system emulation and debug support for F9450 based systems. Also, a 9450 development seat that works in conjunction with a PC is available from a third party.

F9445

The F9445 microprocessor, a 16-bit device that exercises a National superset of the NOVA® instruction set, can address up to 64k words of memory, directly address 62 I/O devices, handle 16 levels of priority interrupt, and perform fast direct memory access. The F9445's sophisticated pipeline architecture is combined with National's bipolar Isoplanar Integrated Injection Logic (I^3L®) to provide very fast execution times.

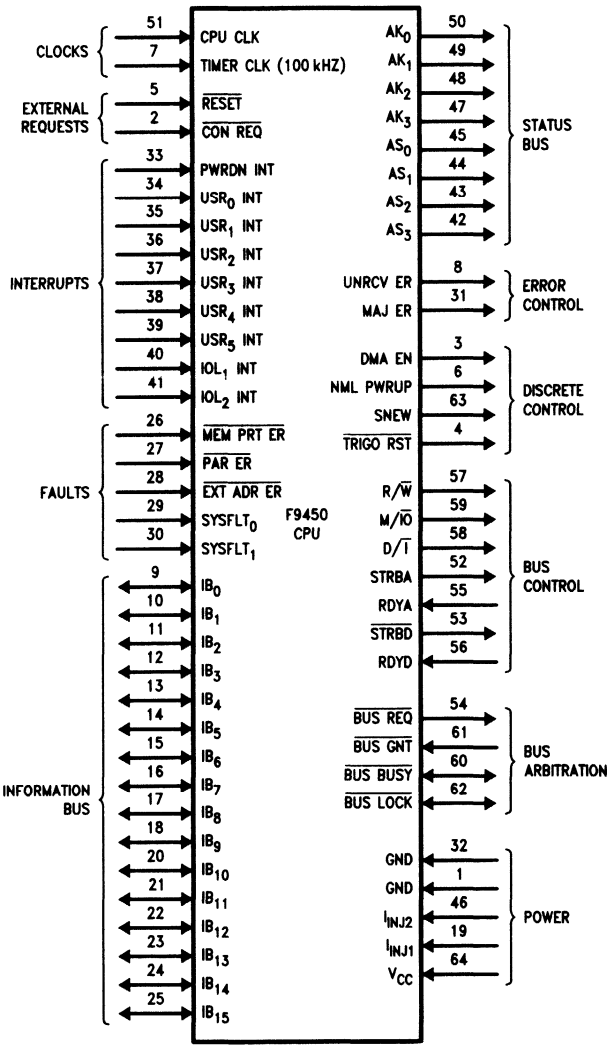
F9450 High-Performance 16-Bit Bipolar Microprocessor MIL-STD-1750A

General Description

The National F9450 microprocessor is the nucleus of a family of high-performance devices intended for commercial and military applications requiring sophisticated, high speed, real-time processing. The F9450 executes the complete requirements of MIL-STD-1750A and has passed the Air Force MIL-STD-1750A compliance certification test. It has, on-chip, all of the functions necessary to perform floating-point operations without the use of a co-processor. Other on-chip capabilities allow addressing of up to 2M words of memory and, with the addition of the optional F9451 Memory Management Unit (MMU), up to 16M words of memory.

Real-time processing is achieved through advanced architecture that incorporates two programmable timers, user-accessible general-purpose registers, a complete 16-level interrupt processor, and a comprehensive fault handler on the chip. Multiprocessing is supported by a flexible bus arbitration scheme, as well as process synchronization (test and set) instruction.

Signal Functions



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Features

- Single-chip 16-bit microprocessor with 32- and 48-bit floating-point arithmetic on-chip
- Real-time processing: two programmable timers, 16 levels of vectored interrupt
- Address space of up to 2M words, expandable to 16M words with optional F9451
- Instruction set optimized for real-time applications (MIL-STD-1750A ISA)
- Built-in self-test, fault handling, and abort
- Twenty-four user-accessible registers
- Built-in multiprocessor capabilities
- Single- and double-precision integer arithmetic
- Built in console operations
- Complete high-level language and design development support available
- Static operation with single 0–20 MHz clock
- TTL inputs and outputs with 8 mA drive capability
- Small-size 64-pin DIP or optional surface-mount packages
- Full performance over −55°C to +125°C operating temperature range
- Bipolar I^3L technology
- Fully compliant with MIL-STD-883C requirements
- Available as DESC Drawing 84169

The F9450 family of support circuits and systems provides additional capabilities. For example, memory-mapped expansion with the F9451 Memory Management Unit.

Comprehensive software support for the F9450, including assemblers, loaders, simulators, and compilers, is provided by National and other sources. Software development for the F9450 can be performed on VAX/VMS systems.

F9451 Memory Management Unit MIL-STD-1750A

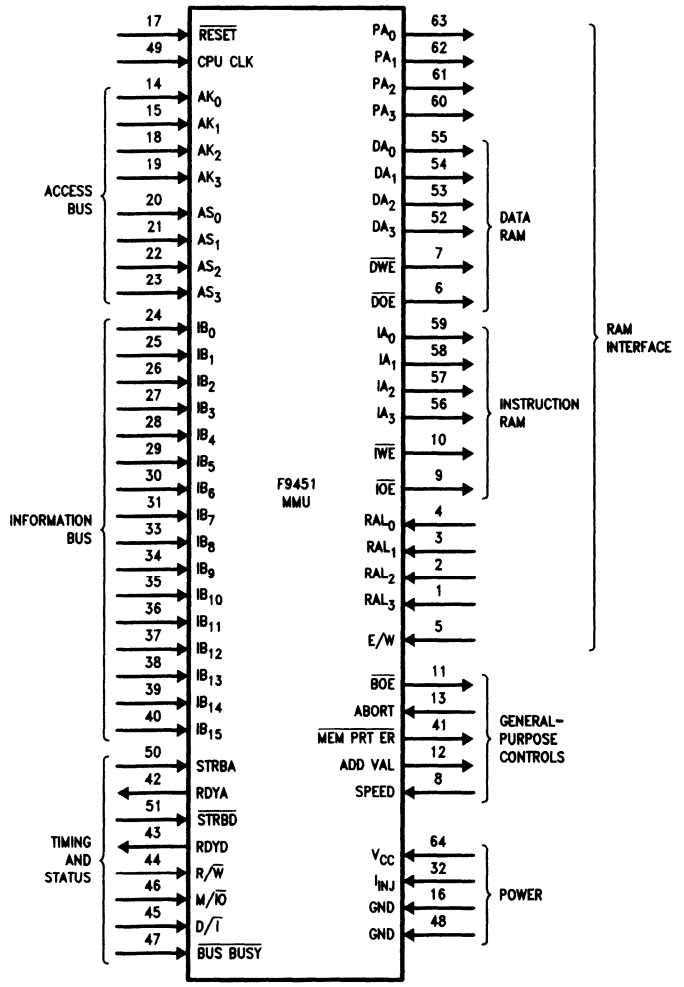
General Description

The F9451 Memory Management Unit (MMU) controller provides facilities to expand the memory addressing range of the F9450 CPU up to 16M words of physical memory and provides access protection mechanisms for instructions and data. The MMU subsystem consists of the F9451 controller together with four F93479 or equivalent static RAMs (SRAMs), used as instruction and data maps, and two octal buffers (54/74F245).

Features

- Allows up to 1M words of memory address space as specified by MIL-STD-1750A
- Logical-to-physical address translation
- Protection of the logical space in 4k word pages for:
  - — access key to access lock match
  - — write protect (data)
  - — execute protect (instructions)
- On-chip cache mechanism
- Two translation maps
  - — instruction map (256 x 16)
  - — data map (256 x 16)
- High performance over military temperature range
- Static operation with single 0–20 MHz clock
- TTL-compatible inputs and outputs
- 64-pin DIP or surface mount
- Bipolar LSI I^3L technology

Signal Functions



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F9445 16-Bit Bipolar Microprocessor

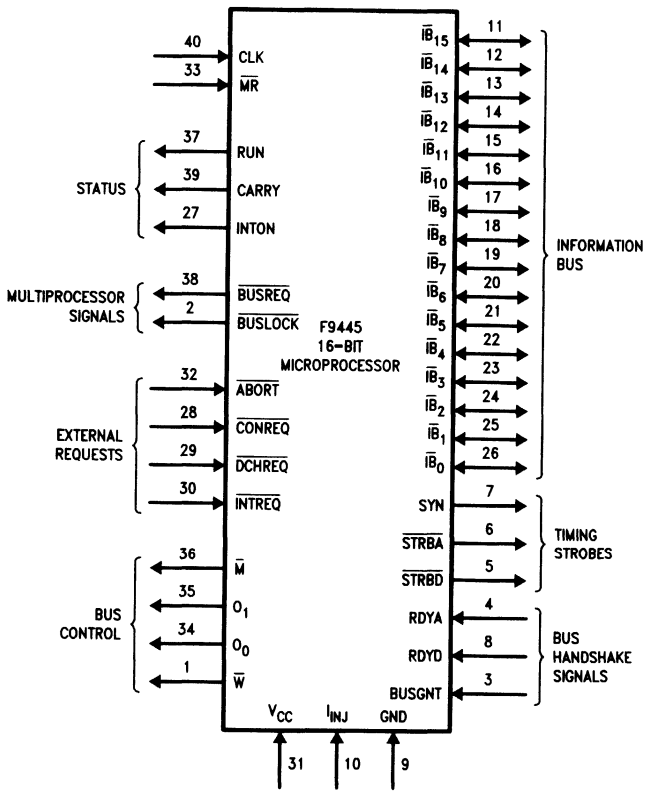
General Description

The F9445 is a 16-bit microprocessor implemented using National's Isoplanar Integrated Injection Logic (I^3L) technology. This bipolar technology and sophisticated pipeline architecture combine to give the F9445 very fast execution times. The processor has eight program-accessible registers and the capability of directly addressing 128 kbytes (64k words) of memory. The F9445 can address 62 I/O devices, handle 16 levels of priority interrupt, and perform fast direct memory access. It has control lines to provide operator-console functions and has an on-chip self-test program.

Features

- Advanced parallel architecture leading to very fast execution times—250 ns register, 2.9 μs 16 x 16 bit multiply
- Directly addresses up to 128 kbytes of memory with 11 addressing modes
- Eight program-accessible registers (AC0, AC1, AC2, AC3, SP, FP, PC, PSW)
- Versatile instruction set including memory reference, ALU, I/O, stack, multiply/divide, and floating-point assist (scale/normalize) instructions with 8-bit byte, 16-bit word, or 32-bit double-word data
- Multiprocessing capabilities
- Flexible operator-control functions and self-test
- Static operation with single clock up to 24 MHz
- LS TTL input/output structure with I^3L internal circuits
- 40-Pin DIP needing a single +5V power supply
- Full military temperature and voltage ranges
- Radiation-tolerant technology

Signal Functions



TL/MS/10368-3

Microprocessors 8-Bit

The NSC800 family offers high-performance CMOS 8-bit microprocessor using National's microCMOS process.

The NSC800 CPU features 158 instructions, minimum instruction execution time of 1 μs (4 MHz version), and power consumption of 75 mW (@4 MHz). In addition, various support chips are provided so that high-speed CMOS systems can easily be created.

Leadless chip carriers (LCC) and plastic chip carriers (PCC) are mass-produced to improve the component packaging efficiency of systems.

Features

- Fully compatible Z80® instruction set: 158 instructions, 10 address modes, 22 internal registers
- Wide power supply range—2.4V to 6.0V
- Addresses up to 64k bytes of memory and 256 I/O devices
- Low power: 50 mW @ 5V V_{CC} with unique power save feature
- Multiplex bus structure
- 5 interrupt request lines on-chip

NSC800 Family Chips

Device Number	Description	Temperature Range	Packaging Information
NSC800-3	microCMOS 8 CPU 2.5 MHz	Industrial/Military	D40, N40
NSC800-1	microCMOS 8 CPU 1.0 MHz	Industrial/Military	E44, V44
NSC800-4	microCMOS 8 CPU 4.0 MHz	Industrial/Military	
NSC810A-3	microCMOS RAM I/O Expander 2.5 MHz	Industrial/Military	D40, N40
NSC810A-1	microCMOS RAM I/O Expander 1.0 MHz	Industrial/Military	E44, V44
NSC810A-4	microCMOS RAM I/O Expander 4.0 MHz	Industrial/Military	
NSC831-3	microCMOS Parallel I/O Expander 2.5 MHz	Industrial/Military	D40, N40
NSC831-1	microCMOS Parallel I/O Expander 1.0 MHz	Industrial/Military	E44
NSC831-4	microCMOS Parallel I/O Expander 4.0 MHz	Industrial/Military	
NSC858	microCMOS UART	−55°C to +125°C	N28, V44
NSC888	NSC800-Evaluation Board		Board

*Temperature ranges available (°C)

−55°C to +125°C	Military
−40°C to +85°C	Industrial
0°C to +70°C	Commercial

Section 10
Programmable Logic

Section 10 Contents Programmable Logic

GAL® is a registered trademark of Lattice Semiconductor

Programmable Logic

At National we understand that different business opportunities call for different logic strategies. Which is why we offer the broadest range of Programmable Logic Devices (PLD) designed to deliver performance tailored to your specific business requirements.

Currently based on three process technologies, our continually expanding product portfolio includes bipolar TTL PAL® devices, electrically erasable and reprogrammable CMOS Generic Array Logic (GAL®) and high-performance ECL PAL devices.

TTL PAL Devices Take AIM

Early on in our work with programmable logic, we recognized that performance, as measured by speed and power consumption, is not the only part to the total product equation. Reliability, in the form of programming yields, testability, the fuse mechanism itself and cost of ownership, is equally critical to the success of your product as well as to our own. Which is why our latest family of high-speed 10 ns PAL devices incorporates a programming technique known as Avalanche Induced Migration (AIM).

Instead of using a high voltage and current to blow a fuse, as in the case of other bipolar PLDs, National's AIM technique is based on special "vertical-fuse" cells which permit a relatively low initial current to be used during programming. Avalanching current in a cell causes aluminum to heat and diffuse downward through the transistor junction to establish a logical connection. The cell is repeatedly measured and reprogrammed with higher current until its integrity is confirmed.

The vertical fuse AIM approach permits not only full AC/DC parametric testing but also the testing of every cell for conductivity and programmability before each blank device is shipped.

Pre-programmed PAL Devices (PL) and National Masked Logic (NML)

Order your PAL devices anyway you like. We can supply blank unprogrammed devices (PAL), pre-programmed devices (PL), or mask-programmed devices (NL). The advantages of buying ready-programmed devices are that:

i. each device is fully tested before leaving the factory

ii. the programming/handling stage of your manufacturing process can be eliminated, saving valuable time.

Many of our franchised distributors are also able to offer an excellent programming and testing service.

Programmable Logic—Military/Aerospace

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD and JAN Slash Sheet numbers. It can also be used as a quick reference to cross index National's generic part numbers with SMD and JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

Many of National Semiconductor's commercial ICs listed in this section are also offered as military qualified devices and are indicated by a "†" preceding the part number. Military products are offered in a variety of flows including MIL-STD-883, SMD (Standard Military Drawing), and MIL-M-38510. For more information, consult the 1989 Military/Aerospace Selection Guide.

Please note that National Semiconductor offers many commercial ICs which operate over the military temperature range (−55°C to +125°C), and are designated by an "M" suffix. These devices are NOT military qualified products. Military devices are indicated by a "†" preceding the part number.

EECMOS GAL Devices Combine High Performance with Low Power

No other PLD offers you so much in design flexibility, performance, reliability and testability as our family of GAL devices. Unlike conventional OTP PLDs, or even UV erasable PLDs, GAL devices can be programmed, erased and reprogrammed in seconds. This makes them ideal for prototyping and for pattern changes or error recovery on the manufacturing floor. What's more, every GAL is 100% tested, including programmability and functionality to several worst-case test patterns, before it leaves the factory.

With an ever increasing number of PLDs becoming available, GAL devices help make purchasing and inventory control easier, while satisfying all design criteria. Just two GAL devices, the 20-pin GAL16V8 and 24-pin GAL20V8, each emulate twenty-one different standard PAL architectures. They are pin-for-pin compatible with full function, fuse-map and parametric compatibility. Which can help you trim parts lists and reduce inventory costs.

ECL PAL Devices—The Fastest in the Industry

With our initial introduction of a 6-ns 10KH/100K I/O compatible device in 1985, we quickly established the industry standard for ECL PAL architecture. At present we are the only supplier shipping 4-ns devices. As we continue to focus our design philosophy on meeting the needs of ultra-fast supercomputers, minis, minisupers and high-end workstations, by offering devices with a range of registered and combinatorial output architectures, we have already begun to adapt our proprietary ASPECT™ process, originally developed for ECL gate arrays, for PAL production.

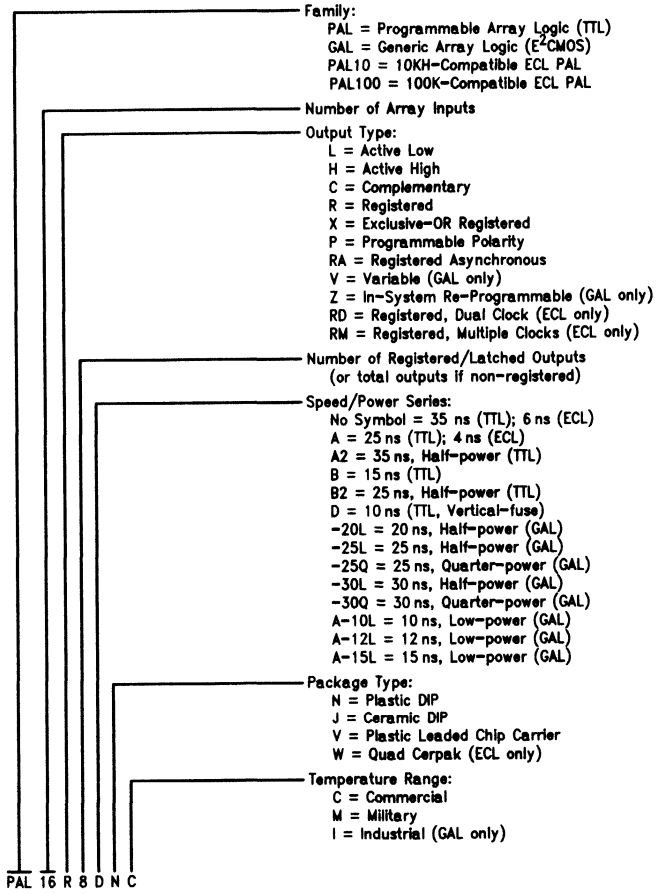
PLAN™—Complete Design Support

National's PLAN software is the ultimate device-independent language that allows you to implement your design in any PLD we make, TTL, ECL or CMOS. PLAN software is simple to use and is designed to run on your IBM compatible personal computer.

The PLAN package contains a Boolean logic assembler which produces fully JEDEC-compatible "fuse-map" files. Additionally, the JED2BEQ program reverse-compiles JEDEC files into the PLAN Boolean equation language ("BEQ") allowing editing or even cross-compiling to a different target device. The PAL2GAL program conveniently converts an existing PAL JEDEC file into a functionally equivalent GAL programming file.

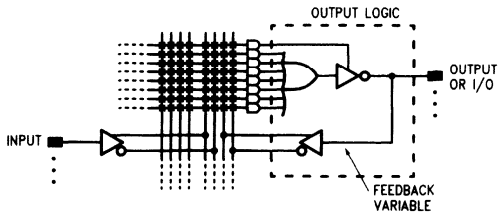
Within one equation file, devices of different technologies or complexities may be specified by the user. PLAN will verify if the specified device can accommodate the logic. If no device is specified, PLAN will select the least complex device to accommodate the logic. In addition to the familiar Boolean equation syntax, the PLAN software syntax also introduces command-words and command-types to define a given logic function, enabling you to specify all your logic using one file syntax so that the architecture of the device becomes transparent.

Programmable Logic Part Numbering



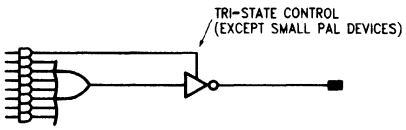
TL/MS/10315-11

PAL Logic Array



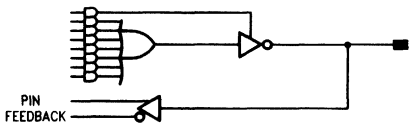
TL/MS/10315–1

PAL Output Logic Types



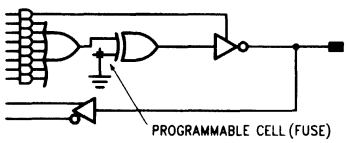
TL/MS/10315–2

Typical Combinatorial Output (Active-Low)



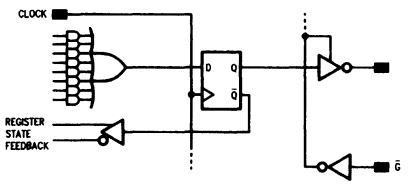
TL/MS/10315–3

Typical Combinatorial I/O (Active-Low)



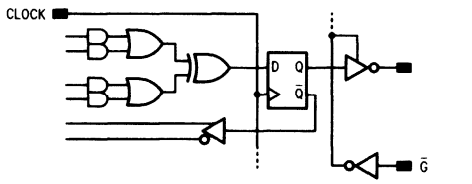
TL/MS/10315–4

Programmable Polarity Output (Combinatorial)



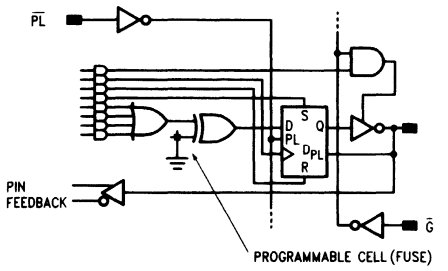
TL/MS/10315–5

Registered Output (Synchronous)



TL/MS/10315–6

Exclusive-OR Registered Output



TL/MS/10315–7

Registered Asynchronous ("RA") I/O

PLD Selection Guide

Family	Part Number	Commercial t_{PD} (max)	I_{CC} (max)	Combinatorial Outputs	Registered Outputs	Comments	Package
TTL							
20-Pin Small PAL (Standard Speed)	†PAL10H8	35	90	8	—		J20A
	†PAL10L8	35	90	8	—		N20A
	†PAL12H6	35	90	6	—		V20A
	†PAL12L6	35	90	6	—		
	†PAL14H4	35	90	4	—		
	†PAL14L4	35	90	4	—		
	†PAL16H2	35	90	2	—		
	†PAL16L2	35	90	2	—		
	†PAL16C1	35	90	1	—		
20-Pin Small PAL Series-A	†PAL10H8A	25	90	8	—		J20A
	†PAL10L8A	25	90	8	—		N20A
	†PAL12H6A	25	90	6	—		
	†PAL12L6A	25	90	6	—		
	†PAL14H4A	25	90	4	—		
	†PAL14L4A	25	90	4	—		
	†PAL16H2A	25	90	2	—		
	†PAL16L2A	25	90	2	—		
	†PAL16C1A	30	90	1	—		
20-Pin Small PAL Series-A2	PAL10H8A2	35	45	8	—		J20A
	PAL10L8A2	35	45	8	—		N20A
	PAL12H6A2	35	45	6	—		V20A
	PAL12L6A2	35	45	6	—		
	PAL14H4A2	35	45	4	—		
	PAL14L4A2	35	45	4	—		
	PAL16H2A2	35	45	2	—		
	PAL16L2A2	35	45	2	—		
	PAL16C1A2	40	45	1	—		
20-Pin Medium PAL Standard	†PAL16L8	35	180	8	—		J20A
	†PAL16R4	35	180	4	4		N20A
	†PAL16R6	35	180	2	6		V20A
	†PAL16R8	35	180	—	8		
20-Pin Medium PAL Series-A	†PAL16L8A	25	180	8	—		J20A
	†PAL16R4A	25	180	4	4		N20A
	†PAL16R6A	25	180	2	6		V20A
	†PAL16R8A	25	180	—	8		
20-Pin Medium PAL Series-A2	PAL16L8A2	35	90	8	—		J20A
	PAL16R4A2	35	90	4	4		N20A
	PAL16R6A2	35	90	2	6		V20A
	PAL16R8A2	35	90	—	8		
20-Pin Medium PAL Series-B	†PAL16L8B	15	180	8	—		J20A
	†PAL16R4B	15	180	4	4		N20A
	†PAL16R6B	15	180	2	6		V20A
	†PAL16R8B	15	180	—	8		

*Preliminary

†Military qualified device.

PLD Selection Guide (Continued)

Family	Part Number	Commercial t_{PD} (max)	I_{CC} (max)	Combinatorial Outputs	Registered Outputs	Comments	Package
TTL (Continued)							
20-Pin Medium PAL Series-B2	†PAL16L8B2	25	90	8	—		J20A
	†PAL16R4B2	25	100	4	4		N20A
	†PAL16R6B2	25	100	2	6		V20A
	†PAL16R8B2	25	100	—	8		
20-Pin Medium PAL Series-D	PAL16L8D	10	180	8	—	Vertical-Fuse (AIM) technology.	J20A
	PAL16R4D	10	180	4	4		N20A
	PAL16R6D	10	180	2	6		V20A
	PAL16R8D	10	180	—	8		
24-Pin Small PAL (Standard Speed)	†PAL12L10	40	100	10	—		J24F
	†PAL14L8	40	100	8	—		N24C
	†PAL16L6	40	100	6	—		V28A
	†PAL18L4	40	100	4	—		
	†PAL20L2	40	100	2	—		
	†PAL20C1	40	100	1	—		
24-Pin Small PAL Series-A	PAL12L10A	25	100	10	—		J24F
	PAL14L8A	25	100	8	—		N24C
	PAL16L6A	25	100	6	—		V28A
	PAL18L4A	25	100	4	—		
	PAL20L2A	25	100	2	—		
	PAL20C1A	25	100	1	—		
24-Pin XOR PAL (Standard)	PAL20L10	50	165	10	—	AND-OR-XOR function on all registered outputs.	J24F
	PAL20X4	50	180	6	4		N24C
	PAL20X8	50	180	2	8		V28A
	PAL20X10	50	180	—	10		
24-Pin XOR PAL Series-A	PAL20L10A	30	165	10	—	AND-OR-XOR function on all registered outputs.	J24F
	PAL20X4A	30	180	6	4		N24C
	PAL20X8A	30	180	2	8		V28A
	PAL20X10A	30	180	—	10		
24-Pin Medium PAL Series-A	PAL20L8A	25	210	8	—		J24F
	PAL20R4A	25	210	4	4		N24C
	PAL20R6A	25	210	2	6		V28A
	PAL20R8A	25	210	—	8		
24-Pin Medium PAL Series-B	PAL20L8B	15	210	8	—		J24F
	PAL20R4B	15	210	4	4		N24C
	PAL20R6B	15	210	2	6		V28A
	PAL20R8B	15	210	—	8		
24-Pin Medium PAL Series-D*	PAL20L8D	10	210	8	—	Vertical-fuse (AIM) technology	J24F
	PAL20R4D	10	210	4	4		N24C
	PAL20R6D	10	210	2	6		V28A
	PAL20R8D	10	210	—	8		
24-Pin Polarity PAL Series-B	PAL20P8B	15	210	8	—	Individually-selectable output polarity on all outputs	J24F
	PAL20RP4B	15	210	4	4		N24C
	PAL20RP6B	15	210	2	6		V28A
	PAL20RP8B	15	210	—	8		

*Preliminary

†Military qualified device.

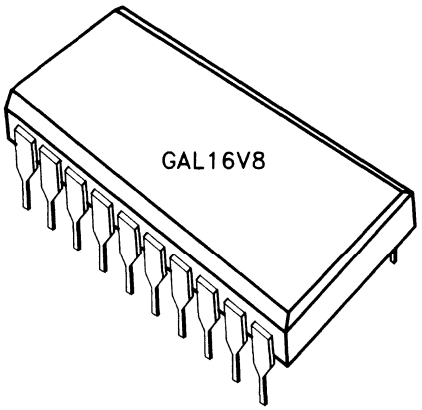
PLD Selection Guide (Continued)

Family	Part Number	Commercial t_{PD} (max)	I_{CC} (max)	Combinatorial Outputs	Registered Outputs	Comments	Package
TTL (Continued)							
20-Pin Registered Asynchronous	PAL16RA8	30	170	—	8	Logic-controlled clock, set, reset, TRI-STATE®, register-select.	J20A, N20A V20A
24-Pin Registered Asynchronous	PAL20RA10	30	200	—	10	Logic-controlled clock, set, reset, TRI-STATE, register-select.	J24F, N24C V28A
E²CMOS							
20-Pin Generic Array Logic	GAL16V8-20L	20	90	—	8	Reprogrammable, reconfigurable, compatible replacement for 20-Pin Small and Medium PAL products. Individual register-select, polarity.	N20A V20A
	GAL16V8-25Q	25	45	—	8		
	GAL16V8-25L	25	90	—	8		
	GAL16V8-30Q	30	45	—	8		
	GAL16V8-30L	30	90	—	8		
24-Pin Generic Array Logic	GAL20V8-20L	20	90	—	8	Reprogrammable, reconfigurable, compatible replacement for 24-Pin Small and Medium PAL products. Individual register-select, polarity.	N24C V28A
	GAL20V8-25Q	25	45	—	8		
	GAL20V8-25L	25	90	—	8		
	GAL20V8-30Q	30	45	—	8		
	GAL20V8-30L	30	90	—	8		
20-Pin Generic Array Logic Series-A	GAL16V8A-10L*	10	115	—	8	Reprogrammable, reconfigurable, compatible replacement for 20-Pin Small and Medium PAL products.	N20A V20A
	GAL16V8A-12L	12	115	—	8		
	GAL16V8A-15L	15	115	—	8		
24-Pin Generic Array Logic Series-A	GAL20V8A-10L*	10	115	—	8	Reprogrammable, reconfigurable, compatible replacement for 24-Pin Small and Medium PAL products	N24C V28A
	GAL20V8A-12L	12	115	—	8		
	GAL20V8A-15L	15	115	—	8		
ECL							
Combinatorial (Standard Speed)	PAL1016P8	6	−240	8	—	Programmable polarity.	J24F
	PAL10016P8	6	−240	8	—		W24B
Combinatorial Series-A	PAL1016P4A	4	−220	4	—	Programmable polarity.	J24F
	PAL10016P4A	4	−220	4	—		W24B
Complementary Series-A*	PAL1012C4A	4	−220	4	—	Complementary Outputs.	J24F
	PAL10012C4A	4	−220	4	—		W24B
Registered (Standard Speed)	PAL1016RD8	6	−280	—	8	Programmable polarity. "RD" = Dual clocks,	J24F
	PAL10016RD8	6	−280	—	8		W24B
Registered Series-A*	PAL1016RM4A	4	−220	—	4	Programmable polarity.	J24F
	PAL10016RM4A	4	−220	—	4		W24B

*Preliminary

GAL16V8 Emulates These 20-Pin PAL Products

10L8	12L6	14L4	16L2	16R8	16R6	16R4	16L8
10H8	12H6	14H4	16H2	16RP8	16RP6	16RP4	16H8
10P8	12P6	14P4	16P2				16P8



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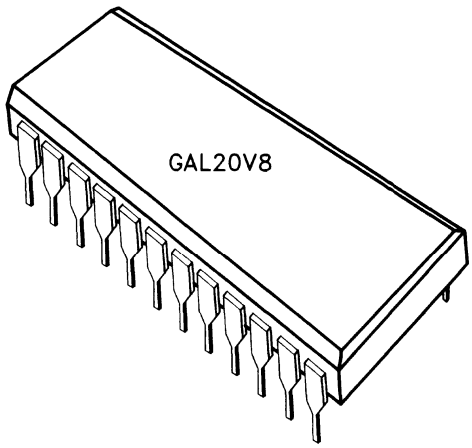
GAL20V8 Emulates These 24-Pin PAL Products

14L8	16L6	18L4	20L2	20R8	20R6	20R4	20L8
14H8	16H6	18H4	20H2	20RP8	20RP6	20RP4	20H8
14P8	16P6	18P4	20P2				20P8



TL/MS/10315–9

National Fixed Logic (NFL) Devices

NFL devices are based on TTL PAL devices with mask-program patterns and are offered as standard LS-TTL logic devices.

		Commercial			
Part Number	**Description**	**I_{CLK} or t_{PD}**	**t_{SU}**	**I_{CC}**	**Packages**
DM74LS380A*	Multifunction Octal Register	15	30	180	J24F, N24C, V28A
DM74LS450A*	16:1 Multiplexer	30	—	100	J24F, N24C, V28A
DM74LS451A*	Dual 8:1 Multiplexer	25	—	100	J24F, N24C, V28A
DM74LS453A*	Quad 4:1 Multiplexer	25	—	100	J24F, N24C, V28A
DM74LS460A*	10-Bit Comparator	30	—	100	J24F, N24C, V28A
DM74LS461A*	8-Bit Up-Counter	15	30	180	J24F, N24C, V28A
DM74LS469A*	8-Bit Up/Down Counter	15	30	180	J24F, N24C, V28A
DM74LS491A*	10-Bit Up/Down Counter	15	30	180	J24F, N24C, V28A
DM74LS498A*	8-Bit Shift Register	15	30	180	J24F, N24C, V28A

*Preliminary

Section 11
Telecommunications

Section 11 Contents Telecommunications

Telecommunications

To coincide with the advent of the Integrated Services Digital Network (ISDN), this guide portrays the continuing evolution of the telecommunications network and the integrated circuit technology required to support it. This guide shows the emergence of a fully digital network, including high capacity public and private digital loops to implement greater worldwide communications capability and flexibility. The integrated circuits required for today's telecommunications technology are no longer simple functions, but are complete systems. With unprecedented functionality and parametric performance levels, they utilize the most advanced silicon process technology available. This guide contains a complete product listing of all "dedicated" telecommunications components for the system designer. Full data sheets on these devices are available upon request.

Shipping over 10 million codec/filter lines per year, National Semiconductor is an industry leader in the field of telecommunications specific integrated circuit functions. In 1977, the introduction of the world's first commercially available integrated codec, the TP3000, led the way to the world's first industry standard single chip codec/filter COMBO™, the TP3054/57. In 1986, the announcement of the TP3070 COMBO II™ proved National's ability to provide state-of-the-art high performance and cost effectiveness. Other line card component developments, such as the Digital Line Interface Controller (DLIC), parallel COMBO, Magnetic Compensation SLIC MC, Time Slot Assigner Circuit (TSAC), and now ISDN are clear signs of National's dedication and long term commitment to the market.

National Semiconductor will continue to monitor the evolving requirements in telecommunications industry applications. New IC designs will provide additional features and further improve cost effectiveness. Systems designers can utilize the most advanced technology available with National's telecommunications integrated circuits. National further assures success by designing products which have the highest quality and reliability standards in the world.

ISDN Systems Solutions

We give you the complete system solution.

TP3420 S-Interface Device (SID™)

The TP3420 SID is a single-chip transceiver for data transmission on four-wire twisted pairs. It provides all the CCITT Layer 1 functions for basic access at the S- and T-interfaces. The SID can be configured to operate in equipment ranging from terminal equipment to NT1 or NT2 network termination to PBX line cards.

The TP3420 features full-duplex transmission at 192 kbits/second on separate transmit and receive twisted pairs, using alternative space inversion line coding. To achieve this aggregate transmission rate, the TP3420 combines two B-channels at 64 kbits/second each, one D-channel at 16 kbits/second, plus overhead.

Extended Point-to Point Range

To improve system performance, the TP3420 extends the 1,000-meter I.430 specification to 1,500 meters in point-to-point configurations. That means if your customers have existing PBX loops greater than 1,000 meters, you can offer extended loop operation at no additional cost.

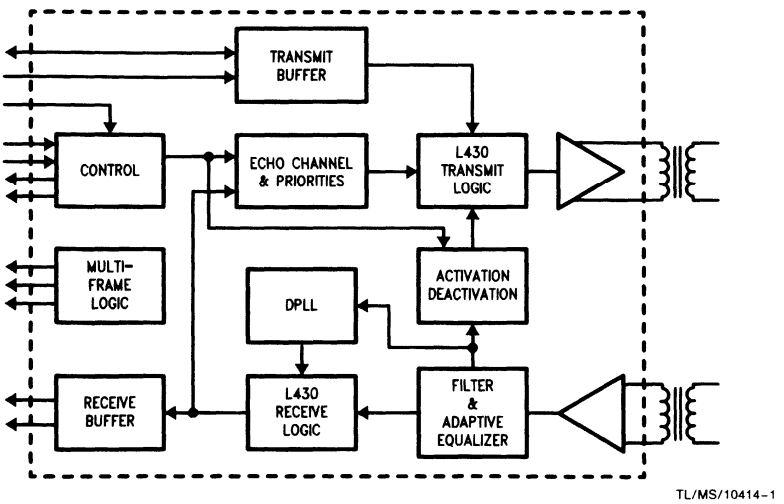
Superior Transmission Performance

The TP3420 combines several advanced signal-processing techniques to achieve low bit-error rates—even on the standard types of cable pairs usually found in older buildings. These techniques include:

- The use of adaptive equalization for increased range over competing designs.
- The use of an oversampling digital filter to provide error-free data transmission even on noisy lines.
- Improving clock jitter by reducing the min/max window to ±130 ns (from the ±360 ns required by I.430).
- The use of elastic data buffers to accommodate frame phase skews in slave-to-slave mode (e.g., line cards on the network side of an NT2). This meets the system wander performance specification of CCITT recommendation Q.502.

Automatic D-Channel Flow Control

The TP3420 offers simplified D-channel control. After activation, it handles all D-channel accesses automatically without time-consuming interrupts to the host processor. This is accomplished using a fast DMA channel on the LAPD controller, rather than expensive FIFOs, which require interrupts. This approach results in more compact code, less software overhead, and better real-time performance.



S-Interface Device (SID)

TP3420 S-Interface Device Features

- Single-chip, four-wire 192 kbits/second transceiver
- Provides all CCITT I.430 Layer 1 functions
- Same device for TE, NT, and PBX line cards
- Point-to-point range extended to 1.5 km (5,000 ft.), exceeding I.430 range
- Point-to-multipoint for all I.430 configurations
- Adaptive and fixed timing options for NTI
- Clock resynchronizer and elastic data buffers for NT2
- Multiframe channel for Layer 1 maintenance
- Selectable system interface formats
- MICROWIRE™-compatible serial control interface
- 5V only CMOS operation
- 20-pin package

Multiple B/D Frame Formats

The TP3420 can be easily interfaced to a variety of Layer 2 devices. It supports four different B/D frame structures, which are program-selectable. You can use the TP3420 with several popular Layer 2 devices and get improved S-interface transmission performance, without adding expensive glue logic.

Multiframe Maintenance Channel

Unlike other S-interface devices, support is built-in for the multiframe maintenance channel, a recent ANSI requirement added to the I.430 specification for U.S. applications. This is an 800-bit second channel in each direction, used for Layer 1 maintenance. By integrating multiframe, the TP3420 reduces the software supervision and code required to handle this function.

Simple MICROWIRE/PLUS™ Interface

The TP3420 uses a simple three-wire interface, called MICROWIRE/PLUS, for device mode control—for example, power up/down, setting loopbacks, activation, etc. This protocol provides high-speed, serial data transfer between a microcontroller and the SID. Its ease of design lets you implement solutions quickly and cost-effectively.

HPC16400 Communications Controller

The HPC16400 is a high-performance communications controller that implements all of the ISDN Layer 2 and Layer 3 functions in a highly integrated yet flexible system. A member of National's HPC™ family, the 16-bit HPC16400 includes a standard-core CPU with unique memory and I/O features for fast, efficient I/O control and high-speed data manipulation.

To the core have been added four functional blocks to support a wide range of communications applications—two HDLC channels, a four-channel DMA controller to facilitate data flow for the HDLC channels, a serial decoder for interchip communications, and a programmable UART.

These features make the HPC16400 an ideal processor for controlling equipment used in TE, TA or line-card applications, including those using LAPB and LAPD protocols.

In a typical application, one of the HDLC channels might be dedicated to running the LAPD protocol in the D-channel while the other provides packet-mode access to one of the B-channels. The UART serves as an RS-232 (V.24) interface running at a standard asynchronous rate up to 208.3 kbaud.

The serial decoder allows either or both HDLC controllers to be directly interfaced to a Layer 1 transceiver or to a variety of backplanes, line-card controllers, or other devices using TDM serial interfaces.

Two Full-Duplex HDLC Channels

The use of twin HDLC channels provides fast, error-free transmission of data and signaling information. Suitable for both the B-and D-channels, they implement proper frame sequencing and control, error detection, and address recognition.

Both HDLC channels can sustain continuous data rates as high as 4.65 Mbits/second through the DMA controller, making them suitable for applications like primary-rate interface networks as well as basic-rate.

Four-Channel DMA Controller

To fully exploit the speed of the HDLC channels, a four-channel DMA controller acts as the interface to external data RAM. Bus requests are initiated automatically and, when acknowledged, completed with no CPU intervention.

The DMA channels support split-frame programmability for improved memory management, chaining for transmission and reception of successive packets, and memory expansion for addressing more than 512 kbytes of memory.

Programmable Serial Decoder Interface

The HPC16400's serial decoder allows the two HDLC channels to work with devices using interchip serial links for point-to-point and multipoint data exchanges, such as ISDN transceivers. It generates enable signals for the HDLC channels, allowing multiplexed D- and B-channel data to be accessed. The decoder can provide the enable itself or it can select one from an external source.

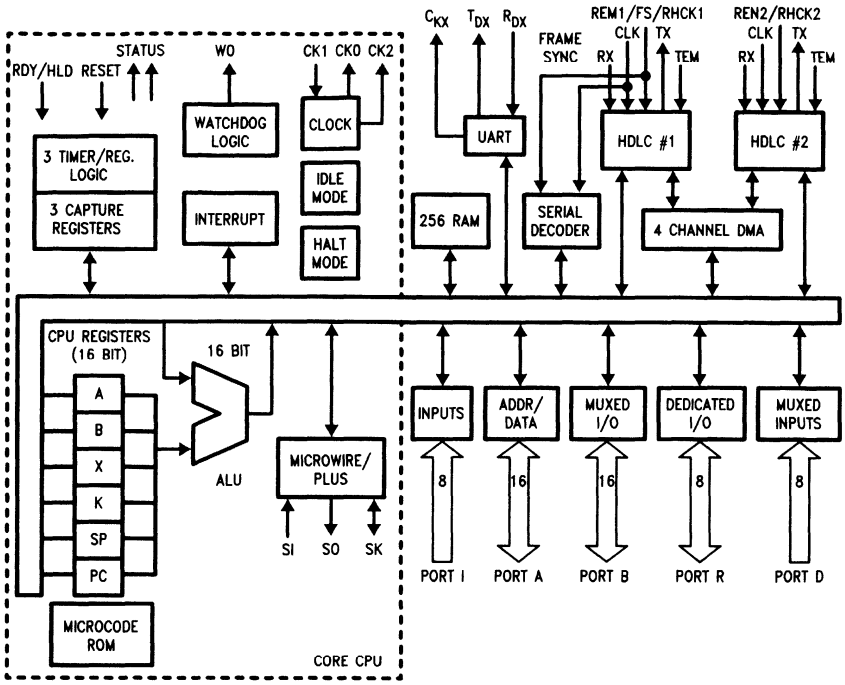
Programmable UART for Terminal Adaptation

The HPC16400's on-board UART allows you to connect existing non-ISDN equipment with serial ports—such as terminals, printers and computers—to an ISDN network, thus providing terminal adaptation capability in a single chip.

The UART includes a programmable baud-rate generator, which allows you to select industry-standard baud rates regardless of crystal frequency. This approach ensures that the system can be operated from a single crystal.

HPC16400 Features

- HPC family core features
  - 16-bit data bus, ALU and registers
  - 544 kbytes of extended addressing
  - 20-MHz system clock
  - High-density, efficient code
  - 16 x 16 multiply and 32 x 16 divide
  - Eight vectored interrupt sources
  - Four 16-bit timer/counters with watchdog logic
  - MICROWIRE/PLUS serial I/O interface
  - 5V only CMOS operation with 2 power-save modes
- Two full-duplex HDLC channels
  - Optimized for LAPB and LAPD applications
  - Programmable frame address recognition
  - Up to 4.65 Mbits/second serial data rate
  - Built-in diagnostics
  - Separate or common receive and transmit clock inputs
- Programmable interchip serial data decoder
- Four-channel DMA controller
  - Split-frame programmability
  - Chaining
- 544 kbytes of extended addressing
- UART—full duplex, programmable baud rate
- Easy interface to S/T- and U-interfaces
- Wide voltage supply ranges (3.0V to 5.5V)
- Industrial and military temperature ranges



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HPC16400 Communications Controller

ANALOG TELECOM PRODUCTS																											
SELECTION GUIDE		T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T
		P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P
		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	5	5	3	3	3	5	5	5
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	2	1	0	0	7
		5	5	5	5	5	5	5	5	5	5	6	6	7	7	7	7	2	2	1	5	4	0	0	5	8	8	0
		1	2	3	4	4	6	7	7	8	9	4	7	0	1	5	6	0	1	6	6	0	0	4	5	8	9	0
						X			X																		
COMBINED	−40°C TO +85°C					*			*																		
CODEC/	A-LAW						*	*	*		*		*														
FILTER	MICRO PROCESSOR INTERFACE									*	*																
COMBO	PARALLEL PCM BUS	*					*			*	*																
DEVICES	PROGRAMMABLE A/U LAW													*	*	*	*										
	PROGRAMMABLE GAINS													*	*	*	*										
	PROGRAMMABLE HYBAL													*	*												
	PROGRAMMABLE LATCHES													*	*	*	*										
	RECEIVE POWER AMPS											*	*														
	SERIAL PCM BUS		*	*	*	*		*	*			*	*	*	*	*	*	*	*	*	*						
	SIGNALLING, LONG FRAME			*																							
	SIGNALLING, SHORT FRAME		*																								
	U-LAW	*	*	*	*	*				*		*															
DTMF DIALER	MICRO PROCESSOR INTERFACE																								*		
DTMF DIALER	KEYPAD INTERFACE																									*	
PCM CODEC	U LAW																	*		*							
PCM CODEC	A LAW																		*		*						
PCM FILTER																						*					
SLIC, MAGNETIC COMPENSATION, +5V																								*			
SLIC, MAGNETIC COMPENSATION, −48V																							*				
TELEPHONE CIRCUIT																											*
TIME SLOT ASSIGNER																								*			
14 PIN DIP																									*		
16 PIN DIP					*	*		*	*											*	*	*				*	*
18 PIN DIP			*																								
20 PIN DIP		*		*			*					*	*		*		*						*	*	*		
22 PIN DIP										*	*								*								
24 PIN DIP																		*									
28 PIN DIP														*		*											
20 PIN PCC/PLCC			*		*	*		*					*									*			*			
28 PIN PCC/PLCC														*		*											
14 PIN SOIC																									*		
16 PIN SOIC																										*	

Section 12
Military/Aerospace Applications

Section 12 Contents Military/Aerospace Applications

Military/Aerospace Applications

Welcome to National Semiconductor Corporation's world of Military/Aerospace products. We are committed to offering the most comprehensive selection of quality, high reliability products and advanced ICs to meet the rapidly changing demands of the Military/Aerospace community.

To support the unique requirements of the Military/Aerospace industry National Semiconductor has created a dedicated selection guide. While general product availability can be determined using the "Master Selection Guide" please refer to "Semiconductors for Military/Aerospace Applications Selection Guide 1989" for specific requirements. The guide addresses product availability in terms of process flow, packaging, and SMD & JAN Slash Sheet numbers. It can also be used as a quick reference to cross National's generic part numbers with SMD & JAN Slash Sheet numbers. We encourage you to use our dedicated guide if you are using Military/Aerospace grade semiconductors.

The Military/Aerospace Selection Guide provides basic product information on National's standard military offering, including part number, pin count, product description, available flows and package types. The information is organized by product family and cross indexed both by part number and function.

The guide also includes:

- Flow definitions
- Process flow charts
- Package definitions
- Glossary of terms

National Semiconductor's Military/Aerospace Program is founded on dedication to excellence. National offers complete support across the broadest range of products with the widest selection of qualification levels and screening flows. These flows include:

Process Flows (Discrete)	Description
JXV	QPL products processed to the JANTV flow per MIL-S-19500.
JTX	QPL products processed to the JANTX flow per MIL-S-19500.
JAN	QPL products processed to the JAN flow per MIL-S-19500.

Process Flows (Integrated Circuits)	Description
JAN S	QPL products processed to MIL-M-38510 Level S for space level applications.
JAN B	QPL products processed to MIL-M-38510 Level B for military applications.
SMD	Standard Military Drawing products processed to Level B with Table I Electricals controlled by DESC. (Formally called DESC Drawing.)
883	Products processed to MIL-STD-883 Level B for military applications.
MLP	Products processed on the Monitored Line (Program) developed by the Air Force for space level applications.
MIL S	Non-JAN products processed to Level S to negotiated electrical specifications for space level applications.
-MIL	Similar to MIL-STD-883 with exceptions noted on Certificate of Conformance.
MSP	Military Screening Program for initial release of advanced products.
MIL TEMP	Products processed to the commercial flow and guardbanded across military temperature range.

- **MIL-M-38510:** The MIL-M-38510 Program, which is sometimes called the JAN IC Program, is administered by the Defense Electronics Supply Center (DESC). The purpose of this program is to provide the military community with standardized products that have been manufactured and screened to government-controlled specifications in government certified facilities. All 38510 manufacturers must be formally qualified and their products listed on DESC's Qualified Products List (QPL) before devices can be marked and shipped as JAN product.

  There are two processing levels specified within MIL-M-38510: Class S and B. Class S is typically specified for space flight applications, while Class B is used for aircraft, naval and ground systems. National is a major supplier of both classes of devices. Screening requirements are outlined in Table III. Tables I and II explain the JAN device marking system.

  Copies of MIL-M-38510, the QPL and other related documents may be obtained from:

  Naval Publications and Forms Center
  5801 Tabor Avenue
  Philadelphia, PA 19120
  (212) 697-2179

- **Standard Military Drawings (SMD):** SMD's are issued to provide standardized versions of devices which are not yet available as JAN product. MIL-STD-883 Class B screening is coupled with tightly controlled electrical specifications which have been written to allow a manufacturer to use his standard electrical tests. A current listing of National's SMD offerings can be obtained from our authorized distributors, sales offices or DESC. DESC is located in Dayton, Ohio.

- **MIL-STD-883:** Although originally intended to establish uniform test methods and procedures, MIL-STD-883 has also become the general specification for non-JAN military product. Revision C of this document defines the minimum requirements for a device to be marked and advertised as 883-compliant. Included are design and construction criteria, documentation controls, electrical and mechanical screening requirements, and quality control procedures. Details can be found in paragraph 1.2.1 of MIL-STD-883.

  National offers both 883 Class B and 883 Class S product. The screening requirements for both classes of product are outlined in Table III.

  As with SMDs a manufacturer is allowed to use his standard electrical tests provided that all critical parameters are tested. Also, the electrical test parameters, test conditions, test limits and test temperatures must be clearly documented. At National Semiconductor, this information is available via our Table I (formerly RETS, Reliability Electrical Test Specification Program). The Table I document is a complete description of the electrical tests performed and is controlled by our QA department. Individual copies are available upon request.

  Some of National's products are produced on a flow similar to MIL-STD-883. These devices are screened to the same stringent requirements as 883 product, but are marked as **-MIL**; specific reasons for prevention of compliancy are clearly defined in the Certificate of Conformance (C of C) shipped with the product.

- **Monitored Line Program (MLP):** is a non JAN Level S program developed by the Air Force. Monitored Line product usually provides the shortest cycle time, and is acceptable for application in several space level programs. Lockheed Missiles and Space Company in Sunnyvale, California, under an Air Force contract, provides "on-site" monitoring of product processing, and as appropriate, program management. Monitored Line orders generally do not allow "customizing", and most flows do not include quality conformance inspection. Drawing control is maintained by the Lockheed Company.

- **Military Screening Program (MSP):** National's Military Screening Program was developed to make screened versions of advanced products such as gate arrays and microprocessors available more quickly than is possible for JAN and 883 devices. Through this program, screened product is made available for prototypes and breadboards prior to or during the JAN or 883 qualification activities. MSP products receive the 100% screening of Table III, but are not subjected to Group C and D quality conformance testing. Other criteria such as electrical testing and temperature range will vary depending upon individual device status and capability.

- **MIL-S-19500:** MIL-S-19500 establishes the general requirements of discrete semiconductor devices. Detail requirements and characteristics are specified in detail specifications. Three levels of product assurance requirements are provided, differentiated by the prefixes JAN, JANTX, and JANTXV. Table XI details the product assurancer requirements for these four levels. The differences in the product assurance requirements are based upon differences in reliability levels for various types of systems and are divided into five basic areas: qualification, lot definition, traceability requirements, screening and quality conformance requirements.

TABLE I. The MIL-M-38510 Part Marking

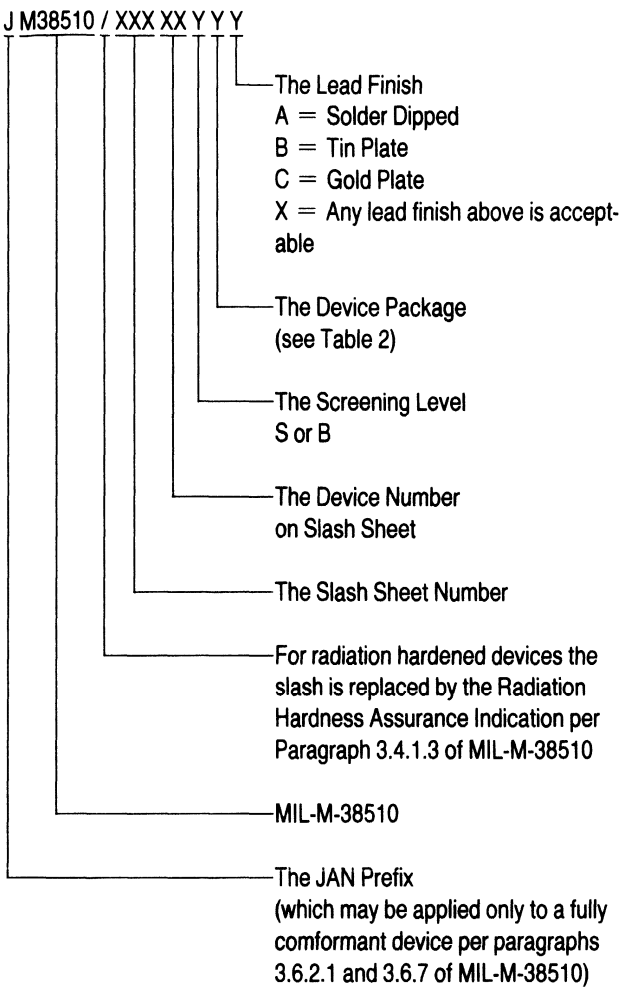


TABLE II. JAN Package Codes

38510 Package Designation	Microcircuit Industry Description
A	14-pin 1/4" x 1/4" (Metal) Flatpak
B	14-pin 3/16" x 1/4" (Metal) Flatpak
C	14-pin 1/4" x 3/4" Dual-In-Line
D	14-pin 1/4" x 3/8" (Ceramic) Flatpak
E	16-pin 1/4" x 7/8" Dual-In-Line
F	16-pin 1/4" x 3/8" (Metal or Ceramic) Flatpak
G	8-pin TO-99 Can or Header
H	10-pin 1/4" x 1/4" (Metal) Flatpak
I	10-pin TO-100 Can or Header
J	24-pin 1/2" x 1 1/4" Dual-In-Line
K	24-pin 3/8" x 5/8" Flatpak
L	24-pin 1/4" x 1 1/4" Dual-In-Line
M	12-pin TO-101 Can or Header
N	(Note 1)
P	8-pin 1/4" x 3/8" Dual-In-Line
Q	40-pin 3/16" x 2 1/16" Dual-In-Line
R	20-pin 1/4" x 1 1/16" Dual-In-Line
S	20-pin 1/4" x 1/2" Flatpak
T	(Note 1)
U	(Note 1)
V	18-pin 3/8" x 15/16" Dual-In-Line
W	22-pin 3/8" x 1 1/8" Dual-In-Line
X	(Note 1)
Y	(Note 1)
Z	(Note 1)
2	20-terminal 0.350" x 0.350" Chip Carrier
3	28-terminal 0.450" x 0.450" Chip Carrier

Note 1: These letters are assigned to packages by individual MIL-M-38510 detail specifications and may be assigned to different packages in different specifications.

TABLE III. 100% Screening Requirements

		Class S		Class B	
	Screen	**Method**	**Reqmt**	**Method**	**Reqmt**
1.	Wafer Lot Acceptance	5007	All Lots		
2.	Nondestructive Bond Pull (Note 14)	2023	100%		
3.	Internal Visual (Note 1)	2020, Condition A	100%	2010, Condition B	100%
4.	Stabilization Bake (Note 16)	1008, Condition C, Min 24 Hrs. Min	100%	1008, Condition C, Min 24 Hrs. Min	100%
5.	Temperature Cycling (Note 2)	1010, Condition C	100%	1010, Condition C	100%
6.	Constant Acceleration	2001, Condition E Min Y_1 Orientation Only	100%	2001, Condition E Min Y_1 Orientation Only	100%
7.	Visual Inspection (Note 3)		100%		100%
8.	Particle Impact Noise Detection (PIND)	2010, Condition A (Note 4)	100%		
9.	Serialization	(Note 5)	100%		

TABLE III. 100% Screening Requirements (Continued)

		Class S		Class B	
	Screen	**Method**	**Reqmt**	**Method**	**Reqmt**
10.	Interim (Pre-Burn-In) Electrical Parameters	Per Applicable Device Specification (Note 13)	100%	Per Applicable Device Specification (Note 6)	
11.	Burn-In Test	1015 240 Hrs. @ 125°C Min (Cond. F Not Allowed)	100%	1015 160 Hrs. @ 125°C Min	100%
12.	Interim (Post Burn-In) Electrical Parameters	Per Applicable Device Specification (Note 3)	100%		
13.	Reverse Bias Burn-In (Note 7)	1015; Test Condition A, C, 72 Hrs. @ 150°C Min (Cond. F Not Allowed)	100%		
14.	Interim (Post-Burn-In) Electrical Parameters	Per Applicable Device Specification (Note 13)	100%	Per Applicable Device Specification	100%
15.	PDA Calculation	5% Parametric (Note 14), 3% Functional	All Lots	5% Parametric (Note 14)	All Lots
16.	Final Electrical Test (Note 15) a) Static Tests	Per Applicable Device Specification		Per Applicable Device Specification	
	1) 25°C (Subgroup 1, Table I, 5005)		100%		100%
	2) Max & Min Rated Operating Temp. (Subgroups 2, 3, Table I, 5005)		100%		100%
	b) Dynamic Tests or Functional Tests				
	1) 25°C (Subgroup 4 or 7)		100%		100%
	2) Max and Min Rated Operating Temp. (Subgroups 5 and 6 or 8, Table I, 5005)		100%		100%
	c) Switching Tests 25°C (Subgroup 9, Table I, 5005)		100%		100%
17.	Seal Fine, Gross	1014	100% (Note 8)	1014	100% (Note 9)
18.	Radiographic (Note 10)	2012 Two Views	100%		
19.	Qualification or Quality Conformance Inspection Test Sample Selection	(Note 11)	Samp.	(Note 11)	Samp.
20.	External Visual (Note 12)	2009	100%		100%

Note 1: Unless otherwise specified, at the manufacturer's option, test samples for Group B, bond strength (Method 5005) may be randomly selected prior to or following internal visual (Method 5004), prior to sealing provided all other specification requirements are satisfied (e.g., bond strength requirements shall apply to each inspection lot, bond failures shall be counted even if the bond would have failed internal visual).

Note 2: For Class B devices, this test may be replaced with thermal shock Method 1011, Test Condition A, minimum.

Note 3: At the manufacturer's option, visual inspection for catastrophic failures may be conducted after each of the thermal/mechanical screens, after the sequence or after seal test. Catastrophic failures are defined as missing leads, broken packages, or lids off.

Note 4: The PIND test may be performed in any sequence after step 6 and prior to step 16. See MIL-M-38510, paragraph 4.6.3.

Note 5: Class S devices shall be serialized prior to interim electrical parameter measurements.

Note 6: When specified, all devices shall be tested for those parameters requiring delta calculations.

Note 7: Reverse bias burn-in is a requirement only when specified in the applicable device specification. The order of performing burn-in and reverse bias burn-in may be inverted.

Note 8: For Class S devices, the seal test may be performed in any sequence between step 16 and step 19, but it shall be performed after all shearing and forming operations on the terminals.

Note 9: For Class B devices, the fine and gross seal tests shall be performed separately or together in any sequence and order between step 6 and step 20 except that they shall be performed after all shearing and forming operations on the terminals. When 100% seal screen cannot be performed after shearing and forming (e.g., flatpaks and chip carriers) the seal screen shall be done 100% prior to these operations and a sample test (LTPD = 5) shall be performed on each inspection lot following these operations. If the sample fails, 100% rescreening shall be required.

Note 10: The radiographic screen may be performed in any sequence after step 9.

Note 11: Samples shall be selected for testing in accordance with the specific device class and lot requirements of Method 5005.

Note 12: External Visual shall be performed on the lot any time after step 19 and prior to shipment.

Note 13: Read and record is required at steps 10 and 12 only for those parameters for which post-burn-in delta measurements are specified. All parameters shall be read and recorded at step 14.

Note 14: The PDA shall apply to all subgroup 1 parameters at 25°C and all delta parameters.

Note 15: Only one view is required for flat packages and leadless chip carriers with leads on all four sides.

Note 16: May be performed at any time prior to step 10.

TABLE IV. Group A Electrical Tests

Subgroup (Notes 1, 2)	LTPD
Subgroup 1 Static Tests at 25°C	2 w/C = 0
Subgroup 2 Static Tests at Maximum Rated Operating Temperature	2 w/C = 0
Subgroup 3 Static Tests at Minimum Rated Operating Temperature	2 w/C = 0
Subgroup 4 Dynamic Tests at 25°C	2 w/C = 0
Subgroup 5 Dynamic Tests at Maximum Rated Operating Temperature	2 w/C = 0
Subgroup 6 Dynamic Tests at Minimum Rated Operating Temperature	2 w/C = 0
Subgroup 7 Functional Tests at 25°C	2 w/C = 0
Subgroup 8 Functional Tests at Maximum and Minimum Rated Operating Temperatures	2 w/C = 0
Subgroup 9 Switching Tests at 25°C	2 w/C = 0
Subgroup 10 Switching Tests at Maximum Rated Operating Temperature	2 w/C = 0
Subgroup 11 Switching Tests at Minimum Rated Operating Temperature	2 w/C = 0

Note 1: The specific parameters to be included for tests in each subgroup shall be specified in the applicable procurement document. Where no parameters have been identified in a particular subgroup or test within a subgroup, no Group A testing is required for that subgroup or test.

Note 2: A single sample may be used for all subgroup testing. Where required size exceeds the lot size, 100% inspection shall be allowed.

Note 3: Group A testing by subgroup or within subgroups may be performed in any sequence, unless otherwise specified.

TABLE V. Group B (Class B)

Test (Note 1)	Method	Condition	LTPD
Subgroup 2			
Resistance to Solvents	2015		4 Devices (No Failures)
Subgroup 3			
Solderability (Note 2)	2003 or 2022	Soldering Temperature of 245°C ± 5°C	10
Subgroup 5			
Bond Strength (Note 3)	2011		15
1) Thermocompression		1) Condition C or D	
2) Ultrasonic or Wedge		2) Condition C or D	
3) Flip-Chip		3) Condition F	
4) Beam Lead		4) Condition H	
Subgroup 6			
Internal Water-Vapor Content (Note 4)	1018	1,000 ppm Maximum Water Content at 100°C	3 Devices (0 Failures) (Note 5) or 5 Devices (1 Failure)

Note 1: Electrical reject devices from the same inspection lot may be used for all subgroups when end-point measurements are not required, except for devices submitted to subgroup 7.

Note 2: All devices submitted for solderability test shall be in the lead finish that will be on the shipped product and which has been through the temperature/time exposure of burn-in except for devices which have been hot-solder dipped or have undergone tin fusing after burn-in. The LTPD for solderability test applies to the number of leads inspected except in no case shall less than 3 devices be used to provide the number of leads required.

Note 3: Test samples for bond strength may, at the manufacturer's option, unless otherwise specified, be randomly selected prior to or following internal visual (precap) inspection provided all other specification requirements are satisfied. Unless otherwise specified, the LTPD sample size for condition C or D is the number of bond pulls selected from a minimum number of 10 devices, and for conditions F or H is the number of dice (not bonds) (see Method 2011).

Note 4: This test is required only if the package contains a desiccant.

Note 5: Test 3 devices, if 1 fails, test 2 additional devices with no failure.

TABLE VI. Group B (Class S)

Test (Note 1)	Method	Condition	Quantity/(Accept No.) or LTPD
Subgroup 1			
a) Physical Dimensions (Note 2)	2016		2 (0)
b) Internal Water-Vapor (Notes 2, 3)	1018	5,000 ppm Maximum Water Content at 100°C	3 (0) or 5 (1) (Note 4)
Subgroup 2 (Note 5)			
a) Resistance to Solvents	2015		4 (0)
b) Internal Visual and Mechanical	2013 & 2014	Failure Criteria from Design and Construction Requirements of Applicable Procurement Document	2 (0)
c) Bond Strength (Note 6)	2011		LTPD = 10
1) Thermocompression		1) Condition C or D	
2) Ultrasonic		2) Condition C or D	
3) Flip-Chip		3) Condition F	
4) Beam Lead		4) Condition H	
d) Die Shear Test	2019	Per Method 2019 for the Applicable Die Size	3 (0)
Subgroup 3			
Solderability (Note 7)	2003 or 2022	Soldering Temperature or 245°C ± 5°C	LTPD = 15

TABLE VI. Group B (Class S) (Continued)

Test (Note 1)	Method	Condition	Quantity/(Accept No.) or LTPD
Subgroup 4			
Lead Integrity (Note 5)	2004	Condition B_2, Lead Fatigue	2 (0)
Seal	1014	As Applicable	
1) Fine			
2) Gross			
Lid Torque (Note 3)		As Applicable	
Subgroup 5 (Notes 8, 9)			
a) Electrical Parameters (Note 11)		Group A, Subgroups 1, 2, 3: Read and Record Group A, Subgroups 4–11: Attributes	LTPD = 5
b) Steady State Life	1005	Condition C, D or E: 1000 Hours	
c) Electrical Parameters		Group A, Subgroups 1, 2, 3: Read and Record Group A, Subgroups 4–11: Attributes	
Subgroup 6 (Note 5)			
a) Electrical Parameters (Note 11)		Group A, Subgroups 1, 2, 3: Read and Record	LTPD = 15
b) Temperature Cycling	1010	Condition C, 100 Cycles/Min	
c) Constant Acceleration	2001	Test Condition E: Y_1 Orientation Only	
d) Seal	1014		
1) Fine			
2) Gross			
e) Electrical Parameters		Group A, Subgroups 1, 2, 3: Read and Record	
Subgroup 7 (Note 12)			
a) Electrical Parameters		Group A, Subgroup 1	15 (0)
b) Electrostatic Discharge Sensitivity	3015		
c) Electrical Parameters		Group A, Subgroup 1	

Note 1: Electrical reject devices from the same inspection may be used for all subgroups where electrical end-point measurements are not required.

Note 2: Not required for qualification or quality conformance inspections where Group D inspection is being performed on samples from the same inspection lot.

Note 3: This test is required only if it is a glass-frit sealed package.

Note 4: Test 3 devices; if 1 fails, test 2 additional devices with no failures.

Note 5: All samples for subgroup B2 must have been through the complete sequence of subgroup B6 tests.

Note 6: Unless otherwise specified, the LTPD sample size for conditions C and D is the number of bond pulls selected from a minimum of 4 devices and for conditions F and H is the number of dice (not bonds).

Note 7: All devices must be in the same lead finish that will be on the shipped product and shall have been through the temperature/time exposure of burn-in except for devices that have been hot-solder dipped or undergone tin fusing after burn-in. The LTPD applies to the number of leads inspected, except in no case shall less than 3 devices be used to provide the number of leads required.

Note 8: The alternate removal-of-bias provisions of Method 1005 shall not apply for test temperatures above 125°C.

Note 9: The same temperature must be employed for operating life that was used for the 100% burn-in.

Note 10: For leadless chip carriers, condition D will apply.

Note 11: Read and record data from Group A of quality conformance is acceptable.

Note 12: Unless otherwise specified, test shall be performed for initial qualification and product redesign as a minimum.

TABLE VII. Group C (Die-Related Tests for Class B)

Test	Method	Condition	LTPD
Subgroup 1			
Steady State Life Test	1005	Test Condition to be Specified (1,000 hours at 125°C)	5
End-Point Electrical Parameters		As Specified in the Applicable Device Specification	

TABLE VIII. Group D (Package-Related Tests for Classes)

Test	Method	Condition	LTPD
Subgroup 1 (Note 1)			
a) Physical Dimensions	2016		15
Subgroup 2 (Notes 1, 4)			
Lead Integrity	2004	Test Condition B2 (Lead Fatigue) (Note 10)	15
Seal	1014	As Applicable	
a) Fine			
b) Gross			
Subgroup 3 (Note 3)			
Thermal Shock	1011	Test Condition B Minimum, 15 Cycles Minimum	15
Temperature Cycling	1010	Test Condition C, 100 Cycles Minimum	
Moisture Resistance (Note 4)	1004		
Seal	1014	As Applicable	
a) Fine			
b) Gross			
Visual Examination		Per Visual Criteria of Method 1004 or 1010	
End-Point Electrical Parameters (Note 4)		As Specified in the Applicable Device Specification	
Subgroup 4 (Note 3)			
Mechanical Shock	2002	Test Condition B Minimum	15
Vibration Variable Frequency	2007	Test Condition A Minimum	
Constant Acceleration	2001	Test Condition E Minimum Y_1 Orientation Only (Note 6)	
Seal	1014	As Applicable	
a) Fine			
b) Gross			
Visual Examination		Per Visual Criteria of Method 1010 or 1011	
End-Point Electrical Parameters		As Specified in the Applicable Device Specification	
Subgroup 5 (Note 1)			
Salt Atmosphere	1009	Test Condition A Minimum	15
Seal	1014	As Applicable	
a) Fine			
b) Gross			
Visual Examination		Per Visual Criteria of Method 1009	
Subgroup 6 (Note 1)			
Internal Water-Vapor Content	1018	5,000 ppm Maximum Water Content at 100°C	3 Devices (0 Failures) or 5 Devices (1 Failure) (Note 5)
Subgroup 7 (Note 1)			
Adhesion of Lead Finish (Notes 7, 8)	2025		15
Subgroup 8 (Note 1)			
Lid Torque (Note 2)	2024		5 (0)

Note 1: Electrical reject devices from that same inspection lot may be used for samples.

Note 2: Lid torque test shall apply only to packages which use a glass-frit seal to lead frame, lead or package body (i.e., wherever frit seal establishes hermeticity or package integrity).

Note 3: Devices used in Subgroup 3, "Thermal and Moisture Resistance" may be used in Subgroup 4 "Mechanical".

Note 4: At the manufacturer's option, end-point electrical parameters may be performed after moisture resistance and prior to seal test.

Note 5: Test 3 devices; if 1 fails, test 2 additional devices with no failures.

Note 6: See paragraph 3 of Method 5005 for the procedure for large cavity packages.

Note 7: Does not apply to leadless chip carriers.

Note 8: The LTPD applies to the number of leads to be tested.

Note 9: The lead bend stress initial conditioning is not required for leadless chip carriers.

Note 10: For leadless chip carriers only, condition D shall apply.

TABLE IX. Group E (Radiation Hardness Assurance Tests)

Test (Note 1)	Method	Condition	Quantity (Accept Number = 0) Class S	Class B
Subgroup 1 (Note 3)				
Neutron Irradiation	1017	25°C		
a) Qualification			11 per Wafer Lot	5 from each of 3 Wafer Lots
b) Quality Conformance			11 per Wafer Lot	11 per Wafer Lot
End-Point Electrical Parameters		Per Applicable Detail Specification		
Subgroup 2				
Steady-State Total Dose Irradiation	1019	25°C, Maximum Supply Voltage		
a) Qualification			(Note 2)	5 from each of 3 Wafer Lots
b) Quality Conformance			(Note 2)	11 per Wafer Lot
End-Point Electrical Parameters		Per Applicable Detail Specification		

Note 1: Parts used for one subgroup test may not be used for the other subgroup but may be used for higher levels in the same subgroup. Total exposure shall not be considered cumulative unless testing is performed within the time limits of the test method.

Note 2: 4 per wafer for devices type S less than or equal to 4000 equivalent transistors per chip, 2 per wafer for larger dice. Samples will be selected at radius approximately equal to two-thirds of the wafer radius and spaced uniformly around this radius.

Note 3: Subgroup 1 is not required for MOS devices.

TABLE X. Wafer Lot Acceptance Tests

Test	Conditions (Note 1)	Limits (Note 2)	Sampling Plan
1. Wafer Thickness (not required when the finished wafer design thickness is greater than 10 mils)	MIL-STD-977, Method 1580. Measurement shall be performed after final lap or polish. All readings shall be recorded.	Maximum deviation of ± 2 mil for approved design nominal 6 mil minimum.	Two wafers per lot. Reject lot if any measurement exceeds limits or revert to test of each wafer.
2. Metallization Thickness	MIL-STD-977 Method 5500. All readings shall be recorded.	a) Conductor: 9 kÅ minimum for single level metal and for the top level of multi-level metal: 6 kÅ minimum for lower levels, with a maximum deviation of $\pm 20\%$ from the approved design nominal. b) Barrier: Maximum deviation of $\pm 30\%$ from the approved design nominal.	One wafer (or monitor) per lot. Reject lot if measurement exceeds limits or revert to test of each wafer.
3. Thermal stability (applicable to: all linear; all MOS; all bipolar digital operating at 10V or more)	MIL-STD-977, Method 2500. Record V_{FB} or V_T. (Note 3)	a) ΔV_{FB} or $\Delta V_T \leq 0.75V$ for bipolar digital devices operating at $\geq$ 10V and all bipolar linear devices not containing MOS transistors. The monitor shall have an oxide and shall be metallized with the lot. b) ΔV_{FB} or $\Delta V_T \leq 1.0V$ for bipolar linear devices that operate above 5V and contain MOS transistors and digital devices that operate above 10V and contain MOS structures. c) ΔV_{FB} or $\Delta V_T \leq 0.4V$ for MOS devices.	One wafer (or monitor) per lot. Reject lot if measurement exceeds limits or revert to test of each wafer. Separate monitors may be used but must be oxidized and metallized with the lot. A monitor consisting of a gate oxide metallized with the lot shall be used.
4. SEM (Note 4)	MIL-STD-883, Method 2018.	MIL-STD-883, Method 2018.	MIL-STD-883, Method 2018. Lot acceptance basis.
5. Glassivation Thickness	MIL-STD-977, Method 5500. All readings shall be recorded.	6 kÅ minimum for SiO_2 and 2 kÅ minimum Si_3N_4 with maximum deviation of $\pm 20\%$ from approved design nominal.	One wafer (or monitor) per lot. Reject lot if any measurement exceeds limits or revert to test of each wafer.
6. Gold backing thickness (when applicable).	MIL-STD-977, Method 5500. All readings shall be recorded.	Per approved design nominal thickness and tolerance.	One wafer (or monitor) per lot. Reject lot if any measurement exceeds limits or revert to test of each wafer.

Note 1: Approved equivalent test methods may be used in lieu of the referenced MIL-STD-997 methods.

Note 2: Approved design nominal values or tolerances shall be submitted for line certification per DESC-EQM-42.

Note 3: All readings shall be normalized to oxide thickness of 1000Å.

Note 4: When wafer lots fail to pass the SEM requirements of Method 2018, compliance with the current density requirement shall not be used to waiver the SEM requirement.

TABLE XI. MIL-S-19500 Product Assurance Requirements

Requirement	MIL-S-19500 Reference	TXV	TX	JAN
Qualification	4.5			
a) Product Assurance Program and Survey	3.4.2 and Appendix D	X	X	X
b) Manufacturer Certification	3.4.2.2 and Appendix D			
c) Inspection and Testing	4.5, 4.6	X	X	X
Inspection Lot	4.3.1.1 and 4.3.1.2	X	X	X
Traceability	4.3.1.4	X	X	X
Inspection During Manufacture	4.8			
Screening	4.6 and Table II	X	X	
Quality Conformance Inspection				
a) Group A (each lot)	4.7.4 and Table III	X	X	X
b) Group B (each lot)	4.7.5 (Table IVa)			
	(Table IVb)	X	X	X
c) Group C (every 6 months)	4.7.6 and Table V	X	X	X
d) Group D (each wafer lot, as applicable	4.7.7 and Table VI	O		

Note: X = Required. O = Optional, per applicable requirement.

TABLE XII. MIL-S-19500 Screening Requirements

Screen	MIL-STD-750 Method	Condition	JAN Reqmt	JANTXV Reqmt	JANTX Reqmt
1. Internal Visual (Precap) Inspection	2072 2073 2074	For transistors For diodes when specified For diodes		100%	
2. High Temp Life (LTPD) (stabilization bake)	1032	24 hrs min at max rated storage temp	100%	100%	100%
3. Thermal Shock (temp cycling) (Note 6)	1051	No dwell is required at 25°C Test Condition C, 20 cycles t (extremes) $>$ 10 minutes		100%	100%
4. Constant acceleration (not required for double plug diodes)	2006	Y_1 direction at 20,000G min (10,000G min for devices with power rating of $\geq$ 10W at T_C = 25°C)		100%	100%
5. Particle impact noise detection (for all devices with an internal cavity)	2052	Condition A			
6. a) Forward instability shock test (FIST) (Note 5)	2081				
b) Backward instability shock test (BIST) (Note 5)	2082				
7. Hermetic Seal					
a) Fine (not required for double plug diodes)	1071	(a) Test condition G or H, max leak rate = 5×10^{-8} atm cc./s (5×10^{-7} atm cc/s for devices with internal cavity $>$ 0.3 cc)		100% (Note 8)	100% (Note 8)
b) Gross		(c) Test condition A, C, E or F		100% (Note 8)	100% (Note 8)
8. Serialization					
9. Interim electrical parameters		As specified			
10. High temp reverse bias (HTRB) (Note 7)		48 hrs min at T_A = 150°C min and min applied voltage as follows:			
Burn-in (for transistors)	1039	Transistor—Cond A, 80% min of rated V_{CB} (bipolar), V_{GS} (FET) or V_{DS} (FET), as applicable		100%	100%
Burn-in (for diodes and rectifiers)	1038	Diodes (except Zeners) and rectifiers rated $\leq$ 10A at $T_C \geq$ 100°C—80% min of rated V_R—Condition A		100%	100%

TABLE XII. MIL-S-19500 Screening Requirements (Continued)

Screen	MIL-STD-750 Method	Condition	JAN Reqmt	JANTXV Reqmt	JANTX Reqmt
11. Interim electrical and delta parameters		As specified but including all delta parameters as a min. Leakage current shall be measured on each device before any other test is made		100% (Read and record delta parameters within 24 hrs after removal of applied voltage in HTRB)	100% (Read and record delta parameters within 24 hrs after removal of applied voltage in HTRB)
12. Power burn-in (Note 4)		As specified		100%	100%
Burn-in (for transistors	1039	Transistors—Cond B		160 hrs min	160 hrs min
Burn-in (for diodes and rectifiers)	1038	Diodes (including Zeners) and all rectifiers—Cond B		96 hrs min	96 hrs min
Burn-in (for thyristors controlled rectifiers)	1040	Thyristors		96 hrs min	96 hrs min
13. Final electrical test		As specified	100%	100%	100%
a) Interim electrical and delta parameters for PDA. PDA, when applicable, is 10% maximum		All parameter measurements must be completed within 96 hrs after removal from burn-in condition	Interim electrical and delta parameters (Read and record)	Interim electrical and delta parameters (Read and record)	Interim electrical and delta parameters (Read and record)
b) Other electrical parameters			Group A, subgroups 2 and 3	Group A, subgroup 2	Group A, subgroup 2
14. Hermetic seal	1071	(Same as 7 above) (Note 3)		Optional (Note 8)	Optional (Note 8)
a) Fine (except double plug diodes)					
b) Gross					
15. Radiography	2076	(Note 3)			
16. External visual examination	2071	To be performed after complete marking			

Note 1: During shock, the forward DC voltage shall be monitored continuously on an oscilloscope or with a "latch and hold" detection circuit of appropriate sensitivity. Any indication of discontinuity shall be cause for rejection.

Note 2: During vibration, the reverse characteristic to the maximum rated power shall be displayed on an oscilloscope swept at 60 Hz and any discontinuity, flutter, drift or shift in oscilloscope trace or any dynamic instabilities shall be cause for rejection.

Note 3: The radiographic and seal screens for JANS may be performed in any order following final electrical test. Glass diodes shall not be painted until after seal tests.

Note 4: Reverse-blocking test shall replace power burn-in for power rectifiers at $\geq$ 10 amp rating at $T_C \geq 100°C$ and all thyristors.

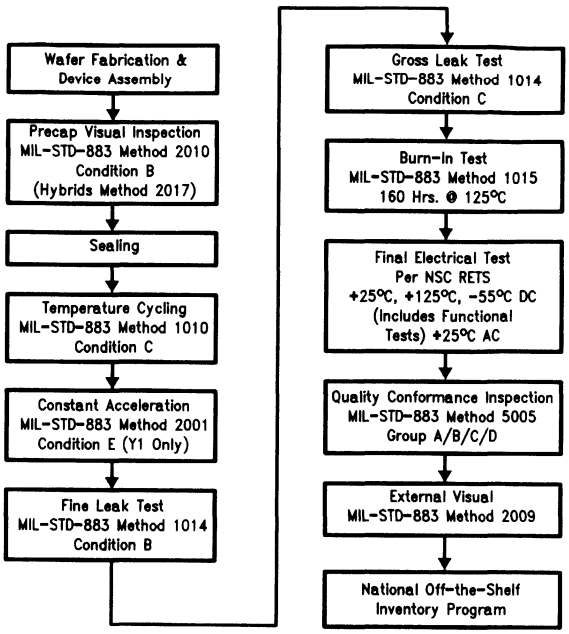
Note 5: Omit BIST and FIST tests for metallurgically bonded double plug or stud mounted diodes. Omit FIST test for temperature-compensated reference diodes.

Note 6: For axial lead glass body diodes, 10 cycles of thermal shock (glass strain) in accordance with MIL-STD-750, Method 1056, test Condition A, over the temperature range 0°C to +100°C shall be substituted for this test.

Note 7: For JANS only. Zener diodes shall be subjected to high temperature reverse bias at 80% of nominal V_Z for $V_Z \geq 10V$. (Not required for Zener diodes with $V_Z < 10V$.)

Note 8: Fine and gross seal leak test for JANTX and JANTXV shall be performed at either step 7 or step 14.

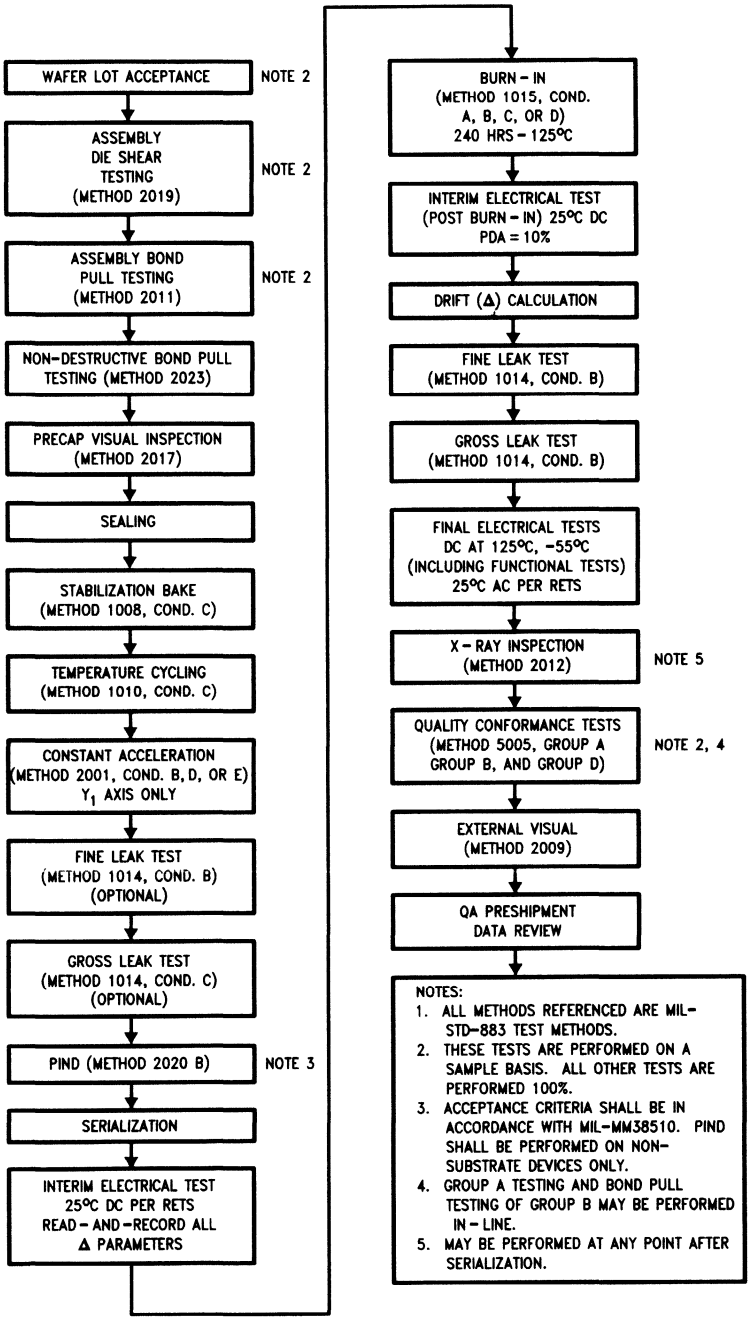
National's 883B/Table I Screening Flow



TL/MS/10373–2

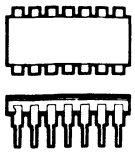
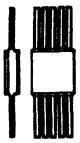
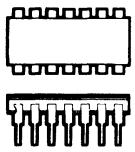
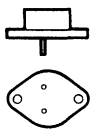
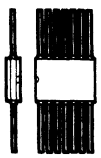
If you make the comparison, you will find that our **Total Standardization Program** is compliant with what your contract tells you you must buy.

JM38510/883 Level S Process Flow



TL/MS/10373-3

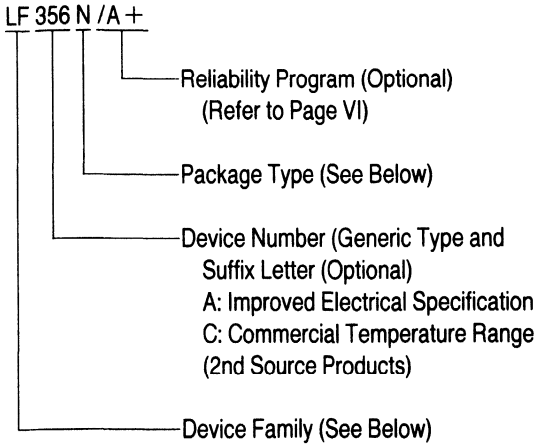
Industry Package Cross-Reference Guide

	NSC	Signetics	Motorola	TI	RCA	General Silicon	AMD	Raytheon	Intel
 14/16 Lead Glass/Metal DIP	D	I	L		D	D	D	D, M	
 Glass/Metal Flat-Pack	F	Q	F	F, S	K	F	F	J, F, Q	
 TO-99, TO-100, TO-5	H	T, K, L, DB	G	L	S*, V1**	T	H	T, H	
 8-, 14- and 16-Lead Low Temperature Ceramic DIP	J	F	U	J				DC, DD	
 TO-3 (Steel) (Aluminum)	K		KS			K		K	
 "SGS" Type Power DIP	S								
 Low Temperature Glass Hermetic Flat Pack	W		F	W			FM		

*With Dual-In-Line formed leads.

**With radially formed leads.

General Product Marking & Code Explanation



Device Family

Integrated Circuits (ICs)

ADC :Data Conversion
AF :Active Filter
AH :Analog Switch (Hybrid)
AM :Analog Switch (Monolithic)
BLC :Board Level Computer
BLMX :Board Level Multi-Tasking Executive
BLX :Board Level Expansion
CD :CMOS (4000 Series Only)
CIM :CMOS Industrial Microcomputer
COP :Control Oriented Processor
DAC :Data Conversion
DB :Development Board
DH :Digital (Hybrid)
DM :Digital (Monolithic)
DP :Interface (Microprocessor)
DS :Interface
HPC :High Performance Controller
HS :Hybrid
ICM :Integrated Computer Module
IDM :Microprocessor (Peripheral)
INS :Microprocessor
ISE :In-System Emulator
JM :MIL-M38510
LF :Linear (BI-FET)
LH :Linear (Hybrid)
LIT :Literature
LM :Linear (Monolithic)
LMC :Linear CMOS
LP :Linear (Low Power)
MA :Macrocomponent
MCA :Gate Array
MF :Linear (Monolithic Filter)
MH :MOS (Hybrid)
MM :CMOS
MOLE :Microcontroller Development System
NL :Programmable Logic
NMC :MOS Memory
NML :Programmable Logic
NS :Microprocessor Component (Memory Systems)
NSC8 :NSC800 Microprocessor
NSP :Series 32000 Publications
NSR :Series 3200 Repair/Service Agreements
NSS :Series 32000 Systems Development Tools
NSV :Series 32000 Evaluation Tools
NSW :Series 32000 Software
NS32 :Series 32000 Components
NS4 :TMP Chip
PAL :Programmable Array Logic
PL :Programmable Logic
PLA :Programmable Logic (FPLA)
RMC :Rack Mount Computer
SD :Special Digital
SF :Special FET
SH :Special Hybrid
SK :Special Kit
SL :Special Linear
SM :Special MOS
SN :Digital (2nd Source)
TMP :Terminal Management Processor
TP :Telecommunication Product

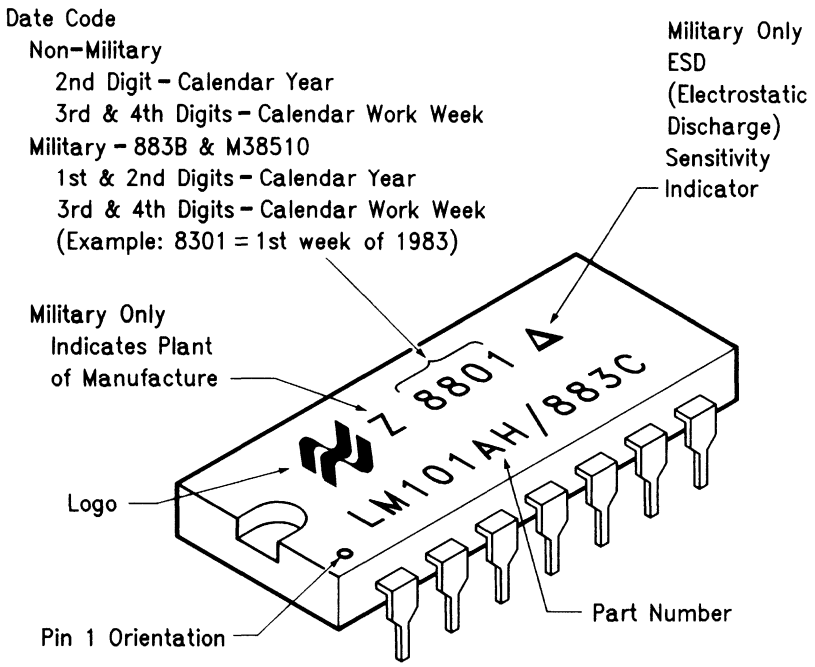
Transistors/FETS

BC :TX-SS
BD :TAX-PWR (PL)
BF :TX-SS & FET
J :FET (PL)
KE :FET (PL)
MJE :TX-PWR (M/C)
MMB :SOT-23
MPF :FET (PL)
MPS :TX-SS (PL)
NCB :TX-PWR
NDF :FET (M/C)
NSD :TX-PWR (PL)
NSE :TX-PWR (PL)
PN :TX-SS (PL)
SE :TX-SS/PWR (PL)
TIP :TX-PWR (PL)
TIS :TX-SS & FET (PL)
TN :TX-PWR
U :FET
2N :TX-SS/PWR (PL)
92PE :TX-SS/PWR (PL)
92PU :TX-SS/PWR (PL)

Package Type

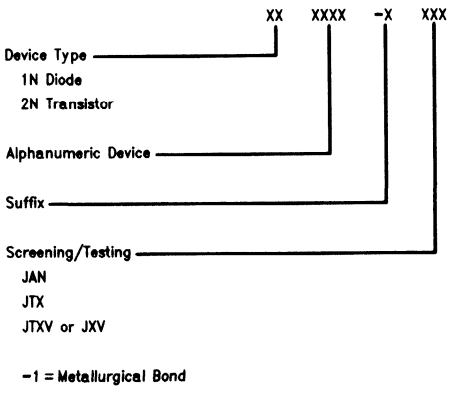
ICs Only

D :Glass/Metal DIP
F :Glass/Metal Flatpak (¼" x ¼")
G :12 Lead TO-8 M/C
H :Multi-Lead M/C
J :Lo-Temp Ceramic DIP (Sometimes referred to as the "Fit-Seal" Package).
J-8 :8 Lead Ceramic DIP ("MiniDIP")
J14 :14 Lead Ceramic DIP (-14 used only when product is also available in -8 pkg).
K :TO-3 M/C in Steel, except LM309K which is shipped in Aluminum
K Steel :TO-3 M/C (Steel)
L :Ceramic Leaded Chip Carrier
Q :Cerdip with UV Window
U :Pin Grid Array
W :Lo-Temp Ceramic Flatpak



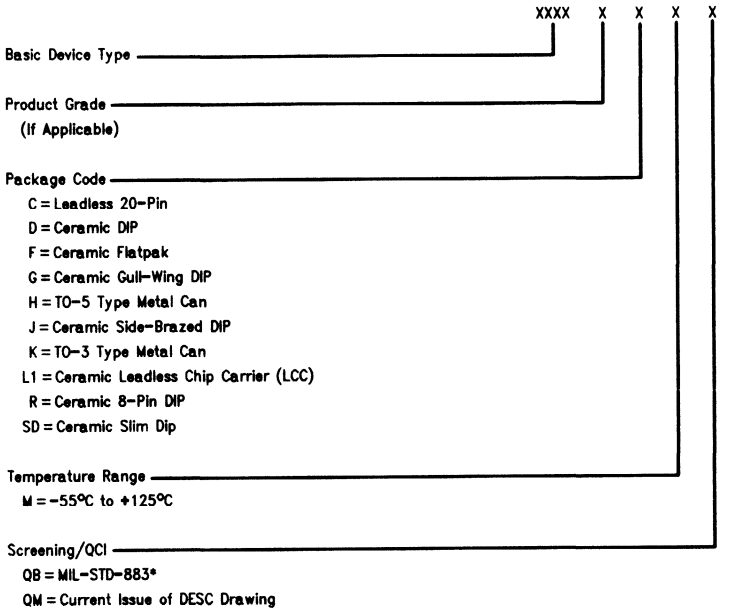
TL/MS/10373-12

MIL-STD-19500 (JAN) Part Numbering System



TL/MS/10373-13

MIL-STD-883 (QB) Part Numbering System



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***Note:** Some products using the "QB" Designator may not be compliant to MIL-STD-883. Contact Local Sales Office for details.

Device Suffix

QM = Current Issue of DESC Drawing
QB = MIL-STD-883*
JAN = MIL-S-19500 JAN
JTX = MIL-S-19500 JAN TX
JXV = MIL-S-19500 JAN TXV

***Note:** Some products using the "QB" Designator may not be compliant to MIL-STD-883. Contact Local NSC Sales Office for details.

Package Code

D = Ceramic DIP
F = Flatpak
H = TO-5 Metal Can
K = TO-3 Metal Can
L = Ceramic 20 Pin LCC
S = Small Outline I.C. (SOIC)
T = Plastic Mini-DIP
U = TO-220
(TO-202 Equivalent)

Military Products Alpha-Numeric Index

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Military Products Alpha-Numeric Index (Continued)

Section 13
Packaging

Section 13 Contents Packaging

Packaging

Whether it's immediately obvious or not, packaging affects everyone in the electronics industry. And revolutions in packaging can lead to revolutions not only in electronic products themselves, but also in the methods used to manufacture those products.

What are driving these new developments in packaging are simply the same pressures that have always driven this industry: the desire to make things smaller, faster, more reliable, and at a lower cost. And that requires semiconductors with very large scales of integration, meaning smaller packages with higher leadcounts and closer lead-spacings.

That's why the vacuum tube gave way to the transistor, why the transistor gave way to the integrated circuit, and why the integrated circuit is giving way to the integrated *system.* Higher densities mean smaller footprints, which mean simpler assemblies, which mean lower costs. Higher densities also mean improved performance with higher reliability.

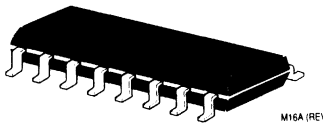
National Semiconductor is both responding to these trends and anticipating them, with innovative approaches to packaging design and technology. Surface Mount Packages, for example, take advantage of innovations in plating and leadframe design to yield reliability equivalent to traditional dual-in-line packages (DIPs) but in component sizes substantially smaller, which in turn allows higher board densities and smaller end products. At the same time, because Surface Mount Packages are so much smaller, they are ideal for automated pick-and-place systems, which lead to faster and more accurate assemblies, and thus to lower manufacturing costs.

Molded Packages

M Packages

These small outline packages consist of a circuit on silicon, mounted on a copper alloy lead frame and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for surface mount application. The final lead finish is solder plate and requires no additional cleaning or processing when used in soldered assemblies.

The M packages conform to JEDEC outlines MS-012 and MS-013 and are available in 8, 14, 16-lead narrow body, and 14, 16, 20, 24, and 28-lead wide body configurations.



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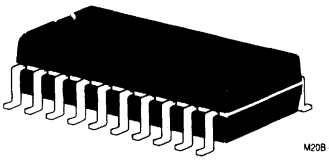
16-Lead M, 150 Mil Narrow Body Package Shown



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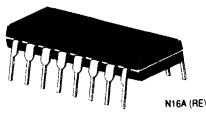
20-Lead M, 300 Mil Wide Body Package Shown

N Packages

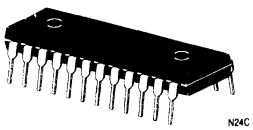
These plastic Dual-In-Line packages consist of a circuit on silicon mounted on a copper alloy lead frame and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The N packages conform to JEDEC outlines MS-001, MS-010, MS-011, and MO-016 and are available in 8, 14, 16, 18, 20, 22, 24, 28, 40, 48, and 64-lead configurations.



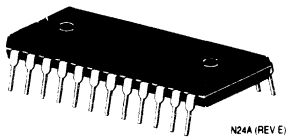
TL/MS/10369–3

16-Lead N 300 Mil Package Shown



TL/MS/10369–4

24-Lead N, 300 Mil Package Shown



TL/MS/10369–5

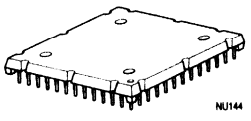
24-Lead N, 600 Mil Package Shown

Molded Packages (Continued)

NU Packages

These plastic pin grid array packages consist of a circuit on silicon, mounted on a single or multilayered printed circuit board with inserted pins, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting of high I/O devices that require low inductance and impedance. The final terminal finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The NU packages conform to JEDEC outline MO-083 and are available in 68, 84, 124, 144, 175, 180, and 323-pin configurations.



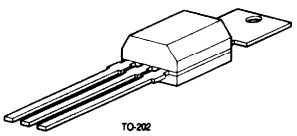
TL/MS/10369-6

144-Pin NU Package Shown

P Packages

These single-in line packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The P packages conform to JEDEC outline TO-202 and are available in 3, and 4-lead configurations.



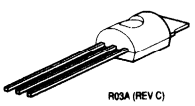
TL/MS/10369-7

4-Lead P Package Shown

R Packages

These packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The R packages conform to JEDEC outline TO-237 and are available in 3-Lead configurations.



TL/MS/10369-8

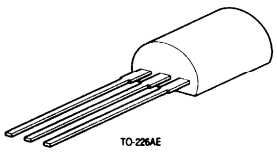
3-Lead R Package Shown

Molded Packages (Continued)

RC Packages

These packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The RC packages conform to JEDEC outline TO-226AE and are available in 3-Lead configurations.



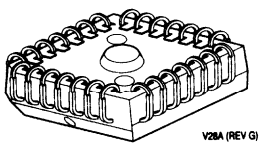
TL/MS/10369-9

3-Lead RC Package Shown

V Packages

These plastic chip carrier packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for surface mount application. The final lead finish is solder plate and requires no additional cleaning or processing when used in soldered assemblies.

The V packages conform to JEDEC outline MO-047 and are available in 20, 28, 44, 52, 68, and 84-lead configurations.



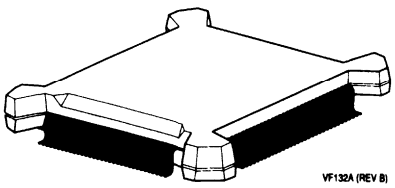
TL/MS/10369-10

28-Lead V Package Shown

VF Packages

These plastic quad flat packs consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for surface mount application. The final lead finish is solder plate and requires no additional cleaning or processing when used in soldered assemblies.

The VF packages conform to JEDEC outline MO-086 and are available in 132-lead configurations. Plus 80, 100, 120, 144, 160 EIAJ configurations.



TL/MS/10369-11

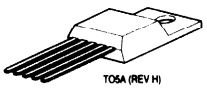
132-Lead VF Package Shown

Molded Packages (Continued)

T Packages

These single-in line packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an elecrtrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole mounting. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The T packages conform to JEDEC outline TO-220 and are available in 3, 5, 11 and 15-lead configurations.



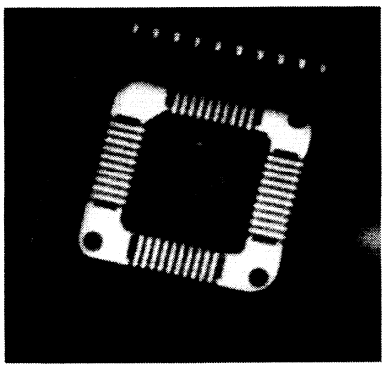
TL/MS/10369-12

3-Lead T Package Shown

TP Packages

These TapePak packages consist of a circuit on silicon, attached to a copper alloy lead frame and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are of variable pitch outline, providing a molded carrier ring on the periphery for the purpose of test and material handling. The package has unformed leads extending from the four (4) sides of the body through the carrier ring to provide test locations. The carrier ring extends above and below the molded body, and is excised away from the body and formed leads immediately prior to board mounting. The final lead finish is solder plate and requires no additional cleaning or processing when used in soldered assemblies.

The TP packages conform to JEDEC outline MO-071 and are available in 40, 84, 132, and 180-lead configurations.



TL/MS/10369-13

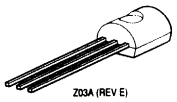
40-Lead TapePak with Carrier Ring

Molded Packages (Continued)

Z Packages

These packages consist of a circuit on silicon, mounted on a copper alloy lead frame, and encapsulated within an electrically nonconductive plastic molding compound. This molding material is a highly reliable compound suitable for commercial applications. The packages are intended for through hole application. The final lead finish is solder and requires no additional cleaning or processing when used in soldered assemblies.

The Z packages conform to JEDEC outline TO-92 and are available in 3-lead configurations.



TL/MS/10369–14

3-Lead Z Package Shown

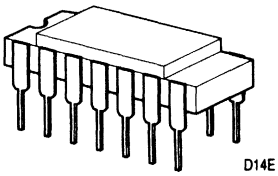
Hermetic Packages

D Packages

These hermetically sealed dual-in-line packages consist of a circuit on silicon, mounted on a ceramic base with a metal lid. The hermetic sealing is accomplished by joining the base and lid with gold-tin eutectic solder ring. The leads are brazed to the base. The packages are intended for through hole mounting. The final lead finish can be full gold plated, tin plated, solder plated, or solder dipped and requires no additional cleaning or processing when used in soldered assemblies.

These multilayer packages have been customized to obtain maximum electrical and thermal enhancements.

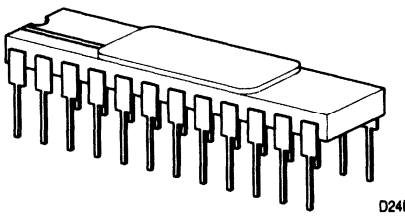
The D packages conform to JEDEC MO-036, MO-38 outlines and MIL-38510, appendix "C" outlines and are available in 8, 14, 16, 18, 20, 22, 24, 28, 40, 48, and 64-lead configurations.



D14E (REV E)

TL/MS/10374-1

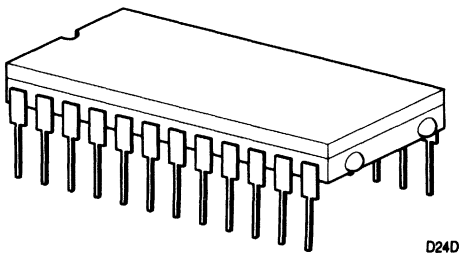
14-Lead D Package Shown



D24H (REV C)

TL/MS/10374-2

24-Lead, 300 Mil D Package Shown



D24D (REV E)

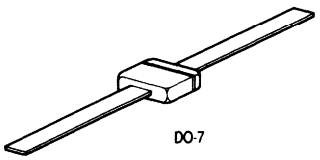
TL/MS/10374-3

24-Lead, 600 Mil D Package Shown

DO-7 Packages

These hermetically sealed diodes consist of a silicon PN junction mounted on a copper clad alloy 42 stud, attached to copper clad alloy-42 external leads and hermetically sealed in glass. The final lead finish is solder dipped and requires no additional cleaning or processing when used in soldered assemblies.

These DO-7 diode packages conform to JEDEC outline DO-7.



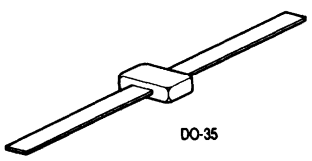
TL/MS/10374-4

DO-7 Diode Package Shown

DO-35 Packages

These hermetically sealed diodes consist of a silicon PN junction mounted on a copper clad alloy 42 stud, and hermetically sealed in glass. The final lead finish is solder dipped and requires no additional cleaning or processing when used in soldered assemblies.

These DO-35 diode packages conform to JEDEC outline DO-35.



TL/MS/10374-5

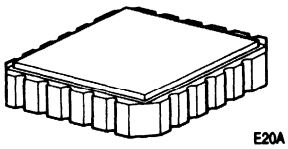
DO-35 Diode Package Shown

E Packages

These hermetically sealed leadless chip carrier packages consist of a circuit on silicon, mounted on a multi-layer ceramic base with a metal lid. The hermetic sealing is accomplished by joining the base and lid with gold-tin eutectic solder ring. The packages are intended for surface mount application. The final terminals can be full gold plated, tin plated, or solder dipped and require no additional cleaning or processing when used in soldered assemblies.

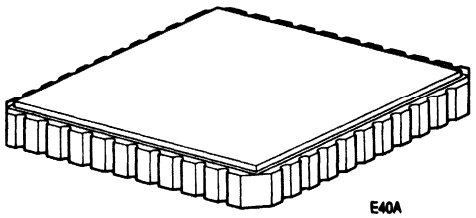
These multilayer packages have been customized to obtain maximum electrical and thermal enhancements.

These chip carrier packages conform to JEDEC outlines and MIL-38510, appendix "C" outlines and are available in 18, 20, 24, 28, 32, 40, 44, 52, 68, 84, and 24-lead configurations.



TL/MS/10374-6

20-Lead E Chip Carrier Shown



TL/MS/10374-7

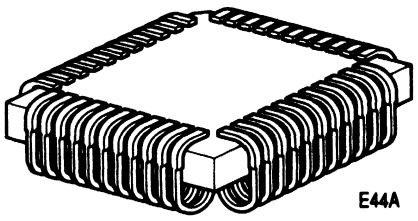
40-Lead, E Chip Carrier Shown

EL Packages

These hermetically sealed leaded chip carrier packages consist of a circuit on silicon, mounted on a multi-layer ceramic base with a metal lid. The hermetic sealing is accomplished by joining the base and lid with gold-tin eutectic solder ring. The packages are intended for surface mount application but can also be mounted to a socket. The alloy 42 leads are brazed to the top surface of the ceramic body, are full gold plated and require no additional cleaning or processing when used in soldered assemblies.

These multilayer packages have been customized to obtain maximum electrical and thermal enhancements.

These chip carrier packages are available in 50 mil pitch in 44, 68, and 124-lead configurations.



TL/MS/10374-8

44-Lead, EL Leaded Chip Carrier Shown

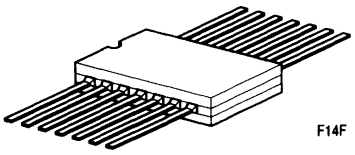
F Packages

These hermetically sealed flat packages consist of a circuit on silicon, mounted on a ceramic base with a metal lid. The hermetic sealing is accomplished by joining the base and lid with gold-tin eutectic solder ring. The alloy-42 or kovar leads are brazed to either the top or bottom surface of the ceramic body. The packages are intended for surface mount application. The final lead finish is full gold plated and requires no additional cleaning or processing when used in soldered assemblies.

These multilayer packages have been customized to obtain maximum electrical and thermal enhancements.

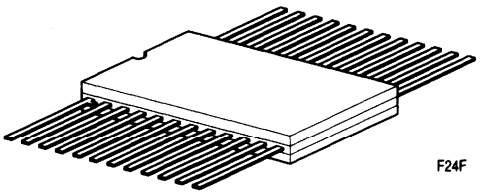
The F flatpak packages conform to JEDEC outlines and MIL-38510, appendix "C" outlines and are available in 10, 14, 16, 20, 24, 28, and 30-lead configurations.

The F ceramic quad flatpak packages conform to JEDEC outline MO-090 and are available in: 50 mil pitch 100, and 124-lead configurations; 25 mil pitch 116, 128, 132, 164, and 172-lead configurations; 20 mil pitch 132, 152, and 256-lead configurations.



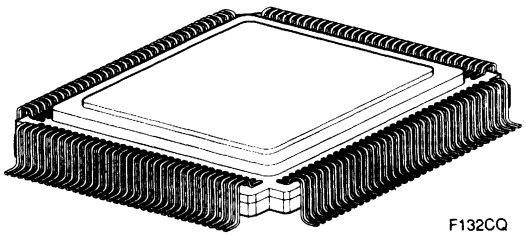
TL/MS/10374-9

14-Lead F Flatpak Package Shown



TL/MS/10374-10

24-Lead F Flatpak Package Shown



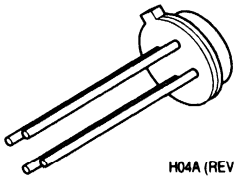
TL/MS/10374-11

132-Lead, 20 Mil Pitch, F CQFP Package Shown

H Packages

These hermetically sealed packages consist of a circuit on silicon mounted on a kovar or steel header with a kovar or steel can. The hermetic sealing is accomplished by joining the header and can by welding, and the leads are secured by an insulating glass. The packages are intended for high reliable commercial as well as military markets and are designed for plug in applications. The lead finish is either nickel or gold plated and requires no additional cleaning or processing when used in soldered assemblies.

The H metal can packages conform to JEDEC outline TO-05 and are available in 3, 4, 6, 8, and 10-pin configurations.



H04A (REV B)

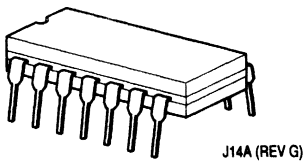
TL/MS/10374–12

4-Lead, H Metal Can Package Shown

J Packages

These hermetically sealed dual-in-line packages consist of a circuit on silicon, mounted on a ceramic base with an alloy-42 leadframe and ceramic cap. The hermetic sealing is accomplished using glass. The packages are intended for through hole mounting. The final lead finish is tin plated and/or solder and requires no additional cleaning or processing when used in soldered assemblies.

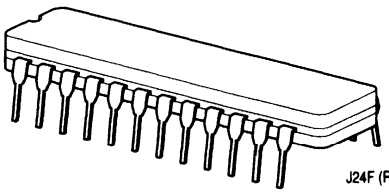
The J packages conform to JEDEC outlines and MIL-38510, appendex "C" outlines and are available in 8, 14, 16, 20, 22, 24, 28, 32, and 40-lead configurations.



J14A (REV G)

TL/MS/10374–13

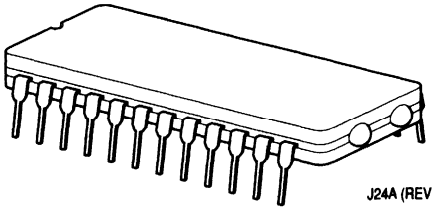
14-Lead J Package Shown



J24F (REV G)

TL/MS/10374–14

24-Lead, 300 Mil J Package Shown



J24A (REV H)

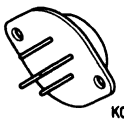
TL/MS/10374–15

24-Lead, 600 Mil J Package Shown

K Packages

These hermetically sealed metal cans consist of a circuit on silicon mounted on a steel header with nickel can. The hermetic sealing is accomplished by joining the header and can by welding, and the pins are secured by an insulating glass. The packages are intended for high reliable commercial as well as military markets and are designed for plug in applications. The terminal finish is either nickel or gold and requires no additional cleaning or processing when used in soldered assemblies.

The K metal can packages conform to JEDEC outline TO-3 and are available in 2, 4, and 8-pin configurations.



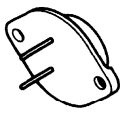
TL/MS/10374–16

4-Lead, K Metal Can Package Shown

KC Packages

These hermetically sealed metal cans consist of a circuit on silicon mounted on an aluminum header with an aluminum can. The hermetic sealing is accomplished by joining the header and can by welding, and the pins are secured by an insulating glass. The packages are intended for commercial markets and are designed for plug in applications. The terminal finish is either nickel or gold plate and requires no additional cleaning or processing when used in soldered assemblies.

The KC metal can packages conform to JEDEC outline TO-3 and are available in 2-pin configuration.

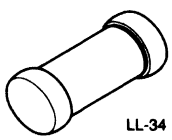


TL/MS/10374–17

2-Lead, KC Metal Can Package Shown

LL-34 Packages

These hermetically sealed diodes consist of a silicon NP junction attached to copper clad alloy-42 external buttons and hermetically sealed in glass. The final lead finish is solder dipped and requires no additional cleaning or processing when used in soldered assemblies.



TL/MS/10374–18

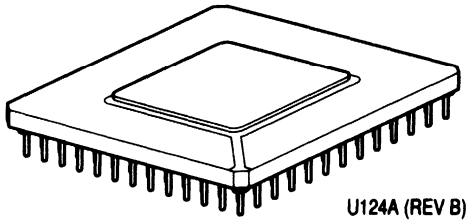
LL-34 Diode Package Shown

U Packages

These hermetically sealed ceramic pin grid array packages consist of a circuit on silicon mounted on a ceramic base with a metal lid. The hermetic sealing is accomplished by joining the base and lid with gold-tin eutectic solder ring. The terminal pins exit the bottom surface of the package in an array of rows and columns. The packages are intended for through hole mounting of high I/O devices that require low inductance and impedance. For high power applications the cavity faces down with heat dissipated through a thermally enhanced heat-sink. The final terminal finish is full gold plated and requires no additional cleaning or processing when used in soldered assemblies.

These multilayer packages have been customized to obtain maximum electrical and thermal enhancements.

The U ceramic pin grid array packages conform to JEDEC outlines MO-066, and MO-067 and are available in 100 mil pitch 28, 44, 68, 74, 84, 100, 109, 119, 120, 124, 125, 143, 144, 149, 156, 169, 172, 175, 180, 224, 225, 301, and 323-pin configurations.



TL/MS/10374-19

124-Lead, U CPGA Package Shown

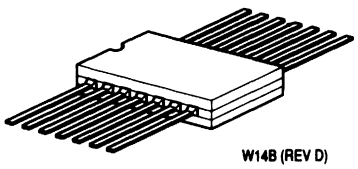
W Packages

These hermetically sealed flat packages consist of a circuit on silicon, mounted on a nonconductive ceramic base with an alloy-42 lead frame and nonconductive ceramic cap. The hermetic sealing is accomplished using glass. The packages are intended for surface mount application. The final lead finish is tin plated and/or solder and requires no additional cleaning or processing when used in soldered assemblies.

The W cerpak packages conform to JEDEC outline and MIL-38510, appendix "C" outlines and are available in 10, 14, 16, 20, 24, 28, 32, and 40-lead configurations.

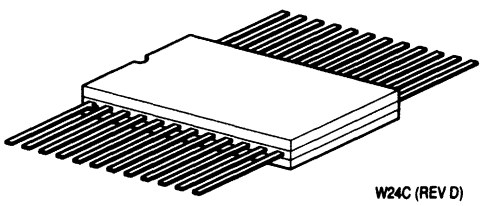
The W cerquad packages conform to JEDEC outline and MIL-38510, appendix "C" outlines and are available in 50 mil pitch 24, 68, and 84-lead configurations; 20 mil pitch 56, and 64-lead configurations.

The W cerquad packages are also available in EIAJ standards and are available in 80, 100, 120, 144, 160, and 196-lead configurations.



TL/MS/10374-20

14-Lead W Cerpak Package Shown



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24-Lead, W Cerpak Package Shown

Advanced Packaging

Making the Transition to Surface-Mount

Many electronics manufacturers are finding the benefits of surface-mount technology increasingly attractive. In addition to shrinking through-hole designs by as much as 70 percent, SMT makes them easier to build, increases their reliability, and cuts labor and manufacturing costs at the same time.

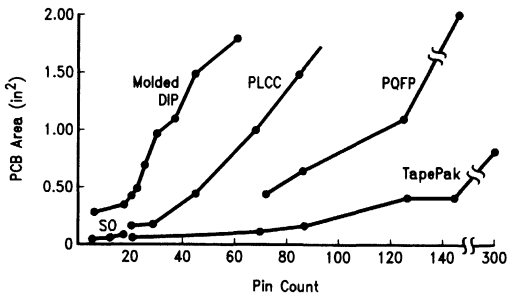
In fact, for some companies, the question about switching to surface-mount is no longer "if" but "when." According to industry experts, "Electronics manufacturers who preempt the competition by adopting SMT early will have a definite marketing edge and added experience in design and manufacturing."

As more and more functions are squeezed onto a semiconductor chip, the demand increases for ever higher lead-count devices in ever smaller packages. In fact, some integrated circuits developed today are already available only in surface-mount packaging.

Because National Semiconductor is committed to the development of high-complexity semiconductor chips, we have devoted a great many resources to package development. National pioneered tape-automated bonding almost 15 years ago for use with DIP packages. And it is this technology that has led directly to the development of TapePak®, the next generation of packaging for high-leadcount ICs.

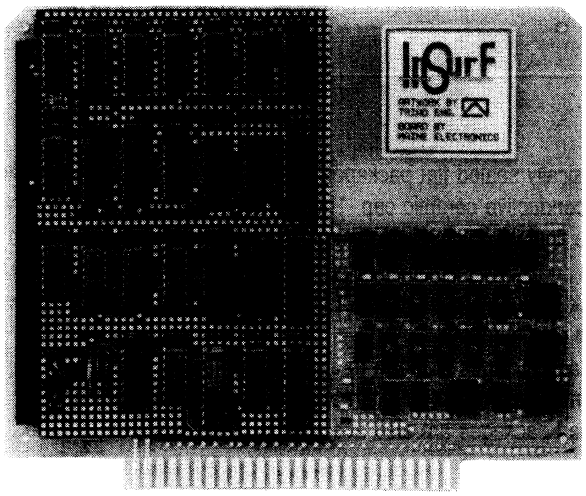
Few other chip manufacturers are able to offer you as great a variety of advanced packaging, including not only TapePak but also plastic quad flat packs, plastic pin-grid array packages, small-outline packages, plastic chip carriers, and ceramic chip carriers. And we can customize packages for your specific applications.

As the leader in advanced packaging technology, National is in a unique position to help you take full advantage of SMT in your designs.



TL/MS/10375–1

PC Board Area versus Pin Count of Various Packages—DIP, SO, PLCC, PQFP, and TapePak



TL/MS/10375–2

Board real estate can be reduced by as much as 70 percent with the use of surface-mount packaging in place of conventional DIPs.

The surface-mount board is not only smaller and lighter in weight but also more reliable and less expensive to produce.

Tape-Automated Bonding

National developed tape-automated bonding (TAB) in the early '70s to increase production throughput, improve produce reliability and yields, and decrease costs.

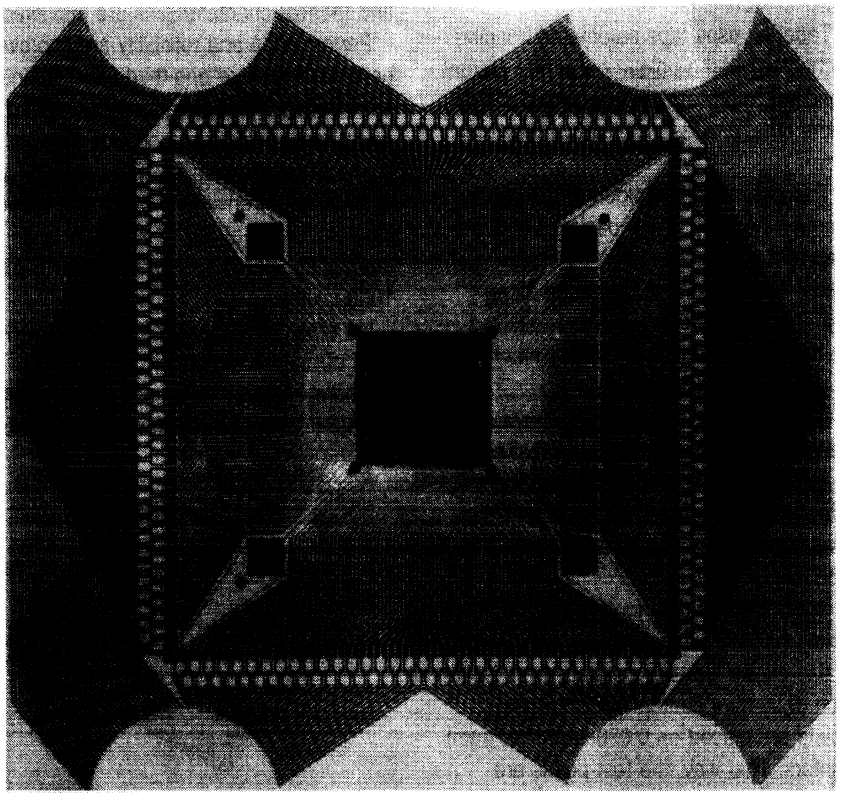
We were one of the first companies to replace wire bonding with TAB in the manufacture of DIP packages and have since produced more than 6 billion bipolar and CMOS logic devices using TAB.

The TAB process has many advantages over traditional wire bonding. First, tape bonds are up to 10 times stronger than wire bonds. Second, the broader connections dissipate heat much better. Other advantages include manufacturing efficiency and improved high-speed signal propagation.

With TAB, a copper-foil tape is used instead of wires to connect each bond pad on the die to the corresponding lead on the leadframe. Individual traces of the copper tape are held together with a polyimide webbing. Each set of connections—die-to-tape and tape-to-leadframe—are made in a single step through a gang-bonding process instead of individually bonding each wire.

In molded packages, TAB prevents wires from electrically shorting when the mold compound is injected. Because shorting is more severe in devices with long wires or close wire spacing, it would be difficult to place high-leadcount devices into low-cost plastic molded packages.

Because of TAB and National's experience in using it, it is now possible to produce packages with more than 360 leads. It has also made possible the development of TapePak, National's fully automated system for packaging high-leadcount ICs. External leads and test points are incorporated right on the tape. This implementation of TAB technology clearly indicates the direction of semiconductor manufacturing for the future.



TL/MS/10375–3

The key advantage of TAB over conventional wire bonding is high-density banding. TAB leads are also stronger and dissipate heat better.

TL/MS/10375–4

Bumps are formed by etching the tape.

TapePak®

The latest generation in VLSI packaging, TapePak is the package of the future—low-cost, reliable, high-leadcount packaging that's easy to handle, easy to test, and easy to mount. It's also compatible with existing surface-mount technology.

TapePak uses tape-automated bonding technology and a unique outer ring (patent pending) to protect the leads and, at the same time, provide an effective test interface.

This outer ring is molded at the same time as the body of the package and creates test points outside the package leads. The test ring is discarded along with the tape as the package is excised by the automatic pick-and-place machine at the point of assembly.

During testing, the leads themselves never come in contact with the test socket, so lead damage and coplanarity problems are eliminated. The test ring also allows burn-in to be performed on each device.

Not only does this ring protect the leads during handling, testing and assembly, but it also allows leads to be placed on 0.020-inch (0.50-mm) centers while the test points are placed on 0.050-inch (1.27-mm) centers. That way, the test points are compatible with existing automatic test equipment.

As a result, packages can be manufactured in smaller sizes with higher leadcounts and still be compatible with automatic assembly systems. With TapePak, packages contain from 40 to more than 300 leads, yet a 300-lead package measures only 1.2 inches (30.5 mm) on a side.

A TapePak device can be less than 1/10 the size of a traditional DIP and 1/3 the size of other surface-mount packages such as a PLCC.

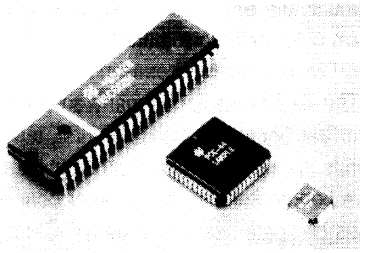
TapePak was designed to take full advantage of automatic assembly systems with their high speed and precision. It can be used with existing precision surface-mount assembly equipment with minimal modification. The only requirement is an accessory for removing the test ring and forming the leads at the point of assembly.

TapePak also provides a significant improvement in the electrical characteristics of each package. Lead capacitance and inductance, for example, can be reduced up to ten times that of other packages. Signal propagation time is also reduced, and thermal characteristics are improved.

Performance and reliability are improved because there are one-third fewer connections between the die and the PC board. Low-stress molding compounds also improve package reliability. TapePak devices pass stringent environmental tests, including autoclaving at 121°C at 15 psi and thermal shock from −65°C to 150°C for 1000 cycles.

No other package takes similar advantage of materials technology to provide the combination of low cost, high density, testability, damage resistance, and reliability.

To further the technology in the industry and make these advantages available to everyone, National has registered TapePak specifications in JEDEC (Joint Electronic Device and Engineering Council) packaging committee as an industry standard. We have also licensed other manufacturers to use TapePak packaging for their own proprietary devices.



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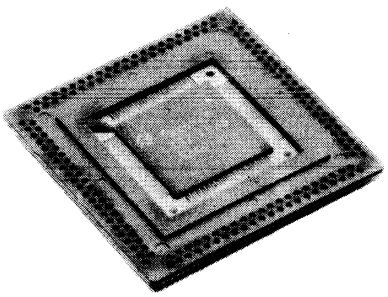
TapePak packaging reduces the size of integrated circuits to about 1/10 that of a standard DIP and about 1/3 that of a plastic chip carrier. A 132-lead TapePak package is about 1/5 the size of a comparable PLCC.



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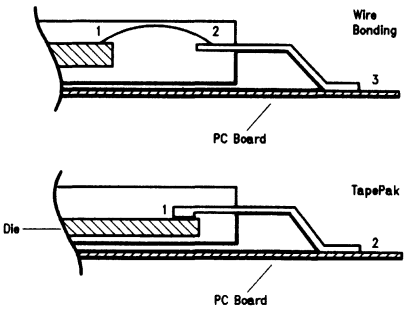
TapePak's unique test ring protects the leads during handling, testing, and assembly.



TL/MS/10375-7

With TapePak, there are one-third fewer connections between die and board than with traditional wire bonding.

Comparison of TapePak and Conventional Packages

	40L DIP	44L PLCC	40L TapePak
Lead Thickness (mils)	10.0	10.0	2.8
Lead Pitch (mils)	100	50	20
Package Length (mils)	2050	650	350
Package Width (mils)	600	650	350
Package Thickness (mils)*	175	180	71
Volume Ratio	24.4	9.1	1

	40L DIP		44L PLCC		40L TapePak	
	Long	Short	Long	Short	Long	Short
Lead Length (in)	1.0	0.3	0.35	0.25	0.1	0.1
Resistance (mΩ)	7	4	4	3	2.4	2.4
Inductance (nH)	22	60	6.5	5	1.2	1.2
Capacitance (pF) (Lead to Lead)	0.5	0.3	0.3	0.2	0.2	0.1

*Measured from seating plane to the top of the package.

Plastic Quad Flat Pack

Developed in 1986 as a joint project among several member companies of EIA/JEDEC, the plastic quad flat pack (PQFP) was designed as a density improvement over the plastic chip carrier. A variety of plastic flat packs already existed, but none of them had the standardized dimensions, lead-protection, and automated-assembly features required for adoption as a long-term standard.

As registered by JEDEC, the PQFP is a high-density, reliable, low-cost plastic package for applications with leadcounts from 52 to 244. To achieve these high leadcounts, the PQFP uses a 0.025-inch (0.63-mm) lead center, much smaller lead spacing than chip carriers and small-outline packages.

In addition to the small lead spacing, the PQFP features a gull-wing leadform, leads on all four sides of the package, and, most important, molded protective bumpers on each corner. These bumpers extend a nominal 0.010-inch (0.25-mm) beyond the lead tips to provide mechanical protection during handling and assembly. They allow the use of shipping tubes and tape-and-reel packing methods as well as special trays.

Unlike previous designs, the new PQFP is also slightly thicker to reduce package cracking.

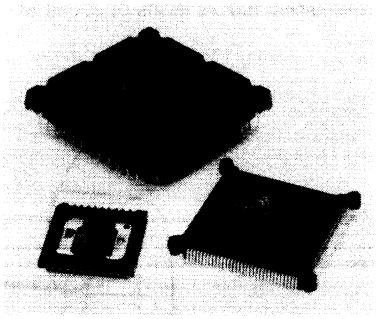
The gull-wing leads, with a minimum foot length of 0.020-inch (0.50-mm), allow for both heated-collet contact reflow and vapor-phase or infrared non-contact reflow methods of mounting to the printed circuit board.

Plastic Pin-Grid Array

The plastic pin-grid array (PPGA) provides a low-cost, high-leadcount, reliable alternative to similar ceramic parts. Developed and patented by National engineers, it provides a highly reliable alternative to the older "blob-top" PGA.

The one-piece molded PPGA is significantly better at withstanding the rigors of thermal cycling because the thermal expansion characteristics of the molding compounds closely match those of the substrate. An improved substrate with lower ionic contamination and superior interconnect materials also contribute to the improved reliability of National's PPGA.

The PPGA is pin-compatible with ceramic pin-grid arrays and is significantly less expensive. It is available with 68, 84, 124, 144, 175, 180, and 323 pin configurations.



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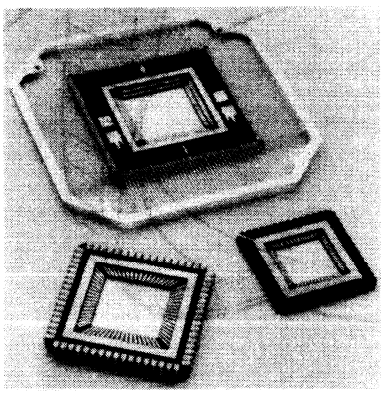
National's newest packages include the plastic pin-grid array, TapePak, and plastic quad flat pack.



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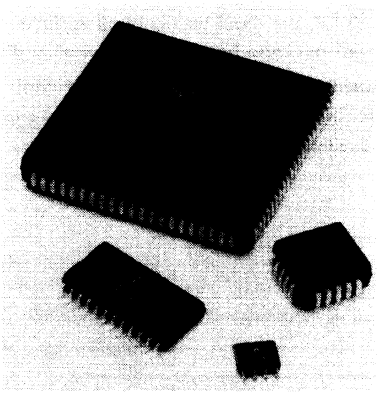
National also offers a variety of ceramic packages, including flat packs and both leaded and leadless chip carriers.

Plastic Leaded Chip Carrier

The PLCC uses a 0.050-inch (1.27-mm) lead spacing, which is half that of traditional DIPs. And like the PQFP, it features leads on all four sides for a significant reduction in footprint.

The PLCC has a rolled-under J-bend leadform, which allows for socketing, so PLCC devices are easier to test and program. Sockets for test/burn-in and production of the PLCC and PQFP are readily available from a variety of manufacturers.

National PLCCs comply with JEDEC registration for square PLCCs with leadcounts of 20, 28, 44, 68 or 84 and rectangular PLCCs with a leadcount of 52.



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Plastic leaded chip carriers and small outline packages are available with a wide range of leadcounts.

Ceramic Chip Carriers

National offers two types of hermetic ceramic packages that share the same footprint with the PLCC—the traditional leadless chip carriers (LCC) and our newly developed leaded chip carrier (LDCC), which uses the J-bend leadform found on the PLCC. Also available are ceramic flat packs for military and high-rel applications.

The leaded chip carrier features compliant leads that reduce the thermal expansion mismatch between the package and the substrate and thereby significantly improve reliability.

Small-Outline Packages

So far, the most widely used surface-mount package has been the small-outline package (SO), configured in agreement with JEDEC standards. The SO package is available in narrow outlines with 8, 14 and 16 leads and in wide outlines with 14, 16, 20, 24 and 28 leads. All SO package leads have the gull-wing configuration on 0.050-inch (1.27-mm) centers. National also offers a three-lead small-outline transistor.

The assembly process used to manufacture the SO, PLCC, and other plastic packages is similar to National's proven DIP assembly technology. The many years of research and development that have gone into improving the quality and reliability of National DIP packages have been directly applied to our advanced surface-mount packaging.

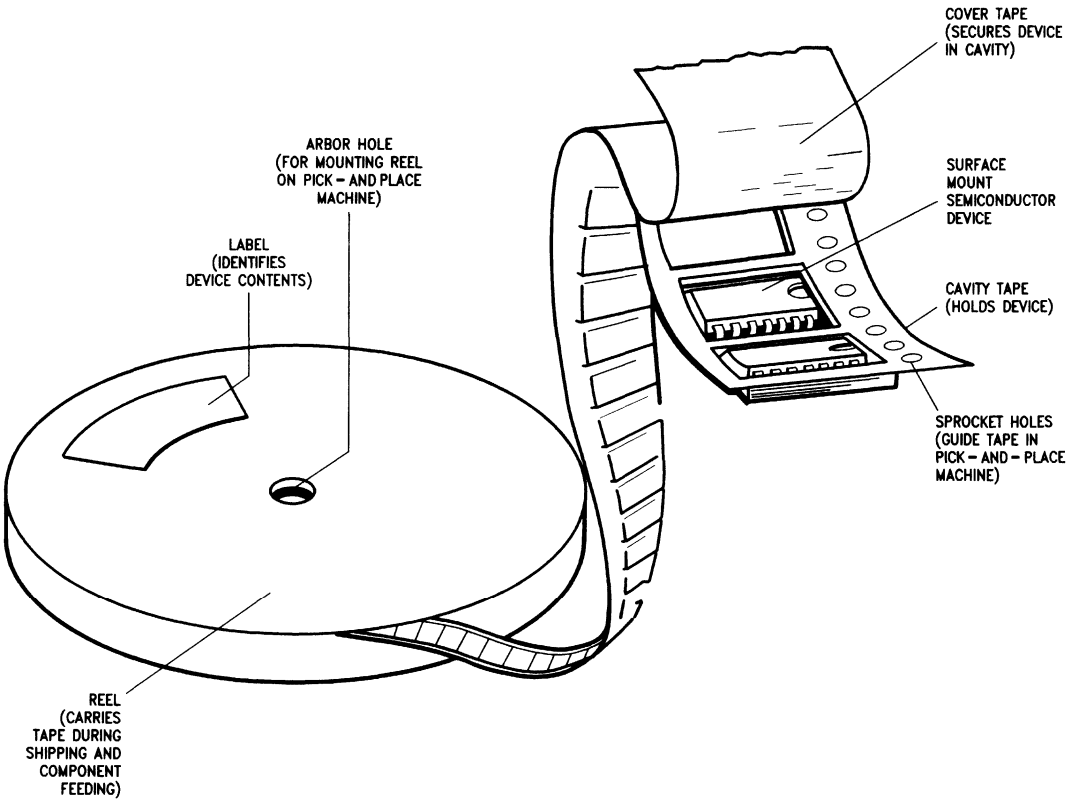
Delivery Systems

The overriding benefit of surface-mount assembly is factory automation. Components can be bulk loaded, rail fed, or tape-and-reel fed. In terms of speed of the assembly process, a tape-and-reel system, such as National's STAR™ system offers many advantages.

It holds hundreds to thousands of components compared to less than 100 in a rail, so that pick-and-place machines have to be reloaded less frequently. You can realize a labor savings of more than 50 to 1, further reducing manufacturing costs.

The STAR system is fully compatible with all of National's surface-mount packages and fully meets proposed EIA RS481A standards. The reels are also provided with high-density Code 39 bar-code labels for automatic inventory management.

National can provide mechanical samples of surface-mount packages in tape-and-reel format to assist in the development of automated assembly processes.



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National's STAR tape-and-reel system helps automatic pick-and-place machines work at maximum output. The tape is a conductive cavity medium that holds hundreds or thousands of devices.

Reliability

National Semiconductor has committed its resources to developing the most reliable surface-mount components in the industry. In fact, surface-mount packages from National perform equally well—or better—than standard dual-in-line packages. The reasons for this are several:

First, while most manufacturers place a single protective layer on the surface of each die, National uses a dual-layer passivation system that minimizes defect density. The probability that both layers will have the same defect in the same place is infinitesimal, so failures from this source are virtually eliminated.

Second, we employ a leadframe design that incorporates several important characteristics to reduce moisture penetration. For one, the leadframes have locking holes that not only lock the leadframe to the package but also lengthen the path moisture must travel to reach the die.

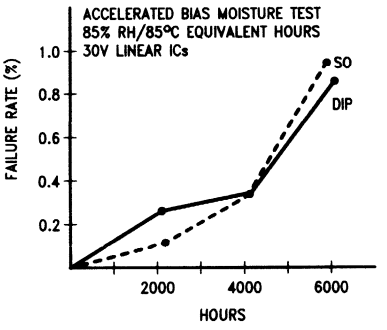
Also, the composition of the leadframe itself is unique. Rather than using the Alloy 42 material typical of most other manufacturers' packages, we construct our leadframes of a special high-strength copper alloy, which has a lower thermal resistance.

Another factor that increases the reliability of National packages is a unique, low-stress, high-purity epoxy molding compound, which was developed specifically for use with copper leadframes. It is purified of halides and other ionic contaminants. And because it provides a thermal coefficient of expansion that closely matches that of the leadframe, package integrity is maintained over a broader range of mechanical and environmental conditions.

Moreover, during the manufacturing process, National uses a sophisticated statistical quality control program that monitors each product, operation, and piece of equipment within the plant on a real-time basis.

The advantages of this reliability-by-design approach are clearly seen in the data obtained through comparative reliability tesing, such as that shown below.

And all other tests—thermal cycling, thermal shock, high-temperature operating life, and storage life—yield similar results. These are described in detail in separate reliability reports.



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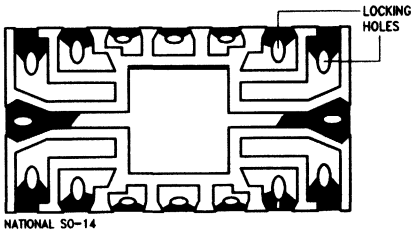
In the "85/85" test, National SO packages compare favorably with our conventional DIPs.



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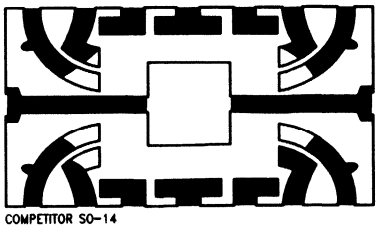

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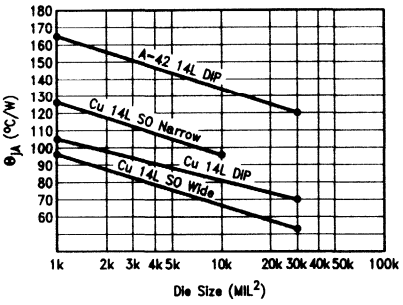
The locking holes retard moisture penetration to the die.



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Because National's copper leadframes offer less thermal resistance (θJA) than conventional Alloy 42 leadframes, heat is dissipated more effectively and reliability is improved.

Support

We at National will do everything we can to help you make the transition to this new technology as smooth and easy as possible.

Our surface-mount laboratory, which has been in operation for almost four years, is available to you at no cost for demonstrations and support as well as technology development. The lab has a variety of screen printers; pick-and-place machines; IR-reflow, vapor-phase-reflow, hot-thermode, and dual-wave soldering machines; board-cleaning equipment; and board-repair and -test facilities.

To eliminate incoming inspection as your usage of surface-mount devices increases, we can implement a ship-to-stock program for you. All of the necessary quality control procedures are built in with our unique statistical quality control program and our testing processes, so your components can be shipped directly to you as you need them.

Just-in-time delivery will not only reduce or eliminate your incoming inspection, scrap and rework, but will also reduce your inventory and increase the quality of your product.

We also offer a wide variety of additional technical briefs concerning surface-mount topics:

A Basic Guide to Surface-Mounting of Electronic Components (113615)
Getting Started in Surface-Mount (includes equipment suppliers) (570435)
Bipolar/PAL/PROM Packaging (114409-001)
Gate-Array Packaging (104350-1)
Surface-Mount Product Availability Guide (980055)
Linear Surface-Mount Availability and Technical Reference Guide (980080)
Plastic Pin-Grid Array (980032)
Plastic Quad Flat Pack Technology (113293)
Plastic Chip Carrier Technology (113295)
Reliability Report: Small-Outline Packages (570430)
Reliability Report: Plastic Chip Carriers (980040)
STAR Surface-Mount Tape-and-Reel Specification (113635)
TapePak Technology (980036)

You can request any of these additional resources by simply returning the enclosed postage-paid card.

Section 14
Appendices/Indices

Section 14 Contents Appendices/Indices

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number

Device Number	Publication
1N456	Discrete Databook
1N456A	Discrete Databook
1N457	Discrete Databook
1N457A	Discrete Databook
1N457JAN	Discrete Databook
1N458	Discrete Databook
1N458A	Discrete Databook
1N458JAN	Discrete Databook
1N459	Discrete Databook
1N459A	Discrete Databook
1N459JAN	Discrete Databook
1N461A	Discrete Databook
1N462A	Discrete Databook
1N463A	Discrete Databook
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1N483B	Discrete Databook
1N483BJAN	Discrete Databook
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1N484B	Discrete Databook
1N485B	Discrete Databook
1N485BJAN	Discrete Databook
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1N5228B	Discrete Databook
1N5229B	Discrete Databook
1N5230B	Discrete Databook
1N5231B	Discrete Databook
1N5232B	Discrete Databook
1N5233B	Discrete Databook
1N5234B	Discrete Databook
1N5235B	Discrete Databook
1N5236B	Discrete Databook
1N5237B	Discrete Databook
1N5238B	Discrete Databook
1N5239B	Discrete Databook
1N5240B	Discrete Databook
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1N5242B	Discrete Databook
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1N5249B	Discrete Databook
1N5250B	Discrete Databook
1N5251B	Discrete Databook
1N5252B	Discrete Databook
1N5253B	Discrete Databook
1N5254B	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
1N5255B	Discrete Databook
1N5256B	Discrete Databook
1N5257B	Discrete Databook
1N5282	Discrete Databook
1N5768	Discrete Databook
1N5770	Discrete Databook
1N5772	Discrete Databook
1N5774	Discrete Databook
1N6099	Discrete Databook
1N6100	Discrete Databook
1N6101	Discrete Databook
1S44	Discrete Databook
1S920	Discrete Databook
1S921	Discrete Databook
1S922	Discrete Databook
1S923	Discrete Databook
2N696	Discrete Databook
2N697	Discrete Databook
2N699	Discrete Databook
2N718	Discrete Databook
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2N915	Discrete Databook
2N916	Discrete Databook
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2N918	Discrete Databook
2N929	Discrete Databook
2N929A	Discrete Databook
2N930	Discrete Databook
2N956	Discrete Databook
2N1420	Discrete Databook
2N1566	Discrete Databook
2N1613	Discrete Databook
2N1711	Discrete Databook
2N1890	Discrete Databook
2N1893	Discrete Databook
2N2102	Discrete Databook
2N2192	Discrete Databook
2N2192A	Discrete Databook
2N2193	Discrete Databook
2N2193A	Discrete Databook
2N2218	Discrete Databook
2N2218A	Discrete Databook
2N2219	Discrete Databook
2N2219A	Discrete Databook
2N2221	Discrete Databook
2N2221A	Discrete Databook
2N2222	Discrete Databook
2N2222A	Discrete Databook
2N2243	Discrete Databook
2N2243A	Discrete Databook
2N2369	Discrete Databook
2N2369A	Discrete Databook
2N2484	Discrete Databook
2N2515	Discrete Databook
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2N2925	Discrete Databook
2N2926	Discrete Databook
2N3009	Discrete Databook
2N3011	Discrete Databook

Device Number	Publication
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2N3014	Discrete Databook
2N3019	Discrete Databook
2N3020	Discrete Databook
2N3053	Discrete Databook
2N3107	Discrete Databook
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2N3109	Discrete Databook
2N3110	Discrete Databook
2N3117	Discrete Databook
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2N3663	Discrete Databook
2N3665	Discrete Databook
2N3666	Discrete Databook
2N3684	Discrete Databook
2N3685	Discrete Databook
2N3686	Discrete Databook
2N3687	Discrete Databook
2N3691	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
2N3692	Discrete Databook
2N3693	Discrete Databook
2N3694	Discrete Databook
2N3700	Discrete Databook
2N3701	Discrete Databook
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2N4059	Discrete Databook
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2N4062	Discrete Databook
2N4082	Discrete Databook

Device Number	Publication
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2N4085	Discrete Databook
2N4091	Discrete Databook
2N4092	Discrete Databook
2N4093	Discrete Databook
2N4117	Discrete Databook
2N4117A	Discrete Databook
2N4118	Discrete Databook
2N4118A	Discrete Databook
2N4119	Discrete Databook
2N4119A	Discrete Databook
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2N4856A	Discrete Databook
2N4857	Discrete Databook
2N4857A	Discrete Databook
2N4858	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
2N4858A	Discrete Databook
2N4859A	Discrete Databook
2N4860	Discrete Databook
2N4860A	Discrete Databook
2N4861	Discrete Databook
2N4861A	Discrete Databook
2N4916	Discrete Databook
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2N5223	Discrete Databook
2N5224	Discrete Databook
2N5225	Discrete Databook
2N5226	Discrete Databook

Device Number	Publication
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2N5228	Discrete Databook
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2N5639	Discrete Databook
2N5640	Discrete Databook
2N5653	Discrete Databook
2N5654	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
2N5769	Discrete Databook
2N5770	Discrete Databook
2N5771	Discrete Databook
2N5772	Discrete Databook
2N5817	Discrete Databook
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2N6770	Discrete Databook
2N7051	Discrete Databook
2N7052	Discrete Databook
2N7053	Discrete Databook
2N48562	Discrete Databook
2N48592	Discrete Databook
11C01	F100K ECL Logic Databook
11C05	F100K ECL Logic Databook
11C06	F100K ECL Logic Databook
11C70	F100K ECL Logic Databook
11C90	F100K ECL Logic Databook
11C91	F100K ECL Logic Databook
27C16	Stand Alone Datasheet
27C32	Stand Alone Datasheet
27C64	Stand Alone Datasheet
27C256	Stand Alone Datasheet
27CP128	Stand Alone Datasheet
29F52	FAST® Advanced Schottky TTL Logic Databook
29F68	FAST® Advanced Schottky TTL Logic Databook
54/DM74ALS00A	ALS/AS Logic Databook
54/DM74ALS01	ALS/AS Logic Databook
54/DM74ALS02	ALS/AS Logic Databook
54/DM74ALS03B	ALS/AS Logic Databook
54/DM74ALS04B	ALS/AS Logic Databook
54/DM74ALS05A	ALS/AS Logic Databook
54/DM74ALS08	ALS/AS Logic Databook
54/DM74ALS09	ALS/AS Logic Databook
54/DM74ALS10A	ALS/AS Logic Databook
54/DM74ALS11A	ALS/AS Logic Databook
54/DM74ALS12A	ALS/AS Logic Databook
54/DM74ALS13	ALS/AS Logic Databook
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54/DM74ALS15A	ALS/AS Logic Databook
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54/DM74ALS240A	ALS/AS Logic Databook
54/DM74ALS241A	ALS/AS Logic Databook
54/DM74ALS242B	ALS/AS Logic Databook
54/DM74ALS243A	ALS/AS Logic Databook
54/DM74ALS244A	ALS/AS Logic Databook
54/DM74ALS245A	ALS/AS Logic Databook
54/DM74ALS251	ALS/AS Logic Databook
54/DM74ALS253	ALS/AS Logic Databook
54/DM74ALS257	ALS/AS Logic Databook
54/DM74ALS258	ALS/AS Logic Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
54/DM74ALS273	ALS/AS Logic Databook
54/DM74ALS352	ALS/AS Logic Databook
54/DM74ALS353	ALS/AS Logic Databook
54/DM74ALS373	ALS/AS Logic Databook
54/DM74ALS465A	ALS/AS Logic Databook
54/DM74ALS466A	ALS/AS Logic Databook
54/DM74ALS467A	ALS/AS Logic Databook
54/DM74ALS468A	ALS/AS Logic Databook
54/DM74ALS518	ALS/AS Logic Databook
54/DM74ALS519	ALS/AS Logic Databook
54/DM74ALS520	ALS/AS Logic Databook
54/DM74ALS521	ALS/AS Logic Databook
54/DM74ALS522	ALS/AS Logic Databook
54/DM74ALS533	ALS/AS Logic Databook
54/DM74ALS534	ALS/AS Logic Databook
54/DM74ALS540	ALS/AS Logic Databook
54/DM74ALS541	ALS/AS Logic Databook
54/DM74ALS563A	ALS/AS Logic Databook
54/DM74ALS564A	ALS/AS Logic Databook
54/DM74ALS573B	ALS/AS Logic Databook
54/DM74ALS574A	ALS/AS Logic Databook
54/DM74ALS576A	ALS/AS Logic Databook
54/DM74ALS580A	ALS/AS Logic Databook
54/DM74ALS632	ALS/AS Logic Databook
54/DM74ALS645A	ALS/AS Logic Databook
54/DM74ALS646	ALS/AS Logic Databook
54/DM74ALS648	ALS/AS Logic Databook
54/DM74ALS652	ALS/AS Logic Databook
54/DM74ALS689	ALS/AS Logic Databook
54/DM74ALS804A	ALS/AS Logic Databook
54/DM74ALS805A	ALS/AS Logic Databook
54/DM74ALS808A	ALS/AS Logic Databook
54/DM74ALS810	ALS/AS Logic Databook
54/DM74ALS811	ALS/AS Logic Databook
54/DM74ALS832A	ALS/AS Logic Databook
54/DM74ALS873B	ALS/AS Logic Databook
54/DM74ALS874B	ALS/AS Logic Databook
54/DM74ALS876A	ALS/AS Logic Databook
54/DM74ALS880A	ALS/AS Logic Databook
54/DM74ALS1000A	ALS/AS Logic Databook
54/DM74ALS1002A	ALS/AS Logic Databook
54/DM74ALS1003A	ALS/AS Logic Databook
54/DM74ALS1004	ALS/AS Logic Databook
54/DM74ALS1005	ALS/AS Logic Databook
54/DM74ALS1008A	ALS/AS Logic Databook
54/DM74ALS1010A	ALS/AS Logic Databook
54/DM74ALS1011A	ALS/AS Logic Databook
54/DM74ALS1020A	ALS/AS Logic Databook
54/DM74ALS1032A	ALS/AS Logic Databook
54/DM74ALS1034	ALS/AS Logic Databook
54/DM74ALS1035	ALS/AS Logic Databook
54/DM74ALS1240	ALS/AS Logic Databook
54/DM74ALS1241A	ALS/AS Logic Databook
54/DM74ALS1242	ALS/AS Logic Databook
54/DM74ALS1243A	ALS/AS Logic Databook
54/DM74ALS1244A	ALS/AS Logic Databook
54/DM74ALS2541	ALS/AS Logic Databook
54AC/74AC00	FACT™ Advanced CMOS Logic Databook
54AC/74AC02	FACT™ Advanced CMOS Logic Databook
54AC/74AC04	FACT™ Advanced CMOS Logic Databook
54AC/74AC08	FACT™ Advanced CMOS Logic Databook
54AC/74AC10	FACT™ Advanced CMOS Logic Databook
54AC/74AC11	FACT™ Advanced CMOS Logic Databook
54AC/74AC14	FACT™ Advanced CMOS Logic Databook
54AC/74AC20	FACT™ Advanced CMOS Logic Databook
54AC/74AC32	FACT™ Advanced CMOS Logic Databook
54AC/74AC74	FACT™ Advanced CMOS Logic Databook
54AC/74AC86	FACT™ Advanced CMOS Logic Databook
54AC/74AC109	FACT™ Advanced CMOS Logic Databook
54AC/74AC138	FACT™ Advanced CMOS Logic Databook
54AC/74AC139	FACT™ Advanced CMOS Logic Databook
54AC/74AC151	FACT™ Advanced CMOS Logic Databook
54AC/74AC153	FACT™ Advanced CMOS Logic Databook
54AC/74AC157	FACT™ Advanced CMOS Logic Databook
54AC/74AC158	FACT™ Advanced CMOS Logic Databook
54AC/74AC161	FACT™ Advanced CMOS Logic Databook
54AC/74AC163	FACT™ Advanced CMOS Logic Databook
54AC/74AC169	FACT™ Advanced CMOS Logic Databook

Device Number	Publication
54AC/74AC174	FACT™ Advanced CMOS Logic Databook
54AC/74AC175	FACT™ Advanced CMOS Logic Databook
54AC/74AC191	FACT™ Advanced CMOS Logic Databook
54AC/74AC240	FACT™ Advanced CMOS Logic Databook
54AC/74AC241	FACT™ Advanced CMOS Logic Databook
54AC/74AC244	FACT™ Advanced CMOS Logic Databook
54AC/74AC245	FACT™ Advanced CMOS Logic Databook
54AC/74AC251	FACT™ Advanced CMOS Logic Databook
54AC/74AC253	FACT™ Advanced CMOS Logic Databook
54AC/74AC257	FACT™ Advanced CMOS Logic Databook
54AC/74AC258	FACT™ Advanced CMOS Logic Databook
54AC/74AC273	FACT™ Advanced CMOS Logic Databook
54AC/74AC299	FACT™ Advanced CMOS Logic Databook
54AC/74AC373	FACT™ Advanced CMOS Logic Databook
54AC/74AC374	FACT™ Advanced CMOS Logic Databook
54AC/74AC377	FACT™ Advanced CMOS Logic Databook
54AC/74AC540	FACT™ Advanced CMOS Logic Databook
54AC/74AC541	FACT™ Advanced CMOS Logic Databook
54AC/74AC574	FACT™ Advanced CMOS Logic Databook
54AC/74AC646	FACT™ Advanced CMOS Logic Databook
54AC/74AC648	FACT™ Advanced CMOS Logic Databook
54AC/74AC821	FACT™ Advanced CMOS Logic Databook
54AC/74AC2708	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT00	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT74	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT109	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT138	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT139	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT151	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT153	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT157	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT158	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT161	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT163	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT174	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT175	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT240	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT241	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT244	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT245	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT251	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT253	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT257	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT258	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT299	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT323	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT373	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT374	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT377	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT399	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT534	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT563	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT564	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT573	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT574	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT818	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT821	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT823	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT825	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT841	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT843	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT845	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT1016	FACT™ Advanced CMOS Logic Databook
54ACT/74ACT2708	FACT™ Advanced CMOS Logic Databook
54F/74F00	FAST® Advanced Schottky TTL Logic Databook
54F/74F02	FAST® Advanced Schottky TTL Logic Databook
54F/74F04	FAST® Advanced Schottky TTL Logic Databook
54F/74F08	FAST® Advanced Schottky TTL Logic Databook
54F/74F10	FAST® Advanced Schottky TTL Logic Databook
54F/74F11	FAST® Advanced Schottky TTL Logic Databook
54F/74F13	FAST® Advanced Schottky TTL Logic Databook
54F/74F14	FAST® Advanced Schottky TTL Logic Databook
54F/74F20	FAST® Advanced Schottky TTL Logic Databook
54F/74F27	FAST® Advanced Schottky TTL Logic Databook
54F/74F30	FAST® Advanced Schottky TTL Logic Databook
54F/74F32	FAST® Advanced Schottky TTL Logic Databook
54F/74F37	FAST® Advanced Schottky TTL Logic Databook
54F/74F38	FAST® Advanced Schottky TTL Logic Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
54F/74F40	FAST® Advanced Schottky TTL Logic Databook
54F/74F51	FAST® Advanced Schottky TTL Logic Databook
54F/74F64	FAST® Advanced Schottky TTL Logic Databook
54F/74F74	FAST® Advanced Schottky TTL Logic Databook
54F/74F86	FAST® Advanced Schottky TTL Logic Databook
54F/74F109	FAST® Advanced Schottky TTL Logic Databook
54F/74F112	FAST® Advanced Schottky TTL Logic Databook
54F/74F113	FAST® Advanced Schottky TTL Logic Databook
54F/74F114	FAST® Advanced Schottky TTL Logic Databook
54F/74F125	FAST® Advanced Schottky TTL Logic Databook
54F/74F132	FAST® Advanced Schottky TTL Logic Databook
54F/74F132	Stand Alone Datasheet
54F/74F138	FAST® Advanced Schottky TTL Logic Databook
54F/74F139	FAST® Advanced Schottky TTL Logic Databook
54F/74F148	FAST® Advanced Schottky TTL Logic Databook
54F/74F151A	FAST® Advanced Schottky TTL Logic Databook
54F/74F153	FAST® Advanced Schottky TTL Logic Databook
54F/74F157A	FAST® Advanced Schottky TTL Logic Databook
54F/74F158A	FAST® Advanced Schottky TTL Logic Databook
54F/74F160A	FAST® Advanced Schottky TTL Logic Databook
54F/74F161A	FAST® Advanced Schottky TTL Logic Databook
54F/74F162A	FAST® Advanced Schottky TTL Logic Databook
54F/74F163A	FAST® Advanced Schottky TTL Logic Databook
54F/74F164	FAST® Advanced Schottky TTL Logic Databook
54F/74F168	FAST® Advanced Schottky TTL Logic Databook
54F/74F169	FAST® Advanced Schottky TTL Logic Databook
54F/74F174	FAST® Advanced Schottky TTL Logic Databook
54F/74F175	FAST® Advanced Schottky TTL Logic Databook
54F/74F181	FAST® Advanced Schottky TTL Logic Databook
54F/74F182	FAST® Advanced Schottky TTL Logic Databook
54F/74F189	FAST® Advanced Schottky TTL Logic Databook
54F/74F190	FAST® Advanced Schottky TTL Logic Databook
54F/74F191	FAST® Advanced Schottky TTL Logic Databook
54F/74F192	FAST® Advanced Schottky TTL Logic Databook
54F/74F193	FAST® Advanced Schottky TTL Logic Databook
54F/74F194	FAST® Advanced Schottky TTL Logic Databook
54F/74F219	FAST® Advanced Schottky TTL Logic Databook
54F/74F240	FAST® Advanced Schottky TTL Logic Databook
54F/74F241	FAST® Advanced Schottky TTL Logic Databook
54F/74F243	FAST® Advanced Schottky TTL Logic Databook
54F/74F244	FAST® Advanced Schottky TTL Logic Databook
54F/74F245	FAST® Advanced Schottky TTL Logic Databook
54F/74F251A	FAST® Advanced Schottky TTL Logic Databook
54F/74F253	FAST® Advanced Schottky TTL Logic Databook
54F/74F257A	FAST® Advanced Schottky TTL Logic Databook
54F/74F258A	FAST® Advanced Schottky TTL Logic Databook
54F/74F269	FAST® Advanced Schottky TTL Logic Databook
54F/74F280	FAST® Advanced Schottky TTL Logic Databook
54F/74F283	FAST® Advanced Schottky TTL Logic Databook
54F/74F299	FAST® Advanced Schottky TTL Logic Databook
54F/74F322	FAST® Advanced Schottky TTL Logic Databook
54F/74F323	FAST® Advanced Schottky TTL Logic Databook
54F/74F350	FAST® Advanced Schottky TTL Logic Databook
54F/74F352	FAST® Advanced Schottky TTL Logic Databook
54F/74F353	FAST® Advanced Schottky TTL Logic Databook
54F/74F365	FAST® Advanced Schottky TTL Logic Databook
54F/74F366	FAST® Advanced Schottky TTL Logic Databook
54F/74F368	FAST® Advanced Schottky TTL Logic Databook
54F/74F373	FAST® Advanced Schottky TTL Logic Databook
54F/74F374	FAST® Advanced Schottky TTL Logic Databook
54F/74F378	FAST® Advanced Schottky TTL Logic Databook
54F/74F379	FAST® Advanced Schottky TTL Logic Databook
54F/74F381	FAST® Advanced Schottky TTL Logic Databook
54F/74F382	FAST® Advanced Schottky TTL Logic Databook
54F/74F385	FAST® Advanced Schottky TTL Logic Databook
54F/74F398	FAST® Advanced Schottky TTL Logic Databook
54F/74F399	FAST® Advanced Schottky TTL Logic Databook
54F/74F401	FAST® Advanced Schottky TTL Logic Databook
54F/74F402	FAST® Advanced Schottky TTL Logic Databook
54F/74F403	FAST® Advanced Schottky TTL Logic Databook
54F/74F407	FAST® Advanced Schottky TTL Logic Databook
54F/74F410	FAST® Advanced Schottky TTL Logic Databook
54F/74F412	FAST® Advanced Schottky TTL Logic Databook
54F/74F413	FAST® Advanced Schottky TTL Logic Databook
54F/74F420	FAST® Advanced Schottky TTL Logic Databook
54F/74F432	FAST® Advanced Schottky TTL Logic Databook
54F/74F433	FAST® Advanced Schottky TTL Logic Databook
54F/74F521	FAST® Advanced Schottky TTL Logic Databook

Device Number	Publication
54F/74F524	FAST® Advanced Schottky TTL Logic Databook
54F/74F525	FAST® Advanced Schottky TTL Logic Databook
54F/74F533	FAST® Advanced Schottky TTL Logic Databook
54F/74F534	FAST® Advanced Schottky TTL Logic Databook
54F/74F537	FAST® Advanced Schottky TTL Logic Databook
54F/74F538	FAST® Advanced Schottky TTL Logic Databook
54F/74F539	FAST® Advanced Schottky TTL Logic Databook
54F/74F540	FAST® Advanced Schottky TTL Logic Databook
54F/74F541	FAST® Advanced Schottky TTL Logic Databook
54F/74F543	FAST® Advanced Schottky TTL Logic Databook
54F/74F544	FAST® Advanced Schottky TTL Logic Databook
54F/74F545	FAST® Advanced Schottky TTL Logic Databook
54F/74F547	FAST® Advanced Schottky TTL Logic Databook
54F/74F548	FAST® Advanced Schottky TTL Logic Databook
54F/74F550	FAST® Advanced Schottky TTL Logic Databook
54F/74F551	FAST® Advanced Schottky TTL Logic Databook
54F/74F552	FAST® Advanced Schottky TTL Logic Databook
54F/74F552	Stand Alone Datasheet
54F/74F563	FAST® Advanced Schottky TTL Logic Databook
54F/74F564	FAST® Advanced Schottky TTL Logic Databook
54F/74F568	FAST® Advanced Schottky TTL Logic Databook
54F/74F569	FAST® Advanced Schottky TTL Logic Databook
54F/74F573	FAST® Advanced Schottky TTL Logic Databook
54F/74F574	FAST® Advanced Schottky TTL Logic Databook
54F/74F582	FAST® Advanced Schottky TTL Logic Databook
54F/74F583	FAST® Advanced Schottky TTL Logic Databook
54F/74F588	FAST® Advanced Schottky TTL Logic Databook
54F/74F632	FAST® Advanced Schottky TTL Logic Databook
54F/74F646	FAST® Advanced Schottky TTL Logic Databook
54F/74F646	Stand Alone Datasheet
54F/74F648	FAST® Advanced Schottky TTL Logic Databook
54F/74F648	Stand Alone Datasheet
54F/74F651	FAST® Advanced Schottky TTL Logic Databook
54F/74F651	Stand Alone Datasheet
54F/74F652	FAST® Advanced Schottky TTL Logic Databook
54F/74F652	Stand Alone Datasheet
54F/74F657	FAST® Advanced Schottky TTL Logic Databook
54F/74F657	Stand Alone Datasheet
54F/74F673A	FAST® Advanced Schottky TTL Logic Databook
54F/74F675A	FAST® Advanced Schottky TTL Logic Databook
54F/74F676	FAST® Advanced Schottky TTL Logic Databook
54F/74F701	FAST® Advanced Schottky TTL Logic Databook
54F/74F702	FAST® Advanced Schottky TTL Logic Databook
54F/74F707	FAST® Advanced Schottky TTL Logic Databook
54F/74F710	FAST® Advanced Schottky TTL Logic Databook
54F/74F821	FAST® Advanced Schottky TTL Logic Databook
54F/74F823	FAST® Advanced Schottky TTL Logic Databook
54F/74F825	FAST® Advanced Schottky TTL Logic Databook
54F/74F827	FAST® Advanced Schottky TTL Logic Databook
54F/74F828	FAST® Advanced Schottky TTL Logic Databook
54F/74F841	FAST® Advanced Schottky TTL Logic Databook
54F/74F843	FAST® Advanced Schottky TTL Logic Databook
54F/74F845	FAST® Advanced Schottky TTL Logic Databook
54F/74F968	FAST® Advanced Schottky TTL Logic Databook
54F/74F2241	FAST® Advanced Schottky TTL Logic Databook
54F/74F2241	Stand Alone Datasheet
54F/74F2243	FAST® Advanced Schottky TTL Logic Databook
54F/74F2243	Stand Alone Datasheet
54F/74F2244	FAST® Advanced Schottky TTL Logic Databook
54F/74F2244	Stand Alone Datasheet
92P2U36	Discrete Databook
92PE487	Discrete Databook
92PE488	Discrete Databook
92PE489	Discrete Databook
92PU01	Discrete Databook
92PU01A	Discrete Databook
92PU05	Discrete Databook
92PU06	Discrete Databook
92PU07	Discrete Databook
92PU10	Discrete Databook
92PU36A	Discrete Databook
92PU36B	Discrete Databook
92PU36C	Discrete Databook
92PU45	Discrete Databook
92PU45A	Discrete Databook
92PU51	Discrete Databook
92PU51A	Discrete Databook
92PU55	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
92PU56	Discrete Databook
92PU57	Discrete Databook
92PU100	Discrete Databook
92PU391	Discrete Databook
92PU392	Discrete Databook
92PU393	Discrete Databook
93L415	Memory Databook
93L415A	Memory Databook
93L422	Memory Databook
93L422A	Memory Databook
93L425	Memory Databook
93L425A	Memory Databook
93Z451	Memory Databook
93Z511	Memory Databook
93Z665	Memory Databook
93Z667	Memory Databook
1600A/1601A	Memory Databook
1620	Memory Databook
1621	Memory Databook
1624	Memory Databook
1625	Memory Databook
2470A	Mass Storage Handbook
100115	Stand Alone Datasheet
100128	Stand Alone Datasheet
100145	Memory Databook
100415	Memory Databook
100422	F100K ECL Logic Databook
100422	Memory Databook
10145A	Memory Databook
10402	Memory Databook
10415	Memory Databook
10422	Memory Databook
93415	Memory Databook
93422	Memory Databook
93425	Memory Databook
93479	Memory Databook
ADC0800	Linear 2 Databook
ADC0801	Linear 2 Databook
ADC0802	Linear 2 Databook
ADC0803	Linear 2 Databook
ADC0804	Linear 2 Databook
ADC0805	Linear 2 Databook
ADC0808	Linear 2 Databook
ADC0808	CMOS Logic Databook
ADC0809	Linear 2 Databook
ADC0811	Linear 2 Databook
ADC0816	Linear 2 Databook
ADC0816	CMOS Logic Databook
ADC0817	Linear 2 Databook
ADC0819	Linear 2 Databook
ADC0820	Linear 2 Databook
ADC0829	CMOS Logic Databook
ADC0829	Linear 2 Databook
ADC0831	Linear 2 Databook
ADC0832	Linear 2 Databook
ADC0833	Linear 2 Databook
ADC0834	Linear 2 Databook
ADC0838	Linear 2 Databook
ADC0841	Linear 2 Databook
ADC0844	Linear 2 Databook
ADC0848	Linear 2 Databook
ADC0852	Linear 2 Databook
ADC0854	Linear 2 Databook
ADC1001	Linear 2 Databook
ADC1005	Linear 2 Databook
ADC1021	Linear 2 Databook
ADC1025	Linear 2 Databook
ADC1205	Linear 2 Databook
ADC1210	Linear 2 Databook
ADC1211	Linear 2 Databook
ADC1225	Linear 2 Databook
ADC3511	CMOS Logic Databook
ADC3511	Linear 2 Databook
ADC3711	CMOS Logic Databook
ADC3711	Linear 2 Databook
ADD3501	CMOS Logic Databook
ADD3501	Linear 2 Databook
ADD3701	CMOS Logic Databook

Device Number	Publication
ADD3701	Linear 2 Databook
AF100	Linear 2 Databook
AF150	Linear 2 Databook
AF151	Linear 2 Databook
AH0014	Linear 2 Databook
AH0014	Stand Alone Datasheet
AH0014C	Linear 2 Databook
AH0015C	Linear 2 Databook
AH0019	Linear 2 Databook
AH0019C	Linear 2 Databook
AH5009	Linear 2 Databook
AH5010	Linear 2 Databook
AH5011	Linear 2 Databook
AH5012	Linear 2 Databook
AH5020C	Linear 2 Databook
BA128	Discrete Databook
BA129	Discrete Databook
BA130	Discrete Databook
BA217	Discrete Databook
BA218	Discrete Databook
BA316	Discrete Databook
BA317	Discrete Databook
BA318	Discrete Databook
BAS16	Discrete Databook
BAS19	Discrete Databook
BAS20	Discrete Databook
BAS21	Discrete Databook
BAS29	Discrete Databook
BAS31	Discrete Databook
BAS35	Discrete Databook
BAV17	Discrete Databook
BAV18	Discrete Databook
BAV19	Discrete Databook
BAV20	Discrete Databook
BAV21	Discrete Databook
BAV70	Discrete Databook
BAV74	Discrete Databook
BAV99	Discrete Databook
BAW56	Discrete Databook
BAW62	Discrete Databook
BAW75	Discrete Databook
BAW76	Discrete Databook
BAX13	Discrete Databook
BAX16	Discrete Databook
BAX17	Discrete Databook
BAY19	Discrete Databook
BAY71	Discrete Databook
BAY72	Discrete Databook
BAY73	Discrete Databook
BAY74	Discrete Databook
BAY80	Discrete Databook
BAY82	Discrete Databook
BC27	Discrete Databook
BC327-10	Discrete Databook
BC327-16	Discrete Databook
BC327-25	Discrete Databook
BC327A	Discrete Databook
BC328	Discrete Databook
BC328-10	Discrete Databook
BC328-16	Discrete Databook
BC328-25	Discrete Databook
BC337	Discrete Databook
BC337-16	Discrete Databook
BC337-25	Discrete Databook
BC337A	Discrete Databook
BC338	Discrete Databook
BC338-16	Discrete Databook
BC338-25	Discrete Databook
BC368	Discrete Databook
BC369	Discrete Databook
BC373A-10	Discrete Databook
BC373A-16	Discrete Databook
BC373A-25	Discrete Databook
BC373B	Discrete Databook
BC373B-10	Discrete Databook
BC373B-25	Discrete Databook
BC373C	Discrete Databook
BC373C-6	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
BC373C-10	Discrete Databook
BC373C-16	Discrete Databook
BC373D	Discrete Databook
BC373D-6	Discrete Databook
BC373D-10	Discrete Databook
BC383B-16	Discrete Databook
BC546	Discrete Databook
BC546A	Discrete Databook
BC546B	Discrete Databook
BC547	Discrete Databook
BC547A	Discrete Databook
BC547B	Discrete Databook
BC547C	Discrete Databook
BC548	Discrete Databook
BC548A	Discrete Databook
BC548B	Discrete Databook
BC548C	Discrete Databook
BC549	Discrete Databook
BC549B	Discrete Databook
BC549C	Discrete Databook
BC550	Discrete Databook
BC550B	Discrete Databook
BC556	Discrete Databook
BC556A	Discrete Databook
BC556B	Discrete Databook
BC557	Discrete Databook
BC557A	Discrete Databook
BC557B	Discrete Databook
BC558	Discrete Databook
BC558A	Discrete Databook
BC558B	Discrete Databook
BC558C	Discrete Databook
BC559	Discrete Databook
BC559B	Discrete Databook
BC559C	Discrete Databook
BC560	Discrete Databook
BC560B	Discrete Databook
BC635	Discrete Databook
BC636	Discrete Databook
BC637	Discrete Databook
BC638	Discrete Databook
BC639	Discrete Databook
BC640	Discrete Databook
BC807	Discrete Databook
BC807-16	Discrete Databook
BC807-25	Discrete Databook
BC807-40	Discrete Databook
BC808	Discrete Databook
BC808-16	Discrete Databook
BC808-25	Discrete Databook
BC808-40	Discrete Databook
BC817	Discrete Databook
BC817-16	Discrete Databook
BC817-25	Discrete Databook
BC817-40	Discrete Databook
BC818	Discrete Databook
BC818-16	Discrete Databook
BC818-25	Discrete Databook
BC818-40	Discrete Databook
BC846	Discrete Databook
BC846-A	Discrete Databook
BC846-B	Discrete Databook
BC847	Discrete Databook
BC847-A	Discrete Databook
BC847-B	Discrete Databook
BC848	Discrete Databook
BC848-A	Discrete Databook
BC848-B	Discrete Databook
BC848-C	Discrete Databook
BC849	Discrete Databook
BC849B	Discrete Databook
BC849C	Discrete Databook
BC850	Discrete Databook
BC850-B	Discrete Databook
BC856	Discrete Databook
BC856-A	Discrete Databook
BC856-B	Discrete Databook
BC857	Discrete Databook

Device Number	Publication
BC857-A	Discrete Databook
BC857-B	Discrete Databook
BC858	Discrete Databook
BC858-B	Discrete Databook
BC858-C	Discrete Databook
BC859	Discrete Databook
BC859-A	Discrete Databook
BC859-B	Discrete Databook
BC859-C	Discrete Databook
BC860	Discrete Databook
BC860-B	Discrete Databook
BCF29	Discrete Databook
BCF30	Discrete Databook
BCF32	Discrete Databook
BCF33	Discrete Databook
BCF70	Discrete Databook
BCV26	Discrete Databook
BCV27	Discrete Databook
BCV71	Discrete Databook
BCV72	Discrete Databook
BCW29	Discrete Databook
BCW30	Discrete Databook
BCW31	Discrete Databook
BCW32	Discrete Databook
BCW33	Discrete Databook
BCW60	Discrete Databook
BCW61	Discrete Databook
BCW65	Discrete Databook
BCW66	Discrete Databook
BCW68	Discrete Databook
BCW69	Discrete Databook
BCW70	Discrete Databook
BCW71	Discrete Databook
BCW72	Discrete Databook
BCW81	Discrete Databook
BCW89	Discrete Databook
BCX17	Discrete Databook
BCX18	Discrete Databook
BCX19	Discrete Databook
BCX20	Discrete Databook
BCX58	Discrete Databook
BCX58-7	Discrete Databook
BCX58-8	Discrete Databook
BCX58-8	Discrete Databook
BCX58-9	Discrete Databook
BCX58-10	Discrete Databook
BCX59	Discrete Databook
BCX59-7	Discrete Databook
BCX59-9	Discrete Databook
BCX59-10	Discrete Databook
BCX70G	Discrete Databook
BCX70H	Discrete Databook
BCX70J	Discrete Databook
BCX71G	Discrete Databook
BCX71H	Discrete Databook
BCX71J	Discrete Databook
BCX78	Discrete Databook
BCX78-7	Discrete Databook
BCX78-8	Discrete Databook
BCX78-9	Discrete Databook
BCX78-10	Discrete Databook
BCX79	Discrete Databook
BCX79-7	Discrete Databook
BCX79-8	Discrete Databook
BCX79-9	Discrete Databook
BCX79-10	Discrete Databook
BD370A	Discrete Databook
BD370A-10	Discrete Databook
BD370A-16	Discrete Databook
BD370A-25	Discrete Databook
BD370B	Discrete Databook
BD370B-10	Discrete Databook
BD370B-16	Discrete Databook
BD370B-25	Discrete Databook
BD370C	Discrete Databook
BD370C-6	Discrete Databook
BD370C-10	Discrete Databook
BD370C-16	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
BD370D	Discrete Databook
BD370D-6	Discrete Databook
BD370D-10	Discrete Databook
BD371A	Discrete Databook
BD371A-10	Discrete Databook
BD371A-16	Discrete Databook
BD371A-25	Discrete Databook
BD371B	Discrete Databook
BD371B-10	Discrete Databook
BD371B-16	Discrete Databook
BD371B-25	Discrete Databook
BD371C	Discrete Databook
BD371C-6	Discrete Databook
BD371C-10	Discrete Databook
BD371C-16	Discrete Databook
BD371D	Discrete Databook
BD371D-6	Discrete Databook
BD371D-10	Discrete Databook
BD372A	Discrete Databook
BD372A-10	Discrete Databook
BD372A-16	Discrete Databook
BD372A-25	Discrete Databook
BD372B	Discrete Databook
BD372B	Discrete Databook
BD372B-10	Discrete Databook
BD372B-16	Discrete Databook
BD372B-25	Discrete Databook
BD372C	Discrete Databook
BD372C-6	Discrete Databook
BD372C-10	Discrete Databook
BD372C-16	Discrete Databook
BD372D-6	Discrete Databook
BD372D-10	Discrete Databook
BD373A	Discrete Databook
BF240	Discrete Databook
BF241	Discrete Databook
BF244A	Discrete Databook
BF244B	Discrete Databook
BF244C	Discrete Databook
BF245A	Discrete Databook
BF245B	Discrete Databook
BF245C	Discrete Databook
BF246A	Discrete Databook
BF246B	Discrete Databook
BF246C	Discrete Databook
BF247A	Discrete Databook
BF247B	Discrete Databook
BF247C	Discrete Databook
BF256A	Discrete Databook
BF256B	Discrete Databook
BF256C	Discrete Databook
BF494	Discrete Databook
BF495	Discrete Databook
BF536	Discrete Databook
BF840	Discrete Databook
BF841	Discrete Databook
BF936	Discrete Databook
BFS18	Discrete Databook
BFS19	Discrete Databook
BSR13	Discrete Databook
BSR14	Discrete Databook
BSR15	Discrete Databook
BSR16	Discrete Databook
BSR17	Discrete Databook
BSR18	Discrete Databook
BSR19	Discrete Databook
BSR20	Discrete Databook
BSR56	Discrete Databook
BSR57	Discrete Databook
BSR58	Discrete Databook
BSS38	Discrete Databook
BSS63	Discrete Databook
BSS64	Discrete Databook
BSS79-B	Discrete Databook
BSS79-C	Discrete Databook
BSS80-B	Discrete Databook
BSS80-C	Discrete Databook
BSV52	Discrete Databook

Device Number	Publication
BSX39	Discrete Databook
CD4000	CMOS Logic Databook
CD4000M/CD4000C	CMOS Logic Databook
CD4001M/CD4001C	CMOS Logic Databook
CD4002M/CD4002C	CMOS Logic Databook
CD4006BM/CD4006BC	CMOS Logic Databook
CD4007M/CD4007C	CMOS Logic Databook
CD4008BM/CD4008BC	CMOS Logic Databook
CD4009M/CD4009C	CMOS Logic Databook
CD4010M/CD4010C	CMOS Logic Databook
CD4011M/CD4011C	CMOS Logic Databook
CD4012M/CD4012C	CMOS Logic Databook
CD4013BM/CD4013BC	CMOS Logic Databook
CD4014BM/CD4014BC	CMOS Logic Databook
CD4015BM/CD4015BC	CMOS Logic Databook
CD4016BM/CD4016BC	CMOS Logic Databook
CD4016C	Linear 2 Databook
CD4017BM/CD4017BC	CMOS Logic Databook
CD4018BM/CD4018BC	CMOS Logic Databook
CD4019BM/CD4019BC	CMOS Logic Databook
CD4020BM/CD4020BC	CMOS Logic Databook
CD4021BM/CD4021BC	CMOS Logic Databook
CD4022BM/CD4022BC	CMOS Logic Databook
CD4023M/CD4023C	CMOS Logic Databook
CD4024BM/CD4024BC	CMOS Logic Databook
CD4025M/CD4025C	CMOS Logic Databook
CD4027BM/CD4027BC	CMOS Logic Databook
CD4028BM/CD4028BC	CMOS Logic Databook
CD4029BM/CD4029BC	CMOS Logic Databook
CD4030M/CD4030C	CMOS Logic Databook
CD4031BM/CD4031BC	CMOS Logic Databook
CD4034BM/CD4034BC	CMOS Logic Databook
CD4035BM/CD4035BC	CMOS Logic Databook
CD4040BM/CD4040BC	CMOS Logic Databook
CD4041UB/CD4041UBC	CMOS Logic Databook
CD4042BM/CD4042BC	CMOS Logic Databook
CD4043BM/CD4043BC	CMOS Logic Databook
CD4044BM/CD4044BC	CMOS Logic Databook
CD4046BM/CD4046BC	CMOS Logic Databook
CD4047BM/CD4047BC	CMOS Logic Databook
CD4048BM/CD4048BC	CMOS Logic Databook
CD4049UBM/CD4049UBC	CMOS Logic Databook
CD4050BM/CD4050BC	CMOS Logic Databook
CD4051BC	Linear 2 Databook
CD4051BM	Linear 2 Databook
CD4051BM/CD4051BC	CMOS Logic Databook
CD4052BC	Linear 2 Databook
CD4052BM	Linear 2 Databook
CD4052BM/CD4052BC	CMOS Logic Databook
CD4053BC	Linear 2 Databook
CD4053BM	Linear 2 Databook
CD4053BM/CD4053BC	CMOS Logic Databook
CD4060BM/CD4060BC	CMOS Logic Databook
CD4066BC	Linear 2 Databook
CD4066BM	Linear 2 Databook
CD4066BM/CD4066BC	CMOS Logic Databook
CD4069UBM/CD4069UBC	CMOS Logic Databook
CD4070BM/CD4070BC	CMOS Logic Databook
CD4071BM/CD4071BC	CMOS Logic Databook
CD4072BM/CD4072BC	CMOS Logic Databook
CD4073BM/CD4073BC	CMOS Logic Databook
CD4075BM/CD4075BC	CMOS Logic Databook
CD4076BM/CD4076BC	CMOS Logic Databook
CD4081BM/CD4081BC	CMOS Logic Databook
CD4082BM/CD4082BC	CMOS Logic Databook
CD4089BM/CD4089BC	CMOS Logic Databook
CD4093BM/CD4093BC	CMOS Logic Databook
CD4094BM/CD4094BC	CMOS Logic Databook
CD4099BM/CD4099BC	CMOS Logic Databook
CD4503BM/CD4503BC	CMOS Logic Databook
CD4510BM/CD4510BC	CMOS Logic Databook
CD4511BM/CD4511BC	CMOS Logic Databook
CD4512BM/CD4512BC	CMOS Logic Databook
CD4514BM/CD4514BC	CMOS Logic Databook
CD4515BM/CD4515BC	CMOS Logic Databook
CD4516BM/CD4516BC	CMOS Logic Databook
CD4518BM/CD4518BC	CMOS Logic Databook
CD4519BM/CD4519BC	CMOS Logic Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
CD4520BM/CD4520BC	CMOS Logic Databook
CD4522BM/CD4522BC	CMOS Logic Databook
CD4526BM/CD4526BC	CMOS Logic Databook
CD4527BM/CD4527BC	CMOS Logic Databook
CD4528BM/CD4528BC	CMOS Logic Databook
CD4529BC	Linear 2 Databook
CD4529BM/CD4529BC	CMOS Logic Databook
CD4538BM/CD4538BC	CMOS Logic Databook
CD4541BM/CD4541BC	CMOS Logic Databook
CD4543BM/CD4543BC	CMOS Logic Databook
CD4584BM/CD4584BC	CMOS Logic Databook
CD4723BM/CD4723BC	CMOS Logic Databook
CD4724BM/CD4724BC	CMOS Logic Databook
CD40106BM/CD40106BC	CMOS Logic Databook
CD40160BM/CD40160BC	CMOS Logic Databook
CD40161BM/CD40161BC	CMOS Logic Databook
CD40162BM/CD40162BC	CMOS Logic Databook
CD40163BM/CD40163BC	CMOS Logic Databook
CD40174BM/CD40174BC	CMOS Logic Databook
CD40175BM/CD40175BC	CMOS Logic Databook
CD40192BM/CD40192BC	CMOS Logic Databook
CD40193BM/CD40193BC	CMOS Logic Databook
COP210C	Microcontrollers Databook
COP211C	Microcontrollers Databook
COP224C	Microcontrollers Databook
COP225C	Microcontrollers Databook
COP226C	Microcontrollers Databook
COP244C	Microcontrollers Databook
COP245C	Microcontrollers Databook
COP310C	Microcontrollers Databook
COP310L	Microcontrollers Databook
COP311C	Microcontrollers Databook
COP311L	Microcontrollers Databook
COP313C	Microcontrollers Databook
COP313CH	Microcontrollers Databook
COP313L	Microcontrollers Databook
COP314L	Microcontrollers Databook
COP320	Microcontrollers Databook
COP320L	Microcontrollers Databook
COP321	Microcontrollers Databook
COP321L	Microcontrollers Databook
COP322	Microcontrollers Databook
COP322L	Microcontrollers Databook
COP324C	Microcontrollers Databook
COP325C	Microcontrollers Databook
COP326C	Microcontrollers Databook
COP340	Microcontrollers Databook
COP341	Microcontrollers Databook
COP342	Microcontrollers Databook
COP344C	Microcontrollers Databook
COP344L	Microcontrollers Databook
COP345C	Microcontrollers Databook
COP345L	Microcontrollers Databook
COP352L	Microcontrollers Databook
COP370	Microcontrollers Databook
COP398	Microcontrollers Databook
COP399	Microcontrollers Databook
COP400	Microcontrollers Databook
COP401L	Microcontrollers Databook
COP401L-R13	Microcontrollers Databook
COP401L-X13	Microcontrollers Databook
COP402	Microcontrollers Databook
COP402M	Microcontrollers Databook
COP404	Microcontrollers Databook
COP404C	Microcontrollers Databook
COP404LSN-5	Microcontrollers Databook
COP410C	Microcontrollers Databook
COP410L	Microcontrollers Databook
COP411C	Microcontrollers Databook
COP411L	Microcontrollers Databook
COP413C	Microcontrollers Databook
COP413CH	Microcontrollers Databook
COP413L	Microcontrollers Databook
COP414L	Microcontrollers Databook
COP420	Microcontrollers Databook
COP420L	Microcontrollers Databook
COP420P	Microcontrollers Databook
COP421	Microcontrollers Databook

Device Number	Publication
COP421L	Microcontrollers Databook
COP422	Microcontrollers Databook
COP422L	Microcontrollers Databook
COP424C	Microcontrollers Databook
COP425C	Microcontrollers Databook
COP426C	Microcontrollers Databook
COP440	Microcontrollers Databook
COP441	Microcontrollers Databook
COP442	Microcontrollers Databook
COP444C	Microcontrollers Databook
COP444CP	Microcontrollers Databook
COP444L	Microcontrollers Databook
COP444LP	Microcontrollers Databook
COP445C	Microcontrollers Databook
COP445L	Microcontrollers Databook
COP452L	Microcontrollers Databook
COP470	Microcontrollers Databook
COP472-3	Microcontrollers Databook
COP498	Microcontrollers Databook
COP499	Microcontrollers Databook
COP620C	Microcontrollers Databook
COP621C	Microcontrollers Databook
COP622C	Microcontrollers Databook
COP640C	Microcontrollers Databook
COP641C	Microcontrollers Databook
COP642C	Microcontrollers Databook
COP820C	Microcontrollers Databook
COP820CP-X	Microcontrollers Databook
COP821C	Microcontrollers Databook
COP822C	Microcontrollers Databook
COP840C	Microcontrollers Databook
COP840CP-X	Microcontrollers Databook
COP841C	Microcontrollers Databook
COP842C	Microcontrollers Databook
COP888CF	Microcontrollers Databook
COP888CG	Microcontrollers Databook
COP888CL	Microcontrollers Databook
COP8720C	Microcontrollers Databook
COP8721C	Microcontrollers Databook
COP8722C	Microcontrollers Databook
CS9011	Discrete Databook
CS9012	Discrete Databook
CS9013	Discrete Databook
CS9014	Discrete Databook
CS9015	Discrete Databook
CS9016	Discrete Databook
CS9018	Discrete Databook
D40C1	Discrete Databook
D40C2	Discrete Databook
D40C3	Discrete Databook
D40C4	Discrete Databook
D40C5	Discrete Databook
D40C7	Discrete Databook
D40C8	Discrete Databook
D40D1	Discrete Databook
D40D2	Discrete Databook
D40D3	Discrete Databook
D40D4	Discrete Databook
D40D5	Discrete Databook
D40D6	Discrete Databook
D40D7	Discrete Databook
D40D8	Discrete Databook
D40D10	Discrete Databook
D40D11	Discrete Databook
D40D13	Discrete Databook
D40D14	Discrete Databook
D40E1	Discrete Databook
D40E5	Discrete Databook
D40E7	Discrete Databook
D40K1	Discrete Databook
D40K2	Discrete Databook
D40K3	Discrete Databook
D40K4	Discrete Databook
D40N1	Discrete Databook
D40N2	Discrete Databook
D40N3	Discrete Databook
D40N4	Discrete Databook
D40P1	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
D40P3	Discrete Databook
D40P5	Discrete Databook
D41D1	Discrete Databook
D41D2	Discrete Databook
D41D4	Discrete Databook
D41D5	Discrete Databook
D41D7	Discrete Databook
D41D8	Discrete Databook
D41D10	Discrete Databook
D41D11	Discrete Databook
D41D13	Discrete Databook
D41D14	Discrete Databook
D41E1	Discrete Databook
D41E5	Discrete Databook
D41E7	Discrete Databook
D41K1	Discrete Databook
D41K2	Discrete Databook
D41K3	Discrete Databook
D41K4	Discrete Databook
D42C1	Discrete Databook
D42C2	Discrete Databook
D42C3	Discrete Databook
D42C4	Discrete Databook
D42C5	Discrete Databook
D42C6	Discrete Databook
D42C7	Discrete Databook
D42C8	Discrete Databook
D42C9	Discrete Databook
D42C10	Discrete Databook
D42C11	Discrete Databook
D42D4	Discrete Databook
D42D6	Discrete Databook
D42D12	Discrete Databook
D43C1	Discrete Databook
D43C2	Discrete Databook
D43C3	Discrete Databook
D43C4	Discrete Databook
D43C5	Discrete Databook
D43C6	Discrete Databook
D43C7	Discrete Databook
D43C8	Discrete Databook
D43C9	Discrete Databook
D43C10	Discrete Databook
D43C11	Discrete Databook
D43C12	Discrete Databook
D44C1	Discrete Databook
D44C2	Discrete Databook
D44C3	Discrete Databook
D44C4	Discrete Databook
D44C5	Discrete Databook
D44C6	Discrete Databook
D44C7	Discrete Databook
D44C8	Discrete Databook
D44C9	Discrete Databook
D44C10	Discrete Databook
D44C12	Discrete Databook
D44H1	Discrete Databook
D44H4	Discrete Databook
D44H5	Discrete Databook
D44H7	Discrete Databook
D44H8	Discrete Databook
D44H10	Discrete Databook
D44H11	Discrete Databook
D45C1	Discrete Databook
D45C2	Discrete Databook
D45C3	Discrete Databook
D45C4	Discrete Databook
D45C5	Discrete Databook
D45C6	Discrete Databook
D45C7	Discrete Databook
D45C8	Discrete Databook
D45C9	Discrete Databook
D45C10	Discrete Databook
D45C12	Discrete Databook
D45H1	Discrete Databook
D45H2	Discrete Databook
D45H4	Discrete Databook
D45H5	Discrete Databook

Device Number	Publication
D45H7	Discrete Databook
D45H8	Discrete Databook
D45H10	Discrete Databook
D45H11	Discrete Databook
DAC0630	Stand Alone Datasheet
DAC0800	Linear 2 Databook
DAC0801	Linear 2 Databook
DAC0802	Linear 2 Databook
DAC0806	Linear 2 Databook
DAC0807	Linear 2 Databook
DAC0808	Linear 2 Databook
DAC0830	Linear 2 Databook
DAC0831	Linear 2 Databook
DAC0832	Linear 2 Databook
DAC1000	Linear 2 Databook
DAC1001	Linear 2 Databook
DAC1002	Linear 2 Databook
DAC1006	Linear 2 Databook
DAC1007	Linear 2 Databook
DAC1008	Linear 2 Databook
DAC1020	Linear 2 Databook
DAC1021	Linear 2 Databook
DAC1022	Linear 2 Databook
DAC1208	Linear 2 Databook
DAC1209	Linear 2 Databook
DAC1210	Linear 2 Databook
DAC1218	Linear 2 Databook
DAC1219	Linear 2 Databook
DAC1220	Linear 2 Databook
DAC1221	Linear 2 Databook
DAC1222	Linear 2 Databook
DAC1230	Linear 2 Databook
DAC1231	Linear 2 Databook
DAC1232	Linear 2 Databook
DAC1265	Linear 2 Databook
DAC1265A	Linear 2 Databook
DAC1266	Linear 2 Databook
DAC1266A	Linear 2 Databook
DAC1655	Linear 2 Databook
DH0006	Stand Alone Datasheet
DH0008	Stand Alone Datasheet
DH0034	Stand Alone Datasheet
DH0035	Stand Alone Datasheet
DM54L00	LS/S/TTL Databook
DM54L02	LS/S/TTL Databook
DM54L04	LS/S/TTL Databook
DM54L10	LS/S/TTL Databook
DM54L72	LS/S/TTL Databook
DM54L73	LS/S/TTL Databook
DM54L74	LS/S/TTL Databook
DM54L93	LS/S/TTL Databook
DM54L95	LS/S/TTL Databook
DM54L98	LS/S/TTL Databook
DM54LS00	LS/S/TTL Databook
DM54LS02	LS/S/TTL Databook
DM54LS03	LS/S/TTL Databook
DM54LS04	LS/S/TTL Databook
DM54LS05	LS/S/TTL Databook
DM54LS08	LS/S/TTL Databook
DM54LS09	LS/S/TTL Databook
DM54LS10	LS/S/TTL Databook
DM54LS11	LS/S/TTL Databook
DM54LS12	LS/S/TTL Databook
DM54LS14	LS/S/TTL Databook
DM54LS20	LS/S/TTL Databook
DM54LS21	LS/S/TTL Databook
DM54LS26	LS/S/TTL Databook
DM54LS27	LS/S/TTL Databook
DM54LS30	LS/S/TTL Databook
DM54LS32	LS/S/TTL Databook
DM54LS37	LS/S/TTL Databook
DM54LS38	LS/S/TTL Databook
DM54LS42	LS/S/TTL Databook
DM54LS51	LS/S/TTL Databook
DM54LS73A	LS/S/TTL Databook
DM54LS74A	LS/S/TTL Databook
DM54LS75	LS/S/TTL Databook
DM54LS83A	LS/S/TTL Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DM54LS85	LS/S/TTL Databook
DM54LS86	LS/S/TTL Databook
DM54LS90	LS/S/TTL Databook
DM54LS93	LS/S/TTL Databook
DM54LS107A	LS/S/TTL Databook
DM54LS109A	LS/S/TTL Databook
DM54LS112A	LS/S/TTL Databook
DM54LS122	LS/S/TTL Databook
DM54LS123	LS/S/TTL Databook
DM54LS125A	LS/S/TTL Databook
DM54LS126A	LS/S/TTL Databook
DM54LS132	LS/S/TTL Databook
DM54LS138	LS/S/TTL Databook
DM54LS139	LS/S/TTL Databook
DM54LS151	LS/S/TTL Databook
DM54LS153	LS/S/TTL Databook
DM54LS154	LS/S/TTL Databook
DM54LS155	LS/S/TTL Databook
DM54LS156	LS/S/TTL Databook
DM54LS157	LS/S/TTL Databook
DM54LS158	LS/S/TTL Databook
DM54LS161A	LS/S/TTL Databook
DM54LS163A	LS/S/TTL Databook
DM54LS164	LS/S/TTL Databook
DM54LS165	LS/S/TTL Databook
DM54LS166	LS/S/TTL Databook
DM54LS169A	LS/S/TTL Databook
DM54LS173A	LS/S/TTL Databook
DM54LS174	LS/S/TTL Databook
DM54LS175	LS/S/TTL Databook
DM54LS190	LS/S/TTL Databook
DM54LS191	LS/S/TTL Databook
DM54LS193	LS/S/TTL Databook
DM54LS194A	LS/S/TTL Databook
DM54LS195A	LS/S/TTL Databook
DM54LS221	LS/S/TTL Databook
DM54LS240	LS/S/TTL Databook
DM54LS241	LS/S/TTL Databook
DM54LS243	LS/S/TTL Databook
DM54LS244	LS/S/TTL Databook
DM54LS245	LS/S/TTL Databook
DM54LS251	LS/S/TTL Databook
DM54LS253	LS/S/TTL Databook
DM54LS257B	LS/S/TTL Databook
DM54LS258B	LS/S/TTL Databook
DM54LS259	LS/S/TTL Databook
DM54LS279	LS/S/TTL Databook
DM54LS283	LS/S/TTL Databook
DM54LS290	LS/S/TTL Databook
DM54LS293	LS/S/TTL Databook
DM54LS352	LS/S/TTL Databook
DM54LS365A	LS/S/TTL Databook
DM54LS366A	LS/S/TTL Databook
DM54LS367A	LS/S/TTL Databook
DM54LS368A	LS/S/TTL Databook
DM54LS373	LS/S/TTL Databook
DM54LS374	LS/S/TTL Databook
DM54LS390	LS/S/TTL Databook
DM54LS393	LS/S/TTL Databook
DM54LS471	Memory Databook
DM54LS645	LS/S/TTL Databook
DM54LS670	LS/S/TTL Databook
DM54LS952	LS/S/TTL Databook
DM54LS962	LS/S/TTL Databook
DM54S00	LS/S/TTL Databook
DM54S02	LS/S/TTL Databook
DM54S03	LS/S/TTL Databook
DM54S04	LS/S/TTL Databook
DM54S05	LS/S/TTL Databook
DM54S08	LS/S/TTL Databook
DM54S10	LS/S/TTL Databook
DM54S11	LS/S/TTL Databook
DM54S20	LS/S/TTL Databook
DM54S30	LS/S/TTL Databook
DM54S32	LS/S/TTL Databook
DM54S40	LS/S/TTL Databook
DM54S51	LS/S/TTL Databook
DM54S64	LS/S/TTL Databook

Device Number	Publication
DM54S74	LS/S/TTL Databook
DM54S86	LS/S/TTL Databook
DM54S112	LS/S/TTL Databook
DM54S113	LS/S/TTL Databook
DM54S133	LS/S/TTL Databook
DM54S138	LS/S/TTL Databook
DM54S139	LS/S/TTL Databook
DM54S140	LS/S/TTL Databook
DM54S151	LS/S/TTL Databook
DM54S153	LS/S/TTL Databook
DM54S157	LS/S/TTL Databook
DM54S158	LS/S/TTL Databook
DM54S161	LS/S/TTL Databook
DM54S163	LS/S/TTL Databook
DM54S174	LS/S/TTL Databook
DM54S175	LS/S/TTL Databook
DM54S181	LS/S/TTL Databook
DM54S182	LS/S/TTL Databook
DM54S188	Memory Databook
DM54S189	Memory Databook
DM54S189A	Memory Databook
DM54S194	LS/S/TTL Databook
DM54S195	LS/S/TTL Databook
DM54S240	LS/S/TTL Databook
DM54S241	LS/S/TTL Databook
DM54S244	LS/S/TTL Databook
DM54S251	LS/S/TTL Databook
DM54S253	LS/S/TTL Databook
DM54S257	LS/S/TTL Databook
DM54S258	LS/S/TTL Databook
DM54S280	LS/S/TTL Databook
DM54S283	LS/S/TTL Databook
DM54S287	Memory Databook
DM54S288	Memory Databook
DM54S299	LS/S/TTL Databook
DM54S373	LS/S/TTL Databook
DM54S374	LS/S/TTL Databook
DM54S381	LS/S/TTL Databook
DM54S387	Memory Databook
DM54S472	Memory Databook
DM54S473	Memory Databook
DM54S474	Memory Databook
DM54S475	Memory Databook
DM54S570	Memory Databook
DM54S571	Memory Databook
DM54S572	Memory Databook
DM54S573	Memory Databook
DM74AS00	ALS/AS Logic Databook
DM74AS02	ALS/AS Logic Databook
DM74AS04	ALS/AS Logic Databook
DM74AS08	ALS/AS Logic Databook
DM74AS10	ALS/AS Logic Databook
DM74AS11	ALS/AS Logic Databook
DM74AS20	ALS/AS Logic Databook
DM74AS21	ALS/AS Logic Databook
DM74AS27	ALS/AS Logic Databook
DM74AS30	ALS/AS Logic Databook
DM74AS32	ALS/AS Logic Databook
DM74AS34	ALS/AS Logic Databook
DM74AS74	ALS/AS Logic Databook
DM74AS86	ALS/AS Logic Databook
DM74AS109	ALS/AS Logic Databook
DM74AS136	ALS/AS Logic Databook
DM74AS157	ALS/AS Logic Databook
DM74AS158	ALS/AS Logic Databook
DM74AS160	ALS/AS Logic Databook
DM74AS161	ALS/AS Logic Databook
DM74AS162	ALS/AS Logic Databook
DM74AS163	ALS/AS Logic Databook
DM74AS168A	ALS/AS Logic Databook
DM74AS169A	ALS/AS Logic Databook
DM74AS174	ALS/AS Logic Databook
DM74AS175A	ALS/AS Logic Databook
DM74AS181B	ALS/AS Logic Databook
DM74AS182	ALS/AS Logic Databook
DM74AS230	ALS/AS Logic Databook
DM74AS231	ALS/AS Logic Databook
DM74AS240	ALS/AS Logic Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DM74AS241	ALS/AS Logic Databook
DM74AS242	ALS/AS Logic Databook
DM74AS243	ALS/AS Logic Databook
DM74AS244	ALS/AS Logic Databook
DM74AS245	ALS/AS Logic Databook
DM74AS257	ALS/AS Logic Databook
DM74AS258	ALS/AS Logic Databook
DM74AS264	ALS/AS Logic Databook
DM74AS280	ALS/AS Logic Databook
DM74AS282	ALS/AS Logic Databook
DM74AS286	ALS/AS Logic Databook
DM74AS373	ALS/AS Logic Databook
DM74AS374	ALS/AS Logic Databook
DM74AS533	ALS/AS Logic Databook
DM74AS534	ALS/AS Logic Databook
DM74AS573	ALS/AS Logic Databook
DM74AS574	ALS/AS Logic Databook
DM74AS575	ALS/AS Logic Databook
DM74AS576	ALS/AS Logic Databook
DM74AS577	ALS/AS Logic Databook
DM74AS580	ALS/AS Logic Databook
DM74AS620	ALS/AS Logic Databook
DM74AS640	ALS/AS Logic Databook
DM74AS645	ALS/AS Logic Databook
DM74AS646	ALS/AS Logic Databook
DM74AS648	ALS/AS Logic Databook
DM74AS651	ALS/AS Logic Databook
DM74AS652	ALS/AS Logic Databook
DM74AS804B	ALS/AS Logic Databook
DM74AS805B	ALS/AS Logic Databook
DM74AS808B	ALS/AS Logic Databook
DM74AS810	ALS/AS Logic Databook
DM74AS811	ALS/AS Logic Databook
DM74AS832B	ALS/AS Logic Databook
DM74AS873	ALS/AS Logic Databook
DM74AS874	ALS/AS Logic Databook
DM74AS876	ALS/AS Logic Databook
DM74AS878	ALS/AS Logic Databook
DM74AS879	ALS/AS Logic Databook
DM74AS880	ALS/AS Logic Databook
DM74AS1000A	ALS/AS Logic Databook
DM74AS1004A	ALS/AS Logic Databook
DM74AS1008A	ALS/AS Logic Databook
DM74AS1032A	ALS/AS Logic Databook
DM74AS1034A	ALS/AS Logic Databook
DM74AS1036A	ALS/AS Logic Databook
DM74AS1804	ALS/AS Logic Databook
DM74AS1805	ALS/AS Logic Databook
DM74AS1808	ALS/AS Logic Databook
DM74AS1832	ALS/AS Logic Databook
DM74AS2620	ALS/AS Logic Databook
DM74L00	LS/S/TTL Databook
DM74L02	LS/S/TTL Databook
DM74L04	LS/S/TTL Databook
DM74L10	LS/S/TTL Databook
DM74L72	LS/S/TTL Databook
DM74L73	LS/S/TTL Databook
DM74L74	LS/S/TTL Databook
DM74L93	LS/S/TTL Databook
DM74L95	LS/S/TTL Databook
DM74L98	LS/S/TTL Databook
DM74LS00	LS/S/TTL Databook
DM74LS02	LS/S/TTL Databook
DM74LS03	LS/S/TTL Databook
DM74LS04	LS/S/TTL Databook
DM74LS05	LS/S/TTL Databook
DM74LS08	LS/S/TTL Databook
DM74LS09	LS/S/TTL Databook
DM74LS10	LS/S/TTL Databook
DM74LS11	LS/S/TTL Databook
DM74LS12	LS/S/TTL Databook
DM74LS14	LS/S/TTL Databook
DM74LS20	LS/S/TTL Databook
DM74LS21	LS/S/TTL Databook
DM74LS26	LS/S/TTL Databook
DM74LS27	LS/S/TTL Databook
DM74LS30	LS/S/TTL Databook
DM74LS32	LS/S/TTL Databook

Device Number	Publication
DM74LS37	LS/S/TTL Databook
DM74LS38	LS/S/TTL Databook
DM74LS42	LS/S/TTL Databook
DM74LS51	LS/S/TTL Databook
DM74LS73A	LS/S/TTL Databook
DM74LS74A	LS/S/TTL Databook
DM74LS75	LS/S/TTL Databook
DM74LS83A	LS/S/TTL Databook
DM74LS85	LS/S/TTL Databook
DM74LS86	LS/S/TTL Databook
DM74LS90	LS/S/TTL Databook
DM74LS93	LS/S/TTL Databook
DM74LS107A	LS/S/TTL Databook
DM74LS109A	LS/S/TTL Databook
DM74LS112A	LS/S/TTL Databook
DM74LS122	LS/S/TTL Databook
DM74LS123	LS/S/TTL Databook
DM74LS125A	LS/S/TTL Databook
DM74LS126A	LS/S/TTL Databook
DM74LS132	LS/S/TTL Databook
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DM74LS139	LS/S/TTL Databook
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DM74LS153	LS/S/TTL Databook
DM74LS154	LS/S/TTL Databook
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DM74LS157	LS/S/TTL Databook
DM74LS158	LS/S/TTL Databook
DM74LS161A	LS/S/TTL Databook
DM74LS163A	LS/S/TTL Databook
DM74LS164	LS/S/TTL Databook
DM74LS165	LS/S/TTL Databook
DM74LS166	LS/S/TTL Databook
DM74LS169A	LS/S/TTL Databook
DM74LS173A	LS/S/TTL Databook
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DM74LS175	LS/S/TTL Databook
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DM74LS195A	LS/S/TTL Databook
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DM74LS279	LS/S/TTL Databook
DM74LS283	LS/S/TTL Databook
DM74LS290	LS/S/TTL Databook
DM74LS293	LS/S/TTL Databook
DM74LS352	LS/S/TTL Databook
DM74LS365A	LS/S/TTL Databook
DM74LS366A	LS/S/TTL Databook
DM74LS367A	LS/S/TTL Databook
DM74LS368A	LS/S/TTL Databook
DM74LS373	LS/S/TTL Databook
DM74LS374	LS/S/TTL Databook
DM74LS390	LS/S/TTL Databook
DM74LS393	LS/S/TTL Databook
DM74LS471	Memory Databook
DM74LS645	LS/S/TTL Databook
DM74LS670	LS/S/TTL Databook
DM74LS952	LS/S/TTL Databook
DM74LS962	LS/S/TTL Databook
DM74S00	LS/S/TTL Databook
DM74S02	LS/S/TTL Databook
DM74S03	LS/S/TTL Databook
DM74S04	LS/S/TTL Databook
DM74S05	LS/S/TTL Databook
DM74S08	LS/S/TTL Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DM74S10	LS/S/TTL Databook
DM74S11	LS/S/TTL Databook
DM74S20	LS/S/TTL Databook
DM74S30	LS/S/TTL Databook
DM74S32	LS/S/TTL Databook
DM74S40	LS/S/TTL Databook
DM74S51	LS/S/TTL Databook
DM74S64	LS/S/TTL Databook
DM74S74	LS/S/TTL Databook
DM74S86	LS/S/TTL Databook
DM74S112	LS/S/TTL Databook
DM74S113	LS/S/TTL Databook
DM74S133	LS/S/TTL Databook
DM74S138	LS/S/TTL Databook
DM74S139	LS/S/TTL Databook
DM74S140	LS/S/TTL Databook
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DM74S153	LS/S/TTL Databook
DM74S157	LS/S/TTL Databook
DM74S158	LS/S/TTL Databook
DM74S161	LS/S/TTL Databook
DM74S163	LS/S/TTL Databook
DM74S174	LS/S/TTL Databook
DM74S175	LS/S/TTL Databook
DM74S181	LS/S/TTL Databook
DM74S182	LS/S/TTL Databook
DM74S188	Memory Databook
DM74S189	Memory Databook
DM74S189A	Memory Databook
DM74S194	LS/S/TTL Databook
DM74S195	LS/S/TTL Databook
DM74S240	LS/S/TTL Databook
DM74S241	LS/S/TTL Databook
DM74S244	LS/S/TTL Databook
DM74S251	LS/S/TTL Databook
DM74S253	LS/S/TTL Databook
DM74S257	LS/S/TTL Databook
DM74S258	LS/S/TTL Databook
DM74S280	LS/S/TTL Databook
DM74S283	LS/S/TTL Databook
DM74S287	Memory Databook
DM74S288	Memory Databook
DM74S289	Memory Databook
DM74S299	LS/S/TTL Databook
DM74S373	LS/S/TTL Databook
DM74S374	LS/S/TTL Databook
DM74S381	LS/S/TTL Databook
DM74S387	Memory Databook
DM74S472	Memory Databook
DM74S473	Memory Databook
DM74S474	Memory Databook
DM74S475	Memory Databook
DM74S570	Memory Databook
DM74S571	Memory Databook
DM74S572	Memory Databook
DM74S573	Memory Databook
DM75S68	Memory Databook
DM75S68A	Memory Databook
DM75X431	Memory Databook
DM75X432	Memory Databook
DM75X433	Memory Databook
DM77S180	Memory Databook
DM77S181	Memory Databook
DM77S184	Memory Databook
DM77S185	Memory Databook
DM77S195	Memory Databook
DM77S280	Memory Databook
DM77S281	Memory Databook
DM77SR27	Memory Databook
DM77SR181	Memory Databook
DM77SR183	Memory Databook
DM77SR191	Memory Databook
DM77SR193	Memory Databook
DM77SR474	Memory Databook
DM77SR476	Memory Databook
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DM87SR181	Memory Databook
DM87SR183	Memory Databook
DM87SR191	Memory Databook
DM87SR193	Memory Databook
DM87SR474	Memory Databook
DM87SR476	Memory Databook
DM2502	LS/S/TTL Databook
DM2502	Linear 2 Databook
DM2503	LS/S/TTL Databook
DM2503	Linear 2 Databook
DM2504	LS/S/TTL Databook
DM2504	Linear 2 Databook
DM5400	LS/S/TTL Databook
DM5401	LS/S/TTL Databook
DM5402	LS/S/TTL Databook
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DM5437	LS/S/TTL Databook
DM5438	LS/S/TTL Databook
DM5442	LS/S/TTL Databook
DM5445	LS/S/TTL Databook
DM5446A	LS/S/TTL Databook
DM5447A	LS/S/TTL Databook
DM5473	LS/S/TTL Databook
DM5474	LS/S/TTL Databook
DM5475	LS/S/TTL Databook
DM5476	LS/S/TTL Databook
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DM5486	LS/S/TTL Databook
DM5490A	LS/S/TTL Databook
DM5493A	LS/S/TTL Databook
DM5495	LS/S/TTL Databook
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DM7131	LS/S/TTL Databook
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DM7408	LS/S/TTL Databook
DM7409	LS/S/TTL Databook
DM7410	LS/S/TTL Databook
DM7414	LS/S/TTL Databook
DM7416	LS/S/TTL Databook
DM7417	LS/S/TTL Databook
DM7420	LS/S/TTL Databook
DM7426	LS/S/TTL Databook
DM7427	LS/S/TTL Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DM7430	LS/S/TTL Databook
DM7432	LS/S/TTL Databook
DM7437	LS/S/TTL Databook
DM7438	LS/S/TTL Databook
DM7442	LS/S/TTL Databook
DM7445	LS/S/TTL Databook
DM7446A	LS/S/TTL Databook
DM7447A	LS/S/TTL Databook
DM7473	LS/S/TTL Databook
DM7474	LS/S/TTL Databook
DM7475	LS/S/TTL Databook
DM7476	LS/S/TTL Databook
DM7485	LS/S/TTL Databook
DM7486	LS/S/TTL Databook
DM7490A	LS/S/TTL Databook
DM7493A	LS/S/TTL Databook
DM7495	LS/S/TTL Databook
DM8123	LS/S/TTL Databook
DM8130	LS/S/TTL Databook
DM8131	LS/S/TTL Databook
DM8136	LS/S/TTL Databook
DM8160	LS/S/TTL Databook
DM8300	LS/S/TTL Databook
DM8301	LS/S/TTL Databook
DM8309	LS/S/TTL Databook
DM8311	LS/S/TTL Databook
DM8312	LS/S/TTL Databook
DM8316	LS/S/TTL Databook
DM8318	LS/S/TTL Databook
DM8322	LS/S/TTL Databook
DM8334	LS/S/TTL Databook
DM8601	LS/S/TTL Databook
DM8602	LS/S/TTL Databook
DM9301	LS/S/TTL Databook
DM9309	LS/S/TTL Databook
DM9311	LS/S/TTL Databook
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DM9602	LS/S/TTL Databook
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DM54121	LS/S/TTL Databook
DM54123	LS/S/TTL Databook
DM54125	LS/S/TTL Databook
DM54132	LS/S/TTL Databook
DM54145	LS/S/TTL Databook
DM54148	LS/S/TTL Databook
DM54150	LS/S/TTL Databook
DM54151A	LS/S/TTL Databook
DM54153	LS/S/TTL Databook
DM54154	LS/S/TTL Databook
DM54155	LS/S/TTL Databook
DM54157	LS/S/TTL Databook
DM54161A	LS/S/TTL Databook
DM54162A	LS/S/TTL Databook
DM54163A	LS/S/TTL Databook
DM54164	LS/S/TTL Databook
DM54166	LS/S/TTL Databook
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DM54181	LS/S/TTL Databook
DM54191	LS/S/TTL Databook
DM54193	LS/S/TTL Databook
DM54194	LS/S/TTL Databook
DM54365	LS/S/TTL Databook
DM54367	LS/S/TTL Databook
DM54368	LS/S/TTL Databook
DM74107	LS/S/TTL Databook
DM74109	LS/S/TTL Databook
DM74121	LS/S/TTL Databook
DM74123	LS/S/TTL Databook
DM74125	LS/S/TTL Databook

Device Number	Publication
DM74132	LS/S/TTL Databook
DM74145	LS/S/TTL Databook
DM74148	LS/S/TTL Databook
DM74150	LS/S/TTL Databook
DM74151A	LS/S/TTL Databook
DM74153	LS/S/TTL Databook
DM74154	LS/S/TTL Databook
DM74155	LS/S/TTL Databook
DM74157	LS/S/TTL Databook
DM74161A	LS/S/TTL Databook
DM74162A	LS/S/TTL Databook
DM74163A	LS/S/TTL Databook
DM74164	LS/S/TTL Databook
DM74166	LS/S/TTL Databook
DM74173	LS/S/TTL Databook
DM74174	LS/S/TTL Databook
DM74175	LS/S/TTL Databook
DM74180	LS/S/TTL Databook
DM74181	LS/S/TTL Databook
DM74191	LS/S/TTL Databook
DM74193	LS/S/TTL Databook
DM74194	LS/S/TTL Databook
DM74365	LS/S/TTL Databook
DM74367	LS/S/TTL Databook
DM74368	LS/S/TTL Databook
DP24H80	Mass Storage Handbook
DP117X	Mass Storage Handbook
DP117XR	Mass Storage Handbook
DP501X	Mass Storage Handbook
DP501XR	Mass Storage Handbook
DP2460	Mass Storage Handbook
DP2461	Mass Storage Handbook
DP2580	Mass Storage Handbook
DP5380	Mass Storage Handbook
DP7304B	Interface Databook
DP7308	Interface Databook
DP7310	Interface Databook
DP7311	Interface Databook
DP8212	Interface Databook
DP8212M	Interface Databook
DP8216	Interface Databook
DP8216M	Interface Databook
DP8224	Interface Databook
DP8226	Interface Databook
DP8226M	Interface Databook
DP8228	Interface Databook
DP8228M	Interface Databook
DP8238	Interface Databook
DP8238M	Interface Databook
DP8303A	Interface Databook
DP8304B	Interface Databook
DP8307A	Interface Databook
DP8308	Interface Databook
DP8310	Interface Databook
DP8311	Interface Databook
DP8340	Datacommunications/LAN/UART Handbook
DP8341	Datacommunications/LAN/UART Handbook
DP8342	Datacommunications/LAN/UART Handbook
DP8343	Datacommunications/LAN/UART Handbook
DP8344	Datacommunications/LAN/UART Handbook
DP8390C	Datacommunications/LAN/UART Handbook
DP8390C-1	Datacommunications/LAN/UART Handbook
DP8391A	Datacommunications/LAN/UART Handbook
DP8392A	Datacommunications/LAN/UART Handbook
DP8400-2	DRAM Management Handbook
DP8402A	DRAM Management Handbook
DP8403	DRAM Management Handbook
DP8404	DRAM Management Handbook
DP8405	DRAM Management Handbook
DP8408A	DRAM Management Handbook
DP8409A	DRAM Management Handbook
DP8417	DRAM Management Handbook
DP8418	DRAM Management Handbook
DP8419	DRAM Management Handbook
DP8419X	DRAM Management Handbook
DP8420A	DRAM Management Handbook
DP8421A	DRAM Management Handbook
DP8422A	DRAM Management Handbook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DP8428	DRAM Management Handbook
DP8429	DRAM Management Handbook
DP8451	Mass Storage Handbook
DP8455	Mass Storage Handbook
DP8459	Mass Storage Handbook
DP8461	Mass Storage Handbook
DP8462	Mass Storage Handbook
DP8463B	Mass Storage Handbook
DP8464B	Mass Storage Handbook
DP8465	Mass Storage Handbook
DP8466A	Mass Storage Handbook
DP8468B	Mass Storage Handbook
DP8469	Mass Storage Handbook
DP8472	Mass Storage Handbook
DP8473	Mass Storage Handbook
DP8474	Mass Storage Handbook
DP8480A	Interface Databook
DP8481	Interface Databook
DP8482A	Interface Databook
DP8483	Interface Databook
DP8490	Mass Storage Handbook
DP8500	Graphics Databook
DP8510	Graphics Databook
DP8511	Graphics Databook
DP8512	Graphics Databook
DP8513	Graphics Databook
DP8514	Graphics Databook
DP8515	Graphics Databook
DP8515-350	Graphics Databook
DP8516	Graphics Databook
DP8516-350	Graphics Databook
DP8520A	Graphics Databook
DP8521A	Graphics Databook
DP8522A	Graphics Databook
DP8530	Graphics Databook
DP83910	Datacommunications/LAN/UART Handbook
DP84240	Interface Databook
DP84244	Interface Databook
DP84300	DRAM Management Handbook
DP84322	DRAM Management Handbook
DP84412	DRAM Management Handbook
DP84422	DRAM Management Handbook
DP84432	DRAM Management Handbook
DP84512	DRAM Management Handbook
DP84522	DRAM Management Handbook
DP84532	DRAM Management Handbook
DS0025C	Interface Databook
DS0026	Interface Databook
DS0056	Interface Databook
DS8T26A	Interface Databook
DS8T26AM	Interface Databook
DS8T28	Interface Databook
DS8T28M	Interface Databook
DS14C88	Datacommunications/LAN/UART Handbook
DS14C88	Interface Databook
DS14C89A	Datacommunications/LAN/UART Handbook
DS14C89A	Interface Databook
DS16F95	Interface Databook
DS26C31C	Interface Databook
DS26C31C	Mass Storage Handbook
DS26C31C	Datacommunications/LAN/UART Handbook
DS26C32C	Mass Storage Handbook
DS26C32C	Datacommunications/LAN/UART Handbook
DS26C32C	Interface Databook
DS26F31C	Interface Databook
DS26F31M	Interface Databook
DS26F32C	Interface Databook
DS26F32M	Interface Databook
DS26LS31C	Datacommunications/LAN/UART Handbook
DS26LS31C	Interface Databook
DS26LS31M	Interface Databook
DS26LS31M	Datacommunications/LAN/UART Handbook
DS26LS32AC	Interface Databook
DS26LS32AC	Datacommunications/LAN/UART Handbook
DS26LS32C	Datacommunications/LAN/UART Handbook
DS26LS32C	Interface Databook
DS26LS32M	Interface Databook
DS26LS32M	Datacommunications/LAN/UART Handbook

Device Number	Publication
DS26LS33AC	Interface Databook
DS26LS33AC	Datacommunications/LAN/UART Handbook
DS26LS33C	Datacommunications/LAN/UART Handbook
DS26LS33C	Interface Databook
DS26LS33M	Datacommunications/LAN/UART Handbook
DS26LS33M	Interface Databook
DS26S10C	Interface Databook
DS26S10M	Interface Databook
DS26S11C	Interface Databook
DS26S11M	Interface Databook
DS34C86	Interface Databook
DS34C86	Datacommunications/LAN/UART Handbook
DS34C86	Mass Storage Handbook
DS34C87	Mass Storage Handbook
DS34C87	Datacommunications/LAN/UART Handbook
DS34C87	Interface Databook
DS34F86	Interface Databook
DS34F87	Interface Databook
DS35F86	Interface Databook
DS35F87	Interface Databook
DS36F95	Interface Databook
DS78C20	Interface Databook
DS78C120	Datacommunications/LAN/UART Handbook
DS78C120	Interface Databook
DS78L12	Interface Databook
DS78LS120	Datacommunications/LAN/UART Handbook
DS78LS120	Interface Databook
DS88C20	Interface Databook
DS88C120	Datacommunications/LAN/UART Handbook
DS88C120	Interface Databook
DS88L12	Interface Databook
DS88LS120	Datacommunications/LAN/UART Handbook
DS88LS120	Interface Databook
DS96F172	Interface Databook
DS96F173	Interface Databook
DS96F174	Interface Databook
DS96F175	Interface Databook
DS1488	Datacommunications/LAN/UART Handbook
DS1488	Interface Databook
DS1489	Interface Databook
DS1489	Datacommunications/LAN/UART Handbook
DS1489A	Datacommunications/LAN/UART Handbook
DS1489A	Interface Databook
DS1603	Interface Databook
DS1628	Interface Databook
DS1630B	Interface Databook
DS1631	Interface Databook
DS1632	Interface Databook
DS1633	Interface Databook
DS1634	Interface Databook
DS1648	Interface Databook
DS1649	Interface Databook
DS1650	Interface Databook
DS1651	Interface Databook
DS1652	Interface Databook
DS1678	Interface Databook
DS1679	Interface Databook
DS1687	Interface Databook
DS1691A	Interface Databook
DS1691A	Datacommunications/LAN/UART Handbook
DS1692	Interface Databook
DS1692	Datacommunications/LAN/UART Handbook
DS2001	Interface Databook
DS2002	Interface Databook
DS2003	Interface Databook
DS2004	Interface Databook
DS3245	Interface Databook
DS3486	Interface Databook
DS3486	Datacommunications/LAN/UART Handbook
DS3487	Datacommunications/LAN/UART Handbook
DS3487	Interface Databook
DS3587	Interface Databook
DS3587	Datacommunications/LAN/UART Handbook
DS3603	Interface Databook
DS3628	Interface Databook
DS3630B	Interface Databook
DS3631	Interface Databook
DS3632	Interface Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DS3633	Interface Databook
DS3634	Interface Databook
DS3647A	Interface Databook
DS3648	Interface Databook
DS3649	Interface Databook
DS3650	Interface Databook
DS3651	Interface Databook
DS3652	Interface Databook
DS3654	Interface Databook
DS3656	Interface Databook
DS3658	Interface Databook
DS3662	Interface Databook
DS3667	Interface Databook
DS3668	Interface Databook
DS3669	Interface Databook
DS3678	Interface Databook
DS3679	Interface Databook
DS3680	Interface Databook
DS3686	Interface Databook
DS3687	Interface Databook
DS3691	Datacommunications/LAN/UART Handbook
DS3691	Interface Databook
DS3692	Interface Databook
DS3692	Datacommunications/LAN/UART Handbook
DS3695	Datacommunications/LAN/UART Handbook
DS3695	Interface Databook
DS3695A	Interface Databook
DS3695T	Datacommunications/LAN/UART Handbook
DS3695T	Interface Databook
DS3696	Datacommunications/LAN/UART Handbook
DS3696	Interface Databook
DS3696T	Interface Databook
DS3696T	Datacommunications/LAN/UART Handbook
DS3697	Interface Databook
DS3697	Datacommunications/LAN/UART Handbook
DS3698	Datacommunications/LAN/UART Handbook
DS3698	Interface Databook
DS3862	Interface Databook
DS3890	Interface Databook
DS3892	Interface Databook
DS3893A	Interface Databook
DS3896	Interface Databook
DS3897	Interface Databook
DS3898	Interface Databook
DS7640	Interface Databook
DS7641	Interface Databook
DS7800	Interface Databook
DS7820	Interface Databook
DS7820A	Interface Databook
DS7830	Interface Databook
DS7831	Interface Databook
DS7832	Interface Databook
DS7833	Interface Databook
DS7834	Interface Databook
DS7835	Interface Databook
DS7836	Interface Databook
DS7837	Interface Databook
DS7838	Interface Databook
DS7839	Interface Databook
DS7880	Interface Databook
DS8614	Interface Databook
DS8615	Interface Databook
DS8616	Interface Databook
DS8617	Interface Databook
DS8627	Interface Databook
DS8628	Interface Databook
DS8629	Interface Databook
DS8640	Interface Databook
DS8641	Interface Databook
DS8654	Interface Databook
DS8669	Interface Databook
DS8800	Interface Databook
DS8820	Interface Databook
DS8820A	Interface Databook
DS8830	Interface Databook
DS8831	Interface Databook
DS8832	Interface Databook
DS8833	Interface Databook

Device Number	Publication
DS8834	Interface Databook
DS8835	Interface Databook
DS8836	Interface Databook
DS8837	Interface Databook
DS8838	Interface Databook
DS8839	Interface Databook
DS8863	Interface Databook
DS8870	Interface Databook
DS8874	Interface Databook
DS8880	Interface Databook
DS8884A	Interface Databook
DS8906	Interface Databook
DS8907	Interface Databook
DS8908	Interface Databook
DS8911	Interface Databook
DS8921	Interface Databook
DS8921	Mass Storage Handbook
DS8921	Datacommunications/LAN/UART Handbook
DS8921A	Mass Storage Handbook
DS8921A	Interface Databook
DS8921A	Datacommunications/LAN/UART Handbook
DS8921AT	Interface Databook
DS8922	Interface Databook
DS8922	Datacommunications/LAN/UART Handbook
DS8922/22A	Mass Storage Handbook
DS8922A	Datacommunications/LAN/UART Handbook
DS8922A	Interface Databook
DS8923	Interface Databook
DS8923	Datacommunications/LAN/UART Handbook
DS8923/23A	Mass Storage Handbook
DS8923A	Datacommunications/LAN/UART Handbook
DS8923A	Interface Databook
DS8924	Interface Databook
DS8924	Datacommunications/LAN/UART Handbook
DS8963	Interface Databook
DS8973	Interface Databook
DS9614	Interface Databook
DS9615	Interface Databook
DS9622	Interface Databook
DS9627	Interface Databook
DS9636A	Interface Databook
DS9636A	Datacommunications/LAN/UART Handbook
DS9637A	Interface Databook
DS9637A	Datacommunications/LAN/UART Handbook
DS9638	Interface Databook
DS9638A	Datacommunications/LAN/UART Handbook
DS9639A	Datacommunications/LAN/UART Handbook
DS9639A	Interface Databook
DS9643	Interface Databook
DS9643	Datacommunications/LAN/UART Handbook
DS16149	Interface Databook
DS16179	Interface Databook
DS36149	Interface Databook
DS36179	Interface Databook
DS55107	Interface Databook
DS55107A	Interface Databook
DS55108	Interface Databook
DS55110A	Interface Databook
DS55113	Interface Databook
DS55114	Interface Databook
DS55115	Interface Databook
DS55121	Interface Databook
DS55325	Interface Databook
DS55451	Interface Databook
DS55452	Interface Databook
DS55453	Interface Databook
DS55454	Interface Databook
DS55461	Interface Databook
DS55462	Interface Databook
DS55463	Interface Databook
DS55464	Interface Databook
DS55493	Interface Databook
DS55494	Interface Databook
DS75107	Interface Databook
DS75108	Interface Databook
DS75110A	Interface Databook
DS75113	Interface Databook
DS75114	Interface Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
DS75115	Interface Databook
DS75121	Interface Databook
DS75123	Interface Databook
DS75124	Interface Databook
DS75125	Interface Databook
DS75127	Interface Databook
DS75128	Interface Databook
DS75129	Interface Databook
DS75150	Interface Databook
DS75150	Datacommunications/LAN/UART Handbook
DS75154	Interface Databook
DS75154	Datacommunications/LAN/UART Handbook
DS75160A	Interface Databook
DS75161A	Interface Databook
DS75162A	Interface Databook
DS75176A	Datacommunications/LAN/UART Handbook
DS75176AT	Datacommunications/LAN/UART Handbook
DS75176B	Interface Databook
DS75176BT	Interface Databook
DS75208	Interface Databook
DS75325	Interface Databook
DS75361	Interface Databook
DS75365	Interface Databook
DS75450	Interface Databook
DS75451	Interface Databook
DS75452	Interface Databook
DS75453	Interface Databook
DS75454	Interface Databook
DS75461	Interface Databook
DS75462	Interface Databook
DS75463	Interface Databook
DS75464	Interface Databook
DS75491	Interface Databook
DS75492	Interface Databook
DS75493	Interface Databook
DS75494	Interface Databook
DS96172	Datacommunications/LAN/UART Handbook
DS96172	Interface Databook
DS96173	Datacommunications/LAN/UART Handbook
DS96173	Interface Databook
DS96174	Datacommunications/LAN/UART Handbook
DS96174	Interface Databook
DS96175	Interface Databook
DS96175	Datacommunications/LAN/UART Handbook
DS96176	Interface Databook
DS96177	Datacommunications/LAN/UART Handbook
ED1402	Discrete Databook
ED1502	Discrete Databook
ED1602	Discrete Databook
ED1702	Discrete Databook
ED1802	Discrete Databook
F100101	F100K ECL Logic Databook
F100102	F100K ECL Logic Databook
F100104	F100K ECL Logic Databook
F100107	F100K ECL Logic Databook
F100112	F100K ECL Logic Databook
F100113	F100K ECL Logic Databook
F100114	F100K ECL Logic Databook
F100117	F100K ECL Logic Databook
F100118	F100K ECL Logic Databook
F100121	F100K ECL Logic Databook
F100122	F100K ECL Logic Databook
F100123	F100K ECL Logic Databook
F100124	F100K ECL Logic Databook
F100125	F100K ECL Logic Databook
F100126	F100K ECL Logic Databook
F100128	F100K ECL Logic Databook
F100130	F100K ECL Logic Databook
F100131	F100K ECL Logic Databook
F100135	F100K ECL Logic Databook
F100136	F100K ECL Logic Databook
F100141	F100K ECL Logic Databook
F100142	F100K ECL Logic Databook
F100150	F100K ECL Logic Databook
F100151	F100K ECL Logic Databook
F100155	F100K ECL Logic Databook
F100156	F100K ECL Logic Databook
F100158	F100K ECL Logic Databook

Device Number	Publication
F100160	F100K ECL Logic Databook
F100163	F100K ECL Logic Databook
F100164	F100K ECL Logic Databook
F100165	F100K ECL Logic Databook
F100166	F100K ECL Logic Databook
F100170	F100K ECL Logic Databook
F100171	F100K ECL Logic Databook
F100175	F100K ECL Logic Databook
F100179	F100K ECL Logic Databook
F100180	F100K ECL Logic Databook
F100181	F100K ECL Logic Databook
F100182	F100K ECL Logic Databook
F100183	F100K ECL Logic Databook
F100250	F100K ECL Logic Databook
FAS02501	Discrete Databook
FAS02503	Discrete Databook
FAS02509	Discrete Databook
FAS02510	Discrete Databook
FAS02563	Discrete Databook
FAS02564	Discrete Databook
FAS02565	Discrete Databook
FAS02566	Discrete Databook
FAS02619	Discrete Databook
FAS02620	Discrete Databook
FAS02719	Discrete Databook
FAS02720	Discrete Databook
FD700	Discrete Databook
FD777	Discrete Databook
FDH300	Discrete Databook
FDH333	Discrete Databook
FDH400	Discrete Databook
FDH444	Discrete Databook
FDH600	Discrete Databook
FDH666	Discrete Databook
FDH900	Discrete Databook
FDH999	Discrete Databook
FDH1000	Discrete Databook
FDLL300	Discrete Databook
FDLL333	Discrete Databook
FDLL400	Discrete Databook
FDLL456	Discrete Databook
FDLL456A	Discrete Databook
FDLL457	Discrete Databook
FDLL457A	Discrete Databook
FDLL458	Discrete Databook
FDLL458A	Discrete Databook
FDLL459	Discrete Databook
FDLL459A	Discrete Databook
FDLL461A	Discrete Databook
FDLL462A	Discrete Databook
FDLL463A	Discrete Databook
FDLL482B	Discrete Databook
FDLL483B	Discrete Databook
FDLL484B	Discrete Databook
FDLL485B	Discrete Databook
FDLL600	Discrete Databook
FDLL625	Discrete Databook
FDLL626	Discrete Databook
FDLL627	Discrete Databook
FDLL628	Discrete Databook
FDLL629	Discrete Databook
FDLL658	Discrete Databook
FDLL659	Discrete Databook
FDLL660	Discrete Databook
FDLL661	Discrete Databook
FDLL666	Discrete Databook
FDLL914	Discrete Databook
FDLL914A	Discrete Databook
FDLL914B	Discrete Databook
FDLL916	Discrete Databook
FDLL916A	Discrete Databook
FDLL916B	Discrete Databook
FDLL920	Discrete Databook
FDLL921	Discrete Databook
FDLL922	Discrete Databook
FDLL923	Discrete Databook
FDLL3064	Discrete Databook
FDLL3070	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
FDLL3595	Discrete Databook
FDLL3600	Discrete Databook
FDLL4009	Discrete Databook
FDLL4148	Discrete Databook
FDLL4149	Discrete Databook
FDLL4150	Discrete Databook
FDLL4151	Discrete Databook
FDLL4152	Discrete Databook
FDLL4153	Discrete Databook
FDLL4154	Discrete Databook
FDLL4305	Discrete Databook
FDLL4446	Discrete Databook
FDLL4447	Discrete Databook
FDLL4448	Discrete Databook
FDLL4449	Discrete Databook
FDLL4450	Discrete Databook
FDLL4454	Discrete Databook
FDLL6099	Discrete Databook
FDS0914	Discrete Databook
FDS01201	Discrete Databook
FDS01202	Discrete Databook
FDS01203	Discrete Databook
FDS01204	Discrete Databook
FDS01205	Discrete Databook
FDS01301	Discrete Databook
FDS01401	Discrete Databook
FDS01402	Discrete Databook
FDS01403	Discrete Databook
FDS01404	Discrete Databook
FDS01405	Discrete Databook
FDS01501	Discrete Databook
FDS01502	Discrete Databook
FDS01503	Discrete Databook
FDS01504	Discrete Databook
FDS01505	Discrete Databook
FDS03070	Discrete Databook
FDS03595	Discrete Databook
FDS04148	Discrete Databook
FDS04448	Discrete Databook
FJT1100	Discrete Databook
FJT1101	Discrete Databook
FMP18N05	Discrete Databook
FMP18N06	Discrete Databook
FMP20N05	Discrete Databook
FMP20N06	Discrete Databook
FRK3205CC	Discrete Databook
FRK3210CC	Discrete Databook
FRK3215CC	Discrete Databook
FRK3220CC	Discrete Databook
FRP805	Discrete Databook
FRP810	Discrete Databook
FRP815	Discrete Databook
FRP820	Discrete Databook
FRP840	Discrete Databook
FRP850	Discrete Databook
FRP860	Discrete Databook
FRP1005	Discrete Databook
FRP1010	Discrete Databook
FRP1015	Discrete Databook
FRP1020	Discrete Databook
FRP1605	Discrete Databook
FRP1605CC	Discrete Databook
FRP1610	Discrete Databook
FRP1610CC	Discrete Databook
FRP1615	Discrete Databook
FRP1615CC	Discrete Databook
FRP1620	Discrete Databook
FRP1620CC	Discrete Databook
FRP1640CC	Discrete Databook
FRP1650CC	Discrete Databook
FRP1660CC	Discrete Databook
FRP2005CC	Discrete Databook
FRP2010CC	Discrete Databook
FRP2015CC	Discrete Databook
FRP2020CC	Discrete Databook
FSA2002	Discrete Databook
FSA2003	Discrete Databook
FSA2500M	Discrete Databook

Device Number	Publication
FSA2501M	Discrete Databook
FSA2501P	Discrete Databook
FSA2503M	Discrete Databook
FSA2503P	Discrete Databook
FSA2504M	Discrete Databook
FSA2508P	Discrete Databook
FSA2509M	Discrete Databook
FSA2509P	Discrete Databook
FSA2510M	Discrete Databook
FSA2510P	Discrete Databook
FSA2563M	Discrete Databook
FSA2563P	Discrete Databook
FSA2564M	Discrete Databook
FSA2564P	Discrete Databook
FSA2565M	Discrete Databook
FSA2565P	Discrete Databook
FSA2566M	Discrete Databook
FSA2566P	Discrete Databook
FSA2619M	Discrete Databook
FSA2619P	Discrete Databook
FSA2620M	Discrete Databook
FSA2620P	Discrete Databook
FSA2621M	Discrete Databook
FSA2621M	Discrete Databook
FSA2719M	Discrete Databook
FSA2719P	Discrete Databook
FSA2720M	Discrete Databook
FSA2720P	Discrete Databook
FSA2721M	Discrete Databook
GAL16V8-20L	Programmable Logic Devices Databook
GAL16V8-25L	Programmable Logic Devices Databook
GAL16V8-25Q	Programmable Logic Devices Databook
GAL16V8-30L	Programmable Logic Devices Databook
GAL16V8-30Q	Programmable Logic Devices Databook
GAL16V8A-10	Programmable Logic Devices Databook
GAL16V8A-12	Programmable Logic Devices Databook
GAL16V8A-15	Programmable Logic Devices Databook
GAL16V8A-20	Programmable Logic Devices Databook
GAL16Z8	Programmable Logic Devices Databook
GAL20V8-20L	Programmable Logic Devices Databook
GAL20V8-25L	Programmable Logic Devices Databook
GAL20V8-25Q	Programmable Logic Devices Databook
GAL20V8-30L	Programmable Logic Devices Databook
GAL20V8-30Q	Programmable Logic Devices Databook
GAL20V8A-10	Programmable Logic Devices Databook
GAL20V8A-12	Programmable Logic Devices Databook
GAL20V8A-15	Programmable Logic Devices Databook
GAL20V8A-20	Programmable Logic Devices Databook
GAL39V18	Programmable Logic Devices Databook
GENIX V.3 Operating System	Series 32000 Microprocessors Databook
HPC16003	Datacommunications/LAN/UART Handbook
HPC16003	Microcontrollers Databook
HPC16083	Microcontrollers Databook
HPC16083	Datacommunications/LAN/UART Handbook
HPC16104	Microcontrollers Databook
HPC16164	Microcontrollers Databook
HPC16400	Microcontrollers Databook
HPC16400	Datacommunications/LAN/UART Handbook
HPC16900	Microcontrollers Databook
HPC26003	Datacommunications/LAN/UART Handbook
HPC26003	Microcontrollers Databook
HPC26083	Datacommunications/LAN/UART Handbook
HPC26083	Microcontrollers Databook
HPC26104	Microcontrollers Databook
HPC26164	Microcontrollers Databook
HPC26900	Microcontrollers Databook
HPC36003	Microcontrollers Databook
HPC36003	Datacommunications/LAN/UART Handbook
HPC36083	Datacommunications/LAN/UART Handbook
HPC36083	Microcontrollers Databook
HPC36104	Microcontrollers Databook
HPC36164	Microcontrollers Databook
HPC36400	Microcontrollers Databook
HPC36400	Datacommunications/LAN/UART Handbook
HPC36900	Microcontrollers Databook
HPC46003	Microcontrollers Databook
HPC46003	Datacommunications/LAN/UART Handbook
HPC46083	Datacommunications/LAN/UART Handbook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
HPC46083	Microcontrollers Databook
HPC46083MH	Stand Alone Datasheet
HPC46104	Microcontrollers Databook
HPC46164	Microcontrollers Databook
HPC46400	Microcontrollers Databook
HPC46400	Datacommunications/LAN/UART Handbook
HPC46900	Microcontrollers Databook
HS7067	Linear 1 Databook
HS7107	Linear 1 Databook
HS9151	Linear 1 Databook
INS82C50A	Datacommunications/LAN/UART Handbook
INS8250	Datacommunications/LAN/UART Handbook
INS8250-B	Datacommunications/LAN/UART Handbook
INS8250A	Datacommunications/LAN/UART Handbook
IRF510	Discrete Databook
IRF511	Discrete Databook
IRF512	Discrete Databook
IRF513	Discrete Databook
IRF520	Discrete Databook
IRF520	Discrete Databook
IRF521	Discrete Databook
IRF522	Discrete Databook
IRF523	Discrete Databook
IRF530	Discrete Databook
IRF530	Discrete Databook
IRF531	Discrete Databook
IRF532	Discrete Databook
IRF533	Discrete Databook
IRF540	Discrete Databook
IRF540	Discrete Databook
IRF541	Discrete Databook
IRF542	Discrete Databook
IRF543	Discrete Databook
IRF610	Discrete Databook
IRF611	Discrete Databook
IRF612	Discrete Databook
IRF613	Discrete Databook
IRF620	Discrete Databook
IRF620	Discrete Databook
IRF621	Discrete Databook
IRF622	Discrete Databook
IRF623	Discrete Databook
IRF630	Discrete Databook
IRF630	Discrete Databook
IRF631	Discrete Databook
IRF632	Discrete Databook
IRF633	Discrete Databook
IRF640	Discrete Databook
IRF640	Discrete Databook
IRF641	Discrete Databook
IRF642	Discrete Databook
IRF710	Discrete Databook
IRF711	Discrete Databook
IRF712	Discrete Databook
IRF713	Discrete Databook
IRF720	Discrete Databook
IRF720	Discrete Databook
IRF721	Discrete Databook
IRF722	Discrete Databook
IRF723	Discrete Databook
IRF730	Discrete Databook
IRF730	Discrete Databook
IRF731	Discrete Databook
IRF732	Discrete Databook
IRF733	Discrete Databook
IRF740	Discrete Databook
IRF740	Discrete Databook
IRF741	Discrete Databook
IRF742	Discrete Databook
IRF743	Discrete Databook
IRF820	Discrete Databook
IRF820	Discrete Databook
IRF821	Discrete Databook
IRF822	Discrete Databook
IRF823	Discrete Databook
IRF830	Discrete Databook
IRF830	Discrete Databook
IRF831	Discrete Databook

Device Number	Publication
IRF832	Discrete Databook
IRF833	Discrete Databook
IRF840	Discrete Databook
IRF840	Discrete Databook
IRF841	Discrete Databook
IRF842	Discrete Databook
IRF843	Discrete Databook
IRFP140	Discrete Databook
IRFP140CF	Discrete Databook
IRFP141	Discrete Databook
IRFP141CF	Discrete Databook
IRFP150	Discrete Databook
IRFP150CF	Discrete Databook
IRFP151	Discrete Databook
IRFP151CF	Discrete Databook
IRFP240	Discrete Databook
IRFP240CF	Discrete Databook
IRFP241	Discrete Databook
IRFP241CF	Discrete Databook
IRFP250	Discrete Databook
IRFP250CF	Discrete Databook
IRFP251	Discrete Databook
IRFP251CF	Discrete Databook
IRFP340	Discrete Databook
IRFP340CF	Discrete Databook
IRFP341	Discrete Databook
IRFP341CF	Discrete Databook
IRFP350	Discrete Databook
IRFP350CF	Discrete Databook
IRFP351	Discrete Databook
IRFP351CF	Discrete Databook
IRFP440	Discrete Databook
IRFP440CF	Discrete Databook
IRFP441	Discrete Databook
IRFP441CF	Discrete Databook
IRFP450	Discrete Databook
IRFP450CF	Discrete Databook
IRFP451	Discrete Databook
IRFP451CF	Discrete Databook
ISDN	Datacommunications/LAN/UART Handbook
ISDN	Stand Alone Datasheet
J105	Discrete Databook
J106	Discrete Databook
J107	Discrete Databook
J108	Discrete Databook
J109	Discrete Databook
J110	Discrete Databook
J111	Discrete Databook
J112	Discrete Databook
J113	Discrete Databook
J114	Discrete Databook
J174	Discrete Databook
J175	Discrete Databook
J176	Discrete Databook
J177	Discrete Databook
J201	Discrete Databook
J202	Discrete Databook
J203	Discrete Databook
J210	Discrete Databook
J211	Discrete Databook
J212	Discrete Databook
J270	Discrete Databook
J271	Discrete Databook
J300	Discrete Databook
J304	Discrete Databook
J305	Discrete Databook
J308	Discrete Databook
J309	Discrete Databook
J310	Discrete Databook
J401	Discrete Databook
J402	Discrete Databook
J403	Discrete Databook
J404	Discrete Databook
J405	Discrete Databook
J406	Discrete Databook
J410	Discrete Databook
J411	Discrete Databook
J412	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
LF111	Linear 1 Databook
LF147	Linear 1 Databook
LF155	Linear 1 Databook
LF155	Linear 1 Databook
LF156	Linear 1 Databook
LF156	Linear 1 Databook
LF157	Linear 1 Databook
LF157	Linear 1 Databook
LF198	Linear 2 Databook
LF198A	Linear 2 Databook
LF211	Linear 1 Databook
LF255	Linear 1 Databook
LF256	Linear 1 Databook
LF257	Linear 1 Databook
LF298	Linear 2 Databook
LF311	Linear 1 Databook
LF347	Linear 1 Databook
LF347A	Linear 1 Databook
LF351	Linear 1 Databook
LF353	Linear 1 Databook
LF355	Linear 1 Databook
LF356	Linear 1 Databook
LF357	Linear 1 Databook
LF398A	Linear 2 Databook
LF400A	Stand Alone Datasheet
LF400C	Linear 1 Databook
LF401	Linear 1 Databook
LF411	Linear 1 Databook
LF412	Linear 1 Databook
LF441	Linear 1 Databook
LF442	Linear 1 Databook
LF444	Linear 1 Databook
LF451	Stand Alone Datasheet
LF453	Stand Alone Datasheet
LF455	Linear 1 Databook
LF456	Linear 1 Databook
LF457	Linear 1 Databook
LF1333	Linear 2 Databook
LF11201	Linear 2 Databook
LF11202	Linear 2 Databook
LF11331	Linear 2 Databook
LF11332	Linear 2 Databook
LF13006	Linear 2 Databook
LF13007	Linear 2 Databook
LF13201	Linear 2 Databook
LF13202	Linear 2 Databook
LF13331	Linear 2 Databook
LF13333	Linear 2 Databook
LF13508	Linear 2 Databook
LF13509	Linear 2 Databook
LF13741	Linear 1 Databook
LH0002	Linear 1 Databook
LH0003	Linear 1 Databook
LH0003	Stand Alone Datasheet
LH0004	Linear 1 Databook
LH0020	Linear 1 Databook
LH0021	Linear 1 Databook
LH0022	Linear 1 Databook
LH0023	Linear 2 Databook
LH0023C	Linear 2 Databook
LH0024	Linear 1 Databook
LH0032	Linear 1 Databook
LH0033	Linear 1 Databook
LH0036	Linear 1 Databook
LH0038	Linear 1 Databook
LH0041	Linear 1 Databook
LH0042	Linear 1 Databook
LH0043	Linear 2 Databook
LH0043C	Linear 2 Databook
LH0044	Linear 1 Databook
LH0045	Linear 1 Databook
LH0052	Linear 1 Databook
LH0053	Linear 2 Databook
LH0053C	Linear 2 Databook
LH0061	Linear 1 Databook
LH0062	Linear 1 Databook
LH0070	Linear 2 Databook
LH0071	Linear 2 Databook

Device Number	Publication
LH0075	Linear 1 Databook
LH0076	Linear 1 Databook
LH0082	Linear 1 Databook
LH0084	Linear 1 Databook
LH0086	Linear 1 Databook
LH0091	Linear 2 Databook
LH0094	Linear 2 Databook
LH0101	Linear 1 Databook
LH2101A	Stand Alone Datasheet
LH2108	Stand Alone Datasheet
LH2110	Stand Alone Datasheet
LH2111	Stand Alone Datasheet
LH2422	Stand Alone Datasheet
LH4001	Linear 1 Databook
LH4002	Linear 1 Databook
LH4003	Linear 1 Databook
LH4004	Linear 1 Databook
LH4006	Linear 1 Databook
LH4008	Stand Alone Datasheet
LH4009	Stand Alone Datasheet
LH4010	Stand Alone Datasheet
LH4011	Stand Alone Datasheet
LH4012	Stand Alone Datasheet
LH4033C	Stand Alone Datasheet
LH4101	Linear 1 Databook
LH4101C	Linear 1 Databook
LH4104	Linear 1 Databook
LH4105	Linear 1 Databook
LH4106	Stand Alone Datasheet
LH4117	Stand Alone Datasheet
LH4118	Stand Alone Datasheet
LH4124C	Stand Alone Datasheet
LH4141C	Stand Alone Datasheet
LH4161A	Stand Alone Datasheet
LH4162A	Stand Alone Datasheet
LH4200	Stand Alone Datasheet
LH4266	Stand Alone Datasheet
LH4860	Stand Alone Datasheet
LH7001	Stand Alone Datasheet
LM10	Linear 1 Databook
LM11	Linear 1 Databook
LM12(L)	Linear 1 Databook
LM34	Linear 2 Databook
LM34A	Linear 2 Databook
LM34C	Linear 2 Databook
LM34CA	Linear 2 Databook
LM34D	Linear 2 Databook
LM35	Linear 2 Databook
LM35A	Linear 2 Databook
LM35C	Linear 2 Databook
LM35CA	Linear 2 Databook
LM35D	Linear 2 Databook
LM78LXX	Linear 1 Databook
LM78XX	Linear 1 Databook
LM79LXXAC	Linear 1 Databook
LM79XX	Linear 1 Databook
LM101A	Linear 1 Databook
LM102	Linear 1 Databook
LM103	Linear 2 Databook
LM104	Linear 1 Databook
LM105	Linear 1 Databook
LM106	Linear 1 Databook
LM107	Linear 1 Databook
LM108	Linear 1 Databook
LM108A	Linear 1 Databook
LM109	Linear 1 Databook
LM110	Linear 1 Databook
LM111	Linear 1 Databook
LM112	Linear 1 Databook
LM113	Linear 2 Databook
LM117	Linear 1 Databook
LM117HV	Linear 1 Databook
LM118	Linear 1 Databook
LM119	Linear 1 Databook
LM120	Linear 1 Databook
LM122	Linear 3 Databook
LM123	Linear 1 Databook
LM124	Linear 1 Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
LM125	Linear 1 Databook
LM126	Linear 1 Databook
LM129	Linear 2 Databook
LM131	Linear 2 Databook
LM131A	Linear 2 Databook
LM133	Linear 1 Databook
LM134	Linear 2 Databook
LM135	Linear 2 Databook
LM135A	Linear 2 Databook
LM136-2.5V	Linear 2 Databook
LM136-5.0V	Linear 2 Databook
LM137	Linear 1 Databook
LM137HV	Linear 1 Databook
LM138	Linear 1 Databook
LM139	Linear 1 Databook
LM140	Linear 1 Databook
LM140L	Linear 1 Databook
LM143	Linear 1 Databook
LM144	Linear 1 Databook
LM145	Linear 1 Databook
LM146	Linear 1 Databook
LM148	Linear 1 Databook
LM149	Linear 1 Databook
LM150	Linear 1 Databook
LM158	Linear 1 Databook
LM160	Linear 1 Databook
LM161	Linear 1 Databook
LM168	Linear 2 Databook
LM169	Linear 2 Databook
LM185	Linear 2 Databook
LM185-1.2	Linear 2 Databook
LM185-2.5	Linear 2 Databook
LM192	Linear 1 Databook
LM193	Linear 1 Databook
LM194	Linear 3 Databook
LM195	Linear 3 Databook
LM196	Linear 1 Databook
LM199	Linear 2 Databook
LM201A	Linear 1 Databook
LM204	Linear 1 Databook
LM205	Linear 1 Databook
LM206	Linear 1 Databook
LM207	Linear 1 Databook
LM208	Linear 1 Databook
LM208A	Linear 1 Databook
LM210	Linear 1 Databook
LM211	Linear 1 Databook
LM212	Linear 1 Databook
LM218	Linear 1 Databook
LM219	Linear 1 Databook
LM221	Linear 1 Databook
LM224	Linear 1 Databook
LM231	Linear 2 Databook
LM231A	Linear 2 Databook
LM234	Linear 2 Databook
LM235	Linear 2 Databook
LM235A	Linear 2 Databook
LM236-2.5V	Linear 2 Databook
LM236-5.0V	Linear 2 Databook
LM239	Linear 1 Databook
LM246	Linear 1 Databook
LM248	Linear 1 Databook
LM249	Linear 1 Databook
LM258	Linear 1 Databook
LM260	Linear 1 Databook
LM261	Linear 1 Databook
LM268	Linear 2 Databook
LM285	Linear 2 Databook
LM285-1.2	Linear 2 Databook
LM285-2.5	Linear 2 Databook
LM292	Linear 1 Databook
LM293	Linear 1 Databook
LM295	Linear 3 Databook
LM299	Linear 2 Databook
LM301A	Linear 1 Databook
LM302	Linear 1 Databook
LM304	Linear 1 Databook
LM305	Linear 1 Databook

Device Number	Publication
LM305A	Linear 1 Databook
LM306	Linear 1 Databook
LM307	Linear 1 Databook
LM308	Linear 1 Databook
LM308A	Linear 1 Databook
LM309	Linear 1 Databook
LM310	Linear 1 Databook
LM311	Linear 1 Databook
LM312	Linear 1 Databook
LM313	Linear 2 Databook
LM317	Linear 1 Databook
LM317HV	Linear 1 Databook
LM317L	Linear 1 Databook
LM318	Linear 1 Databook
LM319	Linear 1 Databook
LM320	Linear 1 Databook
LM320L	Linear 1 Databook
LM321	Linear 1 Databook
LM322	Linear 3 Databook
LM324	Linear 1 Databook
LM325	Linear 1 Databook
LM326	Linear 1 Databook
LM329	Linear 2 Databook
LM330	Linear 1 Databook
LM331	Linear 2 Databook
LM331A	Linear 2 Databook
LM333	Linear 1 Databook
LM334	Linear 2 Databook
LM335	Linear 2 Databook
LM335A	Linear 2 Databook
LM336-2.5V	Linear 2 Databook
LM336-5.0V	Linear 2 Databook
LM337	Linear 1 Databook
LM337HV	Linear 1 Databook
LM337L	Linear 1 Databook
LM338	Linear 1 Databook
LM339	Linear 1 Databook
LM340	Linear 1 Databook
LM340L	Linear 1 Databook
LM343	Linear 1 Databook
LM344	Linear 1 Databook
LM345	Linear 1 Databook
LM346	Linear 1 Databook
LM348	Linear 1 Databook
LM349	Linear 1 Databook
LM350	Linear 1 Databook
LM358	Linear 1 Databook
LM359	Linear 1 Databook
LM360	Linear 1 Databook
LM361	Linear 1 Databook
LM363	Linear 1 Databook
LM368	Linear 2 Databook
LM368-2.5	Linear 2 Databook
LM369	Linear 2 Databook
LM376	Linear 1 Databook
LM377	Linear 3 Databook
LM378	Linear 3 Databook
LM380	Linear 3 Databook
LM381	Linear 3 Databook
LM382	Linear 3 Databook
LM383	Linear 3 Databook
LM384	Linear 3 Databook
LM385	Linear 2 Databook
LM385-1.2	Linear 2 Databook
LM385-2.5	Linear 2 Databook
LM386	Linear 3 Databook
LM387	Linear 3 Databook
LM388	Linear 3 Databook
LM389	Linear 3 Databook
LM390	Linear 3 Databook
LM391	Linear 3 Databook
LM392	Linear 1 Databook
LM393	Linear 1 Databook
LM394	Linear 3 Databook
LM395	Linear 3 Databook
LM396	Linear 1 Databook
LM399	Linear 2 Databook
LM555	Linear 3 Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
LM555C	Linear 3 Databook
LM556	Linear 3 Databook
LM556C	Linear 3 Databook
LM565	Linear 3 Databook
LM565C	Linear 3 Databook
LM566C	Linear 3 Databook
LM567	Linear 3 Databook
LM567C	Linear 3 Databook
LM581	Linear 2 Databook
LM592	Linear 3 Databook
LM604	Linear 1 Databook
LM607	Linear 1 Databook
LM611	Linear 1 Databook
LM614	Linear 1 Databook
LM621	Linear 3 Databook
LM622	Linear 3 Databook
LM627	Stand Alone Datasheet
LM628	Linear 3 Databook
LM675	Linear 1 Databook
LM723	Linear 1 Databook
LM733	Linear 3 Databook
LM733C	Linear 3 Databook
LM741	Linear 1 Databook
LM831	Linear 3 Databook
LM832	Linear 3 Databook
LM833	Linear 1 Databook
LM837	Linear 1 Databook
LM903	Linear 3 Databook
LM1035	Linear 3 Databook
LM1036	Linear 3 Databook
LM1037	Linear 3 Databook
LM1038	Linear 3 Databook
LM1040	Linear 3 Databook
LM1042	Linear 3 Databook
LM1044	Linear 3 Databook
LM1112A	Linear 3 Databook
LM1131A	Linear 3 Databook
LM1141	Linear 3 Databook
LM1201	Linear 3 Databook
LM1203	Linear 3 Databook
LM1211	Linear 3 Databook
LM1391	Linear 3 Databook
LM1458	Linear 1 Databook
LM1496	Linear 3 Databook
LM1558	Linear 1 Databook
LM1578	Linear 1 Databook
LM1596	Linear 3 Databook
LM1800	Linear 3 Databook
LM1801	Linear 3 Databook
LM1812	Linear 3 Databook
LM1815	Linear 3 Databook
LM1818	Linear 3 Databook
LM1819	Linear 3 Databook
LM1823	Linear 3 Databook
LM1830	Linear 3 Databook
LM1837	Linear 3 Databook
LM1851	Linear 3 Databook
LM1863	Linear 3 Databook
LM1865	Linear 3 Databook
LM1866	Linear 3 Databook
LM1868	Linear 3 Databook
LM1870	Linear 3 Databook
LM1871	Linear 3 Databook
LM1872	Linear 3 Databook
LM1875	Linear 3 Databook
LM1877	Linear 3 Databook
LM1880	Linear 3 Databook
LM1881	Linear 3 Databook
LM1884	Linear 3 Databook
LM1886	Linear 3 Databook
LM1889	Linear 3 Databook
LM1893	Linear 3 Databook
LM1894	Linear 3 Databook
LM1895	Linear 3 Databook
LM1896	Linear 3 Databook
LM1897	Linear 3 Databook
LM1921	Linear 3 Databook
LM1946	Linear 3 Databook

Device Number	Publication
LM1949	Linear 3 Databook
LM1951	Linear 3 Databook
LM1964	Linear 3 Databook
LM1965	Linear 3 Databook
LM2002	Linear 3 Databook
LM2005	Linear 3 Databook
LM2065	Linear 3 Databook
LM2578	Linear 1 Databook
LM2877	Linear 3 Databook
LM2878	Linear 3 Databook
LM2879	Linear 3 Databook
LM2889	Linear 3 Databook
LM2893	Linear 3 Databook
LM2900	Linear 1 Databook
LM2901	Linear 1 Databook
LM2902	Linear 1 Databook
LM2903	Linear 1 Databook
LM2904	Linear 1 Databook
LM2905	Linear 3 Databook
LM2907	Linear 3 Databook
LM2917	Linear 3 Databook
LM2924	Linear 1 Databook
LM2925	Linear 1 Databook
LM2930	Linear 1 Databook
LM2931	Linear 1 Databook
LM2935	Linear 1 Databook
LM2936	Stand Alone Datasheet
LM2940C	Linear 1 Databook
LM2941	Stand Alone Datasheet
LM2984C	Linear 1 Databook
LM3045	Linear 3 Databook
LM3046	Linear 3 Databook
LM3080	Linear 1 Databook
LM3080A	Linear 1 Databook
LM3086	Linear 3 Databook
LM3089	Linear 3 Databook
LM3146	Linear 3 Databook
LM3189	Linear 3 Databook
LM3301	Linear 1 Databook
LM3302	Linear 1 Databook
LM3361	Linear 3 Databook
LM3401	Linear 1 Databook
LM3578	Linear 1 Databook
LM3820	Linear 3 Databook
LM3900	Linear 1 Databook
LM3905	Linear 3 Databook
LM3909	Linear 3 Databook
LM3911	Linear 2 Databook
LM3914	Linear 3 Databook
LM3915	Linear 3 Databook
LM3916	Linear 3 Databook
LM3999	Linear 2 Databook
LM4250	Linear 1 Databook
LM4500A	Linear 3 Databook
LM6113	Linear 1 Databook
LM6121	Linear 1 Databook
LM6125	Linear 1 Databook
LM6161	Linear 1 Databook
LM6161/LM6261/LM6361	Linear 1 Databook
LM6164	Linear 1 Databook
LM6164/LM6264/LM6364	Linear 1 Databook
LM6165	Linear 1 Databook
LM6165/LM6265/LM6365	Linear 1 Databook
LM6214	Linear 1 Databook
LM6221	Linear 1 Databook
LM6225	Linear 1 Databook
LM6261	Linear 1 Databook
LM6264	Linear 1 Databook
LM6265	Linear 1 Databook
LM6314	Linear 1 Databook
LM6321	Linear 1 Databook
LM6325	Linear 1 Databook
LM6361	Linear 1 Databook
LM6364	Linear 1 Databook
LM6365	Linear 1 Databook
LM13080	Linear 1 Databook
LM13600	Linear 1 Databook
LM13700	Linear 1 Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
LM18272	Linear 1 Databook
LM18293	Linear 3 Databook
LM18298	Linear 3 Databook
LMC555	Linear 3 Databook
LMC567	Linear 3 Databook
LMC568	Linear 3 Databook
LMC660	Linear 1 Databook
LMC660AM	Stand Alone Datasheet
LMC668	Linear 1 Databook
LMC669	Linear 1 Databook
LMC835	Linear 3 Databook
LMC1992	Linear 3 Databook
LMC1993	Linear 3 Databook
LMC7660	Linear 1 Databook
LMC7669	Linear 1 Databook
LMF60	Linear 2 Databook
LMF90	Linear 2 Databook
LMF100	Linear 2 Databook
LMF120	Linear 2 Databook
LP124	Linear 1 Databook
LP165	Linear 1 Databook
LP311	Linear 1 Databook
LP324	Linear 1 Databook
LP339	Linear 1 Databook
LP365	Linear 1 Databook
LP2902	Linear 1 Databook
LP2950	Linear 1 Databook
LP2951	Linear 1 Databook
MB-18	CMOS Logic Databook
MF4	Linear 2 Databook
MF5	Linear 2 Databook
MF6	Linear 2 Databook
MF8	Linear 2 Databook
MF10	Linear 2 Databook
MM54C00/MM74C00	CMOS Logic Databook
MM54C02/MM74C02	CMOS Logic Databook
MM54C04/MM74C04	CMOS Logic Databook
MM54C08/MM74C08	CMOS Logic Databook
MM54C10/MM74C10	CMOS Logic Databook
MM54C14/MM74C14	CMOS Logic Databook
MM54C20/MM74C20	CMOS Logic Databook
MM54C30/MM74C30	CMOS Logic Databook
MM54C32/MM74C32	CMOS Logic Databook
MM54C42/MM74C42	CMOS Logic Databook
MM54C48/MM74C48	CMOS Logic Databook
MM54C73/MM74C73	CMOS Logic Databook
MM54C74/MM74C74	CMOS Logic Databook
MM54C76/MM74C76	CMOS Logic Databook
MM54C83/MM74C83	CMOS Logic Databook
MM54C85/MM74C85	CMOS Logic Databook
MM54C86/MM74C86	CMOS Logic Databook
MM54C89	Memory Databook
MM54C89/MM74C89	CMOS Logic Databook
MM54C90/MM74C90	CMOS Logic Databook
MM54C93/MM74C93	CMOS Logic Databook
MM54C95/MM74C95	CMOS Logic Databook
MM54C107/MM74C107	CMOS Logic Databook
MM54C150/MM74C150	CMOS Logic Databook
MM54C151/MM74C151	CMOS Logic Databook
MM54C154/MM74C154	CMOS Logic Databook
MM54C157/MM74C157	CMOS Logic Databook
MM54C160/MM74C160	CMOS Logic Databook
MM54C161/MM74C161	CMOS Logic Databook
MM54C162/MM74C162	CMOS Logic Databook
MM54C163/MM74C163	CMOS Logic Databook
MM54C164/MM74C164	CMOS Logic Databook
MM54C165/MM74C165	CMOS Logic Databook
MM54C173/MM74C173	CMOS Logic Databook
MM54C174/MM74C174	CMOS Logic Databook
MM54C175/MM74C175	CMOS Logic Databook
MM54C192/MM74C192	CMOS Logic Databook
MM54C193/MM74C193	CMOS Logic Databook
MM54C195/MM74C195	CMOS Logic Databook
MM54C200	Memory Databook
MM54C200/MM74C200	CMOS Logic Databook
MM54C221/MM74C221	CMOS Logic Databook
MM54C240/MM74C240	CMOS Logic Databook
MM54C244/MM74C244	CMOS Logic Databook

Device Number	Publication
MM54C373/MM74C373	CMOS Logic Databook
MM54C374/MM74C374	CMOS Logic Databook
MM54C901/MM74C901	CMOS Logic Databook
MM54C902/MM74C902	CMOS Logic Databook
MM54C903/MM74C903	CMOS Logic Databook
MM54C904/MM74C904	CMOS Logic Databook
MM54C905/MM74C905	CMOS Logic Databook
MM54C906/MM74C906	CMOS Logic Databook
MM54C907/MM74C907	CMOS Logic Databook
MM54C910	Memory Databook
MM54C910/MM74C910	CMOS Logic Databook
MM54C914/MM74C914	CMOS Logic Databook
MM54C915/MM74C915	CMOS Logic Databook
MM54C922/MM74C922	CMOS Logic Databook
MM54C923/MM74C923	CMOS Logic Databook
MM54C932/MM74C932	CMOS Logic Databook
MM54C941/MM74C941	CMOS Logic Databook
MM54C989	Memory Databook
MM54C989/MM74C989	CMOS Logic Databook
MM54C/MM74C	CMOS Logic Databook
MM54HC00/MM74HC00	CMOS Logic Databook
MM54HC02/MM74HC02	CMOS Logic Databook
MM54HC03/MM74HC03	CMOS Logic Databook
MM54HC04/MM74HC04	CMOS Logic Databook
MM54HC05/MM74HC05	CMOS Logic Databook
MM54HC08/MM74HC08	CMOS Logic Databook
MM54HC10/MM74HC10	CMOS Logic Databook
MM54HC11/MM74HC11	CMOS Logic Databook
MM54HC14/MM74HC14	CMOS Logic Databook
MM54HC20/MM74HC20	CMOS Logic Databook
MM54HC27/MM74HC27	CMOS Logic Databook
MM54HC30/MM74HC30	CMOS Logic Databook
MM54HC32/MM74HC32	CMOS Logic Databook
MM54HC34/MM74HC34	CMOS Logic Databook
MM54HC42/MM74HC42	CMOS Logic Databook
MM54HC51/MM74HC51	CMOS Logic Databook
MM54HC58/MM74HC58	CMOS Logic Databook
MM54HC73/MM74HC73	CMOS Logic Databook
MM54HC74A/MM74HC74A	CMOS Logic Databook
MM54HC75/MM74HC75	CMOS Logic Databook
MM54HC76/MM74HC76	CMOS Logic Databook
MM54HC85/MM74HC85	CMOS Logic Databook
MM54HC86/MM74HC86	CMOS Logic Databook
MM54HC107/MMHC107	CMOS Logic Databook
MM54HC109A/MM74HC109A	CMOS Logic Databook
MM54HC112/MM74HC112	CMOS Logic Databook
MM54HC113/MM74HC113	CMOS Logic Databook
MM54HC123A/MM74HC123A	CMOS Logic Databook
MM54HC125/MM74HC125	CMOS Logic Databook
MM54HC126/MM74HC126	CMOS Logic Databook
MM54HC132/MM74HC132	CMOS Logic Databook
MM54HC133/MM74HC133	CMOS Logic Databook
MM54HC137/MM74HC137	CMOS Logic Databook
MM54HC138/MM74HC138	CMOS Logic Databook
MM54HC139/MM74HC139	CMOS Logic Databook
MM54HC147/MM74HC147	CMOS Logic Databook
MM54HC148/MM74HC148	CMOS Logic Databook
MM54HC149/MM74HC149	CMOS Logic Databook
MM54HC151/MM74HC151	CMOS Logic Databook
MM54HC153/MM74HC153	CMOS Logic Databook
MM54HC154/MM74HC154	CMOS Logic Databook
MM54HC155/MM74HC155	CMOS Logic Databook
MM54HC157/MM74HC157	CMOS Logic Databook
MM54HC158/MM74HC158	CMOS Logic Databook
MM54HC160/MM74HC160	CMOS Logic Databook
MM54HC161/MM74HC161	CMOS Logic Databook
MM54HC162/MM74HC162	CMOS Logic Databook
MM54HC163/MM74HC163	CMOS Logic Databook
MM54HC164/MM74HC164	CMOS Logic Databook
MM54HC165/MM74HC165	CMOS Logic Databook
MM54HC166/MM74HC166	CMOS Logic Databook
MM54HC173/MM74HC173	CMOS Logic Databook
MM54HC174/MM74HC174	CMOS Logic Databook
MM54HC175/MM74HC175	CMOS Logic Databook
MM54HC181/MM74HC181	CMOS Logic Databook
MM54HC182/MM74HC182	CMOS Logic Databook
MM54HC190/MM74HC190	CMOS Logic Databook
MM54HC191/MM74HC191	CMOS Logic Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
MM54HC192/MM74HC192	CMOS Logic Databook
MM54HC193/MM74HC193	CMOS Logic Databook
MM54HC194/MM74HC194	CMOS Logic Databook
MM54HC195/MM74HC195	CMOS Logic Databook
MM54HC221A/MM74HC221A	CMOS Logic Databook
MM54HC237/MM74HC237	CMOS Logic Databook
MM54HC240/MM74HC240	CMOS Logic Databook
MM54HC241/MM74HC241	CMOS Logic Databook
MM54HC242/MM74HC242	CMOS Logic Databook
MM54HC243/MM74HC243	CMOS Logic Databook
MM54HC244/MM74HC244	CMOS Logic Databook
MM54HC245A/MM74HC245A	CMOS Logic Databook
MM54HC251/MM74HC251	CMOS Logic Databook
MM54HC253/MM74HC253	CMOS Logic Databook
MM54HC257/MM74HC257	CMOS Logic Databook
MM54HC258/MM74HC258	CMOS Logic Databook
MM54HC259/MM74HC259	CMOS Logic Databook
MM54HC266A/MM74HC266A	CMOS Logic Databook
MM54HC273/MM74HC273	CMOS Logic Databook
MM54HC280/MM74HC280	CMOS Logic Databook
MM54HC283/MM74HC283	CMOS Logic Databook
MM54HC298/MM74HC298	CMOS Logic Databook
MM54HC299/MM74HC299	CMOS Logic Databook
MM54HC354/MM74HC354	CMOS Logic Databook
MM54HC356/MM74HC356	CMOS Logic Databook
MM54HC365/MM74HC365	CMOS Logic Databook
MM54HC366/MM74HC366	CMOS Logic Databook
MM54HC367/MM74HC367	CMOS Logic Databook
MM54HC368/MM74HC368	CMOS Logic Databook
MM54HC373/MM74HC373	CMOS Logic Databook
MM54HC374/MM74HC374	CMOS Logic Databook
MM54HC390/MM74HC390	CMOS Logic Databook
MM54HC393/MM74HC393	CMOS Logic Databook
MM54HC423A/MM74HC423A	CMOS Logic Databook
MM54HC521/MM74HC521	CMOS Logic Databook
MM54HC533/MM74HC533	CMOS Logic Databook
MM54HC534/MM74HC534	CMOS Logic Databook
MM54HC540/MM74HC540	CMOS Logic Databook
MM54HC541/MM74HC541	CMOS Logic Databook
MM54HC563/MM74HC563	CMOS Logic Databook
MM54HC564/MM74HC564	CMOS Logic Databook
MM54HC573/MM74HC573	CMOS Logic Databook
MM54HC574/MM74HC574	CMOS Logic Databook
MM54HC589/MM74HC589	CMOS Logic Databook
MM54HC595/MM74HC595	CMOS Logic Databook
MM54HC597/MM74HC597	CMOS Logic Databook
MM54HC620/MM74HC620	CMOS Logic Databook
MM54HC623/MM74HC623	CMOS Logic Databook
MM54HC640/MM74HC640	CMOS Logic Databook
MM54HC643/MM74HC643	CMOS Logic Databook
MM54HC646/MM74HC646	CMOS Logic Databook
MM54HC648/MM74HC648	CMOS Logic Databook
MM54HC688/MM74HC688	CMOS Logic Databook
MM54HC4002/MM74HC4002	CMOS Logic Databook
MM54HC4016	Linear 2 Databook
MM54HC4016/MM74HC4016	CMOS Logic Databook
MM54HC4017/MM74HC4017	CMOS Logic Databook
MM54HC4020/MM74HC4020	CMOS Logic Databook
MM54HC4040/MM74HC4040	CMOS Logic Databook
MM54HC4046/MM74HC4046	CMOS Logic Databook
MM54HC4049/MM74HC4049	CMOS Logic Databook
MM54HC4050/MM74HC4050	CMOS Logic Databook
MM54HC4051	Linear 2 Databook
MM54HC4051/MM74HC4051	CMOS Logic Databook
MM54HC4052	Linear 2 Databook
MM54HC4052/MM74HC4052	CMOS Logic Databook
MM54HC4053	Linear 2 Databook
MM54HC4053/MM74HC4053	CMOS Logic Databook
MM54HC4060/MM74HC4060	CMOS Logic Databook
MM54HC4066	Linear 2 Databook
MM54HC4066/MM74HC4066	CMOS Logic Databook
MM54HC4075/MM74HC4075	CMOS Logic Databook
MM54HC4078/MM74HC4078	CMOS Logic Databook
MM54HC4316	Linear 2 Databook
MM54HC4316/MM74HC4316	CMOS Logic Databook
MM54HC4511/MM74HC4511	CMOS Logic Databook
MM54HC4514/MM74HC4514	CMOS Logic Databook
MM54HC4538/MM74HC4538	CMOS Logic Databook
MM54HC4543/MM74HC4543	CMOS Logic Databook
MM54HC7266/MM74HC7266	CMOS Logic Databook
MM54HC/MM74HC	CMOS Logic Databook
MM54HCT00/MM74HCT00	CMOS Logic Databook
MM54HCT03/MM74HCT03	CMOS Logic Databook
MM54HCT04/MM74HCT04	CMOS Logic Databook
MM54HCT05/MM74HCT05	CMOS Logic Databook
MM54HCT08/MM74HCT08	CMOS Logic Databook
MM54HCT32/MM74HCT32	CMOS Logic Databook
MM54HCT34/MM74HCT34	CMOS Logic Databook
MM54HCT74/MM74HCT74	CMOS Logic Databook
MM54HCT76/MM74HCT76	CMOS Logic Databook
MM54HCT109/MM74HCT109	CMOS Logic Databook
MM54HCT112/MM74HCT112	CMOS Logic Databook
MM54HCT138/MM74HCT138	CMOS Logic Databook
MM54HCT139/MM74HCT139	CMOS Logic Databook
MM54HCT147/MM74HCT147	CMOS Logic Databook
MM54HCT148/MM74HCT148	CMOS Logic Databook
MM54HCT149/MM74HCT149	CMOS Logic Databook
MM54HCT151/MM74HCT151	CMOS Logic Databook
MM54HCT153/MM74HCT153	CMOS Logic Databook
MM54HCT155/MM74HCT155	CMOS Logic Databook
MM54HCT157/MM74HCT157	CMOS Logic Databook
MM54HCT158/MM74HCT158	CMOS Logic Databook
MM54HCT164/MM74HCT164	CMOS Logic Databook
MM54HCT166/MM74HCT166	CMOS Logic Databook
MM54HCT190/MM74HCT190	CMOS Logic Databook
MM54HCT191/MM74HCT191	CMOS Logic Databook
MM54HCT192/MM74HCT192	CMOS Logic Databook
MM54HCT193/MM74HCT193	CMOS Logic Databook
MM54HCT240/MM74HCT240	CMOS Logic Databook
MM54HCT241/MM74HCT241	CMOS Logic Databook
MM54HCT244/MM74HCT244	CMOS Logic Databook
MM54HCT245/MM74HCT245	CMOS Logic Databook
MM54HCT251/MM74HCT251	CMOS Logic Databook
MM54HCT253/MM74HCT253	CMOS Logic Databook
MM54HCT257/MM74HCT257	CMOS Logic Databook
MM54HCT258/MM74HCT258	CMOS Logic Databook
MM54HCT273/MM74HCT273	CMOS Logic Databook
MM54HCT373/MM74HCT373	CMOS Logic Databook
MM54HCT374/MM74HCT374	CMOS Logic Databook
MM54HCT521/MM74HCT521	CMOS Logic Databook
MM54HCT533/MM74HCT533	CMOS Logic Databook
MM54HCT534/MM74HCT534	CMOS Logic Databook
MM54HCT540/MM74HCT540	CMOS Logic Databook
MM54HCT541/MM74HCT541	CMOS Logic Databook
MM54HCT640/MM74HCT640	CMOS Logic Databook
MM54HCT643/MM74HCT643	CMOS Logic Databook
MM54HCT688/MM74HCT688	CMOS Logic Databook
MM54HCT/MM74HCT	CMOS Logic Databook
MM54HCU04/MM74HCU04	CMOS Logic Databook
MM70C95/MM80C95	CMOS Logic Databook
MM70C95/MM80C96	CMOS Logic Databook
MM70C97/MM80C97	CMOS Logic Databook
MM70C98/MM80C98	CMOS Logic Databook
MM72C19/MM82C190	CMOS Logic Databook
MM74C89	Memory Databook
MM74C200	Memory Databook
MM74C905	Linear 2 Databook
MM74C908	CMOS Logic Databook
MM74C910	Memory Databook
MM74C911	CMOS Logic Databook
MM74C912	CMOS Logic Databook
MM74C917	CMOS Logic Databook
MM74C918	CMOS Logic Databook
MM74C925	CMOS Logic Databook
MM74C926	CMOS Logic Databook
MM74C927	CMOS Logic Databook
MM74C928	CMOS Logic Databook
MM74C945	CMOS Logic Databook
MM74C946	CMOS Logic Databook
MM74C947	CMOS Logic Databook
MM74C956	CMOS Logic Databook
MM74C989	Memory Databook
MM74HC942	CMOS Logic Databook
MM74HC942	Datacommunications/LAN/UART Handbook
MM74HC943	CMOS Logic Databook
MM74HC943	Datacommunications/LAN/UART Handbook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
MM74HC4016	Linear 2 Databook
MM74HC4051	Linear 2 Databook
MM74HC4052	Linear 2 Databook
MM74HC4053	Linear 2 Databook
MM74HC4066	Linear 2 Databook
MM74HC4316	Linear 2 Databook
MM78C29	Interface Databook
MM78C29/MM88C29	CMOS Logic Databook
MM78C30	Interface Databook
MM78C30/MM88C30	CMOS Logic Databook
MM88C29	Interface Databook
MM88C30	Interface Databook
MM5450	Interface Databook
MM5451	Interface Databook
MM5452	Interface Databook
MM5453	Interface Databook
MM5480	Interface Databook
MM5481	Interface Databook
MM5483	Interface Databook
MM5484	Interface Databook
MM5486	Interface Databook
MM58201	Interface Databook
MM58241	Interface Databook
MM58242	Interface Databook
MM58248	Interface Databook
MM58341	Interface Databook
MM58342	Interface Databook
MM58348	Interface Databook
MMBF4391	Discrete Databook
MMBF4393	Discrete Databook
MMBF5911	Discrete Databook
MMBFJ113	Discrete Databook
MMBFJ174	Discrete Databook
MMBFJ175	Discrete Databook
MMBFJ176	Discrete Databook
MMBFJ177	Discrete Databook
MMBT100	Discrete Databook
MMBT100A	Discrete Databook
MMBT101	Discrete Databook
MMBT200	Discrete Databook
MMBT200A	Discrete Databook
MMBT201	Discrete Databook
MMBT706	Discrete Databook
MMBT706A	Discrete Databook
MMBT918	Discrete Databook
MMBT930	Discrete Databook
MMBT930A	Discrete Databook
MMBT2218	Discrete Databook
MMBT2218A	Discrete Databook
MMBT2219	Discrete Databook
MMBT2219A	Discrete Databook
MMBT2221	Discrete Databook
MMBT2221A	Discrete Databook
MMBT2222	Discrete Databook
MMBT2222A	Discrete Databook
MMBT2369	Discrete Databook
MMBT2369A	Discrete Databook
MMBT2484	Discrete Databook
MMBT2710	Discrete Databook
MMBT2904	Discrete Databook
MMBT2904A	Discrete Databook
MMBT2905	Discrete Databook
MMBT2905A	Discrete Databook
MMBT2906	Discrete Databook
MMBT2906A	Discrete Databook
MMBT2907	Discrete Databook
MMBT2907A	Discrete Databook
MMBT2924	Discrete Databook
MMBT3013	Discrete Databook
MMBT3014	Discrete Databook
MMBT3117	Discrete Databook
MMBT3251	Discrete Databook
MMBT3392	Discrete Databook
MMBT3393	Discrete Databook
MMBT3414	Discrete Databook
MMBT3415	Discrete Databook
MMBT3416	Discrete Databook
MMBT3417	Discrete Databook

Device Number	Publication
MMBT3467	Discrete Databook
MMBT3563	Discrete Databook
MMBT3565	Discrete Databook
MMBT3566	Discrete Databook
MMBT3567	Discrete Databook
MMBT3568	Discrete Databook
MMBT3569	Discrete Databook
MMBT3638	Discrete Databook
MMBT3638A	Discrete Databook
MMBT3639	Discrete Databook
MMBT3640	Discrete Databook
MMBT3641	Discrete Databook
MMBT3642	Discrete Databook
MMBT3643	Discrete Databook
MMBT3644	Discrete Databook
MMBT3645	Discrete Databook
MMBT3646	Discrete Databook
MMBT3693	Discrete Databook
MMBT3694	Discrete Databook
MMBT3700	Discrete Databook
MMBT3702	Discrete Databook
MMBT3703	Discrete Databook
MMBT3903	Discrete Databook
MMBT3904	Discrete Databook
MMBT3905	Discrete Databook
MMBT3906	Discrete Databook
MMBT3946	Discrete Databook
MMBT3962	Discrete Databook
MMBT4121	Discrete Databook
MMBT4122	Discrete Databook
MMBT4123	Discrete Databook
MMBT4124	Discrete Databook
MMBT4125	Discrete Databook
MMBT4126	Discrete Databook
MMBT4143	Discrete Databook
MMBT4248	Discrete Databook
MMBT4249	Discrete Databook
MMBT4250	Discrete Databook
MMBT4250A	Discrete Databook
MMBT4258	Discrete Databook
MMBT4274	Discrete Databook
MMBT4275	Discrete Databook
MMBT4291	Discrete Databook
MMBT4354	Discrete Databook
MMBT4355	Discrete Databook
MMBT4356	Discrete Databook
MMBT4400	Discrete Databook
MMBT4401	Discrete Databook
MMBT4402	Discrete Databook
MMBT4403	Discrete Databook
MMBT4409	Discrete Databook
MMBT4410	Discrete Databook
MMBT4888	Discrete Databook
MMBT4889	Discrete Databook
MMBT4916	Discrete Databook
MMBT4917	Discrete Databook
MMBT5086	Discrete Databook
MMBT5087	Discrete Databook
MMBT5088	Discrete Databook
MMBT5089	Discrete Databook
MMBT5128	Discrete Databook
MMBT5130	Discrete Databook
MMBT5133	Discrete Databook
MMBT5134	Discrete Databook
MMBT5135	Discrete Databook
MMBT5136	Discrete Databook
MMBT5137	Discrete Databook
MMBT5138	Discrete Databook
MMBT5139	Discrete Databook
MMBT5142	Discrete Databook
MMBT5143	Discrete Databook
MMBT5172	Discrete Databook
MMBT5179	Discrete Databook
MMBT5209	Discrete Databook
MMBT5210	Discrete Databook
MMBT5223	Discrete Databook
MMBT5224	Discrete Databook
MMBT5226	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
MMBT5227	Discrete Databook
MMBT5228	Discrete Databook
MMBT5400	Discrete Databook
MMBT5401	Discrete Databook
MMBT5447	Discrete Databook
MMBT5551	Discrete Databook
MMBT5571-2	Discrete Databook
MMBT5769	Discrete Databook
MMBT5771	Discrete Databook
MMBT5771-1	Discrete Databook
MMBT5772	Discrete Databook
MMBT5830	Discrete Databook
MMBT5831	Discrete Databook
MMBT5833	Discrete Databook
MMBT5855	Discrete Databook
MMBT5857	Discrete Databook
MMBT5910	Discrete Databook
MMBT5961	Discrete Databook
MMBT5962	Discrete Databook
MMBT5965	Discrete Databook
MMBT6426	Discrete Databook
MMBT6502	Discrete Databook
MMBT6514	Discrete Databook
MMBT6515	Discrete Databook
MMBT6518	Discrete Databook
MMBT6520	Discrete Databook
MMBT6521	Discrete Databook
MMBT6543	Discrete Databook
MMBT6560	Discrete Databook
MMBT6561	Discrete Databook
MMBT6562	Discrete Databook
MMBTA05	Discrete Databook
MMBTA06	Discrete Databook
MMBTA12	Discrete Databook
MMBTA13	Discrete Databook
MMBTA14	Discrete Databook
MMBTA20	Discrete Databook
MMBTA42	Discrete Databook
MMBTA43	Discrete Databook
MMBTA55	Discrete Databook
MMBTA56	Discrete Databook
MMBTA70	Discrete Databook
MMBTA92	Discrete Databook
MMBTA93	Discrete Databook
MMBTH10	Discrete Databook
MMBTH11	Discrete Databook
MMBTH20	Discrete Databook
MMBTH24	Discrete Databook
MMBTH30	Discrete Databook
MMBTH34	Discrete Databook
MMBTH81	Discrete Databook
MMBTL01	Discrete Databook
MMBTL51	Discrete Databook
MPAS92	Discrete Databook
MPF102	Discrete Databook
MPF103	Discrete Databook
MPF104	Discrete Databook
MPF105	Discrete Databook
MPF106	Discrete Databook
MPF107	Discrete Databook
MPF108	Discrete Databook
MPF109	Discrete Databook
MPF110	Discrete Databook
MPF111	Discrete Databook
MPF112	Discrete Databook
MPF256	Discrete Databook
MPF820	Discrete Databook
MPQ100	Discrete Databook
MPQ200	Discrete Databook
MPQ2222	Discrete Databook
MPQ2907	Discrete Databook
MPQ3467	Discrete Databook
MPQ3468	Discrete Databook
MPQ3724	Discrete Databook
MPQ3725	Discrete Databook
MPQ3904	Discrete Databook
MPQ3906	Discrete Databook
MPQ6426	Discrete Databook

Device Number	Publication
MPQ6700	Discrete Databook
MPQ6700	Discrete Databook
MPQ6700	Discrete Databook
MPQA13	Discrete Databook
MPQA63	Discrete Databook
MPS706	Discrete Databook
MPS706A	Discrete Databook
MPS834	Discrete Databook
MPS918	Discrete Databook
MPS2369	Discrete Databook
MPS2369A	Discrete Databook
MPS2711	Discrete Databook
MPS2712	Discrete Databook
MPS2713	Discrete Databook
MPS2714	Discrete Databook
MPS2716	Discrete Databook
MPS2923	Discrete Databook
MPS2924	Discrete Databook
MPS2925	Discrete Databook
MPS2926	Discrete Databook
MPS3392	Discrete Databook
MPS3393	Discrete Databook
MPS3394	Discrete Databook
MPS3395	Discrete Databook
MPS3396	Discrete Databook
MPS3397	Discrete Databook
MPS3398	Discrete Databook
MPS3563	Discrete Databook
MPS3638	Discrete Databook
MPS3638A	Discrete Databook
MPS3639	Discrete Databook
MPS3640	Discrete Databook
MPS3644	Discrete Databook
MPS3645	Discrete Databook
MPS3646	Discrete Databook
MPS3693	Discrete Databook
MPS3694	Discrete Databook
MPS3702	Discrete Databook
MPS3703	Discrete Databook
MPS3704	Discrete Databook
MPS3705	Discrete Databook
MPS3706	Discrete Databook
MPS3707	Discrete Databook
MPS3708	Discrete Databook
MPS3709	Discrete Databook
MPS3710	Discrete Databook
MPS3711	Discrete Databook
MPS3721	Discrete Databook
MPS3826	Discrete Databook
MPS3827	Discrete Databook
MPS3903	Discrete Databook
MPS3904	Discrete Databook
MPS3905	Discrete Databook
MPS3906	Discrete Databook
MPS4354	Discrete Databook
MPS4355	Discrete Databook
MPS4356	Discrete Databook
MPS5172	Discrete Databook
MPS5770	Discrete Databook
MPS6507	Discrete Databook
MPS6511	Discrete Databook
MPS6512	Discrete Databook
MPS6513	Discrete Databook
MPS6514	Discrete Databook
MPS6515	Discrete Databook
MPS6516	Discrete Databook
MPS6517	Discrete Databook
MPS6518	Discrete Databook
MPS6520	Discrete Databook
MPS6521	Discrete Databook
MPS6522	Discrete Databook
MPS6523	Discrete Databook
MPS6530	Discrete Databook
MPS6531	Discrete Databook
MPS6532	Discrete Databook
MPS6533	Discrete Databook
MPS6534	Discrete Databook
MPS6535	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
MPS6539	Discrete Databook
MPS6540	Discrete Databook
MPS6541	Discrete Databook
MPS6542	Discrete Databook
MPS6543	Discrete Databook
MPS6544	Discrete Databook
MPS6546	Discrete Databook
MPS6547	Discrete Databook
MPS6548	Discrete Databook
MPS6559	Discrete Databook
MPS6562	Discrete Databook
MPS6564	Discrete Databook
MPS6565	Discrete Databook
MPS6566	Discrete Databook
MPS6567	Discrete Databook
MPS6568A	Discrete Databook
MPS6569	Discrete Databook
MPS6570	Discrete Databook
MPS6571	Discrete Databook
MPS6573	Discrete Databook
MPS6574	Discrete Databook
MPS6575	Discrete Databook
MPS6576	Discrete Databook
MPS6715	Discrete Databook
MPS6717	Discrete Databook
MPS6724	Discrete Databook
MPS6725	Discrete Databook
MPS6727	Discrete Databook
MPS6733	Discrete Databook
MPS6734	Discrete Databook
MPS6735	Discrete Databook
MPS8098	Discrete Databook
MPS8099	Discrete Databook
MPSA05	Discrete Databook
MPSA06	Discrete Databook
MPSA09	Discrete Databook
MPSA10	Discrete Databook
MPSA12	Discrete Databook
MPSA13	Discrete Databook
MPSA14	Discrete Databook
MPSA18	Discrete Databook
MPSA20	Discrete Databook
MPSA42	Discrete Databook
MPSA42	Discrete Databook
MPSA43	Discrete Databook
MPSA55	Discrete Databook
MPSA56	Discrete Databook
MPSA62	Discrete Databook
MPSA63	Discrete Databook
MPSA65	Discrete Databook
MPSA66	Discrete Databook
MPSA70	Discrete Databook
MPSA93	Discrete Databook
MPSH10	Discrete Databook
MPSH11	Discrete Databook
MPSH19	Discrete Databook
MPSH20	Discrete Databook
MPSH24	Discrete Databook
MPSH30	Discrete Databook
MPSH31	Discrete Databook
MPSH34	Discrete Databook
MPSH37	Discrete Databook
MPSL01	Discrete Databook
MPSL51	Discrete Databook
MPSW01	Discrete Databook
MPSW06	Discrete Databook
MPSW10	Discrete Databook
MPSW13	Discrete Databook
MPSW42	Discrete Databook
MPSW43	Discrete Databook
MPSW45	Discrete Databook
MPSW45A	Discrete Databook
MPSW63	Discrete Databook
MPSW92	Discrete Databook
MRF501	Discrete Databook
MRF502	Discrete Databook
MTP2N18	Discrete Databook
MTP2N20	Discrete Databook

Device Number	Publication
MTP2N35	Discrete Databook
MTP2N40	Discrete Databook
MTP2N45	Discrete Databook
MTP2N50	Discrete Databook
MTP3N35	Discrete Databook
MTP3N40	Discrete Databook
MTP4N08	Discrete Databook
MTP4N10	Discrete Databook
MTP4N45	Discrete Databook
MTP4N50	Discrete Databook
MTP5N35	Discrete Databook
MTP5N40	Discrete Databook
MTP7N18	Discrete Databook
MTP7N20	Discrete Databook
MTP10N08	Discrete Databook
MTP10N10	Discrete Databook
MTP12N18	Discrete Databook
MTP12N20	Discrete Databook
MTP20N08	Discrete Databook
MTP20N10	Discrete Databook
NA11	Discrete Databook
NA12	Discrete Databook
NA31	Discrete Databook
NA32	Discrete Databook
NB111	Discrete Databook
NB121	Discrete Databook
NDF9406	Discrete Databook
NDF9407	Discrete Databook
NDF9408	Discrete Databook
NDF9409	Discrete Databook
NDF9410	Discrete Databook
NF5011	Discrete Databook
NF5011C	Discrete Databook
NF5012	Discrete Databook
NF5101	Discrete Databook
NF5102	Discrete Databook
NF5103	Discrete Databook
NF5301	Discrete Databook
NF5301-1	Discrete Databook
NF5301-2	Discrete Databook
NF5301-3	Discrete Databook
NM1600	Memory Databook
NM1601	Memory Databook
NM1620	Memory Databook
NM1621	Memory Databook
NM1624	Memory Databook
NM1625	Memory Databook
NM2109	Memory Databook
NM4490	Memory Databook
NM4494	Memory Databook
NM5100	Memory Databook
NM5104	Memory Databook
NM1002109	Memory Databook
NM100490	Memory Databook
NM100494	Memory Databook
NM100500	Memory Databook
NM100504	Memory Databook
NMC27C010	Memory Databook
NMC27C020	Memory Databook
NMC27C16	Memory Databook
NMC27C32	Memory Databook
NMC27C32B	Memory Databook
NMC27C49	Memory Databook
NMC27C51	Memory Databook
NMC27C53	Memory Databook
NMC27C64	Memory Databook
NMC27C64B	Memory Databook
NMC27C64BN	Memory Databook
NMC27C64N	Memory Databook
NMC27C128B	Memory Databook
NMC27C128BN	Memory Databook
NMC27C128C	Memory Databook
NMC27C256	Memory Databook
NMC27C256B	Memory Databook
NMC27C256BN	Memory Databook
NMC27C256C	Memory Databook
NMC27C512A	Memory Databook
NMC27C512AN	Memory Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
NMC27C1024	Memory Databook
NMC27C2048	Memory Databook
NMC27CP128	Memory Databook
NMC48F512	Memory Databook
NMC93C06	Memory Databook
NMC93C26	Memory Databook
NMC93C46	Memory Databook
NMC93C56	Memory Databook
NMC93C66	Memory Databook
NMC93CS06	Memory Databook
NMC93CS26	Memory Databook
NMC93CS46	Memory Databook
NMC93CS56	Memory Databook
NMC93CS66	Memory Databook
NMC98C10	Memory Databook
NMC98C20	Memory Databook
NMC98C40	Memory Databook
NMC2147H	Memory Databook
NMC2148H	Memory Databook
NMC9306	Memory Databook
NMC9307	Memory Databook
NMC9313B	Memory Databook
NMC9314B	Memory Databook
NMC9346	Memory Databook
NPD5584	Discrete Databook
NPD5585	Discrete Databook
NPD5586	Discrete Databook
NPD8301	Discrete Databook
NPD8302	Discrete Databook
NPD8303	Discrete Databook
NPD8304	Discrete Databook
NR421	Discrete Databook
NR431	Discrete Databook
NS16C450	Datacommunications/LAN/UART Handbook
NS32C016-10	Series 32000 Microprocessors Databook
NS32C032-10	Series 32000 Microprocessors Databook
NS32C201-10	Series 32000 Microprocessors Databook
NS32C201-15	Series 32000 Microprocessors Databook
NS32CG16-10	Series 32000 Microprocessors Databook
NS32CG16-15	Series 32000 Microprocessors Databook
NS32CG821	Stand Alone Datasheet
NS32GX32	Stand Alone Datasheet
NS405	Microcontrollers Databook
NS3903	Discrete Databook
NS3904	Discrete Databook
NS16450	Datacommunications/LAN/UART Handbook
NS16550A	Datacommunications/LAN/UART Handbook
NS16550A	Microcommunications Elements Databook
NS32008-10	Series 32000 Microprocessors Databook
NS32016-10	Series 32000 Microprocessors Databook
NS32032-10	Series 32000 Microprocessors Databook
NS32081-10	Series 32000 Microprocessors Databook
NS32082-10	Series 32000 Microprocessors Databook
NS32202-10	Series 32000 Microprocessors Databook
NS32203-10	Series 32000 Microprocessors Databook
NS32332-15	Series 32000 Microprocessors Databook
NS32381-15	Series 32000 Microprocessors Databook
NS32381-20	Series 32000 Microprocessors Databook
NS32382-15	Series 32000 Microprocessors Databook
NS32440	Datacommunications/LAN/UART Handbook
NS32441	Datacommunications/LAN/UART Handbook
NS32442	Datacommunications/LAN/UART Handbook
NS32443	Datacommunications/LAN/UART Handbook
NS32490C	Datacommunications/LAN/UART Handbook
NS32490C-1	Datacommunications/LAN/UART Handbook
NS324910	Datacommunications/LAN/UART Handbook
NS32491A	Datacommunications/LAN/UART Handbook
NS32492A	Datacommunications/LAN/UART Handbook
NS32532-20	Series 32000 Microprocessors Databook
NS32532-25	Series 32000 Microprocessors Databook
NS32532-30	Series 32000 Microprocessors Databook
NS32580-20	Series 32000 Microprocessors Databook
NS32580-25	Series 32000 Microprocessors Databook
NS32580-30	Series 32000 Microprocessors Databook
NS32817	DRAM Management Handbook
NS32818	DRAM Management Handbook
NS32819	DRAM Management Handbook
NS32819X	DRAM Management Handbook

Device Number	Publication
NS32828	DRAM Management Handbook
NS32829	DRAM Management Handbook
NSC800	Series 32000 Microprocessors Databook
NSC810A	Series 32000 Microprocessors Databook
NSC831	Series 32000 Microprocessors Databook
NSC858	Datacommunications/LAN/UART Handbook
NSC888	Series 32000 Microprocessors Databook
NSD36	Discrete Databook
NSD36A	Discrete Databook
NSD36B	Discrete Databook
NSD36C	Discrete Databook
NSD102	Discrete Databook
NSD103	Discrete Databook
NSD104	Discrete Databook
NSD105	Discrete Databook
NSD106	Discrete Databook
NSD131	Discrete Databook
NSD132	Discrete Databook
NSD133	Discrete Databook
NSD134	Discrete Databook
NSD135	Discrete Databook
NSD151	Discrete Databook
NSD152	Discrete Databook
NSD153	Discrete Databook
NSD154	Discrete Databook
NSD202	Discrete Databook
NSD203	Discrete Databook
NSD204	Discrete Databook
NSD205	Discrete Databook
NSD206	Discrete Databook
NSD457	Discrete Databook
NSD458	Discrete Databook
NSD459	Discrete Databook
NSD3429	Discrete Databook
NSD3440	Discrete Databook
NSD6178	Discrete Databook
NSD6179	Discrete Databook
NSD6180	Discrete Databook
NSD6181	Discrete Databook
NSDU01	Discrete Databook
NSDU01A	Discrete Databook
NSDU05	Discrete Databook
NSDU06	Discrete Databook
NSDU07	Discrete Databook
NSDU10	Discrete Databook
NSDU45	Discrete Databook
NSDU45A	Discrete Databook
NSDU51	Discrete Databook
NSDU51A	Discrete Databook
NSDU52	Discrete Databook
NSDU55	Discrete Databook
NSDU56	Discrete Databook
NSDU57	Discrete Databook
NSDU95	Discrete Databook
NSDU95A	Discrete Databook
NSE181	Discrete Databook
NSE457	Discrete Databook
NSE458	Discrete Databook
NSE459	Discrete Databook
P1086	Discrete Databook
P1087	Discrete Databook
PAL10H8	Programmable Logic Devices Databook
PAL10H8A	Programmable Logic Devices Databook
PAL10H8A2	Programmable Logic Devices Databook
PAL10L8	Programmable Logic Devices Databook
PAL10L8A	Programmable Logic Devices Databook
PAL10L8A2	Programmable Logic Devices Databook
PAL12H6	Programmable Logic Devices Databook
PAL12H6A	Programmable Logic Devices Databook
PAL12H6A2	Programmable Logic Devices Databook
PAL12L6	Programmable Logic Devices Databook
PAL12L6A	Programmable Logic Devices Databook
PAL12L6A2	Programmable Logic Devices Databook
PAL12L10	Programmable Logic Devices Databook
PAL12L10A	Programmable Logic Devices Databook
PAL14H4	Programmable Logic Devices Databook
PAL14H4A	Programmable Logic Devices Databook
PAL14H4A2	Programmable Logic Devices Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
PAL14L4	Programmable Logic Devices Databook
PAL14L4A	Programmable Logic Devices Databook
PAL14L4A2	Programmable Logic Devices Databook
PAL14L8	Programmable Logic Devices Databook
PAL14L8A	Programmable Logic Devices Databook
PAL16C1	Programmable Logic Devices Databook
PAL16C1A	Programmable Logic Devices Databook
PAL16C1A2	Programmable Logic Devices Databook
PAL16H2	Programmable Logic Devices Databook
PAL16H2A	Programmable Logic Devices Databook
PAL16H2A2	Programmable Logic Devices Databook
PAL16L2	Programmable Logic Devices Databook
PAL16L2A	Programmable Logic Devices Databook
PAL16L2A2	Programmable Logic Devices Databook
PAL16L6	Programmable Logic Devices Databook
PAL16L6A	Programmable Logic Devices Databook
PAL16L8	Programmable Logic Devices Databook
PAL16L8A	Programmable Logic Devices Databook
PAL16L8A2	Programmable Logic Devices Databook
PAL16L8B	Programmable Logic Devices Databook
PAL16L8B2	Programmable Logic Devices Databook
PAL16L8D	Programmable Logic Devices Databook
PAL16R4	Programmable Logic Devices Databook
PAL16R4A	Programmable Logic Devices Databook
PAL16R4A2	Programmable Logic Devices Databook
PAL16R4B	Programmable Logic Devices Databook
PAL16R4B2	Programmable Logic Devices Databook
PAL16R4D	Programmable Logic Devices Databook
PAL16R6	Programmable Logic Devices Databook
PAL16R6A	Programmable Logic Devices Databook
PAL16R6A2	Programmable Logic Devices Databook
PAL16R6B	Programmable Logic Devices Databook
PAL16R6B2	Programmable Logic Devices Databook
PAL16R6D	Programmable Logic Devices Databook
PAL16R8	Programmable Logic Devices Databook
PAL16R8A	Programmable Logic Devices Databook
PAL16R8A2	Programmable Logic Devices Databook
PAL16R8B	Programmable Logic Devices Databook
PAL16R8B2	Programmable Logic Devices Databook
PAL16R8D	Programmable Logic Devices Databook
PAL16RA8	Programmable Logic Devices Databook
PAL18L4	Programmable Logic Devices Databook
PAL18L4A	Programmable Logic Devices Databook
PAL20C1	Programmable Logic Devices Databook
PAL20C1A	Programmable Logic Devices Databook
PAL20L2	Programmable Logic Devices Databook
PAL20L2A	Programmable Logic Devices Databook
PAL20L8A	Programmable Logic Devices Databook
PAL20L8B	Programmable Logic Devices Databook
PAL20L8D	Programmable Logic Devices Databook
PAL20L10	Programmable Logic Devices Databook
PAL20L10A	Programmable Logic Devices Databook
PAL20P8B	Programmable Logic Devices Databook
PAL20R4A	Programmable Logic Devices Databook
PAL20R4B	Programmable Logic Devices Databook
PAL20R4D	Programmable Logic Devices Databook
PAL20R6A	Programmable Logic Devices Databook
PAL20R6B	Programmable Logic Devices Databook
PAL20R6D	Programmable Logic Devices Databook
PAL20R8A	Programmable Logic Devices Databook
PAL20R8B	Programmable Logic Devices Databook
PAL20R8D	Programmable Logic Devices Databook
PAL20RA10	Programmable Logic Devices Databook
PAL20RP4B	Programmable Logic Devices Databook
PAL20RP6B	Programmable Logic Devices Databook
PAL20RP8B	Programmable Logic Devices Databook
PAL20X4	Programmable Logic Devices Databook
PAL20X4A	Programmable Logic Devices Databook
PAL20X8	Programmable Logic Devices Databook
PAL20X8A	Programmable Logic Devices Databook
PAL20X10	Programmable Logic Devices Databook
PAL20X10A	Programmable Logic Devices Databook
PAL1012C4A	Programmable Logic Devices Databook
PAL1016LD4	Programmable Logic Devices Databook
PAL1016LD8	Programmable Logic Devices Databook
PAL1016LM4A	Programmable Logic Devices Databook
PAL1016P4A	Programmable Logic Devices Databook
PAL1016P8	Programmable Logic Devices Databook

Device Number	Publication
PAL1016RC4	Programmable Logic Devices Databook
PAL1016RC8	Programmable Logic Devices Databook
PAL1016RD4	Programmable Logic Devices Databook
PAL1016RD8	Programmable Logic Devices Databook
PAL1016RM4A	Programmable Logic Devices Databook
PAL10012C4A	Programmable Logic Devices Databook
PAL10016LD4	Programmable Logic Devices Databook
PAL10016LD8	Programmable Logic Devices Databook
PAL10016LM4A	Programmable Logic Devices Databook
PAL10016P4A	Programmable Logic Devices Databook
PAL10016P8	Programmable Logic Devices Databook
PAL10016RC4	Programmable Logic Devices Databook
PAL10016RC8	Programmable Logic Devices Databook
PAL10016RD4	Programmable Logic Devices Databook
PAL10016RD8	Programmable Logic Devices Databook
PAL10016RM4A	Programmable Logic Devices Databook
PE4020	Discrete Databook
PE8550	Discrete Databook
PF5101	Discrete Databook
PF5301	Discrete Databook
PF5301-1	Discrete Databook
PF5301-2	Discrete Databook
PF5301-3	Discrete Databook
PL77X288B	Memory Databook
PL87X288B	Memory Databook
PN100	Discrete Databook
PN100A	Discrete Databook
PN101	Discrete Databook
PN200	Discrete Databook
PN200A	Discrete Databook
PN201	Discrete Databook
PN918	Discrete Databook
PN920	Discrete Databook
PN930	Discrete Databook
PN2221	Discrete Databook
PN2221A	Discrete Databook
PN2222	Discrete Databook
PN2222A	Discrete Databook
PN2369	Discrete Databook
PN2369A	Discrete Databook
PN2484	Discrete Databook
PN2906	Discrete Databook
PN2906A	Discrete Databook
PN2907	Discrete Databook
PN2907A	Discrete Databook
PN3251	Discrete Databook
PN3563	Discrete Databook
PN3564	Discrete Databook
PN3565	Discrete Databook
PN3566	Discrete Databook
PN3567	Discrete Databook
PN3568	Discrete Databook
PN3569	Discrete Databook
PN3638	Discrete Databook
PN3638A	Discrete Databook
PN3639	Discrete Databook
PN3640	Discrete Databook
PN3641	Discrete Databook
PN3642	Discrete Databook
PN3643	Discrete Databook
PN3644	Discrete Databook
PN3645	Discrete Databook
PN3646	Discrete Databook
PN3684	Discrete Databook
PN3685	Discrete Databook
PN3686	Discrete Databook
PN3687	Discrete Databook
PN3691	Discrete Databook
PN3692	Discrete Databook
PN3694	Discrete Databook
PN4091	Discrete Databook
PN4092	Discrete Databook
PN4093	Discrete Databook
PN4117	Discrete Databook
PN4117A	Discrete Databook
PN4118	Discrete Databook
PN4118A	Discrete Databook
PN4119	Discrete Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
PN4119A	Discrete Databook
PN4120	Discrete Databook
PN4120A	Discrete Databook
PN4121	Discrete Databook
PN4122	Discrete Databook
PN4140	Discrete Databook
PN4141	Discrete Databook
PN4142	Discrete Databook
PN4143	Discrete Databook
PN4220	Discrete Databook
PN4221	Discrete Databook
PN4222	Discrete Databook
PN4223	Discrete Databook
PN4224	Discrete Databook
PN4248	Discrete Databook
PN4249	Discrete Databook
PN4250	Discrete Databook
PN4250A	Discrete Databook
PN4258	Discrete Databook
PN4258A	Discrete Databook
PN4274	Discrete Databook
PN4275	Discrete Databook
PN4302	Discrete Databook
PN4303	Discrete Databook
PN4304	Discrete Databook
PN4338	Discrete Databook
PN4339	Discrete Databook
PN4342	Discrete Databook
PN4354	Discrete Databook
PN4355	Discrete Databook
PN4356	Discrete Databook
PN4360	Discrete Databook
PN4391	Discrete Databook
PN4392	Discrete Databook
PN4393	Discrete Databook
PN4416	Discrete Databook
PN4856	Discrete Databook
PN4857	Discrete Databook
PN4858	Discrete Databook
PN4859	Discrete Databook
PN4860	Discrete Databook
PN4861	Discrete Databook
PN4888	Discrete Databook
PN4889	Discrete Databook
PN4916	Discrete Databook
PN4917	Discrete Databook
PN5033	Discrete Databook
PN5102	Discrete Databook
PN5103	Discrete Databook
PN5127	Discrete Databook
PN5128	Discrete Databook
PN5129	Discrete Databook
PN5130	Discrete Databook
PN5131	Discrete Databook
PN5132	Discrete Databook
PN5133	Discrete Databook
PN5134	Discrete Databook
PN5135	Discrete Databook
PN5136	Discrete Databook
PN5137	Discrete Databook
PN5138	Discrete Databook
PN5139	Discrete Databook
PN5140	Discrete Databook
PN5142	Discrete Databook
PN5143	Discrete Databook
PN5163	Discrete Databook
PN5179	Discrete Databook
PN5432	Discrete Databook
PN5433	Discrete Databook
PN5434	Discrete Databook
PN5449	Discrete Databook
PN5816	Discrete Databook
PN5855	Discrete Databook
PN5857	Discrete Databook
PN5910	Discrete Databook
PN5965	Discrete Databook
SA733	Discrete Databook
SA1015	Discrete Databook

Device Number	Publication
SC945	Discrete Databook
SC1815	Discrete Databook
SCLXXXX	ASIC Design Manual
SCX6206	2.0 Micron CMOS Gate Array Design Manual
SCX6212	2.0 Micron CMOS Gate Array Design Manual
SCX6218	2.0 Micron CMOS Gate Array Design Manual
SCX6225	2.0 Micron CMOS Gate Array Design Manual
SCX6232	2.0 Micron CMOS Gate Array Design Manual
SCX6244	2.0 Micron CMOS Gate Array Design Manual
SCX6287	2.0 Micron CMOS Gate Array Design Manual
SCX6B04	1.5 Micron CMOS Gate Array Design Manual
SCX6B10	1.5 Micron CMOS Gate Array Design Manual
SCX6B21	1.5 Micron CMOS Gate Array Design Manual
SCX6B31	1.5 Micron CMOS Gate Array Design Manual
SCX6B48	1.5 Micron CMOS Gate Array Design Manual
SCX6B64	1.5 Micron CMOS Gate Array Design Manual
SCX6B86	1.5 Micron CMOS Gate Array Design Manual
SCX6B120	1.5 Micron CMOS Gate Array Design Manual
SCX6B150	1.5 Micron CMOS Gate Array Design Manual
SE5020	Discrete Databook
SE5021	Discrete Databook
SE5022	Discrete Databook
SE5023	Discrete Databook
SE5024	Discrete Databook
SE5050	Discrete Databook
SE5051	Discrete Databook
SE5052	Discrete Databook
SND132	Discrete Databook
SPLICE	Series 32000 Microprocessors Databook
SS8050	Discrete Databook
SS8550	Discrete Databook
ST3904	Discrete Databook
ST3906	Discrete Databook
ST5771-1	Discrete Databook
ST5771-2	Discrete Databook
SYS32/30	Series 32000 Microprocessors Databook
TBA120S	Linear 3 Databook
TIS58	Discrete Databook
TIS59	Discrete Databook
TIS73	Discrete Databook
TIS74	Discrete Databook
TIS75	Discrete Databook
TIS86	Discrete Databook
TIS87	Discrete Databook
TIS90	Discrete Databook
TIS91	Discrete Databook
TIS92	Discrete Databook
TIS92	Discrete Databook
TIS93	Discrete Databook
TIS97	Discrete Databook
TIS98	Discrete Databook
TIS99	Discrete Databook
TL081CP	Linear 1 Databook
TL082CP	Linear 1 Databook
TN1711	Discrete Databook
TN2102	Discrete Databook
TN2218A	Discrete Databook
TN2219	Discrete Databook
TN2219A	Discrete Databook
TN2904A	Discrete Databook
TN2905	Discrete Databook
TN2905A	Discrete Databook
TN3019	Discrete Databook
TN3020	Discrete Databook
TN3053	Discrete Databook
TN3440	Discrete Databook
TN3467	Discrete Databook
TN3724	Discrete Databook
TN3725	Discrete Databook
TN3742	Discrete Databook
TN4033	Discrete Databook
TN4036	Discrete Databook
TN4037	Discrete Databook
TN4234	Discrete Databook
TN4235	Discrete Databook
TN4236	Discrete Databook
TN4314	Discrete Databook
TP3020	Telecommunications Databook

Appendix A
Guide to Technical Documentation by National Semiconductor Part Number (Continued)

Device Number	Publication
TP3020-1	Telecommunications Databook
TP3021	Telecommunications Databook
TP3021-1	Telecommunications Databook
TP3040	Telecommunications Databook
TP3040-1	Telecommunications Databook
TP3040A	Telecommunications Databook
TP3040A-1	Telecommunications Databook
TP3051	Telecommunications Databook
TP3052	Telecommunications Databook
TP3052-1	Telecommunications Databook
TP3052-X	Telecommunications Databook
TP3053	Telecommunications Databook
TP3053-1	Telecommunications Databook
TP3053-X	Telecommunications Databook
TP3054	Telecommunications Databook
TP3054-1	Telecommunications Databook
TP3054-X	Telecommunications Databook
TP3056	Telecommunications Databook
TP3057	Telecommunications Databook
TP3057-1	Telecommunications Databook
TP3057-X	Telecommunications Databook
TP3058	Telecommunications Databook
TP3059	Telecommunications Databook
TP3064	Telecommunications Databook
TP3067	Telecommunications Databook
TP3070	Telecommunications Databook
TP3071	Telecommunications Databook
TP3155	Telecommunications Databook
TP3200	Telecommunications Databook
TP3202	Telecommunications Databook
TP3204	Telecommunications Databook
TP3401	Datacommunications/LAN/UART Handbook
TP3410	Datacommunications/LAN/UART Handbook
TP3420	Datacommunications/LAN/UART Handbook
TP5088	Telecommunications Databook
TP5089	Telecommunications Databook
TP5116A	Telecommunications Databook
TP5116A-1	Telecommunications Databook
TP5156A	Telecommunications Databook
TP5156A-1	Telecommunications Databook
TP5700A	Telecommunications Databook
U231	Discrete Databook
U232	Discrete Databook
U233	Discrete Databook
U234	Discrete Databook
U235	Discrete Databook
U287	Discrete Databook
U308	Discrete Databook
U309	Discrete Databook
U310	Discrete Databook
U312	Discrete Databook
U401	Discrete Databook

Device Number	Publication
U402	Discrete Databook
U403	Discrete Databook
U404	Discrete Databook
U405	Discrete Databook
U406	Discrete Databook
U440	Discrete Databook
U441	Discrete Databook
U1897	Discrete Databook
U1898	Discrete Databook
U1899	Discrete Databook
VME532	Series 32000 Microprocessors Databook
µA24H80	Mass Storage Handbook
µA117X	Mass Storage Handbook
µA117XR	Mass Storage Handbook
µA212AT	Datacommunications/LAN/UART Handbook
µA501X	Mass Storage Handbook
µA501XR	Mass Storage Handbook
µA2460	Mass Storage Handbook
µA2461	Mass Storage Handbook
µA2580	Mass Storage Handbook
µA9614	Interface Databook
µA9615	Interface Databook
µA9622	Interface Databook
µA9627	Interface Databook
µA9636A	Interface Databook
µA9636A	Datacommunications/LAN/UART Handbook
µA9637A	Interface Databook
µA9637A	Datacommunications/LAN/UART Handbook
µA9638	Interface Databook
µA9638A	Datacommunications/LAN/UART Handbook
µA9639A	Interface Databook
µA9639A	Datacommunications/LAN/UART Handbook
µA9643	Interface Databook
µA9643	Datacommunications/LAN/UART Handbook
µA9665	Interface Databook
µA9666	Interface Databook
µA9667	Interface Databook
µA9668	Interface Databook
µA55110A	Interface Databook
µA75110A	Interface Databook
µA96172	Datacommunications/LAN/UART Handbook
µA96172	Interface Databook
µA96173	Interface Databook
µA96173	Datacommunications/LAN/UART Handbook
µA96174	Interface Databook
µA96174	Datacommunications/LAN/UART Handbook
µA96175	Datacommunications/LAN/UART Handbook
µA96175	Interface Databook
µA96176	Interface Databook
µA96177	Datacommunications/LAN/UART Handbook
µAV22	Datacommunications/LAN/UART Handbook

Appendix B Functional Index

Appendix B Functional Index (Continued)

Bookshelf of Technical Support Information

National Semiconductor Corporation recognizes the need to keep you informed about the availability of current technical literature. This bookshelf is a compilation of books that are currently available. The listing that follows shows the publication year and section contents for each book.

Please contact your local National sales office for possible complimentary copies. A listing of sales offices follows this bookshelf.

We are interested in your comments on our technical literature and your suggestions for improvement.

Please send them to:

Technical Communications Dept. M/S 16300
2900 Semiconductor Drive
P.O. Box 58090
Santa Clara, CA 95052-8090

ALS/AS LOGIC DATABOOK—1987

Introduction to Bipolar Logic • Advanced Low Power Schottky • Advanced Schottky

ASIC DESIGN MANUAL/GATE ARRAYS & STANDARD CELLS—1987

SSI/MSI Functions • Peripheral Functions • LSI/VLSI Functions • Design Guidelines • Packaging

CMOS LOGIC DATABOOK—1988

CMOS AC Switching Test Circuits and Timing Waveforms • CMOS Application Notes • MM54HC/MM74HC MM54HCT/MM74HCT • CD4XXX • MM54CXXX/MM74CXXX • Surface Mount

DATA COMMUNICATION/LAN/UART DATABOOK—Rev. 1—1988

LAN IEEE 802.3 • High Speed Serial/IBM Data Communications • ISDN Components • UARTs Modems • Transmission Line Drivers/Receivers

DISCRETE SEMICONDUCTOR PRODUCTS DATABOOK—1989

Selection Guide and Cross Reference Guides • Diodes • Bipolar NPN Transistors Bipolar PNP Transistors • JFET Transistors • Surface Mount Products • Pro-Electron Series Consumer Series • Power Components • Transistor Datasheets • Process Characteristics

DRAM MANAGEMENT HANDBOOK—1988

Dynamic Memory Control • Error Detection and Correction • Microprocessor Applications for the DP8408A/09A/17/18/19/28/29 • Microprocessor Applications for the DP8420A/21A/22A

F100K DATABOOK—1989

Family Overview • F100K Datasheets • 11C Datasheets • 10K and 100K Memory Datasheets Design Guide • Circuit Basics • Logic Design • Transmission Line Concepts • System Considerations Power Distribution and Thermal Considerations • Testing Techniques • Quality Assurance and Reliability

FACT™ ADVANCED CMOS LOGIC DATABOOK

Reprint of Fairchild 1987 Databook

Description and Family Characteristics • Ratings, Specifications and Waveforms Design Considerations • 54AC/74ACXXX • 54ACT/74ACTXXX

FAST® ADVANCED SCHOTTKY TTL LOGIC DATABOOK—1988

Circuit Characteristics • Ratings, Specifications and Waveforms • Design Considerations • 54F/74FXXX

GRAPHICS DATABOOK—1988

Advanced Graphics Chipset • Application Notes

INTERFACE DATABOOK—1988

Transmission Line Drivers/Receivers • Bus Transceivers • Peripheral Power Drivers • Display Drivers Memory Support • Microprocessor Support • Level Translators and Buffers • Frequency Synthesis • Hi-Rel Interface

LINEAR APPLICATIONS HANDBOOK—1986

The purpose of this handbook is to provide a fully indexed and cross-referenced collection of linear integrated circuit applications using both monolithic and hybrid circuits from National Semiconductor.
Individual application notes are normally written to explain the operation and use of one particular device or to detail various methods of accomplishing a given function. The organization of this handbook takes advantage of this innate coherence by keeping each application note intact, arranging them in numerical order, and providing a detailed Subject Index.

LINEAR 1 DATABOOK—1988

Voltage Regulators • Operational Amplifiers • Buffers • Voltage Comparators • Instrumentation Amplifiers • Surface Mount

LINEAR 2 DATABOOK—1988

Active Filters • Analog Switches/Multiplexers • Analog-to-Digital • Digital-to-Analog • Sample and Hold
Sensors • Voltage References • Surface Mount

LINEAR 3 DATABOOK—1988

Audio Circuits • Radio Circuits • Video Circuits • Motion Control • Special Functions • Surface Mount

LS/S/TTL DATABOOK—1987

Introduction to Bipolar Logic • Low Power Schottky • Schottky • TTL • Low Power

MASS STORAGE HANDBOOK—1988

Winchester Disk Preamplifiers • Winchester Disk Servo Control • Winchester Disk Pulse Detectors
Winchester Disk Data Separators/Synchronizers and ENDECs • Winchester Disk Data Controller
SCSI Bus Interface Circuits • Floppy Disk Controllers

MEMORY DATABOOK—1988

PROMs, EPROMs, EEPROMs • Flash EPROMs and EEPROMs • TTL I/O SRAMs • ECL I/O SRAMs • ECL I/O Memory Modules

MICROCONTROLLER DATABOOK—1988

COP400 Family • COP800 Family • COPS Applications • HPC Family • HPC Applications
MICROWIRE and MICROWIRE/PLUS Peripherals • Display/Terminal Management Processor (TMP)
Microcontroller Development Tools

PROGRAMMABLE LOGIC DATABOOK & DESIGN MANUAL—1989

Product Line Overview • Datasheets • Designing with PLDs • PLD Design Methodology • PLD Design Development Tools
Fabrication of Programmable Logic • Application Examples

SERIES 32000 MICROPROCESSORS DATABOOK—1988

Series 32000 Overview • Central Processing Units • Slave Processors • Peripherals • Board Level Products
Development Systems and Tools • Software Support • Application Notes • NSC800 Family

RELIABILITY HANDBOOK—1986

Reliability and the Die • Internal Construction • Finished Package • MIL-STD-883 • MIL-M-38510
The Specification Development Process • Reliability and the Hybrid Device • VLSI/VHSIC Devices • Radiation Environment
Electrostatic Discharge • Discrete Device • Standardization • Quality Assurance and Reliability Engineering
Reliability and Documentation • Commercial Grade Device • European Reliability Programs
Reliability and the Cost of Semiconductor Ownership • Reliability Testing at National Semiconductor
The Total Military/Aerospace Standardization Program • 883B/RETS™ Products • MILS/RETS™ Products • 883/RETS™ Hybrids
MIL-M-38510 Class B Products • Radiation Hardened Technology • Wafer Fabrication • Semiconductor Assembly and Packaging
Semiconductor Packages • Glossary of Terms • Key Government Agencies • AN/ Numbers and Acronyms
Bibliography • MIL-M-38510 and DESC Drawing Cross Listing

TELECOMMUNICATIONS—1987

Line Card Components • Integrated Services Digital Network Components • Modems
Analog Telephone Components • Application Notes