Semiconductor Master Selection Guide

1988

- 1987 Selection Guide for National Products
- 1987 Selection Guide for Fairchild Products
- New Product Updates for 1988

National Semiconductor

"When I'm looking for solutions, I look to National."

INTERFACE

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

COMMUNICATION SUPPORT
- controllers
- local area network
- receivers
- transmitters
- communication processors

DISK SUPPORT
- floppy
- hard

DISPLAY CONTROLLERS/DRIVERS
- CRT controllers
- display drivers

GRAPHICS
- video shift registers
- video clock generators
- video RAM controller
- BIT BLT processing unit
- raster graphics processor
- video DACs

LEVEL TRANSLATORS/ BUFFERS

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

PERIPERAL/POWER DRIVERS

TRANSMISSION LINE DRIVERS/RECEIVERS
- line drivers
- line receivers

FREQUENCY SYNTHESIS
- phase locked loop frequency synthesizers

BUS TRANSCEIVERS

MIL-AERO

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

ASICs
- gate array

LOGIC
- FAST
- FACT
- CMOS and Bipolar
- TTL
- std Schottky
- 54 HC

LINEAR

DISCRETES

HYBRIDS

MOS MEMORY
- MOS & CMOS EPROM/ SRAM

BIPOLAR MEMORY
- PROM and Programmable Logic (PAL®) devices

MICROPROCESSOR
- 8-, 16- and 32-bit

VHSIC
- Custom
- 64 K-bit
- CMOS RAM

PACKAGING

"Reliable packaging is critical for my applications. So I call National."

- Small Outline (SO) with 3-28 lead counts on .050 inch centers in "gullwing" configuration on two package sides
- Plastic Leaded Chip Carrier (PLCC) with 20-124 lead counts on .050 inch centers in a "J-Bend" configuration on all package sides
- Leadless Ceramic Chip Carriers (LCCC)
- Leaded Ceramic Chip Carrier (LDCC)
- TapePak®; space-saving tape-automated-bonding process with protective outer ring
- Plastic Pin Grid Arrays (PPGA)
- Plastic Quad Flat Packs (PQFP)

BOARDS

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

CMOS INDUSTRIAL MICROCOMPUTER (CIM™)
- digital I/O boards
- memory boards
- software
- systems

MEMORY SYSTEMS

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

SOFTWARE

MICROPROCESSOR/ MICROCONTROLLER

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

MICROPROCESSORS

32-BIT (Series 32000)
- microprocessors (8, 16 & 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 piggyback microcontroller
- 16-bit ROMless microcontrollers
- 16-bit single chip microcontroller

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

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

ASIC

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

CUSTOM CIRCUITS
- foundry/customer-owned-tooling
- full custom

SEMI-CUSTOM
- gate array
- standard cell

CMOS AND ECL

TURN-KEY DESIGN

TRAINING PROGRAMS

ON-SITE ENGINEERING ASSISTANCE

FULL SUPPORT OF MAJOR WORKSTATIONS

DOMESTIC/ INTERNATIONAL DESIGN CENTERS

HIGH-VOLUME SIX-INCH PRODUCTION LINE

PROGRAMMABLE LOGIC
- PAL
- FPLAs
- GAL™

DIGITAL

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

LSI/VLSI CMOS
- clocks
- oscillators/dividers
- real time clocks

FAST®

FACT™

F100K ECL

54/74 LOGIC

74ALS ADVANCED LOW-POWER SCHOTTKY

74AS ADVANCED SCHOTTKY

54C/74C CMOS

54HC/74HC HIGH-SPEED CMOS

54LS/74LS LOW-POWER SCHOTTKY

54S/74S SCHOTTKY

CD4000 SERIES

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
- temperature sensors
- video

CONVERTERS
- analog to digital
- digital to analog

AMPLIFIERS
- buffers
- instrumentation
- operational
- power
- transconductance servo
- video

ANALOG SWITCHES
- combined function analog
- standard analog

DISCRETE DEVICES
- JFETS
- N-channel
- P-channel
- NPN transistors
- PNP transistors
- diodes
- rectifiers
- MOSFET power

FILTERS
- switched capacitor

FREQUENCY SYNTHESIS
- phase locked loop frequency synthesizers

MOTOR CONTROLLERS
- H-switch
- servo-controllers

SAMPLE AND HOLD
- high speed
- standard

SPECIAL ANALOG FUNCTIONS

TELECOMMUNICATIONS CIRCUITS
- modems
- ISDN
- SLIC
- COMBO™ CIRCUITS
- Codecs
- filters
- dialers

VOLTAGE REFERENCES
- adjustable
- fixed
- precision

VOLTAGE REGULATORS
- dual 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."

STANDARD PROGRAMMED CONTROLLERS

EEPROMS

PROMS
- TTL
- ECL

EEPROM CMOS/NMOS

CMOS EPROM

RAMS
- TTL
- ECL
- FIFOs
- MOS static
- BiCMOS

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

The 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-mountable 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 sales office.

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1987 Selection Guide for National Products

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TRADEMARKS

National Semiconductor Corporation

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BI-FET®
BI-FET II™
BI-LINE™
BiPLAN™
BLC™
BLX™
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CIM™
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Clock✔Chek™
COMBO™
COPS™
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DENSPAK™
DIB™
Digitalker®
DISCERN™
DNR®

DPVM™
ELSTAR™
E-Z-LINK™
5-Star Service™
HANDISCAN™
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ISE™
ISE/80™
ISE/16™
ISE/32™
KeyScan™
LMCMOS™
M^2CMOS™
Macrobus™
Macrocomponent™

Meat✔Chek™
MICROBUS®
MICRO-DAC™
μtalker™
Microtalker™
MICROWIRE™
MICROWIRE/PLUS™
MOLE™
MST™
National Semiconductor®
National Semiconductor Corporation® (brand)
NAX800™
Nitride Plus™
Nitride Plus Oxide™
NML™
NOBUS™
NS™
NSCISE™
NSX-16™
NS-XC-16™
NSC800™

NTERCOM™
NURAM™
OXISS™
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Pharma✔Chek™
PLAN™
Polycraft™
POSitalker™
Power + Control™
QUAD3000™
QUIKLOOK™
RAT™
SABR™
Script✔Chek™
Series/800™
Series 3000™
Series 32000®
Shelf✔Chek™
SPIRE™
STAR®
Starlink™
SuperChip™

SuperScript™
SYS32™
TapePak™
TDS™
Telegate™
The National Anthem®
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TRI-STATE®
VIP™
XMOS™
XPU™
ZSTAR™
883B/RETS™
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Macintosh™

AT&T
TOUCH-TONE®
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CBS Labs
CX™

Digital Equipment Corporation
DEC™
Digital™
LSI-11 Series™
MicroPDP-11™
MicroVAX I™
PDP-11™
Q-BUS™
Unibus™
VAX™
VMS™

Digital Research Corporation
CP/M®

Dolby Labs
Dolby®

DuPont
Mylar®
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Intel Corporation
ICE™
ICS™
Intellec™
MCS™
MULTIBUS®

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FutureNet™
IBM®
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MicroSoft Corporation
MS-DOS™
XENIX™

Monolithic Memories Incorporated
PAL®
PALASM™
Skinny DIP™

Opus Systems
Personal Mainframe™

Xerox Corporation
Ethernet™

Zilog Corporation
Z80®
Z80A®
Z80B®
Z8000®
Z80000®

Life Support Policy

NATIONAL'S PRODUCTS ARE NOT AUTHORIZED FOR USE AS CRITICAL COMPONENTS IN LIFE SUPPORT DEVICES OR SYSTEMS WITHOUT THE EXPRESS WRITTEN APPROVAL OF THE PRESIDENT OF NATIONAL SEMICONDUCTOR CORPORATION. As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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Advanced Peripherals

For additional Advanced Peripheral products, see page 407.

High Speed Serial Data Communications

IBM and Non-IBM Hierarchical Star or Polling Bus Topologies

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.

One mode of interconnect is the classic point-to-point, deterministic connection between network nodes, and its derivatives, typically between host controllers and their attached peripherals.

Point-to-Point Communications

In support of advanced point-to-point requirements, National Semiconductor pioneered and introduced the now defacto industry standard DP8340 family of LSI devices which perform high-speed, parallel-to-serial and serial-to-parallel transmit/encoding and receive/decoding. The DP8340/DP8341 pair manage the encoding/decoding function for high speed serial communication which conforms to the protocol defined by the IBM 3270 information display system standard.

The DP8340 generates a 5-bit starting sequence, a 3-bit code violation, a sync bit and a 10-bit data packet—plus a parity bit. Finally, a 3-bit ending code is generated to signal the receiving end of a transmission that the transfer has terminated. The DP8342 performs a similar function—the encoding of parallel data for 8-bit per byte data transfers.

The 10-bit DP8341 and 8-bit DP8343 receivers are the companion components for the DP8340 and DP8342 respectively, and both provide the complete decoding of high speed serial communications. The DP8341 and DP8343 receive the biphase serial data and convert it into ten or eight bits of parallel data respectively.

The DP8340/41 transmit and receive data packets at 2.3587 mb/s. The DP8342/43 support data rates up to 3.5 mb/s.

These chips also feature:

- Single or multibyte data transfers
- Error detection and error type definition on all data transfers
- Internal even or odd parity generation
- Data holding registers
- An automatic clear status function for reduced CPU loading
- An internal crystal-controlled oscillator for all timing requirements

Another significant consideration in the selection of communication devices is the need to transfer data to varying working environments. In many instances, data in the relatively noiseless office setting must be relayed to the much noisier industrial environment. While standard coax cable may be appropriate for the office environment, fiber optics may be called for in the workshop setting. Fiber optics provide a transmission medium which is immune to the EMI generated in the industrial manufacturing environment. As Figure 1 illustrates, the DP8340 family of devices has been designed to communicate over all major media options—coaxial, twisted pair, fiber optic, etc.

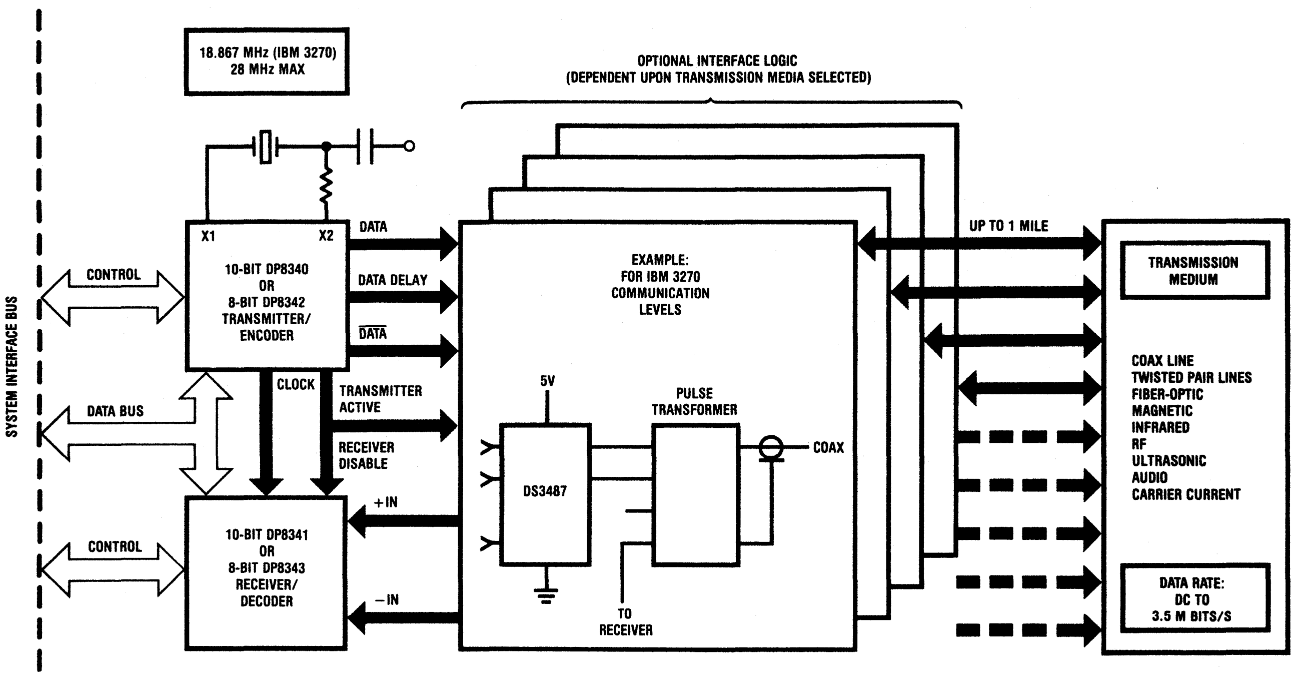


Figure 1. DP8340 Family Media Support Options

National's 2nd Generation IBM Protocol Communication Processor

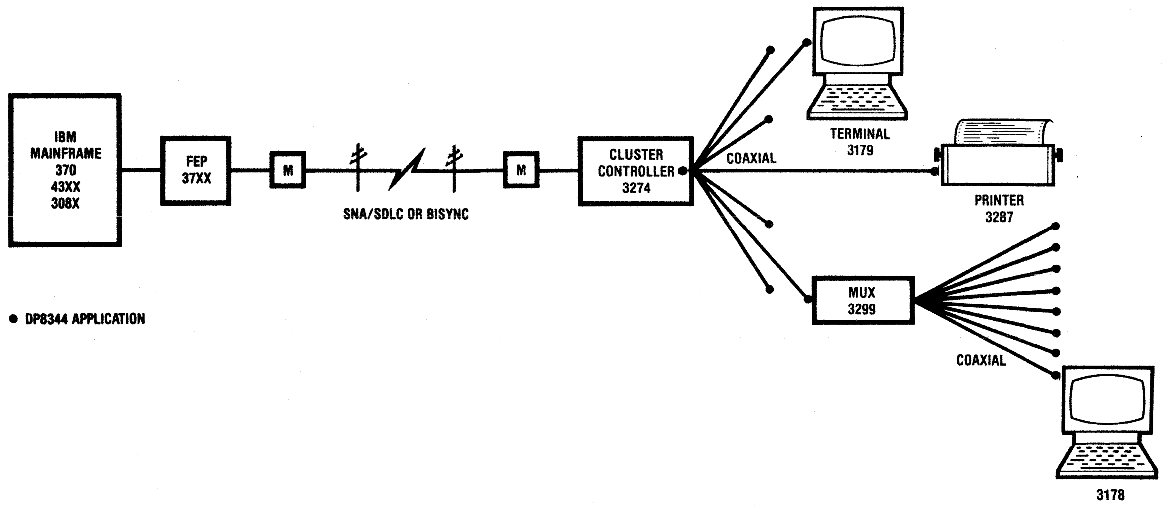
In a traditional IBM 3270 protocol environment, a DP8340/DP8341 chip set would be used in conjunction with a high speed bipolar processor or bit slice approach to execute the peripheral device's response to the polled commands of the IBM 3274 type cluster controller. The polled command response time requirement for the peripheral unit, as specified by IBM, is very fast. This task is usually left to the industry standard 2900 series bit slice devices or the 8X305. These devices, in conjunction with the bipolar DP8340/DP8341 3270 protocol formatter chips and a significant number of miscellaneous logic devices, typically draw well in excess of 1 amp of current, and are limited to servicing polled commands with no overhead processing power left for other system requirements such as keyboard and display functions.

National's 2nd generation release for the IBM 3270 protocol environment is the DP8344V BCP™ Biphase Communications Processor. This new CMOS device integrates a high-speed IBM protocol RISC engine with a front end communications encoder/transmitter-decoder/receiver section which runs at the IBM specified 2.3587 mb/s. The end result is a single 84-pin device which not only replaces the previous generation multichip bipolar solution (thus reducing power consumption and board real estate by a factor of over 10 times) but provides, via its interrupt driven design, up to 80 % processing power overhead for other, non-3270 polled response-system requirements. This multitasking processor is very capable of eliminating other support CPUs required in most systems.

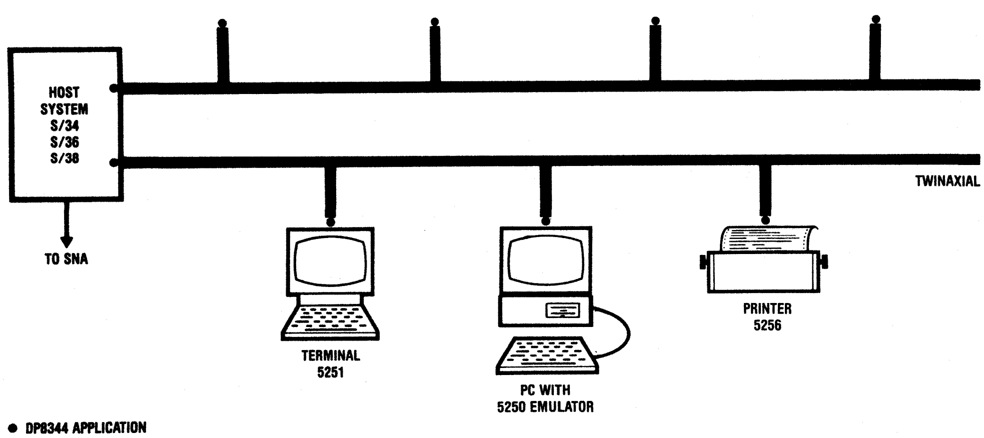
Because the DP8344 incorporates a programmable protocol option transceiver/formatter, it also supports IBM's 3299 coax multiplexer protocol at 2.3587 mb/s and 1 mb/s 5250 "twinax" protocol communications for the sytem 34, 36, 38 departmental processor interface.

The DP8344 is ideally suited for either the controller/system or peripheral interface applications shown in the typical topological system diagrams.

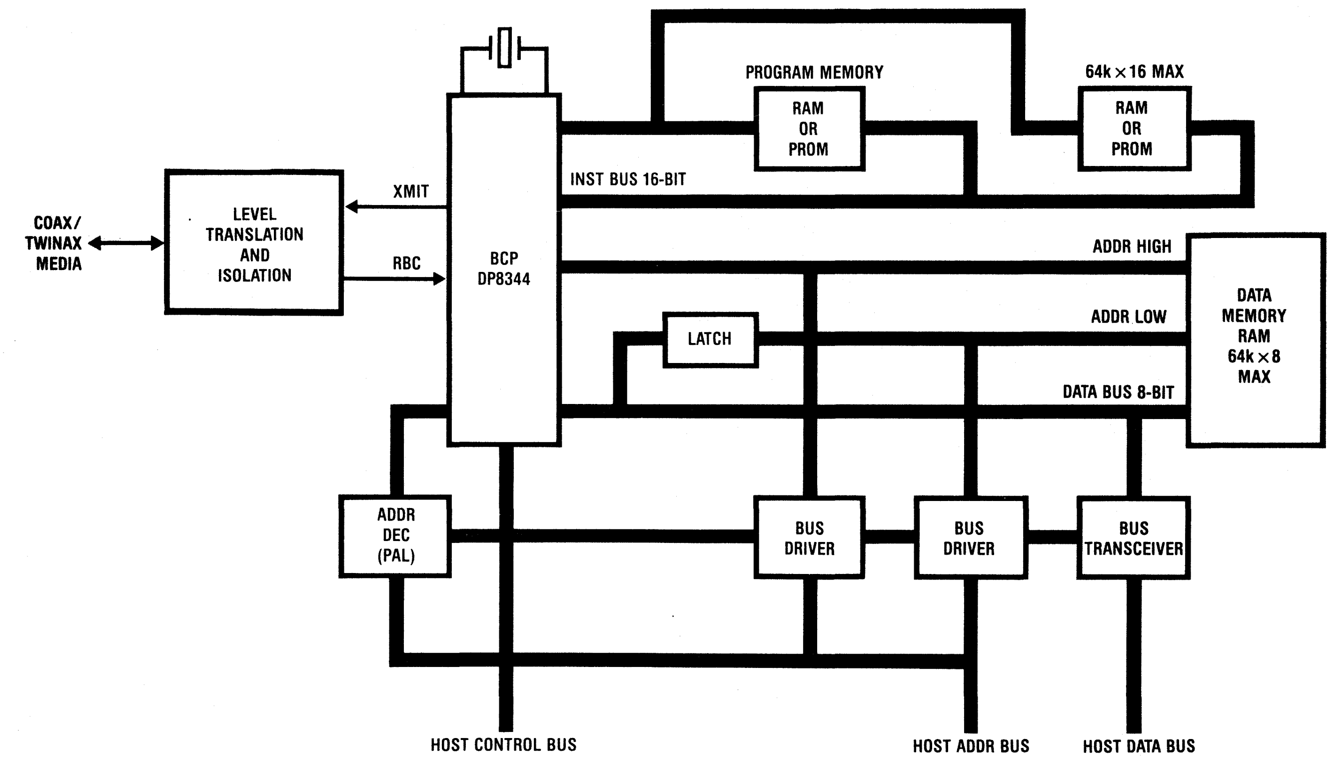
Typical IBM 3270/3299 "Coax" Topological/Protocol Environment



Typical IBM 5250 "Twinax" Topological/Protocol Environment



DP8344 Implementation for 3270 "Coax", 5250 "Twinax", or 8-Bit General Purpose Systems

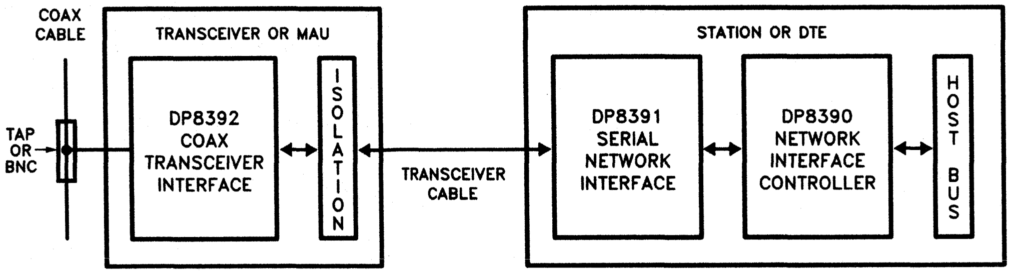


High Speed IBM and Non-IBM Protocol Data Communications Devices

Device #	Pins	Description	Application (Physical Layer)
DP8340 N/J/V	24/28	2.3587 mb/s serial biphase encoder/transmitter	IBM 10-bit 3270 coax protocol
DP8341 N/J/V	24/28	2.3587 mb/s serial biphase decoder/receiver	IBM 10-bit 3270 coax protocol
DP8342 N/J/V	24/28	3.5 mb/s serial biphase encoder/transmitter	8-bit general purpose Manchester data communication
DP8343 N/J/V	24/28	3.5 mb/s serial biphase decoder/receiver	8-bit general purpose Manchester data communication
DP8344 V	84	2.3587 mb/s serial biphase encoder/transmitter-decoder/receiver with high-speed protocol RISC engine	IBM 10-bit 3270 coax protocol
DP8344 V	84	2.3587 mb/s serial biphase encoder/transmitter-decoder/receiver with high-speed protocol RISC engine	IBM addressed 3299 coax protocol
DP8344 V	84	1.0 mb/s serial biphase encoder/transmitter-decoder/receiver with high-speed protocol RISC engine	IBM 5250 twinax protocol
DP8344 V	84	0.1–4.0 mb/s serial biphase encoder/transmitter-decoder/receiver with high-speed protocol RISC engine	8-bit general purpose Manchester data communication

Local Area Network Chip Set

IEEE 802.3 Compatible Ethernet/Thin-Ethernet



DP8390/NS32490 Network Interface Controller

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, Thin/Ethernet and StarLAN™. The NIC implements all Media Access Control (MAC) layer functions for transmission and reception of packets in accordance with the IEEE 802.3 Standard. Unique dual DMA channels and an internal FIFO provide a simple yet efficient packet management design. To minimize system parts count and cost, all bus arbitration and memory support logic are integrated into the NIC.

The NIC is the heart of a three chip set that implements the complete IEEE 802.3 protocol and node electronics as shown above. The other two chips are the DP8391 Serial Network Interface (SNI) and the DP8392 Coaxial Transceiver Interface (CTI).

Features

- Compatible with IEEE 802.3/Ethernet II/ Thin-Ethernet/StarLAN
- Interfaces with 8, 16 and 32-bit microprocessor systems
- Implements simple, versatile buffer management
- Requires single 5V supply
- Utilizes low power microCMOS process
- Includes
  - —Two 16-bit DMA channels
  - —16-byte internal FIFO with programmable threshold
  - —Network statistics storage
- Supports physical, multicast, and broadcast address filtering
- Provides 3 levels of loopback
- Utilizes independent system and network clocks

DP8391/NS32491 Serial Network Interface

General Description

The DP8391 Serial Network Interface (SNI) provides the Manchester data encoding and decoding functions for IEEE 802.3 Ethernet/Thin-Ethernet type local area networks. The SNI interfaces the DP8390 Network Interface Controller (NIC) 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/s signals with as much as ± 20 ns of jitter.

The DP8391 SNI is a functionally complete Manchester encoder/decoder including ECL like balanced driver and receivers, on board crystal oscillator, collision signal translator, and a diagnostic loopback circuit.

The SNI is part of a three chip set that implements the complete IEEE compatible network node electonics as shown above. The other two chips are the DP8392 Coax Transceiver Interface (CTI) and the DP8390 Network Interface Controller (NIC).

Features

- Compatible with Ethernet II, IEEE 802.3 10base5 and 10base2 (Thin-Ethernet)
- 10 Mb/s Manchester encoding/decoding with receive clock recovery
- Patented digital phase locked loop (DPLL) decoder requires no precision external components
- Decodes Manchester data with up to ± 20 ns of jitter
- Loopback capability for diagnostics
- Externally selectable half or full step modes of operation at transmit output
- Squelch circuits at the receive and collision inputs reject noise
- High voltage protection at transceiver interface (16V)
- TTL/MOS compatible controller interface
- Connects directly to the transceiver (AUI) cable

DP8392/NS32492 Coaxial Transceiver Interface

General Description

The DP8392 Coaxial Transceiver Interface (CTI) is used as a coaxial cable line driver/receiver for Ethernet/Thin-Ethernet type local area networks. The CTI is connected between the coaxial cable and the Data Terminal Equipment (DTE). In Ethernet applications the transceiver is usually mounted within a dedicated enclosure and is connected to the DTE via a transceiver cable. In Thin-Ethernet applications, the CTI is typically located within the DTE and connects to the DTE through isolation transformers only. The CTI consists of a Receiver, Transmitter, Collision Detector, and a Jabber Timer. The Transmitter connects directly to a 50Ω coaxial cable where it is used to drive the coax when transmitting. During transmission, a jabber timer is initiated to disable the CTI transmitter in the event of a longer than legal length data packet. 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.

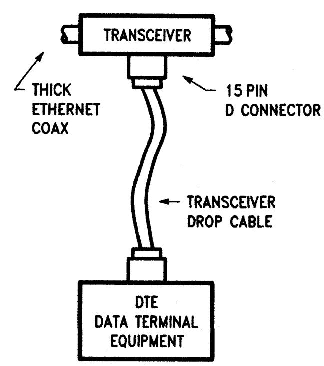
The CTI is part of a three chip set that implements the complete IEEE 802.3 compatible network node electronics. The other two chips are the DP8391 Serial Network Interface (SNI) and the DP8390 Network Interface Controller (NIC).

Features

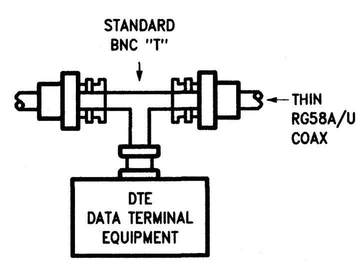
- Compatible with Ethernet II, IEEE 802.3 10base5 and 10base2 (Thin-Ethernet)
- Integrates all transceiver electronics except signal and power isolation
- Innovative design minimizes external component count
- Jabber timer function integrated on chip
- Externally selectable CD Heartbeat allows operation with IEEE 802.3 compatible repeaters
- Precision circuitry implements receive mode collision detection
- Squelch circuitry at all inputs rejects noise
- Designed for rigorous reliability requirements of IEEE 802.3
- Standard 16-pin DIP uses a special leadframe that significantly reduces the operating die temperature

Typical Connection Diagram for an IEEE 802.3 Node

10BASE5 (Ethernet)



10BASE2 (Thin-Ethernet)



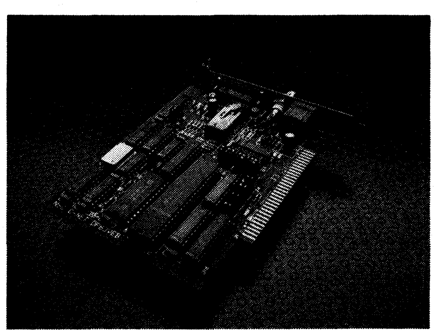
DP839EB LAN Evaluation Board

General Description

The National Semiconductor DP839EB Network Interface Adapter (NIA) provides IBM PCs and PC compatibles with Ethernet, Thin-Ethernet and StarLAN connections. The DP839EB is compatible with the PC-bus and requires only a 1/2 size slot for installation. The NIA utilizes National Semiconductor's IEEE 802.3 chip set consisting of the DP8390 Network Interface Controller, the DP8391 Serial Network Interface and the DP8392 Coaxial Transceiver Interface. The DMA capabilities of the DP8390, coupled with 8 kbytes of buffer RAM, allow the Network Interface Adapter to appear as a standard I/O port to the system.

Hardware Features

- Half-size IBM PC I/O card form factor
- DP8390 Network Interface Controller with DMA
- 8 kbyte on-board multipacket buffer
- Clean DMA interface to IBM-PC
- Ethernet interface via 15-pin D connector
- Thin-Ethernet interface via BNC connector
- StarLAN support with optional daughter card and 8-pin modular phone jack
- Option for driving 3270 93Ω coax
- DP8391 Serial Network Interface
- DP8392 Coaxial Transceiver Interface
- Low power requirement



Mass Storage/ Disk Drive Support

The National Semiconductor family of mass storage interface products offers the industry the 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.

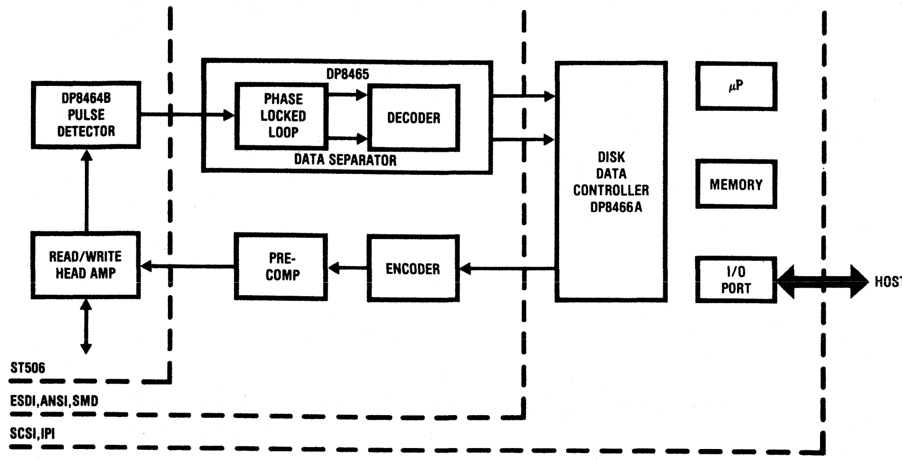


Figure 1. Typical Disk Drive Data Path

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/s. 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 (PCC).

Features

- Wide input signal amplitude range—from 20 mVpp to 660 mVpp
- Data rates up to 15 Mbits/s 2,7 code or 10 Mbits/s 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

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 these 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 PCC (DP8465/61/62) or 20-pin DIP, 20-pin PCC (DP8455/51)

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 DP8463 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

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 Mbits/sec DMA transfer rate

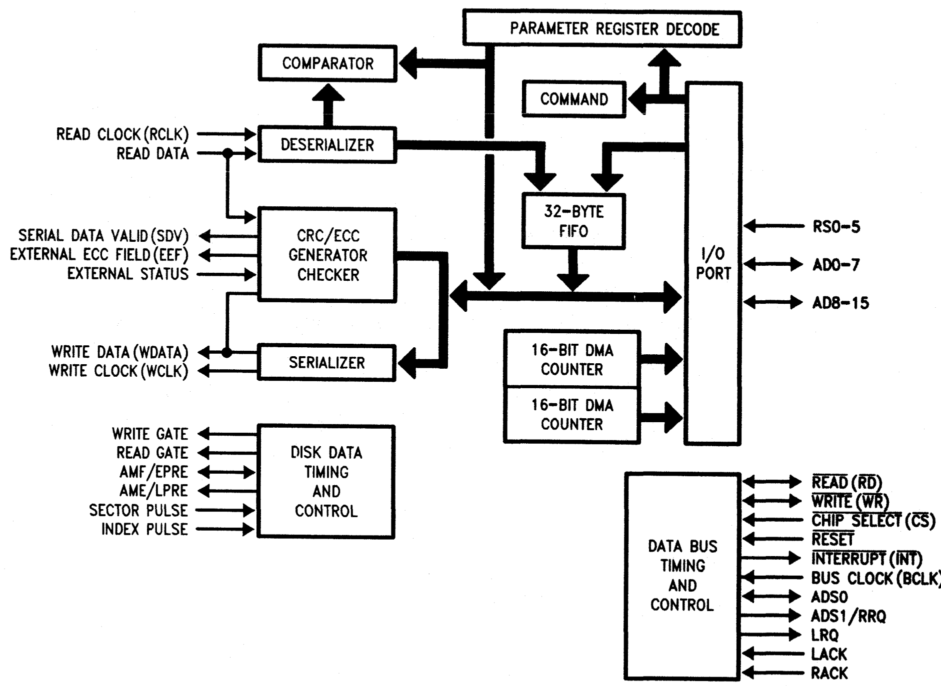


Figure 2. Disk Data Controller (DDC)

DP8470 Floppy Disk Support Chip Data Separator and Write Precompensation

General Description

The DP8470 is a general purpose data separator which can be used to generate a read clock for FM or MFM encoded data. This read clock can be used with many existing floppy disk controllers including the μPD765A, 8272A, and WD179X. It can also be used with National Semiconductor's Hard Disk Controller, DP8466A for a combination hard disk/floppy disk system. The data separator can be used for data rates ranging from 125 kbits/sec up to 1.25 Mbits/sec.

The DP8470 also contains a write precompensation circuit. Normally a disk controller will determine whether a bit of data needs to be shifted early, late, or not at all. The controller does not do the actual shifting however. The DP8470 will do the actual shifting that is requested by the controller.

Features

- Analog PLL data separator
- Write precompensation (0 ns–393 ns)
- Requires no external trimmable components
- Supports FM/MFM 125 kbits/sec to 1.25 Mbits/sec
- Interface to all popular floppy disk controllers
- 24-pin narrow package or 28-pin PCC

DP8472, DP8474 Floppy Disk Controller Plus

General Description

The DP8472/74 is a full featured Floppy Disk Controller. It is software compatible with the μPD765A but also has many enhancements. This includes an internal data separator, internal write precompensation, a motor on/off control, internal line drivers, low power mode, and some software enhancements that simplify programming the DP8472/74.

The internal data separator uses a combination of digital and analog circuits. The analog PLL requires only fixed value external components, no trims are needed.

The internal Write Precompensation can be programmed to shift the outgoing data early or late, anywhere between 0 ns and 464 ns. It uses a standard single level shifting algorithm.

Features

- Internal dual gain, analog data separator
- Internal write precompensation
- Software compatible with the μPD765A/8272A
- Software selectable data rate (125 kbits/sec to 2.5 Mbits/sec)
- No trimmable passive components needed
- Extended track range (up to 4096 tracks)
- 40-pin DIP or 44-pin PCC

Graphics

Advanced Graphics Chip Set Offers:

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

Partitioned Graphics Functions
- Required to provide highest performance
- Allows unlimited user flexibility
- Matches right process for each IC

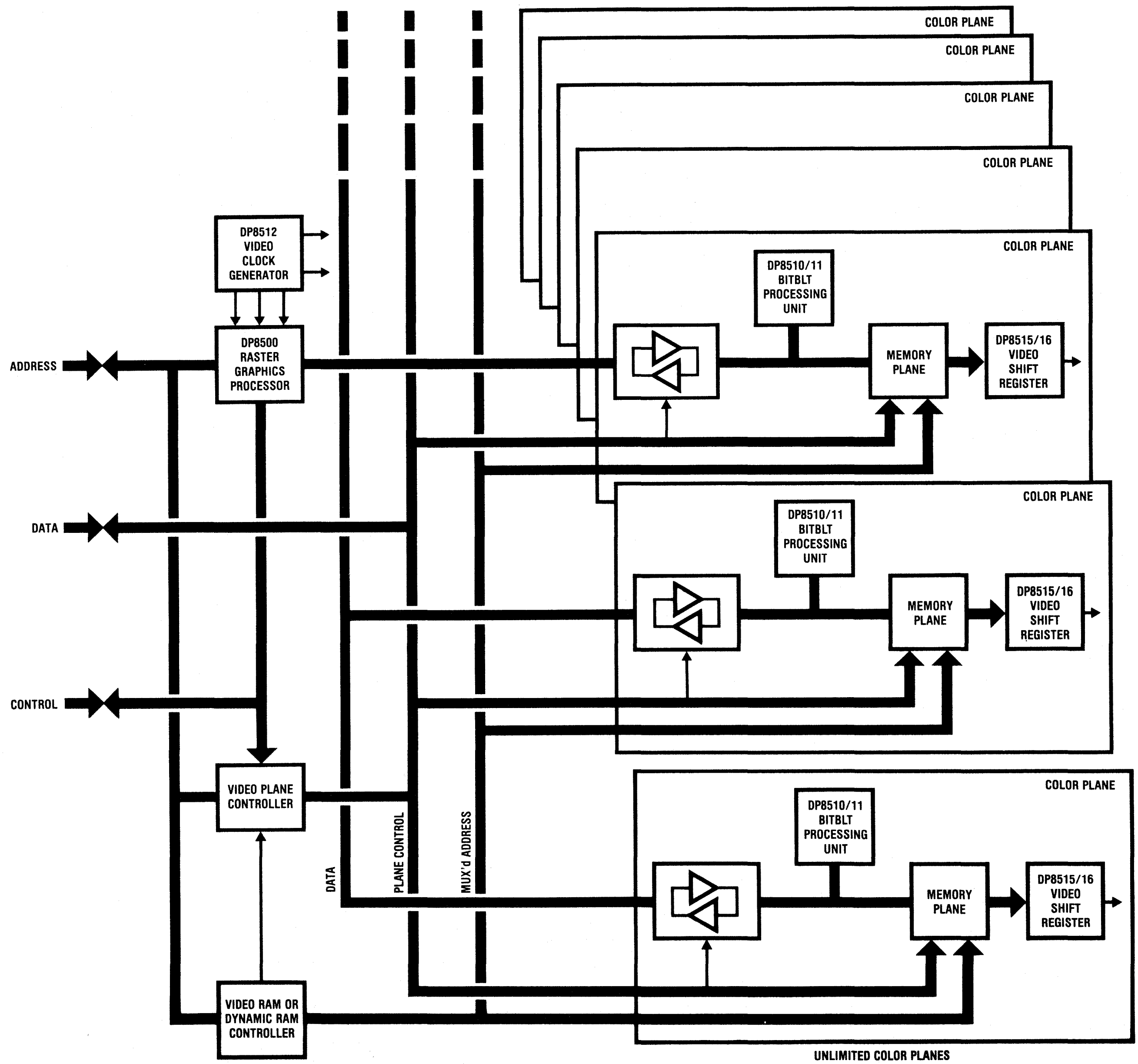
Open Architecture
- Easy/cost effective system design
- Performance flexibility
- Allows use of the host CPU to help
- Allows growth in the family

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 Slave	V44A
DP8514	Crystal Clock Generator	N16A
DP8515	Video Shift Register - 10k ECL Outputs (VSR)	V44A
DP8516	Video Shift Register - 100k ECL Outputs	V44A
DP8520	Video RAM Controller - 256k	V68
DP8521	Video RAM Controller - 1M	V68
DP8522	Video RAM Controller - 4M	V84
DP8530	Video Clock Generator (LFVCG) - 125MHz	V28

Advanced Graphics Chip Set



Memory Support

The DP8400 Family

In National Semiconductor's quest to provide a complete solution to the increasing variety of design applications, an extensive line of memory support peripherals are now provided. Memory support can prove to be most critical in today's memory intensive applications. The rapid development in dynamic random access memory (DRAM) chip storage capability, coupled with significant component cost reductions, has allowed designers to build large memory arrays with high performance specifications. National's current generation of DRAM controller/drivers are the only devices available today which are truly capable of delivering "no-waitstate" CPU to memory accessing at and well above 10 MHz while driving 8 Mbytes of system memory, plus EDAC check bit memory. And you won't require the fastest/most expensive DRAMs to achieve this new performance standard either. The DP8420, DP8421 and DP8422 next generation 256 kbit, 1 Mbit and 4 Mbit DRAM controller/drivers will take this performance standard one step further by offering no-waitstate accessing capability via low power CMOS, a truly single chip solution including fully programmable microprocessor specific interface logic, dual CPU porting, byte write capability, and on-board direct drive capable of directly addressing up to 64 Mbytes of system memory from a single DRAM controller/driver.

Today's large DRAM arrays require sophisticated high performance devices to provide timing and control. National offers the broadest range of DRAM contollers with the highest performance available on the market. Controllers are available for DRAMs from 64 kbit through 4 Mbit devices, supporting memory arrays up to 64 Mbytes in size. For critical applications, National has developed several Error Checking and Correction (ECC) devices to provide maximum data integrity.

The DP8400 DRAM interface family provides complete solutions to memory support (Figure 1). This begins with the LSI functions such as the DP8402A 32-bit error detector/corrector and the DP8429 1 Mbit DRAM controller/driver. It continues with the DP84240 and the DP84244 high performance buffer/drivers. Finally it concludes with easy interface to popular microprocessors with the use of the DP84XX2 series. It is the first family of DRAM support circuits designed for universal applications with multiple microprocessors, with the versatility to support all manufacturers' CPUs equally.

The DP8400 Family of Full Function DRAM Controller/ Drivers

The heart of any DRAM array design is the controller function. Previous LSI controllers supplied a minimum function of address multiplexing with an on-board refresh counter. This required external delay line timing and logic to control memory access, additional logic to perform memory refresh, and external drivers to drive the capacitive

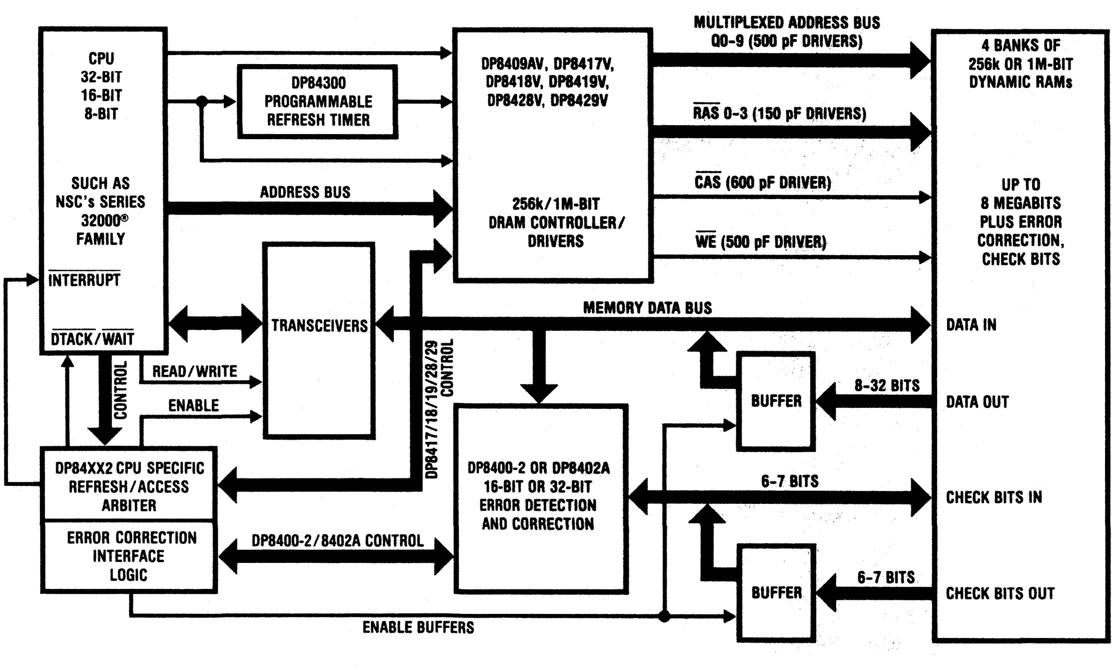


Figure 1. DP8400 Family—The Complete Solution for Fast, Error Free Dynamic Memory Interface

memory array. The complete solution results in significant access delay in relations to DRAM speeds and skews in output sequencing, as well as a large component count.

National's LSI DRAM controllers (Table 1) have brought much of this logic on-chip. These devices provide the flexibility of external access control, along with automatic access timing generation, without the need for an external timing generator clock. In addition, on-board capacitive drivers allow direct drive in excess of 500 pF, or the equivalent of over 88 DRAMs.

The data below is intended to highlight the key differentiable features of each DRAM Controller/Driver offered by National Semiconductor. All NSC DRAM controllers integrate on-board delay line timing, high capacitive drive, row/column muxing logic, refresh counting, row and column input latching and memory bank select logic. Because of the family feature commonality, most devices offer pin for pin up/downward compatibility; however, process and design differences between devices result in a broad selection of feature and performance options for the best system fit.

Error Correction

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.

In addition to the popular DP8400-2 16-bit error checker/corrector, National offers a 32-bit Error Detector and Corrector (EDAC). With a few exceptions, the DP8402A is functionally similar to the DP8400-2. One major exception is that the DP8402A is not expandable beyond 32-bits.

Table 1. DRAM Controller Master Selection Guide

					Max RAS to CAS Out		Guaranteed Row Address Hold				
Device # and Speed Options	DRAMS Supported	Process	Typ I_{CC}	A.C. Specified Word Width	*Fast Mode	Slow Mode	*Fast Mode	Slow Mode	V_{CC}	Operating Temp Range (°C)	Package
DP8408A A-2 A-3	16, 64k	Junction Isolated (S)	210 mA	4 Banks of 16-Bit Data w/ 6-Bit ECC ea.	105 ns/125 ns 85 ns/100 ns 120 ns/145 ns		20 ns/30 ns 12 ns/20 ns 20 ns/30 ns		+ 5V ± 5%	0 to + 70 0 to + 85	48N 48D
DP8409A A-2 A-3	16, 64, 256k	Junction Isolated (S)	210 mA	4 Banks of 16-Bit Data w/ 6-Bit ECC ea.	105 ns/125 ns 85 ns/100 ns 120 ns/145 ns		20 ns/30 ns 12 ns/20 ns 20 ns/30 ns		+ 5V ± 5%	0 to + 70 0 to + 85	48N 48D 68V
DP8417-80 -70	16, 64, 256k	Oxide Isolated (ALS)	150 mA	4 Banks of 16-Bit Data w/ 6-Bit ECC ea.	63 ns/80 ns 50 ns/72 ns		15 ns/25 ns 15 ns/25 ns		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	48N 48D 68V
DP8418-80 -70	16, 64, 256k	Oxide Isolated (ALS)	150 mA	2 Banks of 32-Bit Data w/ 7-Bit ECC ea.	63 ns/80 ns 50 ns/72 ns		15 ns/25 ns 15 ns/25 ns		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	48N 48D 68V
DP8419-80 -70	16, 64, 256k	Oxide Isolated (ALS)	150 mA	4 Banks of 16-Bit Data w/ 6-Bit ECC ea.	63 ns/80 ns 50 ns/72 ns		15 ns/25 ns 15 ns/25 ns		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	48N 48D 68V
DP8420, DP8421 and DP8422	16, 64, 256k, 1 Mega-Bit, and 4 Mega-Bit	2μ CMOS	5 mA	2 Banks of 32-Bit Data w/ 7-Bit ECC ea.	—		—		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	68V 84V
DP8428-80 -70	16, 64, 256k and 1 Mega-Bit	Oxide Isolated (ALS)	150 mA	2 Banks of 32-Bit Data w/ 7-Bit ECC ea.	63 ns/80 ns 50 ns/72 ns		15 ns/25 ns 15 ns/25 ns		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	52D 68V
DP8429-80 -70	16, 64, 256k and 1 Mega-Bit	Oxide Isolated (ALS)	150 mA	4 Banks of 16-Bit Data w/ 6-Bit ECC ea.	63 ns/80 ns 50 ns/72 ns		15 ns/25 ns 15 ns/25 ns		+ 5V ± 10%	0 to + 70 − 40 to + 85 − 55 to + 125	52D 68V

*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.

DP8420/21/22 MicroCMOS Programmable 256k, 1 or 4 Megabit DRAM Controller/Drivers

General Description

National introduces another first in DRAM controllers, the DP8422. The first DRAM controller capable of directly addressing and driving an array of 4-megabit DRAMs up to 64-megabytes in size, the DP8422 can be easily interfaced to all major 8-, 16-, and 32-bit microprocessors without the need for previously required external support circuits.

The DP8422 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 DP8422'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 of the DP8422. By utilizing the most modern process techniques available, National has integrated all major features associated with the interface, control and drive of today's assortment of DRAMs.

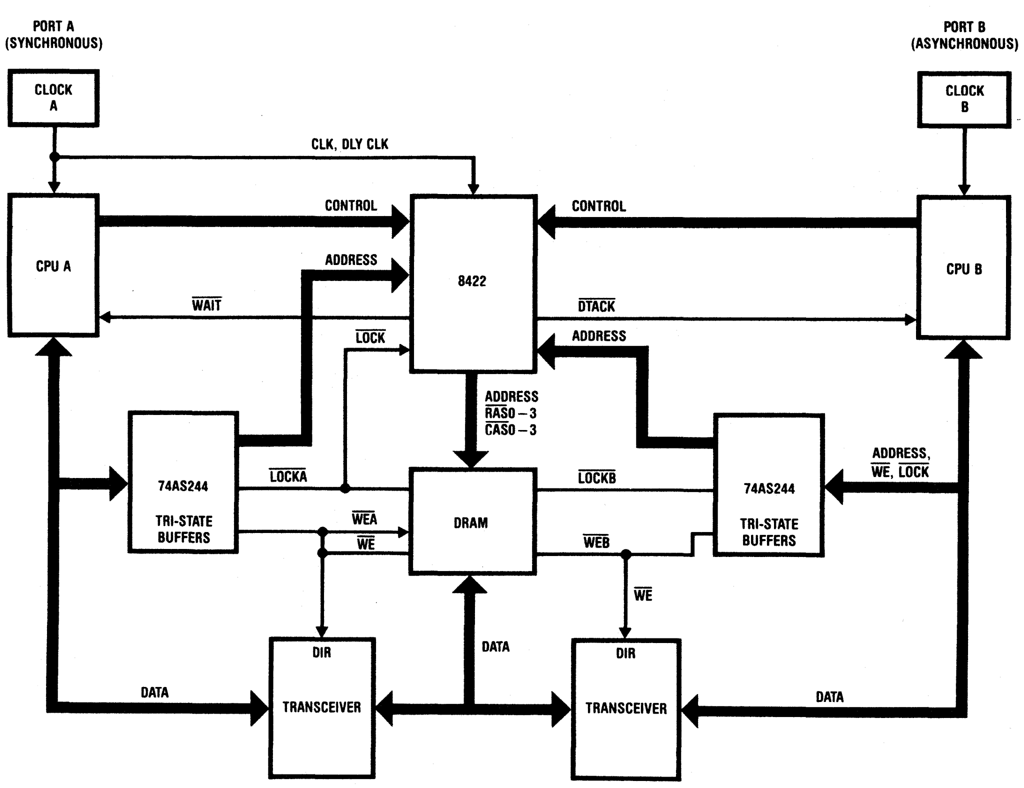
The DP8422 can be easily programmed to work with a variety of computer systems, regardless of DRAM access type. Adjustable control signal pulse widths allow the DP8422 to be used with the full spectrum of microprocessor/CPU operating frequencies, even beyond the 20 MHz boundary. In addition to the DP8422's 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 DP8422 also supports a variety of refresh operations, including staggered and burst refresh, which are automatic and transparent to the system.

The DP8422, along with the single-ported, 1-megabit DP8421 and 256-kbit DP8420 DRAM controller/drivers, is perfectly suited for a wide variety of DRAM-based applications where high-performance, no-wait-state, memory access is essential.

National has complemented the DP8420/21/22 programmable DRAM controller/drivers by packaging them in low cost 68-pin and 84-pin PCC packages.

Programmable Video RAM Controller/Drivers (DP8520/21/22) are also available as part of National's Advanced Graphics chip set.

Dual Accessing with the DP8422



Application Specific ICs

For additional Application Specific IC products, see pages 231 and 419.

ASIC Family

National Semiconductor's ASIC family utilizes a 2 micron (drawn, 1.6 micron effective) dual metal, silicon gate CMOS technology.

National's advanced CMOS technology is capable of achieving operating speed similar to Schottky-TTL but with the inherent lower power dissipation of standard CMOS technology.

All I/O and pad cells in the CMOS family have high noise immunity and are protected from static discharge.

All new LSI/VLSI chips designed at National Semiconductor utilize the same common CMOS process as National's ASICs. This facilitates encompassing these standard products as functional blocks in the standard cell library.

The SCX6200 Series Gate Array family currently ranges from 600–8700 gates, with a 13,000 gate array in design. The gates are arranged in cells, each cell having the equivalent of three 2-input NAND gates. All outputs have the ability to drive 10 LSTTL loads.

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.

Product Features

- 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

Standard Cells Enhanced Product Features

- 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

Gate Array Enhanced Product Features

- 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.

Absolute Maximum Ratings (Referenced to GND)

Parameter	Symbol	Limits	Units
DC Supply Voltage	V_{DD}	− 0.3 to + 7	V
Input Voltage	V_I	− 0.3 to V_{DD} + 0.3	V
DC Input Current	I_I	± 10	mA
Storage Temperature Range (Ceramic)	T_{STG}	− 65 to + 150	°C

Recommended Operating Conditions

Parameter	Symbol	Limits	Units
DC Supply Voltage	V_{DD}	3 to 6	V
Operating Ambient Temperature Range Military	T_A	− 55 to + 125	°C

DC Characteristics Specified at V_{DD} = 5V ± 10%

Symbol	Parameter	Conditions	V_{DD}	Min	Typ	Max	Units
$V_{IL(max)}$	Low Level Input Voltage	$\lvert IO \rvert \le 20\,\mu A$					
	CMOS Level		4.5V			0.3 V_{DD}	V
	TTL Level (Note 1)		4.5V			0.8	V
$V_{IH(min)}$	High Level Input Voltage	$\lvert IO \rvert \le 20\mu A$					
	CMOS Level		5.5V	0.7 V_{DD}			V
	TTL Level (Mil/Comm) (Note 1)		5.5V	2.25			V
$V_{T+(max)}$	Positive Going Threshold Voltage—Schmitt Trigger (Note 1)					4.0	V
$V_{T-(min)}$	Negative Going Threshold Voltage—Schmitt Trigger (Note 1)			0.7			V
$V_{H(typ)}$	Hysteresis Voltage—Schmitt Trigger (Note 1)			1.0	1.5		V
$I_{IL(max)}$	Low Level Input Current	$V_{IN} = V_{SS}$	5.5V			− 10	μA
	with Pull Up Resistor		5.5V		− 40	− 200	μA
$I_{IH(max)}$	High Level Input Current	V_{IN} = 5.5V	5.5V			10	μA
	with Pull Down Resistor		5.5V		40	200	μA
$V_{OL(max)}$	Low Level Output Voltage	$V_{IN} = V_{IL}$ or V_{IH}					
		I_{OL} = 20 μA	4.5V			0.1	V
		I_{OL} = 1 mA	4.5V		0.2	0.4	V
		I_{OL} = 2 mA	4.5V		0.2	0.4	V
		I_{OL} = 4 mA	4.5V		0.2	0.4	V
$V_{OH(min)}$	High Level Output Voltage	$V_{IN} = V_{IL}$ or V_{IH}					
		I_{OH} = − 20 μA	4.5V	V_{DD} − 0.1			V
		I_{OH} = − 1 mA	4.5V	3.7			V
		I_{OH} = − 2 mA	4.5V	3.7			V
		I_{OH} = − 4 mA	4.5V	3.7			V
$I_{OZL(max)}$	Low Level TRI-STATE Output Current (Notes 2,3)	$V_O = V_{SS}$; $V_{IN(EN)} = V_{IL}$ or V_{IH}	5.5V			− 10	μA
$I_{OZH(max)}$	High Level TRI-STATE Output Current (Notes 2,3)	V_O = 5.5V; $V_{IN(EN)} = V_{IL}$ or V_{IH}	5.5V			10	μA
I_{DD}	Quiescent Supply Current	$V_{IN} = V_{SS}$ or V_{DD}			User Design Dependent		
C_{IN}	Input Capacitance (Note 4)				5	10	pF
C_{OUT}	Output Capacitance (Note 4)				7	20	pF

Note 1: This parameter cannot be guaranteed unless a combinatorial logic path is defined.

Note 2: I_{OZ} specs are for output buffers without pull up or down resistors.

Note 3: Spec. limits for I/Os with both TRI-STATE outputs and pull up or down resistors will be the sum of the individual leakages.

Note 4: C_{IN} and C_{OUT} specs are guaranteed by design.

Propagation Delays of Selected Macros (in ns) Note 1

Symbol	Function	Best-Case t_{PLH}	Best-Case t_{PHL}	Worst-Case t_{PLH}	Worst-Case t_{PHL}	C_{LOAD} (pF)
C001	2-NAND	0.095	0.19	0.75	0.95	0
		0.39	0.67	2.40	4.05	1
C002	3-NAND	0.09	0.27	0.95	1.65	0
		0.37	0.92	2.65	5.75	1
C004	2-NOR	0.16	0.15	1.1	0.95	0
		0.62	0.51	4.15	2.85	1
C005	3-NOR	0.23	0.16	1.65	1.13	0
		0.85	0.52	6.1	3.05	1
C007	Clock Buffer	0.07	0.13	0.45	0.55	0
		0.24	0.33	1.45	1.65	1
C008	Inverter	0.095	0.16	0.6	0.75	0
		0.36	0.52	2.35	2.6	1
C011	2-XOR	0.11	0.16	2.6	2.5	0
		0.54	0.53	5.8	5.65	1
C023	D Flip-Flop					
	CLK to Q	0.71	0.59	5.12	4.38	0
		1.02	0.94	7.0	6.25	1
	CLK to Q_B	0.35	0.54	2.38	3.3	0
		0.64	0.98	5.37	6.62	1
C009	TRI-STATE Inverter	0.18	0.18	1.2	1.35	0
		0.60	0.70	4.25	4.15	1
C010	TRI-STATE Buffer	0.30	0.27	1.9	1.8	0
		0.53	0.53	3.4	3.4	1
I_4	CMOS Inverting Input Buffer	0.23	0.19	0.85	0.70	0
		0.45	0.39	2.30	1.80	1
I_1	TTL Input Buffer	0.33	0.39	2.0	2.45	0
		0.60	0.78	3.70	4.80	1
I_6	CMOS Short Circuit Input	0.04	0.04	0.07	0.07	0
		0.15	0.15	0.50	0.50	1
IO_1	TTL Input	0.33	0.39	2.0	2.45	0
(Note 2)		0.60	0.78	3.7	4.8	1
	Output	0.62	0.78	4.4	5.75	15
		1.15	1.55	7.0	9.75	50
IO_2	CMOS Inverting Input Buffer	0.23	0.19	0.85	0.70	0
(Note 2)		0.45	0.39	2.30	1.80	1
	Output	0.62	0.78	4.40	5.75	15
		1.15	1.55	7.0	9.75	50
IO_3	CMOS Short Circuit Input	0.04	0.04	0.07	0.07	0
(Note 2)		0.15	0.15	0.50	0.50	1
	Output	0.62	0.78	4.40	5.75	15
		1.15	1.55	7.0	9.75	50
IO_4	Output	0.65	0.63	4.75	4.5	15
(Note 2)		1.17	1.45	8.25	8.25	50

Note 1: These are sample propagation delay specifications for a sample application. Actual specifications are determined by simulation of the customer's circuit.

Note 2: Input pulse = 1 MHz; 50% duty cycle; $t_r = t_f = 6$ ns; CMOS = 0V to 5V; TTL = 0V to 3V.
$t_r = t_f = 2.5$ ns for 2-micron
Voltage Derate = 1.5%/100 mV from 4.5V to 5V
Temperature Derate = 0.14%/°C from 100°C to −55°C
0.4%/°C from 100°C to 140°C

Best-Case	Worst-Case
Temperature = −40°C	Temperature = 100°C
Supply Voltage = 5.5V	Supply Voltage = 4.5V
Extreme Process	Extreme Process
(Fastest)	(Slowest)

Gate Array/Standard Cell Library

Name	GA Cells	SCL Grids	Description
GATES			
C001	1/3	3	2-Input NAND Gate
C002	1/2	4	3-Input NAND Gate
C003	1/2	5	2-Input NAND Gate with Complement
C004	1/3	3	2-Input NOR Gate
C005	1/2	4	3-Input NOR Gate
C006	1/2	5	2-Input NOR Gate with Complement
C011	1	8	2-Input Exclusive OR Gate
C014	1	7	4-Input OR-NAND Gate with Complement
C015	1	8	4-Input AND-OR Gate with Complement
C017	2/3	5	4-Input NAND Gate
C018	2	6	5-Input NAND Gate (2X Drive)
C019	2/3	6	3-Input NAND Gate with Complement
C020	2/3	5	4-Input NOR Gate
C021	2	6	5-Input NOR Gate (2X Drive)
C022	2/3	6	3-Input NOR Gate with Complement
C046	3	18	4-Input Exclusive-OR Gate
C047	2	16	3-Input Exclusive-OR Gate
C048	1	8	2-Input Exclusive-NOR Gate
C053	1	8	2-Input Exclusive-NOR Gate (2X Drive)
C057	2	8	5-Input NAND Gate with Complement
C058	2	8	5-Input NOR Gate with Complement
C800	2	16	3-Input Exclusive-NOR Gate (2X Drive)
C801	3/4		4-Input Exclusive-NOR Gate
C830	2	9	8-Input NAND Gate with Complement
C878	2	9	8-Input NOR Gate with Complement
BUFFERS			
C007	1/3	3	Inverter (2X Drive)
C008	1/4	2	Inverter
C009	1/2	4	TRI-STATE Inverter
C010	1	8	TRI-STATE Buffer
C025	1	7	Schmitt Trigger (2X Drive)
C043	1	4	Inverter (4X Drive)
C044	1/2	4	Inverter (3X Drive)
C045	1	6	Inverter (1X Drive) with Complement (3X Drive)
C049	1	6	Inverter (2X Drive) with Complement (2X Drive)
C061	1	6	Inverter (3X Drive) with Complement (1X Drive)
C808	1		Quad Pull-Down Buffer with Common Enable-Bar
C811	2	29	Quad Pull-Down Buffer with Decoder for 6 Enable-Bars
C812	2		Quad Pull-Up Buffer with Decoder for 6 Enables
C832	1	6	Quad Pull-Up Buffer with Common Enable
LATCHES			
C012	1	8	NAND Latch and 2-Input NAND Gate
C013	1	8	NOR Latch and 2-Input NOR Gate
C026	2	13	1-Bit D-Latch with Reset-Bar and Enable-Bar
C027	2/3	5	NAND Latch with Reset-Bar and Set-Bar
C031	2/3	5	NOR Latch with Reset and Set
C062	2	15	D-Latch with Reset-Bar and Set
C072	1		D-Latch with Enable
C073	1		D-Latch with Enable-Bar

Name	GA Cells	SCL Grids	Description
MULTIPLEXERS AND DEMULTIPLEXERS			
C016	1	9	2 to 1 Multiplexer
C028	3	21	4 to 1 TRI-STATE Multiplexer
C029	3	20	4 to 1 Multiplexer
C033	4	19	2 to 4 Decoder
C056	1	9	2 to 1 Multiplexer
C138	6		3 to 8 Decoder
C151	6		8 to 1 Multiplexer with Strobe
C157	4	37	Quad 2 to 1 Multiplexer with Select-Bar and Enable-Bar
C257	4		Quad 2 to 1 Multiplexer with Select-Bar and Enable-Bar
REGISTERS AND COUNTERS			
C038	5	35	Presettable Up/Down Counter
C039	5	38	2-Bit Register with Serial-In and Serial/Parallel Out
C042	6	41	2-Bit Shift Register with Serial/Parallel-In and Serial/Parallel-Out
C194	5		1-Bit Universal Shift Register
C871	4		Binary Counter Control Logic
MEMORY BLOCKS FOR GATE ARRAYS			
C065	30		8 × 2 Static RAM
C066	42		8 × 4 Static RAM
C067	66		8 × 8 Static RAM
C068	90		8 × 12 Static RAM
ARITHMETIC FUNCTIONS			
C030	3	18	4-Bit Parity Checker
C032	3	17	1-Bit Full Adder
C040	6	42	7 Function 1-Bit ALU
C041	6	48	2-Bit Magnitude Comparator
FLIP-FLOPS			
C023	2	16	D Flip-Flop
C024	3	19	D Flip-Flop with Set-Bar and Reset-Bar
C034	4		D Flip-Flop with Reset and Parallel Data In with Load-Bar
C035	4	29	Multiplexed D Flip-Flop with Reset
D035			Dedicated Multiplexed D Flip-Flop with Reset
C036	4	22	T Flip-Flop with Toggle Enable and Reset-Bar
C037	5	25	J-K Flip-Flop with Reset and Set
C059	2		D Flip-Flop (2X Drive)
C060	3		D Flip-Flop with Reset-Bar and Set-Bar
C063	4		Multiplexed D Flip-Flop
C064	2	18	D Flip-Flop with Reset
C070	4	24	Multiplexed D Flip-Flop with Reset
C071	4	25	J-K Flip-Flop with Reset and Set
C861	4		T Flip-Flop with Reset-Bar and Parallel Enable

Input Buffers

	TTL Inputs			CMOS Inputs						Schmitt Trigger Inputs		
	Non-Inverting			Inverting			Non-Inverting			Non-Inverting		
	1X	7X	15X	1X	7X	15X	1X	7X	15X	1X	7X	15X
No Resistor	I2* I07* IBON	IB2N	IB4N	I4* I09* IEON	IE2N	IE4N	IFON	IF2N	IF4N	IKON	IK2N	IK4N
With Pull-Up	I1* I06* IBOU	IB2U	IB4U	I3* I08* IEOU	IE2U	IE4U	IFOU	IF2U	IF4U	IKOU	IK2U	IK4U
With Pull-Down	IBOD	IB2D	IB4D	IEOD	IE2D	IE4D	IFOD	IF2D	IF4D	IKOD	IK2D	IK4D

*Available for 6212, 6225 and standard cells. All other input buffers available for 6206, 6218, 6232, 6244, 6287 and standard cells.

Bidirectionals

	TTL I/Os			CMOS I/Os						Schmitt Trigger I/Os		
	Non-Inverting			Inverting			Non-Inverting			Non-Inverting		
	1 mA	2 mA	4 mA	1 mA	2 mA	4 mA	1 mA	2 mA	4 mA	1 mA	2 mA	4 mA
No Resistor	BBOB1N	BBOB2N	BBOB4N	BEOB1N	BEOB2N	BEOB4N I02*	BFOB1N	BFOB2N	BFOB4N	BKOB1N	BKOB2N	BKOB4N
With Pull-Up	BBOB1U	BBOB2U	BBOB4U I012*	BEOB1U	BEOB2U	BEOB4U I013*	BFOB1U	BFOB2U	BFOB4U	BKOB1U	BKOB2U	BKOB4U
With Pull-Down	BBOB1D	BBOB2D	BBOB4D	BEOB1D	BEOB2D	BEOB4D	BFOB1D	BFOB2D	BFOB4D	BKOB1D	BKOB2D	BKOB4D

*Available for 6212, 6225 and standard cells. All other bidirectionals available for 6206, 6218, 6232, 6244, 6287 and standard cells.

TTL/CMOS Output Buffers

Inverting			Non-Inverting		
1 mA	2 mA	4 mA	1 mA	2 mA	4 mA
YC1	YC2	YC4	YD1	YD2	YD4 I04*

*Available for 6212, 6225 and standard cells. All other output buffers available for 6206, 6218, 6232, 6244, 6287 and standard cells.

Oscillators (with non-inverting Schmitt trigger inputs)

	Output DriveYA	No Resistor		With Pull-Up		With Pull-Down	
	Output Drive BP1	2X	15X	2X	15X	2X	15X
Standard	1 mA		OK4C1N		OK4C1U		OK4C1D
	2 mA		OK4C2N		OK4C2U		OK4C2D
	4 mA	I043*	OK4C4N		OK4C4U	I045*	OK4C4D
Gated	1 mA		OK4J1N		OK4J1U		OK4J1D
Low Power	1 mA	OK4CL0					

*Available for 6212, 6225 and standard cells. All other oscillators available for 6206, 6218, 6232, 6244, 6287 and standard cells.

Dedicated Multiplexed D Flip-Flops

A number of dedicated multiplexed D flip-flops is incorporated into the internal array core. These flip-flops have been designed to achieve significant system speed improvement over a logically equivalent macrofunction while minimizing silicon space. They are ideal for scan path design techniques as well as for fast registers and counters.

Array Name	Equivalent 2-Input Gates (Note 1)	Input Cells	I/O Cells	Signal Pins	Test Pins	V_{DD} Pins	V_{SS} Pins
SCX6206	600	8	40	48	1	4	4
SCX6212	1260	17	42	59	1	4	4
SCX6218	1806	3	70	73	1	8	8
SCX6225	2430	12	76	88	1	6	6
SCX6232	3162	3	101	104	1	8	8
SCX6244	4380	3	110	113	1	8	8
SCX6287	8700	3	152	155	1	8	8

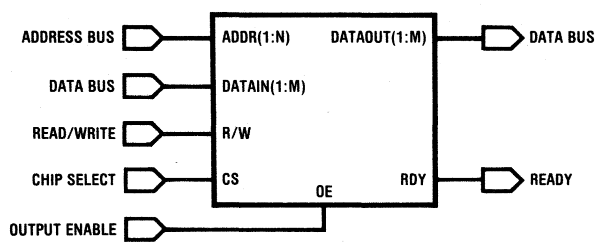
Note 1: Input and I/O cells are not considered part of the internal cell count.

Standard Cell Hardware

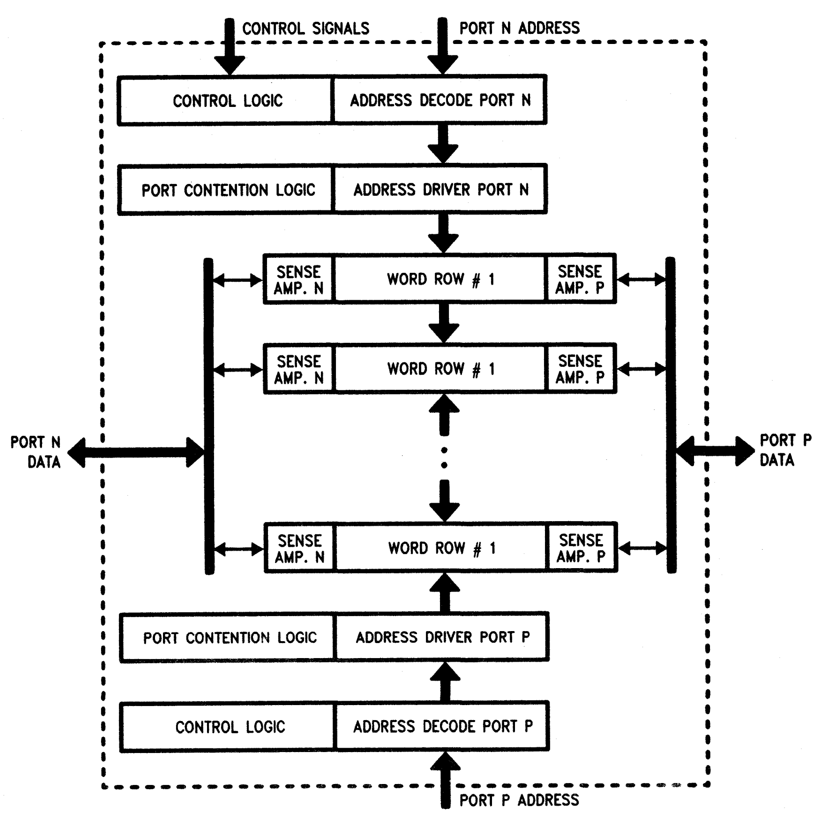
RAMs

- Single Port RAM Blocks:
  64 × 4   32 × 8   16 × 16
  256 × 4   64 × 8   16 × 32
  128 × 8
  256 × 8
  These RAMs are stackable to create larger configurations
- Performance:
  25 ns data access time
  50 ns cycle time
- Other Features:
  —Fully static operation
  —Synchronous
- Dual Port RAM Macros:
  4 × 4   4 × 8   4 × 9   4 × 16   4 × 18
  8 × 4   8 × 8   8 × 9   8 × 16   8 × 18
  16 × 4   16 × 8   16 × 9   16 × 16   16 × 18
  32 × 4   32 × 8   32 × 9   32 × 16   32 × 18
  These RAMs are stackable to create larger configurations.
- Performance:
  25 ns data access time
  40 ns cycle time
- Other Features:
  —Fully static operation
  —Built in contention logic

Block Diagram (Single Port RAM)



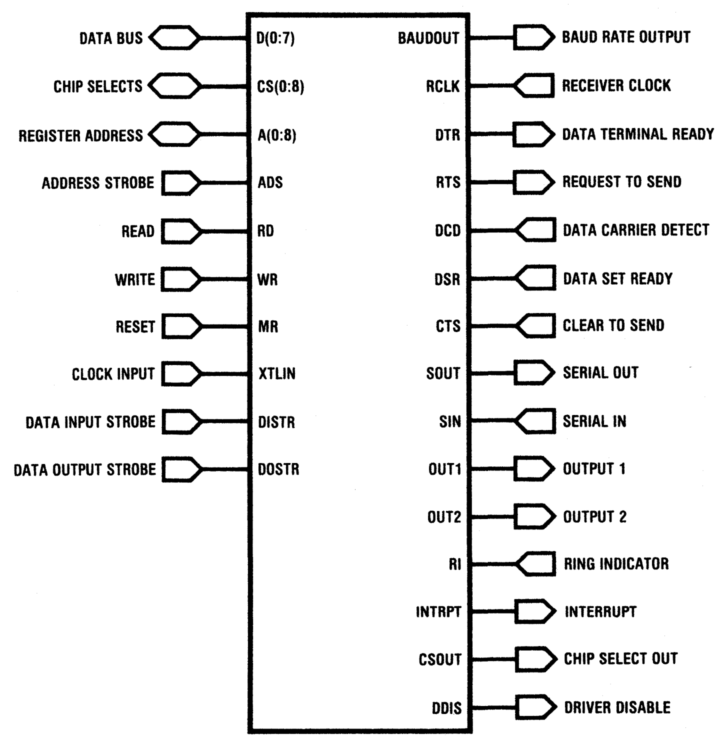
Block Diagram (Dual Port RAM)



UART (INS82C50B/82C50A/16C450)

- Features:
  - —Parallel communication with 8-bit data bus
  - —Standard asynchronous serial communication (RS-232)
  - —Fully programmable serial interface (PARITY, STOP, BITS, BAUD)
  - —Baud rate generator (divide by 1 to $2^{16} - 1$, 10 MHz clock)
  - —Independent receiver clock input
  - —MODEM control functions (CTS, TTS, DSR, DTR, RI, Carrier Detect)
  - —Complete status reporting capabilities
  - —Line break generation and detection
  - —Internal diagnostic capabilities
  - —Prioritized, independently controlled interrupts (4 levels)

Block Diagram (UART)



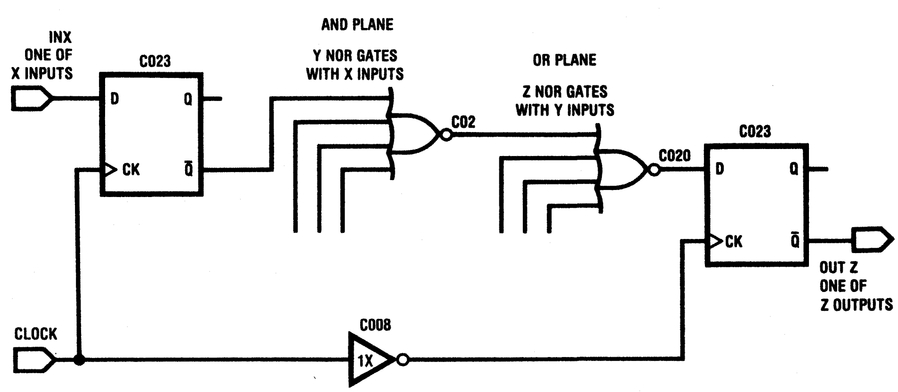
PLA

- Sizes:

Inputs (X)	Products (Y)	Outputs (Z)
8	16	4
8	32	8
16	32	8
16	48	8
24	32	8
24	48	8
24	48	12

- Performance:
  30 ns clock cycle (minimum)
  15 ns propagation delay time (one-half clock cycle)
- Other Features:
  - —Latched inputs and outputs
  - —Domino-type synchronous design
  - —One system clock required
  - —Fixed configurations using NOR-NOR logic

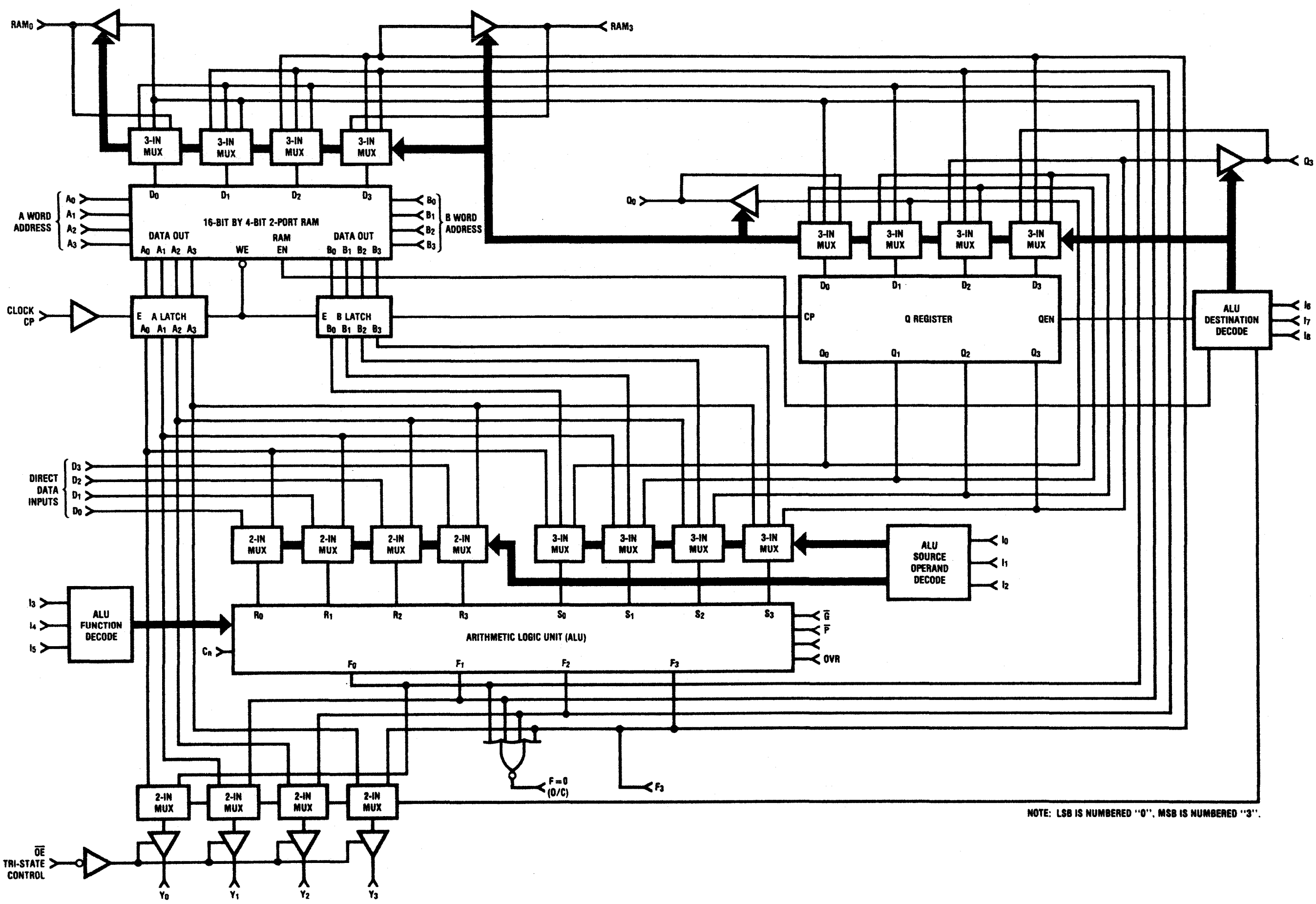
Block Diagram (PLA)



4-Bit Microprocessor (IDM2901)

- Features:
  - —Expandable from 4-bits to 32-bits
  - —32 × 4 internal scratchpad
  - —9-bit microinstruction words
  - —Multifunction ALU (ADD, SUB, OR, AND, XOR, XNOR)
  - —Left/right shift independent of ALU
  - —Four status flags (CARRY, OVERFLOW, ZERO, SIGN)
  - —Flexible data-source selection

Block Diagram (4-Bit Microprocessor)



The Design Automation System

Netlist Translators for Standard Cell Designs

Once a netlist and pattern file have been transferred to mainframe, a netlist translator will convert the design description into the National Hardware Description Language (NHDL). Two translation programs are available. One program simply converts the pinlist format into NHDL.

The second program is an intelligent gate array macro converter. This program can convert any National Semiconductor gate array cell into the equivalent standard cell. In addition, the program recognizes unused logic gates and removes them from the circuit netlist. A complete report of these transactions is generated for the user's inspection.

Design Check

In the next step, a design check is performed on your netlist and pattern files. This is essentially a "network integrity check" which verifies the electrical integrity and connectivity of the user's netlist and checks the pattern file's correlation to the netlist. The program looks for syntax errors, open inputs, shorted outputs, excessive fanouts, and a host of other potential design problems.

Logic Simulation and Timing Analysis

The simulator takes the user's NHDL netlist and pattern files, calculates delays for the individual functions based on estimated wire lengths, and converts the files into a format which can be used by the logic simulator.

The user then runs the simulator to verify the logical function of the netlist and pattern files. A simulation post processor is also available to simplify simulation output analysis. (Its function is very similar to a benchtop logic analyzer.)

Automatic Place and Route

The complete layout of your IC is accomplished using the latest development in automated place and route software.

The program is controlled by an AUXILIARY file, which allows the user to specify pin-out, bonding information, forced cell placement, and signal priority weighting factors. These features and others allow the user to specify layout parameters which can, in some cases, drastically affect circuit performance and silicon efficiency. If these factors are not specified, the program has intelligent algorithms which can make decisions automatically to optimize silicon area.

This program also offers the ability to place variable height/variable width functional blocks on the chip. This readily facilitates the use of (VLSI) functions which can be pre-defined and used in the circuit to save development time and increase silicon area efficiency.

Following layout, the actual wire lengths of interconnect within the IC are extracted for use in post route logic simulation.

Post Route Logic Simulation

The circuit is once again simulated, this time based on actual wire lengths. The user can now re-run the logic simulator to verify that the circuit's performance still meets the designer's system requirement.

Layout Verification

As an added service to the user, National performs a layout verification step.

Completed by National Semiconductor's engineering staff, the program is run to verify the physical layout of the circuit. The program is actually a series of program modules which checks particular aspects of the design.

The first program module is the Layout Design Rule Check, which is also referred to as DRC. This step compares the physical geometries of the layout against process design rules. The geometries are checked for spacing, width, overlap and a variety of other parameters which can affect circuit operation.

The second module is the Electrical Rule Check, or ERC. This program analyzes the physical layout for gross electrical errors such as shorted power supply lines and disconnected transistors.

The final program module run is Layout Versus Schematic, or LVS. This program generates a binary format netlist from the user's layout and compares it against a compiled form of the user's NHDL netlist file. It's purpose is to guarantee that every transistor specified in the user's netlist is represented correctly in the physical layout.

After completing this rigorous evaluation, the IC masks are generated and the wafers fabricated.

Testing the Chips

A test program for the automatic tester is derived automatically from the user's final logic simulator pattern file.

The finished wafers are tested using this program before the chips are packaged. At this point, the chips are tested for functional specifications at room temperature and nominal power supply voltage according to the customer's specifications.

The chips are packaged in one of National's packaging facilities and re-tested according to the customer's specification and delivered to the customer as prototypes for evaluation. Upon approval of these prototypes by the customer, production can begin.

Database Management System

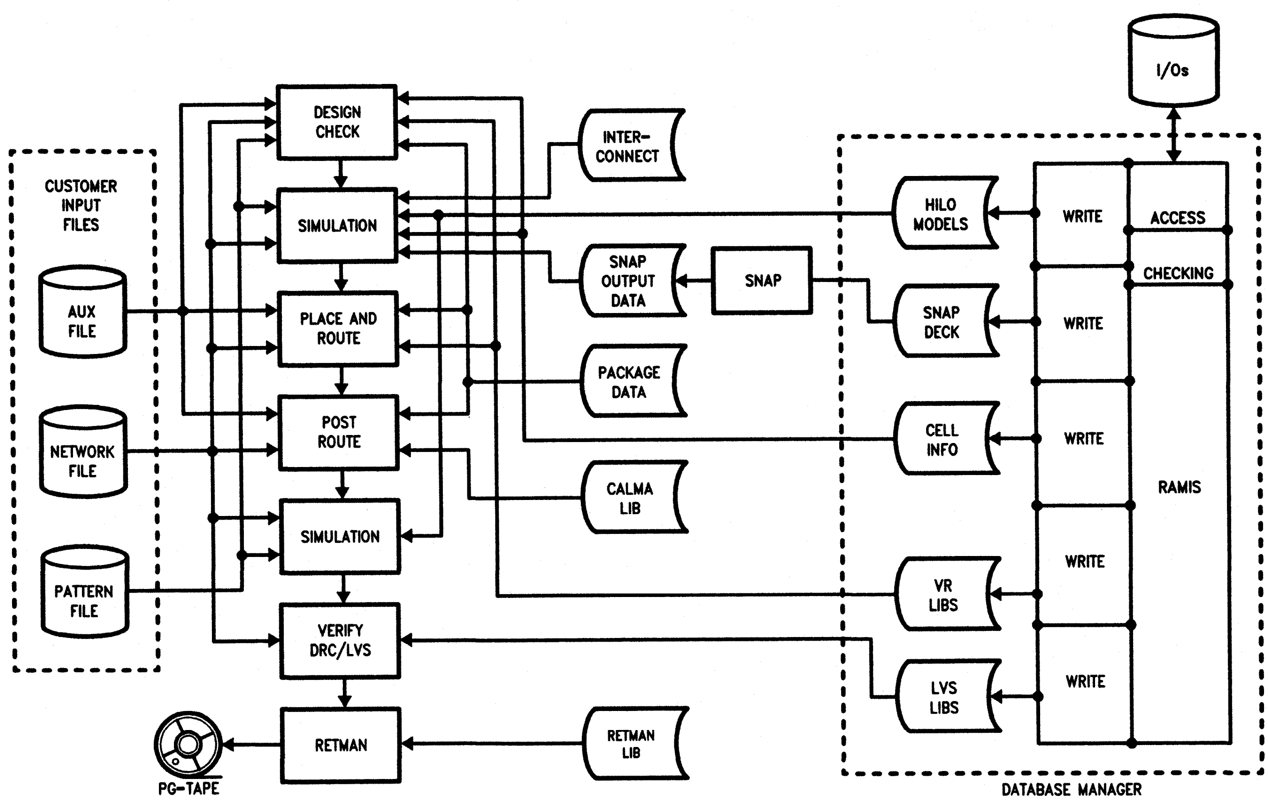
National Semiconductor's ASIC data is managed using a centralized database system revolving around a single database file and a commercial database program. In-house software has been written around this package tailoring input and output to suit the requirements of each software package used during the Design Automation cycle. The system provides full archiving of all cell revisions, enabling fast and accurate updates to cells, and recreation of any particular data environment on demand.

Input to the system is designed to take in all data for a single cell with one input file. The input file encompasses all information necessary to the running of any phase of the Design Automation cycle (i.e., design check, timing analysis, place and route, etc.). Revision control is handled automatically with each addition or update.

All input files needed by any of the applications in the Automated Design System are automatically regenerated after each update of the central database. In this way, customers are guaranteed that any additions to the standard cell family will be made available with minimal turnaround time.

The centralized database scheme allows for easy incorporation of new Design Automation tools as they are developed. New output formats for existing data are easily defined, and additional data needs may be incorporated into the database scheme without disturbing existing data.

Database Management System

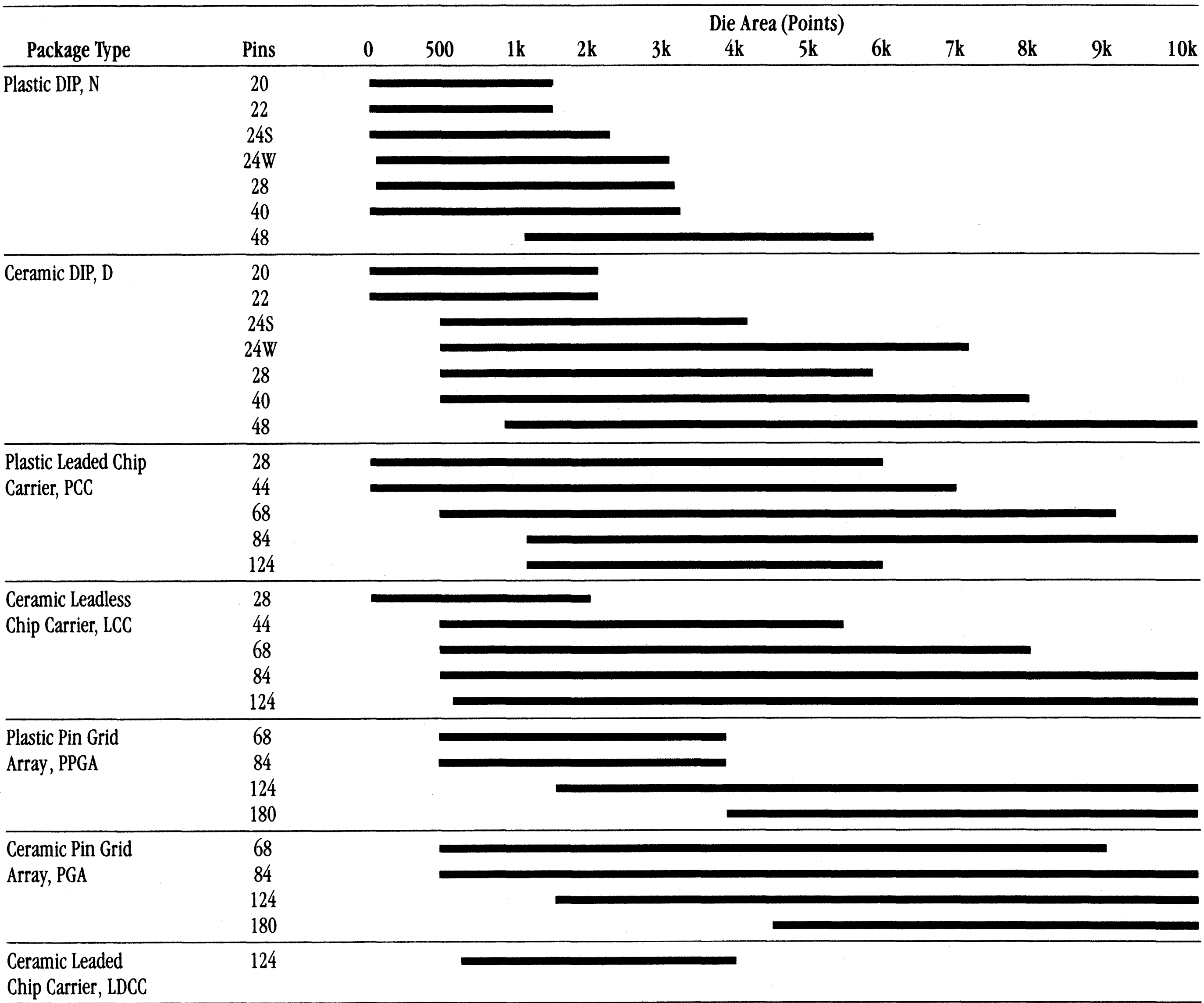


Packaging Information Gate Array

Package Type	Pins	6206	6212	6218	6225	6232	6244	6287
Plastic DIP, N	8	X						
	14	X						
	16	X						
	18	X						
	20	X						
	22	X	X					
	24S	X						
	24W	X	X	X	X	X	X	
	28	X	X	X	X	X	X	
	40	X	X	X	X	X	X	
	48	X	X	X	X	X	X	
Ceramic DIP, D (Side Braze)	8	X						
	14	X						
	16	X						
	18	X						
	20	X						
	22	X	X					
	24S	X						
	24W	X	X	X	X			
	28	X	X	X	X			
	40	X	X	X	X	X	X	
	48	X	X	X	X	X	X	
Plastic Leaded Chip Carrier, PCC	28	X	X	X	X	X	X	
	44	X	X	X	X	X	X	
	68	X	X	X	X	X	X	X
	84				X	X	X	X
Ceramic Leadless Chip Carrier, LCC	28	X	X	X				
	44	X	X	X	X	X	X	
	68	X	X	X	X	X	X	
	84				X	X	X	
	124				X	X	X	
Ceramic Leaded Chip Carrier, LDCC	124				P	P	P	P
Plastic Pin Grid Array, PPGA	68	X	X	X	X	X	X	
	84			X	X	X	X	
	124				X	X	X	X
Ceramic Pin Grid Array, PGA	68	X	X	X	X	X	X	
	84			X	X	X	X	
	124				X	X	X	

X = Available Now P = prototypes only

Packaging Information Standard Cells



Interface

For additional Interface products, see page 239.

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

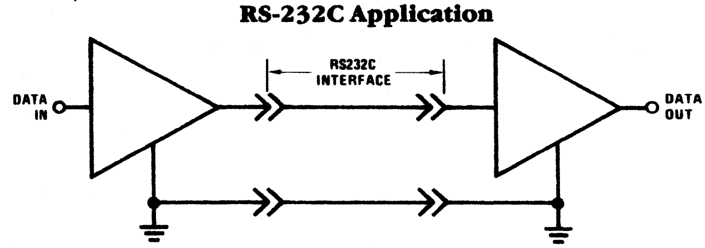
When transmitting at very high data rates, over long distances and through noisy environments, single-ended transmission is often inadequate. In these applications, differential transmission nullifies the effects of ground shifts and noise signals which appear as common-mode voltages on the transmission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

RS-422

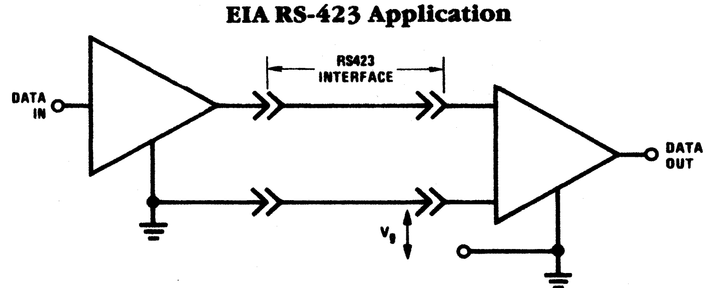
RS-422 was defined by the EIA for this purpose and allows data rates up to 10 Mbaud (up to 40 ft.) and line lengths up to 4000 feet (up to 100 kbaud).

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.

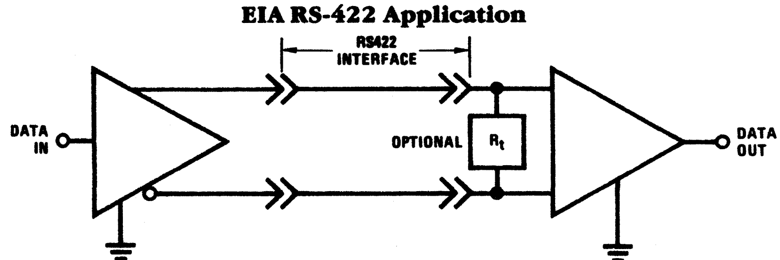
RS-232C Application



EIA RS-423 Application



EIA RS-422 Application



RS-485

To meet the need for truly multipoint communications, the EIA established RS-485 in 1963. 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.

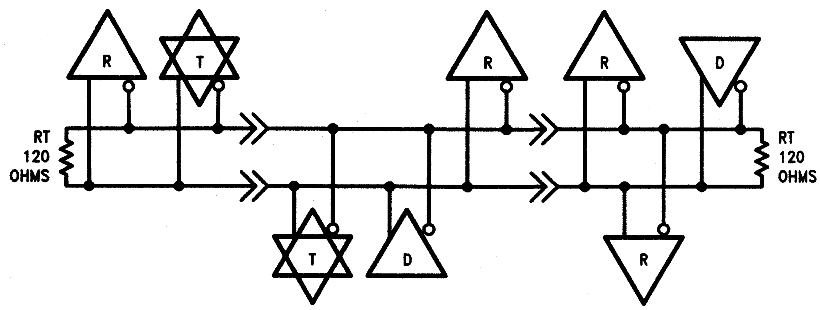
The key features of RS-485:

- 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.

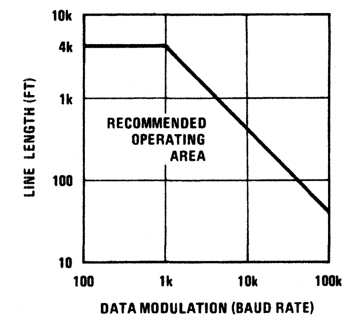
RS-485 Application



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	− 0.25 to + 6V	− 7V to + 12V
Driver Output Signal Level	Loaded	± 3.6V	± 3.6V	± 2V	± 1.5V
	Unloaded	± 15V	± 6V	± 5V	± 5V
Driver Load Impedance		3 kΩ to 7 kΩ	450Ω min	100Ω	54Ω
Maximum Driver Output Current (High Impedance State)	Power On	—	—	—	± 100 μA
	Power Off	V_{MAX}/300Ω	± 100 μA	± 100 μA	± 100 μA
Slew Rate		30 V/μs max	Controls Provided	—	—
Receiver Input Voltage Range		± 15V	± 12V	− 7V to + 7V	− 7V to + 12V
Receiver Input Sensivity		± 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.



Unbalanced Drivers

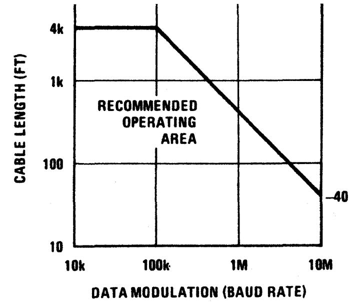
Standard	Device Number and Temperature Range: Commercial 0°C to + 70°C	Military − 55°C to + 125°C	Circuits Per Package	Power Supplies (V)	Open-Collector/ Open-Emitter TRI-STATE	Party-Line Application	Slew Rate Control	Output Current (mA)	Output Voltage (V)	Propagation Delay (ns)	Comments	Package Type
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-423	DS3691	DS1691A	4	+ 5 or ± 5	TRI-STATE	Yes	CEXT	± 20	± 2	200		J, M, 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

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-423	DS26C32		4	5	TRI-STATE							J, M, N
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	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	2	5 to 15	Strobed	CEXT	50	± 25	± 0.2	50	Fail-Safe	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, M
	DS26LS33AC		4	5	TRI-STATE		200	± 15	± 0.5	23	Fail-Safe	J, N, M

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.



Balanced Drivers

Standard	Device Number and Temperature Range: Commercial 0°C to + 70°C	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	DS26C31											J, M, N
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	DS3691	DS1691A	2	+ 5 or ± 5		Yes	Yes	2/ − 20	− 2/20	200		J, M, N
RS-422	DS8921, 21A		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-485	DS3695		1	5		Yes	Yes			15	Transceiver	M, N
RS-485	DS3696		1	5		Yes	Yes			15	Transceiver with Line Fault Reporting	M, N
RS-485	DS3697		1	5		Yes	Yes			15	Repeater	M, N
RS-485	DS3698		1	5		Yes	Yes			15	Repeater with Line Fault Reporting	M, N
RS-485	DS75176A		1	5		Yes	Yes				Transceiver	N, J, M
	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
	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 Receivers

Standard	Device Number and Temperature Range: Commercial 0°C to + 70°C	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	DS26C32		4		TRI-STATE							J, M, N
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	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-485	DS3695		1	5	TRI-STATE		70	+ 12/ − 7	± 200	22	Transceiver	M, N
RS-485	DS3696		1	5	TRI-STATE		70	+ 12/ − 7	± 200	22	Transceiver with Line Fault Reporting	M, N
RS-485	DS3697		1	5	TRI-STATE		70	+ 12/ − 7	± 200	22	Repeater	M, N
RS-485	DS3698		1	5	TRI-STATE		70	+ 12/ − 7	± 200	22	Repeater with Line Fault Reporting	M, N
RS-485	DS75176A		1	5	TRI-STATE		70	+ 12/ − 7	± 200		Transceiver	J, M, 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

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 crosstalk. 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 DS3862 Trapezoidal Bus Transceivers and DS3896 and DS3897 Future Bus 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 Future Bus 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 subsystem'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	6-Bit Bus Comparator	J, N
DM8136	DM7136	1	Receiver			30	0.95/50	2/50	0.65	6-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
DS3893		4	Transceiver	7		8				TURBOTRANSCEIVER	V
DS3896		8	Transceiver							Futurebus Transceiver	J, N
DS3897		4	Transceiver							Futurebus Transceiver	J, N, V
DS3898		8	Repeater	30						Futurebus Repeater	J, N
DS75450	DS55450	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

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
DP83BC04		8	Transceiver									J, N
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
DP83BC08		8	Transceiver									J, N
DS3647		4	Transceiver	8	0.5/50	2.4/ − 5	7	0.8/ − 500	2/100		Quad Bidirectional I/O Register	D, N
DS3666		8	Transceiver	20	0.5/48	2.5/ − 5.2	20	0.8/ − 100	2/20	400	IEEE 488 GPIB	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	DS7839	4	Transceiver	14	0.5/50	2.4/ − 10	20	0.8/ − 40	2/80	400	Non-Inverting	J, N
DS8940		9	Transceiver		0.5/48	2.5/ − 15		0.8/ − 500	2/50		9-Bit Latchable	J, N
DS8941		9	Transceiver		0.5/48	2.5/ − 15		0.8/ − 500	2/50		9-Bit Latchable	J, N, V

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

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.

Device Number and Temperature Range			
−55°C to +125°C	0°C to +70°C	Description	Packaging Information
DP7310	DP8310	Octal Latched Peripheral Drivers	J, N
*DP7311	DP8311	Octal Latched Peripheral Drivers	J, N
*DS1631	DS3631	Dual AND CMOS Peripheral Driver	J, N, H
*DS1632	DS3632	Dual NAND CMOS Peripheral Driver	J, N, H
DS1633	DS3633	Dual OR CMOS Peripheral Driver	J, N, H
*DS1634	DS3634	Dual NOR CMOS Peripheral Driver	J, N, H
—	DS3654	Printer Solenoid Driver	J, N
—	DS3656	Quad Peripheral Driver	N
—	DS3658	Quad High Current Peripheral Driver	N
—	DS3668	Quad High Current Peripheral Driver	N
—	DS3669	Quad High Current Peripheral Driver	N
—	DS3680	Quad Negative Voltage Relay Driver	J, M, N
—	DS3686	Dual Positive Voltage Relay Driver	H, J, N
*DS1687	DS3687	Dual Negative Voltage Relay Driver	H, J, N
—	DS75450	Dual AND Peripheral Driver	J, N
*DS55451	DS75451	Dual AND Peripheral Driver	J, M, N
*DS55452	DS75452	Dual NAND Peripheral Driver	J, M, N
*DS55453	DS75453	Dual OR Peripheral Driver	J, M, N
DS55454	DS75454	Dual NOR Peripheral Driver	J, M, N
DS55461	DS75461	Dual AND Peripheral Driver	J, N, H
*DS55462	DS75462	Dual NAND Peripheral Driver	J, N, H
*DS55463	DS75463	Dual OR Peripheral Driver	J, N, H
*DS55464	DS75464	Dual NOR Peripheral Driver	J, N, H
—	MM74C908	Dual CMOS 30V Driver	N
—	MM74C918	Dual CMOS 30V Driver	N, J

*Also available processed to various Military screening levels.

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. In addition to further information on the specific device types outlined, useful application note on "Applying Modem Clock Drivers to MOS Memories", AN-76, should be reviewed.

Device Number and Temperature Range			
−40°C to +125°C	0°C to +70°C	Description	Packaging Information
—	DP84240	Octal TRI-STATE MOS Driver	J, N
—	DP84244	Octal TRI-STATE MOS Driver	J, N
—	DS0025C	Two Phase MOS Clock Driver	H, J, N
*DS0026	DS0026C	5 MHz Two Phase MOS Clock Driver	H, J, N
*DS0056	DS0056C	5 MHz Two Phase MOS Clock Driver	H, J, N
—	DS3245	Quad MOS Clock Driver	J, N
DS1628	DS3628	Octal TRI-STATE MOS Driver	J, N
DS1645	DS3645	Hex TRI-STATE MOS Latch/Driver	J, N
—	DS3647A	Quad TRI-STATE MOS Memory I/O Register	D, N
DS1648	DS3648	TRI-STATE TTL to MOS Multiplexer/Driver	J, N
*DS1649	DS3649	Hex TRI-STATE TTL to MOS Driver	J, N
*DS1651	DS3651	Quad High Speed MOS Sense Amplifier	J, N
*DS1674	DS3674	Quad TTL to MOS Clock Driver	J, N
DS1675	DS3675	Hex TRI-STATE MOS Latch Driver	J, N
DS1678	DS3678	TRI-STATE TTL to MOS Multiplexer/Driver	J, N
*DS1679	DS3679	Hex TRI-STATE TTL to MOS Driver	J, N
DS16149	DS36149	Hex MOS Driver	J, N
*DS16179	DS36179	Hex MOS Driver	J, N
	DS75361	Dual TTL to MOS Driver	J, N
	DS75365	Quad TTL to MOS Driver	J, N

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 and Temperature Range			
−55°C to +125°C	0°C to +70°C	Description	Packaging Information
—	DP8480	10k ECL to TTL Level Translator with Latch	F, J, N
—	DP8481	TTL to 10k ECL Level Translator with Latch	F, J, N
—	DP8482	100k ECL to TTL Level Translator with Latch	F, J, N
—	DP8483	TTL to 100k Level Translator with Latch	F, J, N
DS1630	DS3630	Hex CMOS Compatible Buffer	J, N
*DS7800	DS8800	Dual Voltage Level Translator	H
*DS78L12	DS88L12	Hex TTL-to-MOS Inverter/Interface Gate	J, N, W
*MM54C901	MM74C901	Hex Inverting TTL Buffer	J, N
*MM54C902	MM74C902	Hex Non-Inverting TTL Buffer	J, N
*MM54C903	MM74C903	Hex Inverting PMOS Buffer	J, N
*MM54C904	MM74C904	Hex Non-Inverting PMOS Buffer	J, N
*MM54C906	MM74C906	Hex Open Drain N-Channel Buffer	J
*MM54C907	MM74C907	Hex Open Drain P-Channel Buffer	N

*Also available processed to various Military screening levels.

CRT Controllers

DP8350 Series of CRT Display Controllers

The DP8350 Series CRT Controllers are designed to be dedicated CRT display refresh circuits. All necessary video timing signals are provided by the DP8350, including the high-speed dot timing which is generated from an on-chip crystal oscillator. This is possible because of its bipolar processing which allows Schottky circuitry to be used for high speed logic and analog I/O functions while I^2L circuitry is used for lower speed internal logic functions.

A typical DP8350 series application is a data terminal with a raster scan monitor. The DP8350 can be used in systems with or without line buffers, using character ROMs or DM86S64 latch/ROM/shift register circuits. Graphics are possible using either character generator or memory mapped graphics techniques.

The DP8350 Series CRT controllers are mask programmable. Mask programmability simplifies the function and reduces external hardware and software overhead. A list of programmable variables follows.

Mask programmability is an advantage as long as the screen format does not need to change and an existing part (ROM variation) can be used, or production quantities justify a new ROM variation. In addition to the ROM programmable variables, three on-chip registers provide for external control of the row starting address, cursor address and top-of-page address.

Standard parts are the DP8350, DP8352 and DP8353 whose sync signals are compatible with Ball Brothers TV-12 or TV-110, RS170 and Motorola M3000 series respectively.

DP8350 CRT Controller Series Selection Guide

Item No.	Parameter		DP8350 Value		DP8352 Value		DP8353 Value	
1	Character Font Size (Reference Only)	Dots per Character (Width)	(5)		(7)		(7)	
2		Scan Lines per Character (Height)	(7)		(9)		(9)	
3	Character Field Cell Size	Dots per Character (Width)	7		9		9	
4		Scan Lines per Character (Height)	10		12		12	
5	Number of Video Characters per Row		80		32		80	
6	Number of Video Character Rows per Frame		24		16		25	
7	Number of Video Scan Lines (Item 4 × Item 6)		240		192		300	
8	Frame Refresh Rate (Hz)		f1 = 60	f0 = 50	f1 = 60	f0 = 50	f1 = 60	f0 = 50
9	Delay after Vertical Blank Start to Start of Vertical Sync (Number of Scan Lines)		4	30	27	53	0	32
10	Vertical Sync Width (Number of Scan Lines)		10	10	3	3	3	3
11	Interval Between Vertical Blank Start and Start of Video (Number of Scan Lines of Video Blanking)		20	72	68	120	20	84
12	Total Scan Lines per Frame (Item 7 + Item 11)		260	312	260	312	320	384
13	Horizontal Scan Frequency (Line Rate) (Item 8 × Item 12)		15.6 kHz		15.6 kHz		19.20 kHz	
14	Number of Character Times per Scan Line		100		50		102	
15	Character Clock Rate (Item 13 × Item 14)		1.56 MHz		0.78 MHz		1.9584 MHz	
16	Character Time (1 ÷ Item 15)		641 ns		1282 ns		510.6 ns	
17	Delay after Horizontal Blank Start to Horizontal Sync Start		0		6		5	
18	Horizontal Sync Width (Character Times)		43		4		9	
19	Dot Frequency (Item 3 × Item 15)		10.92 MHz		7.02 MHz		17.6256 MHz	
20	Dot Time (1 ÷ Item 19)		91.6 ns		142.4 ns		56.7 ns	
21	Vertical Blanking Output Stop before Start of Video (Number of Scan Lines)		1		0		1	
22	Cursor Enable on All Scan Lines of a Row? (Yes or No)		Yes		Yes		Yes	
23	Does the Horizontal Sync Pulse Have Serrations during Vertical Sync? (Yes or No)		No		Yes		No	
24	Width of Line Buffer Clock Logic "0" State within a Character Time (Number of Dot Time Increments)		4		5		5	
25	Serration Pulse Width, if Used (Character Times)		—		4		—	
26	Horizontal Sync Pulse Active State Logic Level (1 or 0)		1		0		1	
27	Vertical Sync Pulse Active State Logic Level (1 or 0)		0		0		1	
28	Vertical Blanking Pulse Active State Logic Level (1 or 0)		1		1		1	

Video Monitor Format: Ball Brothers TV-12, TV-120 or Equivalent. (DP8350)

Video Monitor Format: RS-170-Compatible (Standard American TV). (DP8352)

Video Monitor Format: Motorola M3003 or Equivalent. (DP8353)

MOS/LSI Display Drivers

National's comprehensive family of display drivers encompasses more than fifteen products. The family 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 six 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 six drivers are cascadable for further expansion. Figure 2 illustrates that with (only) two drivers, the MM58341 and MM58348, one can interface to a 32-character (5 × 7 dot-matrix) VF display. Application note AN-371 provides further details on this and other applications.

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.

Family Product Guide

Detailed features/functions of the 16-member display driver family are highlighted in the following product guide.

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.

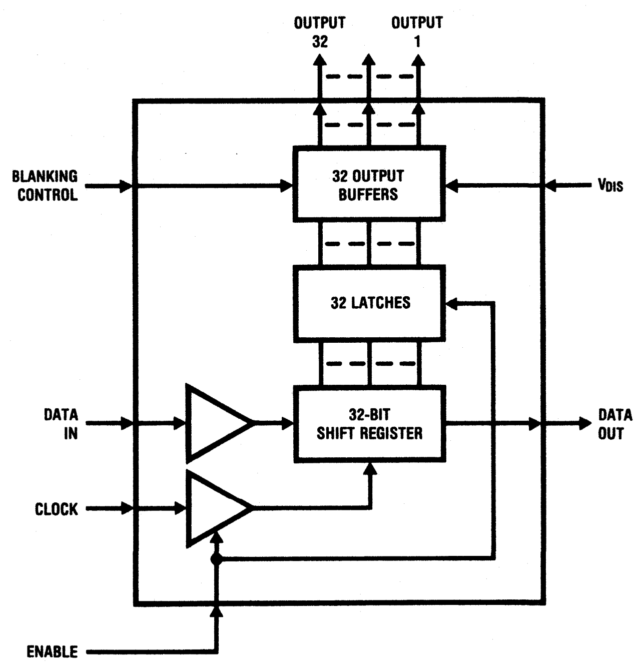


Figure 1. Typical Block Diagram

LSI Display Driver Family Product 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, brightness 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

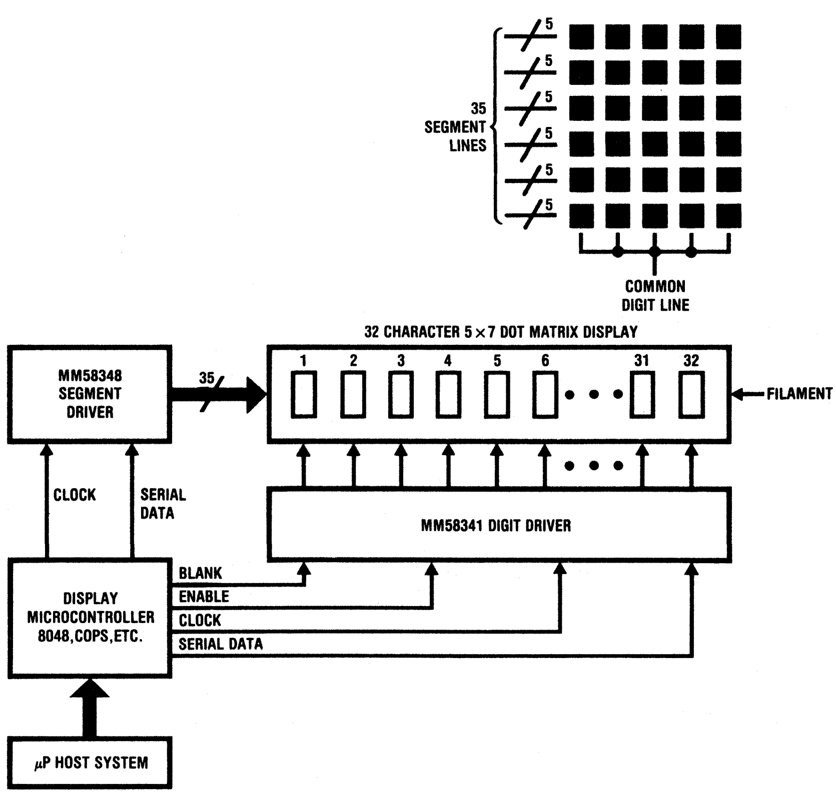


Figure 2. Typical Application of the MM58341 Series High Voltage VF Display Drivers

Bipolar Display Drivers

Simply stated, a display driver is an element which is used to amplify the output of a logic device in order to activate a visual display. Specific display drivers are designed to activate common anode light emitting diodes (LEDs), common cathode LEDs, gas discharge tubes and vacuum fluorescent displays.

National Semiconductor produces a variety of display drivers for all the major display technologies. Refer to the following selection guide.

LED Display Segment Drivers

Device Number and Temperature Range		Drivers/	I_O/Segment (mA)		V_{MAX} (V)			Packaging
0°C to +70°C	−55°C to +125°C	Package	Sink* (Common Anode)	Source (Common Cathode)	Input	Supply	Comments	Information
DS75491		4	50	50	15	10		J, N
DS8859A		6	32		5.5	7	Programmable Output, Active High Latch	J, N
DS8867		8		18	10	7	Constant Current Output	N
DS8654		8		50	36	36		N

*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/	I_O/Segment (mA)		V_{MAX} (V)			Packaging
0°C to +70°C	−55°C to +125°C	Package	Sink (Common Anode)	Source (Common Cathode)	Input	Supply	Comments	Information
DS75491		4		50	10	10		J, N
DS75494	DS55494	6	150		10	10	Enable Control	J, N
DS75492		6	250		10	10		J, N
DS8870		6	350		10	10	DS75492 Pinout, Darlington Output	J, N
DS8863		8	500		15	10		N
DS8963			500		23	18		N
DS8654				50	36	36		N
DS8874			50		10	10	Serial Shift Register Input	N
DS8973			100		10	10	3-Cell Operation—Low Battery Indicator	N
DS3654		10	400		9.5	45	Serial Input	J, N

Gas Discharge Display Drivers

Device Number and Temperature Range		Device Type	Drivers/ Package	Comments	Packaging Information
0°C to +70°C	−55°C to +125°C				
DS8880	DS7880	Cathode Drivers	7	BCD to 7-Segment	J, N
DS8884A			7	BCD to 7-Segment with Comma and DP	N
DS8897A	DS7897A		8	Active Low Inputs	J, N

Vacuum Fluorescent Display Drivers

Device Number and Temperature Range		Device Type	Drivers/ Package	Comments	Packaging Information
0°C to +70°C	−55°C to +125°C				
DS8654		Ground Driver (segments)	8	7-Segment plus DP	N
DS8654		Anode Driver (digit)	8		N
DS8881			16	4 Line BCD Input	N

Printer Drivers

Device Number and Temperature Range		Device Type	Drivers/ Package	Description	Packaging Information
0°C to +70°C	−55°C to +125°C				
DS3680		Mechanical		Relay Hammer	J, M, N
DS3654		Printer		10 Hammer Serial Input Driver	J, N
DS8654				8-Digit Driver	N

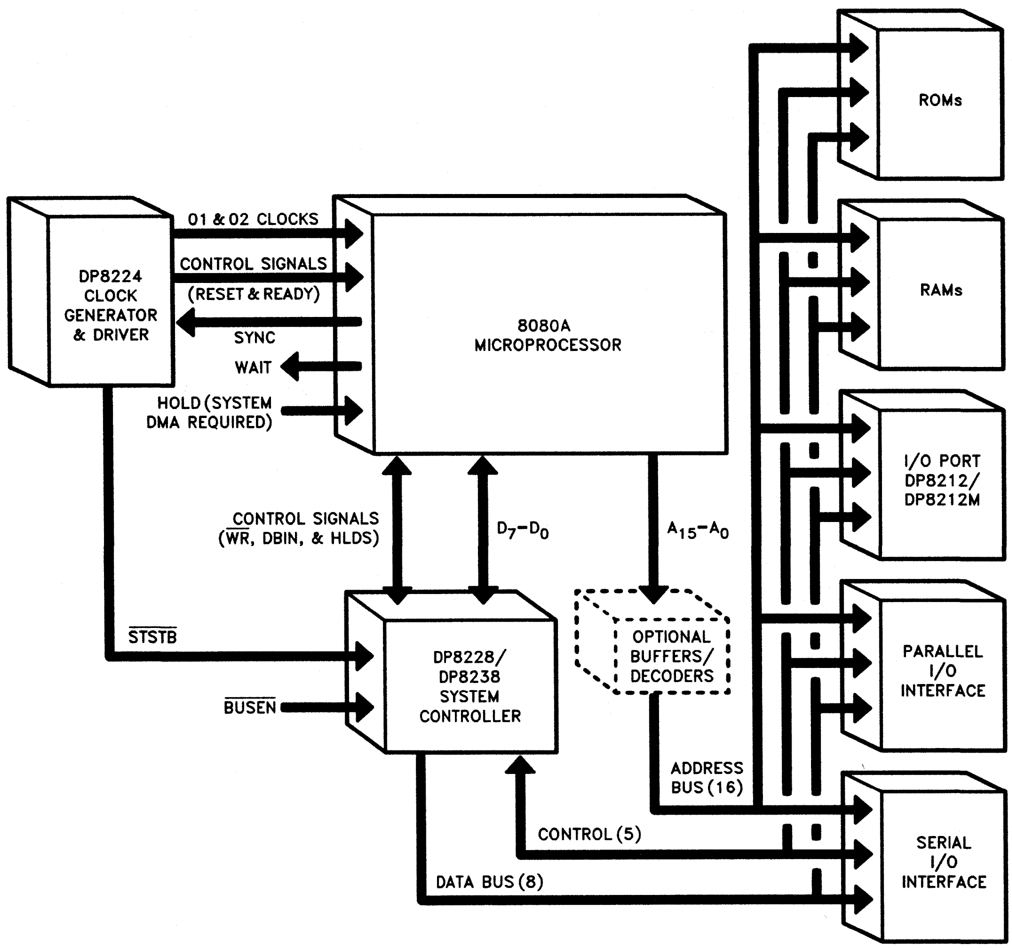
Microprocessor Support

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.

Device Number and Temperature Range			
−55°C to +125°C	0°C to +70°C	Description	Packaging Information
DP8212M	DP8212	8-Bit Input/Output Port	J, N
DP8216M	DP8216	4-Bit Bidirectional Bus Transceiver	J, N
*DP8226M	DP8226	4-Bit Bidirectional Bus Transceiver	J, N
—	DP8224	Clock Generator and Driver	J, N
*DP8228M	DP8228	System Controller and Bus Driver	J, N
DS8238M	DP8238	System Controller and Bus Driver	J, N
—	NS32201	Timing Control Unit	D, N

*Also available processed to various Military screening levels.

National's 8080A Support Circuits



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 this section explains in detail how these two shortcomings of fixed division prescaling are alleviated by using a dual modulus prescaler. A dual mudulus 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 ÷ 20 up to a dual modulus ÷ 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.

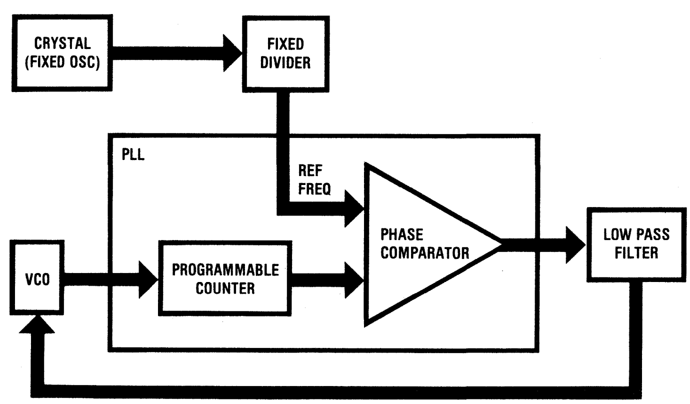


Figure 1

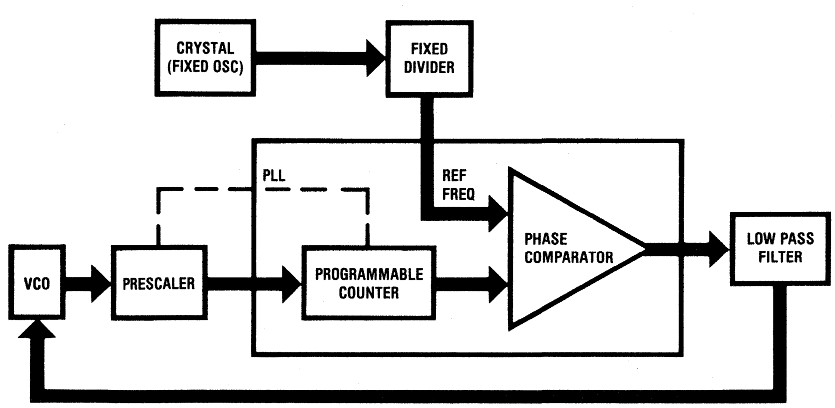


Figure 2

Frequency Synthesis Selection Guide

Device Number	Description	Temperature Range (°C)	Packaging Information
DS8614	130/225 MHz Low Power Dual Modulus Prescalers	− 30 to + 70	N
DS8615	130/225 MHz Low Power Dual Modulus Prescalers	− 30 to + 70	N
DS8616	130/225 MHz Low Power Dual Modulus Prescalers	− 30 to + 70	N
DS8617	130/225 MHz Low Power Dual Modulus Prescalers	− 30 to + 70	N
DS8627	130/225 MHz Low Power Prescalers	− 30 to + 70	N
DS8628	130/225 MHz Low Power Prescalers	− 30 to + 70	N
DS8629	120 MHz Divide-by-100 Prescaler	0 to + 70	N
DS8906	AM/FM Digital Phase-Locked Loop Frequency Synthesizer	0 to + 70	N
DS8907	AM/FM Digital Phase-Locked Loop Frequency Synthesizer	− 40 to + 85	N
DS8908	AM/FM Digital Phase-Locked Loop Frequency Synthesizer	− 40 to + 85	N
DS8911	AM/FM/TV Sound Up Conversion Frequency Synthesizer	− 40 to + 85	M, N, V
DS8912	AM/FM/TV Sound Up Conversion Frequency Synthesizer	− 40 to + 85	M, N, V

Real Time Clocks The RTC Family—MM58167A, MM58174A, MM58274

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 5μA 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 MM58274

The newest member of National's RTC family is the MM58274. The MM58274 is pin-compatible to the industry-popular MM58174A. Easy system upgrade from the MM58174A to the MM58274 is possible with only a system software change. The MM58274 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 MM58274 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

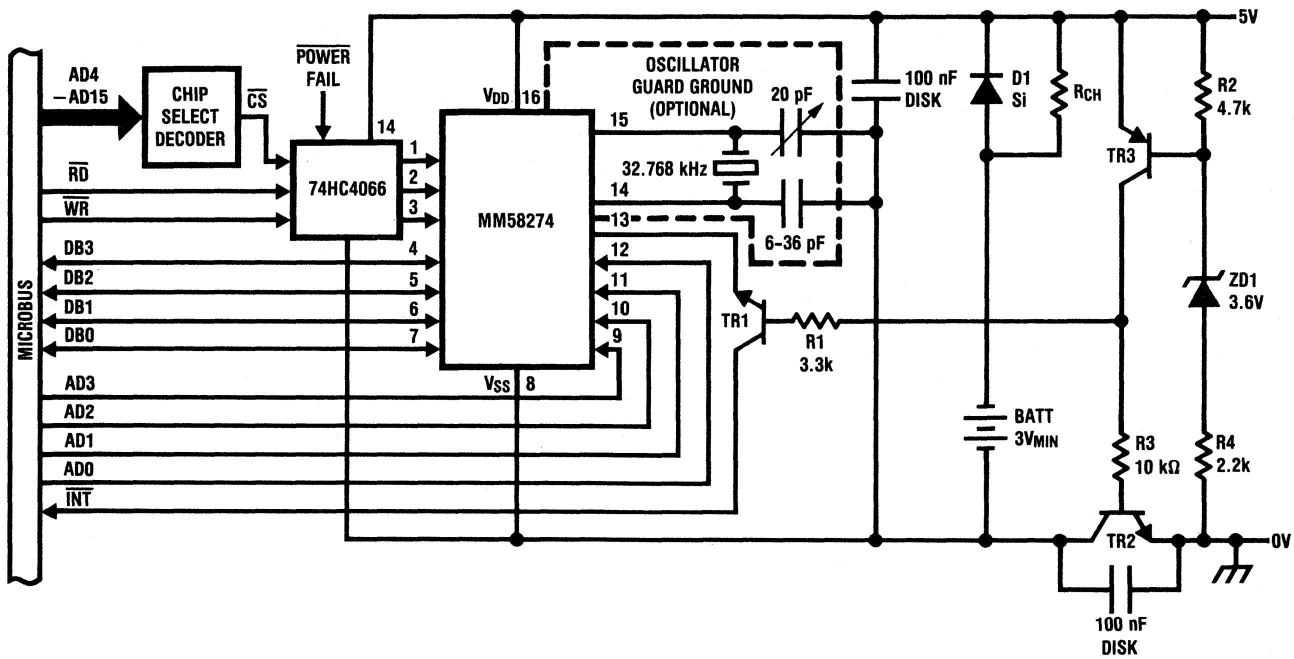
The Real-Time Clock family demonstrates National's capability and commitment to CMOS/LSI—the technology of the 80's.

RTC Family Comparison Guide

Features	MM58167A	MM58174A	MM58274
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	850 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	4–5.5V	4–5.5V	4–5.5V
Standby	2.0V 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 PCC	16* DIP	16* DIP 20 PCC

*Same Pinouts

Typical MM58274 RTC System Diagram



The TCP Family—DP8570, DP8571, DP8572, DP8573

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.

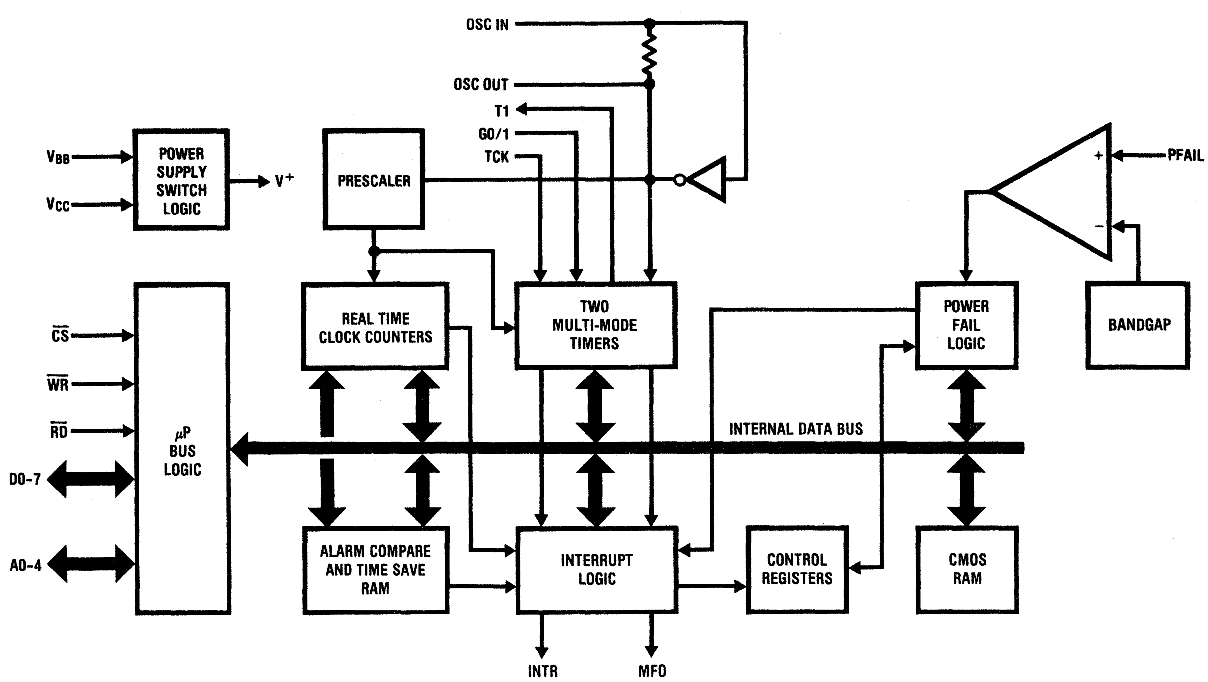
Powerfail Detect and RAM — On-Chip

This advanced RTC family minimizes the complex external circuitry required for powerfail by integrating auto powerfail detect and transition to external battery backup on-chip. A user-selectable reference gives the system designer detect threshold flexibility with minimal external components. 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 DP8571, DP8572, and DP8573, are socket compatible.

DP8570 Block Diagram

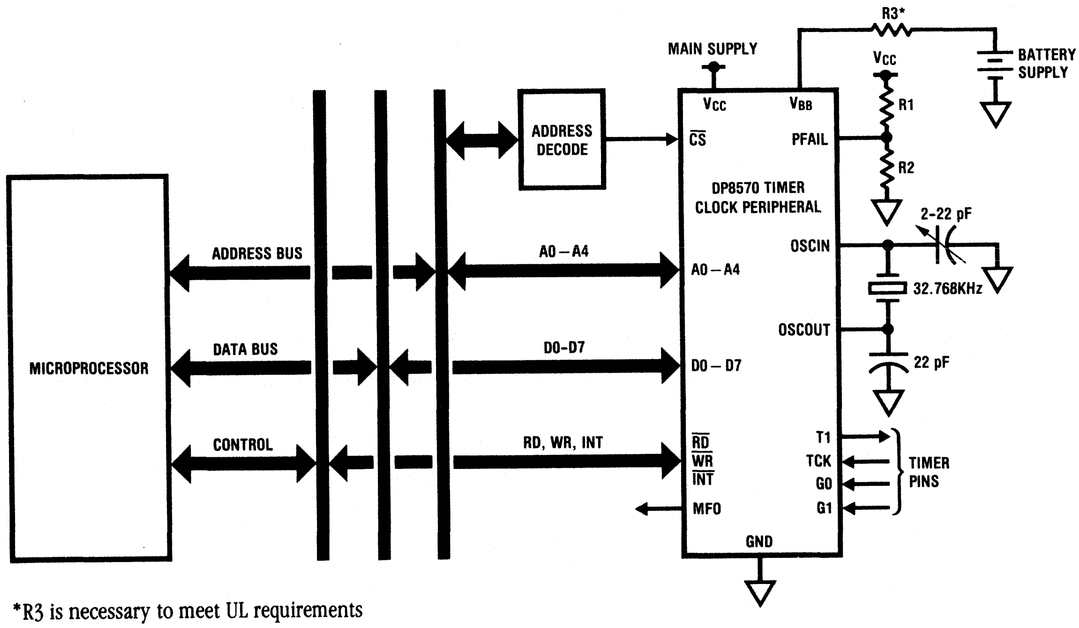


TCP Family Comparison Guide

Features	DP8570	DP8571	DP8572	DP8573
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	51 Bytes	20 Bytes
Timer	2 16-Bit	2 16-Bit	No	No
Interrupts				
Programmable	0.01 thru 1 sec	0.01 thru 1 sec	0.01 thru 1 sec	0.01 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)	32.768 kHz	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	2.0 min	2.0 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 PCC	24 DIP (Note 2)	24 DIP (Note 2) 28 PCC (Note 2)	24 DIP (Note 2)

Note 1: 32 kHz, 32.768 kHz, 4.194304 MHz, 4.9152 MHz
Note 2: Socket equivalent pin outs

Typical Application



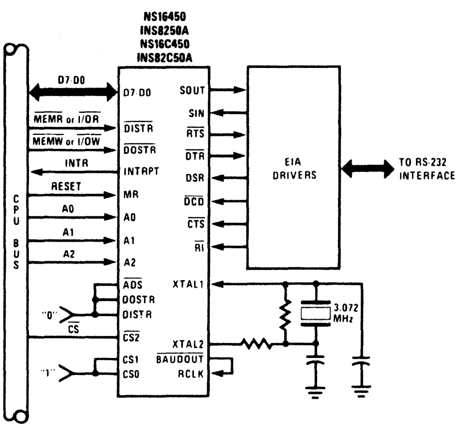
*R3 is necessary to meet UL requirements

Serial Communication— UARTs

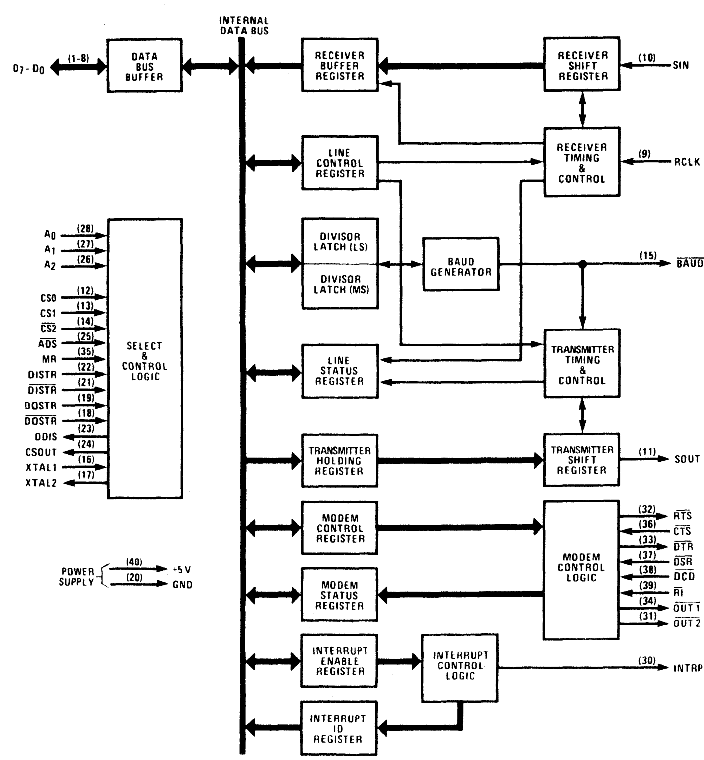
National's family of UARTs provides high performance, low power serial data input/output interface. These UARTs are built using NMOS, CMOS and XMOS technologies. They provide buffered, full duplex receiver and transmitter functions along with a programmable baud rate generator and modem control functions.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

Part #	Baud Rate	Package	Process	Transmission	System Compatibility	Multiplexed Demultiplexed
NS8250N	DC to 56k	N	NMOS	Asynchronous	General Purpose	Demultiplexed
NS8250N-B	DC to 56k	N,V	NMOS	Asynchronous	PCXT	Demultiplexed
NS8250A	DC to 56k	N,V,D	XMOS	Asynchronous	AT, Modems	Demultiplexed
NS82C50A	DC to 56k	N,V,D	CMOS	Asynchronous	Portable PC-AT	Demultiplexed
NS16450N	DC to 56k	N,V,D	XMOS	Asynchronous	PC-AT	Demultiplexed
NS16C450	DC to 56k	N,V,D	CMOS	Asynchronous	Portable PC-AT	Demultiplexed
NS16550	DC to 256k	N,V,D	XMOS	Asynchronous	RT	Demultiplexed
NSC858	DC to 1M	N,D	CMOS	Asynchronous	General Purpose	Multiplexed

Basic Configuration



Block Diagram



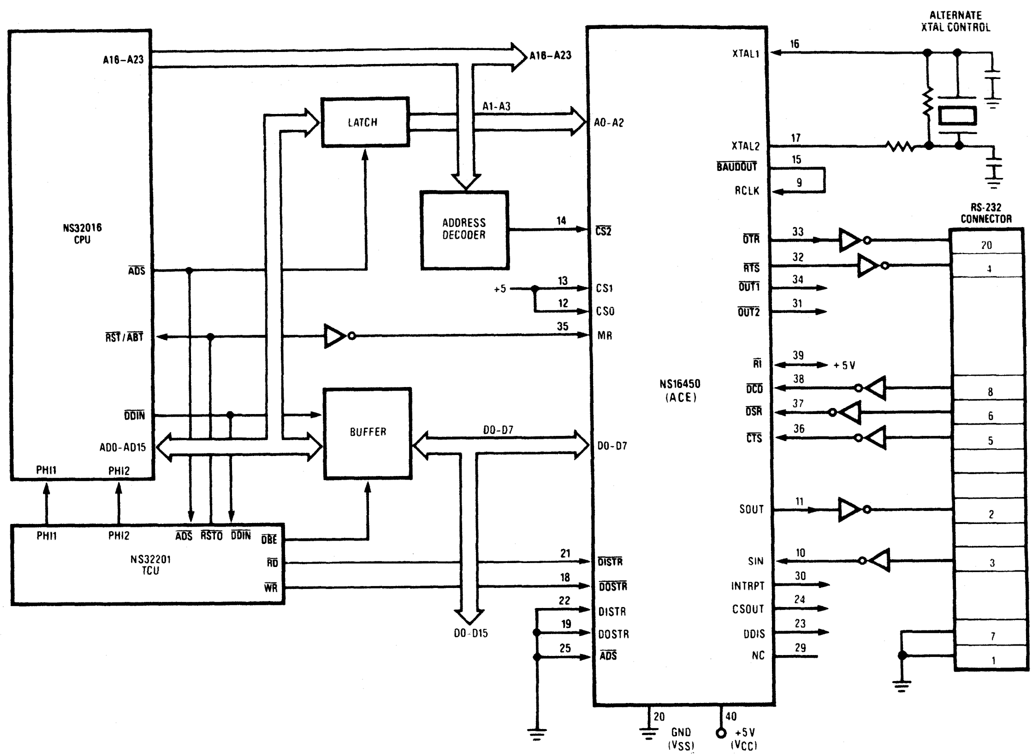
Systems Components

Serial Communication that can Complement

The serial communication function represented by the RS232C has been incorporated into many products as the standard interface of microprocessor-applied equipment. National's UART has a built-in baud rate generator and can easily be connected to a general-purpose microprocessor.

The loopback diagnostic function is equipped to maintain the lines well. The interrupts have 4-level priority and can easily be handled on software by referencing the status register. National offers a high-performance UART group consisting of six devices, including the NS16450 (upper version of INS8250A) for 10 MHz 32-bit CPUs such as the Series 32000 family.

Block Diagram



Linear

For additional Linear products, see pages 247 and 431.

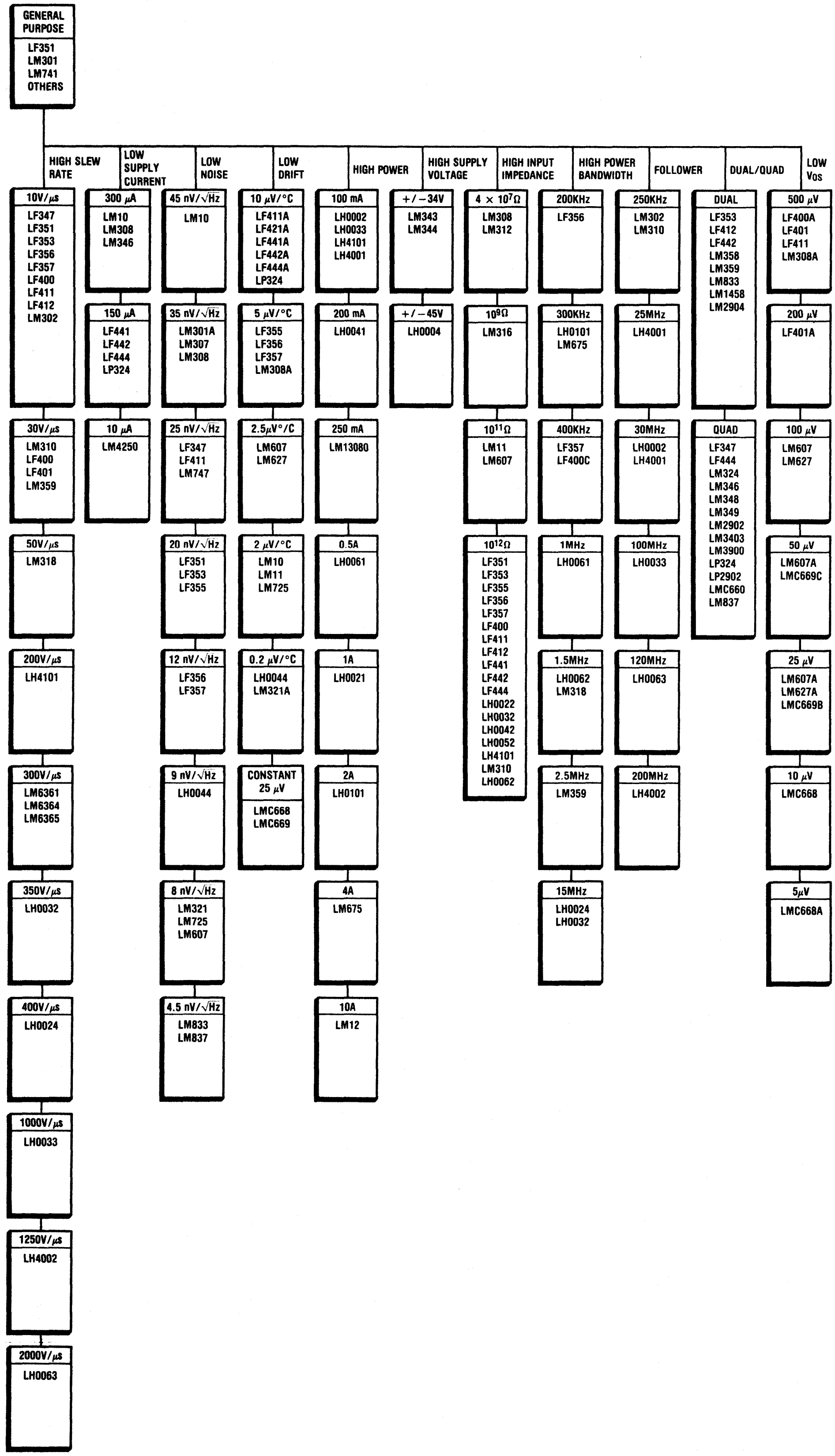
Linear Family

National Semiconductor and Linear ICs are synonymous. Why do so many people associate Linear with National Semiconductor?

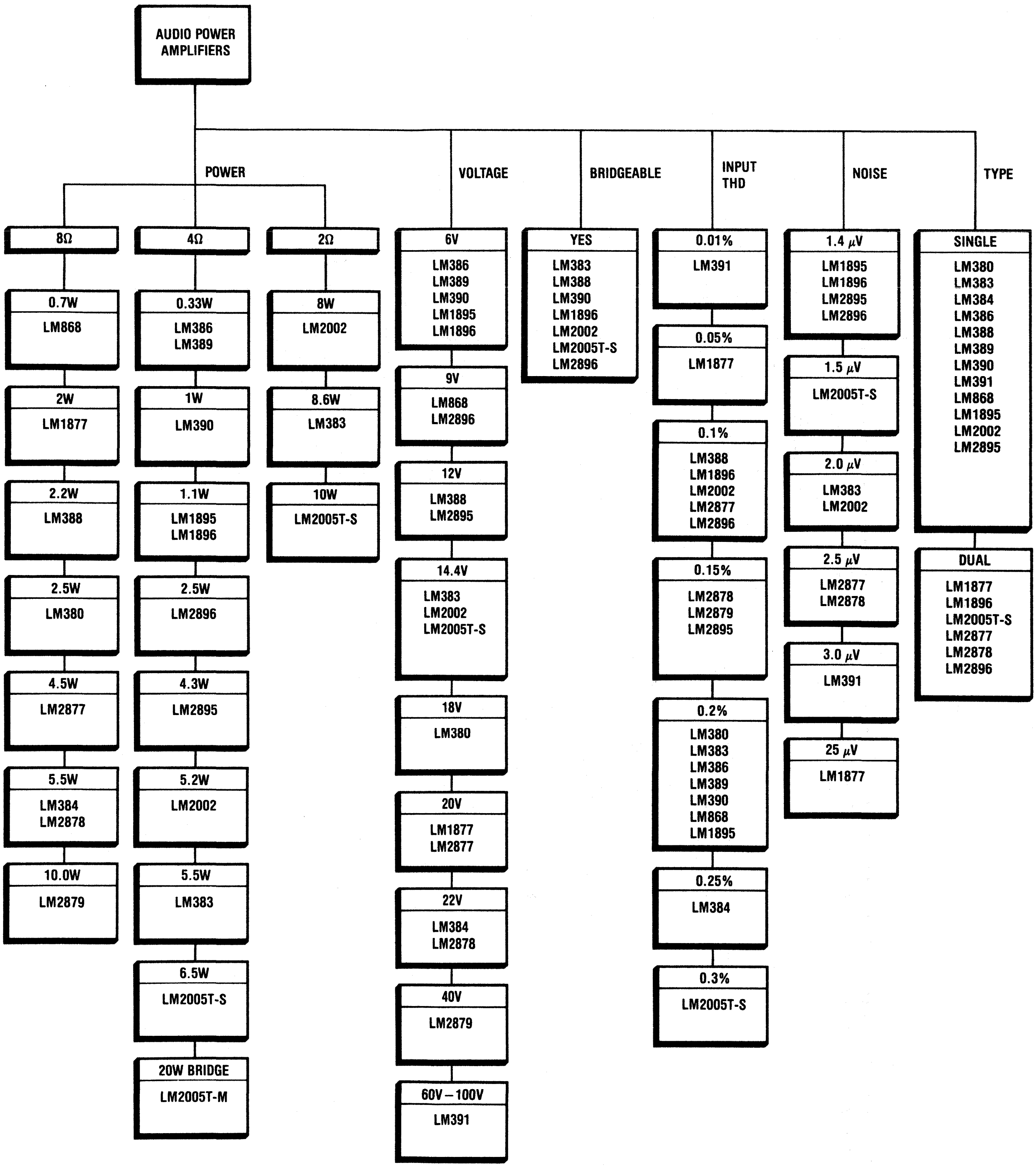
One reason is the large number of Linear ICs we ship every year. Another reason is the large number of Linear ICs that were designed and brought into production by National Semiconductor, such as the LM324, LM358, LM311, LM317 and many others.

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.

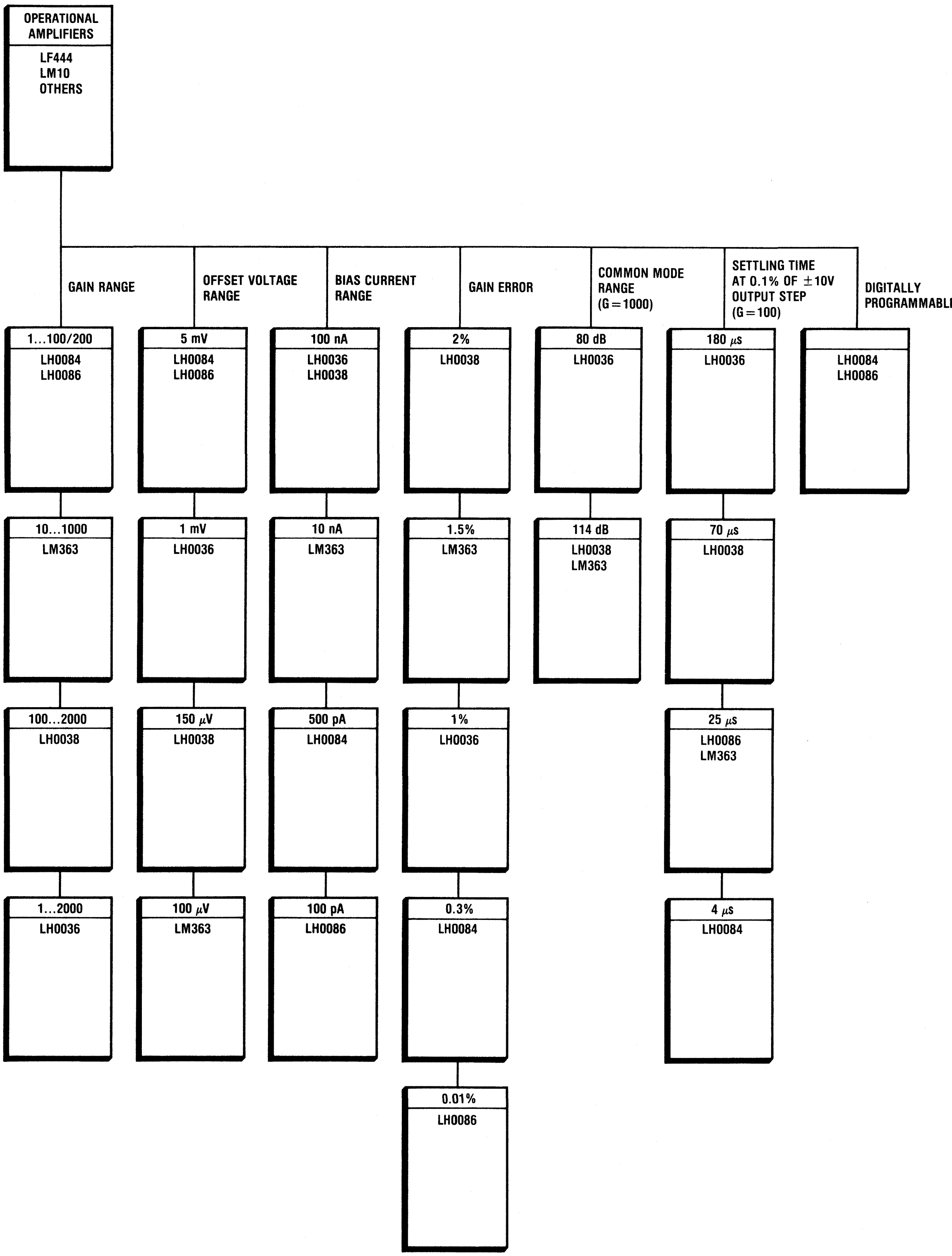
Amplifier Selection Guide



Audio Power Amplifier Selection Guide



Instrumentation Amplifier Selection Guide

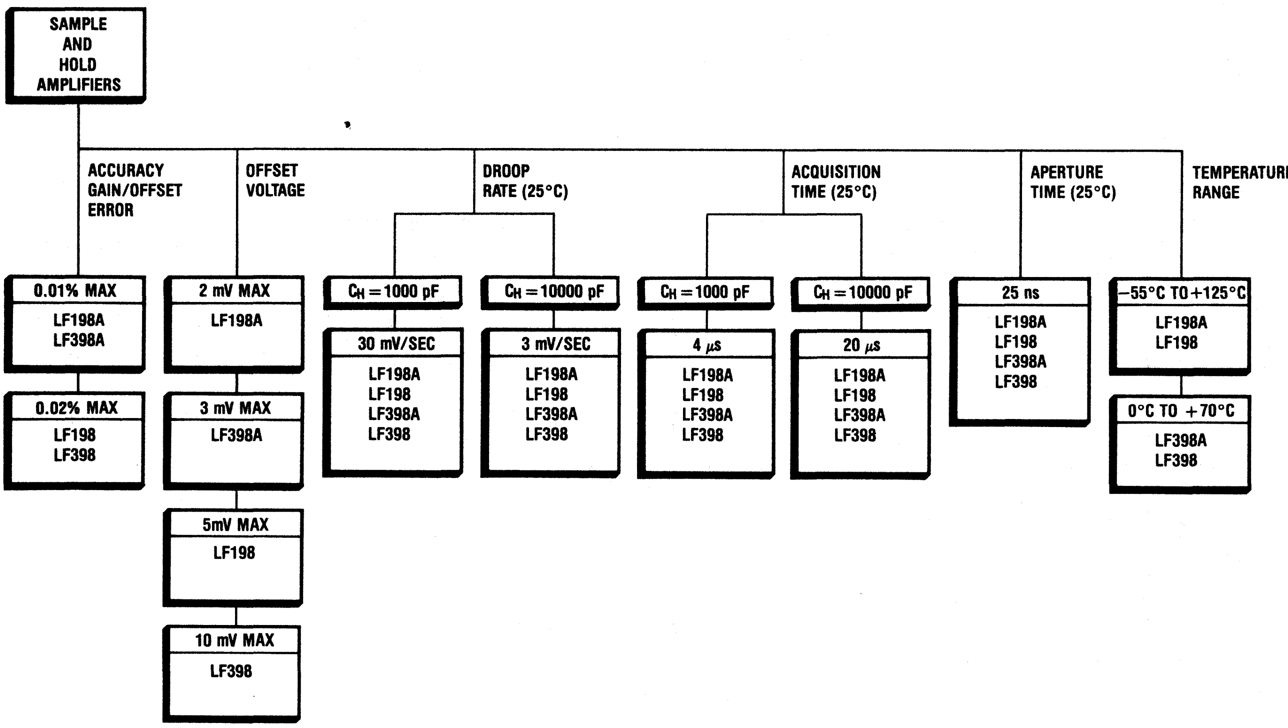


Preamplifier Selection Guide

PREAMPLIFIERS

VOLTAGE RANGE	EQUIVALENT INPUT NOISE	THD	PSR	INPUT COUPLING	APPLICATIONS
3.5V – 18V: LM1818	0.5 μV: LM381 LM833 (DUAL) LM837 (QUAD)	0.0015%: LM837 (QUAD)	85 dB: LM1818	AC: LM381 LM382 LM387 LM1818	AUTOREVERSE: LM1837
4V – 18V: LM1837 LM1897	0.6 μV: LM1837 LM1897	0.002%: LM833 (DUAL)	100 dB: LM833 (DUAL) LM837 (QUAD)	DC: LM833 (DUAL) LM837 (QUAD) LM1837 LM1897	COMPACT DISK: LM833 (DUAL)
9V – 30V: LM387	0.65 μV: LM387	0.03%: LM1837 LM1897	105 dB: LM1837 LM1897		DIGITAL/ PROFESSIONAL AUDIO: LM837 (QUAD)
9V – 40V: LM381 LM382	0.8 μV: LM382	0.1%: LM381 LM382 LM387	110 dB: LM387		STEREO: LM381 LM382 LM387
±12V – ±18V: LM833 (DUAL)	0.85 μV: LM1818	0.5%: LM1818	120 dB: LM381 LM382		TAPE PLAYBACK: LM1897
±18V: LM837 (QUAD)					TAPE SYSTEM: LM1818

Sample and Hold Amplifier Selection Guide



Comparator Selection Guide

GENERAL PURPOSE
- LM339
- LP339
- LM710

DTL/TTL FAN-OUT
- 1: LM339, LM393, LM710, LM1414, LM2901, LM2903, LP339
- 2: LF311, LM319, LM360, LM361
- 5: LM311, LP311
- 10: LM306

SUPPLY VOLTAGE RANGE
- $V^- = -8$, $V^+ = 8$: LM360
- $V^- = -7$, $V^+ = 14$: LM710, LM1414
- $V^- = -15$, $V^+ = 15$: LM306
- ±18V OR 36V_{DC}: LF311, LM311, LM339, LM393, LM2901, LM2903, LP311, LP339

BIAS CURRENT RANGE
- 25 μA: LM306, LM710, LM1414
- 15 μA: LM360
- 0.25 μA: LM311, LM339, LM393, LM2901, LM2903
- 0.15 μA: LF311
- 0.10 μA: LP311
- 25 nA: LP339

OFFSET VOLTAGE RANGE
- 10 mV: LF311, LP339
- 7 mV: LM311, LM2901, LM2903, LP311
- 5 mV: LM306, LM339, LM393
- 4 mV: LM360, LM1414

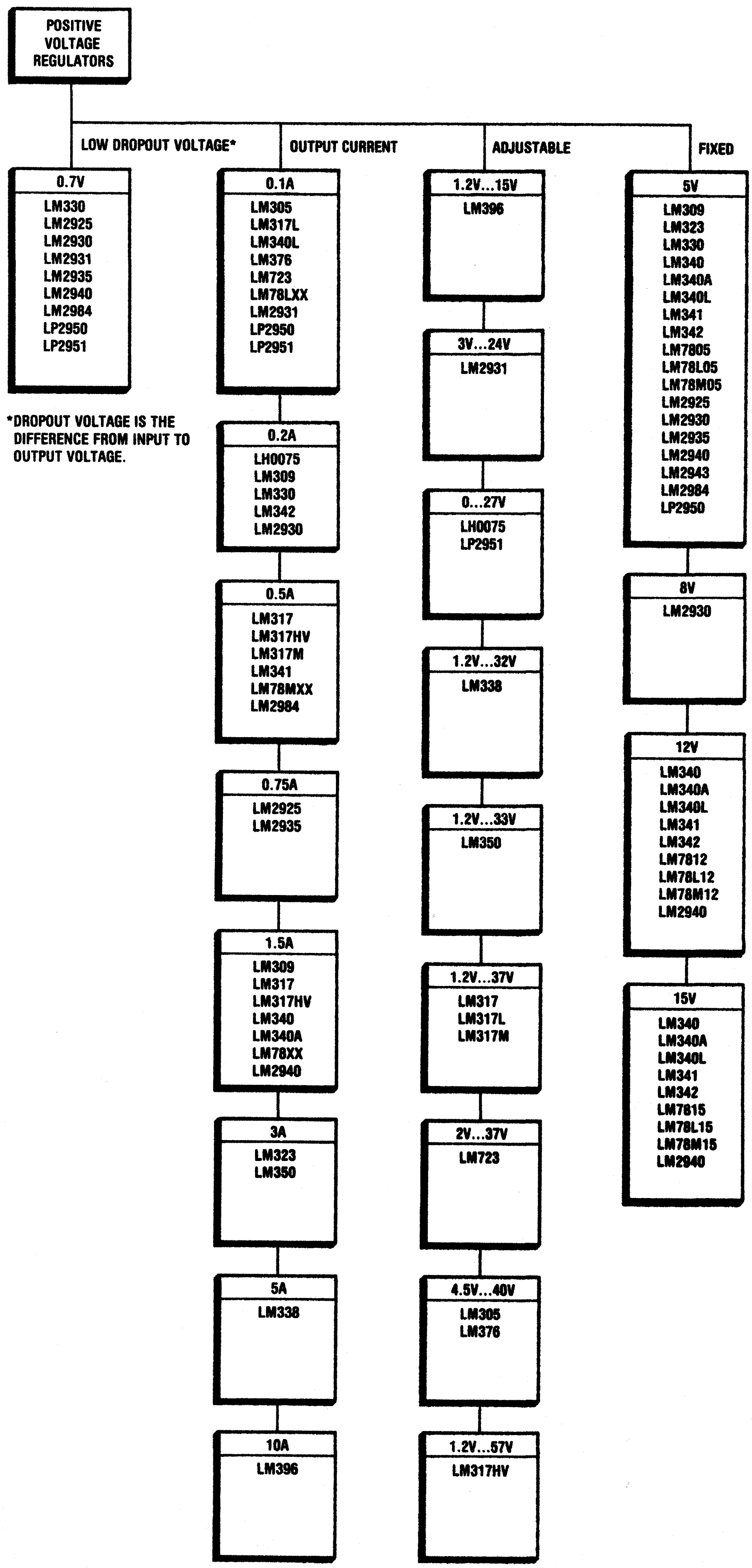
RESPONSE TIME RANGE
- 1.3 μs: LM339, LM393, LM2901, LM2903
- 200 ns: LF311, LM311
- 80 ns: LM319
- 40 ns: LM306, LM710, LM1414
- 16 ns: LM360, LM361

VOLTAGE GAIN RANGE
- 3000: LM360, LM361
- 40000: LM306, LM319
- 200000: LF311, LM311, LM319, LM339, LM393, LM2901, LM2903, LP311, LP339

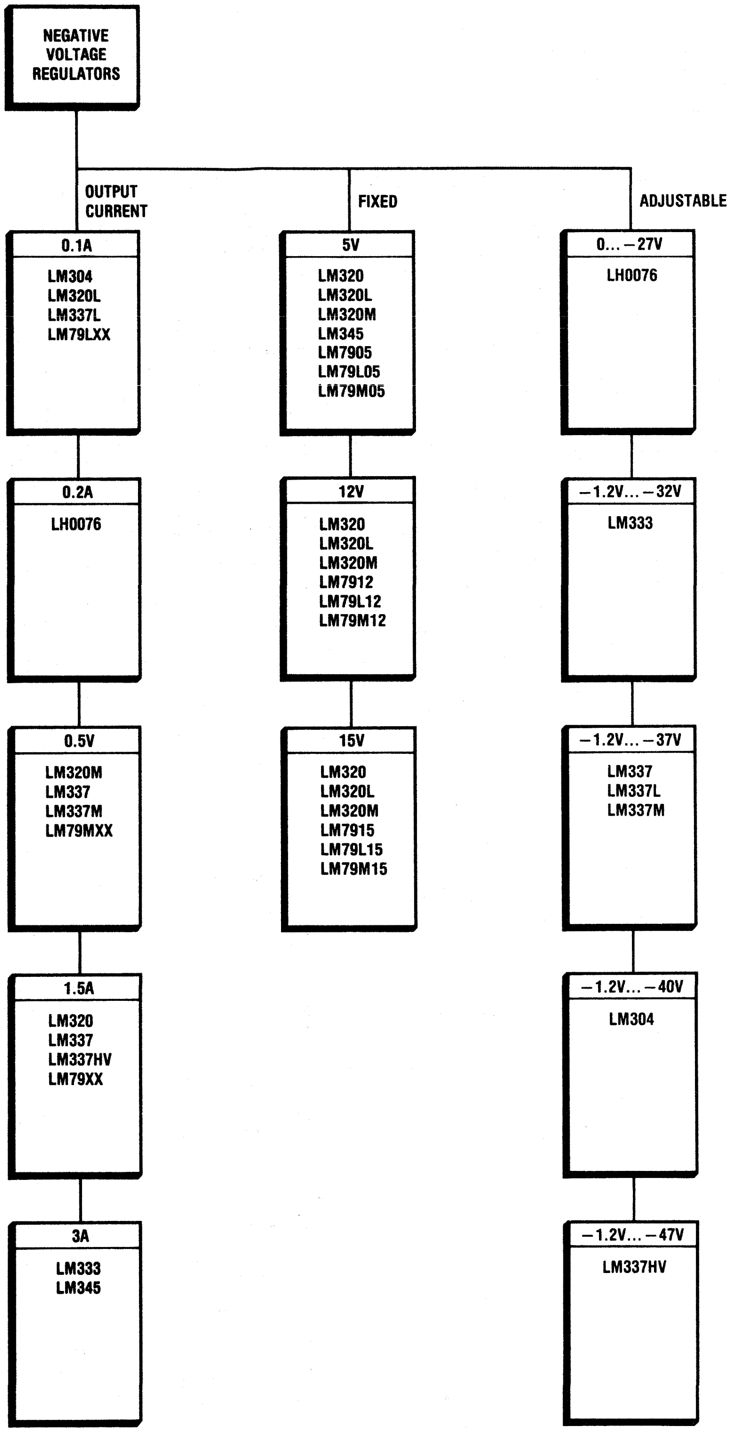
PROGRAMMABLE
- LP365

DUAL/QUAD
- DUAL: LH2111, LM2211, LM319, LM393, LM2903
- QUAD: LM339, LM2901, LM3302, LP339, LP365

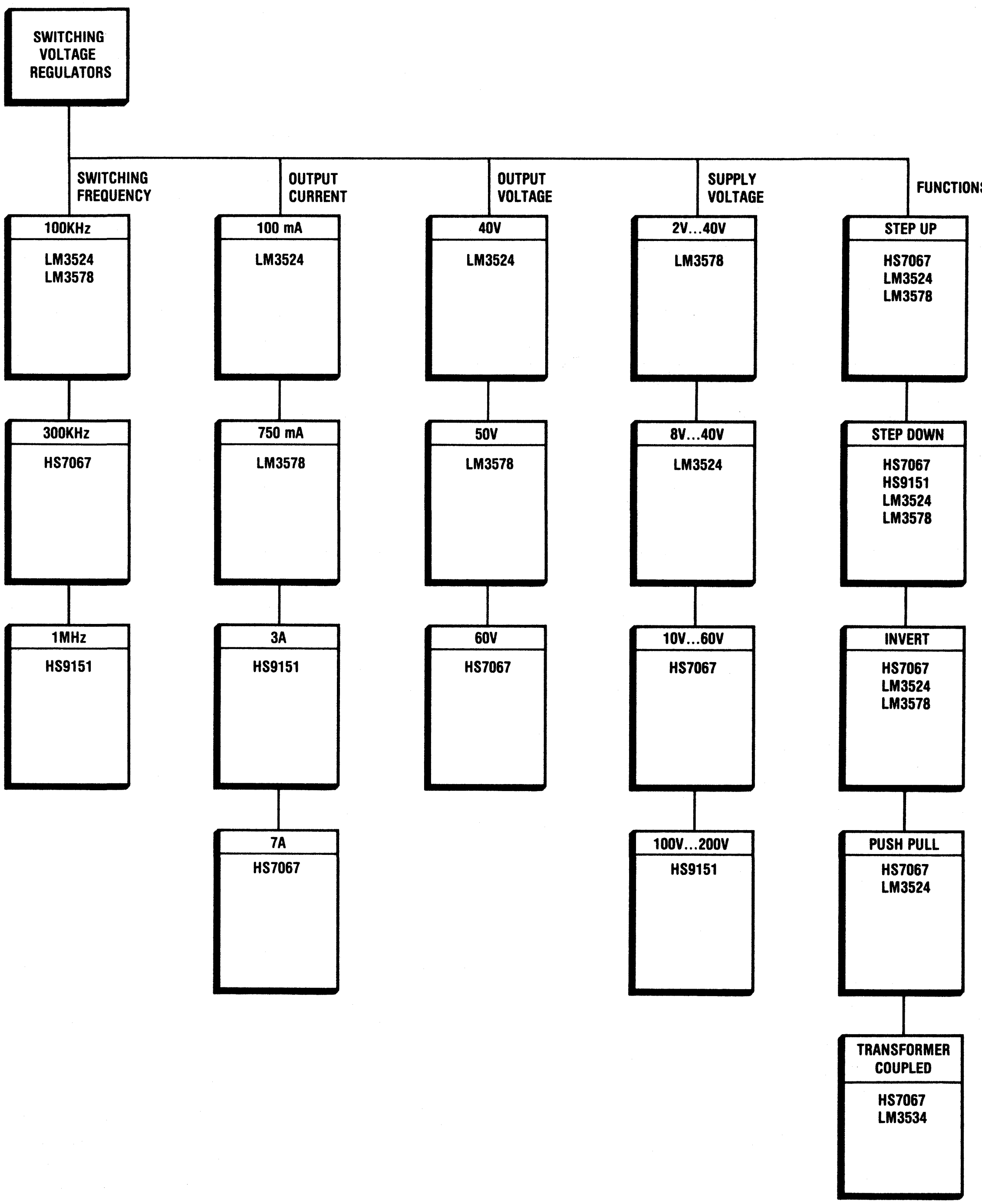
Positive Voltage Regulator Selection Guide



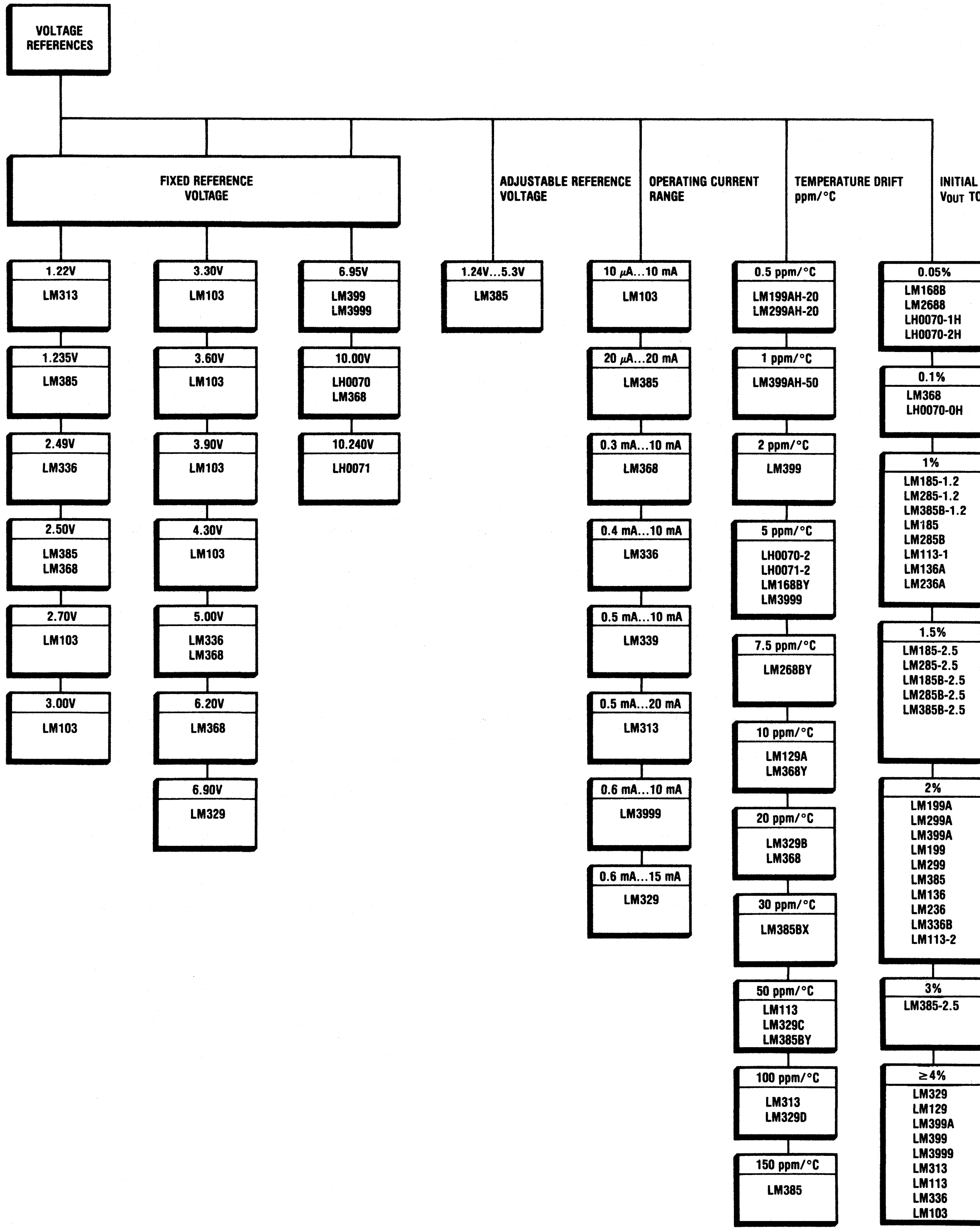
Negative Voltage Regulator Selection Guide



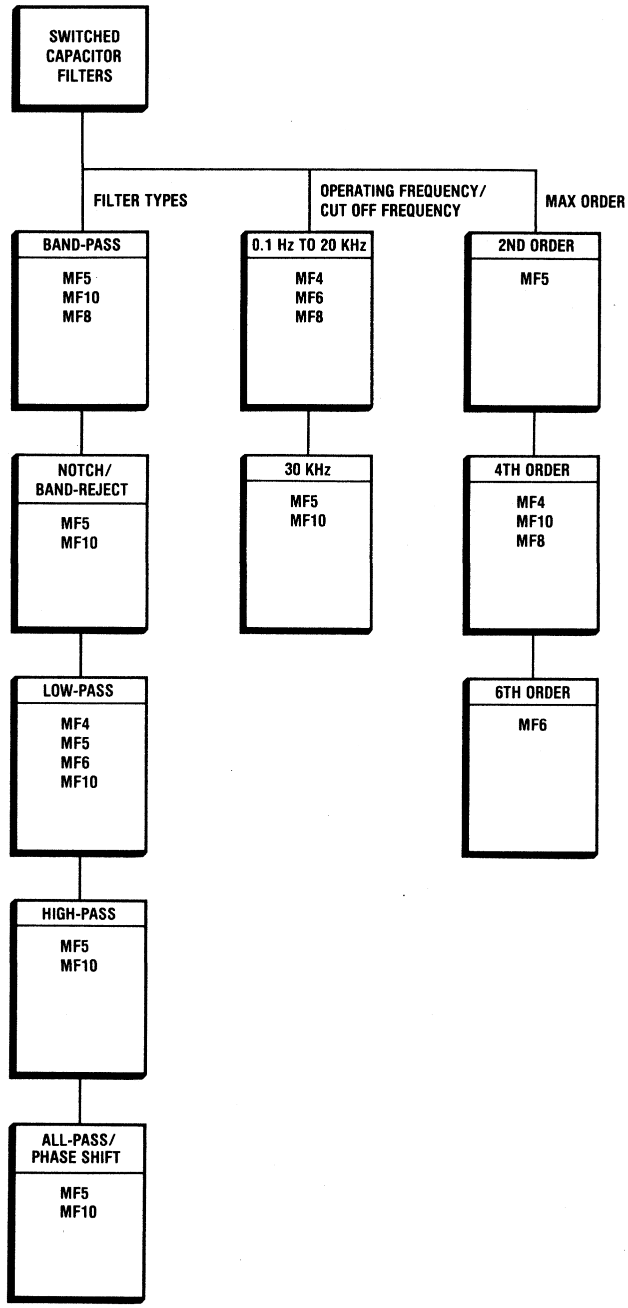
Switching Voltage Regulator Selection Guide



Voltage Reference Selection Guide



Switched Capacitor Filter Selection Guide



THE MF10 DEVICE CONSISTS OF 2 INDEPENDENT ACTIVE FILTER BUILDING BLOCKS (MF5).
ALL DEVICES ARE CASCADABLE WITH TYPICAL f_{CLK}/f_0 ACCURACY OF $\pm 0.3\%$

Analog-to-Digital Converter Selection Guide

Part Number	Resolution (Bits)	Absolute Accuracy (Max)	Conversion Time	Input Voltage Range (V)	Output Logic Levels	Supplies (V)	Comments
ADC0800	8	± 2 LSB	50 μs	± 5	TTL, TRI-STATE	+ 5, − 12	Ratiometric Operation
ADC0801	8	± 1/4 LSB	110 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC0802	8	± 1/2 LSB	110 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC0803	8	± 1/2 LSB	110 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC0804	8	± 1 LSB	110 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC0805	8	± 1/2 LSB	110 μs	5	TTL, TRI-STATE	+ 5	Ratiometric Operation
ADC0808	8	± 1/2 LSB	100 μs	5	TTL, TRI-STATE	+ 5	8-Channel MUX
ADC0809	8	± 1 LSB	100 μs	5	TTL, TRI-STATE	+ 5	8-Channel MUX
ADC0811B	8	± 1/2 LSB	32 μs	5	TTL	+ 5	11-Channel Serial I/O
ADC0811C	8	± 1 LSB	32 μs	5	TTL	+ 5	11-Channel Serial I/O
ADC0816	8	± 1/2 LSB	100 μs	5	TTL, TRI-STATE	+ 5	16-Channel MUX
ADC0817	8	± 1 LSB	100 μs	5	TTL, TRI-STATE	+ 5	16-Channel MUX
ADC0819B	8	± 1/2 LSB	16 μs	5	TTL	+ 5	19-Channel Serial I/O
ADC0819C	8	± 1 LSB	16 μs	5	TTL	+ 5	19-Channel Serial I/O
ADC0820B	8	± 1/2 LSB	1.2 μs	5	TTL, TRI-STATE	+ 5	Built-in Track and Hold Function
ADC0820C	8	± 1 LSB	1.2 μs	5	TTL, TRI-STATE	+ 5	Built-in Track and Hold Function
ADC0829B	8	± 1/2 LSB	100 μs	5	TTL, TRI-STATE	+ 5	Additional Digital Input Capability
ADC0829C	8	± 1 LSB	100 μs	5	TTL, TRI-STATE	+ 5	Additional Digital Input Capability
ADC0831B	8	± 1/2 LSB	32 μs	5	TTL	+ 5	Serial I/O
ADC0831C	8	± 1 LSB	32 μs	5	TTL	+ 5	Serial I/O
ADC0832B	8	± 1/2 LSB	32 μs	5	TTL	+ 5	2-Channel Serial I/O
ADC0832C	8	± 1 LSB	32 μs	5	TTL	+ 5	2-Channel Serial I/O
ADC0833B	8	± 1/2 LSB	32 μs	5	TTL	+ 5 to + 9	4-Channel Serial I/O
ADC0833C	8	± 1 LSB	32 μs	5	TTL	+ 5 to + 9	4-Channel Serial I/O
ADC0834B	8	± 1/2 LSB	32 μs	5	TTL	+ 5 to + 9	4-Channel Serial I/O
ADC0834C	8	± 1 LSB	32 μs	5	TTL	+ 5 to + 9	4-Channel Serial I/O
ADC0838B	8	± 1/2 LSB	32 μs	5	TTL	+ 5 to + 9	8-Channel Serial I/O
ADC0838C	8	± 1 LSB	32 μs	5	TTL	+ 5 to + 9	8-Channel Serial I/O
ADC0844B	8	± 1/2 LSB	40 μs	5	TTL, TRI-STATE	+ 5	4-Channel MUX, Internal Clock
ADC0844C	8	± 1 LSB	40 μs	5	TTL, TRI-STATE	+ 5	4-Channel MUX, Internal Clock
ADC0848B	8	± 1/2 LSB	40 μs	5	TTL, TRI-STATE	+ 5	8-Channel MUX, Internal Clock
ADC0848C	8	± 1 LSB	40 μs	5	TTL, TRI-STATE	+ 5	8-Channel MUX, Internal Clock
ADC1001C	10	± 1 LSB	200 μs	5	TTL, TRI-STATE	+ 5	8-Bit Bus Compatible Differential Input
ADC1005B	10	± 1/2 LSB	200 μs	5	TTL, TRI-STATE	+ 5	8-Bit Bus Compatible Differential Input
ADC1005C	10	± 1 LSB	50 μs	5	TTL, TRI-STATE	+ 5	8-Bit Bus Compatible Differential Input

Analog-to-Digital Converter Selection Guide

Part Number	Resolution (Bits)	Absolute Accuracy (Max)	Conversion Time	Input Voltage Range (V)	Output Logic Levels	Supplies (V)	Comments
ADC1021B	10	± 1/2 LSB	200 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC1021C	10	± 1 LSB	200 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC1025B	10	± 1/2 LSB	50 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC1025C	10	± 1 LSB	50 μs	5	TTL, TRI-STATE	+ 5	Differential Input
ADC1205B	12	± 1/2 LSB	100 μs	± 5	TTL, TRI-STATE	+ 5	8-Bit Bus Compatible Differential Input
ADC1205C	12	± 1 LSB	100 μs	± 5	TTL, TRI-STATE	+ 5	8-Bit Bus Compatible Differential Input
ADC1210	12	± 3/4 LSB	200 μs	10.2	CMOS	+ 5 to ± 15	Bipolar Input
ADC1211	12	± 2 LSB	200 μs	10.2	CMOS	+ 5 to ± 15	Bipolar Input
ADC1225B	12	± 1/2 LSB	100 μs	± 5	TTL, TRI-STATE	+ 5	16-Bit Bus Compatible Differential Input
ADC1225C	12	± 1 LSB	100 μs	± 5	TTL, TRI-STATE	+ 5	16-Bit Bus Compatible Differential Input
ADC3511	3-1/2 Digit	0.05 %	200 ms	2	TTL, TRI-STATE	+ 5	μP Compatible
ADC3711	3-3/4 Digit	0.05 %	400 ms	2	TTL, TRI-STATE	+ 5	μP Compatible
LM131	V-F	0.01 %	N/A	$V_{CC} - 2$	Open Collector	+ 5 to + 40	Voltage-to-Frequency Converter 100kHz Max
DIGITAL VOLT METER							
ADC3501	3-1/2 Digit	0.05 %	200 ms	2	7-Segment LED Drive	+ 5	3-1/2 Digit LED DVM
ADD3701	3-3/4 Digit	0.05 %	400 ms	2	7-Segment LED Drive	+ 5	3-3/4 Digit LED DVM

Digital-to-Analog Converter Selection Guide

Part Number	Resolution (Bits)	Linearity at 25°C (% Max)	Internal Reference	Settling Time (+ 1/2 LSB)	Supplies (V)	Comments
ADC0852	8	0.19		4 μs	5	DAC, Comparator, Serial Input
ADC0854	8	0.39		4 μs	5	DAC, Comparator, Serial Input
DAC0800	8	0.19		100 ns	±5 to ±15	High-Speed Multiplying
DAC0801	8	0.39		100 ns	±5 to ±15	High-Speed Multiplying
DAC0802	8	0.1		100 ns	±5 to ±15	High-Speed Multiplying
DAC0806	8	0.78		150 ns	±5 to ±15	Multiplying
DAC0807	8	0.39		150 ns	±5 to ±15	Multiplying
DAC0808	8	0.19		150 ns	±5 to ±15	Multiplying
DAC0830	8	0.05		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC0831	8	0.10		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC0832	8	0.20		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1000	10	0.05		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1001	10	0.1		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1002	10	0.2		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1006	10	0.05		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1007	10	0.1		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1008	10	0.2		500 ns	5 to 15	μP Compatible, Double Buffered
DAC1020	10	0.05		500 ns	5 to 15	4-Quadrant Multiplying
DAC1021	10	0.1		500 ns	5 to 15	4-Quadrant Multiplying
DAC1022	10	0.2		500 ns	5 to 15	4-Quadrant Multiplying
DAC1208	12	0.012		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1209	12	0.024		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1210	12	0.05		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1218	12	0.012		1 μs	5 to 15	4-Quadrant Multiplying
DAC1219	12	0.024		1 μs	5 to 15	4-Quadrant Multiplying
DAC1220	12	0.05		500 ns	5 to 15	4-Quadrant Multiplying
DAC1221	12	0.1		500 ns	5 to 15	4-Quadrant Multiplying
DAC1222	12	0.2		500 ns	5 to 15	4-Quadrant Multiplying
DAC1230	12	0.012		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1231	12	0.024		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1232	12	0.05		1 μs	5 to 15	μP Compatible, 4-Quadrant Multiplying
DAC1265	12	0.012	Yes	200 ns	±15	High-Speed
DAC1266	12	0.012		200 ns	±12 to ±15	High-Speed
DAC1655	16	0.012		20 μs	5 to 15	High-Speed

Analog Switch/Multiplexer Selection Guide

Part Number	Function	Logic Input	V_S Typ (V)	t_{ON} Typ (ns)	R_{ON} (Ω)
AH5011	Quad SPST	TTL, CMOS		150	100
AH5012		TTL, CMOS		150	150
CD4016		CMOS	± 7.5	20	850
CD4066		CMOS	± 7.5	50	280
LF11201		TTL	± 15	90	200
LF11202		TTL	± 15	90	200
LF11331		TTL	± 15	90	200
LF11332		TTL	± 15	90	200
LF11333		TTL	± 15	90	200
LF13201		TTL	± 15	90	250
LF13202		TTL	± 15	90	250
LF13331		TTL	± 15	90	250
LF13332		TTL	± 15	90	250
LF13333		TTL	± 15	90	250
AH5020	Dual SPDT	TTL, CMOS		150	
CD4053	Triple SPDT	CMOS	± 7.5	150	280
AH5009	4-Channel	TTL, CMOS		150	100
AH5010		TTL, CMOS		150	150
CD4052	4-Channel Differential	CMOS	± 7.5	150	280
CD4529B		CMOS	± 7.5	50	270
LF11509		TTL	± 15	1 μs	350
LF13509		TTL, CMOS	± 18	1.6 μs	350
CD4051	8-Channel	CMOS	± 7.5	150	280
CD4529B		CMOS	± 7.5	50	270
LF13508		TTL, CMOS	± 18	1.6 μs	350

AM/FM Block and Stereo Decoder Selection Guide

The series of AM/FM circuits manufactured by National Semiconductor covers both low cost AM/FM combined circuits and highest quality single system circuits for AM and FM, which support automatic station search and PLL-tuned systems. Stereo decoders are available for both FM and AM-stereo.

Combined Circuits

LM1866	AM/FM Radio System (Low Voltage)
LM1868	AM/FM Radio with Audio Power Amplifier

AM Circuits

LM1863	AM Radio System for μP Tuned Radios
LM3820	AM Radio System

FM Circuits

LM1865	FM-IF System for μP Tuned Radios
LM1965	FM-IF System for Manually Tuned Radios
LM2065	FM-IF System with Forward AGC
LM3089	FM Receiver System
LM3189	FM Receiver IF System
LM3361A	Low Voltage, Low Power Narrow Band FM-IF System

FM Stereo Decoders

LM1800	PLL-FM Stereo Demodulator
LM1870	PLL-FM Stereo Demodulator with Blend
LM4500A	PLL-FM Stereo Demodulator with Blend

Audio Switches and Noise Reduction Systems Selection Guide

National Semiconductor produces two special circuits for electronic switching of audio sources. One is for direct control and the other has latches for μP control. Three different noise reduction systems are supported. Currently in production are Dolby B™ and Dolby C™ circuits and the DNR™ universal noise reduction system invented by National Semiconductor.

Audio Switches

LM1037	Dual Four-Channel Analog Switch
LM1038	Dual Four-Channel Analog Switch

Dolby™ Circuits

LM1112	Single Channel Dolby B
LM1122	Single Channel Dolby C
LM1123	Single Channel Dolby C
LM1131	Dual Channel Dolby B
LM1141	Single Chip Dolby C

DNR Circuits

LM832	Dual Channel DNR (Low Voltage)
LM1894	Dual Channel DNR

Tape Systems

LM834	HiFi Tape System
LM1818	Electronically Switched Tape System
LM1837	Autoreverse Tape Head Preamplifier
LM1897	Stereo Tape Head Preamplifier

Audio Controls Selection Guide

Part Number	Application Portable	Home	Auto	Package	Voltage Range	Control Range	S/N	THD	Separation	Notes
LM1035	•	•	•	N20	8V–18V	80 dB Volume ± 15 dB Tone	80 dB	0.05%	75 dB	Dual channel with DC tone, volume, balance controls. 1 VRMS input loudness.
LM1036	•	•	•	N20	9V–16V	75 dB Volume ± 15 dB Tone	80 dB	0.06%	75 dB	Similar to LM1035 with 0.3 VRMS input level.
LM1040	•	•	•	N24	9V–16V	75 dB Volume ± 15 dB Tone	80 dB	0.06%	75 dB	Similar to LM1036 with stereo enhancement feature.
LMC835		•		N28	5V–16V	± 12 dB ± 6 dB } Selectable	114 dB	0.0015%		Dual 7 band equalizer. 0.1 dB gain accuracy digital control.
LMC1992		•	•	N28		80 dB Volume 40 dB Fader ± 12 dB Tone	92 dB	0.03%	80 dB	Digital control. Loudness, tone, volume, 3 input stereo selector. All levels in 2 dB steps.
LM1037	•	•	•	N18	5V–28V	− 90 db	106 dB	0.04%	95 dB	Four channel analog switch; mute. TTL compatible.
LM1038	•	•	•	N18	5V–28V	− 90 dB	106 dB	0.04%	95 dB	Similar to LM1037, 2 bit control.

Video/TV Circuit Selection Guide

National Semiconductor entered the video world in the 1970's with ICs for home television.

National's broadband expertise is now being applied to ICs for high resolution monitors. Our latest device, the LM1203, offers three 70 MHz video processing channels on a single chip.

Video Processing Circuits

LM1201	Video Amplifier System
LM1203	RGB Video Amplifier System
LM1823	Video IF/Synchronous Detector
LM1880	No Hold Vertical/Horizontal
LM1881	Video Sync Separator

TV Peripheral Circuits

LM1017	4-Bit Binary, 7-Segment Decoder/Driver
LM1886	TV Video Matrix D/A
LM1889	TV Video Modulator (Color)
LM2889	TV Video Modulator (B/W)

Video Amplifiers

LM592	Differential Video Amplifier
LM733	Differential Video Amplifier

Sensor Selection Guide

Temperature Sensors

LM34	Precision Fahrenheit Temperature Sensor
LM35	Precision Centigrade Temperature Sensor
LM334	Current Mode Temperature Sensor
LM335	Precision Temperature Sensor
LM3911	Temperature Controller

Fluid Level Detectors

LM1030	Fluid Level Detector
LM1042	Analog Fluid Level Output
LM1830	Fluid Level Detector

Others

LM1812	Ultrasonic Transceiver
LM1815	Adaptive Sense Amplifier
LM1851	Ground Fault Interrupter
LM1964	Oxygen Sensor Amplifier

Tone Control Circuit Selection Guide

The National Semiconductor range of tone, volume and balance circuits operating under DC control provides a cost effective solution for circuit design.

In addition, a microprocessor compatible graphic equalizer — the LMC835 — complements this range of circuits.

Tone Controllers

LM1035	Dual Tone, Volume, Balance
LM1036	Dual Tone, Volume, Balance
LM1040	Dual Tone, Volume, Balance with Stereo Enhancement
LMC835	Digitally Controlled Graphic Equalizer —14-Band Mono —7-Band Stereo
LMC1992	Digitally Controlled Tone/Vol/Bal/Fader/Loudness

Timer Selection Guide

	LM322	LM2905	LM555	LMC555* (CMOS LM555)	LM556 (Dual LM555)
Shortest Output Pulse					
Longest Output Pulse	2.8 Hours	2.8 Hours	20 Minutes	20 Minutes	20 Minutes
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	4.5-40V	4.5 – 40V	4.5-15V	1.2-12V	4.5-15V
Supply Current (Typical)	2.5 mA	2.5 mA	10 mA	0.15 mA	10 mA (Each Timer Section)
Devices Offered (Refer to Datasheet or R.E.T.S. for Specifications)	LM122H LM122H/883 LM322H LM322N	LM2905N LM3905N (Refer to LM122/322 Datasheet)	LM555CH LM555CJ LM555CM LM555CN LM555H LM555H/883 LM555J LM555J/883	LMC555CH LMC555CM LMC555CN LMC555H/883	LM556CJ LM556CM LM556CN LM556J LM556J/883
Additional Applications Information (Refer to 1986 Linear Applications Handbook)	AN-97 LB-38		AB-7		AB-7

*The CMOS LMC555 can handle up to + 10/ – 50 mA of output current and the bipolar LM555 can handle up to ± 200 mA of output current.

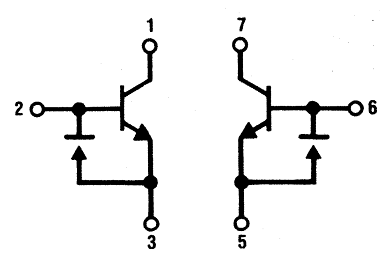
Transistor Array Selection Guide

Special Transistors

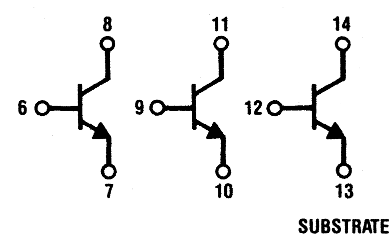
LM194	Supermatched Transistor Pair
LM195	Ultrareliable Power Transistor
LM295	Ultrareliable Power Transistor
LM394	Supermatched Transistor Pair
LM395	Ultrareliable Power Transistor

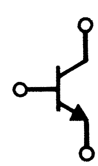
Transistor Arrays

LM3045	Transistor Array
LM3046	Transistor Array
LM3086	Transistor Array
LM3146	High Voltage Transistor Array

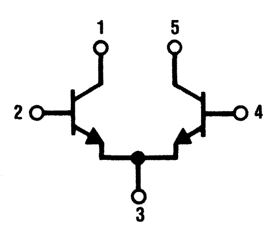


LM194/LM394





LM195
LM295
LM395
(CURRENT LIMIT, THERMAL LIMIT, SAFE AREA PROTECTION)



LM3045
LM3046
LM3086
LM3146

Automotive Circuit Selection Guide

National Semiconductor offers a wide range of products for the automotive industry including A/D, D/A converters, operational amplifiers and voltage regulators. All the devices perform over the entire automotive temperature range.

For more details, please refer to the appropriate product selection guide.

Dashboard Circuits

LM1030	Fluid Level Detector
LM1042	Analog Output Fluid Level IC
LM1819	Aircore Meter Driver
LM1830	Fluid Detector
LM1946	Over/Under Current Detector
LM3909	LED Flasher

Controller Circuits

LM35	Centigrade Temperature Sensor
LM334	Current Mode Temperature Sensor
LM335	Temperature Sensor
LM675	Power Operational Amplifier
LM1815	Adaptive Sense Amplifier
LM1949	Injector Driver Controller
LM1951	1A Intelligent Switch
LM1964	Sensor Interface Amplifier
LM2907	Frequency to Voltage Converter
LM2917	Frequency to Voltage Converter
LM3080	Operational Transconductance Amplifier
LM3911	Temperature Controller
LM13600	Dual Transconductance Amplifier
LM13700	Dual Transconductance Amplifier
LM18272	Power Op Amp
LM18293	Dual H Switch

Industrial Building Block Selection Guide

Additional standard functions such as amplifiers and voltage regulators are available from National Semiconductor. Please refer to the appropriate product selection guide.

Standard Blocks

LM555	Timer
LM556	Dual Timer
LM565	Phase Locked Loop
LM566	Voltage Controlled Oscillator
LM567	Tone Decoder
LM675	Power Operational Amplifier
LM1211	Broadband Demodulator System
LM1391	Phase Locked Loop
LM1496	Balanced Modulator/ Demodulator
LM1596	Balanced Modulator/ Demodulator
LM2907	Frequency to Voltage Converter
LM2917	Frequency to Voltage Converter
LM3080	Transconductance Amplifier
LM3909	LED Flasher/Oscillator
LM13600	Dual Transconductance Amplifier
LM13700	Dual Transconductance Amplifier
LMC555	CMOS Timer
LMC567	Low Power Tone Decoder
LMC568	Low Power Phase Locked Loop

Special Blocks

LM621	Commutator Block for DC Motors
LM622	DC Motor Driver
LM909	Remote Control Receiver
LM1801	Battery Operated Power Comparator
LM1812	Ultrasonic Transceiver
LM1815	Adaptive Sense Amplifier
LM1830	Fluid Level Detector
LM1851	Ground Fault Interrupter
LM1871	RC Encoder/Transmitter
LM1872	RC Receiver/Decoder
LM1893	Current Carrier Transceiver
LM1921	1A Industrial Switch
LM1946	Over/Under Current Detector
LM1951	1A Intelligent Switch
LM2893	Advanced Carrier Current Transceiver
LM3361A	Narrow Band IF System (Cordless Phone)
LM3914	Dot/Bar Display Driver (Linear)
LM3915	Dot/Bar Display Driver (Log)
LM3916	Dot/Bar Display Driver (VU)

Logic

For additional Logic products, see pages 273 and 423.

Logic Device Families

TTL Logic (DM54/DM74)

TTL logic was the first saturating logic integrated circuit family introduced, thus setting the standard for all the future families. It offers a combination of speed, power consumption, output source and sink capabilities suitable for most applications. This family offers the greatest variety of logic functions. The basic gate (Figure 1) features a multiple-emitter input configuration for fast switching speeds, active pull-up output to provide a low driving source impedance which also improves noise margin and device speed. Typical device power dissipation is 10 mW per gate and the typical propagation delay is 10 ns when driving a 15 pF/400Ω load.

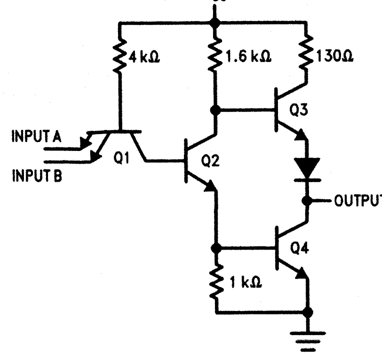


Figure 1. DM5400/DM7400

CMOS Logic (CD4XXX, MM54/74C, MM54/74HC, MM54/74 HCT)

The CD4000 series is National Semiconductor's extensive line of CD40XXB and CD45XXB series devices. These parts meet the standard JEDEC "B-series" specifications.

The popular MM54C/74C series logic family metal-gate CMOS technology is pin-for-pin and function-for-function equivalent to the 54/74 family of TTL devices. Unique special function LSI devices in this family are compatible with MM54HC/74HC and CD4000 series.

Advanced Schottky (DM74AS)

This family of devices is designed to meet the needs of the system designers who require the ultimate in speed. Utilizing Schottky barrier diode clamped transistors with shallower diffusions and advanced oxide-isolation fabrication techniques, the AS family achieves the fastest propagation delay that bipolar technology can offer. The AS family has virtually the same circuit configuration as the ALS family. It has PNP transistor or diode inputs with electrostatic protection base-emitter shorted transistors. The output totempole consists of a Darlington pair transistor pull-up and an active pull-down squaring network. The inputs and outputs are Schottky clamped to attenuate critical transmission line reflections. In addition, the circuit contains the "Miller Killer" network at the output section to improve output rise time and reduce power consumption during switching at high repetition rates. The AS family yields typical power dissipation of 7 mW per gate and propagation delay time of 1.5 ns when driving a 50 pF/2 kΩ load.

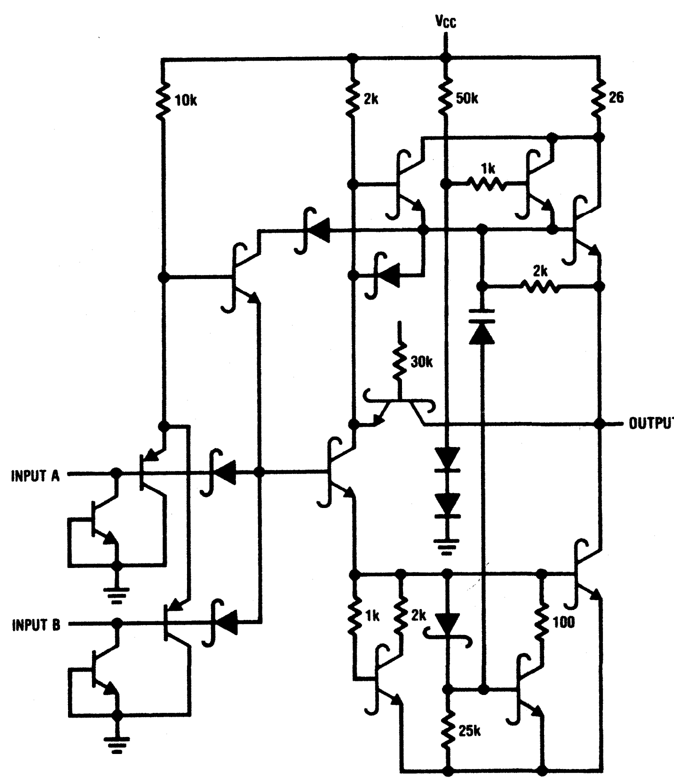


Figure 2. DM74AS00

Low Power Schottky (DM54LS/DM74LS)

The low power Schottky family features a combined fivefold reduction in current and power when compared to the TTL family. Gold doping commonly used in the TTL devices reduces switching times at the expense of current gain. The LS process overcomes this limitation by using a surface barrier diode (Schottky diode) in the baker clamp configuration between the base and collector junction of the transistor. In this way, the transistor is never fully saturated and recovers quickly when base drive is interrupted. Using shallower diffusion and soft-saturating Schottky diode clamped transistors, higher current gains and faster turn-on times are obtained. The LS circuits do not use the multi-emitter inputs. They use diode-transistor inputs which are faster and give increased input breakdown voltage; the input threshold is ~ 0.1V lower than TTL. Another commonly used input is the vertical substrate PNP transistor. In addition to fast switching, it exhibits very high impedance at both the high and low input states, and the transistor's current gain (B) significantly reduces input loading and provides better output performance. The output structure is also modified with a Darlington transistor pair to increase speed and improve drive capability. An active pull-down transistor (Q3) is incorporated to yield a symmetrical transfer characteristic (squaring network). This family achieves circuit performance exceeding the standard TTL family at a fraction of its power consumption. The typical device power dissipation is 2 mW per gate and typical propagation delay is 10 ns while driving a 15 pF/2 kΩ load.

Schottky (DM54S/DM74S)

This family features the high switching speed of unsaturated bipolar emitter-coupled logic, but consumes more power than standard TTL devices. To achieve this high speed, the Schottky barrier diode is incorporated as a clamp to divert the excess base current and to prevent the transistor from reaching deep saturation. The Schottky gate input and internal circuitry resemble the standard TTL gate except the resistor values are about one-half the TTL value. The output section has a Darlington transistor pair for pull-up and an active pull-down squaring network. This family has power dissipation of 20 mW per gate and propagation delays three times as fast as TTL devices with the average time of 3 ns while driving 15 pF/280Ω load.

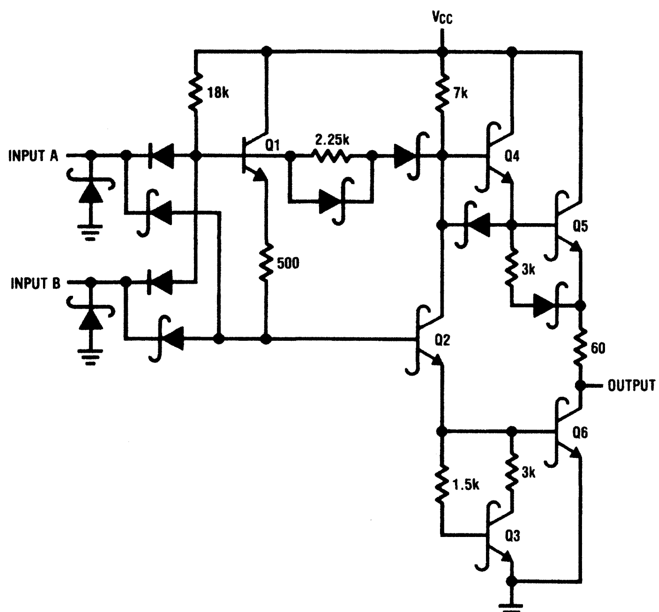


Figure 3. DM54LS00/DM74LS00

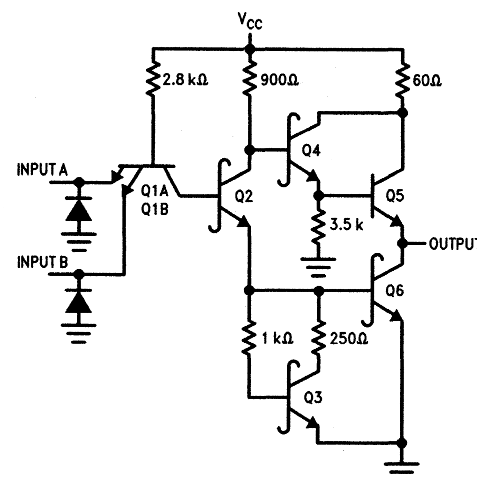


Figure 4. DM54S00/DM74S00

Advanced Low Power Schottky (DM74ALS)

The advanced low power Schottky family is one of the most advanced TTL families. It delivers twice the data handling efficiency and still provides up to 50 % reduction in power consumption compared to the LS family. This is possible because of a new fabrication process where components are isolated by a selectively grown thick-oxide rather than the P-N junction used in conventional processes. This refined process, coupled with improved circuit design techniques, yields smaller component geometries, shallower diffusions, and lower junction capacitances. This enables the devices to have increased f_T in excess of 5 GHz and improved switching speeds by a factor of two, while offering much lower operating currents.

In addition to the pin-to-pin compatibility of the ALS family, a number of MSI and LSI functions are introduced in the high density 24-pin 300 mil DIP. These devices offer the designers greater cost effectiveness with the advantages of reduced component count, reduced circuit board real-estate, increased functional capabilities per device and improved speed-power performance.

The basic ALS gate schematic is quite similar to the LS gate. It consists of either the PNP transistor or the diode inputs, Darlington transistor pair pull-up and active pull-down (squaring network) at the output. Since the shallower diffusions and thinner oxides will cause ALS devices to be more susceptible to damage from electrostatic discharge, additional protection via a base-emitter shorted transistor is included at the input for rapid discharge of high voltage static electricity. Furthermore, the inputs and outputs are clamped by Schottky diodes to prevent them from swinging excessively below ground level. A buried N^+ guard ring around all input and output structures prevents crosstalk. The ALS family has a typical power dissipation of 1 mW per gate and typical propagation delay time of 4 ns into a 50 pF/2 kΩ load.

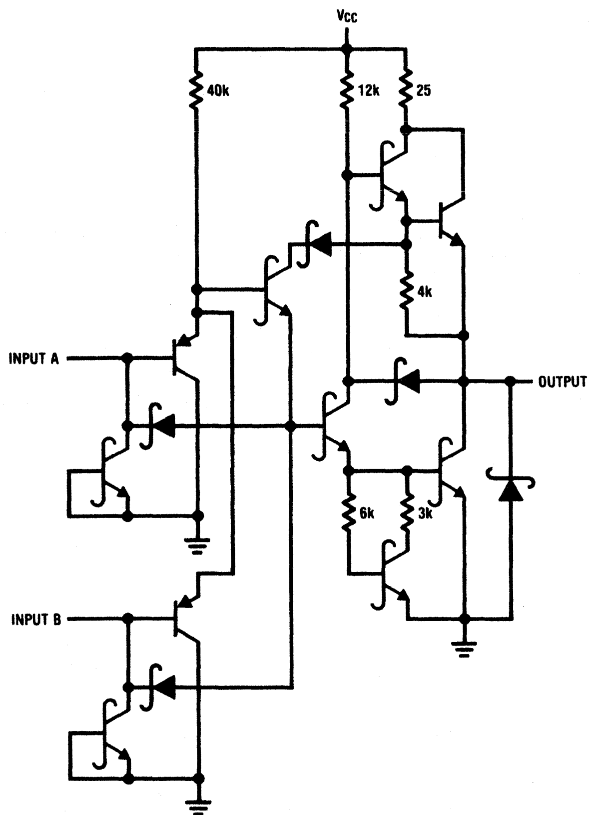


Figure 5. DM74ALS00

Functional Descriptions

Buffer: A logic gate with high output drive capability, or fan-out. Buffers are used where a single circuit must drive a large number of loads.

Comparator: A logic circuit that will compare two separate input signals and produce an output based on that comparison. A simple comparator is the Exclusive-NOR gate, which produces a high level output only when its two inputs are identical.

Counter: A logic circuit that counts the number of input pulses it receives. Counters can be used for frequency division, counting, and sequencing digital operations. Common counter configurations are Binary, where the device counts from 0 to 15 and Decade, where the device counts from 0 to 9.

Data Selector/Multiplexer: A logic circuit that will select one of several input signals and feed that signal onto a common bus line. It can be thought of as a multipole, multiposition switch with each switch pole representing one output and each switch position representing one input.

Decoder/Demultiplexer: A logic circuit that is the complement of the Data Selector/Multiplexer; that is, this circuit takes an input signal and feeds it to any one of several output lines depending on the information placed on its steering, or control, inputs.

Driver: Same as Buffer, above.

Flip-Flop: A logic circuit that is used to store information. A flip-flop is called "bistable" since it has two stable states.

Gate: The basic building block of all logic circuits; an element whose output is a Boolean function of its inputs. The basic functions are the AND, OR, and NOT. By combining these functions, NAND, NOR, and Exclusive-OR and Exclusive-NOR gates are built.

Latch: A bistable element that latches, or holds, data which is present at its input at the time the Enable input goes to its inactive state. When the Enable input is active, the data, present at the input, is passed directly to the output, similar to the operation of a gate.

One-Shot: Monostable multivibrator; a flip-flop that only has one stable state. When triggered by an input transient, it flips to its unstable state for a time period determined by an external R-C network connected to its timing inputs, and then returns to its stable state.

Shift Register: A series of flip-flops in which the data signal is shifted out of one flip-flop and into the succeeding flip-flop during an active transition on the clock input.

Transceiver: A logic circuit that can transmit data onto a bus line and receive data off of the bus line using the same terminal as an input and output. The direction of signal flow is determined by logic levels present at a Direction Control input.

Other Terms

Asynchronous: A mode of operation that does not require any specific timing relationship between different control inputs.

Open Collector: Output configuration that has no internal pull-up. This configuration enables outputs that are connected together (wired-OR) to assume opposite states without incurring damage.

Schmitt Trigger: An input configuration that has a different threshold point depending on whether the input signal is rising or falling. This is especially useful in electrically noisy environments.

Synchronous: A mode of operation where specific timing requirements must be met between control inputs before an indicated action can occur.

Totem Pole: An output configuration that contains an internal pull-up structure, usually a transistor pull-up allowing higher output drive capability than is available with open collector outputs.

TRI-STATE: A registered trademark for a circuit configuration in which the device output can be switched 'off' during which time the output presents a very high impedance to the bus it is connected to. This allows multiple outputs to be connected to a bus line while only one output drives the line, the other outputs being switched into their high impedance states.

Explanation of Function Tables

The following symbols are used in the function tables found in NSC data sheets:

H	=	high logic level (steady state)
L	=	low logic level (steady state)
↑	=	transition from low to high logic level
↓	=	transition from high to low logic level
X	=	irrelevent (any level, including transitions)
Z	=	off (high impedance) state of a TRI-STATE output
a...h	=	the level of steady state inputs at inputs A through H respectively
Q_0	=	the level of Q before the indicated steady state input conditions were established
$\overline{Q}_0$	=	complement of Q_0 or level of $\overline{Q}$ before the indicated steady state input conditions were established
Q_n	=	level of Q before the most recent active transition indicated by ↑ or ↓
⎍	=	one high level pulse
⊔	=	one low level pulse
toggle	=	each output changes to the complement of its previous level on each active transition indicated by ↑ or ↓

If, in the input columns, a row contains only the symbols H, L, and/or X, this means the indicated output is valid whenever the input configuration is achieved regardless of the sequence in which it is achieved. The output persists so long as the input configuration is maintained.

How to Read Digital Products Selection Tables

The following symbols are common to all selection tables

X = Product available in technology indicated

NP = New product planned in technology indicated

The complete device number is composed of a technology prefix plus a device number suffix. For example, hex 2-input NAND gates are available in the following device numbers:

DM74ALS804
DM74AS804B

For further information on military processing of these products or information on obtaining a current catalog, please contact your local National sales office, distribution office or contact National directly.

Technology	Device Prefix/Suffix
TTL	(DM54/DM74)
Low Power	(DM54L/DM74L)
Low Power Schottky	(DM54LS/DM74LS)
Advanced Low Power Schottky	*(DM54ALS/DM74ALS)
Schottky	(DM54S/DM74S)
Advanced Schottky	(DM74AS)
High Speed CMOS	(MM54HC/MM74HC)
CMOS	(MM54C/MM74C)
High Speed Sub-family (Compatible with TTL)	(MM54HCT/MM74HCT)
Standard CMOS	CD4XXX

* DM54ALS functions "selectively available".

Package Information

	Technology		Standard TTL	Advanced Low Power Schottky TTL	Advanced Schottky TTL	Low Power Schottky TTL	Schottky TTL	High-Speed Silicon-Gate CMOS	CD4000 CMOS
Device Series	(0°C to + 70°C)	74	74	74ALS	74AS	74LS	74S		
	(−40°C to +85°C)	74						74HC	CD4XXXBC
	(−55°C to +125°C)	54	54	54ALS		54LS	54S	54HC	CD4XXXBM
Packages Available		74	J, N, M	N, FN, M	N, FN, M	J, N, FN, M	J, N, M	J, N, FH, FN	
		54	J, W, FH	J, FH	J, FH	J, W, FH	J, W, FH	J, FH, FK	

Typical SSI Performance

The electrical characteristics of specific devices within each family may vary. Please consult the appropriate National data sheet or databook for complete specifications.

Power Dissipation/Gate		(mW)	10	1	10	2	19	0.001 +	0.005 +
Propagation Delay Time		(ns)	10	4	1.5	9.5	3	10	125
Speed-Power Product		(pj)	100	4	15	19	57		
Flip-Flop Clock Frequency, f_{max}		(MHz)	35	50	175	45	125	40	2
Input Low Current, I_{IL}		(mA)	−1.0	−0.2	−0.4	−0.2	−1.6	±0.001	±0.001
Output Drive Current, I_{OL}	Standard	(mA)	16	8	20	8	20	4	0.4
	Buffer	(mA)	48	24	48	24	60	8	
*Power Supply Range			5V ± 5%*	5V ± 10%	5V ± 10%		5V ± 5%*	2.6V	3.15V

*54 Series devices in these technologies are specified with power supplies of 5V ± 10%.

Analog Switches

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	S 54/74	TTL 54/74
Quad Analog Switch	4016					X			
8-Channel Analog Multiplexer	4051					X			
Dual 4-Channel Analog Multiplexer	4052					X			
Triple 2-Channel Analog Multiplexer	4053					X			
Quad Analog Switch	4066					X			
Quad Analog Switch with Level Translator	4316					X			

Arithmetic Functions

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
4-Bit Binary Full Adder	83			X						
4-Bit Binary Adder with Fast Carry	83A							X		
4-Bit Magnitude Comparator	85					X		X		X
9-Bit Parity Generator/Checker	180									X
Arithmetic Logic Unit/Function Generator	181					X			X	X
Arithmetic Logic Unit/Function Generator	181B		X							
Look-Ahead Carry Generator	182		X			X			X	
BCD-to-Binary Converter	184									X
Binary-to-BCD Converter	185A									X
9-Bit Parity Generator/Checker	280		X			X			X	
Look Ahead Carry Generator with Selectable Carry Inputs	282		X							
4-Bit Binary Adder with Fast Carry	283					X		X	X	
Parity Generator/Checker	286		X							
Arithmetic Logic Unit/Function Generator	381								X	
8-Bit Magnitude Comparator (Equality Detector)	521	X				X	X			
8-Bit Magnitude Comparator (Equality Detector)	688					X	X			
4-Bit Full Adder	4008BM				X					
TRI-STATE 4-Bit Parallel Binary Multiplier	7875A									X
TRI-STATE 4-Bit Parallel Binary Multiplier	7875B									X
TRI-STATE 4-Bit Parallel Binary Multiplier	8875A									X
TRI-STATE 4-Bit Parallel Binary Multiplier	8875B									X

Buffers/Drivers

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Hex Inverter	04	X	X					X	X	X
Hex Inverting Buffer/Driver with High-Voltage Open Collector Outputs	06									X
Hex Buffer/Driver with High-Voltage Open-Collector Outputs	07									X
Hex Schmitt Trigger Inverter	14	X						X		X
Hex Inverting Buffer/Driver with High-Voltage Open-Collector Outputs	16									X
Hex Buffer/Driver with High-Voltage Open-Collector Outputs	17									X
Quad 2-Input NAND Buffer with High-Voltage Open-Collector Outputs	26							X		X
Quad 2-Input NOR Buffer	28	X								
8-Input NAND Gate	30	X	X	X				X	X	X
Quad 2-Input NOR Buffer with Open-Collector Outputs	33	X								
Quad 2-Input NAND Buffer	37	X						X		X
Quad 2-Input NAND Buffer with Open-Collector Outputs	38	X						X		X
Dual 4-Input NAND Buffer	40	X							X	
TRI-STATE Hex Buffer	95			X						X
TRI-STATE Hex Inverter	96			X						
TRI-STATE Hex Buffer	97			X						
TRI-STATE Hex Inverter	98			X						
Quad TRI-STATE Buffer	125					X				X
Quad TRI-STATE Buffer	125A							X		
Quad TRI-STATE Buffer	126					X				
Quad TRI-STATE Buffer	126A							X		
Dual 4-Input NAND 50Ω Line Driver	140								X	
Octal TRI-STATE Bus Driver/Receiver with True and Inverting Outputs	230		X							
Octal TRI-STATE Inverting Bus Driver/Receiver	231		X						X	
Octal TRI-STATE Inverting Buffer/Line Driver/Line Receiver	240	X	X	X		X	X	X	X	
Octal TRI-STATE Buffer/Line Driver/Line Receiver	241	X	X			X	X	X	X	
Octal TRI-STATE Buffer/Line Driver/Line Receiver	244	X	X	X		X	X	X	X	
Hex TRI-STATE Buffer	365					X				X
Hex TRI-STATE Buffer/Bus Driver	365A							X		
Inverting Hex TRI-STATE Buffer	366					X				
Inverting Hex TRI-STATE Buffer/Bus Driver	366A							X		
Hex TRI-STATE Buffer	367									X
Hex TRI-STATE Buffer/Bus Driver	367A							X		
Inverting Hex TRI-STATE Buffer	368					X		X		X
Octal TRI-STATE Buffer/Bus Driver	465	X						X		
Inverting Octal TRI-STATE Buffer/Bus Driver	466	X						X		
Octal TRI-STATE Buffer/Bus Driver	467	X						X		
Inverting Octal TRI-STATE Buffer/Bus Driver	468	X						X		
Inverting Octal TRI-STATE Buffer	540					X	X			

Buffers/Drivers (Continued)

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Inverting Octal TRI-STATE Buffer	541	X				X	X			
Hex 2-Input NAND Line Driver	804	X								
Hex 2-Input NAND Line Driver	804A		X							
Hex 2-Input NOR Line Driver	805	X								
Hex 2-Input NOR Line Driver	805A		X							
Hex 2-Input AND Line Driver	808	X								
Hex 2-Input AND Line Driver	808A		X							
Hex 2-Input OR Line Driver	832	X								
Hex 2-Input OR Line Driver	832A		X							
Hex Inverting TTL Buffer	901			X						
Hex Non-Inverting Buffer	902			X						
Hex Inverting PMOS Buffer	903			X						
Hex Non-Inverting PMOS Buffer	904			X						
Hex Open Drain N-Channel Buffer	906			X						
Hex Open Drain P-Channel Buffer	907			X						
Dual CMOS 30V Relay Driver	908			X						
4-Digit LED Display Controller	911			X						
4-Digit BCD LED Display Controller Driver	912			X						
Hex Schmitt Trigger with Extended Input Voltage	914			X						
6-Digit Hex LED Display Controller Driver	917			X						
Dual CMOS 30V Relay Driver	918			X						
Octal TRI-STATE Inverting Buffer	940								X	
Octal TRI-STATE Buffer	941								X	
4-Character LED Alphanumeric Display Controller Driver (17-Segment)	956			X						
Quad 2-Input NAND Buffer (ALS37)	1000	X	X							
Quad 2-Input NOR Buffer (ALS28)	1002	X								
Quad 2-Input NAND Buffer with Open-Collector Outputs	1003	X								
Hex Inverting Buffer	1004	X	X							
Hex Inverting Buffer with Open-Collector Outputs	1005	X								
Quad 2-Input AND Buffer	1008	X	X							
Triple 3-Input NAND Buffer	1010	X								
Triple 3-Input AND Buffer	1011	X								
Dual 4-Input NAND Buffer (ALS40)	1020			X						
Quad 2-Input OR Buffer	1032		X	X	X					
Hex Non-Inverting Buffer	1034		X	X	X					
Hex Non-Inverting Buffer with Open-Collector Outputs	1035			X						
Quad 2-Input NOR Driver	1036		X		X					
Octal TRI-STATE Inverting Bus Driver/Receiver	1240	X		X						
Octal TRI-STATE Driver/Receiver	1241	X		X						
Octal TRI-STATE Driver/Receiver	1244	X		X						

Buffers/Drivers (Continued)

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Hex Inverting Buffer	4009				X					
Hex Inverting Buffer	4009C				X					
Hex Non-Inverting Buffer	4010				X					
Hex Non-Inverting Buffer	4010C				X					
Hex Inverting Buffer	4049UBM				X					
Hex Inverting Buffer	4049UBC				X					
Hex Non-Inverting Buffer	4050BM				X					
Hex Non-Inverting Buffer	4050BC				X					
Quad 2-Input NAND Schmitt Trigger	4093BM				X					
Quad 2-Input NAND Schmitt Trigger	4039BC				X					
Hex Non-Inverting TRI-STATE Buffer	4503BM				X					
Hex Non-Inverting TRI-STATE Buffer	4503BC				X					
BCD-to-7-Segment Latch/Decoder/Driver	4511					X				
BCD-to-7-Segment Latch/Decoder/Driver for Liquid Crystal Displays	4543					X				
Hex Schmitt Trigger (See CD40106 data sheet)	4584BM				X					
Hex Schmitt Trigger (See CD40106 data sheet)	4584BC				X					
Hex Schmitt Trigger	40106BM				X					
Hex Schmitt Trigger	40106BC				X					

CMOS Memories

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
64-Bit (16 × 4) TRI-STATE Random Access Memory	89			X						
256-Bit (256 × 1) TRI-STATE Random Access Memory	200			X						
256-Bit (64 × 4) TRI-STATE Random Access Memory	910			X						
64-Bit (16 × 4) TRI-STATE Random Access Memory	989			X						

Comparators

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
4-Bit Magnitude Comparator	85			X				X		X
Octal 8-Bit Identity Comparator with Open-Collector Outputs	518	X								
Octal 8-Bit Identity Comparator with Open-Collector Outputs	519	X								
Octal 8-Bit Identity Comparator	520	X								
Octal 8-Bit Identity Comparator	521	X								
Octal 8-Bit Identity Comparator with Open-Collector Outputs	522	X								
10-Bit Magnitude Comparator with Open-Collector Outputs	7130									X
6-Bit Unified Bus Comparator with Hysteresis on Bus Inputs	7131									X
6-Bit Unified Bus Comparator with Hysteresis on Bus Inputs and Open-Collector Outputs	7136									X
6-Bit Magnitude Comparator with Open-Collector Outputs	7160									X
10-Bit Magnitude Comparator with Open-Collector Outputs	8130									X

Counters

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
Synchronous 4-Bit Up/Down BCD Counter	60									
Synchronous 4-Bit Up/Down Binary Counter	63									
Decade Counter	90			X				X		X
4-Bit Binary Counter	93			X				X		X
Synchronous 4-Bit Decade Counter with Asynchronous Clear	160	X	X	X		X				
Synchronous 4-Bit Decade Counter with Asynchronous Clear	160A							X		
Synchronous 4-Bit Binary Counter with Asynchronous Clear	161	X	X	X		X			X	
Synchronous 4-Bit Binary Counter with Asynchronous Clear	161A							X		X
Synchronous 4-Bit Decade Counter with Asynchronous Clear	162	X	X	X		X				
Synchronous 4-Bit Binary Counter with Asynchronous Clear	163	X	X	X		X			X	
Synchronous 4-Bit Binary Counter with Asynchronous Clear	163A							X		X
Synchronous 4-Bit Up/Down Decade Counter	168	X	X							
Synchronous 4-Bit Up/Down Binary Counter	169	X	X							
Synchronous 4-Bit Up/Down Binary Counter	169A							X		
Synchronous 4-Bit Up/Down Decade Counter with Mode Control	190	X				X		X		
Synchronous 4-Bit Up/Down Binary Counter with Mode Control	191	X				X	X	X		X
Synchronous 4-Bit Up/Down Decade Counter with Dual Clock	192	X				X				
Synchronous 4-Bit Up/Down Decade Counter with Dual Clock	193	X		X		X	X	X		X

Counters (Continued)

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Counter Look Ahead Carry Generator	264		X							
Decade Counter	290							X		
4-Bit Binary Counter	293							X		
Dual 4-Bit Decade Counter	390					X		X		
Dual 4-Bit Binary Counter	393					X		X		
8-Bit Binary Counter with TRI-STATE Output Register	590					X	X			
8-Bit Binary Counter with Input Register	592					X	X			
8-Bit Binary Counter with Bidirectional Input Register/Counter Outputs	593					X	X			
4-Digit Counter with Multiplexed 7-Segment Output Driver	925			X						
4-Digit Counter with Multiplexed 7-Segment Output Driver	926			X						
4-Digit Counter with Multiplexed 7-Segment Output Driver	927			X						
4-Digit Counter with Multiplexed 7-Segment Output Driver	928			X						
4-1/2-Digit LCD Up Counter/Latch/Driver	945			X						
4-Digit LCD Up/Down Counter/Latch/Driver	946			X						
4-Digit LCD Up/Down Counter/Latch/Driver	947			X						
Decade Counter/Divider with 10 Decoded Outputs	4017					X				
Decade Counter/Divider with 10 Decoded Outputs	4017BM				X					
Decade Counter/Divider with 10 Decoded Outputs	4017BC				X					
Presettable Divide-by-N Counter	4018BM				X					
Presettable Divide-by-N Counter	4018BC				X					
14-Stage Binary Counter	4020					X				
14-Stage Ripple-Carry Binary Counter/Divider	4020BM				X					
14-Stage Ripple-Carry Binary Counter/Divider	4020BC				X					
Divide-by-8 Counter/Divider with 8 Decoded Outputs	4022BM				X					
Divide-by-8 Counter/Divider with 8 Decoded Outputs	4022BC				X					
7-Stage Binary Counter	4024					X				
7-Stage Ripple-Carry Binary Counter/Divider	4024BM				X					
7-Stage Ripple-Carry Binary Counter/Divider	4024BC				X					
Presettable Binary/Decade Up/Down Counter	4029BM				X					
Presettable Binary/Decade Up/Down Counter	4029BC				X					
12-Stage Binary Counter	4040					X				
12-Stage Ripple-Carry Binary Counter/Divider	4040BM				X					
12-Stage Ripple-Carry Binary Counter/Divider	4040BC				X					
14-Stage Binary Counter	4060					X				
14-Stage Ripple-Carry Binary Counter/Divider	4060BM				X					
14-Stage Ripple-Carry Binary Counter/Divider	4060BC				X					
Binary Rate Multiplier	4089BM				X					
Binary Rate Multiplier	4089BC				X					

Counters (Continued)

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
BCD Up/Down Counter	4510BM				X					
BCD Up/Down Counter	4510BC				X					
Binary Up/Down Counter	4516BM				X					
Binary Up/Down Counter	4516BC				X					
Dual Synchronous Up Counter	4518BM				X					
Dual Synchronous Up Counter	4518BC				X					
Dual Synchronous Up Counter	4520BM				X					
Dual Synchronous Up Counter	4520BC				X					
Programmable Divide-by-n 4-Bit BCD Counter	4522BM				X					
Programmable Divide-by-n 4-Bit BCD Counter	4522BC				X					
Programmable Divide-by-n 4-Bit Binary Counter	4526BM				X					
Programmable Divide-by-n 4-Bit Binary Counter	4526BC				X					
BCD Rate Multiplier	4527BM				X					
BCD Rate Multiplier	4527BC				X					
Decade Counter with Asynchronous Clear	40160BM				X					
Decade Counter with Asynchronous Clear	40160BC				X					
Binary Counter with Asynchronous Clear	40161BM				X					
Binary Counter with Asynchronous Clear	40161BC				X					
Decade Counter with Asynchronous Clear	40162BM				X					
Decade Counter with Asynchronous Clear	40162BC				X					
Binary Counter with Asynchronous Clear	40163BM				X					
Binary Counter with Asynchronous Clear	40163BC				X					
Synchronous 4-Bit Up/Down Decade Counter	40192BM				X					
Synchronous 4-Bit Up/Down Decade Counter	40192BC				X					
Synchronous 4-Bit Up/Down Binary Counter	40193BM				X					
Synchronous 4-Bit Up/Down Binary Counter	40193BC				X					

Decoders/Encoders

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
BCD-to-Decimal Decoder/Driver (NIXIE Drivers)	41A									X
BCD-to-Decimal Decoder	42			X		X		X		X
BCD-to-Decimal Decoder/Driver	45									X
BCD-to-7-Segment Decoder/Driver with Open-Collector Outputs	46A									X
BCD-to-7-Segment Decoder/Driver with Open-Collector Outputs	47A									X
BCD-to-7-Segment Decoder	48			X						
3-to-8 Line Decoder with Address Latches	131	X								
3-to-8 Line Decoder/Demultiplexer with Address Latches	137	X				X				
3-to-8 Line Decoder/Demultiplexer	138	X				X	X	X	X	
139 Dual 2-to-4 Line Decoder/Demultiplexer	139					X	X	X	X	
BCD-to-Decimal Decoder/Driver	141									X
BCD-to-Decimal Decoder/Driver	145									X
10-Line Decimal to 4-Line BCD Priority Encoder	147					X				
8-Line Decimal to 3-Line Octal Priority Encoder	148									X
8-Line to 8-Line Priority Encoder	149					X	X			
4-to-16 Line Decoder/Demultiplexer	154			X		X		X		X
Dual 2-to-4 Line Decoder/1-to-4 Line Demultiplexer	155					X	X	X		X
Dual 2-to-4 Line Decoder/1-to-4 Line Demultiplexer with Open-Collector Outputs	156							X		
3-to-8 Decoder with Address Latches	237					X				
7-Segment-to-BCD Converter	915			X						
16-Key Keyboard Encoder	922			X						
20-Key Keyboard Encoder	923			X						
BCD-to-Decimal Decoder	4028BC				X					
BCD-to-Decimal Decoder	4028BM				X					
BCD-to-7-Segment Latch/Decoder/Driver	4511BC				X					
BCD-to-7-Segment Latch/Decoder/Driver	4511BM				X					
4-to-16 Line Decoder with Latch	4514			X	X					
4-Bit Latched 4-to-16 Line Decoder	4515BC				X					
4-Bit Latched 4-to-16 Line Decoder	4515BM				X					
Dual 4-Channel or Single 8-Channel Analog Data Selector	4529BC				X					
Dual 4-Channel or Single 8-Channel Analog Data Selector	4529BM				X					
BCD-to-7-Segment Latch/Decoder/Driver for Liquid Crystal Displays	4543BC				X					
4-to-16 Line Decoder/Demultiplexer	8311									X
8-to-3 Line Priority Encoder	8318									X
8-to-3 Line Priority Encoder	9318									X

Error Correction/Detection Circuits

		(Logic Families) Technology								
Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
TRI-STATE 32-Bit Error Detection and Correction Circuit	632	X								
32-Bit Error Detection and Correction Circuit with Open-Collector Outputs	633	X								
TRI-STATE 32-Bit Error Detection and Correction Circuit	634	X								
32-Bit Error Detection and Correction Circuit with Open-Collector Outputs	635	X								

Flip-Flops

		(Logic Families) Technology								
Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Dual J-K Flip-Flop with Clear	73			X		X		X		X
Dual J-K Negative-Edge-Triggered Flip-Flop with Clear	73A							X		
Dual D Flip-Flop with Preset and Clear	74		X	X		X	X		X	X
Dual D Positive-Edge-Triggered Flip-Flop with Preset and Clear	74A	X						X		
Dual J-K Flip-Flop with Preset and Clear	76			X		X	X			X
Dual J-K Negative-Edge-Triggered Flip-Flop with Preset and Clear	76A							X		
Dual J-K Flip-Flop with Clear	107			X		X				X
Dual J-K Negative-Edge-Triggered Master-Slave Flip-Flop with Clear	107A							X		
Dual J-K Flip-Flop with Preset and Clear	109		X			X	X			X
Dual J-K Positive-Edge-Triggered Flip-Flop with Preset and Clear	109A	X						X		
Dual J-K Flip-Flop with Preset and Clear	112					X	X		X	
Dual J-K Negative-Edge-Triggered Flip-Flop with Preset and Clear	112A							X		
Dual J-K Flip-Flop with Preset	113					X			X	
TRI-STATE Quad D Flip-Flop	173			X		X				
Hex D Flip-Flop with Clear	174	X	X	X		X		X	X	X
Quad D-Type Flip-Flop with Clear	175	X	X	X		X		X	X	X
Octal D Flip-Flop with Clear	273	X				X	X			
TRI-STATE Octal D-Type Flip-Flop	374	X	X	X		X	X	X	X	
TRI-STATE Octal D-Type Flip-Flop with Inverted Outputs	534	X	X			X	X			
TRI-STATE Octal D-Type Flip-Flop with Inverted Outputs	564	X				X	X			
Octal TRI-STATE D-Type Flip-Flop	574	X	X			X	X			
Octal TRI-STATE Positive-Edge-Triggered D Flip-Flop with Synchronous Clear	575		X							

Flip-Flops (Continued)

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Octal TRI-STATE Inverting Positive-Edge-Triggered D Flip-Flop	576	X	X							
Octal TRI-STATE Inverting Positive-Edge-Triggered D Flip-Flop with Synchronous Clear	577		X							
Dual TRI-STATE 4-Bit Positive-Edge-Triggered D Flip-Flop	874	X	X							
Dual 4-Bit Inverting Positive-Edge-Triggered D Flip-Flop	876	X	X							
Dual 4-Bit Positive-Edge-Triggered D Flip-Flop with Synchronous Clear	878		X							
Dual 4-Bit Inverting Positive-Edge-Triggered D Flip-Flop with Synchronous Preset	879		X							
Dual D Flip-Flop	4013BC				X					
Dual D Flip-Flop	4013BM				X					
Dual J-K Master/Slave Flip-Flop with Set and Reset	4027BC				X					
Dual J-K Master/Slave Flip-Flop with Set and Reset	4027BM				X					
Quad Clocked D Latch	4042BC				X					
Quad Clocked D Latch	4042BM				X					
TRI-STATE NOR R/S Latch	4043BC				X					
TRI-STATE NOR R/S Latch	4043BM				X					
TRI-STATE NAND R/S Latch	4044BC				X					
TRI-STATE NAND R/S Latch	4044BM				X					
TRI-STATE Quad Flip-Flop	4076BC				X					
TRI-STATE Quad Flip-Flop	4076BM				X					
8-Bit Addressable Latch	4099BC				X					
8-Bit Addressable Latch	4099BM				X					
Dual 4-Bit Addressable Latch	4723BC				X					
Dual 4-Bit Addressable Latch	4723BM				X					
8-Bit Addressable Latch	4724BC				X					
8-Bit Addressable Latch	4724BM				X					
Dual Positive-Edge-Triggered J-K Flip-Flop with Preset and Clear	8024									X
Dual Positive-Edge-Triggered J-K Flip-Flop with Preset and Clear	9024									X
Hex D Flip-Flop	40174BC				X					
Hex D Flip-Flop	40174BM				X					
Quad D Flip-Flop	40175BC				X					
Quad D Flip-Flop	40175BM				X					

Gates/Inverters

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
Quad 2-Input NAND Gate	00	X	X	X		X	X	X	X	X
Quad 2-Input NAND Gate with Open-Collector Outputs	01	X								X
Quad 2-Input NOR Gate	02	X	X	X		X		X	X	X
Quad 2-Input NAND Gate with Open-Collector Outputs	03	X				X		X	X	X
Hex Inverter	04	X	X			X	X	X	X	X
Hex Inverter	U04					X				
Hex Inverter with Open-Collector Outputs	05	X					X	X	X	X
Quad 2-Input AND Gate	08	X	X	X		X	X	X	X	X
Quad 2-Input AND Gate with Open-Collector Outputs	09	X						X	X	X
Triple 3-Input NAND Gate	10	X	X	X		X		X	X	X
Triple 3-Input AND Gate	11	X	X			X		X	X	
Triple 3-Input NAND Gate with Open-Collector Outputs	12	X						X		
Dual 4-Input Schmitt Trigger NAND Gate	13	X								
Hex Schmitt Trigger Inverter	14	X				X		X		X
Triple 3-Input AND Gate with Open-Collector Outputs	15	X								
Dual 4-Input NAND Gate	20	X	X	X		X		X	X	X
Dual 4-Input AND Gate	21	X	X					X		
Dual 4-Input NAND Gate with Open-Collector Outputs	22	X								
Triple 3-Input NOR Gate	27	X	X			X		X		X
8-Input NAND Gate	30	X	X	X		X		X	X	X
Quad 2-Input OR Gate	32	X	X	X		X		X	X	X
Hex Non-Inverter	34		X				X			
Dual AND-OR-Invert Gate	51					X		X	X	
Dual AND-OR Gate	58					X				
4-Wide AND-OR-Invert Gate	64								X	
Quad Exclusive-OR Gate	86		X	X		X		X	X	X
Quad 2-Input Schmitt Trigger NAND Gate	132	X				X		X		X
13-Input NAND Gate	133	X				X			X	
Quad Exclusive-OR Gate with Open-Collector Outputs	136	X	X							
Quad 2-Input Exclusive NOR Gate	266					X				
Quad Exclusive-OR Gate	386							X		
Quad 2-Input Exclusive NOR Gate	810	X	X							
Quad 2-Input Exclusive NOR Gate with Open-Collector Outputs	811	X	X							
Quad Comparator	909			X						
Dual Input NOR Gate Plus Inverter	4000C				X					
Dual Input NOR Gate Plus Inverter	4000M				X					
Quad 2-Input NOR Gate	4001C				X					
Quad 2-Input NOR Gate	4001M				X					
Dual 4-Input NOR Gate	4002				X					

Gates/Inverters (Continued)

Description	Device Number	(Logic Families) Technology								
		ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Dual 4-Input NOR Gate	4002C				X					
Dual 4-Input NOR Gate	4002M				X					
Dual Complementary Pair Plus Inverter	4007C				X					
Dual Complementary Pair Plus Inverter	4007M				X					
Quad 2-Input NAND Gate	4011C				X					
Quad 2-Input NAND Gate	4011M				X					
Quad 2-Input NAND Buffered B Series Gate	4011BC				X					
Quad 2-Input NAND Buffered B Series Gate	4011BM				X					
Dual 4-Input NAND Gate	4012C				X					
Dual 4-Input NAND Gate	4012M				X					
Dual 4-Input Buffered NAND Gate	4012BC				X					
Dual 4-Input Buffered NAND Gate	4012BM				X					
Quad AND-OR Select Gate	4019BC				X					
Quad AND-OR Select Gate	4019BM				X					
Triple 3-Input NOR Gate	4023C				X					
Triple 3-Input NOR Gate	4023M				X					
Triple 3-Input Buffered NAND Gate	4023BC				X					
Triple 3-Input Buffered NAND Gate	4023BM				X					
Triple 3-Input NAND Gate	4025C				X					
Triple 3-Input NAND Gate	4025M				X					
Triple 3-Input Buffered NOR Gate	4025BC				X					
Triple 3-Input Buffered NOR Gate	4025BM				X					
Quad Exclusive-OR Gate	4030C				X					
Quad Exclusive-OR Gate	4030M				X					
Quad True/Complement Buffer	4041C				X					
Quad True/Complement Buffer	4041M				X					
TRI-STATE Expandable 8-Function 8-Input Gate	4048BC				X					
TRI-STATE Expandable 8-Function 8-Input Gate	4048BM				X					
Hex Inverting Logic Level Down Converter	4049					X				
Hex Logic Level Down Converter	4050					X				
Inverter Circuit	4069UBM				X					
Inverter Circuit	4069UBC				X					
Quad 2-Input Exclusive-OR Gate	4070BC				X					
Quad 2-Input Exclusive-OR Gate	4070BM				X					
Quad 2-Input OR Buffered B Series Gate	4071BC				X					
Quad 2-Input OR Buffered B Series Gate	4071BM				X					
Double Buffered Triple 3-Input AND Gate	4073BC				X					
Double Buffered Triple 3-Input AND Gate	4073BM				X					
Triple 3-Input OR Gate	4075					X				

Gates/Inverters (Continued)

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
Double Buffered Triple 3-Input OR Gate	4075BC				X					
Double Buffered Triple 3-Input OR Gate	4075BM				X					
8-Input NOR/OR Gate	4078					X				
Quad 2-Input AND Buffered B Series Gate	4081BC				X					
Quad 2-Input AND Buffered B Series Gate	3081BM				X					
4-Bit AND/OR Selector	4519BC				X					
4-Bit AND/OR Selector	4519BM				X					

Latches

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
4-Bit Bistable Latch with Q and $\overline{Q}$ Output	75					X		X		X
8-Bit Serial In to Parallel Out Addressable Latch	259					X		X		X
Quad S-R Latch	279							X		
Octal TRI-STATE Transparent D Latch	373	X	X	X		X	X	X	X	
Octal TRI-STATE Inverting Transparent D Latch	533	X	X			X	X			
Octal TRI-STATE Transparent D Latch	563	X				X	X			
Octal TRI-STATE Inverting Transparent D Latch	573	X	X			X	X			
Octal TRI-STATE Inverting Transparent D Latch	580	X	X							
Dual TRI-STATE 4-Bit Transparent D Latch	873	X	X							
Dual 4-Bit Inverting Transparent D Latch	880	X	X							
8-Bit Addressable Latch	8334									X
8-Bit Addressable Latch	9334									X

Multiplexers/Demultiplexers

		(Logic Families) Technology								
Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
TRI-STATE 16-Line to 1-Line Multiplexer	19			X						
16-Line to 1-Line Multiplexer	150			X						X
8-Channel Digital Multiplexer	151	X		X		X		X	X	
1-of-8 Line Data Selector/Multiplexer	151A									X
Dual 4-Input Multiplexer	153	X				X		X	X	X
Quad 2-Input Multiplexer	157	X	X	X		X	X	X	X	X
Quad 2-Input Multiplexer (Inverted Output)	158	X	X			X	X	X	X	
8-Channel TRI-STATE Multiplexer	251	X				X		X	X	
Dual 4-Channel TRI-STATE Multiplexer	253	X				X		X	X	
Quad TRI-STATE 2-to-1 Line Data Selector/Multiplexer	257	X	X			X	X		X	
Quad TRI-STATE 2-to-1 Line Data Selector/Multiplexer	257B							X		
Quad TRI-STATE 2-to-1 Line Inverting Data Selector/Multiplexer	258	X	X						X	
Quad TRI-STATE 2-to-1 Line Inverting Data Selector/Multiplexer	258B							X		
Quad 2-Input Multiplexer with Storage	298					X				
Dual 1 of 4 Line Inverting Data Selector/Multiplexer	352	X						X		
Dual TRI-STATE 1 of 4 Line Data Selector/Multiplexer	353	X								
8-Channel TRI-STATE Multiplexer with Latches	354					X				
8-Channel TRI-STATE Multiplexer with Latches	356					X				
Quad Bilateral Switch	4016BC				X					
Quad Bilateral Switch	4016BM				X					
Analog Multiplexer/Demultiplexer	4051BC				X					
Analog Multiplexer/Demultiplexer	4051BM				X					
Analog Multiplexer/Demultiplexer	4052BC				X					
Analog Multiplexer/Demultiplexer	4052BM				X					
Analog Multiplexer/Demultiplexer	4053BC				X					
Analog Multiplexer/Demultiplexer	4053BM				X					
Quad Bilateral Switch	4066BC				X					
Quad Bilateral Switch	4066BM				X					
8-Channel Data Selector	4512BC				X					
8-Channel Data Selector	4512BM				X					
Dual 4-Channel or Single 8-Channel Analog Data Selector	4529BC				X					
Dual 4-Channel or Single 8-Channel Analog Data Selector	4529BM				X					
Quad TRI-STATE 1-of-2 Line Data Selector/Multiplexer	7123									X
Quad TRI-STATE 1-of-2 Line Data Selector/Multiplexer	8123									X
1-of-8 Line Data Selector/Multiplexer	8312									X
Quad 1-of-2 Line Data Selector/Multiplexer	8322									X
Dual 1-of-4 Line Data Selector/Multiplexer with Complementary Outputs	9312									X
Quad 1-of-2 Line Data Selector/Multiplexer	9322									X

Multivibrators

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
Monostable Multivibrator with Schmitt-Trigger Input	121									X
Retriggerable Monostable Multivibrator with Clear	122							X		
Dual Retriggerable Monostable Multivibrator with Clear	123					X		X		X
Dual Monostable Multivibrator	221			X		X		X		
Dual Retriggerable Monostable Multivibrator	423A									X
Phase Comparator	932			X						
CMOS Phase-Lock-Loop	4046				X	X				
Low Power Monostable/Astable Multivibrator	4047				X					
Dual Monostable Multivibrator	4528BC				X					
Dual Monostable Multivibrator	4528BM				X					
Dual Retriggerable Monostable Multivibrator	4538				X					
Dual Monostable Multivibrator	4538BC				X					
Dual Monostable Multivibrator	4538BM				X					
Programmable Timer with Oscillator	4541BC				X					
Programmable Timer with Oscillator	4541BM				X					
Retriggerable Monostable Multivibrator with Complementary Outputs	8601									X
Dual Retriggerable, Resettable Monostable Multivibrator with Complementary Outputs	8602									X
Retriggerable Monostable Multivibrator with Complementary Outputs	9601									X
Dual Retriggerable, Resettable Monostable Multivibrator with Complementary Outputs	9602									X

Registers

Description	Device Number	(Logic Families) Technology ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
4-Bit Parallel Access Shift Register	95			X						X
8-Bit Serial In/Parallel Out Shift Register with Asynchronous Clear	164			X		X	X	X		X
8-Bit Parallel In/Serial Out Shift Register with Complementary Outputs	165	X		X		X		X		
8-Bit Parallel or Serial In/Serial Out Shift Register with Complementary Outputs	166	X						X		X
4-Bit TRI-STATE Register	173									X
4-Bit TRI-STATE Register	173A							X		
4-Bit Bidirectional Universal Shift Register	194					X			X	X
4-Bit Bidirectional Universal Shift Register	194A							X		
4-Bit Parallel Access Shift Register	195			X		X		X	X	
4-Bit Parallel Access Shift Register	299					X	X		X	
8-Bit TRI-STATE Universal Shift Register	323						X			
8-Bit Shift Register with Input Latches and TRI-STATE Serial Output	589					X				
8-Bit Shift Register with Output Latches	595					X				
8-Bit Shift Register with Input Latches	597					X				
12-Bit Successive Approximation Register	905			X						
8-Bit Successive Approximation Register	2502									X
8-Bit Expandable Successive Approximation Register	2503									X
12-Bit Expandable Successive Approximation Register	2504									X
18-Stage Static Shift Register	4006BC				X					
18-Stage Static Shift Register	4006BM				X					
8-Stage Static Shift Register	4014BC				X					
8-Stage Static Shift Register	4014BM				X					
Dual 4-Bit Static Register	4015BC				X					
Dual 4-Bit Static Register	4015BM				X					
8-Stage Static Shift Register	4021BC				X					
8-Stage Static Shift Register	4021BM				X					
64-Stage Static Shift Register	4031BC				X					
64-Stage Static Shift Register	4031BM				X					
8-Stage TRI-STATE Bidirectional Parallel/Serial Input/Output Bus Register	4034BC				X					
8-Stage TRI-STATE Bidirectional Parallel/Serial Input/Output Bus Register	4034BM				X					
4-Bit Parallel-In/Parallel-Out Shift Register	4035BC				X					
4-Bit Parallel-In/Parallel-Out Shift Register	4035BM				X					
4-Bit Positive-Edge-Triggered Parallel or Serial Access Shift Registers	8300									X

Transceivers

Description	Device Number	ALS 74	AS 74	C 54/74	CD 4	HC 54/74	HCT 54/74	LS 54/74	S 54/74	TTL 54/74
		(Logic Families) Technology								
Inverting Quad TRI-STATE Transceiver	242	X	X			X				
Quad TRI-STATE Transceiver	243	X	X			X		X		
Octal TRI-STATE Transceiver	245	X	X			X	X	X		
Octal TRI-STATE Inverting Bus Transceiver	620	X	X							
Octal TRI-STATE Inverting Bus Transceiver	640	X	X			X	X			
Octal TRI-STATE True and Inverting Bus Transceiver	643	X	X			X	X			
Octal TRI-STATE Bus Transceiver	645							X		
Octal TRI-STATE Bus Transceiver/Register	646	X	X			X				
Octal TRI-STATE Inverting Bus Transceiver/Register	648	X	X			X				
Octal TRI-STATE Inverting Bus Transceiver/Register	651		X							
Octal TRI-STATE Bus Transceiver/Register	652	X	X							
Quad TRI-STATE Inverting Bus Transceiver	1242	X								
Quad TRI-STATE Bus Transceiver	1243	X								
Octal Bus Transceiver with Open-Collector and TRI-STATE Outputs	1639									
Octal TRI-STATE True and Inverting Bus Transceiver	1643									
Octal TRI-STATE Inverting Bus Transceiver/MOS Driver	2620		X							
Transceiver/MOS Driver	2645		X							

Memory

For additional Memory products, see pages 311 and 437.

Memory

National Semiconductor Looks at Memory the Way You Do.

Some systems require non-volatile memory with lightning-fast address-access times for high-speed microcontrol storage. To meet those needs, there is National's Bipolar PROM Family.

Our CMOS EPROM family is for systems that require non-volatile memory with low power consumption, reprogrammability, and microprocessor speeds.

For applications where in-circuit, remote-programmable memory will promote design flexibility and end product advantage, National provides you with a family of EEPROMs.

For high performance, National's families of TTL and high-speed MOS static RAMs are designed to meet your system-design requirements for speed and density. ECL is the best choice for ultra-high performance. From the 7 ns access time of our ECL RAMs, to the 256 k-bit density in our high-speed CMOS static RAMs, National has a solution to your RAM needs.

All National RAMs are designed for the military environment.

CMOS EPROMs

The largest family of CMOS EPROMs available worldwide was designed to meet your current and future system requirements in density, speed, and power consumption. Using the latest microCMOS technology with down to 1.5-micron feature sizes, National provides the best cost/performance combination in the industry.

Programming algorithms are installed in all major PROM programmer equipment and ease of programming is enhanced via our manufacturer's identification code.

Device Numbers	Organization	Size	Access Time	Prog Volt	PS Total	Power (mW) Active/Standby	Temp Range (°C)	Packaging Information
NMC27C16BQ35	2k × 8	16k	350	13	5%	26.25/0.53	0 to + 70	Q24A
NMC27C16BQE35	2k × 8	16k	350	13	5%	26.25/0.53	− 40 to + 85	Q24A
NMC27C32BQ200	4k × 8	32k	200	13	10%	27.5/0.55	0 to + 70	Q24A
NMC27C32BQ350	4k × 8	32k	350	13	10%	27.5/0.55	0 to + 70	Q24A
NMC27C32BQE200	4k × 8	32k	200	13	10%	27.5/0.55	− 40 to + 85	Q24A
NMC27C32BQE350	4k × 8	32k	350	13	10%	27.5/0.55	− 40 to + 85	Q24A
NMC27C64Q15	8k × 8	64k	150	13	5%	55/0.55	0 to + 70	Q28A
NMC27C64Q150	8k × 8	64k	150	13	10%	55/0.55	0 to + 70	Q28A
NMC27C64Q200	8k × 8	64k	200	13	10%	55/0.55	0 to + 70	Q28A
NMC27C64Q250	8k × 8	64k	250	13	10%	55/0.55	0 to + 70	Q28A
NMC27C64Q300	8k × 8	64k	300	13	10%	55/0.55	0 to + 70	Q28A
NMC27C64QE200	8k × 8	64k	200	13	10%	55/0.55	− 40 to + 85	Q28A
NMC27C64QM250	8k × 8	64k	250	13	10%	55/0.55	− 55 to + 125	Q28A
NMC27C256Q17	32k × 8	256k	170	13	5%	55/0.55	0 to + 70	Q28A
NMC27C256Q200	32k × 8	256k	200	13	10%	55/0.55	0 to + 70	Q28A
NMC27C256Q250	32k × 8	256k	250	13	10%	55/0.55	0 to + 70	Q28A
NMC27C256Q300	32k × 8	256k	300	13	10%	55/0.55	0 to + 70	Q28A
NMC27C256QE250	32k × 8	256k	250	13	10%	55/0.55	− 40 to + 85	Q28A
NMC27C256QM250	32k × 8	256k	250	13	10%	55/0.55	− 55 to + 125	Q28A
NMC27C256QM350	32k × 8	256k	350	13	10%	55/0.55	− 55 to + 125	Q28A
NMC27C256BQ90	32k × 8	256k	90	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C256BQ120	32k × 8	256k	120	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C256BQ150	32k × 8	256k	150	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C256BQ200	32k × 8	256k	200	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C256BQE120	32k × 8	256k	120	12.5	10%	220/0.55	− 40 to + 85	Q28A
NMC27C256BQM150	32k × 8	256k	150	12.5	10%	220/0.55	− 55 to + 125	Q28A
NMC27C512Q20	64k × 8	512k	200	13	5%	55/0.55	0 to + 70	Q28A
NMC27C512Q250	64k × 8	512k	250	13	10%	55/0.55	0 to + 70	Q28A
NMC27C512Q300	64k × 8	512k	300	13	10%	55/0.55	0 to + 70	Q28A
NMC27C512Q350	64k × 8	512k	350	13	10%	55/0.55	0 to + 70	Q28A
NMC27C512QE250	64k × 8	512k	250	13	10%	55/0.55	− 40 to + 85	Q28A
NMC27C512QM350	64k × 8	512k	350	13	10%	55/0.55	− 55 to + 125	Q28A
NMC27C512AQ90	64k × 8	512k	90	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C512AQ120	64k × 8	512k	120	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C512AQ150	64k × 8	512k	150	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C512AQ200	64k × 8	512k	200	12.5	10%	220/0.55	0 to + 70	Q28A
NMC27C512AQE120	64k × 8	512k	120	12.5	10%	220/0.55	− 40 to + 85	Q28A
NMC27C512AQM150	64k × 8	512k	150	12.5	10%	220/0.55	− 55 to + 125	Q28A

CMOS EPROMs (Continued)

Device Numbers	Organization	Size	Access Time	Prog Volt	PS Total	Power (mW) Active/Standby	Temp Range (°C)	Packaging Information
NMC27C1024Q90	64k × 16	1024k	90	12.5	10%	275/0.55	0 to + 70	Q40A
NMC27C1024Q120	64k × 16	1024k	120	12.5	10%	275/0.55	0 to + 70	Q40A
NMC27C1024Q150	64k × 16	1024k	150	12.5	10%	275/0.55	0 to + 70	Q40A
NMC27C1024Q200	64k × 16	1024k	200	12.5	10%	275/0.55	0 to + 70	Q40A
NMC27C1024QE120	64k × 16	1024k	120	12.5	10%	275/0.55	− 40 to + 85	Q40A
NMC27C1024QM150	64k × 16	1024k	150	12.5	10%	275/0.55	− 55 to + 125	Q40A
NMC27C1023Q90	128k × 8	1024k	90	12.5	10%	275/0.55	0 to + 70	Q32A
NMC27C1023Q120	128k × 8	1024k	120	12.5	10%	275/0.55	0 to + 70	Q32A
NMC27C1023Q150	128k × 8	1024k	150	12.5	10%	275/0.55	0 to + 70	Q32A
NMC27C1023Q200	128k × 8	1024k	200	12.5	10%	275/0.55	0 to + 70	Q32A
NMC27C1023QE120	128k × 8	1024k	120	12.5	10%	275/0.55	− 40 to + 85	Q32A
NMC27C1023QM150	128k × 8	1024k	150	12.5	10%	275/0.55	− 55 to + 125	Q32A

EEPROMs

National EEPROMs expand your design flexibility for systems needing in-circuit and/or remote programming, as the advanced floating gate technology permits both writing and erasing electrically. Designing with EEPROMs not only enhances your product benefits, but will also replace devices such as mechanical dip switches, battery back-up RAM and potentiometers, increasing your overall product reliability and decreasing your product cost. National offers both NMOS and CMOS families of EEPROMs.

Device Number	Organization	Size	Packaging Information	Interface	Power Consumption Active/Standby	Temp Range (°C)
NMC9306	16 × 16	256-bit	N08E, M14B, M08A	Serial	10 mA/3 mA	0 to + 70
NMC9306E	16 × 16	256-bit	N08E	Serial	12 mA/4 mA	− 40 to + 85
NMC9306M	16 × 16	256-bit	N08E	Serial	14 mA/5 mA	− 55 to + 125
NMC9307	16 × 16	256-bit	N08E	Serial	10 mA/3 mA	0 to + 70
NMC9307E	16 × 16	256-bit	N08E	Serial	12 mA/4 mA	− 40 to + 85
NMC9313B	16 × 16	256-bit	N08E	Serial	12 mA/4 mA	0 to + 70
NMC9346	64 × 16	1024	N08E, M14B, M08A	Serial	12 mA/3 mA	0 to + 70
NMC9346E	64 × 16	1024	N08E	Serial	14 mA/4 mA	− 40 to + 85
NMC9346M	64 × 16	1024	N08E	Serial	12 mA/3 mA	− 55 to + 125
NMC9314B	64 × 16	1024	N08E	Serial	14 mA/4 mA	0 to + 70
NMC93CS06	16 × 16	256	N08E, M14B	Serial	2.5 mA/100 mA	− 55 to + 125
NMC93CS26	32 × 16	512	N08E, M14B	Serial	5 mA/0.2 mA	− 55 to + 125
NMC93CS46	64 × 16	1024	N08E, M14B	Serial	5 mA/0.2 mA	− 55 to + 125
NMC93CS56	128 × 16	2048	N08E, M14B	Serial	3 mA/50 mA	− 55 to + 125
NMC93CS66	256 × 16	4096	N08E, M14B	Serial	3 mA/50 mA	− 55 to + 125
NMC98C10	128 × 8	1024	N18A	Mux	10 mA/100 mA	0 to + 70
NMC98C40	512 × 8	4096	N18A	Mux	10 mA/100 mA	0 to + 70

Bipolar PROMs

High-speed microcontrol storage is made practical at very low cost through the use of National's bipolar PROMs. This generic family utilizes the latest in Schottky circuitry and titanium-tungsten fuse link technology. National offers these and other memory and logic products for state-of-the-art solutions to data processing and control logic design problems.

Size (Bits)	Organization	Commercial Part Number	t_{AA} Commercial (Max) in ns	t_{AA} Mil Temp (Max) in ns	I_{CC} (Max) in A	Description	Temp Range (°C)	Package Type
256	32 × 8 OC	DM74S188	35	45	110	(32 × 8) 256-Bit TTL PROM	0 to + 70	J, N16A
	32 × 8 OC	DM74S188A	25	20	110	(32 × 8) 256-Bit TTL PROM	0 to + 70	J, N16A
	32 × 8 TS	DM74S288	35	45	110	(32 × 8) 256-Bit TTL PROM	0 to + 70	J, N16A
	32 × 8 TS	DM74S288A	25	20	110	(32 × 8) 256-Bit TTL PROM	0 to + 70	J, N16A
	32 × 8 TS	PL87X288B	15	12	140	(32 × 8) 256-Bit TTL PROM	0 to + 70	J, N16A
1024	256 × 4 OC	DM74S387	50	60	130	(256 × 4) 1024-Bit TTL PROM	0 to + 70	J, N16A
	256 × 4 OC	DM74S387A	30	20	130	(256 × 4) 1024-Bit TTL PROM	0 to + 70	J, N16A
	256 × 4 TS	DM74S287	50	60	130	(256 × 4) 1024-Bit TTL PROM	0 to + 70	J, N16A
	256 × 4 TS	DM74S287A	30	20	130	(256 × 4) 1024-Bit TTL PROM	0 to + 70	J, N16A
2048	512 × 4 OC	DM74S570	55	65	130	(512 × 4) 2048-Bit TTL PROM	0 to + 70	J, N16A
	512 × 4 TS	DM74S571	55	65	130	(512 × 4) 2048-Bit TTL PROM	0 to + 70	J, N16A
	512 × 4 OC	DM74S570A	45	60	130	(512 × 4) 2048-Bit TTL PROM	0 to + 70	J, N16A
	512 × 4 TS	DM74S571A	45	60	130	(512 × 4) 2048-Bit TTL PROM	0 to + 70	J, N16A
	512 × 4 TS	DM74S571B	35	50	130	(512 × 4) 2048-Bit TTL PROM	0 to + 70	J, N16A
2048	256 × 8 TS	DM74LS471	60	70	100	(256 × 8) 2048-Bit TTL PROM	0 to + 70	J20B, N20A
4096	512 × 8 OC	DM74S475	65	75	170	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J, N24A
	512 × 8 TS	DM74S474	65	75	170	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J, N24A
	512 × 8 OC	DM74S475A	45	60	170	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J, N24A
	512 × 8 TS	DM74S474A	45	60	170	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J, N24A
	512 × 8 TS	DM74S474B	35	50	170	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J, N24A
4096	512 × 8 OC	DM74S473	60	75	155	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J20B, N20A
	512 × 8 TS	DM74S472	60	75	155	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J20B, N20A
	512 × 8 OC	DM74S473A	45	60	155	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J20B, N20A
	512 × 8 TS	DM74S472A	45	60	155	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J20B, N20A
	512 × 8 TS	DM74S472B	35	50	155	(512 × 8) 4096-Bit TTL PROM	0 to + 70	J20B, N20A
4096	1024 × 4 OC	DM74S572	60	75	140	(1024 × 4) 4096-Bit TTL PROM	0 to + 70	J18A, N18A
	1024 × 4 TS	DM74S573	60	75	140	(1024 × 4) 4096-Bit TTL PROM	0 to + 70	J18A, N18A
	1024 × 4 OC	DM74S572A	45	60	140	(1024 × 4) 4096-Bit TTL PROM	0 to + 70	J18A, N18A
	1024 × 4 TS	DM74S573A	45	60	140	(1024 × 4) 4096-Bit TTL PROM	0 to + 70	J18A, N18A
	1024 × 4 TS	DM74S573B	35	55	140	(1024 × 4) 4096-Bit TTL PROM	0 to + 70	J18A, N18A
8192	1024 × 8 OC	DM87S180	55	75	170	(1024 × 8) 8192-Bit TTL PROM	0 to + 70	J24A, N24A
	1024 × 8 TS	DM87S181	55	75	170	(1024 × 8) 8192-Bit TTL PROM	0 to + 70	J24A, N24A

Bipolar PROMs (Continued)

Size (Bits)	Organization	Commercial Part Number	t_{AA} Commercial (Max) in ns	t_{AA} Mil Temp (Max) in ns	I_{CC} (Max) in A	Description	Temp Range*** (°C)	Package Type
8192	2048 × 4 OC	DM87S184	55	70	140	(2048 × 4) 8192-Bit TTL PROM	0 to + 70	J18A, N18A
	2048 × 4 TS	DM87S185	55	70	140	(2048 × 4) 8192-Bit TTL PROM	0 to + 70	J18A, N18A
	2048 × 4 OC	DM87S184A	45	60	140	(2048 × 4) 8192-Bit TTL PROM	0 to + 70	J18A, N18A
	2048 × 4 TS	DM87S185A	45	60	140	(2048 × 4) 8192-Bit TTL PROM	0 to + 70	J18A, N18A
	2048 × 4 TS	DM87S185B	35	50	140	(2048 × 4) 8192-Bit TTL PROM	0 to + 70	J18A, N18A
8192	1024 × 8 OC	DM87S280	55	75	170	(1024 × 8) 8192-Bit TTL PROM	0 to + 70	J24C, N24C
	1024 × 8 TS	DM87S281	55	75	170	(1024 × 8) 8192-Bit TTL PROM	0 to + 70	J24C, N24C
	1024 × 8 TS	DM87S281A	45	65	170	(1024 × 8) 8192-Bit TTL PROM	0 to + 70	J24C, N24C
16384	2048 × 8 OC	DM87S190	65	80	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	DM87S191	65	80	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	DM87S191A	45	60	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	DM87S191B	35	50	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
16384	2048 × 8 OC	*DM87S290	65	80	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	*DM87S291	65	80	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	*DM87S291A	45	60	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
	2048 × 8 TS	*DM87S291B	35	50	175	(2048 × 8) 16,384-Bit TTL PROM	0 to + 70	J24C, N24C
16384	4096 × 4 TS	DM87S195A	45	60	170	(4096 × 4) 16,384-Bit TTL PROM	0 to + 70	J20B, N20A
	4096 × 4 TS	DM87S195B	35	50	170	(4096 × 4) 16,384-Bit TTL PROM	0 to + 70	J20B, N20A
32768	4096 × 8 TS	DM87S321	55	65	185	(4096 × 8) 32,768-Bit TTL PROM	0 to + 70	N24C
	4096 × 8 TS	*DM87S421	55	65	185	(4096 × 8) 32,768-Bit TTL PROM	0 to + 70	N24C

Registered PROMs

Size (Bits)	Organization	Commercial Part Number	Set Up	Clk to Out	Set Up	Clk to Out	I_{CC} (Max) in A	Temp Range (°C)	Package Type
4096	512 × 8 TS	DM87SR25	35	20	40	25	185	0 to + 70	J20B, N20A
	512 × 8 TS	DM87SR476	35	20	40	25	185	0 to + 70	J20B, N20A
	512 × 8 TS	DM87SR474	35	20	40	25	185	0 to + 70	J20B, N20A
4096	512 × 8 REG	DM87SR474B	35	20	40	25		0 to + 70	J20B, N20A
	512 × 8 REG	DM87SR476B	35	20	40	25		0 to + 70	J20B, N20A
	512 × 8 REG	DM87SR25B	35	20	40	25		0 to + 70	J20B, N20A
8192	1024 × 8 TS	DM87SR181	40	20	50	30	175	0 to + 70	J24C, N24C
	1024 × 8 REG	DM87SR183	40	25	45	30		0 to + 70	J24C, N24C
	1024 × 8 REG	DM87SR183B	35	20	40	25		0 to + 70	J24C, N24C
16384	2048 × 4 REG	DM87SR191**	25	10	30	15		0 to + 70	J20B, N20A
	2048 × 4 REG	DM87SR193**	25	10	30	15		0 to + 70	J20B, N20A

Note: To specify military temperature range devices, convert 74SXXX numbers to 54SXXX and 87SXXX numbers to 77SXXX.

* Indicates 0.3" wide package.

** To be released.

*** Commercial range; military range is − 55 to + 125°C.

High-Speed Static RAMs

For systems requiring fast access time National Semiconductor offers high-speed, low power static RAMs from 4k to 256k densities. For higher densities, National uses its 1.5-micron technology to achieve speeds as low as 35 ns.

Device Number	Organization	Size	Packaging	Access	Power (mW)
NMC2147HN-1	4k × 1	4k	N18A	35	990/165
NMC2147HJ-1	4k × 1	4k	J18A	35	990/165
NMC2147HN-2	4k × 1	4k	N18A	45	990/165
NMC2147HJ-2	4k × 1	4k	J18A	45	990/165
NMC2147HN-3	4k × 1	4k	N18A	55	990/165
NMC2147HJ-3	4k × 1	4k	J18A	55	990/165
NMC2147HN-3L	4k × 1	4k	N18A	55	688/110
NMC2147HJ-3L	4k × 1	4k	J18A	55	688/110
NMC2147HN	4k × 1	4k	N18A	70	880/110
NMC2147HJ	4k × 1	4k	J18A	70	880/110
NMC2148HN-2	1k × 4	4k	N18A	45	990/165
NMC2148HJ-2	1k × 4	4k	J18A	45	990/165
NMC2148HN-3	1k × 4	4k	N18A	55	990/165
NMC2148HJ-3	1k × 4	4k	J18A	55	990/165
NMC2148HN	1k × 4	4k	N18A	70	990/165
NMC2148HJ	1k × 4	4k	J18A	70	990/165
NMC2148HN-3L	1k × 4	4k	N18A	55	688/110
NMC2148HJ-3L	1k × 4	4k	J18A	55	688/110
NMC2148HN-L	1k × 4	4k	N18A	70	688/110
NMC2148HJ-L	1k × 4	4k	J18A	70	688/110
NMC6164AN-45L	8k × 8	64k	N28B	45	165/0.55
NMC6164AN-45	8k × 8	64k	N28B	45	165/11
NMC6164AN-55L	8k × 8	64k	N28B	55	165/0.55
NMC6164AN-55	8k × 8	64k	N28B	55	165/11
NMC6164AN-70L	8k × 8	64k	N28B	70	165/0.55
NMC6164AN-70	8k × 8	64k	N28B	70	165/11
NMC61256N-55L	32k × 8	256k	N28B	55	165/2.65
NMC61256N-55	32k × 8	256k	N28B	55	165/11
NMC61256N-70L	32k × 8	256k	N28B	70	165/2.65
NMC61256N-70	32k × 8	256k	N28B	70	165/11
NMC61256N-100L	32k × 8	256k	N28B	100	165/2.65
NMC61256N-100	32k × 8	256k	N28B	100	165/11

TTL RAMs

For the specialized applications of scratch-pad memory and register files, National offers a line of low-density, high-speed, 64-bit TTL RAMs. National's TTL RAMs are fabricated with our advanced Schottky and Oxiss process to provide the high performance and reliability your system requires.

Size (Bits)	Organization	Commercial Part Number	t_{AA} Commercial (Max) in ns	t_{AA} Mil Temp (Max) in ns	I_{CC} (Max) in A	Description	Temp Range (°C)	Package Type
64	16 × 4 TS	DM74S189A	35	50	110	High-Speed 64-Bit TRI-STATE RAM	0 to +70	J16A, N16E
64	16 × 4 TS	DM74S289A	35	50	110	High-Speed 64-Bit Open-Collector	0 to +70	J16A, N16E
64	16 × 4 TS	DM85S06	35	50	100	Open Collector	0 to +70	J16A, N16E
64	16 × 4 TS	DM85S07	35	50	100	TRI-STATE	0 to +70	J16A, N16E
64	16 × 4 TS	DM85S07A	25	30	100	High-Speed TRI-STATE Non-Inverting, 64-Bit RAM	0 to +70	J16A, N16E
64	16 × 4 TS	DM85S68	40	55	100	Edge Triggered Register	0 to +70	J18A, N18E
64	16 × 4 TS	IDM29705	40	55	—	(16 word by 4-Bit Two-Port	0 to +70	J28A
64	16 × 4 TS	IDM29705A	30	35	—	RAM/Register File)	0 to +70	J28A

ECL RAMs

In advanced ECL memory, National's DM series delivers speed, low power dissipation, and a wide range of sizes and configurations—all fully compatible with 10KH or 100K series families. From 256 to 4096 bits, with speeds as fast as 7 ns...National has it all.

National's ECL RAMs are produced with our advanced oxide-isolated process on the latest state-of-the-art 5″ fabrication line and offer the highest degree of alpha-particle immunity.

National's reliable ECL memories offer the broadest choice in density, organization, speed, and power to assure you the maximum cost/performance benefits.

Device Number	Size	Organization	Speed (T_{Max})	I_{EE} (Min)	Temp Range (°C)	Packaging Information
10K Series						
DM10414	256-Bit	256 × 1	15 ns	– 150	0 to + 75	J16A
DM10414A			10 ns	– 150	0 to + 75	J16A
DM10415	1k Bits	1,042 × 1	28 ns	– 150	0 to + 75	J16A
DM10415A			20 ns	– 150	0 to + 75	J16A
DM10422		256 × 4	12 ns	– 200	0 to + 75	J24E, W24B
DM10422A			10 ns	– 200	0 to + 75	J24E, W24B
DM10422A-7			7 ns	– 200	0 to + 75	J24E, W24B
DM10470	4k Bits	4,096 × 1	25 ns	– 200	0 to + 75	J18A
DM10470A			15 ns	– 200	0 to + 75	J18A
DM10474		1,024 × 4	25 ns	– 220	0 to + 75	J24E, W24B
DM10474A			15 ns	– 220	0 to + 75	J24E, W24B
DM10474A-10			10 ns	– 220	0 to + 75	J24E, W24B
DM10474A-8			8 ns	– 220	0 to + 75	J24E, W24B
100K Series						
DM100422	1k Bits	256 × 4	12 ns	– 200	0 to + 85	J16A, W24B
DM100422A			10 ns	– 200	0 to + 85	J16A, W24B
DM100422A-7			7 ns	– 200	0 to + 85	J16A, W24B
DM100470	4k Bits	4,096 × 1	25 ns	– 200	0 to + 85	J18A
DM100470			15 ns	– 200	0 to + 85	J18A
DM100474		1,024 × 4	25 ns	– 200	0 to + 85	J24E, W24B
DM100474A			15 ns	– 200	0 to + 85	J24E, W24B
DM100474A-10			10 ns	– 200	0 to + 85	
DM100474A-8			8 ns	– 200	0 to + 85	

Memory Boards Compatible with Digital Equipment Systems

System	Description	Features	Memory Capacity
VAX8600 VAX8650	NS865-16MB 980010488-16	On board DIAGNOSTICS DRAM LED Display Socketed DRAMs and a spare DRAM on board On-line/off-line switch and associated LED indicator Lifetime warranty For more information, please call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	16 megabyte per board 128 megabytes per system
VAX-11/780 VAX-11/785	NS789-1MB 980010090-001	On-line/off-line switch and associated LED indicator ECC	1 megabyte per board 16 megabytes per system
	NS789-4MB 980010090-002	Socketed DRAMs and a spare DRAM on board 1 megabyte and 4 megabyte boards can not be mixed in one system. For more information, please call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	4 megabytes per board 32 megabytes per system
VAX-11/725	NS753-1MB 980109464-001	On-line/off-line switch and associated LED indicator LED indicator of voltage presence	1 megabyte per board 3 megabytes per system
VAX-11/730	NS753-1MB 980109464-001	ECC Socketed DRAMs and a spare DRAM on board	1 megabyte per board 5 megabytes per system
VAX-11/750	NS753-1MB 980109464-001	For more information, please call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	1 megabyte per board 8 megabytes per sytsem
MicroVAX II	NS630-1MB 980010445-001	On-line/off-line switch and associated LED indicator Spare DRAM on board	1 megabyte per board 3 megabytes per system
	NS630-2MB 980010445-002	Quad width card Any NS630 (1, 2, 4MB) memory size and NS638 (8MB) can be combined in one system.	2 megabytes per board 5 megabytes per system
	NS630-4MB 980010445-004	For more information, please call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	4 megabytes per board 9 megabytes per system
	NS638-8MB 980010482-008		8 megabytes per board 16 megabytes per system

Memory Boards Compatible with Digital Equipment Systems

System	Description	Features	Memory Capacity
MicroVAX I PDP-11/23 PDP-11/23 + PDP-11/53 PDP-11/73	NS23C-1MB 9800101015-015	Block mode transfer compatibility Parity error LED indicator DEC compatible CSR Dual width card	1 megabyte per board 4 megabytes per system
	NS23C-1/2MB 9800101015-016		512 Kbytes per board 4 megabytes per system
	NS23C-1/4MB 9800101015-001		256 Kbytes per board 4 megabytes per system
	NS23D-2MB 980110375-001	Block mode transfer compatibility Parity error LED indicator DEC compatible CSR Dual width card	2 megabytes per board 4 megabytes per system
	NS23S-4MB 980110014-011	Block mode transfer compatibility Parity error LED indicator DEC compatible CSR Quad width card Any configuration of any of the above boards can be mixed in any of the above systems.	4 megabytes per board 4 megabytes per system
	NS23S-3MB 980110014-013		3 megabytes per board 4 megabytes per system
	NS23S-2MB 980110014-015		2 megabytes per board 4 megabytes per system
	NS23S-1MB 980110014-001		1 megabyte per board 4 megabytes per system
		For more information, please Call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	
PDP-11/04 PDP-11/05 PDP-11/10 PDP-11/15	NS11U-1/4MB 980109453-007	On board parity controller and CSR Single voltage operation Spare DRAM on board	256 Kbytes per board 64 Kbytes per system
PDP-11/60	NS11U-1/4MB 980109453-007	Any configuration of NS11U can be mixed in one system.	256 Kbytes per board 256 Kbytes per system
PDP-11/34 PDP-11/34A PDP-11/35 PDP-11/40 PDP-11/45 PDP-11/50 PDP-11/55	NS11U-1MB 980109453-001		1 megabyte per board 1 megabyte per system
	NS11U-1/2MB 980109453-005		512 Kbytes per board 1 megabyte per system
	NS11U-1/4MB 980109453-007		256 Kbytes per board 1 megabyte per system
PDP-11/24 PDP-11/44	NS11U-1MB 980109453-001		1 megabyte per board 4 megabytes per system
	NS11U-1/2MB 980109453-005		512 Kbytes per board 2 megabytes per system
	NS11U-1/4MB 980109453-007		256 Kbytes per board 1 megabyte per system
		For more information, please call: 1-800-538-8510 In CA.: 1-800-345-4006 In Canada: 408-721-8081	

Microcontrollers

For additional Microcontroller products, see page 441.

Microcontrollers for Today and Tomorrow

Our microcontroller families provide a complete range of performance and features from the lowest cost to the highest performance in the industry. Now you can choose a microcontroller that is "just right for your application." We have designed all the latest products to fit in National's standard cell program so they can be customized for a specific application.

The COPS™ 4-bit family of microCMOS and NMOS parts is renowned for its cost effectiveness, memory efficiency, flexibility, high reliability and years of high volume production. This family is now complemented with an 8-bit COP800 microCMOS family and a 16-bit HPC microCMOS family. These new families are designed with the Core/Modularity concept to make it easy to add additional family members. They offer a wide selection of on-board memory and peripherals.

Support from Development to Production

We provide total support for our microcontrollers that includes evaluation boards, emulators, software packages, prototyping parts, training schools and more.

The MOLE™ (Microcomputer On Line Emulator) is a low cost Development System and Emulator common to all our microcontrollers. Our software offering includes assemblers, linkers, compilers, floating point package, etc. Your prototyping and early production needs can be easily met by our devices. Finally, we have established a special production flow to expeditiously transfer your program into Custom Masked ROM production parts.

The COPS Solution

The COPS family of microcontrollers provides a flexible, cost-effective system solution in applications requiring timing, counting or other control functions. COPS 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.

- 0.5k ROM and 32 × 4 RAM to 4k ROM and 192 × 8 RAM
- ROM-efficient instruction set
- 1 μs instruction cycle time plus HALT
- Common pin-out
- Wide temperature ranges: −55°C to +125°C
- MICROWIRE™ serial communication
- Low-cost MOLE development system

National's microCMOS controllers offer a definite edge in performance. These advanced microcontrollers combine NMOS speed and bipolar ruggedness with the inherent benefits of CMOS. All the benefits of microCMOS are found in the high performance microcontroller family that includes both 4-bit and 8-bit devices.

As system designs become more complex, and as low power becomes more important in meeting design objectives, greater performance is required from microcontrollers. The COPS family provides the most cost effective system solution.

COPS 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)	RAM (Digits)	Features: I/O: I/O Pins	Serial I/O	Interrupt	Stack	Time Base Count	Micro Bus	Typ. 5V Operat. Power	Max Standby at 3.3V	Size (Pins)	Development Tools: ROMless Device	Piggyback
COP413L	COP313L		NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	15 mW	7.5 mW	20	COP401L-X13/R13	
COP414L	COP314L		NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	15 mW	7.5mW	20	COP401LN	
COP410L	COP310L		NMOS Low Power	0.5k	32	19	Yes	No	2 Level	No	No	15 mW	7.5 mW	20	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	16	Yes	No	2 Level	No	No	1 mW	0.1 mW	20	COP404CN	COP444CP
COP413CH	COP313CH		CMOS Hi Speed	0.5k	32	16	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	28	COP402N	COP420P
COP421	COP321		NMOS Hi Speed	1.0k	64	19	Yes	No	3 Level	Yes	No	100 mW	N/A	24	COP402N	COP420P
COP422	COP322		NMOS Hi Speed	1.0k	64	16	Yes	No	3 Level	Yes	No	100 mW	N/A	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	28	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	Yes	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
COP420H	COP320H		NMOS Low Power	1.0k	64	23	Yes	1 Source	3 Level	Yes	Yes	40 mW	9.9 mW	28	COP404LSN-5	COP444LP
COP421H	COP321H		NMOS Low Power	1.0k	64	19	Yes	No	3 Level	Yes	No	40 mW	9.9 mW	24	COP404LSN-5	COP444LP
COP422H	COP322H		NMOS Low Power	1.0k	64	16	Yes	No	3 Level	Yes	No	30 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	4 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-5	COP444LP
COP445L	COP345L		NMOS Low Power	2.0k	128	19	Yes	No	3 Level	Yes	No	65 mW	9.9 mW	24	COP404LSN-5	COP444LP

COPS Family Development Tools

		Description				Features							
		Memory		I/O									
Commercial Temp Version 0°C to +70°C	Technology	ROM (Bytes)	RAM (Digits)	I/O Pins	Serial I/O	Interrupt	Stack	Time Base Count	Micro Bus	Typ. 5V Operat. Power	Max Standby at 3.3V	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
COP401LN	NMOS Low Power	0.5k	32	16	Yes	No	2 Level	No	No	100 mW	7.5 mW	40	ROMless Version of COP410L
COP402N	NMOS Hi Speed	1.0k	63	20	Yes	1 Source	3 Level	Yes	No	50 mW	N/A	40	Has Interrupt, No Microbus
COP402MN	NMOS Hi Speed	1.0k	63	16	Yes	No	3 Level	Yes	Yes	125 mW	N/A	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	40	W/Push-Pull Mem Interface
COP404N	NMOS Hi Speed	2.0k	160	23	Yes	4 Sources	4 Level	Yes	Yes	35 mW	15 mW	48	ROMless Version of COP440
COP404CN	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	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	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

COP800C

The COP800 family is an 8-bit microcontroller that combines the powerful COPS instruction set philosophy with a memory mapped core architecture to offer the lowest cost microCMOS 8-bit microcontroller available today.

These chips are complete microcomputers on a single chip. All system timing, internal logic, ROM, RAM, and I/O are provided on the chip to produce a cost effective system solution.

The microCMOS process results in very low current drain and enables the user to select the optimum speed/power product for his system. These devices are available in various pin configurations.

Features

- Fully static microCMOS
- 2.5V to 6.0V voltage
- 1 μs instruction cycle time
- Low current drain
- Ultra low current static halt mode
- Single supply operation
- MICROWIRE/PLUS™ serial I/O
- 20 through 44 pin packages
- Software selectable I/O options
- Fully supported by National's MOLE Development System
- E^2PROM program space
- E^2PROM data space
- Software selectable I/O
- 32k external program capability

COP800 Roadmap (Basic Feature Group)

											Features								
Part #	Masked ROM	RAM	EEPROM (ROM)	EEPROM (RAM)	Supply Voltage	Interrupt	Timer	I/O	Pins	Inst. Set	μW + *	WD*	MIWU*	UART	A/D Conv.	Comp	Idle	Halt	Emulator
COP820C	1k	64 × 8			2.5-6.0	3	1	24	28	A	X							X	COP8720C
COP821C	1k	64 × 8			2.5-6.0	3	1	20	24	A	X							X	COP8721C
COP822C	1k	64 × 8			2.5-6.0	3	1	16	20	A	X							X	COP8722C
COP8620C	1k	64 × 8		64 × 8	2.7-6.0	3	1	24	28	A	X							X	COP8720C
COP8621C	1k	64 × 8		64 × 8	2.7-6.0	3	1	20	24	A	X							X	COP8721C
COP8622C	1k	64 × 8		64 × 8	2.7-6.0	3	1	16	20	A	X							X	COP8722C
COP8720C		64 × 8	1k	64 × 8	2.7-6.0	3	1	24	28	A	X							X	N/A
COP8721C		64 × 8	1k	64 × 8	2.7-6.0	3	1	20	24	A	X							X	N/A
COP8722C		64 × 8	1k	64 × 8	2.7-6.0	3	1	16	20	A	X							X	N/A
COP840C	2k	128 × 8			2.5-6.0	3	1	24	28	A	X							X	COP8740C
COP841C	2k	128 × 8			2.5-6.0	3	1	20	24	A	X							X	COP8741C
COP842C	2k	128 × 8			2.5-6.0	3	1	16	20	A	X							X	COP8742C
COP8640C	2k	128 × 8		64 × 8	2.7-6.0	3	1	24	28	A	X							X	COP8740C
COP8641C	2k	128 × 8		64 × 8	2.7-6.0	3	1	20	24	A	X							X	COP8741C
COP8642C	2k	128 × 8		64 × 8	2.7-6.0	3	1	16	24	A	X							X	COP8742C
COP8740C		128 × 8	2k	64 × 8	2.7-6.0	3	1	24	28	A	X							X	N/A
COP8741C		128 × 8	2k	64 × 8	2.7-6.0	3	1	20	24	A	X							X	N/A
COP8742C		128 × 8	2k	64 × 8	2.7-6.0	3	1	16	20	A	X							X	N/A

*μW + —MICROWIRE/PLUS
WD—Watch Dog Timer
MIWU—Multi-Input Wake-up

COP800 Roadmap (High Feature Group)

Part#	Masked ROM	RAM	EEPROM (ROM)	EEPROM (RAM)	Supply Voltage	Interrupt	Timer	I/O	Pins	Inst. Set	Features							Emulator
											μW + *	WD*	MIWU*	UART	A/D	Idle	Halt	
COP844CF	2k	128 × 8			2.5–6.0	6	2	24	28	B	X	X	X		X	X	X	COP8744C
COP848CF	2k	128 × 8			2.5–6.0	10	2	36	40	B	X	X	X		X	X	X	COP8784C
COP8644CF	2k	128 × 8		64 × 8	2.7–6.0	6	2	24	28	B	X	X	X		X	X	X	COP8744C
COP8648CF	2k	128 × 8		64 × 8	2.7–6.0	10	2	36	40	B	X	X	X		X	X	X	COP8784C
COP884CF	4k	128 × 8			2.5–6.0	6	2	24	28	B	X	X	X		X	X	X	COP8784C
COP888CF	4k	128 × 8			2.5–6.0	10	2	36	40	B	X	X	X		X	X	X	COP8788C
COP8684CF	4k	128 × 8		128 × 8	2.7–6.0	6	2	24	28	B	X	X	X		X	X	X	COP8784C
COP8688CF	4k	128 × 8		128 × 8	2.7–6.0	10	2	36	40	B	X	x	X		X	X	X	COP8788C
COP884CG	4k	192 × 8			2.5–6.0	8	2	24	28	B	X	X	X	X		X	X	COP8784C
COP888CG	4k	192 × 8			2.5–6.0	12	2	36	40	B	X	X	X	X		X	X	COP8788C
COP8684CG	4k	192 × 8		128 × 8	2.7–6.0	8	2	24	28	B	X	X	X	X		X	X	COP8784C
COP8688CG	4k	192 × 8		128 × 8	2.7–6.0	12	2	36	40	B	X	X	X	X		X	X	COP8788C
COP884CK	4k	192 × 8			2.5–6.0	9	2	24	28	B	X	X	X	X	X	X	X	COP8784C
COP888CK	4k	192 × 8			2.5–6.0	13	2	36	40	B	X	X	X	X	X	X	X	COP8788C
COP8684CK	4k	192 × 8		128 × 8	2.7–6.0	9	2	24	28	B	X	X	X	X	X	X	X	COP8784C
COP8688CK	4k	192 × 8		128 × 8	2.7–6.0	13	2	36	40	B	X	X	X	X	X	X	X	COP8788C
COP8784CK		192 × 8	4k	128 × 8	2.7–6.0	9	2	24	28	B	X	X	X	X	X	X	X	Emulator
COP8788CK		192 × 8	4k	128 × 8	2.7–6.0	13	2	36	40	B	X	X	X	X	X	X	X	Emulator

*μW + —MICROWIRE/PLUS
WD—Watch Dog Timer
MIWU—Multi-Input Wake-up

HPC: The World's First Family of 16-Bit CMOS Microcontrollers

National's new high-performance microcontroller family brings an innovative solution to the problem of making a single microcontroller satisfy the varied demands of a broad range of markets.

The internal architecture of the HPC is modular; that is, all members of the family have the same high-performance processor "core." Added to this is a different mix of memory, on-board peripherals and I/O to match specific applications.

This "perfect fit" of controller to application simplifies designs, streamlines programming and lowers systems costs.

And because the controllers are members of the same family, the user learns only one architecture, one programming language and maintains only one development system to produce products in a wide spectrum of applications.

With a 16-bit architecture implemented in microCMOS, capable of operating at speeds beyond 17 MHz, the HPC tackles designs previously considered out of the range of any microcontroller. Designed for high-throughput computation, its powerful instruction set includes a 16 × 16-bit multiply and a 32 × 16-bit divide, single-byte jumps and calls, nine addressing modes, and versatile bit-manipulation instructions.

Backing up this number-crunching power is an internal 16-bit bus to which a large set of on-board peripherals can be attached. These are UARTs, protocol controllers, timers, A/D converters, ROM, RAM, EPROM...to name a few.

This integration means that systems using the HPC will require fewer components, will operate at higher speeds, will be more reliable and will be easier to test. And because the HPC is a microCMOS device, it is fast, it uses very little power, and it operates over a wide range of supply voltages and temperatures.

Part Numbers			Features						
Commercial Temperature Version 0°C to +70°C	Industrial Temperature Version −40°C to +85°C	Military Temperature Version −55°C to +125°C	ROM	RAM	Timers	UART	I/O	Pins	Other
HPC46030	HPC36030	HPC16030	ROMless	256	8	Yes	52	68	Standard Part
HPC46040	HPC36040	HPC16040	4k	256	8	Yes	52	68	Standard Part
HPC46073	HPC36073	HPC16073	ROMless	256	8	Yes	52	68	4-Input Capture Register
HPC46083	HPC36083	HPC16083	8k	256	8	Yes	52	68	4-Input Capture Register
HPC46400	HPC36400	HPC16400	-	256	4	Yes	56	68	2-Channel HDLC + 4 Channel DMA
HPC46730	HPC36730	HPC16730	ROMless	256	4	No	55	68	Gate Array with 1200 Equivalent Gates
HPC46740	HPC36740	HPC16740	4k	256	4	No	55	68	Gate Array with 1200 Equivalent Gates
HPC46900	HPC36900	HPC16900	-	-	-	-	56	68	Port Expansion and Recreation Logic

MICROWIRE (Serial I/O) Peripherals

MICROWIRE is a serial communication scheme that allows microcontrollers to effectively communicate to peripherals and other microcontrollers (MICROWIRE/PLUS). *MICROWIRE makes efficient use of every I/O line.* MICROWIRE communication permits serial data exchange with only three wires. This reduces I/O lines, enabling the use of a more cost-effective package (i.e., fewer number of pins) or the addition of more features and capability to the final product.

Device Number	Description	Temperature Range	Packaging Information
ADC0831	8-bit A/D Converter (CMOS)	C, I, M	J08, N08
ADC0832	8-bit A/D Converter (CMOS)	C, I, M	J08, N08
ADC0833	8-bit A/D Converter (CMOS)	C, I, M	J14, N14
ADC0834	8-bit A/D Converter (CMOS)	C, I, M	J14, N14
ADC0838	8-bit A/D Converter (CMOS)	C, I, M	J20, N20
COP470	Vacuum Fluorescent Display Driver	C	N20
MM58241	Vacuum Fluorescent Display Driver	C	N40
MM58248	Vacuum Fluorescent Display Driver	C	N40
MM58341	Vacuum Fluorescent Display Driver	C	N40
MM58348	Vacuum Fluorescent Display Driver	C	N40
COP472-3	Liquid Crystal Display Driver (CMOS)	C	N20
MM5452	Liquid Crystal Display Driver (CMOS)	C	N40
MM5453	Liquid Crystal Display Driver (CMOS)	C	N40
MM5483	Liquid Crystal Display Driver (CMOS)	C	N40
MM58201	Liquid Crystal Display Driver (CMOS)	C	N40
MM5450	LED Driver (NMOS)	C	N40
MM5451	LED Driver (NMOS)	C	N40
MM5480	LED Driver (NMOS)	C	N28
MM5481	LED Driver (NMOS)	C	N20
MM5484	LED Driver (NMOS)	C	N22
MM5486	LED Driver (NMOS)	C	N40
COP498	CMOS Memory and Timer	C	N14
COP499	CMOS Memory	C	N08
NMC9306	E^2 Memory	C	N08
NMC9346	E^2 Memory	C	N08
DS8906	Digital Synthesizer (AM/FM)	C	J20, N20
DS8907	Digital Synthesizer (AM/FM)	C	J20, N20
DS8908	Digital Synthesizer (AM/FM)	C	J20, N20
COP452	Frequency Generator and Counter (NMOS)	C	N14
LM2893	Bi-Line	C	N18
LMC1992	Tone Controller	C	N28
LMC835	Equalizer	C	N28
LMC843	Equalizer	C	N28
TP3400 DASL	Subscriber Loop	C	N20
TP3410 EL	"4" Subscriber Interface	C	TBD
TP3420 SDD	CCITT Interface	C	N20

Microcontroller Development Systems

The MOLE (Microcontroller On Line Emulator) system was designed to support the development of all NSC microcontroller products. These include the COPS family, TMP, and the HPC family of products. The MOLE provides effective support for the development of both software and hardware in the user's application.

The purpose of MOLE is to provide the user with the tools 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 the user's host computer. This partitioning provides the microcontroller design engineer with a new concept in flexibility. As an example of the flexibility consider the latitude the user has in the choice of a host CPU. The host may be IBM®-PC, Intel's MDS800, or Intellec® Series II, or Kaypro, or one of a number of inexpensive personal computers. The software provided by National Semiconductor will run under control of the host computer CP/M™ or MS-DOS™ operating system.

Further 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 COPS CMOS and NMOS family. This Personality Board provides support for 42 microcontroller device types.

Additionally, Personality Boards are available for the HPC family of products and the NS405 Terminal Management Processor (TMP).

The MOLE components have been designed to provide maximum utility. 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. The Brain Board/Personality Board combination provides FULL emulation capability.

The resident firmware allows the user to down load 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. Hardware and Firmware are provided for programming EPROMs and EEPROMs.

Once debugged, the code is transmitted to National Semiconductor for use in creating the tooling necessary for manufacturing the masked microcontroller part.

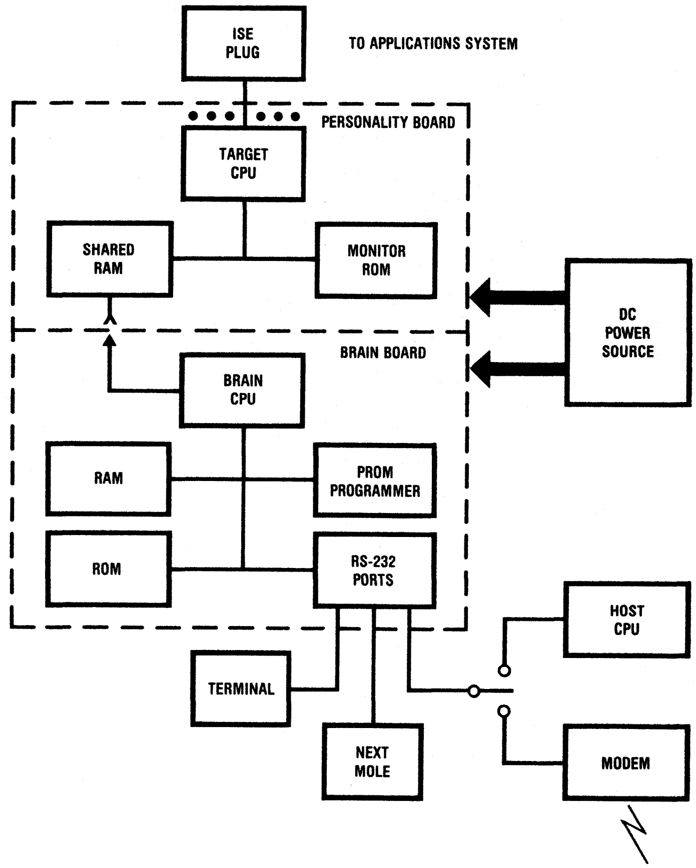
The MOLE concept provides maximum flexibility and maximum utility for development of a microcontroller based system.

MOLE systems are available for a variety of host systems. To order a complete development package, select the section for the microcontroller to be developed and order the parts listed. Order one item from each category (Items A–E). MOLE software is available for several systems; be sure that you choose the correct one for the host system used.

Development Tools Selection Table

Item	Description	HPC	COP800	COP400	TMP
A	Brain Board	MOLE-BRAIN	MOLE-BRAIN	MOLE-BRAIN	MOLE-BRAIN
B	Personality Board	MOLE-HPC-PB1	MOLE-COP8-PB1	MOLE-COPS-PB1	MOLE-TMP-PB1
C	Assembler Software for IBM (5.25″ DD Disk)	MOLE-HPC-IBM	MOLE-COP8-IBM	MOLE-COPS-IBM	MOLE-TMP-IBM
	Assembler Software for CP/M Systems (8″ SD Disk)	MOLE-HPC-CPM	MOLE-COP8-CPM	MOLE-COPS-CPM	MOLE-TMP-CPM
	Assembler Software for Intel Single Density Systems (8″ SD Disk)	MOLE-HPC-INT-S	MOLE-COP8-INT-S	MOLE-COPS-INT-S	MOLE-TMP-INT-S
	Assembler Software for Intel Double Density Systems (8″ DD Disk)	MOLE-HPC-INT-D	MOLE-COP8-INT-D	MOLE-COPS-INT-D	MOLE-TMP-INT-D
	Assembler Software for KAYPRO2 (5.25″ DD Disk)	MOLE-HPC-KAY	MOLE-COP8-KAY	MOLE-COPS-KAY	MOLE-TMP-KAY
	C Compiler for IBM (5.25″ DD Disk) Includes Assembler Software for IBM	MOLE-HPC-IBM-C	MOLE-COP8-IBM-C Available 1988		
D	Programmers Manual	420410704-001	420410703-001	424410284-001	420040401-001
E	Hardware Manual	420410705-001			

MOLE System Block Diagram



Dial-A-Helper

Dial-A-Helper is a service provided by the MOLE (Microcontroller On Line Emulator) applications group. It consists of both an electronic bulletin board information system and a method by which applications can take control of a MOLE Development System at a remote site via modem in order to resolve any problems.

Information System

The Dial-A-Helper system provides access to an automated information storage and retrieval system that may be accessed over standard dial-up telephone lines 24 hours a day. The system capabilities include a MESSAGE SECTION (electronic mail) for communications to and from the Microcontroller Applications Group and a FILE SECTION mode that can be used to search out and retrieve application data about NSC Microcontrollers. The user needs as a minimum, a Dumb terminal, 300 or 1200 baud Modem, and a telephone.

If the user has a PC with a communications package then files from the FILE SECTION can be down loaded to disk for later use.

Factory Applications Support

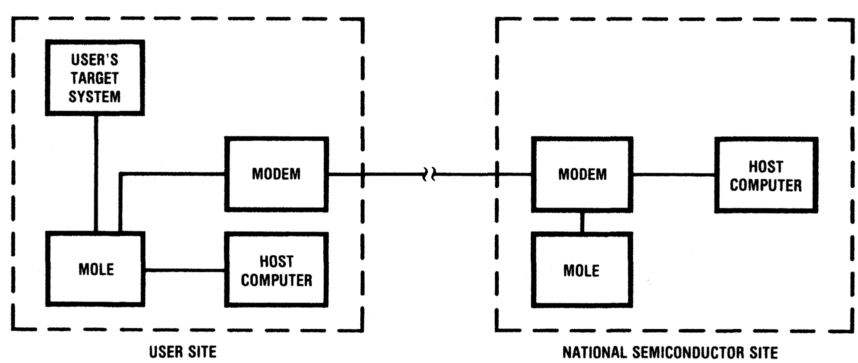
Dial-A-Helper also provides immediate factory applications support. If a user is having difficulty in getting a MOLE to operate in a particular mode or something peculiar is occurring, he can contact us via his system and modem. He can leave messages on our electronic bulletin board, which we will respond to, or he can arrange for us to actually take control of his system via modem for debugging purposes.

The applications group can then cause his system to execute various commands and try to resolve the customer's problem by actually getting the customer's system to respond. Both parties see exactly what is occurring, as it is happening.

This allows us to respond in minutes when applications help is needed.

Data Line: (408) 739-1162
Voice Line: (408) 721-5582

Dial-A-Helper



8050 Family

The NS8048/49/50 family of single chip microcontrollers are available with 1k, 2k and 4k of masked ROM. The 8050U family combines the standard features of the 8050 microcontroller with National's 3-wire serial data communication called MICROWIRE. This feature allows communication between two 8050Us or one 8050U and other MICROWIRE peripherals (such as A/D converters, LCD or VF display drive, etc.). To assist in development as well as some production requirements, National offers a piggyback device to allow the use of EPROMs instead of masking the device. The pig, as it is called, NS87P50U is an exact emulation of the 8050 family of devices.

Device Type	Program Storage	Program Size	Internal RAM	Temperature Ranges Available (°C)	Package
INS 8035	ROMless	1k	64	0 to + 70, − 40 to + 85	40N
INS 8039	ROMless	2k	128	0 to + 70, − 40 to + 85	40N
NS8040U	ROMless	4k	256	0 to + 70, − 40 to + 85	40N
INS 8048	Mask ROM	1k	64	0 to + 70, − 40 to + 85	40N
INS 8049	Mask ROM	2k	128	0 to + 70, − 40 to + 85	40N
NS8050U	Mask ROM	4k	256	0 to + 70, − 40 to + 85	40N
NS87P50U	ROMless (Piggyback)	4k	256	0 to + 70	40D

All devices are available in low power, 6 MHz or 11 MHz and commercial or industrial temperature ranges.

I/O Expander

Device	Description	Temperature Range (°C)	Package
INS 8243	Input/Output Expander	0 to + 70	N24

Series Display Management Processor (TMP)

The NS405 and NS455 are a family of LSI devices providing CRT display functions on a single chip. Conventional terminals consist of many LSI devices including:

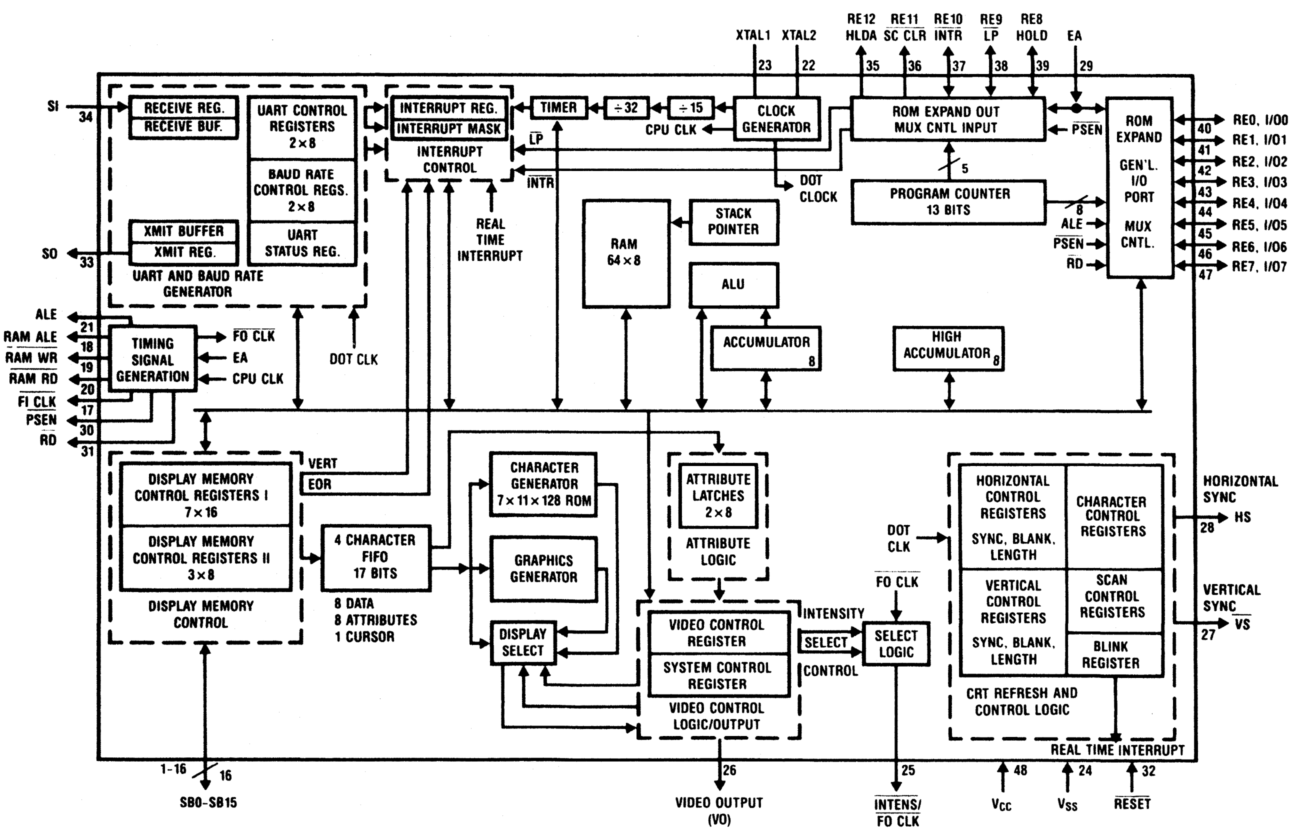
- Microprocessor
- ROM/PROM/EPROM
- CRT Controller
- DMA Controller
- Character Generator
- Video Memory Controller
- UART
- Baud Rate Generator
- Interrupt Controller
- Parallel I/O
- Timers

The display management processor series of chips contains all the functions listed above, allowing small, low cost and highly reliable display electronics. Displays compatible with TMP designs include terminals, point of sale displays, lottery terminals, machine control displays, plasma displays and many others.

Features

- Enhanced 8048 instruction set and architecture
- Up to 8k × 8 ROM external with ROM expand bus
- On-board RAM 64 × 8
- Programmable display format
- On-board video memory management unit
- 16-bit bidirectional display memory bus (direct video and attribute RAM interface)
- Built-in timer
- Real-time clock (may be programmed for 1 Hz)
- Video control signals
- Eight independent attributes
- Pixel and block graphics display modes
- Programmable cursor characteristics
- Programmable CRT refresh rate
- Light pen feature
- UART, programmable baud rate up to 19.2k baud
- Character generator (128 characters 7 × 11 max)
- Single 5V supply @ 110 mA (typ)
- Up to 18 MHz video dot rate (12 MHz CPU clock)
- 48-pin package
- 8-bit parallel I/O port (multiplexed with external ROM)
- Extensive I/O expansion capabilities
- Up to 64k by 8 or 16 video RAM

NS405



TMP Products

Device Type	Program Storage	Character Font*	Video Rate	Maximum No. of Columns
NS405-A12N	ROMless	A	12 MHz	80
NS405-B18N	ROMless	B	18 MHz	80
NS405-C12N	ROMless	C	12 MHz	80
NS405-B12N	ROMless	B	12 MHz	80
NS455-A12N	Masked ROM	A	12 MHz	80

*A type font is a standard 5 × 7 font.
B type font is a standard 7 × 9 font.
C type font is a standard 6 × 8 type VT 100 font.

Development Support			Order Part Numbers
MOLE—Brain Board	A single board general purpose development system.		MOLE-BRAIN
TMP—Personality Board			MOLE-TMP-PB1
TMP Demo Board	A fully functional board implementing TMP for direct connect to a CRT.	12 MHz	TMP-DEMO-12
		18 MHz	TMP-DEMO-18
Applications Manual	A comprehensive technical manual about TMP.		420040401-001

Microprocessors

For additional Microprocessor products, see pages 321 and 451.

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, radiation-hardened versions (1Mrad) 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.

Series 32000 Components

Device	Description	Bus Width Internal	Bus Width External Address	Bus Width External Data	Process	Package Type
Central Processing Units						
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 Chip Carrier 68-pin PLCC
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 68-pin PLCC
NS32016RT	NS32016 CPU specially configured for Real Time (embedded control) applications not requiring virtual memory support.	32	24	16	XMOS (NMOS)	48-pin DIP 68-pin PLCC
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 68-pin PLCC
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 Chip Carrier 68-pin PLCC
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 68-pin PLCC
NS32C016RT	NS32C016 CPU specially configured for Real Time (embedded control) applications not requiring virtual memory support.	32	24	16	CMOS	48-pin DIP 68-pin PLCC
NS32132	Central Processing Unit — CPU same internal and external architecture as NS32032 with addition of dual processor bus arbitration logic on-chip.	32	24	32	XMOS (NMOS)	68-pin LCC Leadless Chip Carrier
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
NS32332RT	NS32332 CPU specially configured for Real Time (embedded control) applications not requiring virtual memory support.	32	32	32	XMOS (NMOS)	84-pin PGA
Slave Processors						
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. Compatible with NS32016, NS32C016, NS32008, NS32C032, NS32032, NS32132 and NS32332 CPUs.	64	—	16	XMOS (NMOS)	24-pin DIP Dual-In-Line Package 44-pin PLCC
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 NS32332.	64	—	32	CMOS	68-pin PLCC
NS32C081	CMOS 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. Compatible with NS32016, NS32C016, NS32008, NS32C032, NS32032, NS32132 and NS32332 CPUs.	64	—	16	CMOS	24-pin DIP Dual-In-Line Package 44-pin PLCC

Series 32000 Components (Continued)

Device	Description	Bus Width Internal	External Address	External Data	Process	Package Type
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
Peripherals						
NS32301	Timing Control Unit — Second generation TCU for Series 32000. Provides all the essential functions in the NS32201-10. Key features include support for burst mode and cache interface features of the NS32332 second generation CPU.	—	—	—	Bipolar	28-pin DIP Dual-In-Line Package
NS32201	Timing Control Unit — TCU fabricated on a Schottky bipolar process. Provides a two-phase clock, system control logic and cycle extension logic for Series 32000 CPUs. TCU provides extremely accurate bus control signals and cycle timing over the bus.	—	—	—	Bipolar	24-pin DIP Dual-In-Line Package
NS32C201	CMOS TCU Timing Control Unit — NS32C201 CMOS TCU fabricated using NSC microCMOS technology with TTL compatible inputs. Same as NS32201 functionally. For use with CMOS CPUs.	—	—	—	CMOS	24-pin DIP Dual-In-Line Package 44-pin PLCC
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)	48-pin DIP Dual-In-Line Package

Series 32000 Support Devices

Device	Description	Package Type
Disk Control and Interface		
NS32951/DP8451	Disk Data Synchronizer — Frequency lock in Read Mode until 16 bits of synch field are recognized. Frequency lock in Non-Read Mode.	20-pin Plastic DIP 20-pin Plastic Chip Carrier
NS32955/DP8455	Disk Data Synchronizer — Phase lock in Read Mode. Frequency lock in Non-Read Mode.	20-pin Plastic DIP 20-pin Plastic Chip Carrier
NS32961/DP8461	Disk Data Synchronizer and MFM Separator — Frequency lock in Read Mode until 16 bits of synch field are recognized. Frequency lock in Non-Read Mode.	24-pin Plastic DIP or 28-pin Plastic Chip Carrier
NS32962/DP8462	Disk Data Synchronizer for 2, 7 Code — Frequency lock until 100 or 1000 synch field is detected (selectable). Frequency lock in the Non-Read Mode.	24-pin Plastic DIP or 28-pin Plastic Chip Carrier
NS32963/DP8463	Disk 2, 7 Code Encoder/Decoder — Provides disk system the ability to record up to 50 % message data in the same media space without any increase in the flux changes per inch.	28-pin Plastic DIP or 28-pin Plastic Chip Carrier
NS32964/DP8464B	Disk Pulse Detector — On-chip differential gain controlled amplifier. Differentiator, compare gating circuitry and output pulse generator.	24-pin Plastic DIP or 28-pin Plastic Chip Carrier
NS32965/DP8465	Disk Data Synchronizer and MFM separator — Phase lock in Read Mode. Frequency lock in Non-Read Mode.	24-pin Plastic DIP or 28-pin Plastic Chip Carrier

Series 32000 Support Devices (Continued)

Device	Description	Package Type
Disk Control and Interface		
NS32966/DP8466	Disk Data Controller — Interfaces Winchester/floppy disk drives. Transfers data rates up to 24 Mbits per second. High speed system data transfer with full on-chip DMA control. 16-bit system I/O interface. Programmable track format enables reconfiguration for different drive types in multiple drive environment.	48-pin Plastic DIP or 68-pin Plastic Chip Carrier
DRAM Interface		
NS32800-2/DP8400-2	16-bit Expandable Error Checker and Corrector — E^2C^2. Directly expandable in 16-bit increments to any word width. Detects and corrects single and double bit errors. Error detection 20 ns (typical). Error detection and correction 40 ns (typical).	48-pin Plastic DIP 48-pin Ceramic DIP 68-pin Plastic Chip Carrier
NS32082A/DP8402A	32-bit parallel Error Detector and Corrector-EDAC. Detects and corrects all single bit errors while flagging double bit errors. Error detection 25 ns (typical). Error detection and correction 45 ns (typical).	52-pin Ceramic DIP 68-pin Plastic Chip Carrier
NS32809A/DP8409A	256K DRAM Controller/Driver. Multiple refresh and access modes. Direct drive up to 2 Mbytes plus error correction check bits.	48-pin Plastic DIP 48-pin Ceramic DIP 68-pin Plastic Chip Carrier
NS32812/DP84412	Series 32000 to DP8409/19 Interface. Performs refresh/access arbitration function.	20-pin Plastic DIP 20-pin Ceramic DIP
NS32819/DP8419	256K DRAM Controller/Driver. No CPU WAIT states at 10 MHz and faster. Direct drive up to 2 Mbytes plus error correction check bits.	48-pin Plastic DIP 48-pin Ceramic DIP 68-pin Plastic Chip Carrier
Timer Clock		
NS32870/DP8570	Real Time Clock/Calendar. Two 10 MHz 16-bit programmable timers, on-chip powerfail detect circuits. Periodic/alarm/powerfail interrupts and 33 bytes of scratchpad CMOS RAM. Data Bus — Read/Write Access: 150 ns (max).	28-pin DIP 28-pin Plastic Chip Carrier
Data Communications and LANs		
NS32455/NS455	Terminal Management Processor — TMP integrates CPU, program memory, scratch RAM, video control, video timing, character generator, video memory control, serial UART, and parallel I/O. Standard terminal program contained in internal ROM.	48-pin Plastic DIP
NS32405/NS405	TMP — ROMless version of NS32455/NS455.	48-pin Plastic DIP
NS32490/DP8390	Local Area Network Interface Controller — Provides all of the protocol and networking functions as specified in the IEEE 802.3 Ethernet/Cheapernet LAN Standard. Features dual DMA capability.	48-pin Plastic DIP
NS32491/DP8391	Serial Network Interface — Digital PLL design provides a fast lock high jitter tolerance interface to the 802.3 Network.	24-pin Plastic Narrow DIP
NS32492/DP8392	Coax Transceiver Interface — Integrates the transmitter, receiver, collision detector and jabber timer functions specified in the 802.3 into one 16-pin package. Unique power package designed for stringent reliability requirement.	16-pin Plastic DIP
NS32440/DP8340	IBM 3270 Biphase Serial Encoder/Transmitter — Generates the complete encoding of parallel data for serial transmission (2.3587 Mbits/sec) which conforms to the IBM 3270 Information Display Standard.	24-pin Plastic DIP 24-pin Ceramic DIP 28-pin Plastic Chip Carrier
NS32441/DP8341	IBM 3270 Biphase Serial Decoder/Receiver provides complete decoding of high speed serial data which conforms to the IBM 3270 Information Display Standard.	24-pin Plastic DIP 24-pin Ceramic DIP 28-pin Plastic Chip Carrier
NS32442/DP8342	High Speed Serial Manchester Encoder/Transmitter — Generates complete encoding of parallel data for serial transmission of 8-bit data bytes at up to 3.5 Mbits/sec using coax, twisted pair, fiber optics, etc.	24-pin Plastic DIP 24-pin Ceramic DIP 28-pin Plastic Chip Carrier
NS32443/DP8343	High Speed Serial Manchester Decoder/Receiver — Provides complete decoding of high speed serial data sent from the NS32442/DP8342.	24-pin Plastic DIP 24-pin Ceramic DIP 28-pin Plastic Chip Carrier

Series 32000 Development Products

Device	Description	User Support	RAM Memory	Mass Storage: Hard Disk	Mass Storage: Floppy Disk	Mass Storage: Streamer Tape
Development Systems						
SYS32/20	A complete development solution for the support of the Series 32000 microprocessor family in the Personal Computer (PC) environment. Allows mainframe-size programs to run on a PC at speeds similar to those of a VAX/780. Consists of a 32-bit Series 32000-based PC add-in board, complete binary port of AT&T System V o/s, specially developed software which integrates the System V and DPS Operating Systems, NSC's Series 32000 Language Tools (GNX), and complete manuals set including AT&T System V Manual Set. Order as NSS-SYS20-KITX.	2	2 Mbyte or 4 Mbyte	Dependent Upon PC-Host Configuration		
VR32	Two-User Target/Development System (TD/S). Provides development support for Series 32000 components. (See SYS32 description). Also provides customized solutions for system implementations through the use of reconfigurable hardware and software. Fortran77 Compiler, C Compiler, and Series 32000 assembler are included with System V/Series 32000 UNIX operating system. Pascal compiler is optional. Supports demand-paged virtual memory, record and file locking, and emulation for Series 32000. (See ISE32 and ISE16 descriptions). Order as NSS-VR32-XXXX.	2 User Expandable	1 Mbyte 3 Card Slots Available for Expansion	40 Mbyte	1 Mbyte	20 Mbyte (Optional)

Device	Description	Devices Supported	Modes	Emulator Memory	Program Flow Tracing	Triggering
In System Emulators						
ISE32	Powerful tool for hardware and software development of NS32032 microprocessor-based product. Used with a host, ISE32 emulates the NS32032 CPU, NS32082 MMU, and NS32201 TCU. Order as NSS-ISE32.	NS32032 NS32201 NS32082	Stand-Aside Mode or Transparent Mode	128 Kbyte	1023 Non-Sequential Fetches	Pre-Post Center
ISE16	Functionally same as ISE32. Supports emulation of NS32016 CPU, NS32082 MMU, and NS32201 TCU. Order as NSS-ISE16.	NS32016 NS32201 NS32082	Stand-Aside Mode or Transparent Mode	30 Kbyte	255 Non-Sequential Fetches	Pre-Post Center

Device	Description	Devices Supported	Memory Capacity
Development Boards			
DB32332	Like the DB32016 and DB32032 development/evaluation board products, DB32332 board provides a platform to assist the evaluation and development of Series 32000-based applications. Contains a monitor firmware program for direct communication with programs developed on a larger host computer system with National's C, Pascal and even FORTRAN77 software packages. DB32332 is based on the NS32332 CPU. Order as NSV-32332XXX.	NS32332 CPU NS32082 MMU NS32201 TCU NS32081 FPU NS32202 ICU	1MB DRAM expandable to 2MB 2MB DRAM 64 Kbytes of JEDEC EPROM
DB32000 (NS32032 based)	Enables evaluation of the architecture, instruction set, cycle timing and bus interfaces for Series 32000. Small programs can be written, assembled, debugged and executed with TDS (Tiny Development System) software. DB32000 provides a native debug/execution environment for programs developed on a larger host computer with National's C and Pascal cross software packages. DB32000 is based on the NS32032 CPU. Order as NSV-32032XXX.	NS32032 (Can be replaced with NS32016 or NS32008 CPUs for evaluation). NS32082 MMU, NS32081 FPU NS32202 ICU and NS32201 TCU Socket provides for CPU dual processing. Two RS232 ports. Wire wrap area for user expansion.	256 Kbytes DRAM Expandable to Mbytes Up to 256 Kbytes of EPROM in two banks

Series 32000 Development Products (Continued)

Device	Description	Devices Supported	Memory Capacity
Development Boards			
DB32016 (NS32016 based)	Development Board designed to assist evaluation/development of application. Provides vehicle for evaluating performance of Series 32000 microprocessors, slave processors and support chips. Small programs can be written, assembled, debugged and executed with TDS (Tiny Development System) software. DB32016 provides a native debug/execution environment for programs developed on a larger host computer with National's C and Pascal cross software packages. DB32016 is based on the NS32016 CPU. Order as NSV-32016XXX.	NS32016 CPU (Can be replaced with NS32008 for evaluation) NS32082 MMU NS32081 FPU NS32202 ICU and NS33201 TCU MULTIBUS® interface and two RS232 ports.	128 Kbytes RAM Up to 96 Kbytes PROM
OEM Board Level Products			
ICM-332-1 System ICM-332-1-10CPU CPU Board	ICM-332-1 is a complete computer system on two printed circuit boards (minimum configuration for the system — CPU and IOP boards). The CPU board contains the full Series 32000 chip set (CPU, MMU, FPU, TCU, ICU), two megabytes of 150 ns dynamic RAM and a 32-bit Memory bus. The board contains the high-performance NS32332 CPU. The CPU board operates at 10 MHz. Since the I/O Processor controls all the I/O for the system, the computing complex on the CPU board can be dedicated full time to computing. (See ICM-332-1-1IOP Description) • Complete Series 32000 chip set (NS32332 CPU) • NS32016 I/O processor • High speed DMA mover to/from system memory • Centronics-compatible printer port • Four asynchronous RS323C-compatible serial ports • Small Computer System Interface (SCSI) port • Minibus expansion bus for interfacing special purpose modules • 2 to 14 Mbytes of random access memory with byte parity • GENIX V.3 (NSC's version of UNIX V.3) available as an option	NS32332-CPU NS32201-TCU NS32082-MMU NS32081-FPU NS32202-ICU	2 Mbytes reside on CPU Board
I/O Processor (IOP) board for ICM-332-1 system. ICM-332-1-1IOP	The IOP handles the interface with the real world. The I/O Processor board contains the serial ports, printer port, SCSI interface, Minibus and 512 Kbytes of private RAM. The NS32016 CPU on the IOP board is used to control all I/O functions for the system. Interface to the CPU board is accomplished with a high speed DMA circuit.	NS32016 CPU NS32201 TCU NS32202 ICU	
Memory Board for ICM-332-1 ICM-332-1-10-06	Each memory expansion board for ICM-332 is 6 Mbytes of memory. An additional 12 megabytes of memory can be added to a system with the addition of 1 or 2 expansion boards.		Up to 14 Mbytes with additional Memory boards
ICM-332-1 Operating System GENIX V.3 ICM-332-1UNV30BT	GENIX V.3 is National's certified port of AT&T System V Release 3.0 UNIX operating system. GENIX V.3 is an enhancement over V.2 featuring Streams, Networking support, and Remote File System. This operating system provides optimal use of Series 32000 architecture. It supports demand-paged virtual memory and offers Job Control as well as File and Record Locking. C and FORTRAN compilers and the Series 32000 assembler are available. Reconfigurable binary drivers are included for rigid disk, floppy disk, streamer tape, serial ports and the printer port.		
ICM R&D kit for ICM-332-1 System ICM-332-1-RD02	The ICM-332 R&D kit provides the user with a complete computer on two boards (CPU board and IOP board is the minimum configuration). The R&D kit includes GENIX V.3 (a certified port of AT&T's System V Release 3.0 Unix OS), Monitor/bootloader EPROM, a complete set of manuals, and the necessary cabling between components. Requires the addition of controllers, disk and tape drives, power supply and terminal. Requires binary user license to be signed prior to shipment.	ICM-332-1 R&D Kit includes: CPU Board (ICM-332-1-10CPU) IOP Board (ICM-332-1-1IOP) GENIX V.3 (ICM-332-1UNV30BT) Monitor EPROM (ICM-332-1MON) Manuals/Adaptors/Cables	

Series 32000 Development Products (Continued)

Device	Description	Devices Supported	Memory Capacity
ICM-3216 System ICM-3216 CPU Board	The ICM-3216 is a complete computer system contained on 2-3 11.02 inch by 9.18 inch printed circuit boards. This Integrated Computer Module (ICM) utilizes the power of the Series 32000 chip set. The CPU cluster, serial ports, printer port, SCSI interface and MiniBus Interface reside on the CPU unit. • Uses the complete Series 32000 chip set (CPU, TCU, MMU, FPU and ICU). • 1 to 8 megabytes of 150 nsec DRAM providing CPU access to memory with no wait states. • NS32016 CPU runs at 10 MHz. • Four RS232 compatible serial ports. • Centronics compatible parallel port. • Small Computer System Interface (SCSI). • "Minibus" expansion bus for interfacing special purpose modules.	NS32016-CPU NS32201-TCU NS32082-MMU NS32081-FPU NS32202-ICU	
Memory boards for ICM-3216 ICM-3216-1MEM (1 Mbyte) ICM-3216-2MEM (2 Mbyte) ICM-3216-4MEM (4 Mbyte)	The ICM-3216 memory board contains the dynamic RAM for the ICM-3216 Integrated Computer Module. Up to two memory boards can be configured with CPU unit to provide between one and eight million bytes of memory. The memory board(s) interface to the CPU unit via a "Direct Connect" local memory bus. The system operates at 10 MHz with no wait states for normal memory access.		Up to 8 Mbytes with additional Memory Boards
ICM-3216 Operating System System V.2/Series 32000 ICM016-1UNV2MBT	System V.2/Series 32000 has been ported to this system. System V.2/Series 32000 is a validated port of UNIX System V Release 2.0 Version 2. This operating system provides optimal use of the Series 32000 architecture. It supports demand-paged virtual memory and offers Job Control as well as File and Record Locking. "C" and FORTRAN compilers, the Series 32000 assembler and all 32000 language support tools are provided. Reconfigurable binary drivers have been written for rigid disk, streaming tape, serial ports and parallel port.		
ICM R&D Kits for ICM-3216 System ICM-3216-RD-1 (1 Mbyte) ICM-3216-RD-4 (4 Mbyte)	The ICM-3216-RD-1 and RD-4 kits provide the user with a 1 Mbyte or 4 Mbyte ICM-3216 board level system. The ICM-3216 system includes the System V/Series 32000 Operating System (a validated port of UNIX System V Version 2), the license required to operate this OS, a complete set of manuals and the necessary cabling between components. • Requires the addition of controllers, disk and tape drives, power supply and terminal to configure a minimum system. • System V/Series 32000 binary users license must be in place prior to shipment of package.	ICM-3216 R&D Kit includes: CPU Board ICM-3216 Memory Board ICM-3216-1MEM or ICM-3216-4MEM GENIX V.2 ICM016-1UNV2MBT Monitor EPROM -ICM-3216-MON Manuals/Adaptors/Cables	

Series 32000 Development Products (Continued)

Device	Description	Devices Supported	Memory Capacity
Serial Input/Output Board (SIO) ICM-SIO-M-8	The Serial Input/Output (SIO) board is designed for use with any ICM system. In a typical system, the primary (host) CPU must handle a number of terminals simultaneously, which can limit the amount of productive work that the host can perform. The Serial I/O board relieves the host of much of this task by supplying the system on board intelligence required to service the eight full-duplex asynchronous communication lines. By incorporating an NS32016 CPU, 256 Kbytes of DRAM and 32 to 128 Kbytes of EPROM on board, the SIO board is able to handle most of the overhead associated with the terminal handling task, leaving the host CPU free to devote itself to more productive work. • NS32016 CPU • 256 Kbytes of Random Access Memory with bytes parity • EPROM sockets for 32K to 128K bytes of EPROM • Eight asynchronous RS232C compatible serial ports • Serial communication rates of up to 19.2 Kbaud • Four general purpose timers • Interface to Host System via Minibus • S/W driver available to run this board under GENIX V.2 or V.3.	NS32016-CPU	
Ancillary Hardware			
Firmware Monitor ICM-3216-MON or ICM-332-1MON	Monitor EPROM set. The EPROM monitors provide the capability of executing most common monitor commands as well as the ability to boot the operating system.		
Minibus I/O Interface ICM-MBIC-C	MiniBus is a high performance 16-bit bus, which will support intelligent bus masters while at the same time maintaining a simple bus interface for non-intelligent I/O boards. The MiniBus Interface Controller (MBIC), a custom VLSI interface chip has been developed to provide a single chip bus interface which provides full bus compatibility. This interface chip is available to the user who wishes to design an intelligent special purpose module to interface with the system via MiniBus.		
ICM-CBL-TELCO	Cable, Telco, 6-wire, 7 feet.		
ICM-CON-FEM	Adaptor, Telco to DB25 to Female connector.		
ICM-CON-MAL	Adaptor, Telco to DB25 to Male connector.		
ICM-POWER-KIT	All necessary connectors to connect a power supply to an ICM system.		
ICM-DESIGN-KIT	All of the custom connector parts needed for the designer to build special purpose modules for an ICM system.		
Future ICM Products			
	Functions such as Local Area Network controllers, Graphics controller, X.25 interface and others will be available in the near future. Contact NSC for availability.		

Series 32000 Software

Device	Description	Host Systems
GENIX Operating Systems and Language Tools		
GENIX 4.1/4.2 Operating System	AT&T licensed Source of Berkeley UNIX Operating System for multi-tasking, multi-user Series 32000 Software development. GENIX 4.1 includes C Compiler and demand-paged virtual memory (Pascal optional). GENIX 4.2 also provides fast file system and local area networking. Order as NSW-GENIX-XXXX.	VAX™/UNIX (GENIX 4.1) VAX/VMS (GENIX 4.2)
SYSTEM V/Series 32000 V.2	Validated port of AT&T UNIX System V.2 Operating System. Multi-tasking, multi-user environment providing demand-paged virtual memory, file and record locking capabilities; C and FORTRAN 77 compilers included. Order as NSW-SYSV-XXXX.	SYS 32/XX VR 32 ICM 3216 VAX/UNIX
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.	SYS 32/XX VR 32 ICM 32XX 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-XXXX. *C COMPILER* used with Assembler to do Series 32000 code development. Order as NSW-C-XXXX. *FORTRAN 77 COMPILER* used with Assembler to do Series 32000 code development. Order as NSW-F77-XXXX. *PASCAL COMPILER* used with Assembler to do Series 32000 code development. Order as NSW-PAS-XXXX.	SYS 32/XX VR 32 ICM 3216 VAX/UNIX VAX/VMS (for all GNX packages)
Real Time Operating Systems and Support Tools		
EXEC	Multi-tasking ROMable executive for real-time applications. Runs on all Series 32000 CPUs. Complete Source code package gives hardware independence and is fully user-configurable. Order as NSW-EXEC-XXXX.	SYS 32/XX VR 32 VAX/UNIX VAX/VMS
VRTX/Real-Time Products	A collection of products for embedded real-time applications. *VRTX* Kernel manages the multi-tasking environment and responds to Operating System service requests. This is the prerequisite for all other VRTX-related packages. Order as NSW-VRTX-XXXX. *TRACER* is an interactive multi-tasking debugger matched to the VRTX Kernel. TRACER displays and modifies VRTX system data structures. Order as NSW-TRAC-XXXX. *SUPPORT LIBRARIES* includes re-entrant C Run-Time Support library; interface libararies for C and Pascal. Order as NSW-VIL-XXXX. *BOARD SUPPORT PACKAGE* provides initialization and configuration routines to bring up VRTX and TRACER on several Series 32000 boards.	SYS 32/XX ICM 32XX VAX/UNIX VAX/VMS

Series 32000 Software Products By Part Number

UNIX-Derived Operating Systems	
NSW-GENIX-1SGC	GENIX 4.1 Source pkg for use on SYS 32/10 host.
NSW-GENIX-1VXR	GENIX 4.1 Source pkg for use on VAX/UNIX 4.1 host.
NSW-GENIX-2VXR	GENIX 4.2 Source pkg for use on VAX/UNIX 4.2 host.
NSW-GENIX-4VXR	GENIX 4.1 Source pkg for use on VAX/UNIX 4.2 host.
NSW-SYSV-BCTF	SYSTEM V.2 Binary pkg for use on ICM 3216 host.
NSW-SYSV-BCTF8	SYSTEM V.2 Binary driver for 4-12 user addition for use on ICM 3216; NSW-SYSV-BCTF prereq.
NSW-SYSV-BHAF	SYSTEM V.2 Binary pkg for SYS 32/20 host; high density diskettes.
NSW-SYSV-BLAF	SYSTEM V.2 Binary pkg for SYS 32/20 host; low density diskettes.
NSW-SYSV-SCTF	SYSTEM V.2 Source pkg for ICM 3216 host.
NSW-SYSV-2VFR	SYSTEM V.2 Source pkg for VAX/UNIX host.
NSW-GV3-SCNX	SYSTEM V.3 Source pkg for UNIX-based host, cartridge tape.
NSW-GV3-SRNX	SYSTEM V.3 Source pkg for UNIX-based host, reel tape.
NSW-GV3-BCTF	SYSTEM V.3 Binary pkg for use on ICM 3216 host.
UNIX-Derived Language Tools (GNX Tools)	
NSW-ASM-BCTF	GNX Assembler Binary pkg including assembler, debuggers, monitors, and utilities for ICM 3216 host.
NSW-C-BCTF	GN C Compiler Binary pkg for ICM 3216 host.
NSW-F77-BCTF	GNX FORTRAN 77 Binary pkg for ICM 3216 host.
NSW-PAS-BCTF	GNX Pascal Binary pkg for ICM 3216 host.
NSW-ASM-BHAF	GNX Assembler Binary pkg including assembler, debuggers, monitors, and utilities for SYS 32/20 host; high density diskettes.
NSW-ASM-BLAF	GNX Assembler Binary pkg including assembler, debuggers, monitors, and utilities for SYS 32/20 host; low density diskettes.
NSW-C-BLAF	GNX C Compiler Binary pkg for SYS 32/20 host; low density diskettes.
NSW-F77 BLAF	GNX FORTRAN 77 Binary pkg for SYS 32/20 host; low density diskettes.
NSW-PAS-BLAF	GNX Pascal Binary pkg for SYS 32/20 host; low density diskettes.
NSW-ASM-BRVM	GNX Assembler Binary pkg including assembler, debuggers, monitors, and utilities for VAX/VMS host.
NSW-C-BRVM	GNX C Compiler Binary pkg for VAX/VMS host.
NSW-F77-BRVM	GNX FORTRAN 77 Binary pkg for VAX/VMS host.
NSW-PAS-BRVM	GNX Pascal Binary pkg for VAX/VMS host.
NSW-ASM-BRVX	GNX Assembler Binary pkg including assembler, debuggers, monitors, and utilities for VAX/UNIX 4.2 bsd host.
NSW-C-BRVX	GNX C Compiler Binary pkg for VAX/UNIX 4.2 bsd host.
NSW-F77-BRVX	GNX FORTRAN 77 Binary pkg for VAX/UNIX 4.2 bsd host.
NSW-PAS-BRVX	GNX Pascal Binary pkg for VAX/UNIX 4.2 bsd host.
NSW-ASM-SRNN	GNX Assembler Source pkg for use on VAX/UNIX 4.2 host.
NSW-C-SRNN	GNX C Compiler Source pkg for use on VAX/UNIX 4.2 host.
NSW-F77-SRNN	GNX FORTRAN 77 Source pkg for use on VAX/UNIX 4.2 host.
NSW-PAS-SRNN	GNX Pascal Source pkg for use on VAX/UNIX 4.2 host.
NSS-SYS32-3001	Pascal Compiler Binary pkg for SYS 32/10 host.
NSS-VR32-3001	Pascal Compiler Binary pkg for VR 32 host.

Series 32000 Software Products By Part Number (Continued)

Real-Time Operating Systems and Tools	
NSW-EXEC-SCSG	Exec Real-time Operating System Source pkg for SYS 32 host.
NSW-EXEC-SDQF	Exec Real-time Operating System Source pkg for VR 32 host.
NSW-EXEC-SRVM	Exec Real-time Operating System Source pkg for VAX/VMS host.
NSW-EXEC-SRVX	Exec Real-time Operating System Source pkg for VAX/UNIX 4.2 host.
NSW-VRTX-BENN	VRTX R and D pkg for EPROM; binary.
NSW-VRTX-BRVM	VRTX R and D pkg for VAX/VMS host; binary.
NSW-VRTX-BRVX	VRTX R and D pkg for VAX/UNIX 4.2 host; binary.
NSW-VRTX-BLAF	VRTX R and D pkg for SYS 32/20 host; low density diskettes; binary.
NSW-VRTX-BCTF	VRTX R and D pkg for ICM 3216 host; binary.
NSW-VRTX-SPNN	VRTX R and D pkg; Source paper.
NSW-TRAC-BENN	TRACER R and D pkg for EPROM; binary.
NSW-TRAC-BRVM	TRACER R and D pkg for VAX/VMS; binary.
NSW-TRAC-BRVX	TRACER R and D pkg for VAX/UNIX 4.2; binary.
NSW-TRAC-BLAF	TRACER R and D pkg for SYS 32/20 host; low density diskettes; binary.
NSW-TRAC-BCTF	TRACER R and D pkg for ICM 3216 host; binary.
NSW-TRAC-SPNN	TRACER R and D pkg; Source paper.
NSW-VBSP-SRVM	VRTX Board Support Package for VAX/VMS; Source.
NSW-VBSP-SRVX	VTRX Board Support Package for VAX/UNIX 4.2; Source.
NSW-VBSP-SCTF	VRTX Board Support Package for ICM 3216; Source.
NSW-VBSP-SLAF	VRTX Board Support Package for SYS 32/20; Source; low density diskettes.
NSW-VIL-SRVM	VRTX C/Pascal Interface libraries for VAX/VMS; Source.
NSW-VIL-SRVX	VRTX C/Pascal Interface libraries for VAX/UNIX 4.2; Source.
NSW-VIL-SLAF	VRTX C/Pascal Interface libraries for SYS 32/20; Source; low density diskettes.
NSW-VIL-SCTF	VRTX C/Pascal Interface libraries for ICM 3216; Source.

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 (°C)	Packaging Information
NSC800-3	microCMOS 8 CPU 2.5 MHz	*	D40, N40
NSC800-1	microCMOS 8 CPU 1.0 MHz	*	E44, V44
NSC800-4	microCMOS 8 CPU 4.0 MHz	*	
NSC810A-3	microCMOS RAM I/O Expander 2.5 MHz	*	D40, N40
NSC810A-1	microCMOS RAM I/O Expander 1.0 MHz	*	E44, V44
NSC810A-4	microCMOS RAM I/O Expander 4.0 MHz	*	
NSC831-3	microCMOS Parallel I/O Expander 2.5 MHz	*	D40, N40
NSC831-1	microCMOS Parallel I/O Expander 1.0 MHz	*	E44
NSC831-4	microCMOS Parallel I/O Expander 4.0 MHz	*	
NSC858	microCMOS UART	− 55 to + 125	N28, V44
NSC888	NSC800-Evaluation Board		Board

*Temperature ranges available (°C)
− 55°C to + 125°C
− 40°C to + 85°C
0°C to + 70°C

Programmable Logic

For additional Programmable Logic products, see page 345.

Programmable Logic

The nature of logic design continues to change, and National Semiconductor is leading the change into software-based logic and systems design with the availability of programmable logic devices. These devices offer powerful capabilities for creating cost-effective new products or for improving the efficiencies of existing logic designs.

National's commitment to the design, development and support of this technology is exemplified by the extensive and continually expanding line of the PAL® devices offered to the user today.

Available in a vast range of speed/power configurations, package types and technologies (bipolar, ECL and CMOS), you can easily select the device which best meets the needs of your design.

Programmable Logic Part Number System

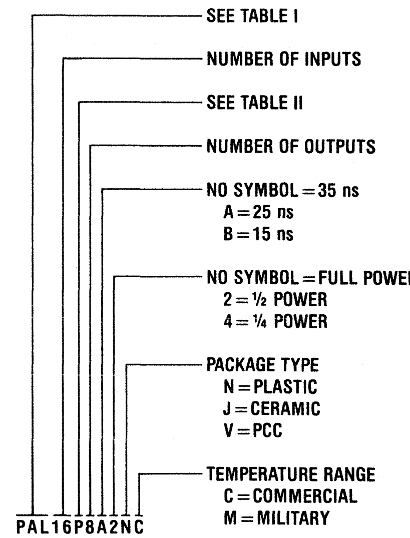
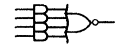
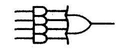
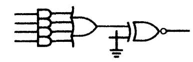
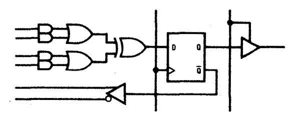
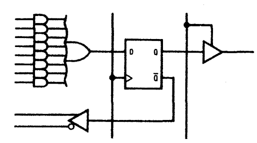
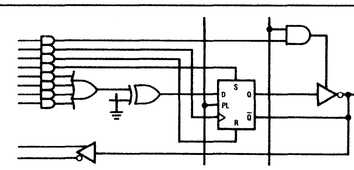
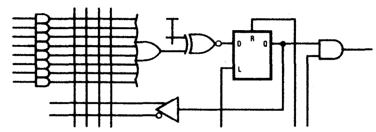
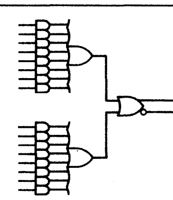


Table 1

Symbol	Meaning
PAL	TTL Field Programmable PAL IC
PL	Factory Programmed PAL IC
PALC	CMOS Programmable Logic Device
NL	National Masked Logic (NML)
PAL 10	10KH Compatible ECL
PAL 100	100K Compatible ECL

Table II

Symbol	Meaning	Configuration
L	Active Low Outputs	
H	Active High Outputs	
P	Programmable Output Polarity (TTL and CMOS)	
X	Exclusive OR Outputs	
R	Synchronous Registered Outputs	
A	Asynchronous Registered Outputs	
L	Latched Outputs (ECL Only)	
C	Complementary Outputs	

PAL Device Cross Reference

	NSC	Comm. t_{PD}	I_{CC}	Military t_{PD}	Product Term Allocation (Outputs × P.T./Output)	Programmable I/O	Registers
20-Pin Small	PAL10H8	35 ns	90 mA	45	8 × 2		
	PAL10L8	35 ns	90 mA	45	8 × 2		
	PAL12H6	35 ns	90 mA	45	4, 4 × 2, 4		
	PAL12L6	35 ns	90 mA	45	4, 4 × 2, 4		
	PAL14H4	35 ns	90 mA	45	4 × 4		
	PAL14L4	35 ns	90 mA	45	4 × 4		
	PAL16H2	35 ns	90 mA	45	2 × 8		
	PAL16L2	35 ns	90 mA	45	2 × 8		
	PAL16C1	40 ns	90 mA	45	16		
20-Pin Fast Small	PAL10H8A	25 ns	90 mA	30	8 × 2		
	PAL10L8A	25 ns	90 mA	30	8 × 2		
	PAL12H6A	25 ns	90 mA	30	4, 4 × 2, 4		
	PAL12L6A	25 ns	90 mA	30	4, 4 × 2, 4		
	PAL14H4A	25 ns	90 mA	30	4 × 4		
	PAL14L4A	25 ns	90 mA	30	4 × 4		
	PAL16H2A	25 ns	90 mA	30	2 × 8		
	PAL16L2A	25 ns	90 mA	30	2 × 8		
	PAL16C1A	30 ns	90 mA	30	16		
20-Pin Small 1/2 Power	PAL10H8A2	35 ns	45 mA	45	8 × 2		
	PAL10L8A2	35 ns	45 mA	45	8 × 2		
	PAL12H6A2	35 ns	45 mA	45	4, 4 × 2, 4		
	PAL12L6A2	35 ns	45 mA	45	4, 4 × 2, 4		
	PAL14H4A2	35 ns	45 mA	45	4 × 4		
	PAL14L4A2	35 ns	45 mA	45	4 × 4		
	PAL16H2A2	35 ns	45 mA	45	2 × 8		
	PAL16L2A2	35 ns	45 mA	45	2 × 8		
	PAL16C1A2	40 ns	45 mA	45	16		
20-Pin Medium	PAL16L8	35 ns	180 mA	45	8 × 7	6	
	PAL16R4	35 ns	180 mA	45	2 × 7, 4 × 8, 2 × 7	4	4
	PAL16R6	35 ns	180 mA	45	7, 6 × 8, 7	2	6
	PAL16R8	35 ns	180 mA	45	8 × 8		8
20-Pin Fast Medium	PAL16L8A	25 ns	180 mA	30	8 × 7	6	
	PAL16R4A	25 ns	180 mA	30	2 × 7, 4 × 8, 2 × 7	4	4
	PAL16R6A	25 ns	180 mA	30	7, 6 × 8, 7	2	6
	PAL16R8A	25 ns	180 mA	30	8 × 8		8
20-Pin Ultra-Fast Medium	PAL16L8B	15 ns	180 mA	20	8 × 7	6	
	PAL16R4B	15 ns	180 mA	20	2 × 7, 4 × 8, 2 × 7	4	4
	PAL16R6B	15 ns	180 mA	20	7, 6 × 8, 7	2	6
	PAL16R8B	15 ns	180 mA	20	8 × 8		8
20-Pin Fast Medium with Programmable Polarity	PAL16P8A	25 ns	180 mA	30	8 × 7	6	
	PAL16RP4A	25 ns	180 mA	30	2 × 7, 4 × 8, 2 × 7	4	4
	PAL16RP6A	25 ns	180 mA	30	7, 6 × 8, 7	2	6
	PAL16RP8A	25 ns	180 mA	30	8 × 8		8

PAL Device Cross Reference

	NSC	Comm. t_{PD}	I_{CC}	Military t_{PD}	Product Term Allocation (Outputs × P.T./Output)	Programmable I/O	Registers
20-Pin	PAL16L8A2	35 ns	90 mA	50	8 × 7	6	
Medium	PAL16R4A2	35 ns	90 mA	50	2 × 7, 4 × 8, 2 × 7	4	4
1/2 Power	PAL16R6A2	35 ns	90 mA	50	7, 6 × 8, 7	2	6
	PAL16R8A2	35 ns	90 mA	50	8 × 8		8
20-Pin	PAL16L8B2	25 ns	90 mA	30	8 × 7	6	
Ultra-Fast	PAL16R4B2	25 ns	90 mA	30	2 × 7, 4 × 8, 2 × 7	4	4
Medium	PAL16R6B2	25 ns	90 mA	30	7, 6 × 8, 7	2	6
1/2 Power	PAL16R8B2	25 ns	90 mA	30	8 × 8		8
24-Pin	PAL12L10	40 ns	100 mA	45	10 × 2		
Small	PAL14L8	40 ns	100 mA	45	4, 6 × 2, 4		
	PAL16L6	40 ns	100 mA	45	2 × 4, 2 × 2, 2 × 4		
	PAL18L4	40 ns	100 mA	45	6, 2 × 4, 6		
	PAL20L2	40 ns	100 mA	45	2 × 8		
	PAL20C1	40 ns	100 mA	45	16		
24-Pin	PAL20L10	50 ns	165 mA	60	10 × 3	8	
Medium	PAL20X4	50 ns	180 mA	60	3 × 3, 4 × 2, 3 × 3		4
	PAL20X8	50 ns	180 mA	60	3, 8 × 2, 3		8
	PAL20X10	50 ns	180 mA	60	10 × 2		10
24-Pin	PAL20L8A	25 ns	210 mA	30	8 × 7	6	
Fast	PAL20R4A	25 ns	210 mA	30	2 × 7, 4 × 8, 2 × 7	4	4
Medium	PAL20R6A	25 ns	210 mA	30	7, 6 × 8, 7	2	6
	PAL20R8A	25 ns	210 mA	30	8 × 8		8
24-Pin	PAL20L8B	15 ns	210 mA	20	8 × 7	6	
Ultra-Fast	PAL20R4B	15 ns	210 mA	20	2 × 7, 4 × 8, 2 × 7	4	4
Medium	PAL20R6B	15 ns	210 mA	20	7, 6 × 8, 7	2	6
	PAL20R8B	15 ns	210 mA	20	8 × 8		8
24-Pin	PAL20P8B	15 ns	210 mA	20	8 × 7	6	
Ultra-Fast	PAL20RP4B	15 ns	210 mA	20	2 × 7, 4 × 8, 2 × 7	4	4
Medium	PAL20RP6B	15 ns	210 mA	20	7, 6 × 8, 7	2	6
with Programmable Polarity	PAL20RP8B	15 ns	210 mA	20	8 × 8		8
24-Pin Registered Asynchronous	PAL20RA10	35 ns	200 mA	40	10 × 4	10	10
ECL PAL	**PAL1016P8	6 ns	220 mA	N/A	8 × 8		8
Devices	PAL1016RC8	6 ns	220 mA	N/A	8 × 8		8
	PAL1016RD8	6 ns	220 mA	N/A	8 × 8		4
	PAL1016RC4	6 ns	220 mA	N/A	8 × 8		4
	PAL1016RD4	6 ns	220 mA	N/A	8 × 8		4
	PAL1016LC8	6 ns	220 mA	N/A	8 × 8		8 Latches
	PAL1016LD8	6 ns	220 mA	N/A	8 × 8		8 Latches
	PAL1016LC4	6 ns	220 mA	N/A	8 × 8		4 Latches
	PAL1016LD4	6 ns	220 mA	N/A	8 × 8		4 Latches

**This family offers both 10KH and 100K logic compatible devices.

All TTL PAL devices available in: N (Molded DIP), J (Ceramic DIP) and V (Plastic Leaded Chip Carrier). ECL PAL devices available in: J (Ceramic DIP), W (Ceramic Flat Package) and E (Leadless Chip Carrier).

Telecommunications

For additional Telecommunications products, see page 349.

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 5 million subscriber or trunk 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 worlds' 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 committment 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.

Telecommunications Selection Guide

Digital Switching Components

TP3020	Monolithic CODEC
TP3020-1	Monolithic CODEC
TP3021	Monolithic CODEC
TP3021-1	Monolithic CODEC
TP3040	PCM Monolithic Filter
TP3040-1	PCM Monolithic Filter
TP3040A-1	PCM Monolithic Filter
TP3051	Monolithic Parallel Data Interface CMOS CODEC/Filter Combo
TP3052	Monolithic Serial Interface CMOS CODEC/Filter Combo
TP3053	Monolithic Serial Interface CMOS CODEC/Filter Combo
TP3054	Monolithic Serial Interface CMOS CODEC/Filter Combo
TP3056	Monolithic Parallel Data Interface CMOS CODEC/Filter Combo
TP3057	Monolithic Serial Interface CMOS CODEC/Filter Combo
TP3064	Monolithic Serial Interface CMOS CODEC/Filter Combo with Dual Power Amps
TP3067	Monolithic Serial Interface CMOS CODEC/Filter Combo with Dual Power Amps
TP3110	Digital Line Interface Controller (DLIC)
TP3120	Digital Line Interface Controller (DLIC)
TP3155	Time Slot Assignment Circuit
TP3200	SLIC-MC Magnetic Compensation SLIC
TP3201	SLIC-MC Magnetic Compensation SLIC
TP5116A	Monolithic CODEC
TP5156A	Monolithic CODEC

Telephone Set Components

TP5087	DTMF (TOUCH-TONE®) Generator
TP5088	DTMF Generator for Binary Data
TP5089	DTMF (TOUCH-TONE) Generator
TP5700	Telephone Speech Circuit
TP5700-1	Telephone Speech Circuit
TP5710	Telephone Speech Circuit

Modems

MM74HC942	300 Baud Modem (+ 5V, − 5V Supply)
MM74HC943	300 Baud Modem (5V Supply)
TP3310	Monolithic Reversible 1200-600/150-75-5 Bit/s CMOS FSK Modem
TP3311	Monolithic Reversible 1200-600/150-75-5 Bit/s CMOS FSK Modem
TP3320	Monolithic Reversible 1200-600/150-75-5 Bit/s CMOS FSK Modem
TP3321	Monolithic Reversible 1200-600/150-75-5 Bit/s CMOS FSK Modem

Telecommunications Selection Guide

		TP3051	TP3052	TP3053	TP3054	TP3056	TP3057	TP3058	TP3059	TP3064	TP3067	TP3054X	TP3057X	TP3020	TP3021	TP5116	TP5156	TP3040	TP3120	TP3155	TP5088	TP5089	TP5700	TP3330	MM74HC942	MM74HC943	TP3070	TP3200
Combined CODEC/ Filter Combos	μ-Law	•	•	•	•			•		•		•		•		•											•	
	A-Law					•	•		•		•		•		•		•										•	
	Serial PCM Bus		•	•	•		•			•	•	•	•	•	•	•	•										•	
	Parallel PCM Bus	•				•		•	•																			
	Receive Power Amps									•	•																•	
	Signaling, Short Frame		•		•									•	•													
	Signaling, Long Frame			•												•	•											
	− 40 to + 85°C											•	•															
	μP Compatible							•	•										•									
	Programmable Gains																										•	
	Programmable Hybrid Balance																										•	
	Programmable SLIC Latches																										•	
Line Card Controller																			•									
Time Slot Assigner																				•							•	
PCM CODEC U-Law														•		•												
PCM CODEC A-Law															•		•											
PCM Filter																		•										
DTMF Generator w/Binary Input																					•							
DTMF Generator for Keypad Interface																						•						
Analog Telephone Network																							•					
300 Baud Modem																									•			
300 Baud Modem 5V Only																										•		
1200 Baud Bell 212A/V.22 Modem																								•				
SLIC—Magnetic Compensation																												•
14-Pin Package																					•							
16-Pin Package					•		•					•	•			•	•	•				•	•					
18-Pin Package			•																									
20-Pin Package		•		•		•				•	•														•	•	•	•
22-Pin Package								•	•						•													•
24-Pin Package														•														
28-Pin Package																				•				•			•	
40-Pin Package																			•									

Military/Aerospace

For additional information on Aerospace/Defense, see page 355.

Military/Aerospace Programs from National Semiconductor

This section is intended to provide a brief overview of military products available from National Semiconductor. For further information, refer to our *1987 Reliability Handbook.*

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: Classes S and B. Class S is typically specified for space flight applications, while Class B is used for aircraft and ground systems. National is a major supplier of both classes of devices. Screening requirements are outlined in Table 3.

Tables 1 and 2 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

Table 1. The MIL-M-38510 Part Marking

JM38510/XXXXXYYY

- The Lead Finish
  A = Solder Dipped
  B = Tin Plate
  C = Gold Plate
  X = Any lead finish above is acceptable
- The Device Package (see Table 2)
- The Screening Level S or B
- The Device Number on Slash Sheet
- The Slash Sheet Number
- For radiation hardened devices the slash is replaced by the Radiation Hardness Assurance Indication per paragraph 3.4.1.3 of MIL-M-38510
- MIL-M-38510
- The JAN Prefix (which may be applied only to a fully conformant device per paragraphs 3.6.2.1 and 3.6.7 of MIL-M-38510)

Table 2. JAN Package Codes

38510 Package Designation	Microcircuit Industry Description
A	14-pin 1/4″ × 1/4″ (metal) flat pack
B	14-pin 3/15″ × 1/4″ flat pack
C	14-pin 1/4″ × 3/4″ dual-in-line
D	14-pin 1/4″ × 3/8″ (ceramic) flat pack
E	16-pin 1/4″ × 7/8″ dual-in-line
F	16-pin 1/4″ × 3/8″ (metal or ceramic) flat pack
G	8-pin TO-99 can or header
H	10-pin 1/4″ × 1/4″ (metal) flat pack
I	10-pin TO-100 can or header
J	24-pin 1/2″ × 1-1/4″ dual-in-line
K	24-pin 3/8″ × 5/8″ flat pack
L	24-pin 1/4″ × 1-1/4″ dual-in-line
M	12-pin TO-101 can or header
N	Note 1
P	8-pin 1/4″ × 3/8″ dual-in-line
Q	40-pin 3/16″ × 2-1/16″ dual-in-line
R	20-pin 1/4″ × 1-1/16″ dual-in-line
S	20-pin 1/4″ × 1/2″ flat pack
T	Note 1
U	Note 1
V	18-pin 3/8″ × 15/16″ dual-in-line
W	22-pin 3/8″ × 1-1/8″ dual-in-line
X	Note 1
Y	Note 1
Z	Note 1
2	20-terminal 0.350″ × 0.350″ chip carrier
3	28-terminal 0.450″ × 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.

DESC Specifications

DESC specifications 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 DESC specification offerings can be obtained from our franchised distributors, sales representatives, 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 3.

As with DESC specifications, 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 RETS (Reliability Electrical Test Specification Program). The RETS 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 older products are not completely compliant with MIL-STD-883, but are still required for use in military systems. These devices are screened to the same stringent requirements as 883 product, but are marked "-MIL".

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 3, 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.

Reliability Electrical Test Specifications (RETS™)

National has implemented the first real-time, electronic catalog of military test specifications called RETS.

Included in this computerized directory is a detailed listing of the electrical tests performed on all military devices qualified by National, including forcing functions, test limits and temperature ranges.

Call your local National sales office for essential up-to-the-minute information on device testing.

Table 3. 100% Screening Requirements

Screen	Class S		Class B	
	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%	—	—
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%

Table 3. 100% Screening Requirements

Screen	Class S Method	Class S Reqmt	Class B Method	Class B Reqmt
12. Interim (Post Burn-In) Electrical Parameters	Per Applicable Device Specification (Note 13)	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)	Per Applicable Device Specification		Per Applicable Device Specification	
a) Static Tests				
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 (Subgroups 4 or 7)		100%		100%
2) Max & 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., flatpacks 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 4. Group A Electrical Tests

Subgroup (Notes 1,2)	LTPD
Subgroup 1 Static Tests at 25°C	2
Subgroup 2 Static Tests at Maximum Rated Operating Temperature	3
Subgroup 3 Static Tests at Minimum Rated Operating Temperature	5
Subgroup 4 Dynamic Tests at 25°C	2
Subgroup 5 Dynamic Tests at Maximum Rated Operating Temperature	3
Subgroup 6 Dynamic Tests at Minimum Rated Operating Temperature	5
Subgroup 7 Functional Tests at 25°C	2
Subgroup 8 Functional Tests at Maximum and Minimum Rated Operating Temperatures	5
Subgroup 9 Switching Tests at 25°C	2
Subgroup 10 Switching Tests at Maximum Rated Operating Temperature	3
Subgroup 11 Switching Tests at Minimum Rated Operating Temperature	5

Note 1: The specific parameters to be included for tests in each subgroup shall be as 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 5. Group B (Class B)

Test (Note 1)	Method	Condition	LTPD
Subgroup 1			
Physical Dimensions (Note 2)	2016		2 Devices (No Failures)
Subgroup 2			
Resistance to Solvents	2015		4 Devices (No Failures)
Subgroup 3			
Solderability (Note 3)	2003 or 2022	Soldering Temperature of 245 $\pm$ 5°C	10
Subgroup 4			
Internal Visual and Mechanical (Note 4)	2014	Failure Criteria from Design and Construction Requirements of Applicable Procurement Document	1 Device (No Failures)
Subgroup 5			
Bond Strength (Note 5)	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 6)	1018	1,000 ppm Maximum Water Content at 100°C	3 Devices (0 Failures) (Note 7) or 5 Devices (1 Failure)
Subgroup 7			
Seal (Note 8)	1014	As Applicable	5
1) Fine			
2) Gross			
Subgroup 8 (Note 9)			
Electrical Parameters	2015	Group A, Subgroup 1	15 (0)
Electrostatic Discharge Sensitivity			
Electrical Parameters		Group A, Subgroup 1	

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: Not required for qualification or quality conformance inspections where Group D inspection is being performed on samples from the same inspection lot.

Note 3: 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 4: Test samples for internal visual and mechanical shall be selected at any point following the seal operation.

Note 5: 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 6: This test is required only if the package contains a desiccant.

Note 7: Test 3 devices, if 1 fails, test 2 additional devices with no failure.

Note 8: This test is not required if either the 100% screen or sample test is performed between steps 14 and 18 and 100% screening of Table 3 of this section.

Note 9: Unless otherwise specified, test shall be performed for initial qualification and product redesign as a minimum.

Table 6. 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 ± 5°C	LTPD = 15
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		Groups A, Subgroups 1, 2, 3: Read and Record Group A, Subgroup 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 7. Group C (Die-Related Tests for Class B and C Only)

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	
Subgroup 2			
Temperature Cycling	1010	Condition C	15
Constant Acceleration	2001	Condition E min, Y_1 Orientation Only (Note 1)	
Seal	1014	As Applicable	
a) Fine			
b) Gross			
Visual Examination		Per Visual Criteria of Method 1010 or 1011 as	
End-point Electrical Parameters		Specified in the Applicable Device Specification	

Note 1: See paragraph 3 of Method 5005 for the procedure for large cavity package.

Table 8. 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 9. 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 sonsidered 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 10. 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 $\pm$ 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: 8 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) $\triangle V_{FB}$ or $\triangle V_T \leq 0.75V$ 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.	One wafer (or monitor) per lot. Reject lot if measurement exceeds limits or revert to test of each wafer.
		b) $\triangle V_{FB}$ or $\triangle V_T \leq 1.0V$ for bipolar linear devices that operate above 5V and contain MOS transistors and digital devices that operate above 10V and contain MOS structures.	Separate monitors may be used but must be oxidized and metallized with the lot.
		c) $\triangle V_{FB}$ or $\triangle V_T \leq 0.4V$ for MOS devices.	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 2kÅ 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-977 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.

Packaging

For additional Packaging information, see page 373.

Surface Mount Devices—Product Availability

Analog

All of the major analog product families are available now in surface mount packages. Most of the products are produced in the SOIC package, including op amps, regulators, data conversion, consumer, and automotive ICs. More highly specialized telecom products come packaged in the PLCC.

Amplifiers and Comparators

Part Number	Package
LF347WM	SO-14W
LF351M	SO-8
LF355M	SO-8
LF356M	SO-8
LF357M	SO-8
LF441CM	SO-8
LF444CWM	SO-14W
LF451CM	SO-8
LM308M	SO-8
LM308AM	SO-8
LM310M	SO-8
LM311M	SO-8
LM318M	SO-8
LM324M	SO-14
LM339M	SO-14
LM346M	SO-16
LM348M	SO-14
LM358M	SO-8
LM359M	SO-14
LM392M	SO-8
LM393M	SO-8
LM741CM	SO-8
LM1458M	SO-8
LM2901M	SO-14
LM2902M	SO-14
LM2903M	SO-8
LM2904M	SO-8
LM2924M	SO-8
LM3403M	SO-8
LM4250M	SO-8
LP324M	SO-14
LP339M	SO-14
LP365WM	SO-16W
LMC669CCWM	SO-20W

Regulators and References

Part Number	Package
LM317LM	SO-8
LM334M	SO-8
LM336M-2.5	SO-8
LM336BM-2.5	SO-8
LM336M-5.0	SO-8
LM336BM-5.0	SO-8
LM385M	SO-8
LM385M-1.2	SO-8
LM385BM-1.2	SO-8
LM385M-2.5	SO-8
LM385BM-2.5	SO-8
LM723CM	SO-14
LM3524M	SO-16
LM78L05ACM	SO-8
LM78L12ACM	SO-8
LM78L15ACM	SO-8
LM79L05ACM	SO-8
LM79L12ACM	SO-8
LM79L15ACM	SO-8
LP2951ACM	SO-8
LP2951CM	SO-8

Analog

Data Acquisition Circuits

Part Number	Package
ADC0802LCV	PCC-20
ADC0802LCWM	SO-20
ADC0804LCV	PCC-20
ADC0804LCWM	SO-20
ADC0808CCV	PCC-28
ADC0809CCV	PCC-28
ADC0811BCV	PCC-20
ADC0811CCV	PCC-20
ADC0820BCV	PCC-20
ADC0820CCV	PCC-20
ADC0838BCV	PCC-20
ADC0838CCV	PCC-20
ADC0841BCV	PCC-20
ADC0841CCV	PCC-20
ADC0848BCV	PCC-28
ADC0848CCV	PCC-28
DAC0800LCM	SO-16
DAC0801LCM	SO-16
DAC0802LCM	SO-16
DAC0806LCM	SO-16
DAC0807LCM	SO-16
DAC0808LCM	SO-16
DAC0830LCWM	SO-20
DAC0830LCV	PCC-20
DAC0832LCWM	SO-20
DAC0832LCV	PCC-20

Hybrids

Part Number	Package
LH0002E	LCC-20

Commercial and Automotive

Part Number	Package
LM386M-1	SO-8
LM592M	SO-14
LM832M	SO-14
LM833M	SO-8
LM837M	SO-14
LM1131CM	SO-20
LM1863M	SO-20
LM1870M	SO-20
LM1894M	SO-14
LM1964V	PCC-20
LM3361AM	SO-16

Telecom Circuits

Part Number	Package
TP3051V	PCC-20
TP3052V	PCC-20
TP3056V	PCC-20
TP3057V	PCC-20
TP3064V	PCC-20
TP3067V	PCC-20
TP3155V	PCC-20
TP5088WM	SO-16W
TP5089WM	SO-14W
TP5700WM	SO-16

Industrial Functions

Part Number	Package
AH5012CM	SO-16
LF13201M	SO-16
LF13202M	SO-16
LF13331M	SO-16
LF13332M	SO-16
LF13333M	SO-16
LF13508M	SO-16
LF13509M	SO-16
LM555CM	SO-8
LM556CM	SO-14
LM567CM	SO-8
LM1496M	SO-14
LM2917M	SO-14
LM3046M	SO-14
LM3086M	SO-14
LM3146M	SO-14
MF4CWM-50	SO-14W
MF4CWM-100	SO-14W
MF5CWM	SO-14W
MF6CWM-50	SO-14W
MF6CWM-100	SO-14W
MF10CCWM	SO-20W

Gate Array

National's SCX family of SCX6200 micro-CMOS gate arrays are offered in a wide variety of packages which allows the user many choices in terms of package type and lead count. Surface mount packages offered include leaded ceramic chip carriers (LDCC), leadless ceramic chip carriers (LCC), and plastic leaded chip carriers (PCC).

Part Number	Package
SCX6206	PCC-28
	LCC-28
	PCC-44
	LCC-44
	PCC-68
	LCC-68
SCX6212	PCC-28
	LCC-28
	PCC-44
	LCC-44
	PCC-68
	LCC-68
SCX6218	PCC-28
	LCC-28
	PCC-44
	LCC-44
	PCC-68
	PCC-84
	LCC-84

Part Number	Package
SCX6225	PCC-28
	LCC-28
	PCC-44
	LCC-44
	PCC-68
	LCC-68
	PCC-84
	LCC-84
	LDCC-124
SCX6232	PCC-44
	LCC-44
	PCC-68
	LCC-68
	PCC-84
	LCC-84
	LCC-124
	LDCC-124
SCX6244	PCC-44
	LCC-44
	PCC-68
	LCC-68
	PCC-84
	LCC-84
	LDCC-124
SCX6287	PCC-68
	PCC-84
	LCC-84

Interface

National's Advanced Peripherals family of products is available in a variety of package types. These LSI devices provide system solutions to complex functions including Hard and Floppy Disk Drive Control, 16k, 64k, 256k and 4 megabit DRAM Control, Ethernet/Thin Ethernet Network Interface, and Graphics Support.

These products make use of National's advanced PCC packaging technology to produce large pin count devices in the most efficient and reliable manner possible. Of note, National's Auto-Die Attach Process, in volume production for over 5 years, is the most advanced technique in the industry for bonding out high pin count PCC and LCC packages.

BTL Transceivers

Part Number	Package
DS3897V	PCC-20
DS3893V	PCC-20

Graphics

Part Number	Package
DP8510V	PCC-44
DP8511V	PCC-44
DP8512	PCC-44
DP8513	PCC-44
DP8514	PCC-20
DP8530	PCC-28
DP8515	PCC-44
DP8516	PCC-44
DP8520	PCC-68
DP8521	PCC-68
DP8522	PCC-68
DP8530	PCC-28

Interface

Part Number	Package
DS1488M	SO-14
DS1489M	SO-14
DS1489AM	SO-14
DS14C88M	SO-14
DS14C89M	SO-14
DS26LS31CM	SO-16
DS26LS32CM	SO-16
DS26S10V	PCC-20
DS3486M	SO-16
DS3487M	SO-16
DS3650M	SO-16
DS3680M	SO-14
DS3691M	SO-16
DS75150M	SO-8
DS75154M	SO-16
DS75492M	SO-14
DS75113M	SO-16
DS8837M	SO-16
DS8838M	SO-16
DP8304BWM	SO-24
DP8340V	PCC-28
DP8341V	PCC-28
DP8344V	PCC-84
DS8921AM	SO-8
DS8921M	SO-8
DS8922AM	SO-16
DS8922M	SO-16
DS8923AM	SO-16
DS8923M	SO-16

LAN

Part Number	Package
DP8390	PCC-68
DP8391	PCC-28

Mass Storage

Part Number	Package
DP8466AV	PCC-68
DP8474V	PCC-44
DP8451V	PCC-20
DP8455V	PCC-20
DP8461V	PCC-28
DP8462V	PCC-28
DP8463BV	PCC-28
DP8464BV	PCC-28
DP8465V	PCC-28
DP8470V	PCC-44
DP8475BV	PCC-44

Memory Support

Part Number	Package
DP8400V-2	PCC-68
DP8402AV	PCC-68
DP8409AV-2	PCC-68
DP8417V	PCC-68
DP8418V	PCC-68
DP8419V	PCC-68
DP8420V	PCC-68
DP8421V	PCC-68
DP8422V	PCC-68
DP8428V	PCC-68
DP8429V	PCC-68
DP84240V	PCC-20
DP84244V	PCC-20

Real Time Clocks

Part Number	Package
DP8570V	PCC-28
MM58167AV	PCC-28
MM58274V	PCC-20

Logic

National Semiconductor's Advanced Low-Power Schottky (ALS) and Advanced Schottky (AS) devices are among the latest advancements in TTL integrated circuit technology. The performance advantages offered by these families are further enhanced by surface mount technology. Many AS/ALS devices are available in the Small Outline package.

Low power dissipation, high speed, and high reliability can describe the benefits available from Small Outline packaging of National's 74HC Logic Family. Utilization of these products in the surface mounted packages will result in improvements in packing density.

While HC and AS/ALS circuits are available for most new designs, National is continuing its effort to provide the widest selection of surface mount components. Traditional Schottky (S) and Low Power Schottky (LS) devices are also available in the SO package.

ALS

Part Number	Package
DM74ALS00AM	SO-14
DM74ALS01M	SO-14
DM74ALS02M	SO-14
DM74ALS03BM	SO-14
DM74ALS04AM	SO-14
DM74ALS05AM	SO-14
DM74ALS08M	SO-14
DM74ALS09M	SO-14
DM74ALS10AM	SO-14
DM74ALS11AM	SO-14
DM74ALS12AM	SO-14
DM74ALS13M	SO-14
DM74ALS14M	SO-14
DM74ALS15M	SO-14
DM74ALS20AM	SO-14
DM74ALS21M	SO-14
DM74ALS22BM	SO-14
DM74ALS27M	SO-14
DM74ALS28AM	SO-14
DM74ALS30AM	SO-14
DM74ALS32M	SO-14
DM74ALS33AM	SO-14
DM74ALS37AM	SO-14
DM74ALS38AM	SO-14
DM74ALS40AM	SO-14
DM74ALS74AM	SO-14
DM74ALS109AM	SO-16
DM74ALS131M	SO-16
DM74ALS132M	SO-14
DM74ALS133M	SO-16
DM74ALS137M	SO-16
DM74ALS138M	SO-16
DM74ALS151M	SO-16
DM74ALS153M	SO-16
DM74ALS160BM	SO-16
DM74ALS161BM	SO-16
DM74ALS162BM	SO-16
DM74ALS163BM	SO-16
DM74ALS168BM	SO-16

Part Number	Package
DM74ALS169BM	SO-16
DM74ALS174M	SO-16
DM74ALS175M	SO-16
DM74ALS240AWM	SO-20
DM74ALS241AWM	SO-20
DM74ALS242AM	SO-14
DM74ALS243AM	SO-14
DM74ALS244AWM	SO-20
DM74ALS245AWM	SO-20
DM74ALS251M	SO-16
DM74ALS253M	SO-16
DM74ALS2541WM	SO-16
DM74ALS257AM	SO-16
DM74ALS258AM	SO-16
DM74ALS273WM	SO-20
DM74ALS352M	SO-16
DM74ALS353M	SO-16
DM74ALS373WM	SO-20
DM74ALS374WM	SO-20
DM74ALS465AWM	SO-20
DM74ALS466AWM	SO-20
DM74ALS467AWM	SO-20
DM74ALS468AWM	SO-20
DM74ALS518WM	SO-20
DM74ALS519WM	SO-20
DM74ALS520WM	SO-20
DM74ALS521WM	SO-20
DM74ALS522WM	SO-20
DM74ALS533WM	SO-20
DM74ALS534WM	SO-20
DM74ALS540WM	SO-20
DM74ALS541WM	SO-20
DM74ALS563WM	SO-20
DM74ALS564WM	SO-20
DM74ALS573AWM	SO-20
DM74ALS574AWM	SO-20
DM74ALS576AWM	SO-20
DM74ALS580AWM	SO-20

Logic

ALS

Part Number	Package
DM74ALS632AV/DP8402AV	PCC-68
DM74ALS645AWM	SO-20
DM74ALS689WM	SO-20
DM74ALS804WM	SO-20
DM74ALS805WM	SO-20
DM74ALS808WM	SO-20
DM74ALS832WM	SO-20
DM74ALS1000AM	SO-14
DM74ALS1002AM	SO-14
DM74ALS1003AM	SO-14
DM74ALS1004M	SO-14
DM74ALS1005M	SO-14
DM74ALS1008AM	SO-14
DM74ALS1010AM	SO-14
DM74ALS1011AM	SO-14
DM74ALS1020AM	SO-14
DM74ALS1032AM	SO-14
DM74ALS1034WM	SO-20
DM74ALS1035M	SO-14
DM74ALS1240AWM	SO-20
DM74ALS1241AWM	SO-20
DM74ALS1242AM	SO-14
DM74ALS1243AM	SO-14
DM74ALS1244AWM	SO-20

LS

Part Number	Package
DM74LS00M	SO-14
DM74LS02M	SO-14
DM74LS03M	SO-14
DM74LS04M	SO-14
DM74LS05M	SO-14
DM74LS08M	SO-14
DM74LS09M	SO-14
DM74LS10M	SO-14
DM74LS11M	SO-14
DM74LS12M	SO-14
DM74LS14M	SO-14
DM74LS20M	SO-14
DM74LS21M	SO-14
DM74LS26M	SO-14
DM74LS27M	SO-14
DM74LS30M	SO-14
DM74LS32M	SO-14
DM74LS37M	SO-14
DM74LS38M	SO-14
DM74LS42M	SO-14
DM74LS51M	SO-14
DM74LS73AM	SO-14
DM74LS74AM	SO-14
DM74LS75M	SO-14
DM74LS77M	SO-14
DM74LS83AWM	SO-16
DM74LS85M	SO-16
DM74LS86M	SO-14
DM74LS90M	SO-14
DM74LS93M	SO-14
DM74LS107AM	SO-14
DM74LS109AM	SO-16
DM74LS112AM	SO-16
DM74LS122M	SO-14
DM74LS123M	SO-16
DM74LS125AM	SO-14
DM74LS126AM	SO-14
DM74LS132M	SO-14
DM74LS138M	SO-16
DM74LS139M	SO-16
DM74LS151M	SO-16
DM74LS153M	SO-16
DM74LS155M	SO-16
DM74LS156M	SO-16

Part Number	Package
DM74LS157M	SO-16
DM74LS158M	SO-16
DM74LS161AM	SO-16
DM74LS163AM	SO-16
DM74LS164M	SO-14
DM74LS165M	SO-16
DM74LS166WM	SO-16W
DM74LS169AM	SO-16
DM74LS173AM	SO-16
DM74LS174AM	SO-16
DM74LS175M	SO-16
DM74LS190M	SO-16
DM74LS191M	SO-16
DM74LS193M	SO-16
DM74LS194AM	SO-16
DM74LS195AM	SO-16
DM74LS221M	SO-16
DM74LS240WM	SO-20
DM74LS241WM	SO-20
DM74LS243WM	SO-14W
DM74LS244WM	SO-20
DM74LS245WM	SO-20
DM74LS251M	SO-16
DM74LS253M	SO-16
DM74LS257BM	SO-16
DM74LS258BM	SO-16
DM74LS259WM	SO-16W
DM74LS279M	SO-16
DM74LS283M	SO-16
DM74LS290M	SO-14
DM74LS293M	SO-14
DM74LS352M	SO-16
DM74LS365AM	SO-16
DM74LS366AM	SO-16
DM74LS367AM	SO-16
DM74LS368AM	SO-16
DM74LS373WM	SO-20
DM74LS374WM	SO-20
DM74LS390M	SO-16
DM74LS645WM	SO-20
DM74LS670M	SO-16
DM81LS95AWM	SO-20
DM81LS96AWM	SO-20
DM81LS97AWM	SO-20
DM81LS98AWM	SO-20

Logic

Schottky

Part Number	Package
DM74S00M	SO-14
DM74S04M	SO-14
DM74S74M	SO-14
DM74S86M	SO-14
DM74S151M	SO-16
DM74S240WM	SO-20
DM74S244WM	SO-20
DM74S280M	SO-14
DM74S373WM	SO-20
DM74S374WM	SO-20

TTL

Part Number	Package
DM7400M	SO-14
DM7404M	SO-14
DM7406M	SO-14
DM7407M	SO-14
DM7438M	SO-14
DM7474M	SO-14

AS

Part Number	Package
DM74AS00M	SO-14
DM74AS02M	SO-14
DM74AS04M	SO-14
DM74AS08M	SO-14
DM74AS32M	SO-14
DM74AS74M	SO-14
DM74AS244M	SO-20
DM74AS280M	SO-14
DM74AS373M	SO-20
DM74AS374M	SO-20
DM74AS574M	SO-20
DM74AS804BM	SO-20
DM74AS808BM	SO-20
DM74AS832BM	SO-20

CD4000

Part Number	Package
CD4001BCM	SO-14
CD4002BCM	SO-14
CD4007BCM	SO-14
CD4010CM	SO-16
CD4011BCM	SO-14
CD4013BCM	SO-14
CD4015CM	SO-16
CD4016BCM	SO-14
CD4017BCM	SO-16
CD4019BCM	SO-16
CD4020BCM	SO-16
CD4021BCM	SO-16
CD4023BCM	SO-14
CD4024BCM	SO-14
CD4025BCM	SO-14
CD4040BCM	SO-16
CD4041CM	SO-14
CD4042BCM	SO-16
CD4046BCM	SO-16
CD4047BCM	SO-14
CD4049CM	SO-16
CD4050BCM	SO-16
CD4051BCM	SO-16
CD4052BCM	SO-16
CD4053BCM	SO-16
CD4060BCM	SO-16
CD4066BCM	SO-14
CD4069UBCM	SO-14
CD4070BCM	SO-14
CD4071BCM	SO-14
CD4081BCM	SO-14
CD4093BCM	SO-14
CD4528BCM	SO-16
CD40174BCM	SO-16
CD40193BCM	SO-16

Logic

HC

Part Number	Package
MM74HC00M	SO-14
MM74HC02M	SO-14
MM74HC03M	SO-14
MM74HCU04M	SO-14
MM74HC04M	SO-14
MM74HC08M	SO-14
MM74HC10M	SO-14
MM74HC11M	SO-14
MM74HC14M	SO-14
MM74HC20M	SO-14
MM74HC27M	SO-14
MM74HC30M	SO-14
MM74HC32M	SO-14
MM74HC42M	SO-16
MM74HC51M	SO-14
MM74HC58M	SO-14
MM74HC73M	SO-14
MM74HC74AM	SO-14
MM74HC75M	SO-16
MM74HC76M	SO-16
MM74HC86M	SO-14
MM74HC109AM	SO-16
MM74HC123AM	SO-16
MM74HC125M	SO-14
MM74HC126M	SO-14
MM74HC132M	SO-14
MM74HC133M	SO-16
MM74HC137M	SO-16
MM74HC138M	SO-16
MM74HC139M	SO-16
MM74HC147M	SO-16
MM74HC149WM	SO-20
MM74HC151M	SO-16
MM74HC153M	SO-16
MM74HC154WM	SO-24
MM74HC157M	SO-16
MM74HC158M	SO-16
MM74HC160M	SO-16
MM74HC161M	SO-16
MM74HC162M	SO-16

Part Number	Package
MM74HC163M	SO-16
MM74HC164M	SO-14
MM74HC165M	SO-16
MM74HC173M	SO-16
MM74HC174M	SO-16
MM74HC175M	SO-16
MM74HC181WM	SO-24
MM74HC182M	SO-16
MM74HC221AM	SO-16
MM74HC237M	SO-16
MM74HC240WM	SO-20
MM74HC241WM	SO-20
MM74HC242M	SO-14
MM74HC243M	SO-14
MM74HC244WM	SO-20
MM74HC245AWM	SO-20
MM74HC251M	SO-16
MM74HC253M	SO-16
MM74HC257M	SO-16
MM74HC259M	SO-16
MM74HC266AM	SO-14
MM74HC273WM	SO-20
MM74HC280M	SO-14
MM74HC283M	SO-16
MM74HC298M	SO-16
MM74HC299WM	SO-20
MM74HC354WM	SO-20
MM74HC356WM	SO-20
MM74HC365WM	SO-16
MM74HC366WM	SO-16
MM74HC367WM	SO-16
MM74HC368WM	SO-16
MM74HC373WM	SO-20

Part Number	Package
MM74HC374WM	SO-20
MM74HC393M	SO-14
MM74HC423AM	SO-16
MM74HC521WM	SO-20
MM74HC533WM	SO-20
MM74HC534WM	SO-20
MM74HC540WM	SO-20
MM74HC541WM	SO-20
MM74HC563WM	SO-20
MM74HC564WM	SO-20
MM74HC573WM	SO-20
MM74HC574WM	SO-20
MM74HC589M	SO-16
MM74HC595M	SO-16
MM74HC597M	SO-16
MM74HC640WM	SO-20
MM74HC643WM	SO-20
MM74HC646M	SO-24
MM74HC648M	SO-24
MM74HC688WM	SO-20
MM74HC942WM	SO-20
MM74HC943WM	SO-20
MM74HC4002M	SO-14
MM74HC4016WM	SO-14
MM74HC4017M	SO-14
MM74HC4020M	SO-16
MM74HC4040M	SO-16
MM74HC4046M	SO-16
MM74HC4049M	SO-16
MM74HC4050M	SO-16
MM74HC4051WM	SO-16
MM74HC4052WM	SO-16
MM74HC4053WM	SO-16
MM74HC4060M	SO-16
MM74HC4066WM	SO-14
MM74HC4075M	SO-14
MM74HC4078M	SO-14
MM74HC4316WM	SO-16
MM74HC4511M	SO-16
MM74HC4514WM	SO-24
MM74HC4538M	SO-16
MM74HC4543M	SO-16
MM74HC7266M	SO-14

Logic

HCT

Part Number	Package
MM74HCT00M	SO-14
MM74HCT04M	SO-14
MM74HCT05M	SO-14
MM74HCT34M	SO-14
MM74HCT74M	SO-14
MM74HCT138M	SO-16
MM74HCT149WM	SO-20
MM74HCT151M	SO-16
MM74HCT164M	SO-14
MM74HCT240WM	SO-20
MM74HCT241WM	SO-20
MM74HCT244WM	SO-20
MM74HCT245WM	SO-20
MM74HCT251M	SO-16
MM74HCT273WM	SO-20
MM74HCT373WM	SO-20
MM74HCT374WM	SO-20
MM74HCT521WM	SO-20
MM74HCT540WM	SO-20
MM74HCT541WM	SO-20
MM74HCT640WM	SO-20
MM74HCT643WM	SO-20
MM74HCT688WM	SO-20

74CXXX Series

Part Number	Package
MM74C00M	SO-14
MM74C14M	SO-14
MM74C32M	SO-14
MM74C74M	SO-14
MM74C240WM	SO-20
MM74C244WM	SO-20
MM74C373WM	SO-20
MM74C374WM	SO-20
MM74C901M	SO-14
MM74C906M	SO-14
MM74C914M	SO-14
MM74C923WM	SO-20
MM80C97M	SO-16

LSI/VLSI

Part Number	Package
MM5450V	PCC-44
MM5451V	PCC-44
MM5452V	PCC-44
MM5453V	PCC-44
MM58241V	PCC-44
MM58242V	PCC-28
MM58248V	PCC-44
MM58341V	PCC-44
MM58342V	PCC-28
MM58348V	PCC-44

Logic

Programmable Array Logic

Part Number	Package
PAL16C1V	PCC-20
PAL16L2V	PCC-20
PAL14L4V	PCC-20
PAL12L6V	PCC-20
PAL10L8V	PCC-20
PAL16H2V	PCC-20
PAL14H4V	PCC-20
PAL10H8V	PCC-20
PAL12H6V	PCC-20
PAL16C1A2V	PCC-20
PAL16L2A2V	PCC-20
PAL14L4A2V	PCC-20
PAL12L6A2V	PCC-20
PAL10L8A2V	PCC-20
PAL16H2A2V	PCC-20
PAL14H4A2V	PCC-20
PAL10H8A2V	PCC-20
PAL12H6A2V	PCC-20

Part Number	Package
PAL16L8V	PCC-20
PAL16R4V	PCC-20
PAL16R6V	PCC-20
PAL16R8V	PCC-20
PAL16L8AV	PCC-20
PAL16R4AV	PCC-20
PAL16R6AV	PCC-20
PAL16R8AV	PCC-20
PAL16L8BV	PCC-20
PAL16R4BV	PCC-20
PAL16R6BV	PCC-20
PAL16R8BV	PCC-20
PAL16L8A2V	PCC-20
PAL16R4A2V	PCC-20
PAL16R6A2V	PCC-20
PAL16R8A2V	PCC-20
PAL16L8B2V	PCC-20
PAL16R4B2V	PCC-20
PAL16R6B2V	PCC-20
PAL16R8B2V	PCC-20
PAL16L8B4V	PCC-20
PAL16R4B4V	PCC-20
PAL16R6B4V	PCC-20
PAL16R8B4V	PCC-20

Part Number	Package
PAL12L10V	PCC-28
PAL14L8V	PCC-28
PAL16L6V	PCC-28
PAL18L4V	PCC-28
PAL20C1V	PCC-28
PAL20L2V	PCC-28
PAL20L10V	PCC-28
PAL20X10V	PCC-28
PAL20X8V	PCC-28
PAL20X4V	PCC-28
PAL20L8AV	PCC-28
PAL20R8AV	PCC-28
PAL20R6AV	PCC-28
PAL20R4AV	PCC-28
PAL20L8BV	PCC-28
PAL20R8BV	PCC-28
PAL20R6BV	PCC-28
PAL20R4BV	PCC-28
PAL20P8BV	PCC-28
PAL20RP8BV	PCC-28
PAL20RP6BV	PCC-28
PAL20RP4BV	PCC-28

Memory

Density has been one of the driving forces for surface mount technology, and density improvements in memory applications can be substantial. National's MOS memory products, including EEPROMs, are available now and in the near future to satisfy industry demands.

Bipolar programmable array logic based upon TTL is readily available in both 20 and 28-pin PCC packages.

Bipolar

Part Number	Package
DM74S188V	PCC-20
DM74S188AV	PCC-20
PL87X288BV	PCC-20
DM74S288V	PCC-20
DM74S288AV	PCC-20
DM74S287V	PCC-20
DM74S287AV	PCC-20
DM74S387V	PCC-20
DM74S387AV	PCC-20
DM74S570V	PCC-20
DM74S570AV	PCC-20
DM74S570BV	PCC-20
DM74S571V	PCC-20
DM74S571AV	PCC-20
DM74S571BV	PCC-20
DM74LS471V	PCC-20
DM74S572V	PCC-20
DM74S572AV	PCC-20
DM74S573V	PCC-20
DM74S573AV	PCC-20
DM74S573BV	PCC-20
DM74S472V	PCC-20
DM74S472AV	PCC-20
DM74S472BV	PCC-20
DM74S473V	PCC-20
DM74S473AV	PCC-20
DM87S184V	PCC-20
DM87S184AV	PCC-20
DM87S185V	PCC-20
DM87S185AV	PCC-20
DM87S185BV	PCC-20
DM74S474V	PCC-28
DM74S474AV	PCC-28
DM74S474BV	PCC-28
DM74S475V	PCC-28
DM74S475AV	PCC-28
DM74S475BV	PCC-28
DM87SR474V	PCC-28
DM87SR474BV	PCC-28
DM87SR476V	PCC-28
DM87SR476BV	PCC-28

Part Number	Package
DM87S180V	PCC-28
DM87S181V	PCC-28
DM87S181AV	PCC-28
DM87LS181V	PCC-28
DM87SR181V	PCC-28
DM87SR183V	PCC-28
DM87SR183AV	PCC-28
DM87S190V	PCC-28
DM87S190AV	PCC-28
DM87S191V	PCC-28
DM87191AV	PCC-28
DM87S191BV	PCC-28
DM87SR191V	PCC-28
DM87SR193V	PCC-28
DM87S321V	PCC-28

Microprocessor

Since LSI functions of the future require high pin count output, National's microprocessor and microcontroller families in surface mount are designed for maximum density, with availability of devices in both PCC and LCC packages.

8-Bit

Part Number	Package
NSC800E	LCC-44
NSC800V	PCC-44
NSC810AE	LCC-44
NSC810AV	PCC-44
NSC858E	LCC-28
NSC858V	PCC-44
INS8250AV	PCC-44
INS82C50AV	PCC-44
NS16450V	PCC-44
NS16C450V	PCC-44
MM82PC08V	PCC-28
MM82PC12V	PCC-28

32-Bit/Series 32000®

Part Number	Package
NS32008V	PCC-68
NS32016V	PCC-68
NS32032V	PCC-68
NS32032E	LCC-68
NS32081V	PCC-44
NS32082V	PCC-68
NS32202V	PCC-44
NS32C016V	PCC-68
NS32C032E	PCC-68
NS32C032V	LCC-68
NS32C201	PCC-44

Microcontrollers

Part Number	Package
HPC16030E	LCC-68
HPC16030V	PCC-68
HPC16040E	LCC-68
HPC16040V	PCC-68
HPC16083E	LCC-68
HPC16083V	PCC-68
COP411L-XXX/WM	SO-20
COP413L-XXX/WM	SO-20
COP411C-XXX/WM	SO-20

Transistors

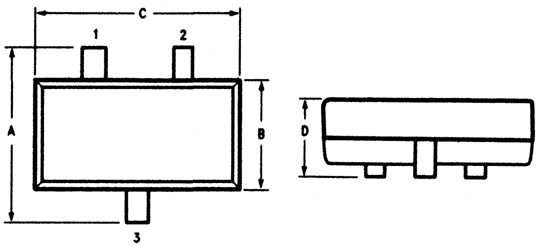
The MMBT and MMBF families of transistors utilize the smallest surface mount package available, the SOT-23. In addition, National is offering a variety of dual channel and higher power devices in the small outline and plastic chip carrier packages for optimum reliability.

Part Number	Package
MMBD914	SOT-23
MMBD4002	SOT-23
MMBD4148	SOT-23
MMBDAV70	SOT-23
MMBFJ111	SOT-23
MMBFJ112	SOT-23
MMBFJ113	SOT-23
MMBFJ174	SOT-23
MMBFJ175	SOT-23
MMBFJ176	SOT-23
MMBFJ177	SOT-23
MMBFJ309	SOT-23
MMBFJ310	SOT-23
MMBF4391	SOT-23
MMBF4392	SOT-23
MMBF4393	SOT-23
MMBF4416	SOT-23
MMBF4860	SOT-23
MMBF4861	SOT-23
MMBF5457	SOT-23
MMBF5459	SOT-23
MMBF5460	SOT-23
MMBF5484	SOT-23
MMBF5485	SOT-23
MMBF5486	SOT-23
MMBTA05	SOT-23
MMBTA06	SOT-23
MMBTA13	SOT-23
MMBTA20	SOT-23
MMBTA55	SOT-23
MMBTA56	SOT-23
MMBTA70	SOT-23
MMBTH10	SOT-23
MMBTH11	SOT-23
MMBTH20	SOT-23
MMBTH24	SOT-23
MMBTH30	SOT-23
MMBT100	SOT-23
MMBT100A	SOT-23
MMBT200	SOT-23

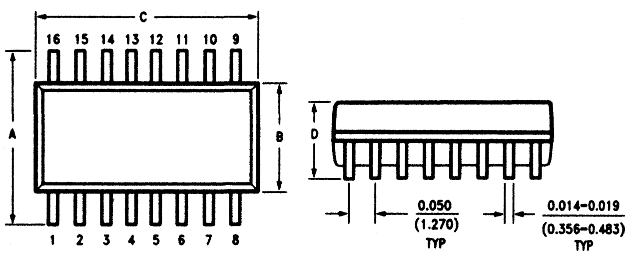
Part Number	Package
MMBT200A	SOT-23
MMBT2222	SOT-23
MMBT2222A	SOT-23
MMBT2484	SOT-23
MMBT2905	SOT-23
MMBT2907	SOT-23
MMBT2907A	SOT-23
MMBT3393	SOT-23
MMBT3638A	SOT-23
MMBT3642	SOT-23
MMBT3645	SOT-23
MMBT3904	SOT-23
MMBT3906	SOT-23
MMBT4123	SOT-23
MMBT4124	SOT-23
MMBT4125	SOT-23
MMBT4126	SOT-23
MMBT4248	SOT-23
MMBT4249	SOT-23
MMBT4250	SOT-23
MMBT4401	SOT-23
MMBT4403	SOT-23
MMBT5086	SOT-23
MMBT5087	SOT-23
MMBT5088	SOT-23
MMBT5089	SOT-23
MMBT5179	SOT-23
MMBT5210	SOT-23
MMBT6515	SOT-23
MMBT6543	SOT-23
MMBT918	SOT-23
NPDS5564	SO-8
NPDS5565	SO-8
NPDS5566	SO-8
NPDS5911	SO-8
NPDS5912	SO-8

Physical Dimensions inches (millimeters)

SOT-23



SO Narrow

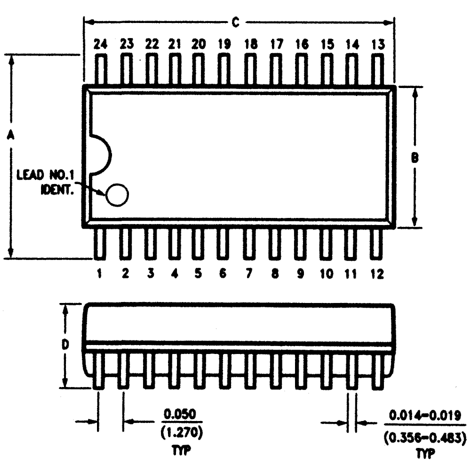


SO "M" Package (Narrow Body)

Lead Count	Dimensions inches (mm) A Min	A Max	B Min	B Max	C Min	C Max	D Min	D Max
3	0.083 (2.108)	0.098 (2.489)	0.047 (1.194)	0.055 (1.397)	0.110 (2.794)	0.120 (3.048)	(a) 0.031 (0.787) (b) 0.027 (0.689)	0.047 (1.397) 0.041 (1.041)
8	0.228 (5.791)	0.244 (6.198)	0.150 (3.810)	0.158 (4.013)	0.188 (4.775)	0.196 (4.978)	0.053 (1.346)	0.069 (1.753)
14	0.228 (5.791)	0.244 (6.198)	0.150 (3.810)	0.158 (4.013)	0.336 (8.534)	0.344 (8.738)	0.053 (1.346)	0.069 (1.753)
16	0.228 (5.791)	0.244 (6.198)	0.150 (3.810)	0.158 (4.013)	0.385 (9.779)	0.394 (10.01)	0.053 (1.346)	0.069 (1.753)

(a) SOT-23 High Profile (b) SOT-23 Low Profile

SO Wide

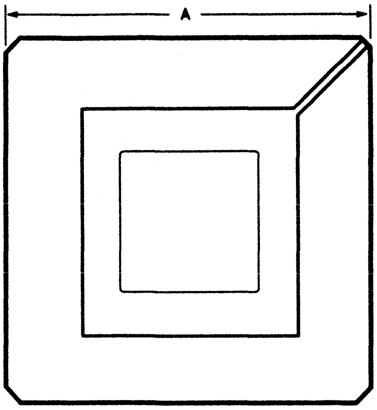


SO "M" Package (Wide Body)

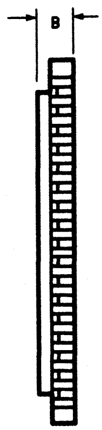
Lead Count	Dimensions inches (mm) A Min	A Max	B Min	B Max	C Min	C Max	D Min	D Max
14W	0.394 (10.01)	0.419 (10.64)	0.291 (7.391)	0.299 (7.595)	0.346 (8.788)	0.362 (9.195)	0.093 (2.362)	0.104 (2.642)
16W	0.394 (10.01)	0.419 (10.64)	0.291 (7.391)	0.299 (7.595)	0.346 (8.788)	0.412 (10.46)	0.093 (2.362)	0.104 (2.642)
20	0.394 (10.01)	0.419 (10.64)	0.291 (7.391)	0.299 (7.595)	0.496 (12.60)	0.512 (13.01)	0.093 (2.362)	0.104 (2.642)
24	0.394 (10.01)	0.419 (10.64)	0.291 (7.391)	0.299 (7.595)	0.596 (15.14)	0.612 (15.54)	0.093 (2.362)	0.104 (2.642)

Physical Dimensions inches (millimeters)

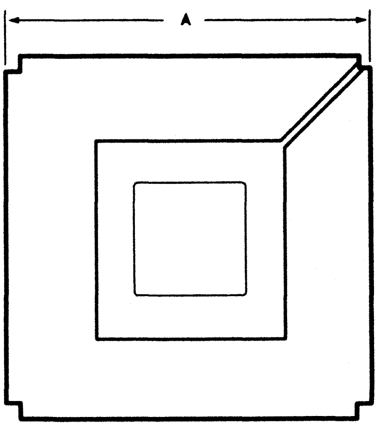
Top View
LCC-28
LCC-44



Side View
All



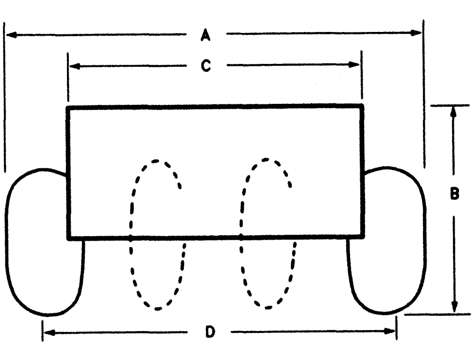
Top View
LCC-68
LCC-84
LCC-124



LCC "E" Package

Lead Count	Dimensions inches (mm) A Min	A Max	B Min	B Max
28	0.442 (11.23)	0.458 (11.63)	0.065 (1.651)	0.076 (1.930)
44	0.640 (16.256)	0.660 (16.764)	0.065 (1.651)	0.076 (1.930)
68	0.940 (23.876)	0.960 (24.384)	0.069 (1.753)	0.085 (2.159)
84	1.139 (28.931)	1.161 (29.489)	0.070 (1.778)	0.078 (1.981)
124	1.642 (41.707)	1.658 (42.113)	0.092 (2.337)	0.100 (2.54)

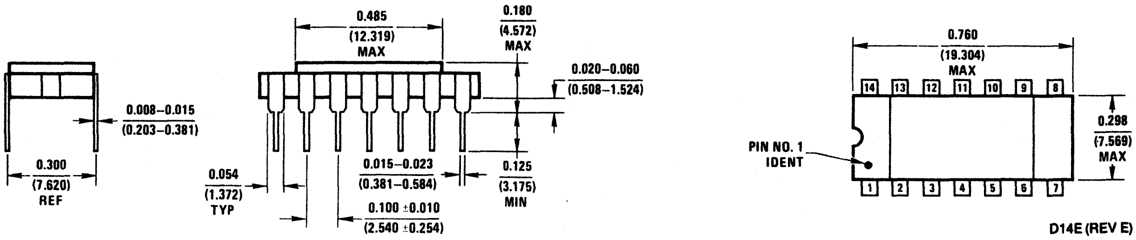
PCC



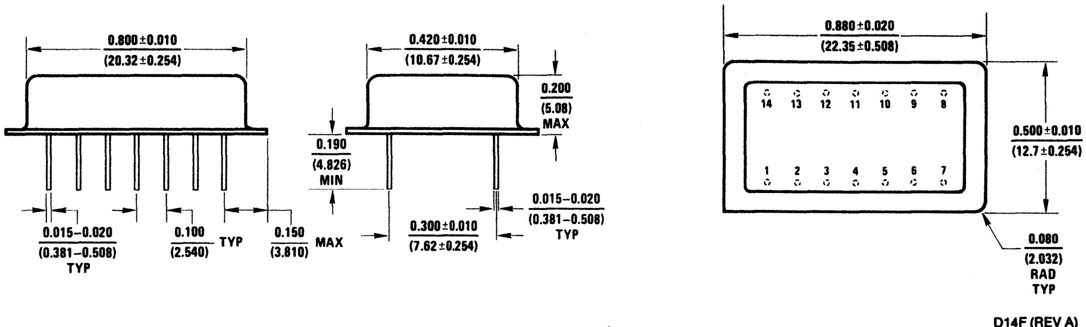
PCC "V" Package

Lead Count	Dimensions inches (mm) A Min	A Max	B Min	B Max	C Min	C Max	D Min	D Max
20	0.385 (9.779)	0.395 (10.03)	0.165 (4.191)	0.180 (4.572)	0.345 (8.763)	0.355 (9.017)	0.310 (7.874)	0.330 (8.382)
28	0.485 (12.32)	0.495 (12.57)	0.165 (4.191)	0.180 (4.572)	0.445 (11.30)	0.455 (11.56)	0.410 (10.41)	0.430 (10.92)
44	0.685 (17.40)	0.695 (17.65)	0.165 (4.191)	0.180 (4.572)	0.645 (16.38)	0.655 (16.64)	0.610 (15.49)	0.630 (16.00)
68	0.985 (25.02)	0.995 (25.27)	0.165 (4.191)	0.180 (4.572)	0.945 (24.00)	0.955 (24.26)	0.910 (23.11)	0.930 (23.62)
84	1.185 (30.10)	1.195 (30.36)	0.165 (4.191)	0.180 (4.572)	1.150 (29.21)	1.158 (29.41)	1.110 (28.20)	1.130 (28.70)
124	1.685 (49.13)	1.695 (49.39)	0.180 (4.572)	0.200 (5.080)	1.650 (41.91)	1.658 (42.11)	1.610 (40.90)	1.630 (41.40)

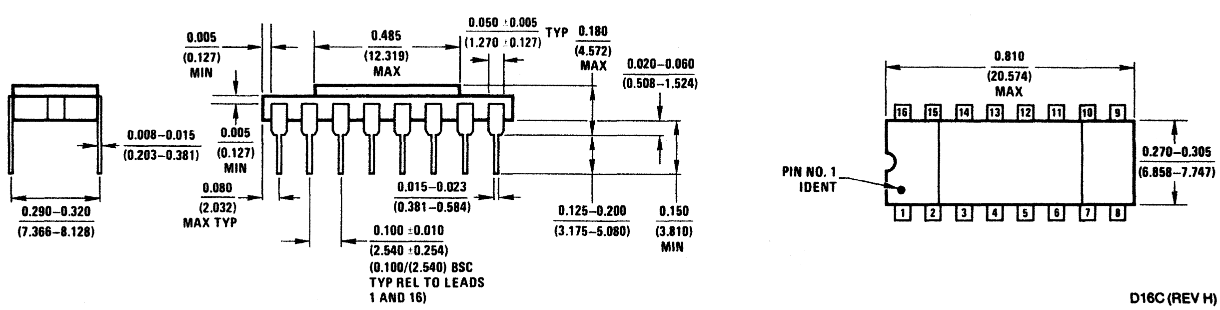
Physical Dimensions inches (millimeters)



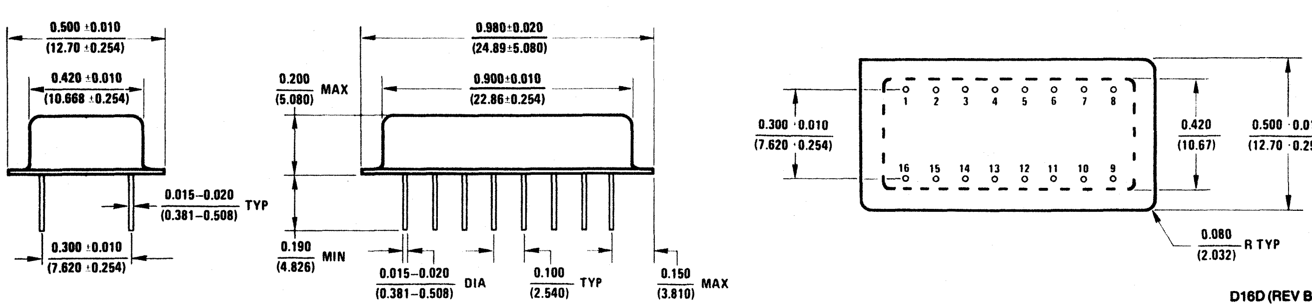
NS Package D14E
14-Lead Hermetic DIP (D)



NS Package D14F
14-Lead Hybrid Metal Can DIP (D)

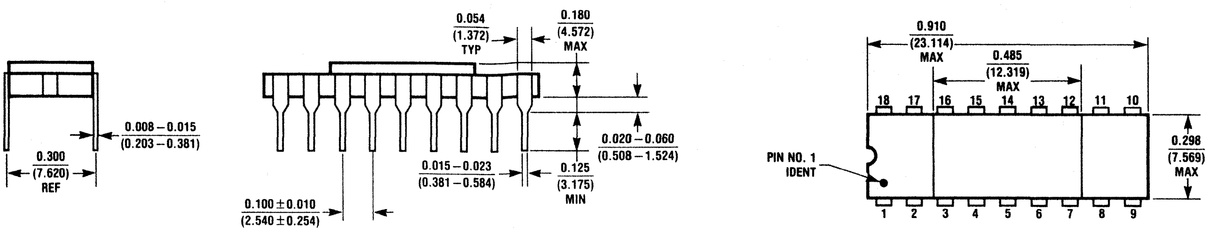


NS Package D16C
16-Lead Hermetic DIP (D)

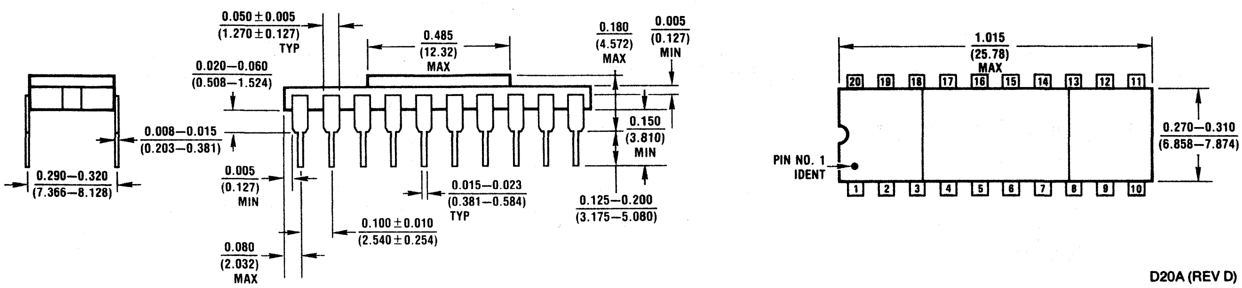


NS Package D16D
16-Lead Hybrid Metal Can DIP (D)

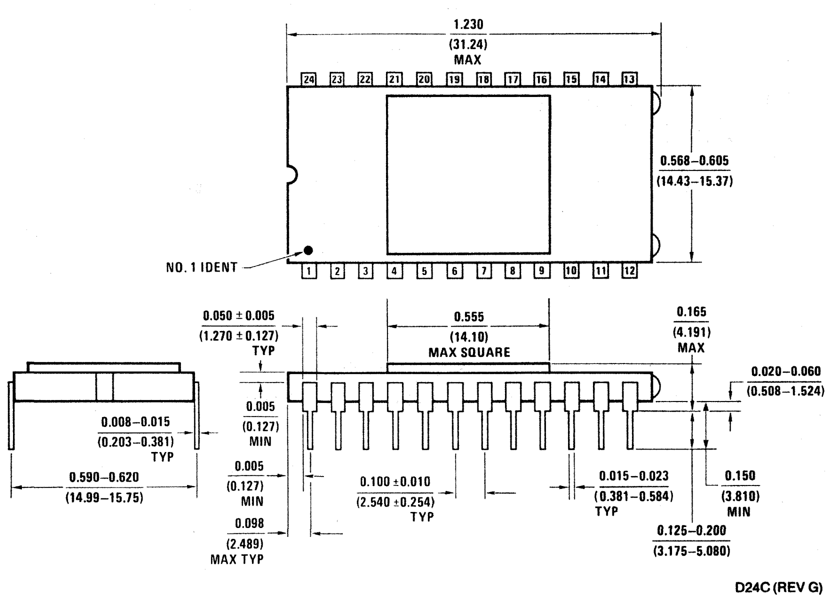
Physical Dimensions inches (millimeters)



NS Package D18A
18-Lead Hermetic DIP (D)

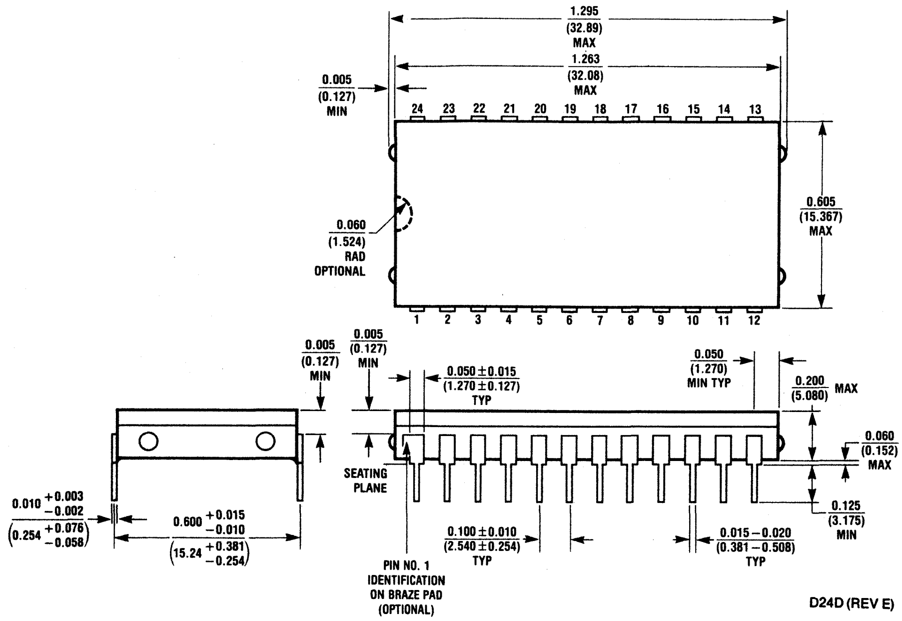


NS Package D20A
20-Lead Hermetic DIP (D)

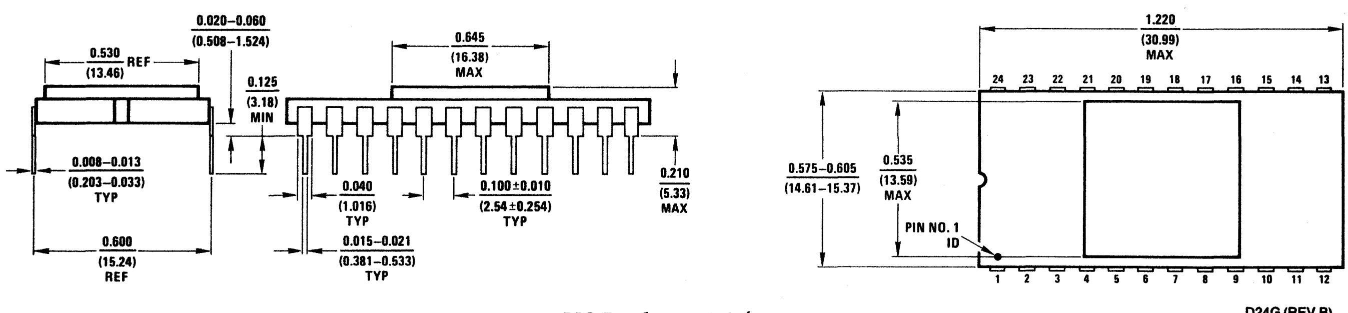


NS Package D24C
24-Lead Hermetic DIP (D)

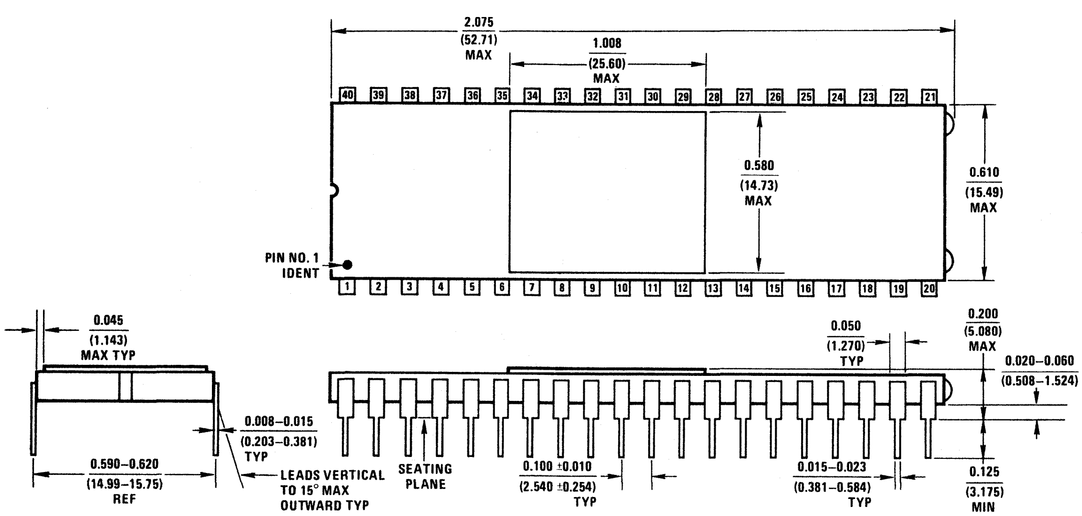
Physical Dimensions inches (millimeters)



NS Package D24D
24-Lead Hermetic DIP (D)
(Sidebraze)



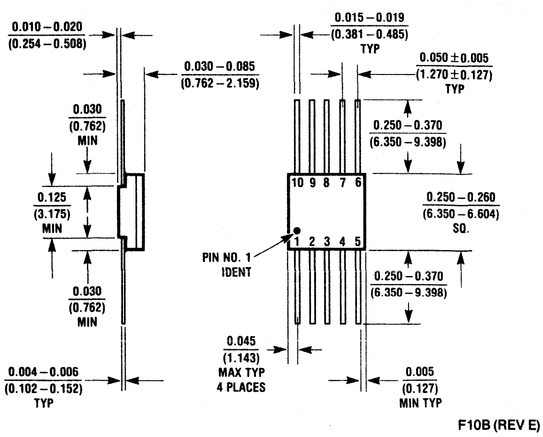
NS Package D24G
24-Lead Hybrid Hermetic DIP (D)



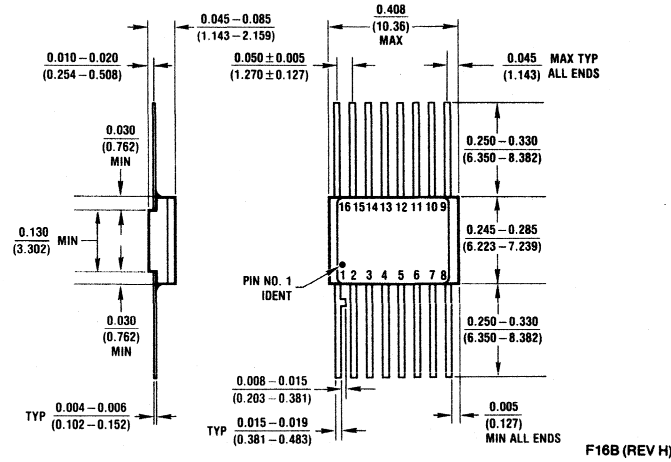
NS Package D40C
40-Lead Hermetic DIP (D)

D40C (REV H)

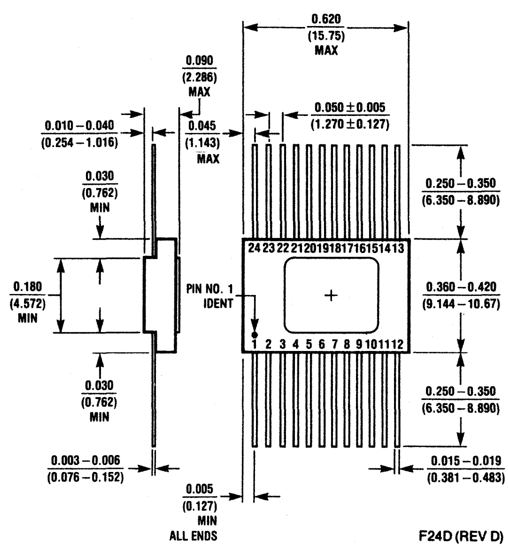
Physical Dimensions inches (millimeters)



NS Package F10B
10-Lead Ceramic Flat Package (F)

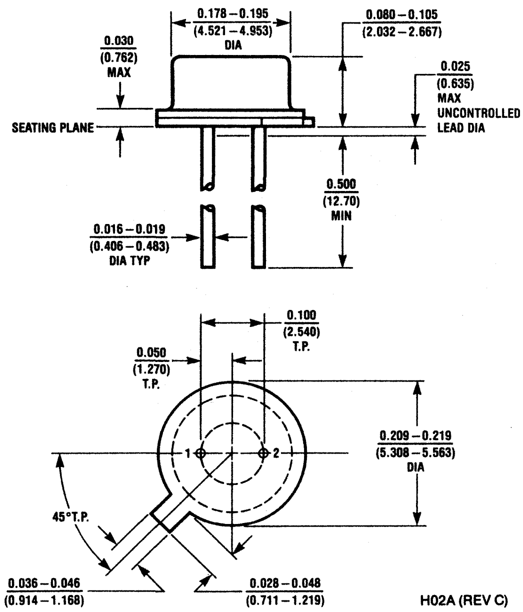


NS Package F16B
16-Lead Ceramic Flat Package (F)

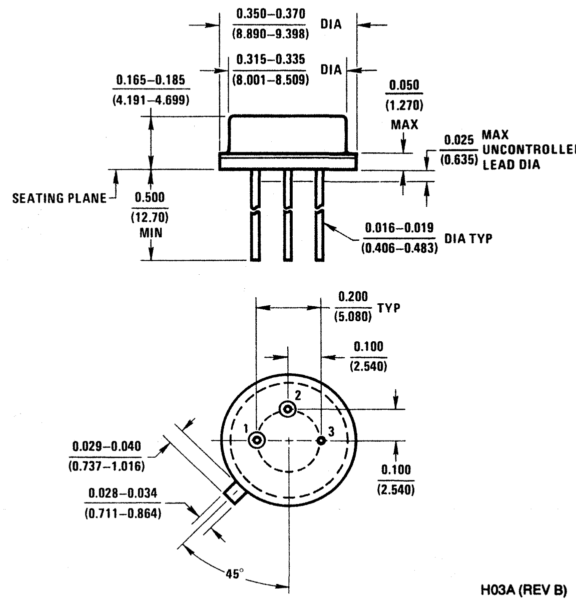


NS Package F24D
24-Lead Ceramic Flat Package (F)

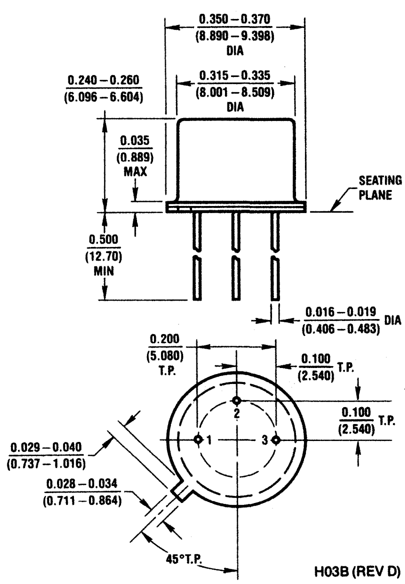
Physical Dimensions inches (millimeters)



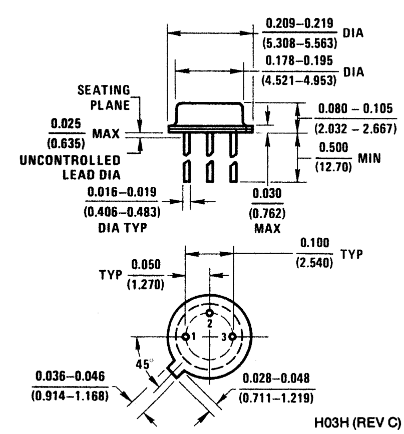
NS Package H02A
2-Lead TO-46 Metal Can Package (H)



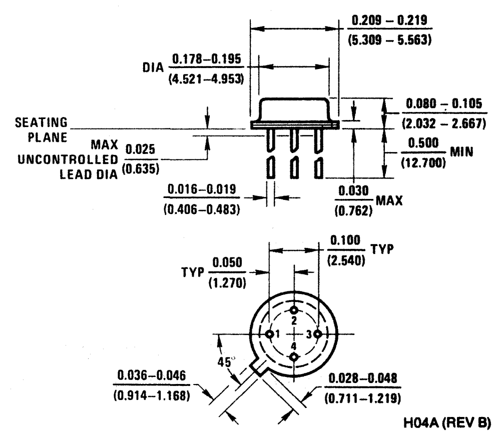
NS Package H03A
3-Lead TO-39 Metal Can Package (H)



NS Package H03B
3-Lead TO-39 Metal Can Package (H)

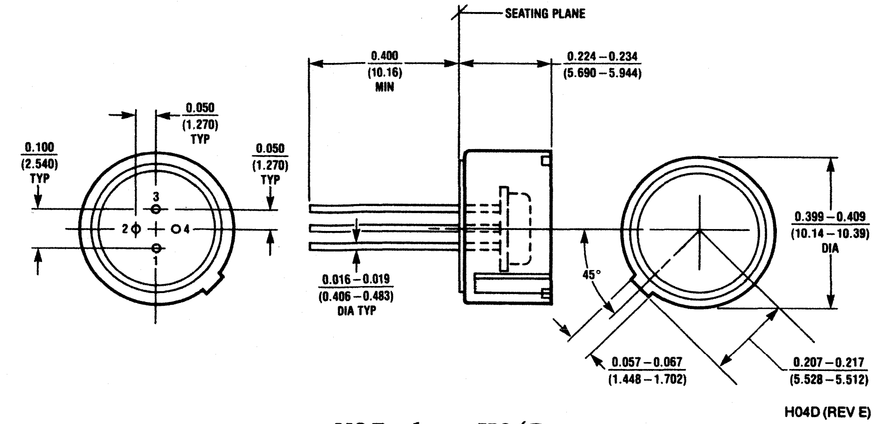


NS Package H03H
3-Lead TO-46 Metal Can Package (H)

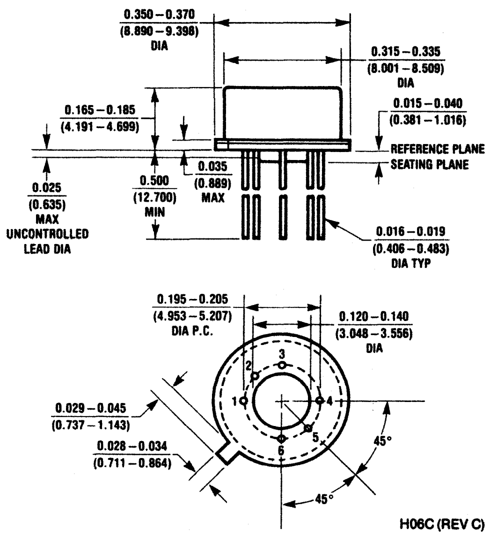


NS Package H04A
4-Lead TO-46 Metal Can Package (H)

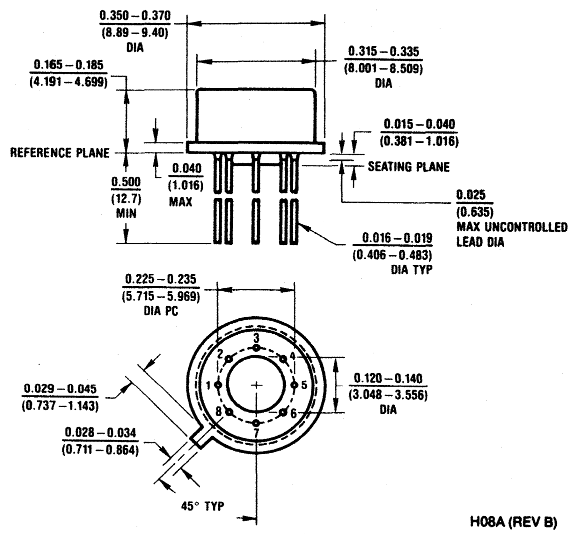
Physical Dimensions inches (millimeters)



NS Package H04D
Thermal Shield Metal Can Package (H)

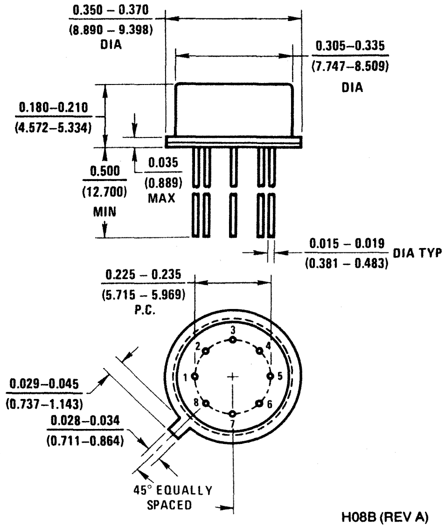


NS Package H06C
6-Lead TO-99 Metal Can Package (H)

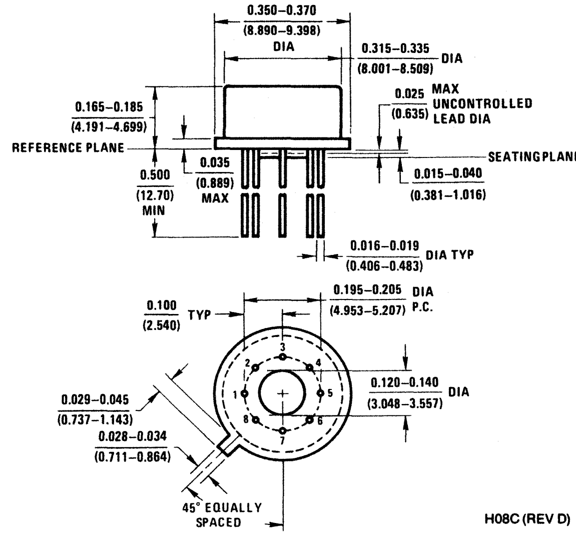


NS Package H08A
8-Lead TO-5 Metal Can Package (H)

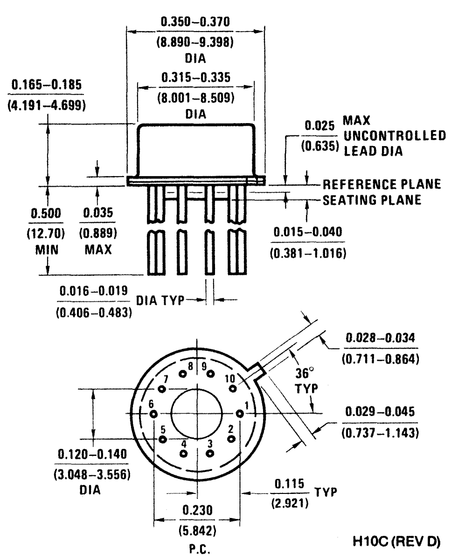
Physical Dimensions inches (millimeters)



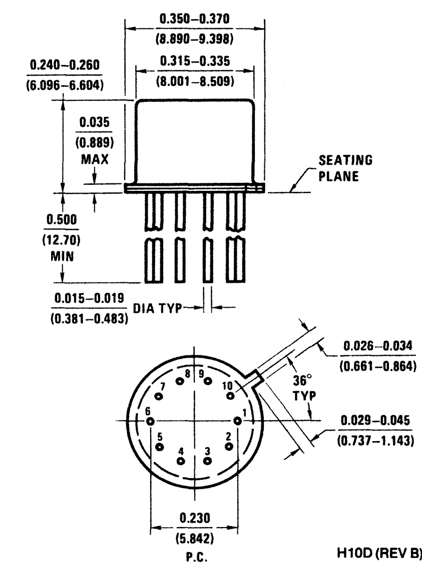
NS Package H08B
8-Lead TO-5 Metal Can Package (H)



NS Package H08C
8-Lead TO-99 Metal Can Package (H)

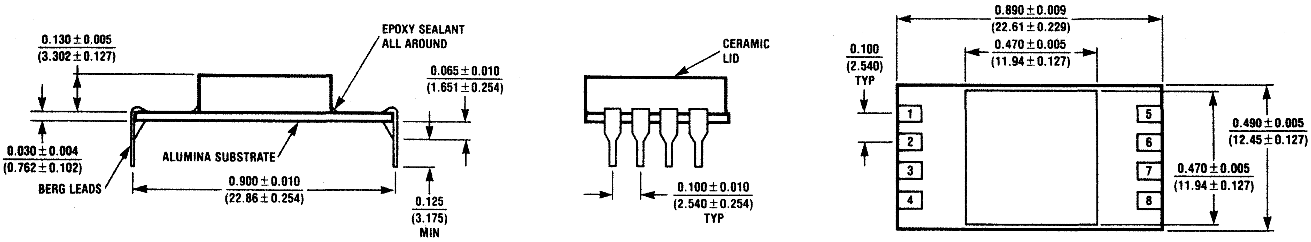


NS Package H10C
10-Lead TO-100 Metal Can Package (H)



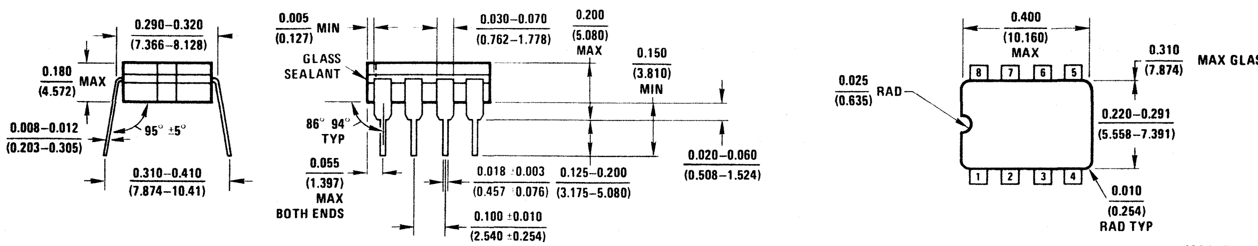
NS Package H10D
10-Lead TO-96 Metal Can Package (H)

Physical Dimensions inches (millimeters)



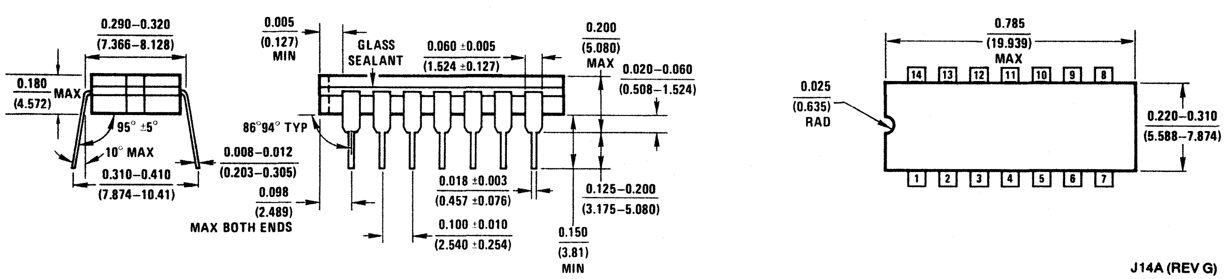
HY08A (REV B)

NS Package HY08A
8-Lead Cavity DIP (J) (Hybrid)



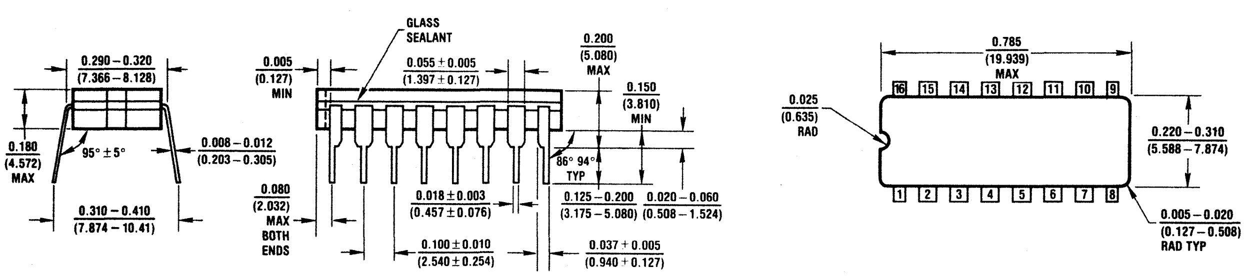
J08A (REV H)

NS Package J08A
8-Lead Ceramic DIP (J)



J14A (REV G)

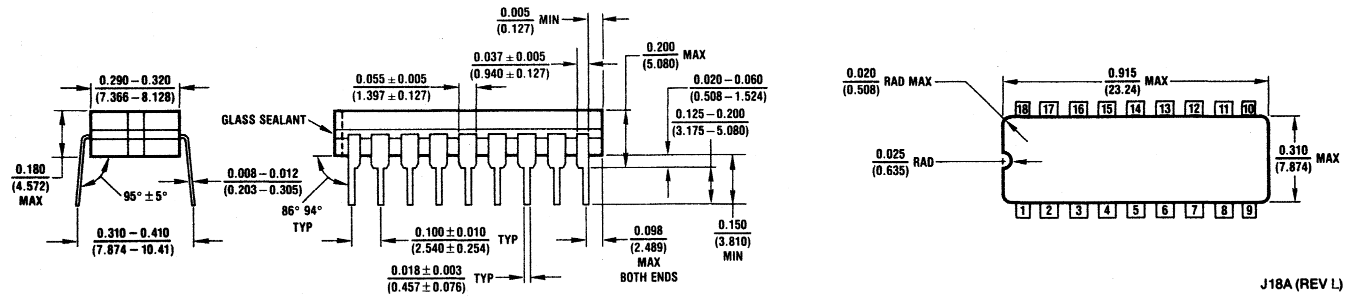
NS Package J14A
14-Lead Ceramic DIP (J)



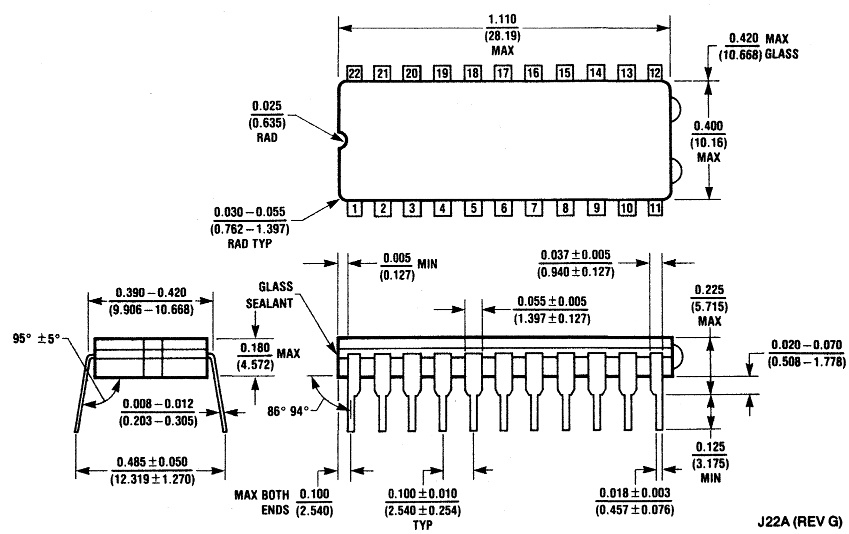
J16A (REV K)

NS Package J16A
16-Lead Ceramic DIP (J)

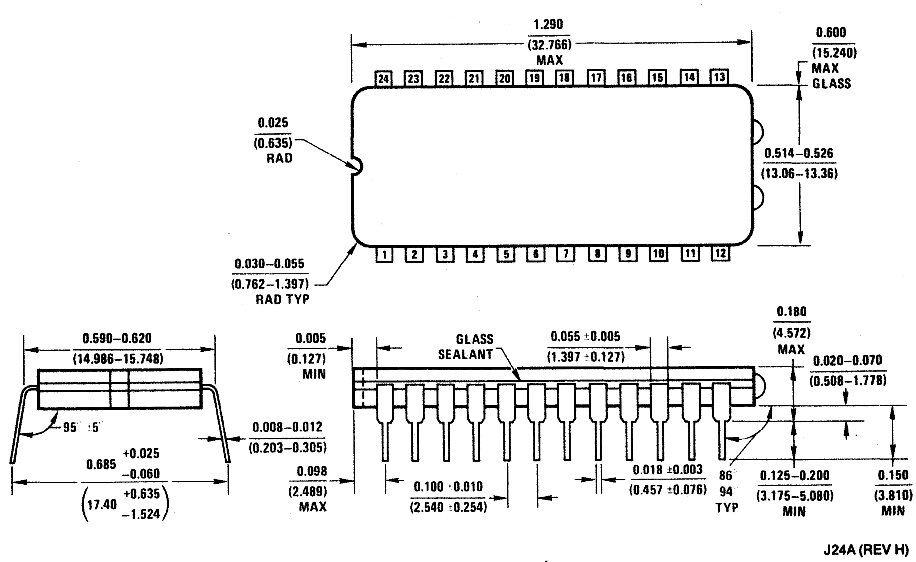
Physical Dimensions inches (millimeters)



NS Package J18A
18-Lead Ceramic DIP (J)

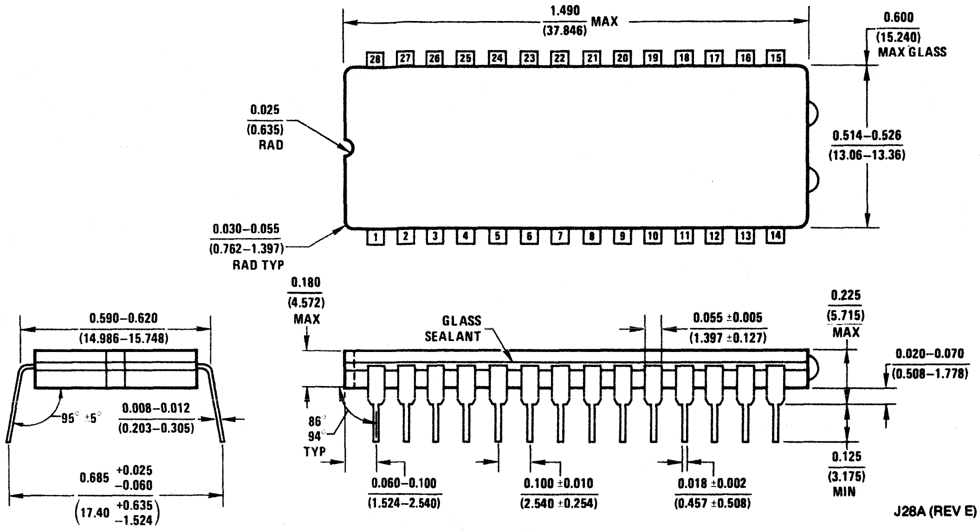


NS Package J22A
22-Lead Ceramic DIP (J)

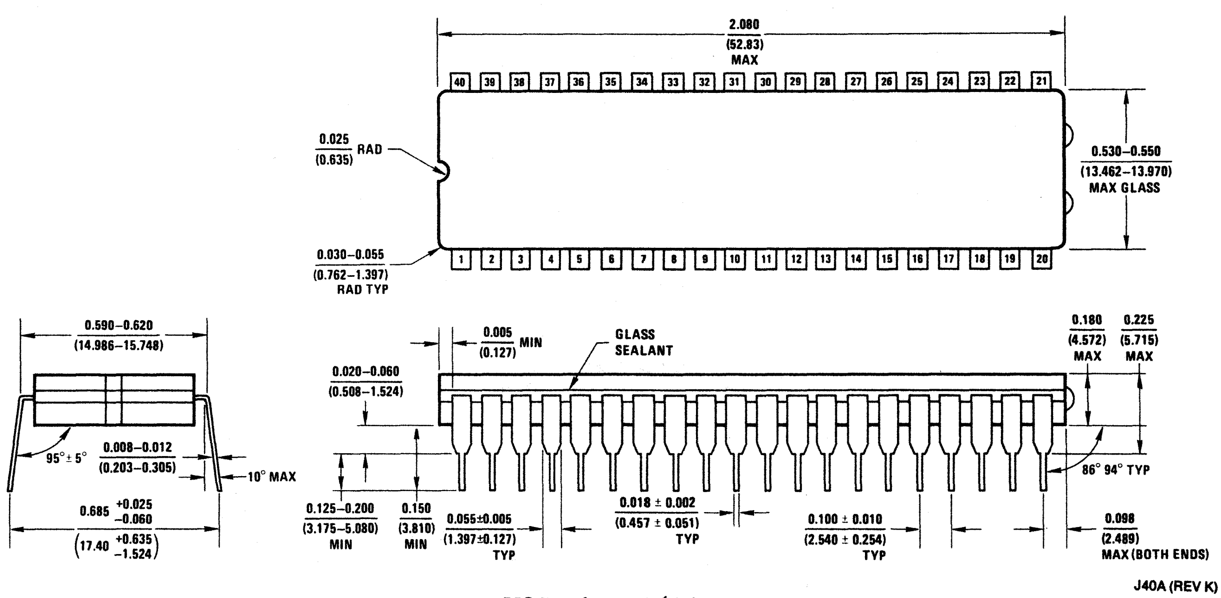


NS Package J24A
24-Lead Ceramic DIP (J)

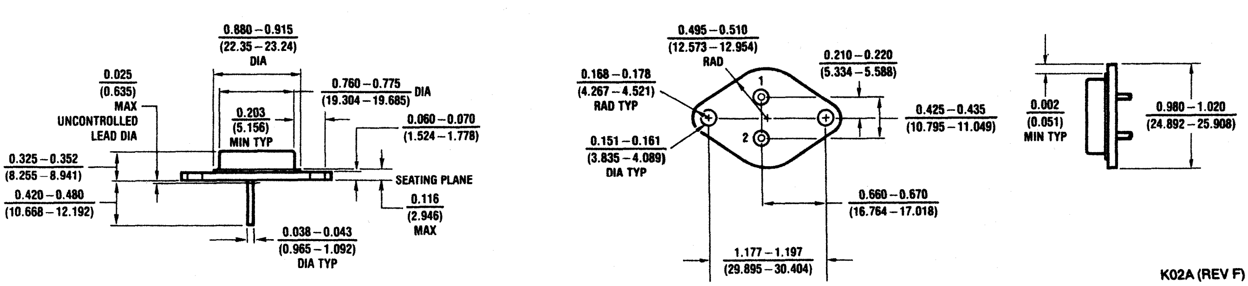
Physical Dimensions inches (millimeters)



NS Package J28A
28-Lead Ceramic DIP (J)

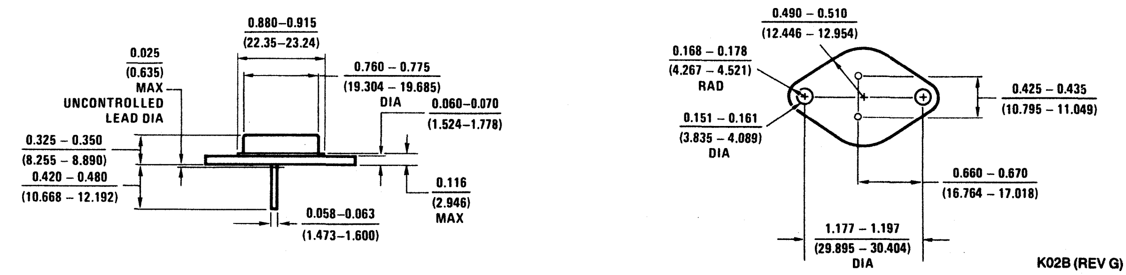


NS Package J40A
40-Lead Ceramic DIP (J)

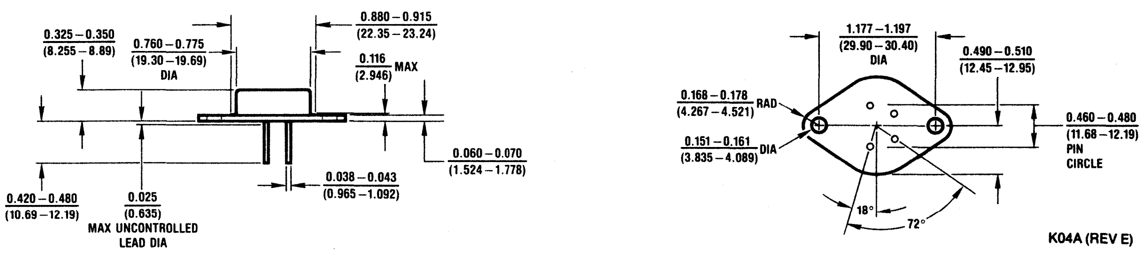


NS Package K02A
2-Lead TO-3 Metal Can Package (K)
(Steel)

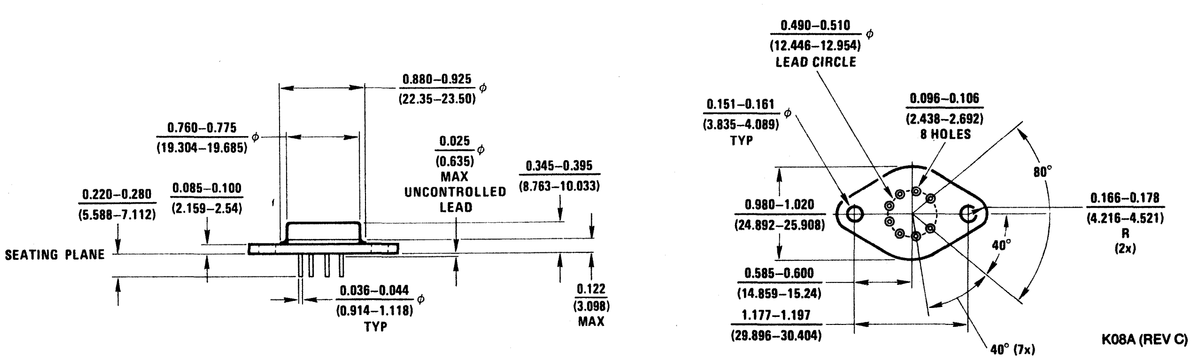
Physical Dimensions inches (millimeters)



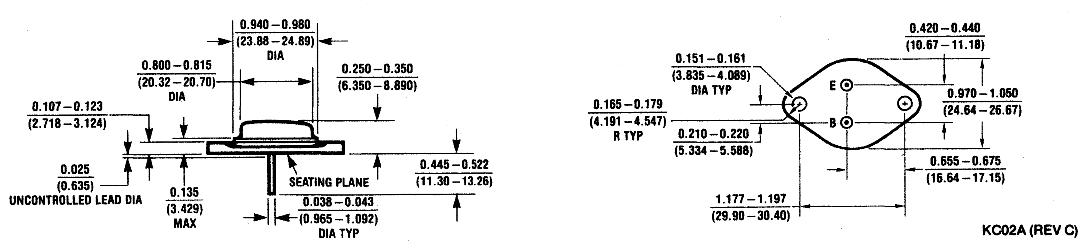
NS Package K02B
2-Lead TO-3 Metal Can Package (K)



NS Package K04A
4-Lead TO-3 Metal Can Package (K)

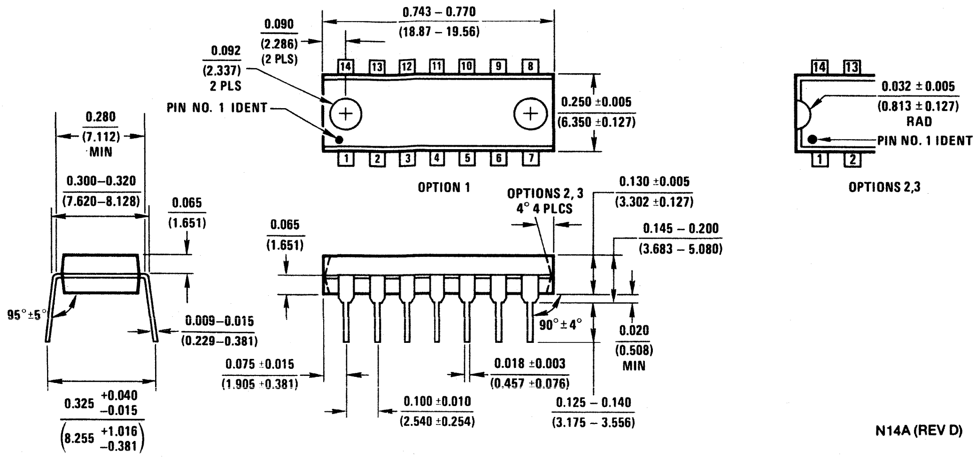


NS Package K08A
8-Lead TO-3 Metal Can Package (K)

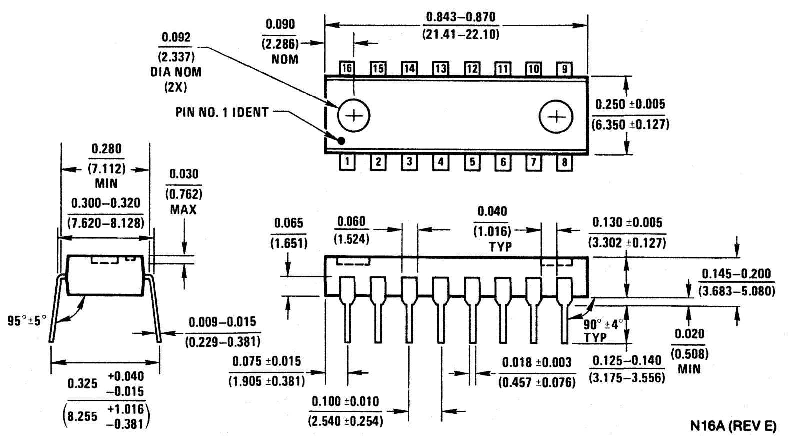


NS Package KC02A
2-Lead TO-3 Metal Can Package (KC)
(Aluminum)

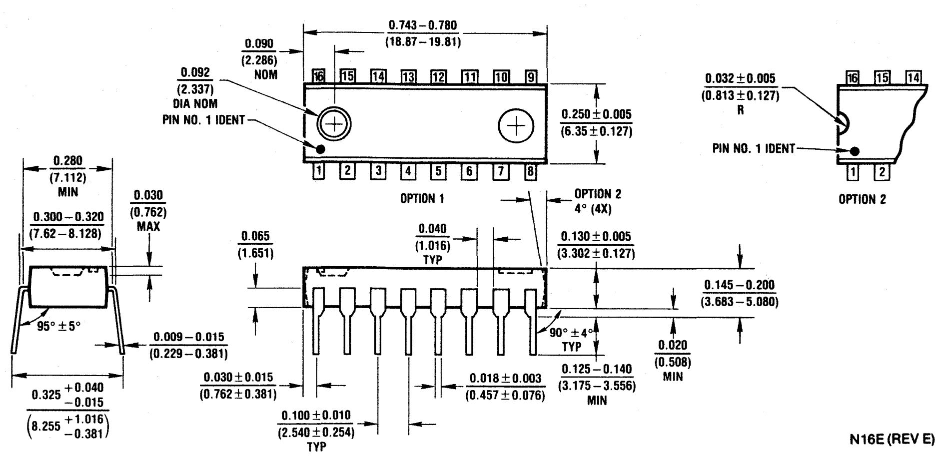
Physical Dimensions inches (millimeters)



NS Package N14A
14-Lead Molded DIP (N)

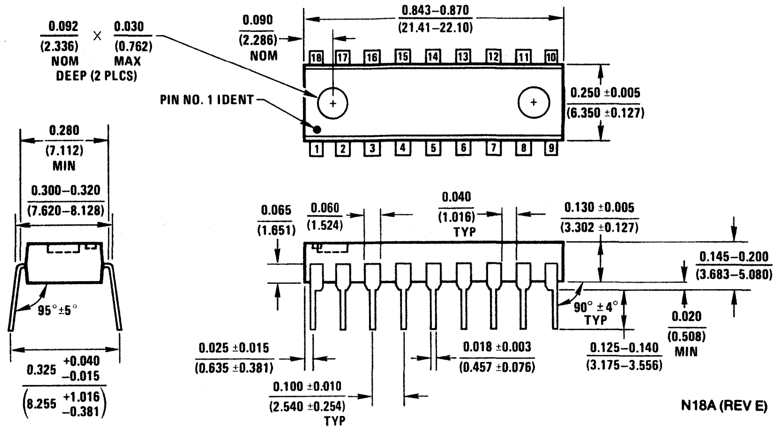


NS Package N16A
16-Lead Molded DIP (N)

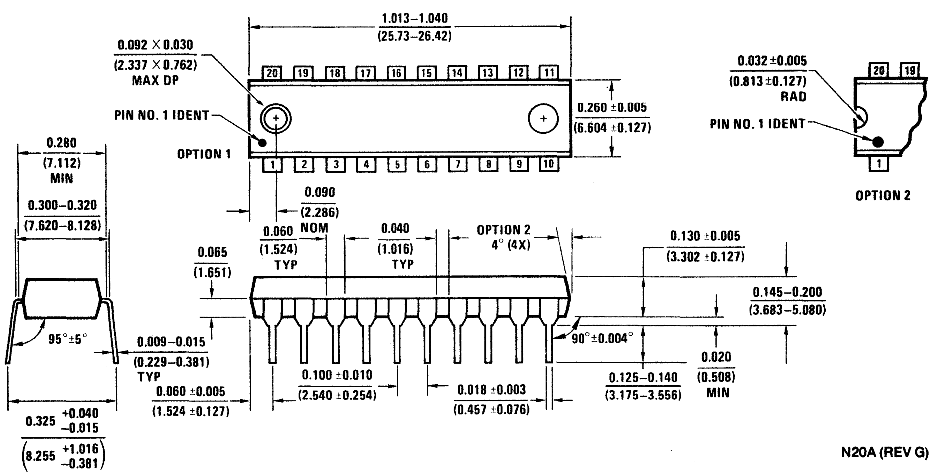


NS Package N16E
16-Lead Molded DIP (N)

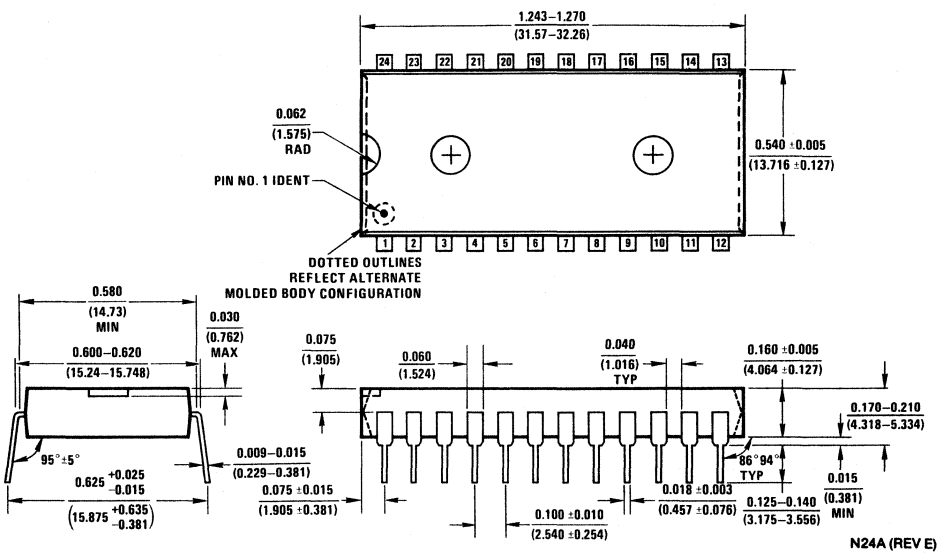
Physical Dimensions inches (millimeters)



NS Package N18A
18-Lead Molded DIP (N)

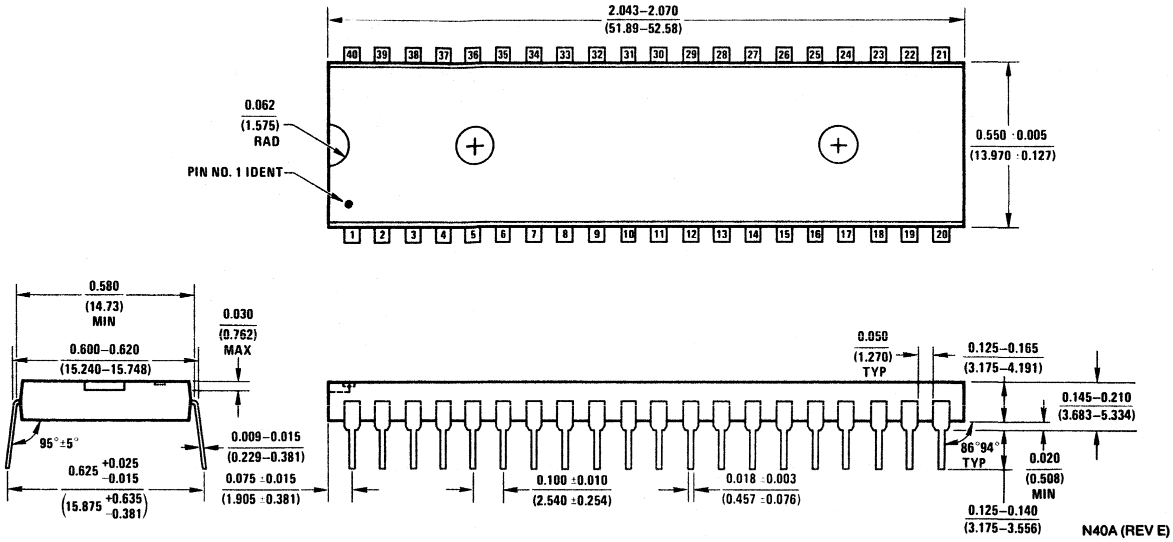


NS Package N20A
20-Lead Molded DIP (N)

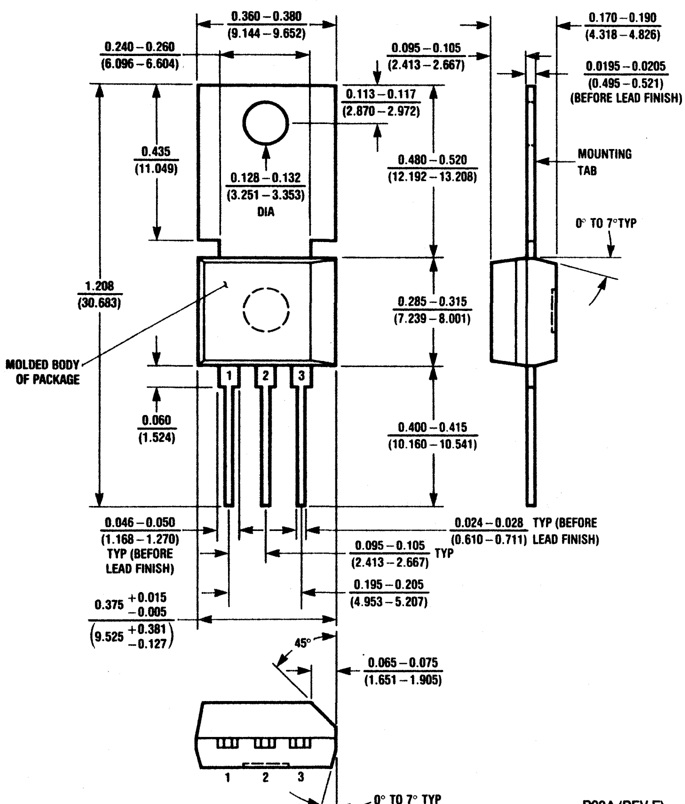


NS Package N24A
24-Lead Molded DIP (N)

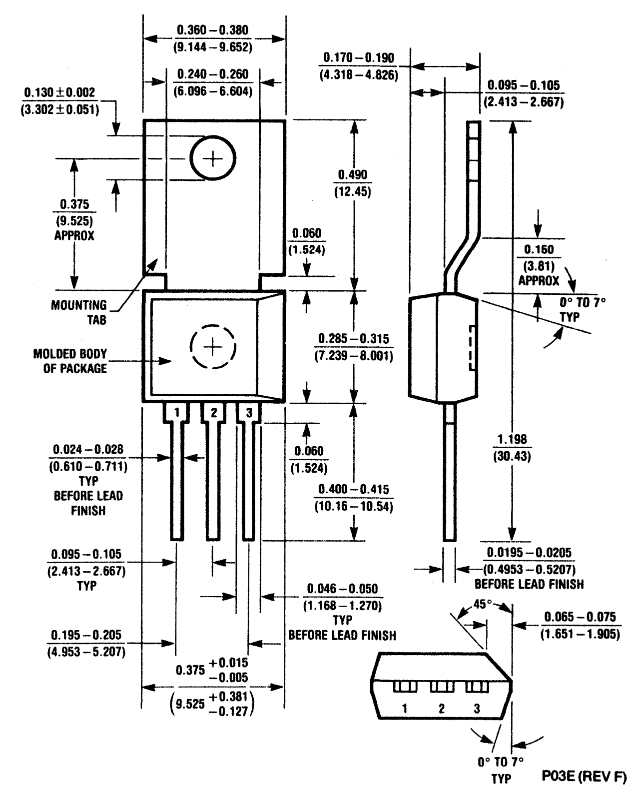
Physical Dimensions inches (millimeters)



NS Package N40A
40-Lead Molded DIP (N)

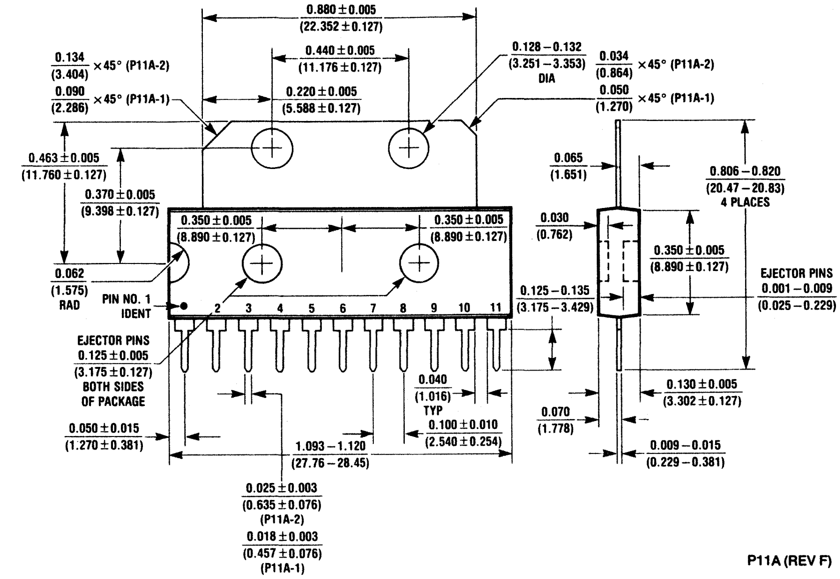


NS Package P03A
3-Lead TO-202 Power Package (P)

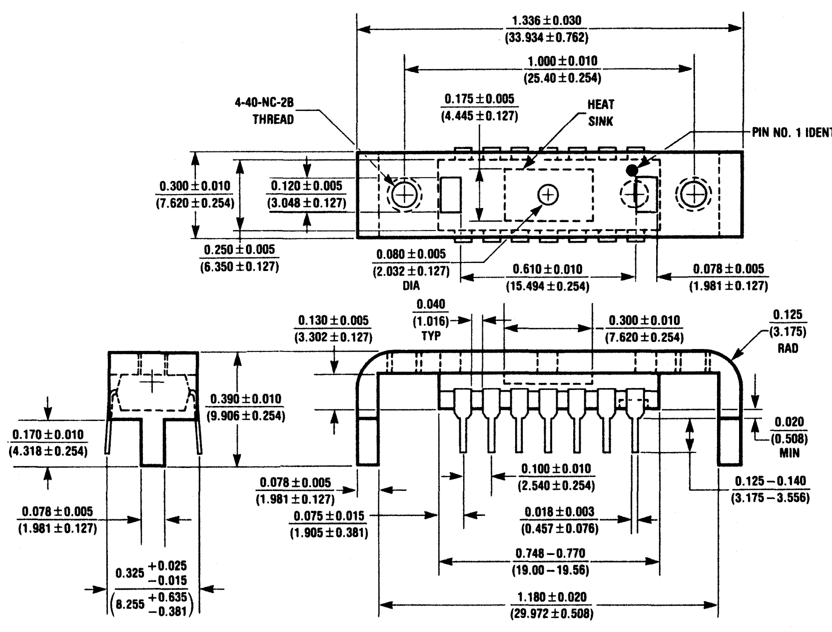


NS Package P03E
Tab Formed 3-Lead
TO-202 Power Package (P)

Physical Dimensions inches (millimeters)

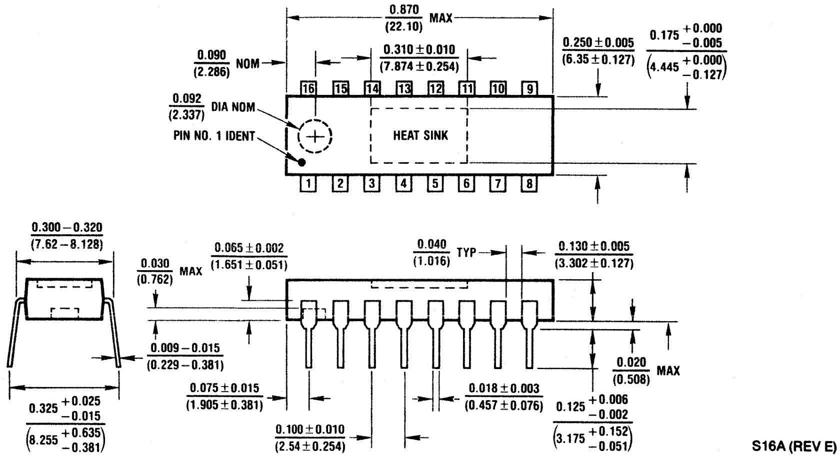


NS Package P11A
11-Lead Single-In-Line Package (P)

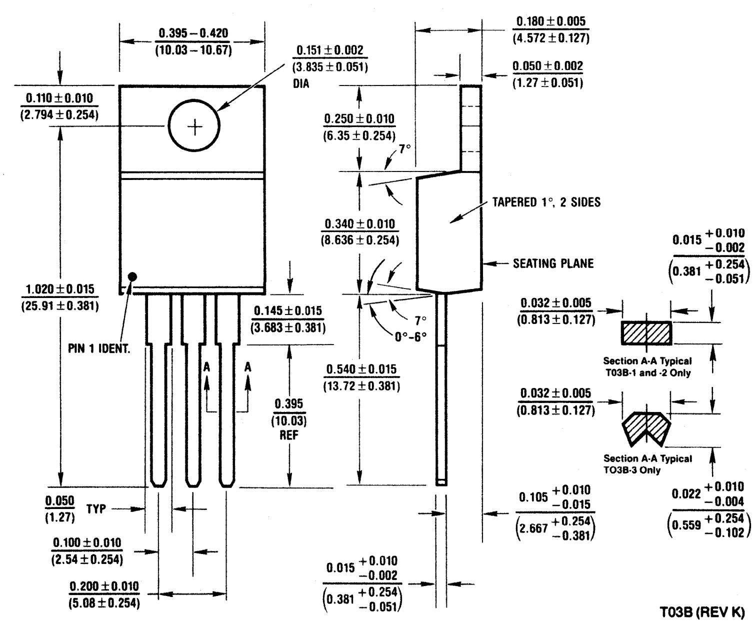


NS Package S14A
14-Lead "SGS" Type Power DIP (S)

Physical Dimensions inches (millimeters)

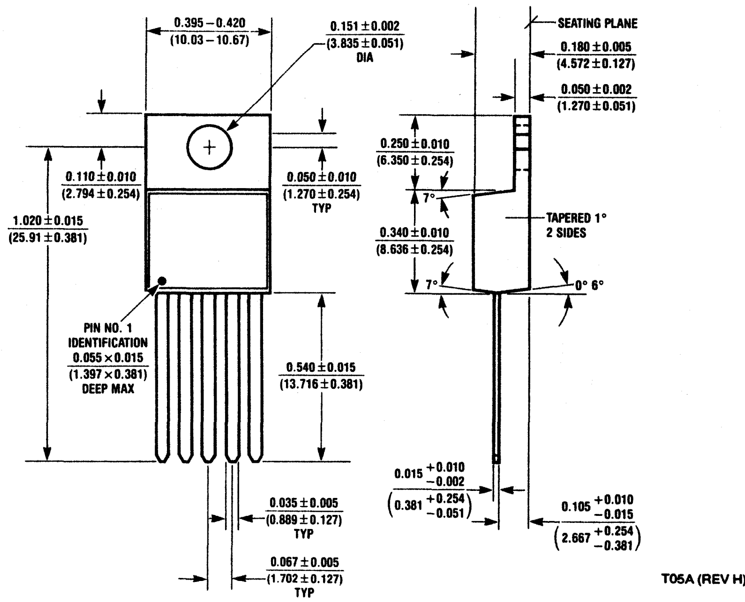


NS Package S16A
16-Lead Power DIP (S)

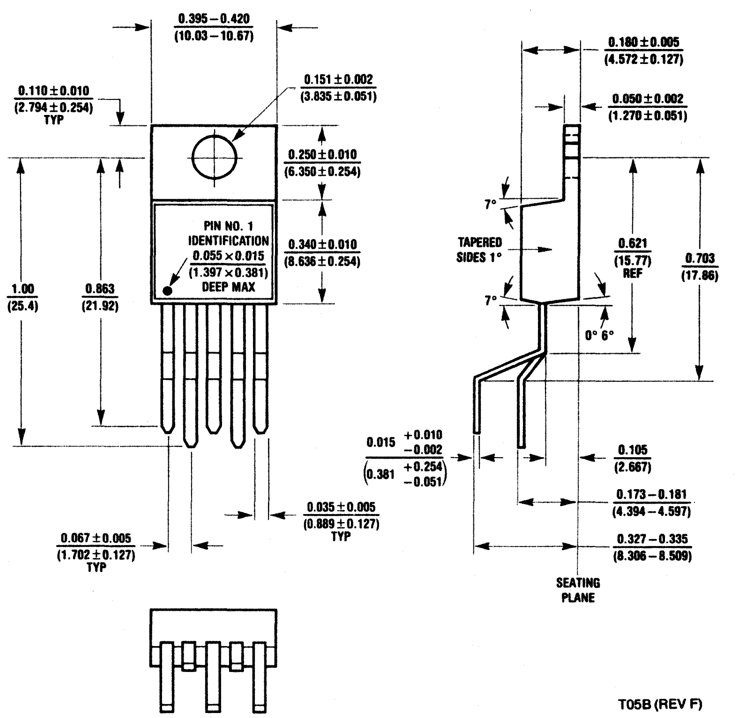


NS Package T03B
3-Lead TO-220 Power Package (T)

Physical Dimensions inches (millimeters)

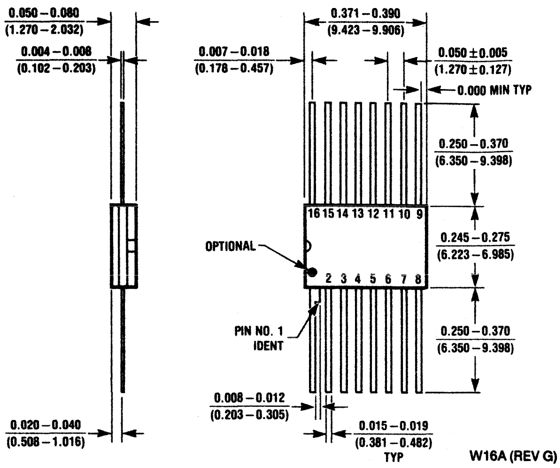


NS Package T05A
5-Lead TO-220 Power Package (T)

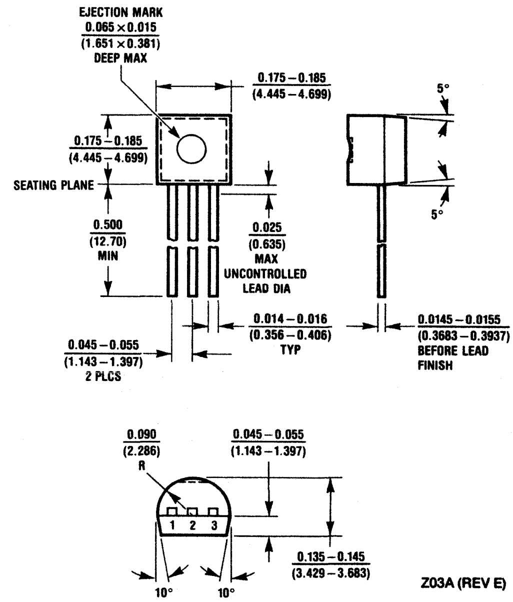


NS Package T05B
5-Lead TO-220 Power Package (T)

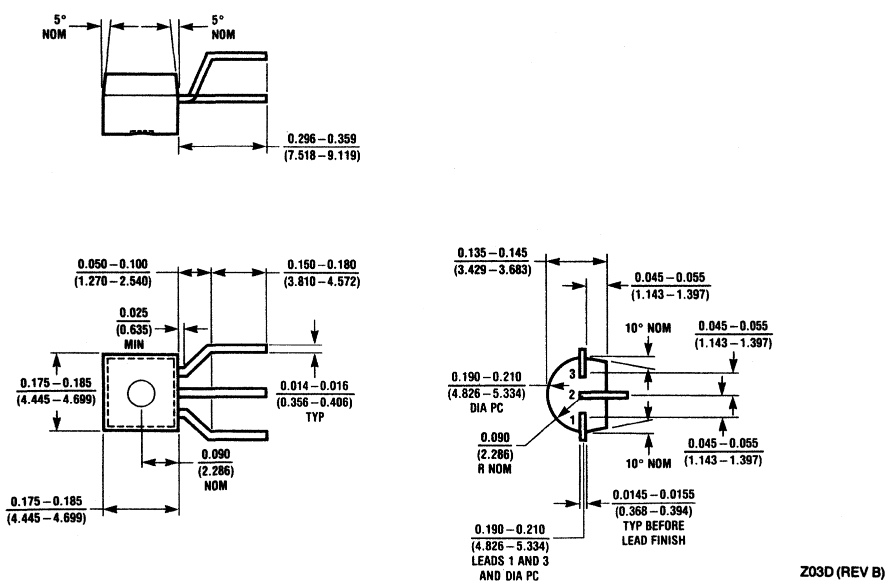
Physical Dimensions inches (millimeters)



NS Package W16A
16-Lead Ceramic Flat Package (W)



NS Package Z03A
3-Lead TO-92 Plastic Package (Z)



NS Package Z03D
3-Lead TO-92 Plastic Package (Z)

Appendix

Glossary of Terms

DC Operating Conditions and Characteristics

General Definitions

I: Current is the flow of electric charge from one potential to another through a conductor. The unit of measure is the Ampere, or Amp, abbreviated A. One Amp is equal to the current flowing through one ohm of resistance when one volt is applied across that resistance. Common units found in the semiconductor industry are the milliampere, abbreviated mA, equal to 0.001 A and the microampere, abbreviated μA, equal to 0.000001A. Negative current is defined as current flowing out of a device terminal and positive current is defined as current flowing into a device terminal.

V: Voltage, or the electromotive force which causes current to flow through a conductor. One Ampere of current flowing through one ohm of resistance develops a potential difference of one volt across that resistance. The unit of measure is the Volt, abbreviated V, and a common unit is the millivolt, abbreviated mV, equal to 0.001V.

Input Current Parameters

I_I Maximum High Level Input Current: Current flowing into an input when that input has the maximum voltage specified for the family applied to it. This test is used to guarantee the minimum reverse breakdown voltage of the input structure.

I_{IH} High Level Input Current: The current flowing into an input when that input has a high level voltage equal to the minimum high level output voltage specified for the family. This test is used to check the emitter-to-emitter leakage and the inverse transistor action of a multi-emitter transistor input, the input leakage of a diode, PNP transistor, or C-B short type of input, and to guarantee the fan-in specified for the family.

I_{IK} Input Clamp Current: The current flowing out of an input when that input is pulled below ground. This test is used to guarantee the integrity of the input clamp diode. The input clamp diode is used to limit the voltage swings on the input by clamping the negative excursions to a level equal to one diode drop below ground. This serves to reduce ringing on an incoming signal. Pulling the input below ground for an extended length of time can cause parasitic transistor action to occur between adjacent tanks on the die which can cause erroneous data to occur on the outputs of the device. To prevent this, voltages on the inputs during operation (other than high speed ringing) should be limited to no more than 0.5V below ground at all times.

I_{IL} Low Level Input Current: The current flowing out of an input when a low level voltage equal to the maximum low level output voltage specified for the family is applied to the input. This test is used to check the input pull-up resistor on an MET or a diode input and to guarantee the specified fan-in of the family.

I_T+ Current at Positive-Going Threshold Point: The current flowing out of a transition-operated (Schmitt trigger) input when a voltage equal to the positive-going threshold voltage is applied to the input.

I_T- Current at Negative-Going Threshold Point: The current flowing out of a transition-operated (Schmitt trigger) input when a voltage equal to the negative-going threshold voltage is applied to the input.

Output Current Parameters

I_{CEX} Output Leakage Current: The current flowing into an open collector output when input conditions have been applied that, according to the product specification, will cause the output to be in the logic high state. This test checks the reverse breakdown of the output transistor.

I_O(off) Off-State Output Current: The current flowing into an output with input conditions applied that, according to the product specification, will cause the output switching element to be in the off state.

NOTE: This parameter is usually specified for open collector outputs intended to drive devices other than logic circuits, such as displays. Any leakage current applied to a display may cause the display to be activated.

I_{OH} High Level Output Current: The current flowing out of an output with input conditions applied that, according to the product specification, will establish a logic high level at the output. This test guarantees the current sourcing (drive) capability of the output and the fan-out specified for the family.

I_{OL} Low Level Output Current: The current flowing into an output with input conditions applied that, according to the product specification, will establish a logic low level at the output. This test guarantees the current sinking capability of the output and the fan-out specified for the family.

I_{OS} **Output Short-Circuit Current:** The current out of an output when that output is shorted to ground, or another specified potential, with input conditions applied that, according to the product specification, will establish a logic high level at the output.

I_{OZ} **High-Impedance State Output Current:** These tests guarantee that the device will not excessively load a bus line when the device output is put into the TRI-STATE® mode.

I_{OZH} **(or I_{SINK}):** The current flowing into an output with input conditions applied to the output control pin such that the output is in the high impedance state and input conditions applied to the other inputs that, according to the product specification, will establish a logic low level at the output.

I_{OZL} **(or I_{SOURCE}):** The current flowing out of an output with input conditions applied to the output control pin such that the output is in the high impedance state and input conditions applied to the other inputs that, according to the product specification, will establish a logic high level at the output.

Supply Current Parameters

I_{CCH} **Supply Current (outputs in the high state):** The current flowing into the V_{CC} terminal of a device with input conditions applied that, according to the product specification, will establish a logic high level at the output(s).

I_{CCL} **Supply Current (outputs in the low state):** The current flowing into the V_{CC} terminal of a device with input conditions applied that, according to the product specification, will establish a logic low level at the output(s).

I_{CCZ} **Supply Current (outputs in the high impedance state):** The current flowing into the V_{CC} terminal of a device with input conditions applied that, according to the product specification, will establish a high impedance state at the output.

Input Voltage Parameters

BV_{IN} **Input Breakdown Voltage:** The maximum voltage that the device is guaranteed to be able to withstand without exceeding the maximum input current specification.

V_F **Input Forward Voltage:** The voltage applied to the input of a device that causes the input structure to become forward biased; usually equal to the maximum output low voltage specified for the family.

V_{IH} **High Level Input Voltage:** The minimum positive voltage level that can be applied to an input terminal of a device and be recognized as a logic high level.

V_{IK} **Input Clamp Voltage:** The input clamp voltage specification checks the quality of the input diode whose purpose is to damp out ringing. This is not intended to be an operating condition and if this voltage is allowed to persist for any length of time, parasitic transistor action will occur between adjacent geometry tanks and circuit performance will be degraded, in some cases to the point of failure.

V_{IL} **Low Level Input Voltage:** The maximum positive voltage level that can be applied to an input terminal of a device and be recognized as a logic low level.

V_R **Input Reverse Voltage:** The voltage applied to an input of a device that causes the input structure to become reverse biased; usually equal to the minimum high level output voltage specified for the family.

V_T+ **Positive-Going Threshold Voltage:** The voltage level at a transition-operated (Schmitt trigger) input that causes operation of the logic element according to specification as the input voltage rises from a level below the negative-going threshold voltage V_T-.

V_T- **Negative-Going Threshold Voltage:** The voltage level at a transition-operated (Schmitt trigger) input that causes operation of the logic element according to specification as the input voltage falls from a level above the positive-going threshold voltage, V_T+.

Output Voltage Parameters

V_{OH} **High Level Output Voltage:** The voltage at an output terminal with input conditions applied that, according to the product specification, will establish a high level at the output.

V_{OL} **Low Level Output Voltage:** The voltage at an output terminal with input conditions applied that, according to the product specification, will establish a low level at the output.

V_O**(off) Off-State Output Voltage:** The voltage at an output terminal with input conditions applied that, according to the product specification, will cause the output switching element to be in the off state.

NOTE: This characteristic is usually specified only for outputs without internal pull-up elements intended for driving devices other than logic circuits.

V_O**(on) On-State Output Voltage:** The voltage at an output terminal with input conditions applied that, according to the product specification, will cause the output switching element to be in the on state.

NOTE: This characteristic is usually specified only for outputs without internal pull-up elements intended for driving devices other than logic circuits.

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Interface Databook—1986

Transmission Line Drivers/Receivers • Bus Transceivers • Peripherals/Power Drivers • Display Controllers/Drivers • Memory Support • Microprocessor Support • Level Translators/Buffers • Frequency Synthesis

Intuitive IC CMOS Evolution—1984

Thomas M. Frederiksen's new book targets some of the most significant transitions in semiconductor technology since the change from germanium to silicon. *Intuitive IC CMOS Evolution* highlights the transition in the reduction in defect densities and the development of new circuit topologies. The author's latest book is a vital aid to engineers and industry observers who need to stay abreast of the semiconductor industry.

Intuitive IC Op Amps—1984

Thomas M. Frederiksen's new book, *Intuitive IC Op Amps,* explores the many uses and applications of different IC op amps. Frederiksen's detailed book differs from others in the way he focuses on the intuitive groundwork in the basic functioning concepts of the op amp. Mr. Frederiksen's latest book is a vital aid to engineers, designers, and industry observers who need to stay abreast of the computer industry.

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 3 Databook—1988

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Logic Databook Volume I—1984

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LS/S/TTL Logic Databook—1987

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Microcommunication Elements Databook—1987

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Reliability Handbook—1986

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NSC Index (For index of Fairchild products, see page 393.)

Section 2

1987 Selection Guide for Fairchild Products

TRADEMARKS

Fairchild Semiconductor Corporation

ASPECT™
CLASIC™
FACT™
FAIRCAD™
Fairtech™
FAST®
I^3L®
ISOPLANAR™
ISOPLANAR-Z™
PLANAR™
POWERplanar™

Application Specific ICs

For additional Application Specific IC products, see pages 19 and 419.

Application Specific ICs (ASIC)

Fairchild's ASIC product line includes the ECL and CMOS high-performance gate array families. In addition, extensive customer support facilities include the unique capabilities of the FAIRCAD™ design system, full-service FAIRTECH design centers, and the industry's first combination of an on-site Cray supercomputer and E-Beam Direct-Write-On-Silicon system to speed turn-around. To meet aerospace and defense applications, both CMOS and ECL gate arays are total dose radiation-hardened to 10^6 Rads (Si).

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.

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.

CMOS

FGC Series: The FGC Series of CMOS gate arrays provides densities from 500 to 8,000 gates, on-chip test, operating frequencies as high as 70 MHz, and CMOS- or TTL-selectable I/Os.

FACTCELL FSB/FSH Series: The FACTCELL Series is an advanced CMOS cell-based family that provides high-density, high-performance solutions for digital logic system designers. The system uses the traditional standard cell design methodology together with the newer silicon compiler techniques to produce customized VLSI designs.

Both the ECL and CMOS families are available in a wide variety of voltage and temperature specifications and advanced packaging configurations.

FAIRCAD

Fairchild's fully integrated, technology-independent gate array design software supports all design tasks from design capture through final design database creation for prototype manufacturing. And FAIRCAD is available on tape for installation on your VAX™ VMS™ system including the MicroVAX™ II. A proven tool for designing circuitry using our CMOS and ECL gate arrays, FAIRCAD combines engineering graphics with powerful programs to compile, analyze, simulate, and place and route your design. FAIRCAD is menu-driven with extensive on-line help listings and a built-in system monitor that ensure the proper program sequence.

This combination of high-density, multiple technology, fully integrated computer-aided design, and advanced computer hardware provide the industry's most comprehensive choice of speed, power, cost, volume, and turnaround time.

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	0.0	0.45	10–20	256	323 CPGA	Now
FGA14040R	7,390/ 4,600 RAM	10K/100K ECL	0.120-0.20	0.0	0.45	10-20	256	323 CPGA	2Q88
FGA8000	8,050	10K/100K TTL/ECL	0.120-0.20	0.0	0.45	6-12	220	301 CPGA	3Q88
FGA4000	4,070	10K/100K TTL/ECL	0.120-0.20	0.0	0.45	3-6	128	172 CPGA	1Q88
FGA1300	1,445	10K/100K TTL/ECL	0.120-0.20	0.0	0.45	1-3	72	108 CPGA	1Q88
FGA600	605	10K/100K TTL/ECL	0.120-0.20	0.0	0.45	0.5-1.5	32	44 LDCC	3Q88

CMOS Gate Arrays

FGC Series

Device	Gate Equivalent	I/O Levels	Typical Internal Gate Delay (ns)	Typical Buffer Delay Input (ns)	Typical Buffer Delay Output (ns)	Max. I/O	Package Codes
FGC0500	540	TTL/CMOS	1.1	2.1	2.3	40	PDIP, CDIP, PLCC, CLCC
FGC1200	1188	TTL/CMOS	1.1	2.0	3.8	73	PDIP, CDIP, PLCC, CLCC, CPGA
FGC2400	2625	TTL/CMOS	1.1	2.0	3.8	109	PDIP, CDIP, PLCC, CLCC, CPGA
FGC4000	3960	TTL/CMOS	1.1	2.0	3.8	133	PLCC, CLCC, CPGA
FGC6000	6000	TTL/CMOS	1.1	2.0	3.8	161	PLCC, CLCC, CPGA
FGC8000	7896	TTL/CMOS	1.1	2.0	3.8	181	PLCC, CLCC, CPGA

FACTCELL FSC Series—CMOS Standard Cells

Device	Gate Equivalent	I/O Levels	Typical Internal Gate Delay (ns)	Typical Buffer Delay Input (ns)	Typical Buffer Delay Output (ns)	Max. I/O (Approx.)
FSC0500	to 500	TTL/CMOS	0.9	1.7	3.1	68
FSC1000	to 1000	TTL/CMOS	0.9	1.7	3.1	84
FSC2000	to 2000	TTL/CMOS	0.9	1.7	3.1	107
FSC3000	to 3000	TTL/CMOS	0.9	1.7	3.1	124
FSC4000	to 4000	TTL/CMOS	0.9	1.7	3.1	140
FSC5000	to 5000	TTL/CMOS	0.9	1.7	3.1	153
FSC6000	to 6000	TTL/CMOS	0.9	1.7	3.1	165
FSC7000	to 7000	TTL/CMOS	0.9	1.7	3.1	176
FSC8000	to 8000	TTL/CMOS	0.9	1.7	3.1	186
FSC9000	to 9000	TTL/CMOS	0.9	1.7	3.1	195
FSC10K	to 10K	TTL/CMOS	0.9	1.7	3.1	204
FSC11K	to 11K	TTL/CMOS	0.9	1.7	3.1	213
FSC12K	to 12K	TTL/CMOS	0.9	1.7	3.1	221
FSC13K	to 13K	TTL/CMOS	0.9	1.7	3.1	229
FSC14K	to 14K	TTL/CMOS	0.9	1.7	3.1	237
FSC15K	to 15K	TTL/CMOS	0.9	1.7	3.1	244
FSC16K	to 16K	TTL/CMOS	0.9	1.7	3.1	251
FSC17K	to 17K	TTL/CMOS	0.9	1.7	3.1	258
FSC18K	to 18K	TTL/CMOS	0.9	1.7	3.1	265
FSC19K	to 19K	TTL/CMOS	0.9	1.7	3.1	271
FSC20K	to 20K	TTL/CMOS	0.9	1.7	3.1	277

FAIRCAD

FAIRCAD Features

- Interactive Design Capture
- Design Rule Checking
- Interactive Logic and Timing Simulation
- Controllability Fault Analysis
- Auto/Interactive Placement and Routing
- Test Vector Formatting for ATE

FAIRCAD Design Advantages

FAIRCAD is a proven tool for designing circuitry using CMOS and ECL gate arrays. It combines engineering graphics with powerful programs to compile, analyze, simulate, and place and route designs. Proper program sequence is assured through the use of menu-driven programs with on-line help listings and a built-in system monitor.

Fairchild's fully integrated, technology-independent gate array design software supports all design tasks, from design capture through final design database creation for prototype manufacturing.

Fault simulation on FAIRCAD is simplified through the use of our Cray 1-S Supercomputer, which processes simulations as much as 50 times faster than on other devices. Remote communication links to the Cray make designing at customer facilities even more convenient. In addition, turnaround times at Fairchild are further reduced by an in-house Cambridge E-Beam Direct-Write-On-Silicon system. FAIRCAD is also available on tape for installation on a VAX VMS system, including the MicroVAX II.

Engineering Support

Fairchild applications engineers, the experts of gate array design, are available for assistance and, by arrangement, can complete some or all of FAIRCAD's design tasks for the customer.

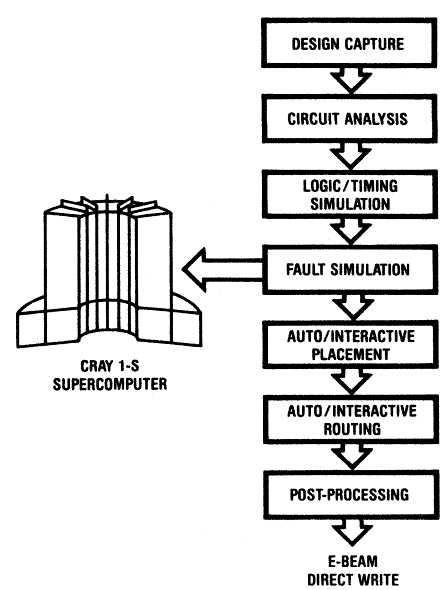
Customer Instruction

Fairchild offers complete instruction to assist customers in developing circuit concepts. Courses are taught by knowledgeable applications engineers at FAIRTECH Design Centers and, by special arrangement, at customer facilities. Classrooms equipped with color graphics terminals (one per student) and video projection systems provide a unique opportunity to explore gate array design.

First-time customers take both the hardware design course (1–2 days) for the chosen gate array family and the FAIRCAD training course (5 days). Since FAIRCAD processes designs independent of technology, the course need not be repeated to accomplish a design using a different Fairchild gate array family.

Instruction on FAIRCAD system installation and administration is also available. A complete listing of class dates and times is available at FAIRTECH Design Centers and sales offices.

Typical FAIRCAD Design Flow



Fairchild Technology Centers

FAIRTECH Centers

FAIRTECH 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 Fairchild 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 FAIRTECH 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 FAIRCAD 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 a CRAY I, 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 Fairtech Centers serve as a gateway to all of Fairchild'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 FAIRTECH Center is staffed by Technical Product Specialists who offer in-depth knowledge of specific product lines and Fairtech 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 Fairchild's products.

Support that Follows the Design

FAIRTECH Centers exist to support your design needs—and will do whatever it takes to get the job done right. Fairchild'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 FAIRTECH Centers are the shortest distance between your idea and the marketplace.

Boston Office

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Phone (714) 259-1540

Santa Clara Office

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Phone (408) 721-6247

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Interface

For additional Interface products, see page 35.

Interface

Fairchild offers a comprehensive line of compatible drivers, receivers, transceivers, and repeaters meeting EIA RS-485 and RS-422 specifications. These circuits offer such special features as thermal shutdown protection, 3-state outputs, and monotonic output switching.

In addition, Fairchild offers an enhanced version that incorporates our new state-of-the-art L FAST bipolar technology. The L FAST technology allows for higher speeds and lower currents by utilizing extremely short gate delay times. Thus, L FAST allows the offering of lower power, extended temperature range, and improved specifications.

The RS-485 designs can include multipoint or party-line buses of as many as 32 driver/receiver pairs, handling transmissions of up to 15 Mb/sec at 40-foot bus lengths.

Upgrading RS-422-based systems is simplified by using the RS-485 family, whose data rate capabilities match the fastest RS-422, and provide a compatible interface between the two systems.

Interface Products Cross-Reference Guide

Fairchild	Motorola	National	TI	SG	Signetics
Dual Line Drivers and Receivers					
μA9614		DS75114			
μA9615		DS75115	SN75115		
μA9636A	MC3488A		uA9636A		
μA9637A			uA9637A		
μA9638			uA9638		
μA9639A			uA9639A		
μA9643					
μA55107A					
μA75107A	MC75107	DS75107	SN75107A		
μA75107B			SN75107B		
μA75108B	MC75108	DS75108	SN75108B		
μA55110A					
μA75110A	MC75110		SN75110A		
μA75150		DS75150	SN75150		
Quad Line Drivers and Receivers					
μA1488	MC1488	DS1488	SN75188, MC1488		MC1488
μA1489	MC1489	DS1489	SN75189		
μA1489A	MC1489A	DS1489A	MC1489	SG1489A	MC1489A
μA26LS31	AM26LS31	DS26LS31	AM26LS31		AM26LS31
μA26LS32	AM26LS32	DS26LS32	AM26LS32		
μA3486	MC3486	DS3486	MC3486		
μA3487	MC3487	DS3487	MC3487		
μA9645					
μA9665	MC1411	LM2001	ULN2001	SG2001	
μA9666	TDA2002	LM2002, TDA2002	ULN2002A	SG2002	
μA9667	MC1413	TDA2003	ULN2003A	SG2003	
μA9668	MC1416		ULN2004A	SG2004	ULN2004
μA75154		DS75154	SN75154	SG75154	
μA75491	MC75491	DS75491	SN75491		
μA75492	MC75492	DS75492	SN75492		
μA96172			SN75172		
μA96173			SN75173		
μA96174			SN75174		
μA96175			SN75175		

Interface Products Cross-Reference Guide (Continued)

Fairchild	Motorola	National	TI	SG	Signetics
Peripheral Drivers					
μA75450		DS75450	SN75450		
μA75451A		DS75451	SN75451		
μA75451B		DS75451	SN75451B	SG75451	
μA75452A		DS75452	SN75452B	SB75452	
μA75453A		DS75453	SN75453B		
μA75453B		DS75453	SN75453B	SG75453	
μA75461		DS75461	SN75461	SG75461	
μA75462		DS75462	SN75462	SG75462	
μA75471			SN75471		
μA75472			SN75472		
Bus Transceivers and Repeaters					
μA9640	MC26S10, MC3340 MC3344	DS26S10	AM26S10		
μA9679					
μA96176		DS3695	SN75176		
μA96177		DS3697	SN75177		
μA96178			SN75178		

Dual Line Drivers and Receivers

Device	Type	Package Type	Package Codes
μA9614	Dual Differential Line Driver	16-L DIP	DC (6B), DM (6B), PC (9B)
μA9615	Dual Differential Line Driver	16-L DIP	DC (6B),DM (6B), PC (9B)
μA9636A	Dual Programmable Slew Rate Driver, RS-423	8-L DIP	RM (6T), RC (6T), TC (9T)
μA9637A	Dual Differential Line Receiver, RS-422/423	8-L DIP, SO-8	RM (6T), RC (6T), TC (9T), SC (KC)
μA9638	Dual High-Speed Differential Line Driver, RS-422	8-L DIP, SO-8	RM (6T), RC (6T), TC (9T), SC (KC)
μA9639A	Dual Differential Line Receiver, RS-232C/422/423	8-L DIP	TC (9T)
μA9643	Dual TTL-to-MOS/CCD Driver	8-L DIP	TC (9T)
μA55107A	Dual Line Receiver	14-L DIP	DM (6A)
μA75107A		14-L DIP, SO-14	DC (6A), PC (9A), SC (KD)
μA75107B		14-L DIP, SO-14	DC (6A), PC (9A), SC (KD)
μA75108B		14-L DIP, SO-14	PC (9A), SC (KD)
μA55110A	Dual Line Driver, RS-232C	14-L DIP	DM (6A)
μA75110A		14-L DIP, SO-14	DC (6A), PC (9A), SC (KD)
μA75150		14-L DIP	PC (9A)
μA75150		8-L DIP, SO-8	RC (6T), TC (9T), SC (KC)

Quad Line Drivers and Receivers

Device	Type	Package Type	Package Codes
υA1488	Quad Line Driver, RS-232C	14-L DIP, SO-14	DC, PC, SC (6A, 9A, KD)
μA1489	Quad Line Receiver, RS-232C	14-L DIP, SO-14	DC, PC, SC (6A, 9A, KD)
μA1489A		14-L DIP	DC, PC (6A, 9A)
μA26LS31	Quad High-Speed Diff. Line Driver, RS-422	16-L DIP	DC, PC (7B, 9B)
μA26LS32	Quad Differential Line Receiver, RS-422/423	16-L DIP	DC, PC (7B, 9B)
μA3486	Quad Line Receiver w/3-State Outputs, RS-422/423	16-L DIP	DC, PC (7B, 9B)
μA3487	Quad Line Driver w/3-State Outputs, RS-422/423	16-L DIP	DC, PC (7B, 9B)
μA9645	Quad TTL-to-MOS/CCD Driver	16-L DIP	DC, PC (7B, 9B)
μA9665 μA9666 μA9667 μA9668	High Current/Voltage Darlington Driver	16-L DIP	DC, PC (6B, 9B)
μA75154	Quad Line Receiver, RS-232C	16-L DIP	DC, PC (6B, 9B)
μA75491	MOS-to-LED Segment and Digit Driver	14-L DIP	PC (9A)
μA75492		14-L DIP	PC (9A)
μA96172	Quad Differential Line Driver, RS-485	16-L DIP	DC, PC (7B, 9B)
μA96174		16-L DIP	DC, PC (7B, 9B)
μA96173	Quad Differential Line Receiver, RS-485	16-L DIP	DC, PC (7B, 9B)
μA96175		16-L DIP	DC, PC, (7B, 9B)

Peripheral Drivers

Device	Type	Package Type	Package Codes
μA75450	Dual Positive AND	14-L DIP	DC, PC (6A, 9A)
μA75451A		8-L DIP, SO-8	RC, TC, SC (6T, 9T, KC)
μA75451B		8-L DIP	
μA75461		8-L DIP	TC (9T)
μA75471		8-L DIP	TC (9T)
μA75452A	Dual Positive NAND	8-L DIP, SO-8	TC, SC (9T, KC)
μA75462		8-L DIP	TC (9T)
μA75472		8-L DIP	TC (9T)
μA75453A	Dual Positive OR	8-L DIP, SO-8	RC, TC, SC (6T, 9T, KC)
μA75453B			

Bus Transceivers and Repeaters

Device	Type	Package Type	Package Codes
μA9640	Quad General-Purpose Transceiver	16-L DIP	DM, DC, PC (6B, 9B)
μA9679	Differential Repeater, RS-422A/485	8-L DIP	TC (9T)
μA75177	Differential Repeater, RS-422A/485	8-L DIP, SO-8	RC, TC, SC (6T, 9T, KC)
μA75178			
μA96176	Differential Transceiver, RS-422A/485	8-L DIP	RC, TC (6T, 9T)
μA96177	Differential Repeater, RS-422A/485	8-L DIP	RC, TC (6T, 9T)
μA96178		8-L DIP	RC, TC (6T, 9T)

Linear

For additional Linear products, see pages 67 and 431.

Linear

The linear product line includes both specialized high-performance interface circuits and a broad line of industry standard components. A wide selection of interface, op amps, and voltage regulators are available. Fairchild continues to maintain a leadership position in high-reliability products by providing the largest selection of JAN QPL available anywhere.

Op Amps

Included in this family are a wide variety of single, dual, and quad op amps that encompasses general-purpose, low power, JFET input, high-speed, and precision amplifiers. The family also includes several high-performance comparators.

Voltage Regulators

A broad range of fixed, programmable, positive, and negative regulators are included in Fairchild's linear families.

QB-883 Processing

An alpha suffix of QB indicates conformance to Class "B" process requirements of MIL-STD-883 to Fairchild MIL temperature range data sheet electricals. For complete information on MIL-STD-883, JAN, and other aerospace/defense product availability, contact your National Sales Representative.

Linear Part Numbering System

XXXXX X X X

- Temperature Range
  - C (Commercial) = 0°C to + 70°C
  - V (Industrial) = − 40°C to + 85°C
  - M (Military/Extended) = − 55°C to + 125°C
- Package Code
  - D = Dual In-Line (Hermetic, Ceramic)
  - F = Flatpack (Hermetic)
  - G = Flatpack (Brazed)
  - H = 8-Lead Metal
  - J = Dual In-Line (Side-Brazed)
  - K = Metal Power (TO-3)
  - L = Leadless Ceramic Chip Carrier (LCC)
  - P = Dual In-Line (Molded)
  - Q = Plastic Leaded Chip Carrier (PLCC)
  - R = 8-Lead Dual In-Line (Hermetic, Ceramic)
  - S = Small Outline Integrated Circuit (SOIC)
  - T = 8-Lead Dual In-Line (Molded)
  - U = Power, Molded (TO-220)
  - W = 8-Lead Molded (TO-92 Outline)
  - K = 8-Lead Surface-Mount (SO-8)
- Electrical Class (If Used)
- Device Type

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers

Single Operational Amplifiers, Externally Compensated

Device	Type	Input Offset Voltage V_{IO} (mV) (Max)	Input Bias Current I_{IB} (Max)	Input Offset Current I_{IO} (nA) (Max)	Input Offset Voltage Temp. Sensitivity $\Delta V_{IO}/\Delta T$ (μV/°C) (Typ)	Large Signal Voltage Gain A_{VS} (V/mV) (Min)	Common Mode Rejection CMR (dB) (Min)	Power Supply Rejection Ratio PSRR (dB) (Min)	Supply Voltage (± V)	Operating Temp. (Note 1)	Package Codes
μA101	General-Purpose	6.0	1.5 μA	500	6.0	25	70	70	22	M	5W
μA201		10.0	2.0μA	750	10.0	15	65	70	22	C	5W, 9T
μA101A	General-Purpose	3.0	100 nA	20	6.0	25	80	80	22	M	5W
μA201A		3.0	100 nA	20	6.0	25	80	80	22	V	5W
μA301A		10.0	300 nA	70	6.0	15	70	70	18	C	5W, 9T, KC
μA108	Super Beta	3.0	3 nA	0.4	3.0	25	85	80	20	M	5W
μA208		3.0	3 nA	0.4	3.0	25	85	80	20	V	5W
μA308		10.0	10 nA	1.5	6.0	15	80	80	18	C	5W, 9T, KC
μA108A	Super Beta	1.0	3 nA	0.4	1.0	40	96	96	20	M	5W
μA208A		1.0	3 nA	0.4	1.0	40	96	96	20	V	5W
μA308A		0.73	10 nA	1.5	1.0	60	96	96	18	C	5W, 9T, KC
μA709	High-Performance	6.0	1500 nA	200	3.0	25	70	150 (Note 2)	18	M	5W
μA709A		3.0	600 nA	50	1.8	25	80	150 (Note 2)	18	M	5W
μA709C		10.0	2000 nA	750		15	65	200 (Note 2)	18	C	5W, 9A, 9T, KC
μA715	High-Speed	7.5	750 nA	250		10	74	300 (Note 2)	18	M	5X, 6A
μA715C		10.0	1500 nA	250		8	74	400 (Note 2)	18	C	5X, 6A
μA725	Instrumentation	1.5	100 nA	20	0.6	250	115	20 (Note 2)	22	M	5W, 9T
μA725A		0.75	70 nA	4	0.6	500	115	8 (Note 2)	22	M	5W
μA725C		3.5	125 nA	35	2.0	125	115	20 (Note 2)	22	C	5W
μA725E		0.75	70 nA	4	0.6	500	115	8 (Note 2)	22	C	5W
μA748	High-Performance	6.0	5000 nA	200		25	70	150 (Note 2)	22	M	5W
μA748C		7.5	500 nA	300		15	70	150 (Note 2)	22	C	5W, 6T, 9T, KC

Note 1: Operating Temperature: C = 0°C to + 70°C, V = − 40°C to + 85°C, M = − 55°C to + 125°C.
Note 2: Power Supply Rejection Ratio measured in μV/V.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers (Continued)

Single Operational Amplifiers, Internally Compensated

Device	Type	Input Offset Voltage V_{IO} (mV) (Max)	Input Bias Current I_{IB} (Max)	Input Offset Current I_{IO} (nA) (Max)	Input Offset Voltage Temp. Sensitivity $\Delta V_{IO}/\Delta T$ (μV/°C) (Typ)	Large Signal Voltage Gain A_{VS} (V/mV) (Min)	Common Mode Rejection CMR (dB) (Min)	Power Supply Rejection Ratio PSRR (dB) (Min)	Supply Voltage (± V)	Operating Temp. (Note 1)	Package Codes
μA714	Precision	200 μV	6.0 nA	5.6	1.3	150	106	94	22	M	5W
μA714C		250 μV	9.0 nA	8.0	1.6	100	97	86	22	C	5W, 9T, KC
μA714E		130 μV	5.5 nA	5.3	1.3	180	103	90	22	C	5W
μA714L		400 μV	60 nA	40	3.0	80	94	83	18	C	5W, 9T, KC
μA741	High-Performance	6.0	5000 nA	200		25	70	150 (Note 2)	22	M	5W, 6T
μA741A		4.0	210 nA	70	15.0	32	80	50 (Note 2)	22	M	5W, 6T
μA741C		7.5	800 nA	300		15			18	C	5W, 6T, 9T, KC
μA741E		4.0	210 nA	70	15.0	32	80	50 (Note 2)	22	C	5W, 6T, 9T
μA759	Power	4.5	300 nA	60		25	80	80	18	M	5W
μA759C		7.5	400 nA	100		25	70	80	18	C	5W, 8Z
μA77000		10.0	400 nA	100		25	70	80	18	C	8Z
μA771	JFET	13.0	8 nA	4	10.0	25	70	70	18	C	6T, 9T, KC
μA771AM		5.0	50 nA	20	10.0	25	80	80	18	M	6T
μA771AC		4.0	4 nA	2	10.0	25	80	80	18	C	6T, 9T, KC
μA771BM		5.0	50 nA	20	10.0	25	80	80	18	M	6T
μA771BC		7.0	4 nA	2	10.0	25	80	80	18	C	6T, 9T, KC
μA771LC		20.0	8 nA	4	10.0	25	70	70	18	C	6T, 9T, KC
μA776	Programmable	7.5	7.5 nA	5		100	70	150 (Note 2)	18	M	5W
μA776C		7.5	10 nA	6		50	70	200 (Note 2)	18	C	5W, 9T

Note 1: Operating Temperature: C = 0°C to + 70°C, V = − 40°C to + 85°C, M = − 55°C to + 125°C.
Note 2: Power Supply Rejection Ratio measured in μV/V.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers (Continued)

Dual Operational Amplifiers, Internally Compensated

Device	Type	Input Offset Voltage V_{IO} (mV) (Max)	Input Bias Current I_{IB} (Max)	Input Offset Current I_{IO} (nA) (Max)	Input Offset Voltage Temp. Sensitivity $\Delta V_{IO}/\Delta T$ (μV/°C) (Typ)	Large Signal Voltage Gain A_{VS} (V/mV) (Min)	Common Mode Rejection CMR (dB) (Min)	Power Supply Rejection Ratio PSRR (dB) (Min)	Supply Voltage (± V)	Operating Temp. (Note 1)	Package Codes
μA747	General-Purpose	6.0	0.5 μA	200	15 max	25	70	30 (Note 2)	22	M	5X, 6A
μA747A		4.0	210 nA	70	15 max	32	80	15 (Note 2)	22	M	5X, 6A
μA747C		7.5	800 nA	300	15 max	15	70	30 (Note 2)	18	C	5X, 6A, 9A, KD
μA747E		4.0	210 nA	70	15 max	32	80	15 (Note 2)	18	C	5X, 6A
μA772	JFET	13.0	8 nA	4	10	25	70	70	30	C	6T, 9T, KC
μA772A		4.0	4 nA	2	10	25	80	80	30	M	6T
μA772A		4.0	4 nA	2	10	25	80	80	30	C	6T, 9T, KC
μA772B		7.0	4 nA	2	10	25	80	80	30	M	6T
μA772B		7.0	4 nA	2	10	25	80	80	30	C	6T, 9T, KC
μA772L		20.0	8 nA	4	10	25	70	70	30	C	6T, 9T, KC
μA798	Dual	7.5	400 nA	200	10	15	70	30 (Note 2)	3-36	C	9T, KC
μA1458	High-Performance	7.5	0.8 μA	0.3 μA	15	15	70	30 (Note 2)	18	C	5W, 6T, 9T, KC
μA1458C		12.0	1.0 μA	0.4 μA	15	15	60	30 (Note 2)	18	C	5W, 6T, 9T
μA1558		6.0	1.5 μA	0.5 μA	15	25	70	30 (Note 2)	22	M	5W, 6T

Note 1: Operating Temperature: C = 0°C to + 70°C, V = − 40°C to + 85°C, M = − 55°C to + 125°C.
Note 2: Power Supply Rejection Ratio measured in μV/V.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers (Continued)

Quad Operational Amplifiers, Internally Compensated

Device	Type	Input Offset Voltage V_{IO} (mV) (Max)	Input Bias Current I_{IB} (nA) (Max)	Input Offset Current I_{IO} (nA) (Max)	Input Offset Voltage Temp. Sensitivity $\Delta V_{IO}/\Delta T$ (μV/°C) (Typ)	Large Signal Voltage Gain A_{VS} (V/mV) (Min)	Common Mode Rejection CMR (dB) (Min)	Power Supply Rejection Ratio PSRR (dB) (Min)	Supply Voltage (± V)	Operating Temp. (Note 1)	Package Codes
μA124	Quad	7.0	300	100	7	25	70	65	32	M	6A
μA224		7.0	300	100	7	25	70	65	32	V	6A, 9A
μA324		9.0	500	150	7	15	65	65	32	C	6A, 9A, KD
μA2902		10.0	500	200	7	15	50	50	32	V	9A
μA148	General-Purpose	6.0	325	75		25	70	77	22	M	6A
μA248		7.5	500	125		25	70	77	18	V	6A, 9A
μA348		7.5	400	100		15	70	77	18	C	6A, 9A
μA774	JFET	13.0	8	4	10	25	70	70	18	C	7A, 9A, KD
μA774A		4.0	4	2	10	25	80	80	18	C	7A, 9A
μA774A		5.0	50	20	10	25	80	80	18	M	7A
μA774B		7.0	4	2	10	25	80	80	18	C	7A, 9A
μA774B		8.0	50	20	10	25	80	80	18	M	7A
μA774L		20.0	8	4	10	25	70	70	18	C	7A, 9A
μA3303	Quad	10.0	1000	250	10	15	70	150 (Note 2)	36	V	6A, 9A
μA3403		10.0	800	200	10	15	70	150 (Note 2)	36	C	6A, 9A, KD
μA3503		6.0	1200	200	10	25	70	150 (Note 2)	36	M	6A
μA4136	Quad	7.5	800	300		15	70	150 (Note 2)	18	C	6A, 9A, KD

Note 1: Operating Temperature: C = 0°C to + 70°C, V = − 40°C to + 85°C, M = − 55°C to + 125°C.
Note 2: Power Supply Rejection Ratio measured in μV/V.

Operational Amplifiers (Continued)

Operational Amplifiers Cross-Reference Guide

Device	Type	Fairchild	Motorola	National	TI	SG	Signetics
LM101	General-Purpose	μA101		LM101	LM101	SG101	
LM201		μA201		LM201	TC201	SG201	
LM101A	General-Purpose	μA101A	LM101A	LM101A	LM101A	SG101A	LM101A
LM201A		μA201A	LM201A	LM201A	LM201A	SG201A	LM201A
LM301A		μA301A	LM301A	LM301A	LM301A	SG301A	LM301A
LM108	Super Beta	μA108	LM108	LM108	LM108	SG108	
LM208		μA208	LM208	LM208	LM208	SG208	
LM308		μA308	LM308	LM308	LM308	SG308	
LM108A	Super Beta	μA108A	LM108A	LM108A		SG108A	
LM208A		μA208A	LM208A	LM208A		SG208A	
LM308A		μA308A	LM308A			SG308A	
LM124	Quad	μA124	LM124	LM124	LM124	SG124	LM124
LM224		μA224	LM224	LM224	LM224	SG224	LM224
LM324		μA324	LM324	LM324	LM324	SG324	LM324
μA2902		μA2902					
LM148	Quad General-Purpose	μA148	LM148		LM148		
LM248		LM248	LM248	LM248	LM248		
LM348		LM348	LM348	LM348	LM348		
μA709	High-Performance	μA709	MC1709	LM709	μA709		
μA714	High Precision	μA714			μA714		
μA715	High-Speed	μA714					
μA725	Instrumentation	μA714					
μA741	General-Purpose	μA741	MC1741	LM741	μA741	SG741	μA741
μA747	Dual General-Purpose	μA747	MC1747	LM747	μA747	SG747	μA747
μA748	High-Performance	μA747	MC1748	LM748	μA748	SG748	μA748
μA759	Power	μA759					
μA77000		μA77000					
μA771	Single JFET	μA771	MC34001	LF351	TL071/81		
μA772	Dual JFET	μA772	MC34002	LF353	TL072/82		
μA774	Quad JFET	μA774	MC34004	LF347	TL074		
μA776	Programmable	μA776	MC1776				
LM798	Dual	μA798	MC3458/* MC3558*	LM358*	LM358*		LM358*
MC1458	Dual High-Performance	μA1458	MC1458	LM1458	MC1458	SG1458	MC1458
μA1558							
μA3303	Quad	μA3303					
MC3403		μA3403	MC3403		MC3403		MC3403
μA3503		μA3503					
RC4136	Quad	μA4136			RC4136		

Operational Amplifiers (Continued)

Comparators

Device	Type	Input Offset Voltage V_{IO} (mV) (Max)	Input Bias Current I_{IB} (Max)	Input Offset Current I_{IO} (nA) (Max)	Response Time t_{PD} (ns) (Typ)	Output Sink Current I_{OL} (mA) (Min)	Large Signal Voltage Gain A_{VS} (V/mV) (Typ)	Supply Voltage (V)	Operating Temp. (Note 1)	Package Codes
μA111	Voltage	4.0	150 nA	20	200		200	5 – ± 15	M	5W
μA311		10.0	300 nA	70	200		200	5 – ± 15	C	5W, 9T, KC
μA139	Quad	9.0	300 nA	+ 100	1.3 μs	6.0	200	36 or + 18	M	6A
μA239		9.0	400 nA	+ 150	1.3 μs	6.0	200	36 or + 18	V	6A, 9A, KD
μA339		9.0	400 nA	+ 150	1.3 μs	6.0	200	36 or + 18	C	6A, 9A, KD
μA2901	Quad	15.0	500 nA	200	300	6.0	100	36 or + 18	V	6A, 9A
μA3302		40.0	1000 nA	300	300	2.0	30	28 or + 14	V	6A, 9A, KD
μA685	High-Speed	2.0	10 μA	+ 1 μA	9.5			+ 7	M	5X, 6B
μA685		2.0	10 μA	+ 1 μA	12.0			+ 7	V	5X, 6B, 9B, KD
μA6685	Ultra-Fast	3.0	10 μA	+ 1 μA	2.7			+ 7	M	5X, 6B
μA6685		3.5	10 μA	+ 1 μA	2.7			+ 7	V	5X, 6B, 9B, KD
μA687	Dual High-Speed	3.0	10 μA	+ 1 μA	20.0			+ 7	M	6B
μA687	Differential	3.5	10 μA	+ 1 μA	14.0			+ 7	V	6B, 9B
μA687A		3.0	10 μA	+ 1 μA	12.5			+ 7	M	6B
μA687A		3.5	10 μA	+ 1 μA	10.0			+ 7	V	6B, 9B
μA6687	Ultra-Fast Voltage	3.0	10 μA	+ 1 μA	4.0			+ 7	M	6B
μA6687		3.0	10 μA	+ 1 μA	4.0			+ 7	V	6B, 9B
μA710	High-Speed	3.0	45 μA	3 μA	40.0	0.5	800 (Note 2)	+ 14, – 7	M	5W, 6A
μA710		6.5	40 μA	5 μA	40.0	0.5	1000 (Note 2)	+ 14, – 7	V	5W, 6A, 9A
μA711	Dual High-Speed	6.0	150 μA	20 μA	40.0	0.5	500 (Note 2)	+ 14, – 7	M	5X, 6A
μA711		4.5	150 μA	25 μA	40.0	0.5	500 (Note 2)	+ 14, – 7	C	5X, 6A, 9A
μA760	High-Speed	6.0	60 μA	7.5 μA	18.0			+ 8, – 8	M	5W, 6A, 6T
μA760		6.0	60 μA	7.5 μA	18.0			+ 8, – 8	V	5W, 6A, 6T

Note 1: Operating Temperature: C = 0°C to + 70°C, V = – 40°C to + 85°C, M = – 55°C to + 125°C.
Note 2: Large Signal Voltage Gain measured in V/V.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers (Continued)

Comparators Cross-Reference Guide

Device	Type	Fairchild	Motorola	National	TI	SG	Signetics
LM111	Voltage	μA111	LM111	LM111	LM111	SG111	LM111
LM311		μA311	LM311	LM311	LM111	SG111	LM111
LM139	Quad	μA139	LM139	LM139	LM139	SG139	LM139
LM239		μA239	LM239	LM239	LM239	SG239	LM239
LM339		μA339	LM339	LM339	LM339	SG339	LM339
MC685	High-Speed	μA685	MC685				
MC6685	Ultra-Fast	μA6685	MC6685				
MC687	Dual High-Speed Differential	μA687	MC687				
μA687A		μA687A					
MC6687		μA6687	MC6687				
μA710	High-Speed Differential	μA710	MC1710	LM710	μA710	SG710	
μA711	Dual High-Speed	μA711	MC1711	LM711	μA711	SG711	
μA760	High-Speed Differential	μA760		LM760			
μA2901	Quad	μA2901	LM2901	LM2901	LM2901		LM2901
μA3302		μA3302	MC3302	LM3302	LM3302		

Special Functions

Device		Supply Voltage (V)	Operating Temperature*	Package Codes
μA555	Single Timing Circuit	+ 18	C	9T, KC
μA556	Dual Timing Circuit	+ 18	C	9A
μA592	Differential Video Amplifier	+ 8	M	6A
μA592		+ 8	C	6A, 9A, 9T, KC
μA733		+ 8	M	5X, 6A
μA733		+ 8	C	5X, 6A, 9A, KD
μA2240	Programmable Timer/Counter	18	C	7B, 9B
μA3046	Transistor Array		C	9A, KD
μA3086			V	6A, 9A, KD
μA3680	Quad Telephone Relay Driver	BAT + 20	V	6A, 9A, KD
μA7392	DC Motor Speed Control Circuit	6.3 – 16	V	6A, 9A

*Operating Temperature: C = 0°C to + 70°C, V = – 40°C to + 85°C, M = – 55°C to + 125°C.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Operational Amplifiers (Continued)

Special Functions Cross-Reference Guide

Device	Type	Fairchild	Motorola	National	TI	SG	Signetics
NE555	Single Timing Circuit	μA555	MC1455	LM555	NE555	SG555	NE555
NE556	Dual Timing Circuit	μA556	MC3456	LM556	NE556	SG556	NE556
NE592	Differential Video Amplifier	μA592	NE592	LM592	TL592		NE592
μA733		μA733	MC1733	LM733	μA733	SG733	μA733
μA2240	Programmable Timer/Counter	μA2240			μA2240		
μA3046	Transistor Array	μA3046					
μA3086		μA3086					

Voltage Regulators

Fixed Output Voltage Regulators

Device	Type	Standard V_{OUT} Range (V)	Standard I_{OUT}	Input Voltage V_{IN} (V) Min/Max	Average Temperature Coefficient Output Voltage $\Delta V_O/\Delta T$ (mV)	Regulation Line (mV Max)	Regulation Load (mV Max)	Package Type	Package Codes (Package Suffix)
Positive Output									
μA109M	3-Terminal	4.7–5.4	1A	35	2.0 Max	50	100	TO-39, TO-3	HM, KM (XC, YC)
μA209C								TO-3	KC (YC)
μA309C								TO-3	KC (YC)
μA7805M	3-Terminal	4.8–5.2	1A	35–40	0.3/0.4 Max	50	100	TO-3	KM (HJ)
μA7805C		4.8–5.2			1.1 Typ	50	100	TO-3, TO-220	KC, UC (HJ, GH)
μA7806C		5.75–6.25			0.8 Typ	120	120	TO-3, TO-220	KC, UC (HJ, GH)
μA7808M		7.7–8.3			0.3/0.4 Max	80	100	TO-3	KM (HJ)
μA7808C		7.7–8.3			0.8 Typ	160	160	TO-3, TO-220	KC, UC (HJ, GH)
μA7812M		11.5–12.5			0.3/0.4 Max.	120	120	TO-3	KM (HJ)
μA7812C		11.5–12.5			1.0 Typ	240	240	TO-3, TO-220	KC, UC (HJ, GH)
μA7815M		14.4–15.6			0.3/0.4 Max	150	150	TO-3	KM (HJ)
μA7815C		14.4–15.6			1.0 Typ	300	300	TO-3, TO-220	KC, UC (HJ, GH)
μA7818M		17.3–18.7			0.3/0.4 Max	180	180	TO-3	KM (HJ)
μA7818C		17.3–18.7			1.0 Typ	360	360	TO-3, TO-220	KC, UC (HJ, GH)
μA7824M		23.0–25.0			0.3/0.4 Max	240	240	TO-3	KM (HJ)
μA7824C		23.0–25.0			1.5 Typ	480	480	TO-3, TO-220	KC, UC (HJ, GH)
μA7885C		8.15–8.85			0.8 Typ	170	170	TO-220	UC* (GH)
μA78L05	3-Terminal	4.8–5.2	100 mA	35	– 0.65 Typ	150	60	TO-92, SO-8	AWC/V, ASC/V (EI, KC)
μA78L62		5.95–6.45			– 0.75 Typ	175	80	TO-92	AWC/V (EI)
μA78L82		7.87–8.53			– 0.8 Typ	175	80	TO-92	AWC/V (EI)
μA78L09		8.64–9.36			– 0.9 Typ	200	90	TO-92	AWC/V (EI)
μA78L12		11.5–12.5			– 1.0 Typ	250	100	TO-92	AWC/V (EI)
μA78L15		14.4–15.6			– 1.3 Typ	300	150	TO-92	AWC/V (EI)
μA78M05M	3-Terminal	4.8–5.2	500 mA	35–40	0.3/0.4 Max	50	50	TO-39	HM (FC)
μA78M05C		4.8–5.2			1.0 Typ	100	100	TO-39, TO-220	HC, UC (FC, GH)
μA78M06M		5.75–6.25			0.3/0.4 Max	60	60	TO-39	HM (FC)
μA78M06C		5.75–6.25			0.5 Typ	100	120	TO-39, TO-220	HC, UC (FC, GH)
μA78M08M		7.7–8.3			0.3/0.4 Max	60	80	TO-39	HM (FC)
μA78M08C		7.7–8.3			0.5 Typ	100	160	TO-39, TO-220	HC, UC (FC, GH)
μA78M12M		11.5–12.5			0.3/0.4 Max	60	120	TO-39	HM (FC)
μA78M12C		11.5–12.5			1.0 Typ	100	240	TO-39, TO-220	HC, UC (FC, GH)
μA78M15M		14.4–15.6			0.3/0.4 Max	60	150	TO-39	HM (FC)
μA78M15C		14.4–15.6			1.0 Typ	100	300	TO-39, TO-220	HC, UC (FC, GH)
μA78M24M		23.0–25.0			0.3/0.4 Max	60	240	TO-39	HM (FC)
μA78M24C		23.0–25.0			1.2 Typ	100	480	TO-39, TO-220	HC, UC (FC, GH)

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Voltage Regulators (Continued)

Fixed Output Voltage Regulators (Continued)

Device	Type	Standard V_{OUT} Range (V)	Standard I_{OUT}	Input Voltage V_{IN} (V) Min/Max	Average Temperature Coefficient Output Voltage $\Delta V_O/\Delta T$ (mV)	Regulation (mV Max) Line	Load	Package Type	Package Codes (Package Suffix)
Negative Output									
μA7905M	3-Terminal	−4.8−−5.2	1A	−35	0.3 Max	50	100	TO-3	KM (HJ)
μA7905C		−4.8−−5.2			0.4 Typ	100	100	TO-3, TO-220	KC, UC (HJ, GH)
μA7908M		−7.7−−8.3			0.3 Max	80	100	TO-3	KM (HJ)
μA7908C		−7.7−−8.3			0.6 Typ	160	160	TO-3, TO-220	KC, UC (HJ, GH)
μA7912M		−11.5−−12.5			0.3 Max	120	120	TO-3	KM (HJ)
μA7912C		−11.5−−12.5			0.8 Typ	240	240	TO-3, TO-220	KC, UC (HJ, GH)
μA7915M		−14.4−−15.6			0.3 Max	150	150	TO-3	KM (HJ)
μA7915C		−14.4−−15.6			1.0 Typ	300	300	TO-3, TO-220	KC, UC (HJ, GH)
μA79M05M	3-Terminal	−5.2−−4.8	500 mA	−35	0.3 Max	50	100	TO-3	HM (FC)
μA79M05C		−5.2−−4.8			0.4 Typ	50	100	TO-3, TO-220	HC, UC (FC, GH)
μA79M08M		−8.3−−7.7			0.3 Max	80	160	TO-3	HM (FC)
μA79M08C		−8.3−−7.7			0.6 Typ	80	160	TO-3, TO-220	HC, UC (FC, GH)
μA79M12M		−12.5−−11.5			0.3 Max	80	240	TO-3	HM (FC)
μA79M12C		−12.5−−11.5			0.8 Typ	80	240	TO-3, TO-220	HC, UC (FC, GH)
μA79M15M		−15.6−−14.4			0.3 Max	80	240	TO-3	HM (FC)
μA79M15C		−15.6−−14.4			1.0 Typ	80	240	TO-3, TO-220	HC, UC (FC, GH)

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Voltage Regulators (Continued)

Fixed Output Voltage Regulators Cross-Reference Guide

Device	Type	Fairchild	National	Motorola	TI
LM109	3-Terminal	μA109	LM109K	LM109K	
μA7805	3-Terminal	μA7805	LM78XXCT	MC78XXCT	μA78XXCKC
μA7806		μA7806	LM78XXCK	MC78XXCK	
μA7808		μA7808	LM78XXCK	MC78XXCK	
μA7812		μA7812	LM140K/XX	MC78XXX	
μA7815		μA7815	LM340T-XX		
μA7818		μA7818	LM340K-XX		
μA7824		μA7824			
μA7885		μA7885	LM340T-XX		
μA78L05	3-Terminal	μA78L05	LM78LXXACZ	MC78LXXACP	μA78LXXCLP
μA78L09		μA78L09			
μA78L12		μA78L12			
μA78L15		μA78L15			
μA78L62		μA78L62			
μA78L82		μA78L82			
μA78M05	3-Terminal	μA78M05	LM78MXXCP	MC78MXXCT	μA78MXXCKC
μA78M06		μA78M06			
μA78M08		μA78M08		MC78MXXCG	
μA78M12		μA78M12			
μA78M15		μA78M15	LM341-XX		
μA78M24		μA78M24			
μA7905	3-Terminal	μA7905	LM79XXCT	MC79XXCT	μA79XXCKC
μA7908		μA7908	LM79XXCK	MC79XXCK	
μA7912		μA7912	LM120K-XX	MC79XX	
μA7915		μA7915	LM320T/K-XX		
μA79M05	3-Terminal	μA79M05	LM79MXXCP	MC79MXXCT	μA79MXXCKC
μA79M08		μA79M08			
μA79M12		μA79M12			
μA79M15		μA79M15			

Voltage Regulators (Continued)

Adjustable Output Voltage Regulators

Device	Type	Standard V_{OUT} Range (V)	Standard I_{OUT}	Input Voltage V_{IN} (V) Min/Max	Regulation Line (%/V) Max	Regulation Load (%) Max	Package Type	Package Codes (Package Suffix)
Positive Output								
μA105M	Adjustable	4.5–40	12 mA	8.5–50	0.06	0.1	TO-99 8-Lead	HM (5W)
μA305		4.5–30		8.5–40	0.06	0.1	TO-99 8-Lead	HC (5W)
μA305A		4.5–40		8.5–50	0.06	0.4	TO-99 8-Lead	HC (5W)
μA376		5.0–37		9.0–40	0.03	0.5	8-Lead DIP	TC (9T)
μA117M	3-Terminal	1.2–37	1.5A		0.02	15 mV	TO-3	KM (HJ)
μA217V					0.02	15 mV	TO-3, TO-220	KV, UV (HJ, GH)
μA317C					0.04	25 mV	TO-3, TO-220	KC, UC (HJ, GH)
μA138M	5-Amp	1.2–32	5A		0.01	15 mV	TO-3	KM (FT)
μA238V					0.01	15 mV	TO-3	KV (FT)
μA338C					0.03	25 mV	TO-3, TO-220	KC, UC (FT, GH)
μA150M	3-Amp	2–37	3A		0.01	15 mV	TO-3	KM (FT)
μA250V					0.01	15 mV	TO-3	KV (FT)
μA350C					0.03	25 mV	TO-3, TO-220	KC, UC (FT, GH)
μA723M	General-Purpose	2–37	150 mA	9.5–40	0.01	0.15	10-Lead Metal	HM, DM (5X, 6A)
μA723C					0.01	0.20	10-Lead Metal, 14-Lead DIP, SO-14	HC, DC, PC, SC (5X, 6A, 9A, KD)
μA78G	4-Terminal	5–30	1A	7.5–40	1.0	1.0	TO-202	U1C (8Z)
μA78MG					1.0	1.0	Power Pack	U1C (8Z)
Negative Output								
μA79G	4-Terminal	– 30– – 2.23	1A	– 40– – 7	1.0	1.0	TO-202	U1C (8Z)
μA79MG					1.0	1.0	Power Pack	U1C (8Z)

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Voltage Regulators (Continued)

Adjustable Output Voltage Regulators Cross-Reference Guide

Device	Type	Fairchild	National	Motorola	TI
µA105	Adjustable	µA105	LM105H		
µA305		µA305	LM305H		
µA305A		µA305A	LM305AH		
µA376		µA376	LM376N		
LM117	3-Terminal	µA117	LM117K	LM117K	
LM217		µA217	LM217K	LM217K	LM217KC
LM317		µA317	LM317T/K	LM317T/K	LM317KC
µA138	5-Amp	µA138	LM138K		
µA238		µA238	LM238K		
µA338		µA338	LM338K		
µA150	3-Amp	µA150	LMJ150K	LM150K	
µA250		µA250	LM250K	LM250K	
µA350		µA350	LM350K/T	LM350K/T	LM350KA/C
µA723	General-Purpose	µA723	LM723CH, H, CN, CJ, J	MC1723CG, CP, CL, L	µA723CN, CJ, J
µA78G	4-Terminal	µA78G			
µA78MG		µA78MG			
µA79G	4-Terminal	µA79G			
µA79MG		µA79MG			

Voltage Regulators (Continued)

Switching Regulators and Voltage References

Device	Type	V_{CC} Range (V)	Package Type	Package Codes (Package Suffix)
μA431A	Adjustable Precision Zener Shunt	2.5–36	TO-92 SO-8	WC, WV (EI) SC (KC)
μA494V/C	Pulse-Width Modulated	7–40	16-Lead DIP	PV, DC, PC (9B, 7B)
μA1524A μA2524A μA3524A	Pulse-Width Modulated	5	16-Lead DIP	DM (7B) DV, PV (7B, 9B) PC, DC (9B, 7B)
μA78S40M μA78S40V/C	Universal	2.5–40	16-Lead DIP	DM (9B) PV, PC, DC (9B, 7B)

Switching Regulators and Voltage References Cross-Reference Guide

Device	Type	Fairchild	National	Motorola	TI
TL431A	Adjustable Shunt/Precision Zener	μA431A		TL431CLP	TL431CLP
TL494	Pulse-Width Modulated Switching	μA494		TL494CN, CJ, MJ	TL494CN, CJ, MJ
μA1524A μA2524A μA3524A	Pulse-Width Modulated Switching	μA1524A μA2524A μA3524A	LM1524 LM2524 LM3524		EG1524 EG2524 EG3524
μA78S40	Switching	μA78S40		μA78S40PC, DC, DM	

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

CLASIC

The Fairchild 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

There are presently over 150 cells in the CLASIC library, covering 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 Fairchild'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 sheets 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.

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 (Continued)

Op-Amps

Cell Reference	Cell Description	Similar Industry Standard	Cell Area Units	Cell Power (mW)
BUF201	Voltage Follower Ground-Sensing 16X NPN Output		0.8 A	3.0
BUF301	Voltage Follower w/Resistor Input Divider		0.8 A	4.0
OPGM101	Low-Power Transconductance		0.5 A	3.0
OPGP101	General-Purpose	μA741	1.0 A	6.5
OPGP124	Ground-Sensing 124-Type	LM124	0.8 A	5.0
OPGP201	General-Purpose Low-Power	LM101A	0.7 A	4.0
OPGP301	General-Purpose 7 MHz BW, 2.5 V/μs Slew Rate	μA741A	1.0 A	6.5
OPHS101	High-Speed 22 MHz BW, 42 V/μs Slew Rate	LM118	2.0 A	40.0
OPLB101	Low-Input Bias Current 10 nA, 6 MHz BW, 2.3 V/μs	LM108	1.3 A	10.0
OPLN101	Low-Noise Voltage 4 nV/rt Hz, 12 MHz BW	OP27	1.6 A	18.0
OPNR101	Norton Current Mode 40 MHz BW, 26 V/μs Slew Rate	LM159	0.7 A	20.0
OPLV101	Low-Input Offset Voltage 0.1 mV V_{OS}, 4.5 MHz BW, 2 V/μs	OP07	1.2 A	8.0
OPSS101	124-Type 5 MHz BW, 2 V/μs	LM124	0.7 A	4.0

AGC Functions

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
AGCAMP01	AGC Amp w/ DC Restore, 20 MHz BW	2.0 A	8.0
AGCCON01	Control Amp for GCAMP301	0.5 A	3.0
CONAM101	Fast-Response AGC Control Amp	0.8 A	6.0
CONAMP01	Control Amp for AGCAMP	0.9 A	6.0
FWR101	AGC Rectifier	0.5 A	2.0
GCA101	AGC Amp 25 MHz BW, 30 dB Range	2.0 A	8.0
GCA102	High-Gain AGC Amp, Low-Noise Version of GCAMP301	2.0 A	9.0
GCALN101	Current-Out AGC Amp, 25 MHz BW, 30 dB Range	2.0 A	8.0
GCAMP201	Low-Noise AGC Amp, Wider Range	2.0 A	9.0
GCAMP401	AGC Amp, Differential Input/Output	2.0 A	8.0

CLASIC (Continued)

Comparators

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
CMPEC101	ECL, < 10 ns Delay	0.8 A	22.0
CMPLS101	Level Shifter for use with CMPEC101	0.8 A	1.0
CMPGP101	General-Purpose < 200 ns Delay	0.8 A	5.0
CMPGP201	General-Purpose < 100 ns Ground-Sensing	0.8 A	7.0
CMPGP301	General-Purpose 20 MHz, ECL Output	1.0 A	35.0
CMPHS101	High-Speed 50 MHz, < 20 ns	1.2 A	40.0
CMPHS201	High-Speed 75 MHz, < 15 ns	1.3 A	50.0
CMPLS201	TTL Level Shifter for CMPHS201	0.1 A	1.0
CMPHS301	High-Speed Differential Input/Output	1.5 A	35.0
CMPHY101	High-Speed w/Hysteresis, 0–100 mV	0.9 A	7.0
CMPHY201	Ground-Sensing w/Hysteresis, 0–100 mV	1.0 A	8.0
CMPHY301	High-Speed Hysteresis, ECL Output	1.0 A	9.0
CMPTTL01	TTL, < 20ns	0.7 A	10.0
CMP3MX01	Three-Input, < 10 ns	0.7 A	6.0
CMPTTL01	Set/Reset Latch	1.0 A	8.0
DFECL101	ECL Gain-Stage Differential, Input/Output	0.3 A	3.0
PRCMP01	12-Bit, for use in AC/DC, < 20 ns	4.0 A	50.0

Voltage References

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
VBG101	Band-Gap, 3 %, 1.25V	1.0 A	5.0
BSVCC03	12V–5V Zener, 10 %	0.4 A	3.0
BGTRIM	Band-Gap Trim Cell, Zener Zap Elements	0.5 A	
VBG201	Band-Gap, 2 %, 1.25V	1.0 A	6.0
ZAP201	Band-Gap Trim Cell, Zener Zap Elements	0.5 A	
VBG203	Band-Gap, 1 %, 2.5V	1.0 A	6.0
ZAP101	Band-Gap Trim Cell, Zener Zap Elements	0.5 A	
AGCREF	For AGC Amp, Resistor Ratio	0.1 A	1.0
FAIL5	Under-Voltage Detector for 5V, 4.3V Nominal Trip Point Adjustable	1.1 A	4.0
FAIL12	Under-Voltage Detector for 12V, 10.2V Nominal Trip Point Adjustable	1.1 A	4.0
VBG	Band-Gap, 0.5 %, 2.5V		

CLASIC (Continued)

Data Acquisition

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
DAC8B101	8-Bit Current Output, $I_{OUT}/\overline{I_{OUT}}$ Inverting	3.3 A	15.0
SW2H	Fast-Sample/Hold, Diode Bridge < 50 ns	1.0 A	20.0
SW2L	Lower Power SW2H, < 100 ns	1.0 A	10.0
SH	Sample/Hold, High-Speed, 15 V/μs External Hold Capacitor	0.7A	25.0
SHSW	Sample/Hold Switch, ECL Input	1.0 D	2.0

Interface

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
OUTA101	200 mA Source Output Driver	4.0 A	50.0
OUTB101	200 mA Sink Output Driver	4.0 A	50.0

Bias Cells

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
BIASA101	Analog Bias Temperature-Compensated	0.4 A	27.0
BIASD101	Digital Bias Temperature-Compensated	1.4 D	12.0
BIASZ101	Peripheral Bias	1.7 D	12.0
AGCB101	Bias for GCA101	0.5 A	25.0
PDBIAS04	Bias for 8464	0.5 A	25.0
BIASA201	Lower AC Output Impedance (w/Cap.)	0.6 A	27.0
BIASD201	Lower AC Output Impedance (w/Cap.)	2.5 D	12.0
PKBS	Bias for PKDET	0.5 A	20.0
BIASD102	Digital ECL Logic Family Bias Sink Cell	1.4 D	15.0

CLASIC (Continued)

Logic Cells

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
FFD101	D Flip-Flop 140 MHz Max. Clock	3.4 D	5.0
GEXOR101	2-Input Exclusive-OR/NOR, 2–4 ns Delay	1.4 D	0.9
GxOR101	2-5 Input OR/NOR Family, Medium Power/Speed 1.6–1.9 ns Delay	1 to 1.5 D	1.8
GxORF101	2-5 Input OR/NOR Fast Family, High Power/Speed 1–1.3 ns Delay	1 to 1.5 D	2.8
GxORL101	2-5 Input OR/NOR Low-Power Family, 2.6–3.3 ns Delay	1 to 1.5 D	1.3
NAND101	TTL NAND Totem-Pole Output, 3 ns	2.0 D	4.0
NAND201	TTL NAND Open-Collector Output, 5 ns	1.5 D	3.0
DFFLOP01	FFD101 w/o Set/Reset	3.4 D	5.0
PDLY201	ECL Delay Cell, 30 ns	2.0 D	2.0
TTECL201	TTL/ECL Converter, no Pad	2.0 D	7.5
TTLXOR	TTL XOR Gate Open Collector	1.0 D	2.5
FFD201	FFD101 w/One Pull-Down on Q	1.0 D	5.0
AND101	1-Input TTL and Open Collector	1.0 D	2.0
AND201	1-Input TTL and Open Collector	1.0 D	2.0
INVERTER	Simple Inverter	0.7 D	1.5
CHGPMPD	Open-Collector Inverter	0.5 D	1.5
DELAYZ2	TTL Delay Cell	0.8 D	1.8
DELAY03	ECL Delay Cell	0.8 D	1.8
S3ORF101	3-Input OR ECL w/no Pull-Down	1.3 D	1.8
PULRES02	ECL 1-Input w/Pull-Up	1.0 D	1.8
FFTOG101	Divide-by-Two Low-Power	3.0 D	3.0
ED101	Rising-Edge Detector, 5–15 ns Pulse Output	2.0 D	3.0
MS101	One-Shot 555-Type Timer w/o F-F, Differential Output	4.0 D	7.0
ONES01	Negative-Edge-Triggered One-Shot, Differential Output	6.0 D	6.0
EDGS02	Negative Edge-Triggered, 10 ns, One-Shot	2.0 D	2.0
EDGL01	Negative-Edge-Triggered, Programmable One-Shot	3.0 D	3.0
ECTLT101	ECL-to-TTL Converter, no Pad	2.0 D	3.5
ECTLR101	ECL-to-TTL Converter, no Pad	2.0 D	7.0
TTECL101	TTL/ECL Differential Output	1.5 D	2.0
GEXOR201	Exclusive-OR/NOR Differential, Input/Output	1.5 D	1.0
ONEST101	One-Shot	5.0 D	4.0
TOUTOC	Open-Collector Output	3.0 D	7.0
TOUTCH	High-Current Open-Collector	4.0 D	8.0
TOUTCP	Reverse-Phase Tout Open Collector	3.0 D	7.0
CMPLS101	Emitter-Follower ECL Driver	0.2 D	
PLUP	ECL 1-Input Differential In	0.2 D	
PULRES02	ECL 1-Input w/Pull-Up/Down	0.3 D	
RCVR101	ECL Differential Outputs	1.0 D	1.0
FFASD101	Set/Reset Latch	0.2 D	
TRIGEN03	Unity-Gain ECL Stage-Differential In/Out	4.0 D	4.0
CONV02	ECL-Gain Stage-Differential In/Out	0.8 D	1.0
SWTH03	ECL 2:1 Multiplexer	1.5 D	1.5

CLASIC (Continued)

Bonding Pad Cells

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
ZPAD101	Bonding Pad	0.2 A	
ZPIN101	Pad with TTL/ECL Converter	3.1 D	3.3
ZPOUT101	Pad with ECL/TTL Converter	4.3 D	7.5
ZPOUT301	ECL-to-TTL 20 mA Output	2.5 D	3.0
ZPROT401	Schottky Clamp to VEED	0.5 D	
ZPIN201	TTL In, Complementary ECL Output	3.0 D	3.5
BUF101	ECL Buffer, High-Current Output	1.5 D	
ZPROT301	Small ZPROT101	0.7 D	
ZPOUT201	Pad with 20 mA ECL/TTL Converter	5.0 D	8.0
ZPROT201	ESD Protection	0.8 D	
ZPROT101	ESD Protection w/Bias	0.8 D	

CLASIC (Continued)

Special Cells

Cell Reference	Cell Description	Cell Area Units	Cell Power (mW)
PKDET101	Peak Detector	1.1 A	10.0
BKBS101	Bias Cell for PKDET101	0.5 A	5.0
TIME101	555 Timer	1.0 A	1.5
PKDCUR	Current Sources for PKDET101	0.3 A	
GATEPK01	Gated Peak Detector, 15 V/μs	1.5 A	12.0
PKDET	Peak Detector, 3-State, Fast Charge/ Discharge/Hold	1.2 A	12.0
SW1	Fast Peak Detector, 5 MHz BW	0.5 A	2.0
AGCPK101	Peak Detector for AGC Cell, Rectifier and Dual Filters	0.5 A	3.0
READWT03	1 μs and 2 μs Delay Elements	1.0 A	5.0
DIFFWR01	Full-Wave Rectifier w/Differentiator	0.8 A	4.0
FWRDIF101	Full-Wave Rectifier w/Differentiator	0.8 A	6.0
3MUX01	321 Mux Amp Input	1.0 A	2.0
MUXOP124	124 Op Amp used w/Mux 2 MHz BW	1.0 A	15.0
VTOI101	Analog Level Shifter, V-to-I Converter	0.5 A	3.0
FREC	Full-Wave Rectifier, Differential Input/Single-Ended Output	0.5 A	2.0
VCO05	VCO 50 MHz, 1% Linearity	0.7 A	20.0
OSRMP101	Oscillator, Medium Frequency Range	2.0 A	15.0
IX2MIR	Subcell, Wilson PNP Current Mirror	0.3 A	2.0
INTQ	Current Mirror, 4 Outputs, 10:1 Ratio, PNP 1X	0.2 A	
INTBIQR	Current Output Cell for Op Amp, Darlington NPN 2X	0.2 A	
CHGPMP101	Charge Pump, Medium Speed	0.8 A	5.0
VCO70Y	VCO 70 MHz, 1% Linearity	1.0 A	25.0
CHGPMP03	Charge Pump, Differential Outputs, Variable Charge/Discharge Rate	4.0 D	20.0
CHGPMP05	CHGPMP03 w/Small PNP	4.0 D	20.0
CHGPMP	Single-Ended TTL Charge Pump, 5 ns Minimum Output Pulse	0.8 A	10.0
CHGPMPY	Charge Pump, Dual Rate, Adjustable Differential	4.0 D	15.0
LVS202	Current Source 150 μA NPN Output	0.2 A	2.0
LOGP1C	Logic Level Shifter 2 VD	0.2 A	1.0

Components

Cell Reference	Cell Description	Cell Area Units
CxPF	Capacitor Cells 1, 2, 5, 10 pF ± 10%, 0.5% Matching	0.2-1.0A
RBx	Base Resistor Cells, 66Ω, 13KΩ ± 11%, 0.5% Matching	0.1 A
RIx	Implant Resistor Cells, 450Ω, 55KΩ ± 22%, 1% Matching	0.1 A

Logic

For additional Logic products, see pages 89 and 423.

Logic

Representing over two decades of technology evolution, Fairchild's standard logic families provide SSI, MSI, and LSI solutions in TTL, ECL, and CMOS technologies. This comprehensive capability serves the widest possible application areas, from mainframes and workstations to office automation and portable systems. Fairchild's advanced-technology families are providing the highest performance available in the industry, as well as supporting customer designs in the hi-rel market.

TTL Families

Products included in this group are the standard TTL, Low Power TTL, Schottky, Low Power Schottky, and FAST® families. Introduced in 1979, Fairchild Advanced Schottky TTL (FAST) logic has become the industry standard for new high-performance bipolar designs. FAST products feature a 30% speed improvement at one-fifth the power of Schottky TTL products, plus improved noise margins, lower input current, and superior capacitive and line driving characteristics.

ECL

Fairchild high-performance ECL product lines encompass the most popular industry standards available today. The ECL offerings also include a selection of the very fast SSI 11C family. See page 234 for ECL ASIC products.

For new designs, the logic of choice is the F100K family, which provides a number of enhancements: fast gate speeds with moderate edge rates, lower power consumption, full voltage and temperature compensation, extremely small parasitic capacitances, and complementary outputs. The F100K pin assignments minimize crosstalk, noise coupling, and feedthrough, making this the industry's easiest system design upgrade from TTL.

CMOS

The Fairchild Advanced CMOS Technology (FACT™) product line is the industry's first CMOS high-performance standard logic family. By incorporating sub-2 micron technology and advanced design, the FACT product line offers 1 ns internal gate delays with a full 24 mA drive capability. In addition, the family provides a breakthrough in solving latch-up and ringing by using proprietary design techniques.

The family is offered in CMOS and TTL interface configurations with wide voltage (2V to 6V) and extended temperature range specifications. Intended as a replacement for Advanced Low Power Schottky (ALS) and HC product lines, the FACT family has set the next-generation standard for high speed and low power applications. See page 235 for CMOS ASIC product offerings.

CMOS devices are grouped in two categories:

AC Standard logic functions with CMOS-compatible inputs and TTL- and MOS-compatible outputs.

ACT Standard logic functions with TTL-compatible inputs and TTL-and MOS-compatible outputs.

Logic Part Numbering System

XXXXX X X XX

- Special Variations
  - QR = Commercial grade device with burn-in
  - QB = Military grade device with environmental and burn-in processing
  - T = Devices shipped in 7″ reels
  - X = Devices shipped in 14″ reels
  - TR = Commercial grade devices with burn-in shipped in 7″ reels
  - XR = Commercial grade devices with burn-in shipped in 14″ reels
- Temperature Range
  - C (Commercial) = 0°C to + 70°C / + 75°C
  - V (Industrial) = − 25°C to + 85°C
  - A (Automotive) = − 40°C to + 85°C
  - M (Military) = − 55°C to + 125°C
- Package Code
  - P = Plastic DIP
  - SP = Slim Plastic DIP
  - D = Ceramic DIP
  - SD = Slim Ceramic DIP
  - F = Flatpak
  - L = Ceramic Leadless Chip Carrier (LCC)*
  - Q = Plastic Chip Carrier (PCC)*
  - S = Small Outline IC (SOIC), 150 mils
- Device Type

*For information on commercial availability, contact your local National Sales Representative.

FACT (54AC/74ACXX) (54ACT/74ACTXX)

Gates

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

Dual Edge-Triggered Flip-Flops

Device	Type	Clock Edge	Direct Set	Direct Clear	Pins	Package Codes
54AC/74AC74	D	Positive	X	X	14	PC, DC, SC, DM, FM, LM
54ACT/74ACT74	D	Positive	X	X	14	PC, DC, SC, DM, FM, LM
54AC/74AC109	J-K	Positive	X	X	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT109	J-K	Positive	X	X	16	PC, DC, SC, DM, FM, LM

Multiple Flip-Flops

Device	Type	Master Reset	3-State Outputs	Pins	Package Codes
54AC/74AC174	Hex D	X		16	PC, DC, SC, DM, FM, LM
54ACT/74ACT174	Hex D	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC175	Quad D	X		16	PC, DC, SC, DM, FM, LM
54ACT/74ACT175	Quad D	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC273	Octal D	X		20	PC, DC, SC, DM, FM, LM
54AC/74AC374	Octal D		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT374	Octal D		X	20	PC, DC, SC, DM, FM, LM
54AC/74AC377	Octal D		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT377	Octal D		X	20	PC, DC, SC, DM, FM, LM
74ACT534	Octal D		X	20	PC, DC, SC
54ACT/74ACT564	Octal D		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT574	Octal D		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT821	Octal D	X		24	SPC, SDC, QC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FACT (54AC/74ACXX) (54ACT/74ACTXX) (Continued)

Shift Register

Device	Type	Serial Inputs	Parallel Inputs	3-State Outputs	Pins	Package Codes
54AC/74AC299	8-Bit Octal Storage	2	X	X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT323	8-Bit Octal Storage	2	X	X	20	PC, DC, SC, DM, FM, LM

Latches

Device	Type	Enable Inputs (Level)	3-State Outputs	Pins	Package Codes
54AC/74AC373	Octal	1 (H)	X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT373	Octal	1 (H)	X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT563	Octal D		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT573	Octal D		X	20	PC, DC, SC, DM, FM, LM

Counters

Device	Type	Parallel Entry	Reset	Up/ Down	Pins	Package Codes
54AC/74AC161	4-Bit Binary	S	A		16	PC, DC, SC, DM, FM, LM
74ACT161	4-Bit Binary	S	A		16	PC, DC, SC
54AC/74AC163	4-Bit Binary	S	S		16	PC, DC, SC, DM, FM, LM
74ACT163	4-Bit Binary	S	S		16	PC, DC, SC
54AC/74AC169	4-Bit Binary	S		X	16	PC, DC, SC, DM, FM, LM
54AC/74AC191	4-Bit Decade	A		X	16	PC, DC, SC, DM, FM, LM

S = Synchronous
A = Asynchronous

Octal Buffers/Line Drivers

Device	Enable Inputs (Level)	Inverting	Noninverting	Pins	Package Codes
54AC/74AC240	2 (L)	X		20	PC, DC, SC, DM, FM, LM
54ACT/74ACT240	2 (L)	X		20	PC, DC, SC, DM, FM, LM
54AC/74AC241	1 (L), 1 (H)		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT241	1 (L), 1 (H)		X	20	PC, DC, SC, DM, FM, LM
54AC/74AC244	2 (L)		X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT244	2 (L)		X	20	PC, DC, SC, DM, FM, LM
54AC/74AC540	2 (L)	X		20	PC, DC, SC, DM, FM, LM
54AC/74AC541	1 (L), 1 (H)		X	20	PC, DC, SC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FACT (54AC/74ACXX) (54ACT/74ACTXX) (Continued)

Transceivers

Device	Type	Enable Inputs (Level)	3-State Output	Pins	Package Codes
54AC/74AC245	Octal Bus	1 (L)	X	20	PC, DC, SC, DM, FM, LM
54ACT/74ACT245	Octal Bus	1 (L)	X	20	PC, DC, SC, DM, FM, LM
54AC/74AC646	Octal Bus w/Register	1 (L), 1 (H)	X	24	SPC, SDC, SC, SDM
54AC/74AC648	Octal Bus w/Register	1 (L), 1 (H)	X	24	SPC, SDC, SC, SDM

Multiplexers

		Enable Inputs	Outputs			
Device	Type	(Level)	True	Complement	Pins	Package Codes
54AC/74AC151	8-Input	1 (L)	X	X	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT151	8-Input	1 (L)	X	X	16	PC, DC, SC, DM, FM, LM
54AC/74AC153	Dual 4-Input	2 (L)	X		16	PC, DC, SC, DM, FM, LM
54ACT/74ACT153	Dual 4-Input	2 (L)	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC157	Quad 2-Input	1 (L)	X		16	PC, DC, SC, DM, FM, LM
54ACT/74ACT157	Quad 2-Input	1 (L)	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC158	Quad 2-Input	1 (L)		X	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT158	Quad 2-Input	1 (L)		X	16	PC, DC, SC, DM, FM, LM
54AC/74AC251	8-Input	1 (L)	X	X	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT251	8-Input	I (L)	X	X	16	PC, DC, SC, DM, FM, LM
54AC/74AC253	Dual 4-Input	2 (L)	X		16	PC, DC, SC, DM, FM, LM
54ACT/74ACT253	Dual 4-Input	2 (L)	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC257	Quad 2-Input	I (L)	X		16	PC, DC, SC, DM
54ACT/74ACT257	Quad 2-Input	1 (L)	X		16	PC, DC, SC, DM, FM, LM
54AC/74AC258	Quad 2-Input	1 (L)		X	16	PC, DC, SC, DM, FM, LM
74ACT258	Quad 2-Input	1 (L)		X	16	PC, DC, SC

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low Enable	Active High Enable	Active Low Outputs	Pins	Package Codes
54AC/74AC138	1-of-8	3	2	1	8	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT138	1-of-8	3	2	1	8	16	PC, DC, SC, DM, FM, LM
54AC/74AC139	Dual 1-of-4	2, 2	1, 1		4, 4	16	PC, DC, SC, DM, FM, LM
54ACT/74ACT139	Dual 1-of-4	2, 2	1, 1		4, 4	16	PC, DC, SC, DM, FM, LM

Specialized LSI

Device	Type	Pins	Package Codes
74ACT708	64 × 9 FIFO Memory	28	PC, DC
74ACT1010	16 × 16 Multiplier/Accumulator	64	DC
74ACT1016	16 × 16 Multiplier	64	DC

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX)

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, DM, FM, LM
54F/74F10	Triple 3-Input	3	3	14	PC, DC, SC, DM, FM, LM
54F/74F20	Dual 4-Input	4	2	14	PC, DC, SC, DM, FM, LM
74F30	8-Input	8	1	14	PC, DC, SC, DM, FM, LM
74F37	Quad 2-Input Buffer	2	4	14	PC, DC, SC
54F/74F38	Quad 2-Input Buffer	2	4	14	PC, DC, SC, DM, FM, LM
74F40	Dual 4-Input Buffer	4	2	14	SC, PC, DC
AND					
54F/74F08	Quad 2-Input	2	4	14	PC, DC, SC, DM, FM, LM
54F/74F11	Triple 3-Input	3	3	14	PC, DC, SC, DM, FM, LM
OR/NOR, Exclusive-OR					
54F/74F02	Quad 2-Input NOR	2	4	14	PC, DC, SC, DM, FM, LM
74F27	Triple 3-Input NOR	3	3	14	SC, PC, DC
54F/74F32	Quad 2-Input OR	2	4	14	PC, DC, SC, DM, FM, LM
54F/74F86	Quad 2-Input Exclusive-OR	2	4	14	PC, DC, SC, DM, FM, LM
AND/OR-Invert					
54F/74F04	Hex Inverter	1	6	14	PC, DC, SC, DM, FM, LM
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, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

Flip-Flops/Registers

Device	Type	FF Type	Pins	Package Codes
54F/74F74	Dual Positive Edge-Trigger	D	14	PC, DC, SC, DM, FM, LM
54F/74F109	Dual Positive Edge-Trigger	J-K	16	PC, DC, SC, DM, FM, LM
74F112	Dual Negative Edge-Trigger	J-K	16	PC, DC, SC
74F113	Dual Edge-Trigger	J-K	14	PC, DC, SC
74F114	Dual Negative Edge-Trigger	J-K	14	PC, DC, SC
54F/74F174	Hex Master Reset	D	16	PC, DC, SC, DM, FM, LM
54F/74F175	Quad Master Reset	D	16	PC, DC, SC, DM, FM, LM
54F/74F374	Octal, 3-State Outputs	D	20	PC, DC, SC, DM, FM, LM
54F/74F378	Parallel w/Enable	D	16	PC, DC, SC, DM, FM, LM
54F/74F379	Quad Parallel w/Enable	D	16	PC, DC, SC, DM, FM, LM
54F/74F398	Quad Register	2-Port	20	PC, DC, SC, DM, FM, LM
54F/74F399	Quad Register	2-Port	16	PC, DC, SC, DM, FM, LM
54F/74F407	Data Access Register		24	SPC, SDC, SDM, FM, LM
54F/74F410	Register Stack		18	DC, SC, DM
54F/74F534	Octal, 3-State Outputs	D	20	PC, DC, SC, DM, FM, LM
54F/74F564	Octal, 3-State Outputs	D	20	PC, DC, SC, DM, FM, LM
54F/74F574	Octal, 3-State Outputs	D	20	PC, DC, DM, FM, LM
54F/74F821	10-Bit Master Reset	D	24	SPC, SDC, QC
74F823	9-Bit Master Reset	D	24	SPC, SDC, QC
74F825	8-Bit Master Reset	D	24	SPC, SDC, QC

Latches

Device	Broadside Pinout	Inverting	Transparent	3-State Outputs	No. of Bits	Pins	Package Codes
54F/74F373			X	X	8	20	PC, DC, SC, DM, FM, LM
54F/74F412			X	X	8	24	SPC, SDC, SDM, FM
74F432		X	X	X	8	24	SPC, SDC, SC
54F/74F533		X	X	X	8	20	PC, DC, SC, DM, FM, LM
54F/74F563	X	X	X	X	8	20	PC, DC, SC, DM, FM, LM
54F/74F573	X		X	X	8	20	PC, DC, SC, DM, FM, LM
74F841	X		X	X	10	24	SPC, SDC, QC
74F843	X		X	X	9	24	SDC, SPC, SC
74F845	X		X	X	8	24	SPC, SDC, SC

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

Counters

Device	Type	Up/ Down	Reset	Pins	Package Codes
54F/74F160A	4-Bit BCD Decade		A	16	PC, DC, SC, DM, FM, LM
54F/74F161A	4-Bit Binary		A	16	PC, DC, SC, DM, FM, LM
54F/74F162A	4-Bit BCD Decade		S	16	PC, DC, SC, DM, FM, LM
54F/74F163A	4-Bit Binary		S	16	PC, DC, SC, DM, FM, LM
74F168	4-Bit BCD Decade	X		16	PC, DC, SC
74F169	4-Bit Binary	X		16	PC, DC, SC
54F/74F190	4-Bit BCD Decade	X		16	PC, DC, SC, DM, FM, LM
54F/74F191	4-Bit Binary	X		16	PC, DC, SC, DM, FM, LM
54F/74F192	4-Bit BCD Decade	X	A	16	PC, DC, SC, DM, FM, LM
54F/74F193	4-Bit Binary	X	A	16	PC, DC, SC, DM, FM, LM
74F269	8-Bit Binary	X		24	SPC, SDC, SC
74F525	16-Stage Programmable		A	28	DC, SC
74F568	4-Bit BCD Decade, 3S	X	S/A	20	PC, DC, SC
74F569	4-Bit Binary, 3S	X	S/A	20	PC, DC, SC

S = Synchronous
A = Asynchronous
3S = 3-State

Shift Registers

Device	Type	Serial Inputs	Parallel Inputs	3-State Outputs	Pins	Package Codes
54F/74F164	8-Bit	2			14	PC, DC, SC, DM, FM, LM
54F/74F194	4-Bit Bidirectional	2	X		16	PC, DC, SC, DM, FM, LM
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, FM
74F323	8-Bit Storage	2	X	X	20	PC, DC, SC
74F673A	16-Bit S/P Out	1		X	24	SPC, SDC
74F675A	16-Bit S/P Out	1			24	SPC, SDC
54F/74F676	16-Bit Serial Out	1	X		24	SPC, SDC, SDM, FM

S/P = Serial/Parallel

Microprocessor Support

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

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

ALUs

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

ALU Support

Device	Type	Pins	Package Codes
74F182	Carry Lookahead Generator	16	PC, DC, SC
74F350	4-Bit Shifter	16	PC, DC, SC
74F381	ALU/Function Generator	20	PC, DC, SC
74F382	ALU/Carry Lookahead Generator	20	PC, DC, SC

Adders/Subtractors

Device	Type	Pins	Package Codes
54F/74F283	Binary Full Adder w/Carry Lookahead	16	PC, DC, SC, DM, FM, LM
54F/74F385	Quad Adder/Subtractor w/Master Reset	20	PC, DC, SC, DM, FM, LM
54F/74F583	BCD Full Adder w/Carry Lookahead	16	PC, DC, SC, DM, FM, LM

Comparators

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

Divider

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

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

Buffers/Line Drivers

Device	No. of Bits	Inverting	Noninverting	Pins	Package Codes
74F125			X	14	PC, DC, SC
54F/74F240	8	X		20	PC, DC, SC, DM, FM, LM
54F/74F241	8		X	20	PC, DC, SC, DM, FM, LM
54F/74F244	8		X	20	PC, DC, SC, DM, FM, LM
54F/74F365			X	16	PC, DC, SC, DM, FM, LM
74F366		X		16	PC, DC, SC
74F368		X		16	PC, DC, SC
54F/74F540		X		20	PC, DC, SC, DM, FM, LM
74F541			X	20	PC, DC, SC
54F/74F827	10		X	24	SPC, SDC, SC, DM, FM, LM, PC
54F/74F828	10	X		24	SPC, SDC, SC, DM, FM, LM, PC

Transceivers/Registered Transceivers

Device	Transceivers	Registered	Features	3-State Outputs	Pins	Package Codes
54F/74F243	4			X	14	DC, DM, FM, LM
54F/74F245	8			X	20	PC, DC, SC, DM, FM, LM
74F543	8	X		X	24	SPC, SDC, SC
54F/74F544	8	X	Inverting	X	24	SPC, SDC, DM, SDM, FM
54F/74F545	8			X	20	PC, DC, SC, DM, FM
74F550	8	X	Status Flags	X	28	DC
74F551	8	X	Status Flags, Inverting	X	28	DC
74F552	8	X	Parity and Flag	X	28	DC
74F588	8		GPIB Compatible	X	20	PC, DC, SC
54F/74F657	8		Parity	X	24	SPC, SC, SDC, SDM, FM, LM
29F52	8	X		X	24	SDC
29F53	8	X	Inverting	X	24	SDC

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

Multiplexers

Device	Type	Outputs True	Outputs Complement	Pins	Package Codes
54F/74F151A	8-Input	X	X	16	PC, DC, SC, DM, FM, LM
54F/74F153	Dual 4-Input	X		16	PC, DC, SC, DM, FM, LM
54F/74F157A	Quad 2-Input	X		16	PC, DC, SC, DM, FM, LM
54F/74F158A	Quad 2-Input		X	16	PC, DC, SC, DM, FM, LM
54F/74F251A	8-Input	X	X	16	PC, DC, SC, DM, FM, LM
54F/74F253	Dual 4-Input	X		16	PC, DC, SC, DM, FM, LM
54F/74F257A	Quad 2-Input	X		16	PC, DC, SC, DM, FM, LM
54F/74F258A	Quad 2-Input		X	16	PC, DC, SC, DM, FM, LM
74F350	4-Input w/Shift	X		16	PC, DC, SC
54F/74F352	Dual 4-Input		X	16	PC, DC, SC, DM, FM, LM
54F/74F353	Dual 4-Input		X	16	PC, DC, SC, DM, FM, LM
54F/74F398	Quad 2-Port w/Flip-Flop	X	X	20	PC, DC, SC, DM, FM, LM
54F/74F399	Quad 2-Port w/Flip-Flop	X		16	PC, DC, SC, DM, FM, LM

Decoders/Demultiplexers

Device	Type	3-State Outputs	Latched Input	Acknowledge Output	Pins	Package Codes
54F/74F138	1-of-8				16	PC, DC, SC, DM, FM, LM
54F/74F139	Dual 1-of-4				16	PC, DC, SC, DM, FM, LM
74F537	1-of-10	X			20	PC, DC, SC
74F538	1-of-8	X			20	PC, DC, SC
74F539	Dual 1-of-4	X			20	PC, DC, SC
54F/74F547	3-to-8		X	X	20	PC, DC, SC, DM, FM, LM
54F/74F548	3-to-8			X	20	PC, DC, SC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

FAST (54F/74FXX) (Continued)

Memory

Device	Type	Pins	Package Codes
54F/74F189	16 × 4 RAM	16	PC, DC, SC, DM, FM, LM
54F/74F219	16 × 4 RAM	16	PC, DC, SC, DM, FM, LM
54F/74F403	16 × 4 FIFO	24	SPC, SDC, SDM, FM, LM
54F/74F413	64 × 4 FIFO	16	PC, DC, DM
74F433	64 × 4 FIFO	24	SPC, SDC, SC

Memory Support

Device	Type	Features	Pins	Package Codes
54F/74F407	Data Access Register	3-State Outputs	24	SPC, SDC, SDM, FM, LM
54F/74F410	Register Stack	3-State Outputs	18	DC, SC, DM

Cyclic Redundancy Checker-Generator

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

Parity Generator/Checker

Device	Features	Pins	Package Codes
54F/74F280	Odd/Even Outputs, 9 Bits In	14	PC, DC, SC, DM, FM, LM

Error Detection and Correction

Device	Features	Pins	Package Codes
74F420	Parallel Error Detection and Correction	48	QC
74F632	32-Bit Error Detection and Correction	52	DC, QC

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX)

NAND Gates

Device	Type	Pins	Package Codes
54LS/74LS00	Quad 2-Input	14	PC, DC, DM, FM, LM
54LS/74LS03	Quad 2-Input (OC)	14	PC, DC, DM, FM
54LS/74LS04	Hex Inverter	14	PC, DC, DM, FM, LM
54LS/74LS05	Hex Inverter (OC)	14	PC, DM, FM
54LS/74LS10	Triple 3-Input	14	PC, DC, DM, FM, LM
74LS12	Triple 3-Input	14	PC, DC
54LS/74LS13	Dual 4-Input Schmitt	14	PC, DM, FM, LM
54LS/74LS14	Hex Schmitt Trigger Inverter	14	PC, DC, DM, FM, LM
54LS/74LS20	Dual 4-Input	14	PC, DC, DM, FM, LM
54LS22	Dual 4-Input (OC)	14	DM, FM
54LS/74LS26	Quad 2-Input (12V)	14	PC, DC, DM, FM
54LS/74LS30	8-Input	14	PC, DC, DM, FM, LM
54LS/74LS37	Quad 2-Input Buffer	14	PC, DC, DM, FM, LM
54LS/74LS38	Quad 2-Input (OC/48 mA)	14	PC, DC, DM, FM
54LS/74LS40	Dual 4-Input Buffer	14	PC, DM, FM, LM
74LS132	Quad 2-Input Schmitt	14	PC, DC
54LS/74LS133	13-Input	16	PC, DC, DM, FM, LM

NOR Gates

Device	Type	Pins	Package Codes
54LS/74LS02	Quad 2-Input	14	PC, DC, DM, FM, LM
54LS/74LS27	Triple 3-Input	14	PC, DC, DM, FM, LM
54LS/74LS28	Quad 2-Input	14	PC, DM, FM, LM
54LS/74LS33	Quad 2-Input (OC)	14	PC, DM, FM
54LS/74LS260	Dual 5-Input	14	PC, DC, DM, FM, LM
54LS/74LS266	Quad 2-Input (OC)	14	PC, DC, DM, FM

OC = Open Collector

AND Gates

Device	Type	Pins	Package Codes
54LS/74LS08	Quad 2-Input	14	PC, DC, DM, FM, LM
54LS/74LS09	Quad 2-Input (OC)	14	PC, DM, FM
54LS/74LS11	Triple 3-Input	14	PC, DC, DM, FM, LM
54LS/74LS15	Triple 3-Input (OC)	14	PC, DM, FM
54LS/74LS21	Dual 4-Input	14	PC, DC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

OR Gates

Device	Type	Pins	Package Codes
54LS/74LS32	Quad 2-Input	14	PC, DC, DM, FM, LM

Exclusive-OR Gates

Device	Type	Pins	Package Codes
74LS86	Quad 2-Input	14	PC, DC
54LS/74LS136	Quad 2-Input (OC)	14	PC, DM, FM
74LS386	Quad 2-Input	14	PC, DC

Exclusive-NOR Gates

Device	Type	Pins	Package Codes
54LS/74LS266	Quad 2-Input (OC)	14	PC, DC, DM, FM

OC = Open Collector

AND/OR-Invert Gates

Device	Type	Pins	Package Codes
54LS/74LS51	Quad 2-2 Input	14	PC, DC, DM, FM, LM
54LS/74LS54	4-Wide, 2-Input	14	PC, DC, DM, FM
54LS/74LS55	2-Wide, 4-Input	14	PC, DM, FM

Buffer Gates and Drivers

Device	Type	Pins	Package Codes
54LS/74LS125A	Quad Buffer (3S)	14	PC, DC, DM, FM, LM
54LS/74LS126	Quad Buffer (3S)	14	PC, DC, DM, FM
54LS/74LS365A	Hex (3S)	16	PC, DC, DM, FM, LM
54LS/74LS366A	Hex Inverter (3S)	16	PC, DC, DM, FM, LM
54LS/74LS367A	Hex (3S)	16	PC, DC, DM, FM, LM
54LS/74LS368A	Hex Inverter (3S)	16	PC, DC, DM, FM, LM

3S = 3-State

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS74	Dual D	D	X	X	30	14	DM, FM, LM
74LS74A	Dual D	D	X	X	30	14	PC
54LS109	Dual JK	J,K	X	X	30	16	DM, FM
74LS109A	Dual JK	J,K	X	X	30	16	PC
54LS/74LS112	Dual JK	J,K	X	X	30	16	PC, DC, DM, FM, LM
54LS113	Dual JK	J,K	X		30	14	DM, FM, LM
54LS114	Dual JK	J,K	X	X	30	14	DM, FM, LM
54LS/74LS174	Hex D	D		X	30	16	PC, DC, DM, FM, LM
54LS/74LS175	Quad	D		X	30	16	PC, DC, DM, FM, LM
54LS/74LS374	Octal D	D			35	20	PC, DC, DM, FM, LM
54LS/74LS377	Octal D	D			30	20	PC, DC, DM, FM, LM
74LS574	Octal D	D			35	20	PC, DC

Latches

Device	Type	Data Inputs	Common Clear	Enable Inputs (Level)	Min. Enable Pulse Width (ns)	Max. Delay Enable to Output (ns)	Pins	Package Codes
54LS/74LS170	16-Bit D	4		2	25	35	16	PC, DM, FM
54LS/74LS256	Dual 4-Bit Addressable	8	L	2 (L)	17	27	16	PC, DM, FM
54LS/74LS259	8-Bit Addressable	1	L	1 (L)	17	27	16	PC, DM, FM, LM
54LS/74LS279	4-Bit Set-Reset	4					16	PC, DM, FM, LM
74LS373	8-Bit D	8		1 (H)	15	30	20	PC, DC
54LS/74LS375	4-Bit D	4		2 (H)	20	30	16	PC, DC, DM, FM
54LS533	8-Bit D	8		1 (H)	15	30	20	PC, DC
74LS563	8-Bit D	8		1 (H)	15	30	20	PC, DC
74LS573	8-Bit D	8		1 (L)	15	30	20	PC, DC
54LS/74LS670	16-Bit D	4		2	25	35	16	PC, DC, DM, FM, LM

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/74LS174	6-Bit D	6	L	30	16	PC, DC, DM, FM, LM
54LS/74LS175	4-Bit D	4	L	30	16	PC, DC, DM, FM, LM
54LS74LS374	8-Bit D	8		35	20	PC, DC, DM, FM, LM
74LS534	8-Bit D	8		35	20	PC, DC
74LS564	8-Bit D	8		35	20	PC, DC

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

Multiplexers

Device	Type	Enable Inputs	Outputs True	Outputs Complement	Pins	Package Codes
54LS/74LS151	8-Input	1	X	X	16	PC, DM, FM, LM
54LS152	8-Input			X	16	FM
54LS/74LS153	Dual 4-Input	2	X		16	PC, DC, DM, FM, LM
54LS/74LS157	Quad 2-Input	1	X		16	PC, DC, DM, FM, LM
54LS/74LS158	Quad 2-Input	1		X	16	PC, DC, DM, FM, LM
54LS/74LS251	8-Input	1	3S	3S	16	PC, DC, DM, FM
54LS/74LS253	Dual 4-Input	2	3S		16	PC, DC, DM, FM, LM
54LS/74LS257A	Quad 2-Input	1	3S		16	PC, DC, DM, FM, LM
54LS/74LS258A	Quad 2-Input	1		3S	16	PC, DC, DM, FM, LM
54LS/74LS298	Quad 2-Port	Clock (E-T)	Latched		16	PC, DM, FM
54LS/74LS352	Dual 4-Input	2		X	16	PC, DC, DM, FM
54LS/74LS353	Dual 4-Input	2		3S	16	PC, DC, DM, FM

3S = 3-State
E-T = Edge-Trigger

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low Enable	Active Low Outputs	Open Collector Output Voltage (V)	Pins	Package Codes
54LS/74LS42	1-of-10	4 (BCD)		10		16	PC, DC, DM, FM
54LS/74LS138	1-of-8	3	2	8		16	PC, DC, DM, FM, LM
54LS/74LS139	Dual 1-of-4	2 + 2	1 + 1	4 + 4		16	PC, DC, DM, FM, LM
54LS/74LS155	Dual 1-of-4	2	2 + 1	4 + 4		16	PC, DC, DM, FM, LM
54LS/74LS156	Dual 1-of-4	2	2 + 1	4 + 4	5.5	16	PC, DM, FM
54LS/74LS259	1-of-8	3	1	8 H		16	PC, DC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54LS/74LS95B	Right/Left Shift	4	D	4S	30	14	PC, DC, DM, FM
54LS/74LS164	Serial-In/Parallel-Out Shift	8	2D		25	14	PC, DC, DM, FM, LM
54LS/74LS165	Parallel/Serial-In Serial-Out Shift	8	D	8A	30	16	PC, DC, DM, FM
54LS/74LS170	Register File (OC)	4 × 4		4A		16	PC, DM, FM
54LS/74LS173	Quad D (3S)	4		4S	30	16	PC, DC, DM, FM, LM
54LS/74LS194A	Bidirectional Universal	4	DR, DL	4S	30	16	PC, DC, DM, FM, LM
54LS/74LS195A	Universal Shift	4	J, K	4S	30	16	PC, DC, DM, FM, LM
54LS/74LS273	Octal D	8		8S	30	20	PC, DC, DM, FM, LM
54LS/74LS295A	Shift (3S)	4	D	4S	30	14	PC, DC, DM, FM
54LS/74LS298	Quad 2-Port	4		2D (Mux)	30	16	PC, DM, FM
54LS/74LS299	Universal Shift/Storage	8	DR, DL	8S	35	20	PC, DC, DM, FM, LM
54LS/74LS322	Serial/Parallel (3S)	8	2D	8S	35	20	PC, DC, DM, FM
54LS/74LS323	Universal Shift/Storage	8	DR, DL	8S	35	20	PC, DC, DM, FM
54LS/74LS378	Parallel D	6		6S	30	16	PC, DM, FM
54LS/74LS379	Quad D	4		4S	30	16	PC, DC, DM, FM, LM
54LS/74LS395	Parallel Shift Right (3S)	4	D	4S	30	16	PC, DC, DM, FM, LM
54LS/74LS502	Successive Approximation	8	D		15	16	PC, DC, DM, FM
54LS/74LS503	Successive Approximation	8	D		15	16	PC, DC, DM, FM
54LS/74LS670	Register File (3S)	4 × 4		4A		16	PC, DC, DM, FM, LM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
74LS90	Decade	2 × 5		32	14	PC, DC
74LS93	Divide-by-16	2 × 8		32	14	PC, DC
54LS/74LS160A	BCD Decade	10 P	S	25	16	PC, DM, FM, LM
54LS/74LS161A	Binary	16 P	S	25	16	PC, DC, DM, FM, LM
54LS/74LS162A	BCD Decade	10 P	S	25	16	PC, DM, FM, LM
54LS/74LS163A	Binary	16 P	S	25	16	PC, DM, FM, LM
54LS168	Up/Down	10 P	S	25	16	DM, FM, LM
54LS/74LS169	Up/Down	16 P	S	25	16	PC, DC, DM, FM, LM
74LS190	Up/Down Decade	10	A	20	16	PC
74LS191	Up/Down Binary	16	A	20	16	PC, DC
54LS/74LS192	Up/Down Decade	10	A	30	16	PC, DC, DM, FM, LM
54LS/74LS193	Up/Down Binary	16	A	30	16	PC, DC, DM, FM, LM
74LS196	Decade	2 × 5	A	45	14	PC
74LS197	Binary	2 × 8	A	50	14	PC, DC
74LS290	BCD Decade	2 × 5		32	14	PC, DC
74LS293	Binary	2 × 8		32	14	PC, DC
74LS390	Dual Decade	2 × 5		40	16	PC, DC
74LS393	Dual Modulo 16	2 × 8		40	14	PC, DC
54LS/74LS490	Dual Decade	2 × 5		40	16	PC, DM, FM

S = Synchronous
A = Asynchronous

Display Decoder/Drivers

Device	Type	Output Current (mA)	Output Voltage (V)	Active High/Low	Ripple Blanking	Pins	Package Codes
54LS/74LS47	BCD to 7 Segment	24.0	15.0	L	X	16	PC, DC, DM, FM
54LS/74LS48	BCD to 7 Segment	1.3	5.5	H	X	16	PC, DC, DM, FM
54LS49	BCD to 7 Segment	8.0	5.5	H	X	14	DM, FM
54LS/74LS247	BCD to 7 Segment	24.0	15.0	L	X	16	PC, DC, DM, FM
54LS/74LS248	BCD to 7 Segment	1.3	5.5	H	X	16	PC, DC, DM, FM
54LS/74LS249	BCD to 7 Segment	8.0	5.5	H	X	16	PC, DC, DM, FM
54LS/74LS347	BCD to 7 Segment	24.0	7.0	L	X	14	PC, DC, FM
54LS/74LS447	BCD to 7 Segment	24.0	7.0	L	X	16	PC, DC, DM, FM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power Schottky (54LS/74LSXX, 96LSXX) (Continued)

Monostables (One-Shots)

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
96LS02	Dual Retriggerable, Resettable	± 1.0	± 0.8	1	1	35	16	PC, DC, DM, FM

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min. I_{OS} (mA)	Pins	Package Codes
54LS/74LS240	Octal Inverting Bus Driver (3S)	Any TTL	64	− 40	20	PC, DC, DM, FM, LM
54LS/74LS241	Octal Noninverting Bus Driver (3S)	Any TTL	64	− 40	20	PC, DC, DM, FM, LM
54LS/74LS244	Octal Noninverting Bus Driver (3S)	Any TTL	64	− 40	20	PC, DC, DM, FM, LM
54LS/74LS245	Octal Bus Transceiver	Any TTL	24	− 40	20	PC, DC, DM, FM, LM
74LS540	Octal Buffer Line Driver	Any TTL	64	− 40	20	PC, DC

3S = 3-State

Arithmetic Operators, 4-Bit

Device	Type	Features	Pins	Package Codes
54LS/74LS83A	Adder	Full Binary 4-Bit with Carry	16	PC, DC, DM, FM
54LS/74LS85	Comparator	4-Bit Magnitude with Expander	16	PC, DC, DM, FM, LM
54LS/74LS181	Arithmetic-Logic	External Carry Lookahead	24	PC, DM, FM
54LS/74LS283	Adder	Full Binary 4-Bit with Carry	16	PC, DC, DM, FM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Schottky (54S/74SXX, 93SXX, 96SXX)

Gates

Device	Type	Pins	Package Codes
NAND			
74S00	Quad 2-Input	14	PC, DC
74S03	Quad 2-Input (OC)	14	PC, DC
74S04	Hex Inverter	14	PC, DC
74S05	Hex Inverter (OC)	14	PC, DC
74S10	Triple 3-Input	14	PC, DC
74S20	Dual 4-Input	14	PC, DC
74S30	8-Input	14	PC, DC
74S40	Dual 4-Input Buffer	14	PC, DC
74S132	Quad 2-Input Schmitt	14	PC, DC
74S133	13-Input	14	PC, DC
AND			
74S08	Quad 2-Input	14	PC, DC
74S11	Triple 3-Input	14	PC, DC
NOR			
74S02	Quad 2-Input	14	PC, DC
OR			
74S32	Quad 2-Input	14	PC, DC
Exclusive-OR			
74S86	Quad 2-Input	14	PC, DC
AND/OR-Invert			
74S51	Quad 2-2 Input	14	PC, DC
74S64	4-2-3-2 Input	14	PC, DC

OC = Open Collector

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
74S74	Dual D	D	X	X	75	14	PC, DC
74S109	Dual J-K	J, K	X	X	75	16	PC, DC
74S112	Dual J-K	J, K	X	X	80	16	PC, DC
74S174	Hex D	D		X	75	16	PC, DC
74S175	Quad D	D		X	75	16	PC, DC

Schottky (54S/74SXX, 93SXX, 96SXX) (Continued)

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
74S174	6-Bit D	6	L	75	16	PC, DC
74S175	4-Bit D	4	L	75	16	PC, DC

Multiplexers

Device	Type	Enable Inputs	Outputs		Pins	Package Codes
			True	Complement		
74S151	8-Input	1	X	X	16	PC, DC
74S153	Dual 4-Input	2	X		16	PC, DC
74S157	Quad 2-Input	1	X		16	PC, DC
74S158	Quad 2-Input	1		X	16	PC, DC
74S253	Dual 4-Input	2	3S		16	PC, DC
74S257	Quad 2-Input	1	3S		16	PC, DC
74S258	Quad 2-Input	1		3S	16	PC, DC

3S = 3-State

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low		Pins	Package Codes
			Enable	Outputs		
74S138	1-of-8	3	2	8	16	PC, DC
74S139	Dual 1-of-4	3	2	8	16	PC, DC

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
74S194	Bidirectional Universal	4	DR, DL	4S	70	16	PC, DC
93S00	Universal Shift	4	J, $\overline{K}$	4S	70	16	PC, DC

Schottky (54S/74SXX, 93SXX, 96SXX) (Continued)

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
93S10	BCD Decade	10 P	S	70	16	DC
93S16	4-Bit Binary	16 P	S	70	16	DC

S = Synchronous
P = Presettable

Monostables (One-Shots)

Device	Type	Pulse Width Variation (%)		No. of Inputs		Min. Output (tw) (ns)	Pins	Package Codes
		vs. Temp	vs. V_{CC}	Pos.	Neg.			
96S02	Dual Retriggerable, Resettable	± 1.0	± 1.0	1	1	27	16	PC, DC

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min. I_{OS} (mA)	Pins	Package Codes
74S40	Dual 4-Input NAND Buffer	Any TTL	60	– 50	14	PC, DC

Arithmetic Operators

Device	Type	Features	No. of Bits	Pins	Package Codes
93S41	Arithmetic-Logic	External CLA	4	24	PC, DC
93S43	Multiplier	Twos Complement	4 × 2	24	PC, DC
93S46	Comparator	6-Bit Identity w/Expander	6	16	PC, DC
93S47	Comparator, High-Speed	6-Bit Identity (OC)	6	16	PC, DC
93S62	Parity	9-Bit Parity Generator/Checker	9	14	PC, DC

OC = Open Collector

Standard TTL (54/74XX, 93XX, 96XX)

Gates

Device	Type	Pins	Package Codes
NAND			
54/7400	Quad 2-Input	14	PC, DC, DM, FM
7401	Quad 2-Input (OC)	14	PC, DC
7403	Quad 3-Input (OC)	14	PC, DC
54/7404	Hex Inverter	14	PC, DC, DM, FM
7405	Hex Inverter (OC)	14	PC, DC
7406	Hex Inverter (OC/30V)	14	PC, DC
54/7410	Triple 3-Input	14	PC, DC, DM, FM
54/7414	Hex Schmitt Trigger	14	PC, DC, DM, FM
7416	Hex Inverter (OC/15V)	14	PC, DC
54/7420	Dual 4-Input	14	PC, DC, DM, FM
54/7430	8-Input	14	PC, DC, DM, FM
54/7437	Quad 2-Input Buffer	14	PC, DC, DM, FM
7438	Quad 2-Input (OC/48 mA)	14	PC, DC
7439	Quad 2-Input NAND Buffer (OC)	14	DC
54/7440	Dual 4-Input Buffer	14	PC, DC, DM, FM
74132	Quad 2-Input Schmitt	14	PC, DC
96101	Quad 2-Input NAND Buffer (OC)	14	PC, DC
NOR			
54/7402	Quad 2-Input	14	PC, DC, DM, FM
54/7425	Dual 4-Input w/Strobe	14	PC, DC, DM, FM
7427	Triple 3-Input	14	PC, DC
AND			
7407	Hex Buffer (OC/30V)	14	PC, DC
54/7408	Quad 2-Input	14	PC, DC, DM, FM
54/7409	Quad 2-Input (OC)	14	PC, DC, DM, FM
7411	Triple 3-Input	14	PC, DC
7417	Hex Buffer (OC/15V)	14	PC, DC
OR			
54/7432	Quad 2-Input	14	PC, DC, DM, FM
Exclusive-OR			
54/7486	Quad 2-Input	14	PC, DC, DM, FM
AND/OR-Invert			
7450	Quad 2-2 Input Expandable	14	PC, DC
54/7451	Dual 2-2 Input	14	PC, DC, DM, FM

OC = Open Collector

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Standard TTL (54/74XX, 93XX, 96XX) (Continued)

Buffer Gates and Drivers

Device	Type	Pins	Package Codes
54/74125	Quad Bus Buffer (3S)	14	PC, DC, DM, FM

3S = 3-State

Single and Dual Flip-Flops

Device	Type	Inputs	Direct Set	Direct Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/7473	Dual J-K	J, K		X	15	14	PC, DC, DM, FM
54/7474	Dual D	D	X	X	15	14	PC, DC, DM, FM
54/7476	Dual J-K	J, K	X	X	15	16	PC, DC, DM, FM
54/74174	Hex D				25	16	PC, DC, DM, FM
54/74175	Quad D				25	16	PC, DC, DM, FM

Latches

Device	Type	Data Inputs	Common Clear	Enable Inputs (Level)	Min. Enable Pulse Width (ns)	Max. Delay Enable to Output (ns)	Pins	Package Codes
54/7475	4-Bit D	4		2 (H)	20	30	16	PC, DC, DM, FM
54/74170	16-Bit D	4		2	25	45	16	PC, DC, DM, FM
54/74279	4-Bit RS	4					16	PC, DC, DM, FM
9308	Dual 4-Bit D	8	2 × L	2 × 2 AND	18	30	24	PC, DC, DM, FM
9314	Quad 4-Bit D, RS	4	L	1 (L)	18	24	16	PC, DC, DM, FM
9334	8-Bit Addressable	1	L	1 (L)	17	24	16	PC, DC, DM, FM

Multiple Flip-Flops

Device	Type	Data Inputs	Common Clear	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/74174	6-Bit D	6	L	25	16	PC, DC, DM, FM
54/74175	4-Bit D	4	L	25	16	PC, DC, DM, FM
9338	8-Bit Multiple Port Register	1		27	16	PC, DC, DM, FM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Standard TTL (54/74XX, 93XX, 96XX) (Continued)

Multiplexers

Device	Type	Enable Inputs	Outputs True	Outputs Complement	Pins	Package Codes
54/74150	16-Input	1		X	24	PC, DC, DM, FM
54/74151A	8-Input	1	X	X	16	PC, DC, DM, FM
54/74153	Dual 4-Input	2	X		16	PC, DC, DM, FM
54/74157	Quad 2-Input	1	X		16	PC, DC, DM, FM
54298	Quad 2-Port	Clock (E-T)	Latched		16	DM, FM
9309	Dual 4-Input		X	X	16	PC, DC, DM, FM
9312	8-Input	1	X	X	16	PC, DC, DM, FM
9322	Quad 2-Input	1	X		16	PC, DC, DM, FM

E-T = Edge Triggered

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low Enable	Active Low Outputs	OC Output Voltage (V)	Pins	Package Codes
54/7442A	1-of-10	4 (BCD)		10		16	PC, DC, DM, FM
7445	1-of-10	4 (BCD)		10	30	16	PC, DC
74145	1-of-10	4 (BCD)		10	15	16	PC, DC
54/74154	1-of-16	4	2	16		24	PC, DM, FM
74155	Dual 1-of-4	2	2 + 1	4 + 4		16	PC, DC
9301	1-of-10	4 (BCD)		10		16	PC, DC, DM, FM
9311	1-of-16	4	2	16		24	PC, DC, DM, FM
9321	Dual 1-of-4	2 + 2	1 + 1	4 + 4		16	PC, DC, DM, FM
9334	1-of-8	3	1	8		16	PC, DC, DM, FM

Standard TTL (54/74XX, 93XX, 96XX) (Continued)

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
54/7495A	Right/Left Shift	4	D	4S	25	14	PC, DC, DM, FM
54/74164	Serial-In/Parallel-Out Shift	8	2D		25	14	PC, DC, DM, FM
54/74165	Parallel to Serial Converter	8	D	8A	25	16	PC, DC, DM, FM
54/74170	Register File (OC)	4 × 4		4A		16	PC, DC, DM, FM
54/74173	Quad D (3S)	4		4S	25	16	PC, DC, DM, FM
54298	Quad 2-Port	4	2D (Multiplexer)		30	16	DM, FM
9300	Universal Shift	4	J, $\overline{K}$	4S	30	16	PC, DC, DM, FM
9328	Shift	2 × 8	2 × 2 D (Multiplexer)		20	16	PC, DC, DM, FM

OC = Open Collector
3S = 3-State

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
5490	Decade	2 × 5		32	14	DM, FM
7490A	Decade	2 × 5		32	14	PC, DC
7493A	Divide-by-16	2 × 8		32	14	PC, DC
54/7497	Rate Multiplier	64		25	16	PC, DC, DM, FM
54/74161	Binary	16 P	S	25	16	PC, DC, DM, FM
74163	Binary	16 P	S	25	16	PC, DC
54/74191	Up/Down Binary	16	A	20	16	PC, DC, DM, FM
74197	Binary	2 × 8 P	A	50	14	PC, DC
9316	Binary	16 P	S	30	16	PC, DC, DM, FM

A = Asynchronous
S = Synchronous
P = Presettable

Standard TTL (54/74XX, 93XX, 96XX) (Continued)

Display Decoder/Drivers

Device	Type	Output Current (mA)	Output Voltage (V)	Active High/ Low	Ripple Blanking	Blanking Above BCD 9-Input	Pins	Package Codes
7445	1-of-10 Driver (OC)	80	30.0	L		X	16	PC, DC
7447A	BCD to 7-Segment (OC)	40	15.0	L	X		16	PC, DC
74145	1-of-10 Driver (OC)	80	15.0	L		X	16	PC, DC
9368	7-Segment LED Driver, Common Cathode	20	1.7	H	X		16	PC, DC
9370	7-Segment LED Driver, Common Anode (OC)	20	1.7	H	X		16	PC, DC
9374	7-Segment LED Driver, Common Anode	15	10.0	L	X		16	PC, DC

OC = Open Collector

Monostables (One-Shots)

Device	Type	Pulse Width Variation (%)		No. of Inputs		Min. Output (tw) (ns)	Pins	Package Codes
		vs. Temp	vs. V_{CC}	Pos.	Neg.			
54/74121	Single Non-Retriggerable	± 0.25	± 0.15	1	2	40	14	PC, DC, DM, FM
54122	Single Retriggerable, Resettable	± 2.7	± 1.0	2	2	45	14	DM, FM
54/74123	Dual Retriggerable, Resettable	± 2.7	± 1.0	1	1	45	16	PC, DC, DM, FM
9601	Single Retriggerable	± 2.7	± 1.0	2	2	50	14	PC, DC, DM, FM
9602	Dual Retriggerable	± 1.5	± 1.5	1	1	72	16	PC, DC, DM, FM

Standard TTL (54/74XX, 93XX, 96XX) (Continued)

Line and Bus Drivers/Transceivers/Receivers

Device	Type	Companion Receiver	I_{OL} (mA)	Min. I_{OS} (mA)	Pins	Package Codes
54/7437	Quad 2 NAND Buffer	Any TTL	48	– 20	14	PC, DC, DM, FM
7438	Quad 2 NAND Buffer (OC)	96106	48	OC	14	PC, DC
54/7440	Dual 2 NAND Buffer	Any TTL	48	– 20	14	PC, DC, DM, FM
96106	Quad 2 NAND Buffer (OC)	96106	80	OC	14	PC, DC

OC = Open Collector

Arithmetic Operators

Device	Type	Features	No. of Bits	Pins	Package Codes
5483A	Adder	Full Binary w/Carry	4	16	DM, FM
54/7485	Comparator	Magnitude w/Expander	4	16	PC, DC, DM, FM
74180	Parity	Generator/Checker	8	14	PC, DC
54/74283	Adder	Full Binary w/Carry	4	16	PC, DC, DM, FM
9318	Encoder	Priority w/Expander	8	16	PC, DC
9324	Comparator	Magnitude	5	16	PC, DC, DM, FM
9348	Parity	Generator/Checker	12	14	DM, FM
9386	Comparator	Identity Exclusive-NOR (OC)	5	16	PC, DC

OC = Open Collector

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

Low Power TTL (93LXX, 96LXX)

Latches

Device	Type	Data Inputs	Common Clear	Enable Inputs (Level)	Min. Enable Pulse Width (ns)	Max. Delay Enable to Output (ns)	Pins	Package Codes
93L08	Dual 4-Bit	8	2 × L	2 × 2 AND	30	45	24	PC, DC, DM, FM
93L14	4-Bit RS or D	4	L	1 (L)	30	45	16	PC, DC, DM, FM
93L34	8-Bit Addressable	1	L	1 (L)	26	45	16	PC, DC, DM, FM

Multiple Flip-Flops

Device	Type	Data Inputs	CP Inputs (Level)	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
93L38	8-Bit Multiple Port Register	1	1 (L)	14	16	PC, DC, DM, FM

Multiplexers

Device	Type	Enable Inputs	Outputs		Pins	Package Codes
			True	Complement		
93L12	8-Input	1		X	16	DM, FM
93L22	Quad 2-Input	1	X		16	DM, FM

Decoders/Demultiplexers

Device	Type	Address Inputs	Active Low		Pins	Package Codes
			Enable	Outputs		
93L01	1-of-10	4 (BCD)		10	16	DM, FM
93L21	Dual 1-of-4	2 + 2	1 + 1	4 + 4	16	DM, FM
93L34	1-of-8	3	1	8	16	PC, DC, DM, FM

Low Power TTL (93LXX, 96LXX) (Continued)

Registers

Device	Type	No. of Bits	Serial Entry	Parallel Entry No. of Bits	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
93L00	Universal Shift	4	J, $\overline{K}$	4S	10	16	DM, FM
93L28	Dual 8-Bit Shift	2 × 8	2 × 2 D (MUX)		5	16	PC, DC, DM, FM
93L38	Multiport	8	D		20	16	PC, DC, DM, FM

Counters

Device	Type	Modulus	Parallel Entry	Guaranteed Clock Frequency (MHz)	Pins	Package Codes
93L10	BCD Decade	10 P	S	13	16	DM, FM

S = Synchronous
P = Presettable

Monostables (One-Shots)

		Pulse Width Variation (%)		No. of Inputs		Min.		
Device	Type	vs. Temp	vs. V_{CC}	Pos.	Neg.	Output (tw) (ns)	Pins	Package Codes
96L02	Dual Retriggerable, Resettable	± 1.6	± 1.5	1	1	110	16	PC, DC, DM, FM

Arithmetic Operators

Device	Type	Features	No. of Bits	Pins	Package Codes
93L24	Comparator	Magnitude	5	16	PC, DC, DM, FM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

F100K High-Speed 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
F100102	Quint OR/NOR	2	0.95	24	DC, FC
F100104	Quint AND/NAND	2	1.40	24	DC, FC
F100107	Quint Exclusive-OR/NOR	2	1.40	24	DC, FC
F100117	Triple 2-Wide OA/OAI	5	2.30	24	DC, FC
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

*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
F100135	Triple J-K Flip-Flop	565 MHz	24	DC, FC
F100150	Hex D Latch	1.20 ns	24	DC, FC
F100151	Hex D Flip-Flop	375 MHz	24	DC, FC
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
F100170	Dual 1-of-4 or Single 1-of-8 Demultiplexer/Decoder	2.50	24	DC, FC
F100171	Triple 4-Input Multiplexer	1.40	24	DC, FC

*Maximum propagation delay at 25°C in flatpak.

F100K High-Speed 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
F100114	Quint Differential Line Receiver	1.80	24	DC, FC
F100123	Hex Bus Driver	2.2/4.10	24	DC, FC
F100126	9-Bit Backplane Driver	2.55	24	DC, FC
F100250	Quint Line Transceiver	4.1	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
F100141	8-Bit Bidirectional Shift Register	300	24	DC, FC
F100241	8-Bit Shift Register	565	24	DC, FC

**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
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 × 8-Bit Recode Multiplier	3.60	24	DC, FC

†Maximum propagation delay at 25°C in flatpak.

F100K High-Speed ECL (100XXX) (Continued)

Translators

Device	Type	Propagation Delay* (ns)	Pins	Package Codes
F100124	Hex TTL-to-ECL	2.70	24	DC, FC
F100125	Hex ECL-to-TTL	3.50	24	DC, FC
F100128	ECL/TTL Bidirectional Translator	3.56	24	DC, FC

*Maximum propagation delay at 25°C in flatpack.

Special Functions

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

F100K High-Speed ECL (100XXX) (Continued)

F100K ECL Devices Cross-Reference Guide

Device	Description	Hitachi	Signetics
F100101	Triple 5-Input OR/NOR Gate	100101	100101
F100102	Quint 2-Input OR/NOR Gate	100102	100102
F100104	Quint 2-Input AND/NAND Gate		
F100107	Quint Exclusive OR/NOR Gate	100107	100107
F100112	Quad Driver	100112	100112
F100113	Quad Line Driver		100113
F100114	Quint Line Receiver	100114	100114
F100117	Triple 2-Wide OA-OAI	100117	100117
F100118	Triple 5-Wide OA-OAI	100118	100118
F100121	9-Bit Inverting Buffer		
F100122	9-Bit Buffer	100122	100122
F100123	Hex Bus Driver	100123	100123
F100124	Hex TTL-to-ECL Translator		
F100125	Hex ECL-to-TTL Translator	100125	
F100126	9-Bit Backplane Driver	100126	100126
F100128	ECL/TTL Bidirectional Translator		
F100130	Triple D Latch	100130	
F100131	Triple D Flip-Flop	100131	100131
F100135	Triple J-K Flip-Flop	100135	100135
F100136	4-Bit Shift Register/Counter	100136	100136
F100141	8-Bit Shift Register	100141	100141
F100142	4 × 4 Content-Addressable Memory	100142	
F100145	16 × 4 Register File		
F100150	Hex D Latch	100150	100150
F100151	Hex D Flip-Flop	100151	100151
F100155	Quad Multiplexer/Latch	100155	100155
F100156	Mask-Merge Latch	100156	
F100158	8-Bit Shift Matrix	100158	100158
F100160	Dual Parity Generator/Checker	100160	100160
F100163	Dual 8-Bit Multiplexer	100163	100163
F100164	16-Input Multiplexer	100164	100164
F100165	Priority Encoder	100165	100165
F100166	9-Bit Comparator	100166	100166
F100170	Universal Decoder/Demultiplexer	100170	100170
F100171	Triple 4-Input Multiplexer	100171	100171
F100175	Quint 100K/10K Latch		100175
F100179	Carry Lookahead Generator	100179	
F100180	High-Speed 6-Bit Adder		100180
F100181	4-Bit ALU	100181	
F100182	9-Bit Wallace Tree Adder	100182	100182
F100183	2 × 8-Bit Multiplier	100183	
F100241	8-Bit Shift Register		
F100250	Quint Line Transceiver		
F100402	16 × 4 Register File		

F11C ECL (11CXX)

11C (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, DM
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, DM
11C91	650 MHz Prescaler	X	16	DC, DM

Fairchild Video Graphics (FVGXXX)

Video Graphics

Device	Type	Pins	Package Codes
FVG101	Triple 8-Bit DAC (CMOS Process)	40	DC
FVG108	Single 8-Bit DAC (Bipolar Process)	24	DC, FC
FVG450	Triple 4-Bit RAMDAC™ (CMOS Process)	28	DC
FVG451*	Triple 8-Bit 256 × 12 RAMDAC (CMOS Process)	84	CPGA
FVG453	Triple 8-Bit 256 × 24 RAMDAC (CMOS Process)	40	DC
FVG458*	Triple 8-Bit 256 × 24 RAMDAC (CMOS Process)	84	CPGA

Note: Product is available for purchase but is not explicitly manufactured in Fairchild facilities.
*Please consult your local National Semiconductor Representative to confirm product availability.

Memory

For additional Memory products, see pages 113 and 437.

Memory

The Fairchild memory product line provides multiple technologies (ECL, TTL, CMOS) as well as a selection of volatile and nonvolatile memory alternatives.

ECL

The ECL SRAM product line is targeted to provide very high speeds at industry standard densities for cache, scratchpad, control, and buffer storage applications. Selections are available as fast as 10 ns and as large as 16K. Fairchild's ECL PROMs are designed for high-speed control, mapping, code conversion, and logic replacement. These PROMs feature a typical access time of 12 ns and a decrease in power dissipation with increase in temperature.

BiCMOS

BiCMOS technology's SRAMs combine a CMOS array with ECL decoding and I/O circuitry, giving the advantages of high speed, good drive capability, and low power at high densities.

TTL

In TTL, there is a wide selection of both SRAMs and PROMs. RAMs are available in 1-bit, 4-bit, and 9-bit architectures designed for applications ranging from high-speed cache, control, and buffer storage to scratchpad and small buffers. The PROM family includes popular densities up to 64K bits and access times as fast as 35 ns. Fairchild's Isoplanar-Z PROMs use a vertical fuse processing that eliminates surface fuses to achieve higher densities. This family has the lowest power requirements in the industry.

Both families offer products with full military processing and multiple package configurations.

CMOS

The CMOS SRAM family includes the 64K × 1 standard high-speed 45 ns version and the new data-retention version. This family is also available in military versions and multiple package choices.

Memory Part Numbering System

XXXXX X X X X

Special Variations
QB = MIL-STD-883 Level B
QR = Commercial Device w/160-Hour Burn-In or Equivalent

Temperature Range
C = 0°C to + 75°C
M = − 55°C to + 125°C

Package Code
P = Plastic DIP
PS = Plastic SIP
PZ = Plastic ZIP
D = Ceramic DIP
CZ = Ceramic ZIP
F = Flatpack
L = Ceramic Leadless Chip Carrier (LCC)
SD = Slim DIP

Speed Grade
Blank = Standard Speed
A = "A" Grade

Device Type

ECL Memory

Bipolar Static RAMs (ECL I/O)

Device	Type	Max. t_{AA} (ns)	Max. I_{EE}[1] (mA)	Pins	Package Codes
F10145A	16 × 4 Reg. File	9	− 150	16	DC, FC
F100145	16 × 4 Reg. File	7	− 247	24	DC, FC, LC
F10402	16 × 4 Reg. File	5	− 170	16	DC, FC
F100402	16 × 4 Reg. File	5	− 170	16	DC[2], FC
F10415	1024 × 1	10	− 200	16	DC, FC
F100415	1024 × 1	10	− 200	16	DC, FC
F10422	256 × 4	5, 7, 10	− 230, − 200, − 230	24	DC, FC
F100422	256 × 4	5, 7, 10	− 230, − 200, − 230	24	DC[2], FC
F10474	1024 × 4	10	− 225	24	DC, FC
F100474	1024 × 4	10	− 225	24	DC, FC
F10545A	16 × 4 Reg. File	9	− 150	16	DC, FC

Note 1: Most negative value.
Note 2: Choice of CERDIP or side-braze DIP.

ECL SRAMs Cross-Reference Guide

Fairchild	Type	t_{AA} (ns)	AMD	Fujitsu	Hitachi	Motorola	National	Signetics
F10145A	16 × 4	9			HD10145	MCM10145		
F100145	16 × 4	9			HD100145			100145
F10402	16 × 4	6				MCM10H145		
F100402	16 × 4	6						
F10415	1K × 1	10	AM10415	MBM10415	HD10415		DM10415	10415
F100415	1K × 1	10	AM100415	MBM100415	HD100415			100415
F10422	256 × 4	10		MBM10422	HD10422		DM10422	10422
F100422	256 × 4	10		MBM100422	HD100422			100422

BiCMOS Memory

BiCMOS Static RAMs (ECL I/O) $V_{EE} = -5.0V \pm 10\%$

Device	Type	Max. t_{AA} (ns)	Max. I_{EE} (mA)	Pins	Package Codes
NM4490	64K × 1	12	180	22	DC, FC
NM4490		15			DM, FM
NM4494	16K × 4	12	200	28	DC, FC
NM4494		15			DM, FM
NM5100	256K × 1	15	180	24	DC, FC
NM5100		17			DM, FM
NM5400	64K × 4	15	200	28	DC, FC
NM5400		17			DM, FM

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

TTL Memory

Bipolar Static RAMs (TTL I/O)

Device	Type	Max. t_{AA} (ns)	Max. I_{CC} (mA)	Pins	Package Codes
F93415[2]	1024 × 1 OC	20, 25, 45	65, 125, 155	16	PC, DC[1], FC
F93415		25, 30, 40, 60	75, 135, 170		DM[1], FM
F93415A[2]	1024 × 1 OC	30	155	16	PC, DC[1], FC
F93L415[2]	1024 × 1 OC	35, 45, 60	65, 65, 65	16	PC, DC[1], FC
F93L415		50, 70	75, 75		DM[1], FM
F93422[3]	256 × 43S	25, 45	80, 120	16	PC, DC[1], FC, LC
F93422		30, 60	90, 130		DM[1], FM, LM
F93422A[3]	256 × 4 3S	35	120	16	PC, DC[1], FC, LC
F93422A		45	130		DM[1], FM, LM
F93L422[3]	256 × 4 3S	60	80	16	PC, DC[1], FC, LC
F93L422		75	90		DM[1], FM, LM
F93L422A[3]	256 × 4 3S	45	80	16	PC, DC[1], FC, LC
F93L422A		55	90		DM[1], FM, LM
F93425[3]	1024 × 1 3S	20, 25, 45	65, 125, 155	16	PC, DC[1], FC, LC
F93425		25, 30, 40, 60	90, 135, 135, 170		DM[1], FM, LM
F93425A[3]	1024 × 1 3S	30	155	16	PC, DC[1], FC, LC
F93L425[3]	1024 × 1 3S	35, 45, 60	65, 65, 65	16	PC, DC[1], FC, LC
F93L425		40, 50, 70	75, 75, 75		DM[1], FM, LM
F93479[3]	256 × 9 3S	45	185	16	PC, DC[1], LC
F93479		60	200		DM[1], FM, LM
F93479A[3]	256 × 9 3S	35	185	16	PC, DC[1], LC
F93479A		45	200		DM[1], FM, LM

Note 1: Choice of CERDIP or side-braze DIP.
Note 2: Open collector.
Note 3: 3-state.

TTL SRAMs Cross-Reference Guide

Fairchild	Type	t_{AA}(ns)	AMD	Cypress	Intel	Motorola	Signetics
F93415	1K × 1	25/30	AM93415		2125	MCM93415	
F93L415	1K × 1	35/45					
F93425	1K × 1	25/30	AM93425		2125	MCM93425	
F93L425	1K × 1	35/45	AM93L425				
F93422	256 × 4	35/45	AM93422	CYC122		MCM93422	
F93L422	256 × 4	45/60	AM93L422	CYC122		MCM93L422	
F93479	256 × 9	35/45					S82S212

Note: This cross-reference guide lists devices that are equivalent in speed and functions. The data is based on competitive claims. Not all devices are available.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

TTL Memory (Continued)

Bipolar PROMs (TTL I/O)

Device	Type	Max. t_{AA} (ns)	Max. I_{CC} (mA)	Pins	Package Codes
F93Z451	1024 × 8 3S	40	135	24/8	PC, DC[1], SDC, FC, LC
F93Z451		55	135		DM[1], SDM, FM, LM
F93Z451A	1024 × 8 3S	35	135	24/8	PC, DC[1], SDC, FC, LC
F93Z451A		45	135		DM[1], SDM, FM, LM
F93Z511	2048 × 8 3S	45	175	24/8	PC, DC[1], SDC, FC, LC
F93Z511		55	175		DM[1], SDM, FM, LM
F93Z565	8196 × 8 3S	55	180	24/8	DC[2], LC
F93Z565		65	180		DM[2], LM
F93Z565A	8196 × 8 3S	45	180	24/8	DC[2], LC
F93Z565A		55	180		DM[2], LM
F93Z665	8196 × 8 3S	35, 40, 45, 50	180, 180, 180	24/8	DC[2], LC
F93Z665		45, 50, 55	185, 185, 185		DM[2], LM
F93Z667	8196 × 8 3S	35, 40, 45, 50	180, 180, 180	24	DC[3]
F93Z667		45, 50, 55	185, 185, 185		DM[3]

Note 1: Choice of CERDIP or side-braze DIP.
Note 2: 600-mil side-braze DIP.
Note 3: 300-mil side-braze DIP.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

TTL Memory (Continued)

TTL PROMs Cross-Reference Guide

Fairchild	Type	t_{AA} (ns)	AMD	Cypress	Fujitsu	Hitachi	IXICOR	MMI	Motorola	National	NEC	Raytheon	Signetics	TI
F93Z451	1K × 8	35/40	AM27S181		MB7132	HN25089		53/6381	MCM7681	DM87S181	uBP417	29631	N82S181	TBP28S86
F93Z451	1K × 8	35/40	AM27S281		MB7132SK					DM87S281				TBP28S86
F93Z511	2K × 8	45	AM27S191	CY7C245	MB7138	HN25169		63S1681	MCM76161	DM87S191	uBP429	29681	N82S191	TBP38L166
F93Z511	2K × 8	45	AM27S291		MB7138SK					DM87S291			N82S191	
F93Z565	8K × 8	45/55	AM27S49		MB7144								N82S641	
F93Z665	8K × 8	35		CY7C264										
F93Z667[1]	8K × 8	35		CY7C264										
F93Z665	8K × 8	40	AM27S49	CY7C264			X2664							
F93Z667[1]	8K × 8	40	AM27S49	CY7C264			X2664							
F93Z665	8K × 8	45	AM27S49	CY7C264	MB7144			53/6356481A					H82HS641A	
F93Z667[1]	8K × 8	45	AM27S49	CY7C264	MB7144			53/6356481A						
F93Z665	8K × 8	50		CY7C264	MB7144									
F93Z667[1]	8K × 8	50		CY7C264	MB7144									

Note 1: Slim Line Package

This cross-reference guide lists devices that are equivalent in both speed and functions. The data is based on competitive claims. Not all devices are available.

For additional information on aerospace and defense products, please refer to the Aerospace and Defense section of this Guide (Page 355), or contact your National Sales Representative.

CMOS Memory

CMOS Static RAMs (TTL I/O)

Device	Type	Max. t_{AA} (ns)	Max. I_{CC} (mA)	Max. I_{CCDR} (μA)	Pins	Package Codes
F1600A	64K × 1	25, 35, 45	90, 80, 70		22	DC[1], LC
F1600A		30, 35, 45, 55	90, 80, 70			DM[1], LM
F1601A	64K × 1 DR[2]	25, 35, 45	90, 80, 70	50	22	DC[1], LC
F1601A		30, 35, 45, 55	90, 80, 70	200		DM[1], LM
F1620	16K × 4	25, 35, 45	100, 90, 80		22	DC[1], LC
F1620		30, 35, 45, 55	100, 90, 80			DM[1], LM
F1621	16K × 4 DR	25, 35, 45	100, 90, 80	50	22	DC[1], LC
F1621		30, 35, 45, 55	100, 90, 80	200		DM[1], LM
F1624	16K × 4 OE[3]	25, 35, 45	100, 90, 80		24/8	DC[1], LC
F1624		30, 35, 45, 55	100, 90, 80			DM[1], LM
F1625	16K × 4 OE	25, 35, 45	100, 90, 80	50	24/8	DC[1], LC
F1625	and DR	30, 35, 45, 55	100, 90, 80	200		DM[1], LM

Note 1: 600-mil side-braze DIP.
Note 2: DR = data retention.
Note 3: OE = open emitter.

CMOS Memory (Continued)

CMOS Static RAMs Cross-Reference Guide

Fairchild	Type	t_{AA} (ns)	AMD	Cypress	Fujitsu	Hitachi	Hyundai	INMOS	IDT	Lattice	Mitsubishi	Motorola	NEC	Performance	VLSI
F1600A	64K × 1	25	AM99C641	CY7C187	MB81C71A	HM6787			IDT7187	SR764K1	M5M5187A	MCM6287		P4C187	
F1600A		35	AM99C641	CY7C187	MB81C71A		HY62C87		IDT7187	SR764K1	M5M5187A	MCM6287			
F1600A		45	AM99C641	CY7C187	MB81C71		HY62C87	IMS1600	IDT7187	SR764K1	M5M5187	MCM6287	uPD4361		
F1601A	64K × 1	25	AM99C641						IDT7187L						
F1601A		35	AM99C641						IDT7187L						
F1601A		45	AM99C641						IDT7187L						
F1620	16K × 4	25		CY7C164	MB81C74				IDT7188		M5M5188A	MCM6288		P4C188	VT64KS4
F1620		35	AM99C164	CY7C164	MB81C74	HM6788	HY62C88		IDT7188		M5M5188A	MCM6288		P4C188	VT64KS4
F1620		45	AM99C164	CY7C164			HY62C88		IDT7188		M5M5188	MCM6288	uPD4362		VT64KS4
F1621	16K × 4	25							IDT7188L						
F1621		35	AM99C164						IDT7188L						
F1621		45	AM99C164						IDT7188L						
F1624	16K × 4	25		CY7C166	MB81C75				IDT7198						VT65KS4
F1624		35	AM99C165	CY7C166	MB81C75				IDT7198	SR64K4					VT65KS4
F1624		45	AM99C164	CY7C166				IMS1624	IDT7198	SR64K4	M5M5188				
F1625	16K × 4	25							IDT7198L						
F1625		35	AM99C165						IDT7198L						
F1625		45	AM99C165						IDT7198L						

This cross-reference guide lists devices that are equivalent in both speed and functions. The data is based on competitive claims. Not all devices are available.

Microprocessors

For additional Microprocessor products, see pages 141 and 451.

16-Bit Microprocessors

Fairchild'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, and all military-grade products fully comply with the requirements of MIL-STD-883C and Military 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. Training seminars and programming courses are available from both Fairchild and major suppliers of development systems and software. To assist in your software development efforts, Fairchild provides MACRO-50, a macro-assembler for the F9450. In addition, a development board, the SRC50, is available to aid in hardware and software integration.

Third party support for the F9450 includes Ada, JOVIAL, FORTRAN and 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.

F9445

The F9445 microprocessor, a 16-bit device that exercises a Fairchild 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 Fairchild's bipolar Isoplanar Integrated Injection Logic (I^3L®) to provide very fast execution times.

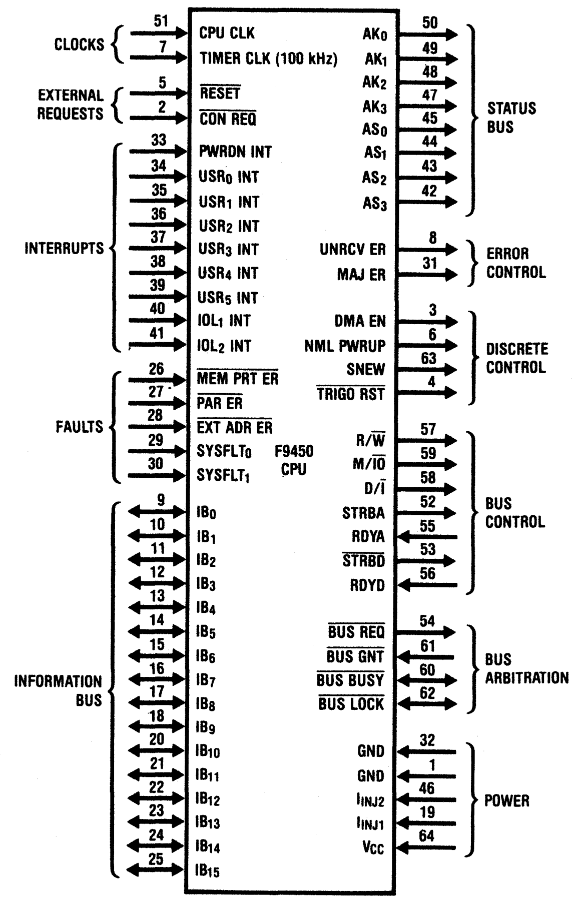
F9450 High-Performance 16-Bit Bipolar Microprocessor MIL-STD-1750A

General Description

The Fairchild 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 coprocessor. 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



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. These include memory-mapped expansion with the F9451 Memory Management Unit and write protection with the F9452 Block Protect Unit. The F9454 Memory Interface Unit also provides for memory expansion, as well as access protection for instruction and data space. The F9455 System Integration Unit furnishes basic functions necessary for implementing board-level systems with 64K words of memory or less, based on the F9450.

Comprehensive software support for the F9450, including assemblers, loaders, simulators, and compilers, is provided by Fairchild and other sources. Software development for the F9450 can be performed on VAX/VMS systems.

F9451 Memory Management Unit MIL-STD-1750A

General Description

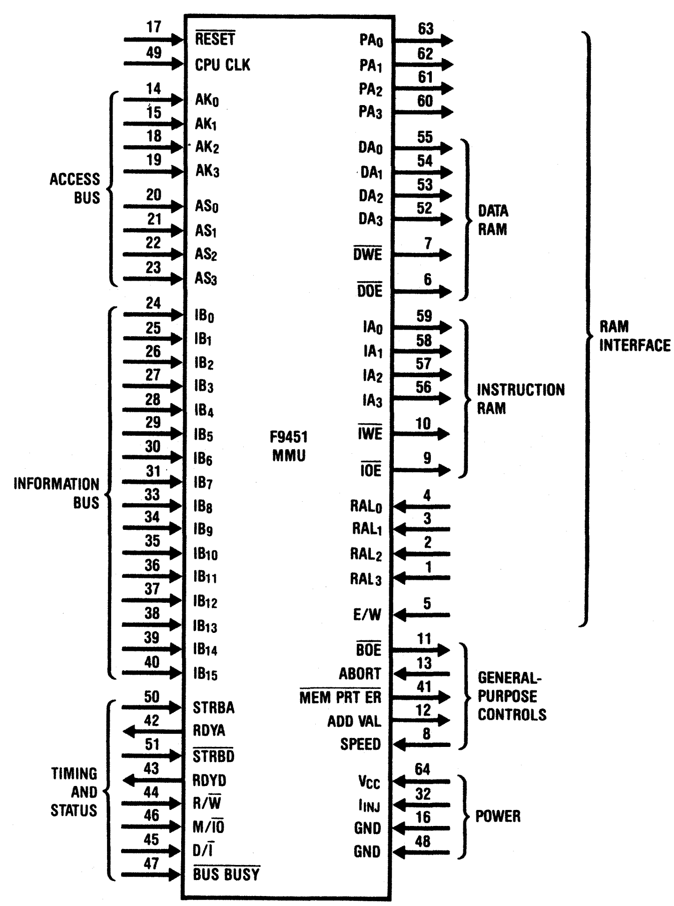
The F9451 Memory Management Unit (MMU) controller provides facilities to expand the memory addressing range of the F9450 CPU up to 16M words of physical memory and provides access protection mechanisms for instructions and data. The MMU subsystem consists of the F9451 controller together with four F93479 or equivalent static RAMs (SRAMs), used as instruction and data maps, and two octal buffers (54/74F245).

The MMU chip set works with the F9450, either by itself or together with the F9452 Block Protect Unit (BPU), to implement MIL-STD-1750A memory management and protection functions.

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 × 16)
  - — data map (256 × 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



F9452 Block Protect Unit MIL-STD-1750A

General Description

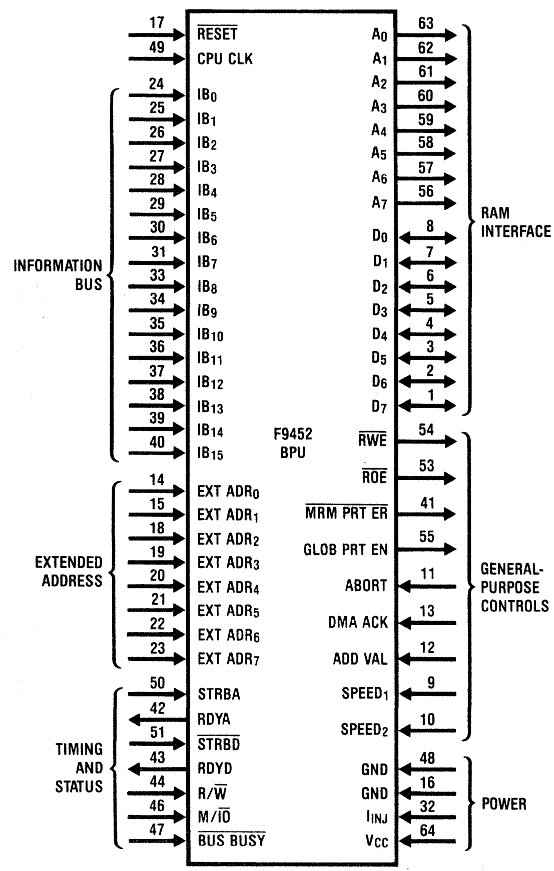
The Fairchild F9452 Block Protect Unit (BPU) controller provides write protection for up to 1M word of physical memory for both CPU and DMA access in systems using the F9450 CPU. The BPU chip set works with the F9450 microprocessor, either by itself or together with the F9451 Memory Management Unit (MMU) to implement MIL-STD-1750A memory block protection functions.

A complete BPU consists of the F9452 controller and one F93479 or equivalent static RAM (SRAM) that is used for storage of CPU and DMA protection tables. Separate tables are maintained for CPU and DMA memory spaces. Global write protection is provided from reset until memory writes are enabled.

Features

- Write protection of physical CPU and DMA memory space
- Protection of 1K pages
- Global memory protection from initialization/reset to enable
- 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



F9445 16-Bit Bipolar Microprocessor

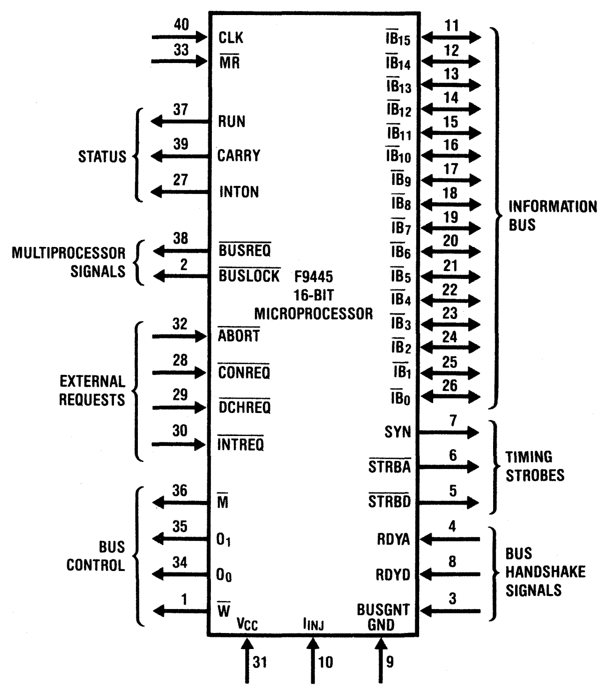
General Description

The F9445 is a 16-bit microprocessor implemented using Fairchild'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 128K bytes (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 × 16 bit multiply
- Directly addresses up to 128K bytes 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



Power & Discrete

Power and Discrete

Fairchild's power and discrete products meet the needs of the consumer, industrial, computer, telecommunications, and high-reliability industries. Many of the devices are available in surface-mount packages, including leadless diodes (LL), small-outline transistors (SOT), and small-outline integrated circuits (SOIC).

The discrete devices include small signal switching and zener diodes in hermetic glass packages, and monolithic diode arrays in both plastic and ceramic packages. General-purpose and switching bipolar transistors are available in plastic and hermetic metal can packages, as well as plastic quad transistor arrays and plastic photo-transistors.

The power devices are designed to offer special advantages in switching power supply applications. The full spec, full voltage MOSFET line has over 250 products, with more in development. In addition to industry standard types, Fairchild offers COOLFETs™, featuring a lower $r_{DS(on)}$ for greater efficiency and reliability and lower power loss. A growing line of JANTX and JANTXV MOSFETs meets the requirements of high-reliability applications.

Fairchild also offers ultrafast power rectifiers. Available in both single- and dual-chip configurations, these rectifiers have the lowest forward voltage drop in the industry, ensuring low power loss, and their soft recovery minimizes any noise generation. All power products are available in both TO-220 plastic and TO-3 hermetic metal can packaging. New TO-247 plastic packages will be available shortly. All power devices are also available in die and wafer form (for more information, consult the factory).

Other power devices in development reflect Fairchild's commitment to providing the power conversion system market with the leading edge in semiconductor technology. These products include higher cell density power MOSFETs, insulated gate devices, improved control circuits, high-power integrated circuits, and lower cost packages displaying improved thermal characteristics.

Small Signal Diodes

Small Signal Diodes (DO-35 Package)

BA128	BAX16	FDH900	1N462A	1N659	1N3600	1N4448
	BAY71	FDH999	1N463A	1N660	1N4009	1N4449
BA130	BAY72	FDH1000	1N482B	1N661	1N4148	1N4450
BA216	BAY73	1N456	1N483B	1N914	1N4149	1N4454
BA217	BAY74	1N456A	1N484B	1N914A	1N4150	1N4938
BA218	BAY80	1N457	1N485B	1N914B	1N4151	1N5282
BAV17	FDH300	1N457A	1N625	1N916	1N4152	1N6099
BAV18	FDH333	1N458	1N626	1N916A	1N4153	1S44
BAV19	FDH400	1N458A	1N627	1N916B	1N4154	1S920
BAV20	FDH444	1N459	1N628	1N3064	1N4305	1S921
BAV21	FDH600	1N459A	1N629	1N3070	1N4446	1S922
BAX13	FDH666	1N461A	1N658	1N3595	1N4447	1S923

Small Signal Diodes (DO-7 Package)

BAY82	FD700	FD777	FJT1100	1N4376

Zener Diodes (DO-35 and DO-41 Packages)

1N746A	1N759A	1N969B	1N4736A	1N4749A	1N5234B	1N5246B
1N747A	1N957B	1N970B	1N4737A	1N4750A	1N5235B	1N5247B
1N748A	1N958B	1N971B	1N4738A	1N4751A	1N5236B	1N5248B
1N749A	1N959B	1N972B	1N4739A	1N4752A	1N5237B	1N5249B
1N750A	1N960B	1N973B	1N4740A	1N5226B	1N5238B	1N5250B
1N751A	1N961B	1N4728A	1N4741A	1N5227B	1N5239B	1N5251B
1N752A	1N962B	1N4729A	1N4742A	1N5228B	1N5240B	1N5252B
1N753A	1N963B	1N4730A	1N4743A	1N5229B	1N5241B	1N5253B
1N754A	1N964B	1N4731A	1N4744A	1N5230B	1N5242B	1N5254B
1N755A	1N965B	1N4732A	1N4745A	1N5231B	1N5243B	1N5255B
1N756A	1N966B	1N4733A	1N4746A	1N5232B	1N5244B	1N5256B
1N757A	1N967B	1N4734A	1N4747A	1N5233B	1N5245B	1N5257B
1N758A	1N968B	1N4735A	1N4748A			

Leadless Small Signal Diodes (LL-34 Package)

FDLL300	FDLL458A	FDLL485B	FDLL660	FDLL916A	FDLL3595	FDLL4154
FDLL333	FDLL459	FDLL600	FDLL661	FDLL916B	FDLL3600	FDLL4305
FDLL400	FDLL459A	FDLL625	FDLL666	FDLL920	FDLL4009	FDLL4446
FDLL444	FDLL461A	FDLL626	FDLL700	FDLL921	FDLL4148	FDLL4447
FDLL456	FDLL462A	FDLL627	FDLL777	FDLL922	FDLL4149	FDLL4448
FDLL456A	FDLL463A	FDLL628	FDLL914	FDLL923	FDLL4150	FDLL4449
FDLL457	FDLL482B	FDLL629	FDLL914A	FDLL1000	FDLL4151	FDLL4450
FDLL457A	FDLL483B	FDLL658	FDLL914B	FDLL3064	FDLL4152	FDLL4454
FDLL458	FDLL484B	FDLL659	FDLL916	FDLL3070	FDLL4153	FDLL6099

Small Signal Diodes (Continued)

Surface-Mount Small Signal Diodes (SOT-23 Package) (TO-236AA/AB)

BAS16	BAW56	FDS01204	FDS01403	FDS01502	FDS01701	FDS01705
BAV70	FDS01201	FDS01205	FDS01404	FDS01503	FDS01702	
BAV74	FDS01202	FDS01401	FDS01405	FDS01504	FDS01703	
BAV99	FDS01203	FDS01402	FDS01501	FDS01505	FDS01704	

Monolithic Diode Arrays (Plastic-Metal-Ceramic Packages)

FSA1410M	FSA2502M	FSA2510M	FSA2565M	FSA2620M	FSA2705M	1N5768
FSA1411M	FSA2503M	FSA2510P	FSA2565P	FSA2620P	FSA2719M	1N5770
FSA2002M	FSA2503P	FSA2563M	FSA2566M	FSA2621M	FSA2719P	1N5772
FSA2003M	FSA2504M	FSA2563P	FSA2566P	FSA2702M	FSA2720M	1N5774
FSA2500M	FSA2509M	FSA2564M	FSA2619M	FSA2703M	FSA2720P	1N6100
FSA2501M	FSA2509P	FSA2564P	FSA2619P	FSA2704M	FSA2721M	1N6101
FSA2501P						

Surface-Mount Monolithic Diode Arrays (SOIC Package)

FAS02501	FAS02510	FAS02565	FAS02619	FAS02719	FAS05770	FAS06101
FAS02503	FAS02563	FAS02566	FAS02620	FAS02720	FAS05772	
FAS02509	FAS02564	FAS02618	FAS02718	FAS05768	FAS05774	

Small Signal Transistors

Small Signal Transistors (TO-92 Package)

MPS706	MPS6535M	PE4020	PN2907	PN4249	PN5143	2N5088
MPS706A	MPS6560	PE7058	PN2907A	PN4250	PN5770	2N5089
MPS918	MPS6561	PE7059	PN3251	PN4250A	PN5855	2N5209
MPS2369	MPS6562	PE8050	PN3563	PN4258	PN5857	2N5210
MPS2924	MPS6571	PE8050B	PN3565	PN4274	PN5965	2N5220
MPS3392	MPSA05	PE8550	PN3566	PN4275	2N697	2N5223
MPS3393	MPSA06	PN918	PN3567	PN4354	2N706	2N5224
MPS3563	MPSA10	PN930	PN3569	PN4355	2N3903	2N5225
MPS3639	MPSA12	PN2218	PN3638	PN4356	2N3904	2N5226
MPS3640	MPSA13	PN2218A	PN3638A	PN4888	2N3905	2N5227
MPS3646	MPSA14	PN2219	PN3639	PN4889	2N3906	2N5228
MPS3702	MPSA18	PN2219A	PN3640	PN4916	2N4123	2N5400
MPS3703	MPSA20	PN2221	PN3641	PN4917	2N4124	2N5401
MPS3704	MPSA42	PN2221A	PN3642	PN5128	2N4125	2N5550
MPS3705	MPSA43	PN2222	PN3643	PN5130	2N4126	2N5551
MPS4355	MPSA55	PN2222A	PN3644	PN5133	2N4400	2N5769
MPS4356	MPSA56	PN2484	PN3645	PN5134	2N4401	2N5771
MPS5172	MPSA70	PN2904	PN3646	PN5135	2N4402	2N5772
MPS6514	MPSA92	PN2904A	PN3693	PN5136	2N4403	2N5830
MPS6515	MPSA93	PN2905	PN3694	PN5137	2N4409	2N5831
MPS6518	MPSL01	PN2905A	PN4121	PN5138	2N4410	2N5833
MPS6520	MPSL51	PN2906	PN4122	PN5139	2N5086	2N5961
MPS6521	PE4010	PN2906A	PN4248	PN5142	2N5087	2N5962

Small Signal Transistors (TO-18 Package)

2N930	2N2222	2N2484	2N2906A	2N3117	2N3946	2N4014
2N930A	2N2222A	2N2586	2N2907	2N3700	2N3962	2N4208
2N2221	2N2369	2N2710	2N2907A	2N3701	2N4013	2N4209
2N2221A	2N2369A	2N22906				

Small Signal Transistors (TO-39 Package)

2N697	2N2219	2N3019	2N3440	2N4037	2N5320	2N5679
2N1132	2N2219A	2N3020	2N3724	2N4234	2N5321	2N5680
2N1132A	2N2270	2N3053	2N3725	2N4235	2N5322	2N5681
2N1613	2N2405	2N3107	2N4030	2N4236	2N5323	2N5682
2N1890	2N2904	2N3108	2N4031	2N4237	2N5336	
2N1893	2N2904A	2N3109	2N4032	2N4238	2N5338	
2N2218	2N2905	2N3253	2N4033	2N4239	2N5415	
2N2218A	2N2905A	2N3439	2N4036	2N4896	2N5416	

Small Signal Transistors (Continued)

Quad Transistors (TO-116 Package)

FPQ2222	FPQ3724	FPQ3904	FPQ3906	FPQ6426	FPQ6502	FPQ6700
FPQ2907	FPQ3725					

Surface-Mount Quad Transistors (SOIC Package)

FQS02222	FQS03724	FQS03904	FQS03906	FQS06426	FQS06502	FQS06700
FQS02907	FQS03725					

Surface-Mount Transistors (SOT-23 Package) (TO-236AA/AB)

BCF29	BSS63	FTS02904	FTS03645	FTS04250A	FTS05137	FTS05961
BCF30	BSS64	FTS02904A	FTS03646	FTS04258	FTS05138	FTS05962
BCF70	BSS79B	FTS02905	FTS03693	FTS04274	FTS05139	FTS05965
BCF81	BSS79C	FTS02905A	FTS03694	FTS04275	FTS05142	FTS06514
BCW29	BSS80B	FTS02906	FTS03702	FTS04354	FTS05143	FTS06515
BCW30	BSS80C	FTS02906A	FTS03703	FTS04355	FTS05172	FTS06518
BCW32	BSV52	FTS02907	FTS03704	FTS04356	FTS05209	FTS06520
BCW33	BSX39	FTS02907A	FTS03705	FTS04400	FTS05210	FTS06521
BCW60A	FTS0697	FTS02924	FTS03903	FTS04401	FTS05220	FTS06560
BCW61A	FTS0706	FTS03013	FTS03904	FTS04402	FTS05223	FTS06561
BCW65A	FTS0706A	FTS03014	FTS03905	FTS04403	FTS05224	FTS06562
BCW66F	FTS0918	FTS03117	FTS03906	FTS04409	FTS05225	FTS06571
BCW69	FTS0930	FTS03251	FTS03946	FTS04410	FTS05226	FTS0A05
BCW70	FTS0930A	FTS03392	FTS03962	FTS04888	FTS05227	FTS0A06
BCW72	FTS02218	FTS03393	FTS04036	FTS04889	FTS05228	FTS0A13
BCW81	FTS02218A	FTS03563	FTS04037	FTS04916	FTS05400	FTS0A14
BCX70G	FTS02219	FTS03565	FTS04121	FTS04917	FTS05401	FTS0A20
BCX70H	FTS02219A	FTS03566	FTS04122	FTS05086	FTS05550	FTS0A42
BCX70J	FTS02221	FTS03569	FTS04123	FTS05087	FTS05551	FTS0A43
BCX71H	FTS02221A	FTS03638	FTS04124	FTS05088	FTS05769	FTS0A55
BCX71J	FTS0222	FTS03638A	FTS04125	FTS05089	FTS05771	FTS0A56
BCX71K	FTS0222A	FTS03639	FTS04126	FTS05128	FTS05772	FTS0A70
BSR13	FTS02369	FTS03640	FTS04208	FTS05130	FTS05830	FTS0A92
BSR14	FTS02369A	FTS03641	FTS04209	FTS05133	FTS05831	FTS0A93
BSR15	FTS02484	FTS03642	FTS04248	FTS05134	FTS05833	FTS0L01
BSR16	FTS02586	FTS03643	FTS04249	FTS05135	FTS05855	FTS0L51
BSR17	FTS02170	FTS03644	FTS04250	FTS05136	FTS05857	

Power Electronic Components

Metal Packages (TO-204AA/TO-204AE)

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRF450CF	500	14.5	0.320	TO-204AA
IRF450	500	13.0	0.400	TO-204AA
2N6770	500	12.0	0.400	TO-204AE
IRF452	500	12.0	0.500	TO-204AA
MTM7N50	500	7.0	0.800	TO-204AA
IRF440	500	8.0	0.850	TO-204AA
IRF442	500	7.0	1.100	TO-204AA
IRF430	500	4.5	1.500	TO-204AA
MTM4N50	500	4.0	1.500	TO-204AA
2N6762	500	4.5	1.500	TO-204AA
IRF432	500	4.0	2.000	TO-204AA
IRF420	500	2.5	3.000	TO-204AA
IRF422	500	2.0	4.000	TO-204AA
IRF451	450	13.0	0.400	TO-204AA
IRF453	450	12.0	0.500	TO-204AA
2N6769	450	11.0	0.500	TO-204AA
MTM7N45	450	7.0	0.800	TO-204AA
IRF441	450	8.0	0.850	TO-204AA
IRF443	450	7.0	1.100	TO-204AA
IRF431	450	4.5	1.500	TO-204AA
MTM7N45	450	4.0	1.500	TO-204AA
IRF433	450	4.0	2.000	TO-204AA
2N6761	450	4.0	2.000	TO-204AA
IRF421	450	2.5	3.000	TO-204AA
IRF423	450	2.0	4.000	TO-204AA
IRF350CF	400	16.8	0.240	TO-204AA
IRF350	400	15.0	0.300	TO-204AA
IRF352	400	13.0	0.400	TO-204AA
2N6768	400	14.0	0.300	TO-204AE
MTM8N40	400	8.0	0.550	TO-204AA
IRF340	400	10.0	0.550	TO-204AA
IRF342	400	8.0	0.800	TO-204AA
IRF330	400	5.5	1.000	TO-204AA
2N6760	400	5.5	1.000	TO-204AA
MTM5N40	400	5.0	1.000	TO-204AA
IRF332	400	4.5	1.500	TO-204AA
IRF320	400	3.0	1.800	TO-204AA
IRF322	400	2.5	2.500	TO-204AA

Power Electronic Components (Continued)

Metal Packages (TO-204AA/TO-204AE) (Continued)

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRF351	350	15.0	0.300	TO-204AA
IRF353	350	13.0	0.400	TO-204AA
2N6767	350	12.0	0.400	TO-204AA
IRF341	350	10.0	0.550	TO-204AA
MTM8N35	350	8.0	0.550	TO-204AA
IRF343	350	8.0	0.800	TO-204AA
IRF331	350	5.5	1.000	TO-204AA
MTM5N35	350	5.0	1.000	TO-204AA
IRF333	350	4.5	1.500	TO-204AA
2N6759	350	4.5	1.500	TO-204AA
IRF321	350	3.0	1.800	TO-204AA
IRF323	350	2.5	2.500	TO-204AA
IRF250CF	200	33.0	0.068	TO-204AE
2N6766	200	30.0	0.085	TO-204AE
IRF250	200	30.0	0.085	TO-204AA
IRF252	200	25.0	0.120	TO-204AA
IRF240	200	18.0	0.180	TO-204AE
IRF242	200	16.0	0.220	TO-204AE
2N6758	200	9.0	0.400	TO-204AA
IRF230	200	9.0	0.400	TO-204AA
IRF232	200	8.0	0.600	TO-204AA
IRF220	200	5.0	0.800	TO-204AA
IRF222	200	4.0	1.200	TO-204AA
IRF251	150	30.0	0.085	TO-204AA
2N6765	150	25.0	0.120	TO-204AA
IRF253	150	25.0	0.120	TO-204AA
IRF241	150	18.0	0.180	TO-204AE
IRF243	150	16.0	0.220	TO-204AE
IRF231	150	9.0	0.400	TO-204AA
IRF233	150	8.0	0.600	TO-204AA
2N6757	150	8.0	0.600	TO-204AA
IRF221	150	5.0	0.800	TO-204AA
IRF223	150	4.0	1.200	TO-204AA

Power Electronic Components (Continued)

Metal Packages (TO-204AA/TO-204AE) (Continued)

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRF150CF	100	44.0	0.044	TO-204AE
IRF150	100	40.0	0.055	TO-204AE
2N6764	100	38.0	0.055	TO-204AE
IRF152	100	33.0	0.080	TO-204AE
IRF140	100	27.0	0.085	TO-204AE
IRF142	100	24.0	0.110	TO-204AE
2N6756	100	14.0	0.180	TO-204AA
IRF130	100	14.0	0.180	TO-204AA
IRF132	100	12.0	0.250	TO-204AA
IRF120	100	8.0	0.300	TO-204AA
IRF122	100	7.0	0.400	TO-204AA
IRF151	60	40.0	0.055	TO-204AE
2N6763	60	40.0	0.055	TO-204AE
IRF153	60	33.0	0.080	TO-204AE
IRF141	60	27.0	0.085	TO-204AE
IRF143	60	24.0	0.110	TO-204AE
IRF131	60	14.0	0.180	TO-204AA
2N6755	60	12.0	0.250	TO-204AE
IRF133	60	12.0	0.250	TO-204AA
IRF121	60	8.0	0.300	TO-204AA
IRF123	60	7.0	0.400	TO-204AA

Plastic Encapsulated Packages (TO-220AB/TO-3P)

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRFP450CF	500	15.5	0.320	TO-3P
IRFP450	500	14.0	0.400	TO-3P
IRF840CF	500	8.9	0.680	TO-220AB
IRFP440CF	500	10.5	0.680	TO-3P
IRF840	500	8.0	0.850	TO-220AB
IRFP440	500	8.8	0.850	TO-3P
IRF842	500	7.0	1.100	TO-220AB
IRF830CF	500	5.0	1.200	TO-220AB
IRF830	500	4.5	1.500	TO-220AB
MTP4N50	500	4.0	1.500	TO-220AB
IRF832	500	4.0	2.000	TO-220AB
IRF820CF	500	2.8	2.400	TO-220AB
IRF820	500	2.5	3.000	TO-220AB
IRF822	500	2.0	4.000	TO-220AB
MTP2N50	500	3.0	4.000	TO-220AB

Power Electronic Components (Continued)

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

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRFP451CF	450	15.5	0.320	TO-3P
IRFP451	450	14.0	0.400	TO-3P
IRFP441CF	450	10.5	0.680	TO-3P
IRF841	450	8.0	0.850	TO-220AB
IRFP441	450	8.8	0.850	TO-3P
IRF843	450	7.0	1.100	TO-220AB
MTP4N45	450	4.0	1.500	TO-220AB
IRF831	450	4.5	1.500	TO-220AB
IRF833	450	4.0	2.000	TO-220AB
IRF821	450	2.5	3.000	TO-220AB
IRF823	450	2.0	4.000	TO-220AB
MTP2N45	450	3.0	4.000	TO-220AB
IRFP350CF	400	18.0	0.340	TO-3P
IRFP350	400	16.2	0.300	TO-3P
IRF740CF	400	11.0	0.440	TO-220AB
IRFP340CF	400	12.0	0.440	TO-3P
IRF740	400	10.0	0.550	TO-220AB
IRFP340	400	11.0	0.550	TO-3P
IRF742	400	8.0	0.800	TO-220AB
IRF730CF	400	6.2	0.800	TO-220AB
IRF730	400	5.5	1.000	TO-220AB
MTP5N40	400	5.0	1.000	TO-220AB
IRF720CF	400	3.8	1.440	TO-220AB
IRF732	400	4.5	1.500	TO-220AB
IRF720	400	3.0	1.800	TO-220AB
IRF722	400	2.5	2.500	TO-220AB
MTP3N40	400	3.0	3.300	TO-220AB
IRF710	400	1.5	3.600	TO-220AB
IRF712	400	1.3	5.000	TO-220AB
MTP2N40	400	2.0	5.000	TO-220AB

Power Electronic Components (Continued)

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

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRFP351CF	350	18.0	0.240	TO-3P
IRFP351	350	16.2	0.300	TO-3P
IRFP341CF	350	12.0	0.440	TO-3P
IRF741	350	10.0	0.550	TO-220AB
IRFP341	350	11.0	0.550	TO-3P
IRF743	350	8.0	0.800	TO-220AB
IRF731	350	5.5	1.000	TO-220AB
MTP5N35	350	5.0	1.000	TO-220AB
IRF733	350	4.5	1.500	TO-220AB
IRF721	350	3.0	1.800	TO-220AB
IRF723	350	2.5	2.500	TO-220AB
MTP3N35	350	3.0	3.300	TO-220AB
IRF711	350	1.5	3.600	TO-220AB
IRF713	350	1.3	5.000	TO-220AB
MTP2N35	350	2.0	5.000	TO-220AB
IRFP250CF	200	32.9	0.068	TO-3P
IRFP250	200	32.5	0.085	TO-3P
IRF640CF	200	20.0	0.144	TO-220AB
IRFP240CF	200	28.0	0.144	TO-220AB
IRF640	200	18.0	0.180	TO-220AB
IRFP240	200	19.8	0.180	TO-3P
IRF642	200	16.0	0.220	TO-220AB
IRF630CF	200	10.0	0.320	TO-220AB
MTP12N20	200	10.0	0.320	TO-220AB
IRF630	200	9.0	0.400	TO-220AB
IRF632	200	8.0	0.600	TO-220AB
IRF620CF	200	5.6	0.640	TO-220AB
MTP7N20	200	7.0	0.700	TO-220AB
IRF620	200	5.0	0.800	TO-220AB
IRF622	200	4.0	1.200	TO-220AB
IRF610	200	2.5	1.500	TO-220AB
MTP2N20	200	3.3	1.800	TO-220AB
IRF612	200	2.0	2.400	TO-220AB
MTP12N18	180	12.0	0.350	TO-220AB
MTP7N18	180	7.0	0.700	TO-220AB
MTP2N18	180	3.3	1.800	TO-220AB

Power Electronic Components (Continued)

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

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRFP251CF	150	38.9	0.068	TO-3P
IRFP251	150	32.5	0.085	TO-3P
IRFP241CF	150	28.0	0.144	TO-3P
IRF641	150	18.0	0.180	TO-220AB
IRFP241	150	19.8	0.180	TO-3P
IRF643	150	16.0	0.220	TO-220AB
IRF631	150	9.0	0.400	TO-220AB
IRF633	150	8.0	0.600	TO-220AB
IRF621	150	5.0	0.800	TO-220AB
IRF623	150	4.0	1.200	TO-220AB
IRF611	150	2.5	1.500	TO-220AB
IRF613	150	2.0	2.400	TO-220AB
IRFP150CF	100	47.5	0.044	TO-3P
IRFP150	100	43.0	0.055	TO-3P
IRF540CF	100	30.0	0.068	TO-220AB
IRFP140CF	100	33.0	0.068	TO-3P
IRF540	100	27.0	0.085	TO-220AB
IRFP140	100	29.5	0.085	TO-3P
IRF542	100	24.0	0.110	TO-220AB
IRF530CF	100	16.0	0.144	TO-220AB
MTP20N10	100	20.0	0.150	TO-220AB
IRF530	100	14.0	0.180	TO-220AB
IRF520CF	100	9.1	0.240	TO-220AB
IRF532	100	12.0	0.250	TO-220AB
IRF520	100	8.0	0.300	TO-220AB
MTP10N10	100	10.0	0.330	TO-220AB
IRF522	100	7.0	0.400	TO-220AB
IRF510	100	12.0	0.600	TO-220AB
IRF512	100	3.5	0.800	TO-220AB
MTP4N10	100	5.0	0.800	TO-220AB
MTP20N08	80	20.0	0.150	TO-220AB
MTP10N08	80	10.0	0.330	TO-220AB
MTP4N08	80	5.0	0.800	TO-220AB

Power Electronic Components (Continued)

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

Device	V_{DSS} (V)	I_{DR} (A)	$r_{DS(on)}$ (Ω)	Package Types
IRFP151CF	60	47.5	0.044	TO-3P
IRFP151	60	43.0	0.055	TO-3P
IRFP141CF	60	33.0	0.068	TO-3P
IRF541	60	27.0	0.085	TO-220AB
IRFP141	60	29.5	0.085	TO-3P
FMP20N06	60	20.0	0.085	TO-220AB
FMP18N06	60	18.0	0.100	TO-220AB
IRF543	60	24.0	0.110	TO-220AB
IRF531	60	14.0	0.180	TO-220AB
IRF533	60	12.0	0.250	TO-220AB
IRF521	60	8.0	0.300	TO-220AB
IRF523	60	7.0	0.400	TO-220AB
IRF511	60	4.0	0.600	TO-220AB
IRF513	60	3.5	0.800	TO-220AB
FMP20N05	50	20.0	0.085	TO-220AB
FMP18N05	50	18.0	0.100	TO-220AB

COOLFETs

Device	V_{DSS} (V)	I_D (Max.) (A)	$r_{DS(on)}$ (Max.) (Ω)	Power Dissipation (W)	Package Types
IRF820CF	500	2.8	2.400	40	TO-220AB
IRF830CF	500	5.0	1.200	75	TO-220AB
IRF840CF	500	8.9	0.680	125	TO-220AB
IRF450CF	500	14.5	0.320	150	TO-204AE
IRF720CF	400	3.4	1.440	40	TO-220AB
IRF730CF	400	6.2	0.800	75	TO-220AB
IRF740CF	400	11.0	0.440	125	TO-220AB
IRF350CF	400	16.8	0.240	150	TO-204AE
IRF620CF	200	5.6	0.640	40	TO-220AB
IRF630CF	200	10.0	0.320	75	TO-220AB
IRF640CF	200	20.0	0.144	125	TO-220AB
IRF250CF	200	33.0	0.068	150	TO-204AE
IRF520CF	100	9.1	0.240	40	TO-220AB
IRF530CF	100	16.0	0.144	75	TO-220AB
IRF540CF	100	30.0	0.068	125	TO-220AB
IRF150CF	100	44.0	0.044	150	TO-204AE

Power Electronic Components (Continued)

Ultrafast Reverse Recovery Rectifiers (Package TO-3P/TO-220AC)

Device	V_{RSM} (V)	I_F (Avg) (A)	t_{rr} (ns)	V_F (V)	Package Types
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	100	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
FRK1605	50	16	50	0.95	TO-3P
FRK1610	100	16	50	0.95	TO-3P
FRK1615	150	16	50	0.95	TO-3P
FRK1620	200	16	50	0.95	TO-3P

Dual Rectifiers, Common Cathode (Package TO-3P/TO-220AB)

Device	V_{RSM} (V)	I_F (Avg) (A)	t_{rr} (ns)	V_F (V)	Package Types
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

Programmable Logic

For additional Programmable Logic products, see page 155.

Programmable Logic

Fairchild's programmable logic family is focused on the high-performance FASTPLAs. Combining unique architectural features, high speed, and low power, these products enable designers to create for themselves any functions they wish to add to the FAST family. In addition, the product line includes the 93Z459 FPLA, which is fabricated using Fairchild's proprietary Isoplanar-Z™ process, providing all of the density, speed, and reliability of vertical fuse programming.

FASTPLAs (16XX)

FAST Programmable Logic Arrays (FASTPLAs)

Device	Array Inputs	Logic	OE	Outputs	Speed	Pins	Package Codes
16L8D	10 Dedicated	8 7-Wide AND/OR	8 Individually Programmable	6 Bidirectional 2 Dedicated	10 ns	20	PC, DC, QC
16R8D	8 Dedicated 1 Clock	8 8-Wide AND/OR	8 Dedicated	8 Registered (w/Feedback)	10 ns	20	PC, DC, QC
16R6D	8 Dedicated 1 Clock	2 7-Wide AND/OR 6 8-Wide AND/OR	2 Individually Programmable 6 Dedicated	2 Bidirectional 6 Registered (w/Feedback)	10 ns	20	PC, DC, QC
16R4D	8 Dedicated 1 Clock	4 7-Wide AND/OR 4 8-Wide AND/OR	4 Individually Programmable 4 Dedicated	4 Bidirectional 4 Registered (w/Feedback)	10 ns	20	PC, DC, QC

Field Programmable Logic Arrays (93ZXX)

Field Programmable Logic Arrays

Device	Type	Speed	Pins	Package Codes
F93Z459A	16 × 48 × 8, Isoplanar-Z Fuse, 3-State	45 ns	28	DC, DM, FM, LM

Telecommunications

For additional Telecommunications products, see page 161.

Telecommunications

Fairchild telecommunications products utilize combined analog-digital LSI designs fabricated with Fairchild's advanced double-poly CMOS process. Included are the μA212AT and μAV22 single-chip 1200 bps modems, and COMBOs™.

μA212AT and μAV22 1200 bps Modems

Fairchild's μA212AT is the single-chip solution to Bell 212A/103-compatible modem designs. It provides such features as analog loopback, remote and local digital loopback, and self-test patterns. Handshaking for remote loopback is included on-chip. Applications utilizing smart dialing are enhanced by call-progress tone detection (busy, dial, and ringback) and DTMF tone generation. The μA212AT's amazing 35 mW (typical) power dissipation is unequalled in the industry—three times lower than its nearest competitor! Combined with a CMOS microcontroller, the μA212AT provides extremely power-efficient portable, and battery- and line-powered modem designs.

The μAV22 1200/600 bps single-chip modem performs all signal processing required for a CCITT V.22 Alternative B-compatible modem, including selection of 550 or 1800 Hz guard tones and up to 2.3% overspeed in asynchronous operation. Pin-compatible with the μA212AT, the μAV22 also offers analog loopback, local and remote digital loopback, and "smart dialer" functions (DTMF dialing and call-progress tone detection). Its power dissipation of 40 mW (typical) is second only to that of the μA212AT.

The stunning line performance of both products is unsurpassed among all integrated 212A/V.22 products utilizing fixed equalization, and approaches that of adaptively equalized units.

The μA212AT/μAV22 combination reduces modem design to the provision of microcontroller code and a telephone line interface. Fairchild has extensive and easily modified code available for several popular microcontroller families, as well as considerable expertise in design of the line interface.

Full Duplex Modem Chip
μA212ATDC

General Description

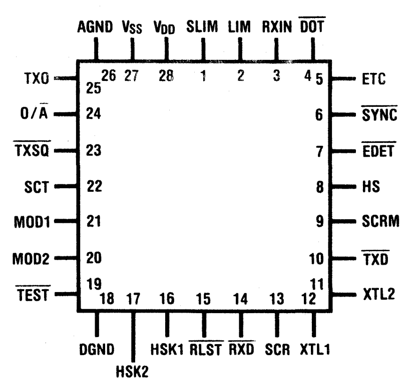
The μA212AT single-chip modem IC performs all signal processing functions required for a Bell 212A/103-compatible modem. Handshaking protocols and mode control functions are provided by a general-purpose single-chip microcontroller. The μA212AT and microcontroller, along with several components to handle the control and telephone line interfaces, provide a high-performance, cost-effective solution for an intelligent Bell 212A-compatible modem design.

The modem chip performs the modulation, demodulation, filtering, and certain control and self-test functions required for a Bell 212A-compatible modem, as well as additional functional enhancements. Switched-capacitor filters provide channel isolation, spectral shaping, and fixed compromise equalization for both high and low speed modes.

A novel switched-capacitor modulator and a digital coherent demodulator provide 1200 bps QPSK operation while a separate digital FSK modulator and demodulator handle the 0-300 bps requirement. The μA212AT includes an integral DTMF tone generator on-chip. The receive filter and energy detector may be configured for call-progress tone detection (dial tone, busy, ringback, voice), providing the front end for a smart dialer.

The μA212AT is fabricated in Fairchild's advanced double-poly silicon-gate CMOS process.

28-Lead PLCC

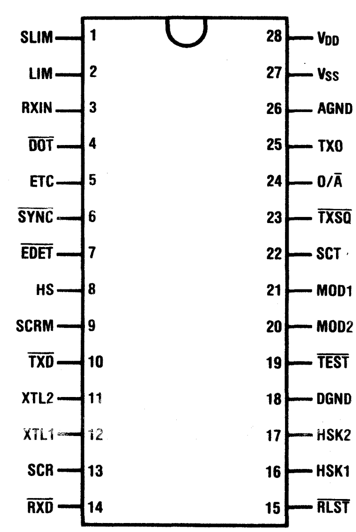


TOP VIEW

Features

- Functions as a 212A- and 103-compatible modem
- Performs all single processing functions
- Interfaces to single-chip microcontroller, which handles handshaking protocols and mode control functions
- DTMF tone generation
- Pin- and firmware-compatible with the μA212A (without integral DTMF) for easy upgrade
- Call-progress tone detection for smart dialer applications
- On-chip oscillator uses standard 3.6864 MHz crystal
- Few external components required
- Industrial temperature range option (− 40°C to + 85°C)
- Operates from + 5V and − 5V supplies
- Low operating power: 35mW typical
- 28-lead ceramic DIP, 28-lead plastic DIP, and 28-lead plastic leaded chip carrier (PLCC)
- μA212AT designer's kit is available

28-Lead DIP



TOP VIEW

Full Duplex Modem Chip μAV22

General Description

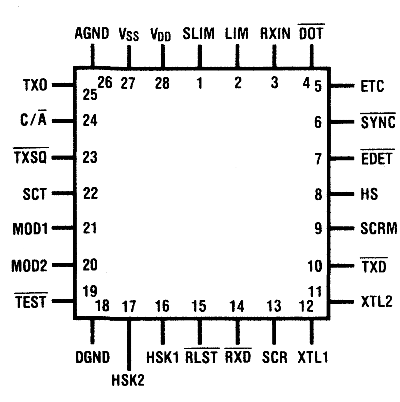
The μAV22 1200/600 bps single-chip modem IC performs all signal processing required for a CCITT V.22 Alternative B-compatible modem, while typically dissipating only 40 mW. Handshaking protocols and dialing mode control functions can be serviced by a general-purpose single-chip microcontroller. These two chips, along with several components to handle the control and telephone line interfaces, provide a cost-effective approach compared to either discrete or integrated chip set designs.

The modem chip performs the required V.22 modulation, demodulation, buffering, filtering, scrambling, descrambling, and control and self-test functions, as well as additional functional enhancements. A novel switched-capacitor modulator and a digital coherent demodulator provide 1200 and 600 bps QPSK operation.

Switched-capacitor filters provide channel isolation, spectral shaping, fixed compromise equalization, and guard tone rejection. Additionally, the receive filter and energy detector may be configured for call-progress tone detection (dial tone, busy, ringback, voice) in the 350 to 850 Hz band, providing the front end for a smart V.25-compatible dialer. On-chip tone generators provide DTMF dialing, 1300 Hz calling tone, 2100 Hz answer tone, and selectable 550 and 1800 Hz guard tones. The μAV22 also supports the Extended Signaling Rate Option (up to 2.3% overspeed in asynchronous mode) and provides on-chip handshaking for Remote Digital Loop (V.54/Loop 2).

The μAV22 is fabricated in Fairchild's advanced double-poly silicon-gate CMOS process.

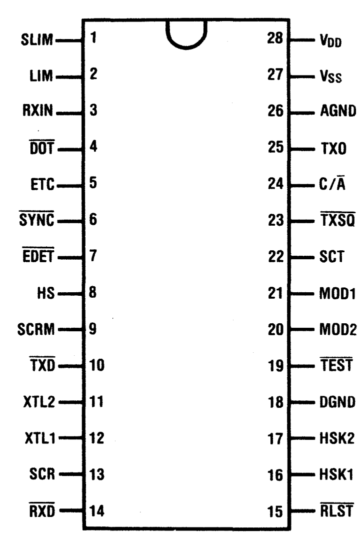
28-Lead PLCC



Features

- Performs all V.22 Alternative-B signal processing
- Very low power dissipation (40 mW typical)
- Excellent bit error rate (BER) performance
- Interface to a microcontroller or bus for mode and handshake control
- Selectable extended signaling rate range
- On-chip tone generators provide:
  - DTMF dialing
  - 1300 Hz calling tone
  - 2100 Hz answer tone
  - Selectable 550 and 1800 Hz guard tones
- Call-progress tone detection
- Supports V.54 diagnostics on-chip
  - Loop 1 (local digital loop)
  - Loop 2 (remote digital loop)
  - Loop 3 (analog loop)
- On-chip oscillator uses 3.6864 MHz crystal
- Requires $\pm$ 5V
- Requires few external components
- Available in three 28-lead packages:
  - Ceramic DIP
  - Plastic DIP
  - Plastic Leaded Chip Carrier (PLCC)

28-Lead DIP



Aerospace & Defense

For additional information on Military/Aerospace, see page 167.

Aerospace and Defense

MIL-STD-883 (QB) Part Numbering System

XXXX X X X X

- Screening/QCI
  - QB = MIL-STD-883 Level B Process Flow
- Temperature Range
  - M = − 55°C to 125°C
- Package Code
  - C = Leadless 20-Pin
  - D = Ceramic DIP
  - F = Ceramic Flatpak
  - G = Ceramic Gull-Wing DIP
  - H = TO-5 Type Metal Can
  - J = Ceramic Side-Brazed DIP
  - K = TO-3 Type Metal Can
  - L = Ceramic Leadless Chip Carrier (LCC)
  - R = Ceramic 8-Pin DIP
  - SD = Ceramic Slim DIP
- Product Grade (If Applicable)
- Basic Device Type

MIL-M-38510 (JAN) Part Numbering System

J® M38510/ XXX XX X X X

- Lead Finish
  - A Hot Solder Dip
  - B Tin Plate
  - C Gold Plate
  - X Any Finish
- Package Type
  - A 14-Lead 1/4 × 1/4 Flatpak
  - B 14-Lead 1/4 × 1/8 Flatpak
  - C 14-Lead 1/4 × 3/4 DIP
  - D 14-Lead 1/4 × 3/8 Flatpak
  - E 16-Lead 1/4 × 7/8 DIP
  - F 16-Lead 1/4 × 3/8 Flatpak
  - G 8-Lead Can
  - H 10-Lead 1/4 × 1/4 Flatpak
  - I 10-Lead Can
  - J 24-Lead 1/2 × 1-1/4 DIP
  - K 24-Lead 3/8 × 5/8 Flatpak
  - P 8-Lead 1/4 × 3/8 DIP
  - R 20-Lead 1/4 × 1-1/16 DIP
  - S 20-Lead 1/4 × 1/2 Flatpak
  - X 3-Lead Can
  - Y 2-Lead TO-3 Can
  - Z 24-Lead 1/4 × 3/8 Flatpak
  - 2 20-Terminal LCC 0.350 × 0.350
  - Others as Designated
- Processing Level
  - S
  - B
- Device Type
- Detail Specification
- General Procurement Specification
- JAN® Designator: Cannot be marked with "J" unless qualified on Part I or II of the QPL.

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Digital, Linear and Memory Process Flow — MIL-STD-883 (QB)

Note: Compliant to MIL-STD-883C paragraph 1.2 only as noted on the appropriate product pages.

Process Step	Method	Condition	Requirement
Internal Visual	2010	B	100%
Stabilization Bake	1008	C	100%
Temperature Cycle	1010	C	100%
Constant Acceleration	2001	E (D, if applicable)	100%
Fine Leak	1014	B	100% (optional)
Gross Leak	1014	C	100% (optional)
Interim Electricals	5004	Fairchild Table I	100%
Burn-In	1015	C or D	100%
Final Electricals			
DC + 25°C*	5004	Fairchild Table I	100%
PDA	5004	5% Max. Allowed	
DC + 125°C*	5004	Fairchild Table I	100%
DC − 55°C*	5004	Fairchild Table I	100%
AC + 25°C	5004	Fairchild Table I	100%
Group A			**Sample Size = 116** **ACC No. = 0**
Applicable Subgroups	5005	Fairchild Table I	Per Subgroup
Fine Leak	1014	B	2% LTPD or 100%
Gross Leak	1014	C	2% LTPD or 100%
External Visual	2009		100%
Group B, C, D	5005	Generic Data	Sampled

*Includes functional testing.

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Digital, Linear and Memory Process Flow — MIL-M-38510 (JAN) Class B

Process Step	Method	Condition	Requirement
Internal Visual	2010	B	100%
Stabilization Bake	1008	C	100%
Temperature Cycle	1010	C	100%
Constant Acceleration	2001	E (D, if applicable)	100%
Fine Leak	1014	B	100% (optional)
Gross Leak	1014	C	100% (optional)
Pre Burn-In Electricals	5004	Slash Sheet	100%
Burn-In	1015	D	100%
Final Electricals			
DC + 25°C*	5004	Slash Sheet	100%
PDA		5% Maximum	
DC + 125°C*	5004	Slash Sheet	100%
DC − 55°C*	5004	Slash Sheet	100%
AC + 25°C	5004	Slash Sheet	100%
Group A			**Sample Size = 116** **ACC No. = 0**
Applicable Subgroups	5005	Slash Sheet	Per Subgroup
Fine Leak	1014	B	2% LTPD or 100%
Gross Leak	1014	C	2% LTPD or 100%
External Visual	2009		100%
Group B, C, D	5005	JAN Data	Sampled

*Includes functional testing.

Digital Process Flow—MIL-M-38510 (JAN) Class S

Process Step	Method	Condition	Requirement
Wafer Lot Acceptance	5007		All Lots
Non-Destructive Bond Pull	2023		100%
Internal Visual	2010	A	100%
Stabilization Bake	1008	C	100%
Temperature Cycling	1010	C	100%
Constant Acceleration	2001	E	100%
Serialization			100%
Radiographic	2012	Two Views	100%
Pre Burn-In Electricals	5004	Slash Sheet	100%
PIND Testing	2020	A	100%
Burn-In	1015	D, 240 Hrs./125°C Min.	100%
Final Electricals			
DC + 25°C*	5004	Slash Sheet	100%
PDA		3% Func. and 5% DC Max.	
Read & Record + 25°C	5004	Slash Sheet	100%
DC + 125°C*	5004	Slash Sheet	100%
DC − 55°C*	5004	Slash Sheet	100%
AC + 25°C	5004	Slash Sheet	100%
AC + 125°C (if required)	5004	Slash Sheet	100%
AC − 55°C (if required)	5004	Slash Sheet	100%
Group A			**Sample Size = 116** **ACC No. = 0**
DC + 25°C*	5005	Slash Sheet	Per Subgroup
DC + 125°C*	5005	Slash Sheet	Per Subgroup
DC − 55°C*	5005	Slash Sheet	Per Subgroup
AC + 25°C	5005	Slash Sheet	Per Subgroup
AC + 125°C	5005	Slash Sheet	Per Subgroup
AC − 55°C	5005	Slash Sheet	Per Subgroup
Fine Leak	1014	B	100%
Gross Leak	1014	C	100%
External Visual	2009		100%
Group B & D	5005	JAN Data	Sampled

*Includes functional testing.

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Device/JAN Cross Reference

Digital

Device	JAN/ Sheet	Device Type
FAST® (54FXX)		
54F00	330	01
54F02	333	01
54F04	330	02
54F08	340	01
54F10	330	03
54F11	340	02
54F20	330	04
54F32	335	01
54F64	334	01
54F74	341	01
54F86	345	01
54F109	341	02
54F138	337	01
54F139	337	02
54F151	339	01
54F153	339	02
54F157	339	03
54F158	339	04
54F160A	344	01
54F161A	343	01
54F162A	344	02
54F163A	343	02
54F174	341	07
54F175	341	04
54F181	338	01
54F192	344	04
54F193	343	04
54F240	332	01
54F241	332	02
54F244	332	03
54F251	339	05
54F253	339	08
54F257	339	06
54F258	339	07
54F280	349	01
54F283	342	01
54F352	339	09
54F353	339	10
54F373	346	01
54F374	341	05
54F398	350	01
54F399	350	02
54F521	347	01
54F533	346	02
54F563	346	03
54F573	346	04

Device	JAN/ Sheet	Device Type
Low Power Schottky (54LSXX)		
54LS00	300	01
54LS02	303	01
54LS03	300	02
54LS04	300	03
54LS05	330	04
54LS08	310	04
54LS10	300	05
54LS11	310	01
54LS20	300	07
54LS21	310	03
54LS22	300	08
54LS27	303	02
54LS30	300	09
54LS32	305	01
54LS42	307	03
54LS51	304	01
54LS54	304	02
54LS74	301	02
54LS83A	312	01
54LS85	311	01
54LS95	306	03
54LS109	301	09
54LS112	301	03
54LS113	301	04
54LS114	301	05
54LS138	307	01
54LS139	307	02
54LS151	309	01
54LS153	309	02
54LS157	309	03
54LS158	309	04
54LS174	301	06
54LS175	301	07
54LS193	315	08
54LS194A	306	01
54LS240	324	01
54LS241	324	02
54LS244	324	03
54LS253	309	08
54LS257A	309	06
54LS258A	309	07
54LS259	316	03
54LS266	303	03
54LS273	325	01
54LS279	316	02
54LS283	312	02
54LS365A	322	01
54LS366A	322	02
54LS367A	322	03
54LS368A	322	04

Device	JAN/ Sheet	Device Type
Standard TTL (54XX)		
5400	001	04
5402	004	01
5404	001	05
5408	016	01
5409	016	02
5410	001	03
5420	001	02
5430	001	01
5437	003	02
5440	003	01
5442A	010	01
5474	002	05
5483A	006	02
5486	007	01
54121	012	01
54122	012	02
54123	012	03
54151A	014	06
54153	014	03
54157	014	05
54174	017	01
54175	017	02
TTL 9300		
9309	014	04
9322	014	05
TTL 9600		
9601	012	04
9602	012	05
DTL (930)		
930	030	01
936	030	03
946	030	04
962	030	05

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Device/JAN Cross Reference (Continued)

Linear

Device	JAN/ Sheet	Device Type
Operational Amplifiers		
101,A	101	03
108, A	101	04
124	110	05
148	110	01
741,A	101	01
747,A	101	02
771B	119	04
772B	119	05
774B	119	06
1558	101	08
2101,A	101	05
2108,A	101	06
4136,A	110	04
Voltage Regulators		
109	107	01
117H	117	03
117K	117	04
138	117	06
150	117	05
723	102	01
7805	107	06
7812	107	07
7815	107	08
7824	107	09
78M05	107	02
78M12	107	03
78M15	107	04
78M24	107	05
78MG	117	01
7905	115	05
7912	115	06
7915	115	07
79M05	115	01
79M12	115	02
79M15	115	03

Device	JAN/ Sheet	Device Type
Interface Products		
9614	104	03
9615	104	04
55107,A	104	01
Comparators		
110	106	02
111	103	04
139	112	01
710	103	01
711	103	02
2111	103	05
Special Functions		
555	109	01
733	105	01
3045	108	02

Memory

Device	JAN/ Sheet	Device Type
TTL SRAMs		
93L415	231	03
93422	231	10
	231	14
93L422	231	12
	231	15
93425	231	02
	231	06
	231	08
93L425	231	04
	231	13
TTL PROMs		
93Z511	210	02
	210	04

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

MIL-S-19500 (JAN) Part Numbering System

X XXX XX XXXX – X

- Suffix
  – 1 = Metallurgical Bond
- Alphanumeric Device
- Device Type
  1N Diode
  2N Transistor
- Screening/Testing
  JAN
  JAN TX
  JAN TXV
- JAN-Qualified

Process Flow MIL-S-19500G (JAN) Semiconductor Devices

Process Step	Method	Condition	Requirement
High Temperature Storage	1032	24 Hours Min.	100 %
Temperature Cycle	1051	Slash Sheet	100 %
Constant Acceleration	2006	Slash Sheet	100 %
High Temperature Gate Bias	1042	B	100 %
Pre-Burn-In Electrical Tests		Slash Sheet	100 %
High Temperature Reverse Bias	1042	A	100 %
Final Electrical Test			100 %
Solder Lead Finish			100 %
Mark			100 %
Fine Leak	1071	$5 \times 10^{(-7)}$	100 %
Gross Leak	1071		100 %
Group A		Slash Sheet	

Referenced Test Methods from MIL-STD-750C.

Device/JAN Cross Reference (Continued)

Discrete (MIL-S-19500)

Device	JAN	JANTX	JANTXV
Monolithic Diode Arrays			
1N5768	X	X	X
1N5770	X	X	X
1N5772	X	X	X
1N5774	X	X	X
1N6100	X	X	X
1N6101	X	X	X
Small Signal Diodes			
1N457	X		
1N458	X		
1N459	X		
1N483B	X	X	
1N485B	X	X	
1N486B	X	X	
1N914	X	X	
1N3064	X	X	
1N3595	X	X	X
1N3600	X	X	X
1N4148-1	X	X	X
1N4150-1	X	X	X
1N4376	X	X	X
1N4454-1	X	X	X

Device	JAN	JANTX	JANTXV
Transistors			
2N718A	X	X	X
2N930	X	X	
2N1613	X	X	X
2N2060	X	X	
2N2218A	X	X	X
2N2221A	X	X	X
2N2222A	X	X	X
2N2369A	X	X	X
2N2484	X	X	X
2N2904A	X	X	X
2N2905A	X	X	X
2N2906A	X	X	X
2N2907A	X	X	X
2N2920	X	X	X
2N3019	X	X	X
2N3700	X	X	X

Power (MIL-S-19500)

Device	JANTX	JANTXV
Power MOSFETs		
2N6756	X	X
2N6758	X	X
2N6760	X	X
2N6762	X	X
2N6764	X	X
2N6766	X	X
2N6768	X	X
2N6770	X	X

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Process Flow CMOS Hi-Rel Production Processing MIL-STD-883, Gate Array

Process Step	Method	Condition	Requirement
Internal Visual	2010	B	100%
Stabilization Bake	1008	C	100%
Temperature Cycle	1010	C	100%
Constant Acceleration	2001	D, E (Note 1), Y1 Orientation	100%
Initial Electricals	Per Applicable Spec.	25°C	100%
Burn-In	1015	A or C, 160 Hr. @ + 125°C	100%
Post Burn-In	Per Applicable Spec.	25°C, PDA 5%	100%
Final Electricals			
DC Static	Per Applicable Spec.		
+ 25°C Ambient			100%
− 55°C Ambient			100%
+ 125°C Ambient			100%
DC Functional	Per Applicable Spec.		
− 55°C Ambient			100%
+ 25°C Ambient			100%
+ 125°C Ambient			100%
AC (Note 2)			
+ 25°C Ambient	1014		100%
Seal			
Fine Leak		B	100%
Gross Leak		C	100%
External Visual	2009		100%
Group B			**Quantity**
Subgroup 1			2
Physical Dimensions	2016		
Subgroup 2			4
Solvent Resistance	2015		
Subgroup 3 (Note 3)			10
Solderability	2003		
Subgroup 4			1
Internal Visual & Mechanical	2014		
Subgroup 5			15
Bond Strength	2011		

Note 1: Package dependent.
Note 2: Based on critical paths accepted and mutually agreed upon. Normally not tested.
Note 3: May deviate from MIL-STD-883 Method 2003. Solder dipped leads, if possible, may permit full military compliance. Waiver required for gold leads.

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Process Flow CMOS Hi-Rel Production Processing MIL-STD-883, Gate Array (Continued)

Process Step	Method	Condition	Quantity
Group C			
Subgroup 1			5
A) Steady State Life	1005	A or C, 1000 Hr. @ + 25°C	
B) Endpoint Electrical	Per Applicable Spec.		
Subgroup 2			15
A) Temperature Cycle	1010	C	
B) Constant Acceleration	2001	D or E (Note 1)	
C) Seal	1014		
Fine Leak		B	
Gross Leak		C	
D) Visual	1010 or 1011		
E) Endpoint Electrical	Per Applicable Spec.		
Group D			
Subgroup 1			15
A) Physical Dimensions	2016		
Subgroup 2			15 (0)
A) Lead Integrity (Note 2)	2004		
B) Seal	1014		
Fine Leak		B	
Gross Leak		C	
Subgroup 3			15
A) Thermal Shock	1011	B, 15 Cycles	
B) Temperature Cycle	1010	C, 100 Cycles	
C) Moisture Resistance	1004		
D) Seal	1014		
Fine Leak		B	
Gross Leak		C	
E) Visual	1004 and 1011		
F) Endpoint Electrical	Per Applicable Spec.		

Note 1: Package dependent; may deviate from MIL-STD-883C for extremely large VLSI packages.
Note 2: Package dependent.

Process Flow CMOS Hi-Rel Production Processing MIL-STD-883, Gate Array (Continued)

Process Step	Method	Condition	Quantity
Group D (Continued)			
Subgroup 4			15
A) Mechanical Shock	2002	B	
B) Vibration, Variable Frequency	2007	A	
C) Constant Acceleration	2001	D or E (Note 1)	
D) Seal	1014		
Fine Leak		B	
Gross Leak		C	
E) Visual	1001 or 1011		
F) Endpoint Electrical	Per Applicable Spec.		
Subgroup 5			15
A) Salt Atmosphere	1009	A	
Gold Finish (Note 2)			
B) Seal	1014		
Fine Leak		B	
Gross Leak		C	
C) Visual	1009		
Subgroup 6			3 (0), 5 (1)
A) Internal Water Vapor Content, 100°	1018	5000 ppm max.	
Subgroup 7			15
A) Lead Finish Adhesion	2025		
Subgroup 8			5
A) Lid Torque (Note 3)	2024		

Note 1: Package dependent.
Note 2: Waiver required for gold lids and/or leads. Fairchild can negotiate on a case-by-case basis depending on the package.
Note 3: Lid torque test shall apply only to packages which use a glass frit seal to lead frame, lead or body package.

Process Flow ECL Hi-Rel Production Processing MIL-STD-883, Gate Array
(Not Compliant with MIL-STD-883C)

Process Step	Method	Condition	Requirement
Internal Visual	2010.7	B	100%
Stabilization Bake	1008.2	C, 24 Hr.	100%
Temperature Cycle	1010	C	100%
Constant Acceleration	2001, Y1 Orientation	TBD (Note 1)	100%
Seal, Fine and Gross	1014		100%
Initial Electricals	Per Applicable Spec.	+ 25°C	100%
Burn-In (Note 2)	1015	C, 160 Hr.@ + 125°C	100%
Post Burn-In	Per Applicable Spec.	+ 25°C, PDA 5%	100%
Final Electricals			
DC Static	Per Applicable Spec.		
+ 25°C Case			100%
− 10°C Case			100%
+ 125°C Case			100%
DC Functional	Per Applicable Spec.		
+ 25°C Case			100%
− 10°C Case			100%
+ 125°C Case			100%
AC (Note 3)	Per Applicable Spec.		
+ 25°C Case			100%
External Visual	2009		100%
Group B			**Quantity**
Subgroup 1			2
Physical Dimensions	2016		
Subgroup 2			4
Solvent Resistance	2015		
Subgroup 3			15
Solderability	2003.3		
Subgroup 4			1
Internal Visual & Mechanical	2014		
Subgroup 5			15
Bond Strength	2011		
Subgroup 6 (Note 4)			3
Internal Water Vapor	1018		
Subgroup 7			5
Seal, Fine and Gross	1014		

Note 1: Package dependent.
Note 2: ECL product burn-in at + 125°C case. High-power devices to be negotiated.
Note 3: Must use Fairchild standard frequency domain test and one path only. Normally not tested.
Note 4: Required only if the package contains a dessicant.

Process Flow ECL Hi-Rel Production Processing MIL-STD-883, Gate Array (Continued)

(Not Compliant with MIL-STD-883C)

Process Step	Method	Condition	Quantity
Group C			
Subgroup 1			
A) Steady State Life (Note 1)	1005	C, 1000 Hr.	
B) Endpoint Electrical	Per Applicable Spec.		
Subgroup 2			
A) Temperature Cycle	1010	C	
B) Constant Acceleration	2001	TBD (Note 2)	
C) Seal, Fine and Gross	1014		
D) Visual	1010 or 1011		
E) Endpoint Electrical	Per Applicable Spec.		
Group D			
Subgroup 1			15
A) Physical Dimensions	2016		
Subgroup 2			15
A) Lead Integrity (Note 3)	2004		
B) Seal, Fine and Gross	1014		
Subgroup 3			15
A) Thermal Shock	1011	B, 15 Cycles	
B) Temperature Cycle	1010	C, 100 Cycles	
C) Moisture Resistance	1004		
D) Seal, Fine and Gross	1014		
E) Visual	1004 and 1010		
F) Endpoint Electrical	Per Applicable Spec.		
Subgroup 4			
A) Mechanical Shock	2002	B	
B) Vibration, Variable Frequency	2007	A	
C) Constant Acceleration	2001	TBD (Note 2)	
D) Seal, Fine and Gross	1014		
E) Visual	1001 or 1011		
F) Endpoint Electrical	Per Applicable Spec.		

Note 1: ECL product burn-in at + 125°C case. High-power devices to be negotiated.
Note 2: Package dependent.
Note 3: Lead integrity not performed on pin grid arrays or leadless chip carrier. Therefore, Subgroup 2 not performed on these package types.

Microcontroller Products

Description

The Fairchild F9450 is a high performance microprocessor implementing the complete MIL-STD-1750A Instruction Set Architecture, which was developed specifically for real-time applications. The F9450 is defined by DESC Standard Military Drawing 84169.

The F9450 is available in two packaging styles, qualified to operate at military temperatures ranging from − 55°C to + 125°C.

The F9450 has been certified to be compliant with the MIL-STD-1750A Instruction Set Architecture by the Systems Engineering Avionics Facility (SEAFAC) at Wright Patterson AFB, Ohio.

Process

F9450-15DMQB, F9450-15GMQB, F9450-20DMQB, F9450-20GMQB, F9451DMQB, F9451GMQB, F9452DMQB, and F9452GMQB are MIL-STD-883C certified products. Screening and QCI are performed in accordance with the requirements of MIL-M-38510 and MIL-STD-883.

The F9450 performance and test specifications are specified by Military Drawing 84169. This drawing requires the following electrical tests on all delivered product:

- MIL-STD-883 Method 5004:
  - DC Electrical
  - AC Electrical
  - Microprocessor Functional Test (75K test vectors)
    - All of the above tests are performed on all product, after burn-in at − 55°C, room temperature, and + 125°C
  - MIL-STD-1750A VSW Functional Test (13 million test vectors) at room temperature.
- Quality Conformance Inspection per MIL-STD-883 Method 5005
- Group A and C:
  - DC Electrical
  - AC Electrical
  - Microprocessor Functional Test (75K test vectors)
  - MIL-STD-1750A VSW Functional Test (13 million test vectors)
    - All of these tests are performed on all product at − 55°C, room temperature, and + 125°C.
  - Group C, 1000-hour life test units receive all of the above tests at all three temperatures at the completion of life test.
- Group B and D:
  - Standard 883 Method 5004 requirements

The following special requirements of Military Drawing 84169 are applicable to F9450 processes:

Para 3.7—Certification. Certification to MIL-STD-1750A verification software (VSW) test V2.1 + 2 shall be required and the manufacturer shall be listed on the Air Force VSW compliant computer list.

Note: V2.1 + 2 applicable to 8416901

Para 4.1—Sampling and inspection. Sampling and inspection procedures shall be in accordance with Section 4 of MIL-M-38510 to the extent specified in MIL-STD-883. In addition, a device shall be submitted once every 12 months of production to WPAFB (SEAFAC) for verification to MIL-STD-1750 VSW test V2.1 + 2 (see 3.7). The results of such testing shall be reported to DESC-ECS.

Para 4.2C—Subgroup 12 shall be added and shall consist of the MIL-STD-1750 VSW test at V2.1 + 2 deterministic portion only, at room ambient (see 3.7).

Para 4.3D—Subgroup 13 shall be added and shall consist of the MIL-STD-1750 VSW test V2.1 + 2, deterministic portion only, at − 55°C instant on and + 125°C Tc (see 3.7).

Discrete Products—Analog Small Signal Custom Processing

Fairchild's Small Signal Product Group offers a complete line of Hi-Reliability devices produced in modern production facilities both onshore and offshore. Although emphasis is placed on designing and built-in quality and reliability, a complete reliability screening program has been established. Most products offered in this product guide are available in all of the following Hi-Rel configurations:

- Hi-Rel Wafers and Die
- Military Qualified Diodes and Transistors
- Source Controlled Devices (SCD)
- Custom "Level S" Processing

Hi-Rel Wafers and Die

Wafer and Die are available in four standard configurations.

Source Controlled Devices (SCD)

Many devices listed in this product guide are available with processing defined and controlled by customer documents, commonly referred to as SCD's. Using the Fairchild-developed Modular Processing table, along with standard test methods and conditions, complete custom processing can be designed. Fairchild will conform to the requirements of furnished documents, however, reference to modules within the Modular Processing sequence in the SCD as equal to or exceeding the requirements specified will expedite quote response and product delivery.

Custom "Level B" Processing

Top of the line built and processed devices, requiring baseline documentation, wafer lot acceptance and traceability, clean room assembly and Level S process controls and screening are available. Consult the factory for details.

Standard Test Methods & Conditions

Test	MIL-STD-750 Method	Test Condition	Comments
Internal Visual	2072, 2073, 2074		
High Temp Storage	1032		200°C, 48 hrs.
Temp Cycle	1061	C	− 65°C to + 200°C, 20 cyc, 15 min. at extremes
Constant Acceleration	2006		30 Kg. Y1, one minute does not apply. (Not applicable to DO-35 pkg.)
Fine Leak	1071	G	5×10^{-8} atmos cc/sec. (Not applicable to DO-35 pkg.)
Gross Leak	1071	C	Test condition E for glass diodes
HTRB Burn-In	1038 and 1039		150°C, 48 hrs, 80% V_{CB} (transistor), 80% V_R (Diode) min. (use 72 hrs, if not followed by Power Burn-In)
Power Burn-In	1038 and 1039	B	Transistors—160 hrs., Diodes—96 hrs.
X-Ray	2076		2 views
External Visual	2071		
Group A			MIL-STD-19500 Table III, JAN TXV
Group B			MIL-STD-19500 Table IVb
Group C			MIL-STD-19500 Table V
Solderability	2026		LTPD = 15, Electrical rejects may be used.
Resistance to Solvents	1022		LTPD = 15, Electrical rejects may be used.

For complete information on MIL-STD-883, JAN and other aerospace/defense product availability, contact your National Sales Representative.

Packaging and Order Information

For additional Packaging information, see page 181.

Packaging and Order Information

Ever since it developed and introduced the classic through-hole plastic dual-in-line package in the early 1960s, Fairchild has been on the forefront of package technology. Today, Fairchild's products are available in the full range of industry standard through-hole packages. Fairchild devices are also available in a variety of surface-mount packages:

Package Equivalents

Through-Hole	Surface-Mount
Plastic DIP	Small Outline IC
Ceramic DIP	Ceramic Flatpak
Plug-In PGA	PLCC/LCC
Plastic and Metal Can Transistors	SOT
	Leadless SOT (MELF)
Glass Diodes	

Through-Hole Packaging

The most widely used through-hole packages are TOs and 14- and 16-lead plastic and ceramic dual-in-lines. TO cans cover the discrete, power, and military markets. Low power plastic DIPs, in 8 to 40 leads, represent the bulk of the commericial board market, through limited multi-layer technologies. The low power ceramic DIP models are used in military, memory, and small logic applications.

Fairchild has developed one of the highest power-dissipating through-hole packages currently available, in a 64-lead composite ceramic, which can be used as a surface-mount device in some applications.

*For more packaging and order information, please contact your local National Sales Office.

Surface-Mount Packaging

The demand for thin, miniature packages, adaptable to high-density die size and surface conditions, has produced wide-body SOICs in 8- to 24-lead sizes. The thrust in surface-mount technology encompasses all product lines and will experience substantial growth over the next two years.

While requiring adequate board technology for effective routing, the advantages of greater lead count (from 20 to 88 pins, with 130 pins in development) make the PLCC expecially popular in high-density uses.

The ease of mounting J-lead or gull-wing packages also satisfies tight board space and routing problems.

Historically, high-reliability military applications have preferred flatpacks, which offer a wide variety of configurations and lead counts—ranging from 20 to hundreds of pins. While flatpacks are considered surface-mount packages, special commercial applications use them as through-hole packaging.

The devices listed in this guide show only the basic device numbers. This basic number forms part of a simplified order code.

XXXXX X X X X XX

Special Variations
- QR = Commercial-grade device with burn-in
- QB = Military-grade device with environmental and burn-in processing
- T = Devices shipped in 7″ reels
- X = Devices shipped in 14″ reels
- TR = Commercial-grade devices with burn-in, shipped in 7″ reels
- XR = Commercial-grade devices with burn-in, shipped in 14″ reels

Temperature Range
- C (Commercial) = 0°C to + 70°C / + 75°C / + 125°C
- V (Industrial) = − 25°C to + 85°C
- A (Automotive) = − 40°C to + 85°C
- M (Military) = − 55°C to + 125°C

Package Code
- P = Plastic DIP
- PC = Plastic DIP
- PDIP = Plastic Dual In-Line
- SP = Slim Plastic DIP
- D = Ceramic DIP
- DC = Ceramic DIP
- CDIP = Ceramic DIP
- G = Ceramic Gull-Wing DIP
- SD = Slim Ceramic DIP
- LDCC = Leaded Chip Carrier
- PLCC = Plastic Leaded (J-Bend) Chip Carrier
- CLCC = Ceramic Leaded (J-Bend) Chip Carrier
- S = Small Outline IC (SOIC), 150 mils
- F = Flatpack
- FPK = Flatpack
- LCC = Leadless Chip Carrier
- L = Ceramic Leadless Chip Carrier (LCC)
- L1 = Ceramic Leadless Chip Carrier (LCC)
- Q = Plastic Chip Carrier (PCC)
- CPGA = Ceramic Pin Grid Array

Speed Grade (If Used)

Electrical Class (If Used)

Device Type

Surface-Mount Device Index

Standard Logic—FACT

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54AC/74AC00	Quad 2-Input Gate	X	X	X		
54ACT/74ACT00	Quad 2-Input Gate	X	X	X		
54AC/74AC02	Quad 2-Input NOR Gate	X	X	X		
54AC/74AC04	Hex Inverter Gate	X	X	X		
54AC/74AC08	Quad 2-Input Gate	X	X	X		
54AC/74AC10	Triple 3-Input Gate	X	X	X		
54AC/74AC11	Triple 3-Input Gate	X	X	X		
54AC/74AC14	Hex Schmitt Trigger Gate	X	X	X		
54AC/74AC20	Dual 4-Input Gate	X	X	X		
54AC/74AC32	Quad 2-Input OR Gate	X	X	X		
74AC74	Dual D Flip-Flop	X				
74ACT74	Dual D Flip-Flop	X				
74AC109	Dual J-K Flip-Flop	X				
74ACT109	Dual J-K Flip-Flop	X				
54AC/74AC138	1-of-8 Decoder/Demultiplexer	X	X	X		
54ACT/74ACT138	1-of-8 Decoder/Demultiplexer	X	X	X		
54AC/74AC139	Dual 1-of-4 Decoder/Demultiplexer	X	X	X		
54ACT/74ACT139	Dual 1-of-4 Decoder/Demultiplexer	X	X	X		
54AC/74AC151	8-Input Multiplexer	X	X	X		
74ACT151	8-Input Multiplexer	X				
54AC/74AC153	Dual 4-Input Multiplexer	X	X	X		
54ACT/74ACT153	Dual 4-Input Multiplexer	X	X	X		
74AC157	Quad 2-Input Multiplexer	X				
74ACT157	Quad 2-Input Multiplexer	X				
74AC158	Quad 2-Input Multiplexer	X				
74ACT158	Quad 2-Input Multiplexer	X				
74ACT161	4-Bit Binary Counter	X				
74AC163	4-Bit Binary Counter	X				
74ACT163	4-Bit Binary Counter	X				
74AC169	4-Bit Binary Counter	X				
54AC/74AC174	Hex D Flip-Flop	X	X	X		
74ACT174	Hex D Flip-Flop	X				
74ACT175	Quad D Flip-Flop	X				
74AC191	4-Bit Decade Counter	X				
54AC/74AC240	Octal Buffer/Line Driver	X		X		
74ACT240	Octal Buffer/Line Driver	X				
54AC/74AC241	Octal Buffer/Line Driver	X		X		
74ACT241	Octal Buffer/Line Driver	X				
54AC/74AC244	Octal Buffer/Line Driver	X		X		
74ACT244	Octal Buffer/Line Driver	X				
54AC/74AC245	Octal Bus Transceiver	X	X	X		
54ACT/74ACT245	Octal Bus Transceiver	X	X	X		
54AC/74AC251	8-Input Multiplexer	X	X	X		
54AC/74AC253	Dual 4-Input Multiplexer	X	X	X		

Surface-Mount Device Index (Continued)

Standard Logic—FACT (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54ACT/74ACT253	Dual 4-Input Multiplexer	X	X	X		
74ACT257	Quad 2-Input Multiplexer	X				
74AC258	Quad 2-Input Multiplexer	X				
74ACT258	Quad 2-Input Multiplexer	X				
54AC/74AC273	Octal D Flip-Flop	X	X	X		
54AC/74AC373	Octal Latch	X	X	X		
54ACT/74ACT373	Octal Latch	X	X	X		
54AC/74AC374	Octal D Flip-Flop	X	X	X		
54ACT/74ACT374	Octal D Flip-Flop	X	X	X		
74AC377	Octal D Flip-Flop	X				
54ACT/74ACT377	Octal D Flip-Flop	X	X	X		
54AC/74AC540	Octal Buffer/Line Driver	X	X	X		
74AC541	Octal Buffer/Line Driver	X				
74AC563	Octal D Latch	X				
74ACT564	Octal D Flip-Flop	X				
74AC573	Octal D Latch	X				
74ACT574	Octal D Flip-Flop	X				
74AC646	Octal Bus Transceiver w/Register	X				
74AC648	Octal Bus Transceiver w/Register	X				

Standard Logic—FAST

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54F/74F00	Quad 2-Input NAND Gate	X	X	X		
54F/74F02	Quad 2-Input NOR Gate	X	X	X		
54F/74F04	Hex Inverter Gate	X	X	X		
54F/74F08	Quad 2-Input AND Gate	X	X	X		
54F/74F10	Triple 3-Input NAND Gate	X	X	X		
54F/74F11	Triple 3-Input AND Gate	X	X	X		
54F/74F20	Dual 4-Input NAND Gate	X	X	X		
74F27	Triple 3-Input NOR Gate	X				
74F30	8-Input NAND Gate	X				
54F/74F32	Quad 2-Input OR Gate	X	X	X		
54F/74F38	Quad 2-Input Buffer	X	X	X		
74F40	Dual 4-Input Buffer	X				
74F51	AND/OR-Invert Gate	X				
54F/74F64	4-2-3-2 Input AND/OR-Invert Gate	X	X	X		
54F/74F74	Dual D Flip-Flop	X	X	X		
54F/74F86	Quad 2-Input Exclusive-OR Gate	X	X	X		
54F/74F109	Dual J-K Flip-Flop	X	X	X		
74F112	Dual J-K Flip-Flop	X				
74F113	Dual J-K Flip-Flop	X				
74F114	Dual J-K Flip-Flop	X				

Surface-Mount Device Index (Continued)

Standard Logic—FAST (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
74F125	Buffer	X				
54F/74F138	1-of-8 Decoder/Demultiplexer	X	X	X		
54F/74F139	Dual 1-of-4 Decoder/Demultiplexer	X	X	X		
74F148	8-to-3 Priority Encoder	X				
54F/74F151A	8-Input Multiplexer	X	X	X		
54F/74F153	Dual 4-Input Multiplexer	X	X	X		
54F/74F157A	Quad 2-Input Multiplexer	X	X	X		
54F/74F158A	Quad 2-Input Multiplexer	X	X	X		
54F/74F160A	4-Bit BCD Decade Counter	X	X	X		
54F/74F161A	4-Bit Binary Counter	X	X	X		
54F/74F162A	4-Bit BCD Decade Counter	X	X	X		
54F/74F163A	4-Bit Binary Counter	X	X	X		
54F/74F164	8-Bit Shift Register	X	X	X		
74F168	4-Bit BCD Decade Counter	X				
74F169	4-Bit Binary Counter	X				
54F/74F174	Hex D Flip-Flop	X	X	X		
54F/74F175	Quad D Flip-Flop	X	X	X		
54F181	ALU		X	X		
74F182	Carry Lookahead Generator	X				
54F/74F189	16 × 4-Bit RAM	X	X	X		
54F/74F190	4-Bit BCD Decade Counter	X	X	X		
54F/74F191	4-Bit Binary Counter	X	X	X		
54F/74F192	4-Bit BCD Decade Counter	X	X	X		
54F/74F193	4-Bit Binary Counter	X	X	X		
54F/74F194	4-Bit Bidirectional Shift Register	X	X	X		
54F/74F219	16 × 4-Bit RAM	X	X	X		
54F/74F240	8-Bit Inverting Buffer	X	X	X		
54F/74F241	8-Bit Noninverting Buffer	X	X	X		
54F/74F243	Quad Bus Transceiver	X	X	X		
54F/74F244	8-Bit Noninverting Buffer	X	X	X		
54F/74F245	Octal Bus Transceiver	X	X	X		
54F/74F251A	8-Input Multiplexer	X	X	X		
54F/74F253	Dual 4-Input Multiplexer	X	X	X		
54F/74F257A	Quad 2-Input Multiplexer	X	X	X		
54F/74F258A	Quad 2-Input Multiplexer	X	X	X		
54F/74F280	Parity Checker/Generator	X	X	X		
54F/74F283	Binary Full Adder, Lookahead	X	X	X		
74F299	8-Bit Octal Storage	X				
54F/74F322	8-Bit Parallel Shift Register	X		X		
74F323	8-B torage Register	X				
74F350	4-Bit Shifter	X				
54F/74F352	Dual 4-Input Multiplexer	X	X	X		
54F/74F353	Dual 4-Input Multiplexer	X	X	X		
54F/74F365	Hex Buffer/Driver	X	X	X		

Surface-Mount Device Index (Continued)

Standard Logic—FAST (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54F/74F373	Transparent Latch	X	X	X		
54F/74F374	Octal, 3-State Output Flip-Flop	X	X	X		
54F/74F378	Hex Parallel D Register	X		X		
54F/74F379	Quad Parallel D Register	X	X	X		
74F381	ALU/Function Generator	X				
74F382	Carry Lookahead Generator	X				
54F/74F385	Quad Adder/Subtractor, Reset	X	X	X		
54F/74F398	Quad 2-Port Register	X	X	X		
54F/74F399	Quad 2-Port Register	X	X	X		
74F401	Cyclic Redundancy Checker-Generator	X				
54F/74F402	Cyclic Redundancy Checker-Generator	X	X	X		
54F403	16 × 4 FIFO		X	X		
54F407	Data Access Register		X	X		
74F410	Register Stack	X				
54F/74F412	Latch			X		
74F413	16 × 4 FIFO	X				
54F/74F521	Identity Comparator	X	X	X		
74F524	Magnitude OR Complement Comparator	X				
54F/74F533	Inverting Transparent Latch	X	X	X		
54F/74F534	Octal D Flip-Flop	X	X	X		
74F537	1-of-10 Decoder/Demultiplexer	X				
74F538	1-of-8 Decoder/Demultiplexer	X				
74F539	Dual 1-of-4 Decoder/Demultiplexer	X				
54F/74F540	Octal Buffer/Line Driver	X	X	X		
74F541	Octal Buffer/Line Driver	X				
74F543	Octal Registered Transceiver	X				
54F544	Octal Registered Transceiver		X	X		
54F/74F545	Octal Bus Transceiver	X		X		
54F/74F547	3-to-8 Decoder/Demultiplexer	X	X	X		
54F/74F548	3-to-8 Decoder/Demultiplexer	X	X	X		
54F/74F563	Latch	X	X	X		
54F/74F564	Octal D Flip-Flop	X	X	X		
74F568	4-Bit BCD Decade Counter	X				
74F569	4-Bit Binary Counter	X				
54F/74F573	Latch	X	X	X		
54F574	Octal D Flip-Flop		X	X		
54F/74F583	BCD Adder, Lookahead	X		X		
74F588	Octal Bidirectional Transceiver	X				
74F657	Octal Transceiver with Parity	X				
54F676	16-Bit Serial Shift Register			X		

Surface-Mount Device Index (Continued)

Standard Logic—Field Programmable Logic Arrays

Device	Function	SOIC	LCC	FLAT	SOT	MELF
F93Z459	16 × 48 × FPLA		X	X		

Standard Logic—Low-Power Schottky

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54LS00	Quad 2-Input NAND Gate		X	X		
54LS02	Quad 2-Input NOR Gate		X	X		
54LS03	Quad 2-Input NAND Gate			X		
54LS04	Hex Inverter Gate		X	X		
54LS05	Hex Inverter Gate			X		
54LS08	Quad 2-Input AND Gate		X	X		
54LS09	Quad 2-Input AND gate			X		
54LS10	Triple 3-Input NAND Gate		X	X		
54LS11	Triple 3-Input AND Gate		X	X		
54LS13	Dual 4-Input Schmitt Trigger Gate		X	X		
54LS14	Hex Schmitt Trigger Gate		X	X		
54LS15	Triple 3-Input AND Gate			X		
54LS20	Dual 4-Input NAND Gate		X	X		
54LS21	Dual 4-Input AND Gate		X	X		
54LS22	Dual 4-Input NAND Gate			X		
54LS26	Quad 2-Input NAND Gate			X		
54LS27	Triple 3-Input NOR Gate		X	X		
54LS28	Quad 2-Input NOR Gate		X	X		
54LS30	8-Input NAND Gate		X	X		
54LS32	Quad 2-Input OR Gate		X	X		
54LS33	Quad 2-Input NOR Gate			X		
54LS37	Quad 2-Input NAND Buffer Gate		X	X		
54LS38	Quad 2-Input NAND Buffer Gate			X		
54LS40	Dual 4-Input NAND Buffer Gate		X	X		
54LS42	1-of-10 Decoder/Demultiplexer			X		
54LS47	BCD to 7-Segment Decoder/Driver			X		
54LS48	BCD to 7-Segment Decoder/Driver			X		
54LS49	BCD to 7-Segment Decoder/Driver			X		
54LS51	Dual 2-2 AND/OR-Invert Gate		X	X		
54LS54	2-2-3-3 AND/OR-Invert Gate			X		
54LS55	4-4 AND/OR-Invert Gate			X		
54LS74A	Dual D Flip-Flop		X	X		
54LS83A	4-Bit Binary Full Adder w/Carry			X		
54LS85	4-Bit Magnitude Comparator		X	X		
54LS95B	4-Bit Shift Register			X		
54LS109	Dual J-K Flip-Flop			X		

Surface-Mount Device Index (Continued)

Standard Logic—Low-Power Schottky (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54LS112	Dual J-K Flip-Flop		X	X		
54LS113	Dual J-K Flip-Flop		X	X		
54LS114	Dual J-K Flip-Flop		X	X		
54LS125A	Quad Buffer		X	X		
54LS126	Quad Buffer			X		
54LS133	13-Input NAND Gate		X	X		
54LS136	Quad 2-Input Exclusive-OR Gate			X		
54LS138	1-of-8 Decoder/Demultiplexer		X	X		
54LS139	Dual 1-of-4 Decoder/Demultiplexer		X	X		
54LS151	8-Input Multiplexer		X	X		
54LS152	8-Input Multiplexer			X		
54LS153	Dual 4-Input Multiplexer		X	X		
54LS155	Dual 1-of-4 Decoder/Demultiplexer		X	X		
54LS156	Dual 1-of-4 Decoder/Demultiplexer			X		
54LS157	Quad 2-Input Multiplexer		X	X		
54LS158	Quad 2-Input Multiplexer		X	X		
54LS160A	BCD Decade Counter		X	X		
54LS161A	4-Bit Binary Counter		X	X		
54LS162A	BCD Decade Counter		X	X		
54LS163A	4-Bit Binary Counter		X	X		
54LS164	8-Bit Shift Register		X	X		
54LS165	8-Bit Shift Register			X		
54LS168	BCD Decade Up/Down Counter		X	X		
54LS169	4-Bit Binary Up/Down Counter		X	X		
54LS170	16-Bit D Latch			X		
54LS173	Quad D Register		X	X		
54LS174	Hex D Flip-Flop		X	X		
54LS175	Quad D Flip-Flop		X	X		
54LS181	4-Bit ALU			X		
54LS192	BCD Decade Up/Down Counter		X	X		
54LS193	4-Bit Binary Up/Down Counter		X	X		
54LS194A	4-Bit Bidirectional Shift Register		X	X		
54LS195A	4-Bit Shift Register		X	X		
54LS240	Octal Inverting Bus Driver		X	X		
54LS241	Octal Noninverting Bus Driver		X	X		
54LS244	Octal Noninverting Bus Driver		X	X		
54LS245	Octal Bus Transceiver		X	X		
54LS247	BCD to 7-Segment Decoder/Driver			X		
54LS248	BCD to 7-Segment Decoder/Driver			X		
54LS249	BCD to 7-Segment Decoder/Driver			X		

Surface-Mount Device Index (Continued)

Standard Logic—Low-Power Schottky (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54LS251	8-Input Multiplexer			X		
54LS253	Dual 4-Input Multiplexer		X	X		
54LS256	Dual 4-Bit Address Latch			X		
54LS257A	Quad 2-Input Multiplexer		X	X		
54LS258A	Quad 2-Input Multiplexer		X	X		
54LS259	8-Bit Address Latch		X	X		
54LS260	Dual 5-Input NOR Gate		X	X		
54LS266	Quad 2-Input Exclusive-NOR Gate			X		
54LS273	Octal D Register		X	X		
54LS279	4-Bit RS Latch		X	X		
54LS283	4-Bit Binary Full Adder w/Carry			X		
54LS295A	4-Bit Shift Register			X		
54LS298	Quad 2-Port Register			X		
54LS299	8-Bit Shift Register		X	X		
54LS322	8-Bit Shift Register			X		
54LS323	8-Bit Shift Register			X		
54LS347	BCD to 7-Segment Decoder/Driver			X		
54LS352	Dual 4-Input Multiplexer			X		
54LS353	Dual 4-Input Multiplexer			X		
54LS365A	Hex Buffer Gate		X	X		
54LS366A	Hex Inverter Gate		X	X		
54LS367A	Hex Buffer Gate		X	X		
54LS368A	Hex Inverter Gate		X	X		
54LS374	Octal D Flip-Flop		X	X		
54LS375	4-Bit D Latch			X		
54LS377	Octal D Flip-Flop		X	X		
54LS378	Hex Parallel D Register			X		
54LS379	Quad Parallel D Register		X	X		
54LS395	4-Bit Shift Register		X	X		
54LS447	BCD to 7-Segment Decoder/Driver			X		
54LS490	Dual 2 × 5 Counter			X		
54LS502	8-Bit Successive Approximation Register			X		
54LS503	8-Bit Successive Approximation Register			X		
54LS670	16-Bit D Latch		X	X		
96LS02	Dual Retriggerable Monostable Multivibrator			X		

Surface-Mount Device Index (Continued)

Standard Logic—TTL

Device	Function	SOIC	LCC	FLAT	SOT	MELF
5400	Quad 2-Input NAND Gate			X		
5402	Quad 2-Input NOR Gate			X		
5404	Hex Inverter NAND Gate			X		
5408	Quad 2-Input AND Gate			X		
5409	Quad 2-Input AND Gate			X		
5410	Triple 3-Input NAND Gate			X		
5414	Hex Schmitt Trigger NAND Gate			X		
5420	Dual 4-Input NAND Gate			X		
5425	Dual 4-Input NOR Gate			X		
5430	8-Input NAND Gate			X		
5432	Quad 2-Input OR Gate			X		
5437	Quad 2-Input Buffer Gate			X		
5440	Dual 4-Input NAND Buffer			X		
5442A	1-of-10 Decoder/Demultiplexer			X		
5451	Dual 2-2 AND/OR-Invert Gate			X		
5473	Dual J-K Flip-Flop			X		
5474	Dual D Flip-Flop			X		
5475	4-Bit D Latch			X		
5476	Dual J-K Flip-Flop			X		
5483A	4-Bit Binary Full Adder w/Carry			X		
5485	4-Bit Magnitude Comparator			X		
5486	Quad 2-Input Exclusive-OR Gate			X		
5490	Decade Counter			X		
5495A	4-Bit Shift Register			X		
5497	Rate Multiplier			X		
54121	Monostable Multivibrator			X		
54122	Retriggerable Monostable Multivibrator			X		
54123	Dual Retriggerable Monostable Multivibrator			X		
54125	Quad Bus Buffer			X		
54150	16-Input Multiplexer			X		
54151A	8-Input Multiplexer			X		
54153	Dual 4-Input Multiplexer			X		
54154	1-of-16 Decoder/Demultiplexer			X		
54157	Quad 2-Input Multiplexer			X		
54161	Binary Counter			X		
54164	8-Bit Shift Register			X		
54165	8-Bit Shift Register			X		
54170	4 × 4 Register File (16-Bit D Latch)			X		
54173	4-Bit D Register			X		
54174	Hex D Flip-Flop			X		
54175	Quad D Flip-Flop			X		
54191	Up/Down Binary Counter			X		
54279	4-Bit RS Latch			X		
54283	Full Binary Adder w/Carry			X		

Surface-Mount Device Index (Continued)

Standard Logic—TTL (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
54298	Quad 2-Port Register			X		
9300	4-Bit Universal Shift Register			X		
9301	1-of-10 Decoder/Demultiplexer			X		
9308	Dual 4-Bit D Latch			X		
9309	Dual 4-Input Multiplexer			X		
9311	1-of-16 Decoder/Demultiplexer			X		
9312	8-Input Multiplexer			X		
9314	Quad 4-Bit D Latch			X		
9316	4-Bit Binary Counter			X		
9321	Dual 1-of-4 Decoder/Demultiplexer			X		
9322	Quad 2-Input Multiplexer			X		
9324	5-Bit Magnitude Comparator			X		
9328	Dual Serial 8-Bit Shift Register			X		
9334	8-Bit Address Latch			X		
9338	8-Bit Multiple Port Register			X		
9348	12-Bit Parity Checker/Generator			X		
9601	Retriggerable Monostable Multivibrator			X		
9602	Dual Retriggerable Monostable Multivibrator			X		

Standard Logic—Low Power TTL

Device	Function	SOIC	LCC	FLAT	SOT	MELF
93L00	4-Bit Universal Shift Register			X		
93L01	1-of-10 Decoder/Demultiplexer			X		
93L08	Dual 4-Bit D Latch			X		
93L10	BCD Decade Counter			X		
93L12	8-Input Multiplexer			X		
93L14	4-Bit Latch			X		
93L21	Dual 1-of-4 Decoder/Demultiplexer			X		
93L22	Quad 2-Input Multiplexer			X		
93L24	5-Bit Magnitude Comparator			X		
93L28	Dual Serial 8-Bit Shift Register			X		
93L34	1-of-8 Decoder/Demultiplexer			X		
93L38	Multiple Port Register			X		
96L02	Dual Retriggerable Monostable			X		

Surface-Mount Device Index (Continued)

Standard Logic—High-Speed ECL

Device	Function	SOIC	LCC	FLAT	SOT	MELF
F100101	Triple 5-Input OR/NOR Gate		X	X		
F100102	Quint 2-Input OR/NOR Gate		X	X		
F100104	Quint 2-Input AND/NAND Gate			X		
F100107	Quint Exclusive-OR/NOR Gate		X	X		
F100112	Quad Line Driver		X	X		
F100113	Quad Line Driver		X	X		
F100114	Quint Differential Line Receiver		X	X		
F100117	Triple 2-Wide OR-NOR/AND-NAND Gate		X	X		
F100118	5-Wide 5, 4, 4, 4, 2 OA/OAI Gate		X	X		
F100121	9-Bit Inverter Gate		X	X		
F100122	9-Bit Buffer		X	X		
F100123	Hex Bus Driver			X		
F100124	Hex TTL-to-ECL Translator			X		
F100125	Hex ECL-to-TTL Translator			X		
F100126	9-Bit Backplane Driver			X		
F100128	ECL/TTL Bidirectional Translator			X		
F100130	Triple D Latch			X		
F100131	Triple D Flip-Flop			X		
F100135	Triple J-K Flip-Flop			X		
F100136	4-Bit Bidirectional Shift Register			X		
F100141	8-Bit Bidirectional Shift Register			X		
F100142	4 × 4 Content-Addressable Memory			X		
F100145	16 × 4 Register File			X		
F100150	Hex D Latch			X		
F100151	Hex D Flip-Flop			X		
F100155	Quad Multiplexer/Latch		X	X		
F100156	Merge-Mask Latch			X		
F100158	8-Bit Shift Matrix			X		
F100160	Dual Parity Checker/Generator		X	X		
F100163	Dual 8-Input Multiplexer		X	X		
F100164	16-Input Multiplexer		X	X		
F100165	Universal Priority Encoder		X	X		
F100166	9-Bit Comparator		X	X		
F100170	1-of-8/Dual 1-of-4 Demux/Decoder		X	X		
F100171	Triple 4-Input Multiplexer			X		
F100179	Carry Lookahead Generator			X		
F100180	High-Speed 6-Bit Adder		X	X		
F100181	4-Bit Binary/BCD ALU			X		
F100182	9-Bit Wallace Tree Adder			X		
F100183	2 × 8-Bit Recode Multiplier			X		
F100250	Quint Line Transceiver			X		
F100402	16 × 4 Register File			X		

Surface-Mount Device Index (Continued)

Standard Logic—F11C ECL

Device	Function	SOIC	LCC	FLAT	SOT	MELF
11C01	Dual 5-4 Input OR/NOR Gate			X		
11C05	1 GHz Divide by-4 Counter			X		

Application Specific ICs—FGE Series

Device	Function	SOIC	LCC	FLAT	SOT	MELF
FGE0050	100-Gate Equivalent			X		
FGE0500	680-Gate Equivalent		X			

Memory

Device	Function	SOIC	LCC	FLAT	SOT	MELF
Bipolar Static RAMs (ECL I/O)						
F10145A	16 × 4-Bit Register File			X		
F10402	16 × 4-Bit Register File			X		
F10415	1024 × 4-Bit			X		
F10422	256 × 4-Bit			X		
F10474	1024 × 4-Bit			X		
F10545	16 × 4-Bit Register File			X		
F100145	16 × 4-Bit Register File		X	X		
F100402	16 × 4-Bit Register File			X		
F100415	1024 × 1-Bit			X		
F100422	256 × 4-Bit			X		
F100474	1024 × 4-Bit			X		
BiCMOS Static RAMs (ECL I/O)						
F10490	64K × 1			X		
F10494	16K × 4			X		
F10500	256K × 1			X		
F10504	64K × 4			X		
F100490	64K × 1			X		
F100494	16K × 4			X		
F100500	256K × 1			X		
F100504	64K × 4			X		

Surface-Mount Device Index (Continued)

Memory (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
TTL Static RAMs						
F93415	1024 × 1-Bit			X		
F93415A	1024 × 1-Bit			X		
F93L415	1024 × 1-Bit			X		
F93422	256 × 4-Bit		X	X		
F93422A	256 × 4-Bit		X	X		
F93L422	256 × 4-Bit		X	X		
F93L422A	256 × 4-Bit		X	X		
F93425	1024 × 1-Bit		X	X		
F93425A	1024 × 1-Bit		X	X		
F93L425	1024 × 1-Bit		X	X		
F93479	256 × 9-Bit		X	X		
F93479A	256 × 9-Bit		X	X		
Bipolar PROMs (TTL I/O)						
F93Z451	1024 × 8-Bit		X	X		
F93Z451A	1024 × 8-Bit		X	X		
F93Z511	2048 × 8-Bit		X	X		
F93Z565	8196 × 8-Bit		X			
F93Z565A	8196 × 8-Bit		X			
F93Z665	8196 × 8-Bit		X			
CMOS Static RAMs (TTL I/O)						
F1600A	64K × 1-Bit		X			
F1601A	64K × 1-Bit		X			
F1620	16K × 4-Bit		X			
F1621	16K × 4-Bit		X			
F1622	16K × 4-Bit		X			
F1623	16K × 4-Bit		X			

Surface-Mount Device Index (Continued)

Linear

Device	Function	SOIC	LCC	FLAT	SOT	MELF
Operational Amplifiers						
μA301A	General-Purpose	X				
μA308, A	Super Beta	X				
μA324	Quad	X				
μA709C	High-Performance	X				
μA714	Precision	X				
μA741	High-Performance	X				
μA747	General-Purpose	X				
μA748	High-Performance	X				
μA771	JFET	X				
μA772	JFET	X				
μA774	JFET	X				
μA798	Dual	X				
μA1458	High-Performance	X				
μA3403	Quad	X				
μA4136	Quad	X				
Comparators						
μA239	Quad	X				
μA311	Voltage	X				
μA339	Quad	X				
μA3302	Quad	X				
μA685	High-Speed	X				
μA6685	Ultra-Fast	X				
Special Function						
μA555	Single Timer	X				
μA592	Differential Video Amplifier	X				
μA733	Differential Video Amplifier	X				
μA3046	Transistor Array	X				
μA3086	Transistor Array	X				
μA3680	Quad Telephone Relay Driver	X				

Surface-Mount Device Index (Continued)

Linear (Continued)

Device	Function	SOIC	LCC	FLAT	SOT	MELF
Voltage Regulators						
μA109	3-Terminal	X				
μA117	3-Terminal	X				
μA138	5-Amp	X				
μA150	3-Amp	X				
μA209	3-Terminal	X				
μA217	3-Terminal	X				
μA238	5-Amp	X				
μA250	3-Amp	X				
μA309	3-Terminal	X				
μA317	3-Terminal	X				
μA338	5-Amp	X				
μA350	3-Amp	X				
μA7805	3-Terminal	X				
μA7815	3-Terminal	X				
μA7824	3-Terminal	X				
μA78L05	3-Terminal	X				
μA7905	3-Terminal	X				
μA7908	3-Terminal	X				
μA7912	3-Terminal	X				
μA7915	3-Terminal	X				
μA431A	Adjustable Precision	X				

Interface Products

μA1488	Quad Line Driver, RS-232	X				
μA1489	Quad Line Receiver, RS-232	X				
μA9637A	Dual Differential Line Receiver	X				
μA9638	Dual Differential Line Driver	X				
μA75107A, B	Dual Line Receiver	X				
μA75108B	Dual Line Receiver	X				
μA75110A	Dual Line Driver	X				
μA75150	Dual Line Driver	X				
μA75176	Differential Transceiver	X				
μA75177	Differential Repeater	X				
μA75178	Differential Repeater	X				
μA75451A	Dual Positive AND Driver	X				
μA75452A	Dual Positive NAND Driver	X				
μA75453A	Dual Positive OR Driver	X				
μA96176A	Differential Transceiver	X				
μA96177A	Differential Receiver	X				
μA96178A	Differential Receiver	X				

Surface-Mount Device Index (Continued)

Power and Discrete

Device	SOIC	LCC	FLAT	SOT	MELF
Leadless Small Signal Diodes					X
Small Signal Diodes				X	
Monolithic Diode Arrays	X		X		
Small Signal Transistors				X	
Quad Transistors	X				

Index

For index of National products, see page 223.

Fairchild Index

Section 3

New Product Updates for 1988

Advanced Peripherals

For additional Advanced Peripheral products, see page 1.

New Graphics Processor from National Offers Highest Performance, Flexible Design

National Semiconductor Corporation has announced availability of the DP8500 Raster Graphics Processor (RGP), a high-speed, programmable processor for bitmapped graphics systems. The new chip joins National's Advanced Graphics Chip Set (AGCS), a family of very large-scale integrated (VLSI) building blocks for a wide range of high-performance video graphics and printer applications.

The RGP is the fastest component of its type on the market. The 20-megahertz complementary metal-oxide semi-conductor (CMOS) chip features a 100-nanosecond bus cycle time on back-to-back vector and block operations. The chip dramatically boosts the rendering speed of graphics operations and also controls video refresh function.

"The need for greater resolution. richer colors and faster graphics performance is a major competitive force in the computer systems market today," said Roger Reak, director of graphics marketing. "The RGP and other AGCS chips provide the highest level of graphics performance and resolution available on commercial chips. Yet their pricing and modular architecture make them cost-effective for low- and high-end systems alike, from personal computers to sophisticated workstations."

One of the RGP's advantages is its coupling of flexibility and speed. Like special-purpose, fixed-function chips, the RGP has hard-wired high-performance circuitry for graphics operations such as line drawing, fill and parallel clipping. On the other hand, the chip also offers the programmability typical of general-purpose processors. Programmability enables manufacturers to differentiate their products through proprietary algorithms and to optimize them for particular applications in engineering, business and desktop publishing.

The Advanced Graphics Chip Set provides an architecture adaptable enough to support whole families of graphics products that include a range of price and performance options. Users of the chip set can build on the AGCS architecture as new graphics components emerge and as system requirements evolve. Together with the chips' industry-leading performance, this architectural openness supports long-lived product lines.

Suitable applications for the RGP and other AGCS chips include high-performance graphics boards for personal computers, graphics sub-systems for engineering workstations, and rasterization engines for laser printers and other high-resolution hard-copy devices. The chips are capable of supporting the highest resolution devices with performance that is independent of color depth.

The RGP works with all types of memory, allowing designers to tailor the overall processing speed and control system cost through the choice of memory device. The RGP can access frame buffers in both a planar or pixel fashion, with the two modes selectable on an operation-by-operation basis.

A full range of software tools from National is available for the RGP. In addition, Nova Graphics International of Austin, Texas, is providing full support for graphics software standards.

Samples of the DP8500 Raster Graphics Processor are available now, production quantities becoming available by the third quarter of 1988.

National Semiconductor's family of graphics chips provides a rich collection of graphics functions and gives designers the performance they need to build a wide range of graphics products featuring a common hardware and software core.

Biphase Communications Processor Links IBM Mainframes To Office Computers

The DP8344 Biphase Communications Processor allows systems designers to develop the next generation of highly integrated communication devices to improve the efficiency of peripheral-to-IBM mainframe communications.

The DP8344 lowers the cost of implementing IBM 3270, 3299 and 5250 protocol communications capabilities and reduces the size and complexity of products designed to encode, decode and process the protocols. It can be easily integrated into cluster controllers, personal computers (PCs), terminals and printers to access IBM 370-class mainframes and IBM System 34/36/38 mid-frame/departmental computers.

The typical system implementation using the DP8344 requires only 6.4 square inches of space on a printed circuit board. Device designers combined the CPU and transceiver elements on one chip and integrated the functions of 30 MSI/LSI components to make the DP8344 compact, versatile and very fast.

Eliminating System Microprocessors

The device features a 20-MHz, 50-nanosecond T-state processor with a minimum instruction-cycle time of 100 nanoseconds and a maximum instruction-cycle time of 200 nanoseconds. The processor is powerful enough to eliminate previously required system microprocessors because it typically requires only 20 percent of its bandwidth to service 3270 coax-polled commmands. Eighty percent of its processing power remains for other non-communications system tasks.

Additional processor features include direct access to 64K by 16-bit instruction memory, access to separate 64K by 8-bit data memory, 30 instruction types, a 16-bit timer and an arithmetic logic unit (ALU) and barrel shifter.

The transceiver section of the DP8344 is protocol-selectable through software and can support IBM 3270/3299 coax, 5250 twinax and general 8-bit protocols. The transceiver also features fully registered status and control capabilities and an on-chip CMOS differential line receiver.

Power And Flexibility

The DP8344 brings power and flexibility to the IBM protocol communications environment. Because the DP8344's processor is general purpose, users can readily respond to changes in communication-protocol command content and sequences, and easily integrate the unit into current and future products.

The 20-MHz processor, fabricated with National's M²CMOS process, features subroutine and interrupt capabilities, on-board address and data stacks, software-controlled waitstates for program and data memory and general-purpose bus interfacing with on-board arbitration logic capable of supporting all major CPUs and bus standards. It can operate together with a remote processor or in a stand-alone mode as the system host.

The transceiver's complete system interface for the three IBM protocols and general 8-bit protocol makes the physical IBM system connection uncomplicated. In addition to traditional IBM plug-compatible terminal and printer applications, the DP8344 can be used to "gateway" between the coax or twinax cabling world and various local area networks such as Ethernet, token ring, Arcnet and others.

The DP8344 can be installed on a communications card designed for a PC-expansion slot to provide a micro-to-mainframe link. The card lets the PC emulate a 3270- or 5250-type terminal, but the PC retains its distributed processing power. If a local area network (LAN) card is installed in the same PC, gateway capabilities can also be provided. Up to 40 mainframe sessions can be distributed to the LAN through the 3299 protocol conduit.

The DP8344 may also function as an IBM 3270-to-ASCII/ANSI protocol converter, giving inexpensive terminals access to powerful IBM mainframes.

IBM Sets The Pace

Market trends and IBM's direction in data communications underscore the significance of the DP8344's introduction.

IBM's role in the data communications world, which is mainframe/mid-frame-oriented, greatly influences the future direction of the market. IBM will continue to support the 3270 and 5250 terminals as the primary connection vehicles to mainframes and medium-sized computers into the 1990s, according to Dataquest. The 3270 protocol, in particular, will remain a major standard for IBM host interactive communications.

Expanded media, connectivity and application program options for the 3270/5250 protocol environment are likely to be introduced by IBM. An example of this includes Advanced Program-to-Program Communication (APPC) in the 3270 environment, which would give users "peer-to-peer" LAN-like communications capabilities. Distributed Function Devices (DFDs) that will deliver more mainframe sessions to a greater number of intelligent peripherals, without increasing user costs, is another example.

The cost of 3270/5250 connectivity will continue to decline and approach today's price levels of RS232 connections in the 1990s. The protocols will become a communications standard for all products requiring access to IBM host-processing resources and applications programs.

DP8344 Design Wins

The DP8344 already boasts an impressive list of over 100 design wins. Companies that have designed the chip into new products that are scheduled for shipment include Hewlett-Packard, Local Data, Pathway Designs, Capstone Technology, Centronics/Genicom, McData and Microplus.

Products designed with the DP8344 cover all major applications, including cluster controllers, terminals, printer interfaces, 3270-to-token ring gateways and terminal-emulation devices for the PC.

Hewlett-Packard is using the DP8344 in its recently announced 700/71 terminal, a plug-compatible alternative to the industry-standard 3191 terminal. It is their first release of a plug-compatible 3270-protocol product.

Development Support Available

The DP8344 is backed by a full range of development tools and an extensive network of design centers.

Development tools available include a DP8344-based evaluation board kit with a monitor/debugger program, 3178 terminal demo software, a macro assembler with linker, and system development tools for line analysis and word generation/line stimulizers for coax/twinax product development and testing.

World's Fastest Turbo Transceiver Introduced

The fastest single-ended transceiver in the industry allows users to add a large number of printed circuit (PC) boards to a computer backplane with no degradation in system speed.

Designed for use in systems with heavily loaded backplanes, the new DS3893 Turbotransceiver improves the performance of any synchronous or asynchronous bus. It features a typical driver-enable and receiver propagation delay of only 3.5 nanoseconds, and can drive densely loaded backplanes with equivalent load impedances down to 10 ohms. The bipolar unit meets the signaling characteristics of the BTL (backplane transceiver logic) standard, developed to improve the performance of backplane buses.

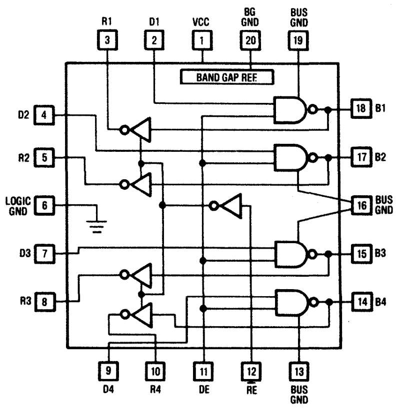
BTL-compatible transceivers feature a nominal 1-volt signal swing (1 volt low to 2 volts high) for low-power consumption, drivers with low-output capacitance to minimize bus-loading and receivers with very precise thresholds (1.47 to 1.62 volts) for maximum noise immunity. On the Turbotransceiver, a built-in bandgap reference assures the accuracy of the receiver threshold.

All of these features allow higher bus-transfer rates, improve overall system reliability and eliminate the "settling" time delays that severely limit TTL bus performance.

IEEE 896: Futurebus Conformance

The DS3893 Turbotransceiver also conforms to the requirements of the IEEE 896 Futurebus standard, a proposed general-purpose bus standard for high-performance microcomputer systems. The Futurebus standard offers unmatched performance levels for multiple-processor and cache-based systems.

Other features of the DS3893 Turbotransceiver include a busport capacitance of less than 7 picofarads, high-impedance MOS- and TTL-compatible inputs, and TRI-STATE control for the receiver outputs.



DRAM Controllers Drive Arrays To New Heights

National introduces the first DRAM controller capable of directly addressing and driving 4-megabit DRAM arrays up to 64 megabytes.

The DP8422 conroller/driver is versatile enough to be easily interfaced to all major 8-, 16- and 32-bit microprocessors without the need for previously required external support circuits.

The device offers users unmatched performance in terms of versatility, power, and addressing capabilities. Its programmability feature provides more flexibility than any current generation DRAM controller, and its support for two access ports simplifies applications requiring shared-memory access. The additional port allows a second CPU, DMA (Direct Memory Access), LAN (Local Area Network), or graphics controller access to the same memory bank.

Partners In Performance

The DP8422, along with the new single-ported, 1-megabit DP8421 and 256K-bit DP8420 DRAM controller/drivers, is ideally suited for a wide variety of DRAM-based applications where high-performance, no wait-state memory access is essential.

Several speed-enhancing features, such as support for memory interleaving and Burst-Nibble, Page, and Static Column memory access modes, allow the DP8420/21/22 to reach performance levels achieved by the fastest previous generation of 1-megabit, bipolar DRAM controller/drivers–the DP8428/29s.

The integration of programmable, on-chip, wait-state logic and the elimination of previously required external support logic also aid in the improved performance level of these CMOs devices. In addition, a built-in, high-precision delay line that uses a high-speed Phase Lock Loop (PLL) significantly enhances the DP8420/21/22's performance by tightening critical timing parameters.

Four RAS drivers, four CAS drivers, WE (write enable) and the necessary address drivers are provided on chip. For DRAM-based applications employing error detection and correction, the DP8420/21/22 features scrubbing during refresh with on-chip row, column, and bank counters, as well as the required arbitration logic.

Highly Programmable

The DP8420/21/22 DRAM controllers can easily be programmed to work with a variety of computer systems, regardless of DRAM access type. Adjustable control signal pulse widths allow use with the full spectrum of microprocessor/CPU operating frequencies, even beyond the 20 MHz boundary. Their programmable t_{RAH} (Row Address Hold) and T_{ASC} (Column Address Setup) times permit operation with fast or slow DRAMS.

In addition, they also allow programmable selection of RAS low time during refresh, the refresh time span, RAS precharge time, and the RAS/CAS configuration. A variety of refresh operations, including staggered and burst refresh, are automatic and transparent to the system.

Total Integration

By using the most modern process techniques available, National has integrated all major features associated with the interface, control and drive functions of today's DRAMs. These include on-chip address latches, bank-select logic, arbitration logic to support shared-memory accessing (DP8422), wait-state logic, and an on-chip delay line and refresh counter. Also provided are a high-speed row/column/refresh multiplexer, access/refresh arbitration logic, an automatic on-chip column address incrementor and high-capacitive drivers.

National has complemented the DP8420/21/22s by packaging them in low-cost 68-pin and 84-pin PCC packages. The DP8420 and DP8421 are offered in 68-pin PCCs and the DP8422 in an 84-pin PCC.

Video DRAM Controller/ Drivers Go Graphic

The most versatile and powerful Video DRAM Controllers in the industry join National's Advanced Graphics Chip Set (AGCS).

National's AGCS provides a new level of VLSI graphics performance for a wide range of CRT and hard-copy system designs. The new DP8520/21/22 programmable video DRAM controller/drivers can address and drive arrays 256K-bit, 1-megabit, or 4-megabit video DRAMs. The devices can be easily programmed to work with a variety of computer systems, regardless of video DRAM access type.

The DP8522 controller/driver directly addresses and drives an array of 4-megabit video DRAMs up to 64 megabytes in size. It easily interfaces to all major 8-, 16-, and 32-bit microprocessors, without the need for any external support circuits.

The DP8522's support for two access ports simplifies applications requiring shared-memory access by allowing two processors to address the same dual-ported memory component. Along with the new single-ported 1-megabit DP8521 and 256K-bit DP8520 video DRAM controller/drivers, the DP8522 is well-suited for a wide range of video DRAM-based applications where no-wait-state memory access is required.

Active Transfer Cycles

When the DP8520, DP8521 and DP8522 are used in a graphics frame buffer application, they are able to support a video DRAM transfer cycle during active video time. This is an extremely attractive feature supported by National's AGCS. Most commercially available graphics controller chip sets support video DRAM transfer cycles only during "video-blanking" periods (while the video DRAM is in standby mode).

Several speed-enhancing features allow the CMOS DP8520/21/22 devices to reach performance levels achieved by bipolar DRAM controller/drivers. These include support for memory interleaving and Burst/Nibble, Page and Static Column memory access modes.

The DP8520 and DP8521 are offered in 68-pin PCCs and the DP8522 in an 84-pin PCC. Samples, designated DP8520V, DP8521V and DP8522V are available now.

Multi-Board Clock System Boosts Color Graphics

Two additions to National's Advanced Graphics Chip Set (AGCS) solve clock synchronization problems in high-performance color graphics systems.

The DP8513 Video Clock Generator and the DP8514 Crystal Clock Generator form a multi-board clock system that puts virtually no limits on the allowable number of memory boards and color planes. The DP8513 has the identical features of the DP8512 Video Clock Generator (VCG), which is also designed for use in graphics systems.

Except for the reference-frequency input format, the DP8513 has the identical features of the DP8512 Video Clock Generator (VCG), which is also designed for use in graphics systems.

The device simplifies timing and minimizes phase skew between the various signals involved in the transfer of DRAM or video DRAM data into a D-to-A converter for display on a CRT. Used in conjunction with the DP8514, the Multi-Board Clock System employs digital phase-locked loop (PLL) techniques to originate a graphics processor clock, a raster-scan pixel clock, and a gated and non-gated load clock.

Phase-Locked Graphics

The DP8513 features a 225 MHz ECL differential output pixel clock. A non-overlapping 2-phase MOS-compatible clock output, required for 20 MHz operation of a raster graphics processor, is also generated. An on-chip PLL allows the clocks to be locked to an external horizontal synch pulse so that the graphics system can be phase-locked to an outside video source. All clock rates are pin-programmable.

The TTL-compatible device accommodates video data word widths from 4 to 64 bits, in increments of 4 bits. Its ECL circuitry can be referenced to a positive or negative power supply, or a single-5 volt supply.

In a multi-board system, the DP8513's REFIN and REFCLK inputs allow the graphics system's motherboard and slave boards to be synchronized from a single master clock source, such as the DP8514.

Oscillating Factors

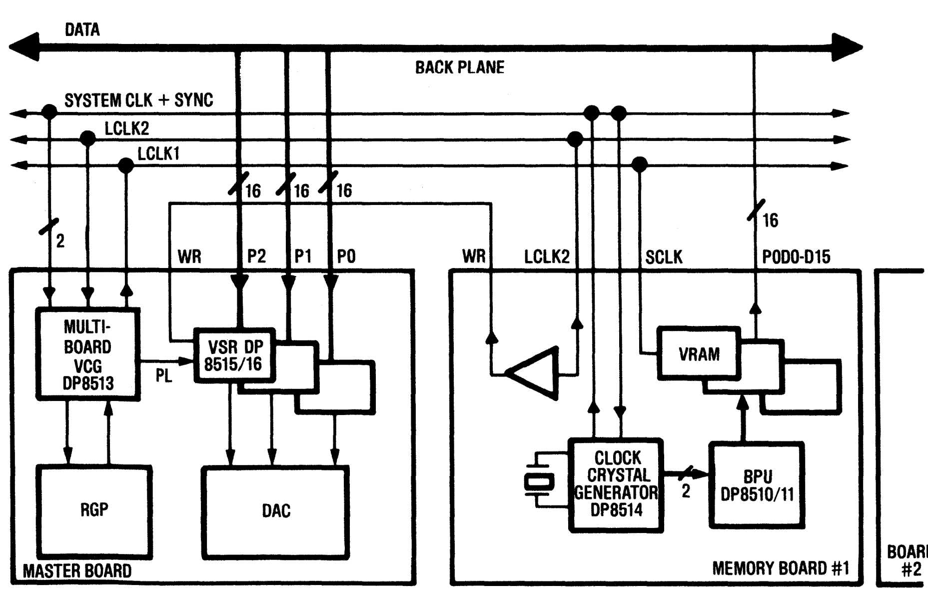
Although it is designed to work directly with the DP8513, the DP8514's features and flexibility allow it to be used in many other applications where conversion of the crystal oscillator signal into a device-level TTL-compatible signal is required.

The device consists of a crystal oscillator and a re-synchronizer/MOS clock generator, both of which may be used independently of each other. There are two TTL-compatible outputs from the crystal oscillator. The re-synchronizer has a clock input and a reference input (both TTL-compatible). The DP8514 can also be referenced to positive or negative ECL signals or a single 5-volt power supply.

Common Core: Flexible Performance

The AGCS is the first partitioned, high-performance chip family designed to meet any required performance specifications. The family of chips, featuring various graphics functions, gives designers the performance they need to build a wide range of graphics products featuring a common hardware and software core.

MULTIBOARD GRAPHICS INTERFACE



Video Shift Registers Speed Parallel-to-Serial Conversion

A new version of the DP8515/16 video shift registers supports very high-resolution displays in graphics systems.

The DP8515V-350 and DP8516V-350 are the latest members of National's Advanced Graphics Chip Set (AGCS). Featuring a parallel load rate of 30 MHz and a maximum shift rate of 350 MHz, the devices can also be used for very high-speed parallel-to-serial conversion in test equipment and fiber optic communications applications.

The two high-speed versions of the video shift register join the existing DP8515V and DP8516V, which feature a parallel load rate of 20 MHz and a maximum shift rate of 225 MHz.

AGCS: Partitioned Graphics Functions

The original DP8515/16 video shift registers, introduced in mid-1986, were the first components of National's AGCS, which provides a new level of VLSI graphics performance for a wide range of systems designs.

The chips in the family, used as modular building blocks, feature "partitioned" graphics functions. When tied together in a systems design, they support a virtually unlimited number of color planes under the control of a single raster-graphics processor.

AGCS members include the DP8513/14 multi-board clock system, the DP8512 and DP8530 video clock generators, the DP8510/11 BITBLT processing units and the DP8520/21/22 programmable video RAM controller/drivers.

Feature-Rich And Flexible

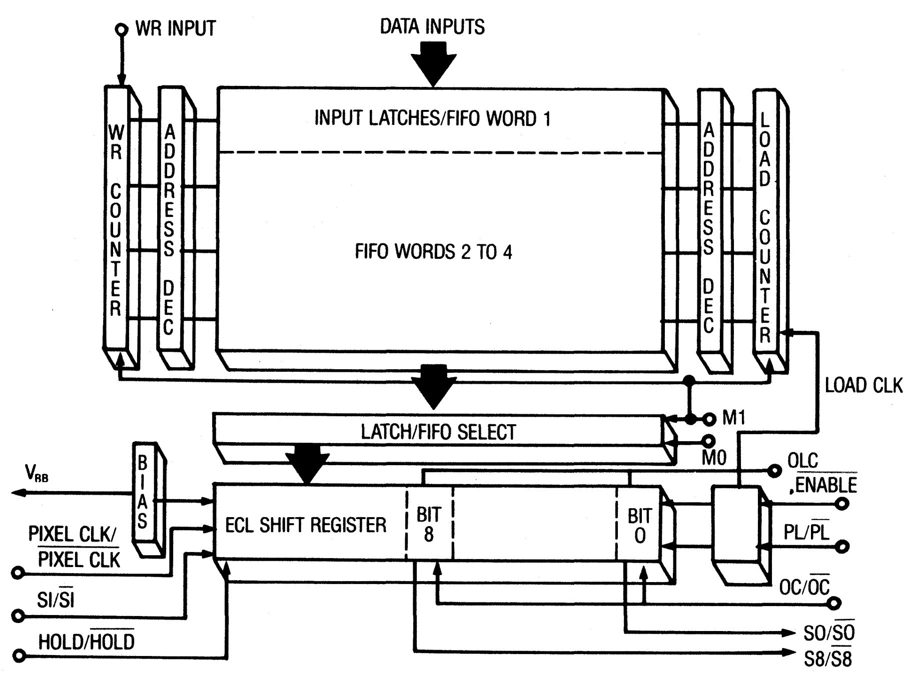
The new video shift registers are parallel-in, serial-out 16-bit units that can also act as two 8-bit shift registers through a tap at the eighth bit. They operate from a single +5-volt power supply, or plus and minus supplies, and feature four 16-bit words of FIFO, essential for high-speed multiple board systems.

Additional features include on-chip TTL-to-ECL translators and single-ended or differential ECL inputs and outputs, which add to the flexibility of the devices.

The devices have three input configurations: inputs set as transparent latches, inputs set as flip-flops (one-word FIFO mode) or inputs set up in a four-word FIFO mode. The four-word FIFO mode significantly eases system-timing constraints because it allows four write operations to occur before requiring a shift register load operation.

The DP8515V-350 and DP8516V-350 are fabricated with bipolar/CMOS process technology, offering users the advantages of both high speed and low power consumption.

The DP8515, available in a 44-pin PLCC, features 10K ECL-compatible outputs. The DP8516, offered in the same package, has 100K ECL-compatible outputs. Parallel data inputs on both units are TTL-compatible.



CMOS UARTS Go Portable

National has upgraded its popular UART product line with CMOS device versions aimed at the portable PC market.

The new NS16C450 and NS82C50A are functionally equivalent to their CMOS counterparts, the NS16450 and NS8250A, but consume only 10 milliamps of power in active mode. The new units function as serial data input/output interfaces in a microcomputer system. Their primary purpose is to provide full duplexed, bi-directional, asynchronous data communications between a CPU and a peripheral device, such as a printer, terminal or modem.

National is the leading supplier of UARTs for IBM PCs and compatibles, and its devices are installed in nearly all of those computers. The CMOS units are ideally suited for low-power applications, such as portable PCs.

Programmable Baud Rate Generator

The new CMOS UARTs (Universal Asynchronous Receiver-Transmitters) contain a programmable Baud Rate Generator (BRG) that is capable of taking any clock input (DC to 3.1 MHz) and dividing it by any divisor. The baud rate (the rate at which serial data is transmitted or received) is equal to the output of the BRG, divided by the clock factor (16X).

The functional configuration of the UARTs, including the on-board BRG, is programmed by the system software through a TRI-STATE 8-bit directional data bus.

Also contained in the UARTs is a complete modem-control capability and a processor-interrupt system that may be software-tailored to minimize the computing required to handle the communications link.

Other features include full double-buffering; independently controlled transmit, receive, line status, and data-set interrupts; false start bit detection; and line break generation, detection and internal diagnostic capabilities.

Both the NS16C450 and NS82C50A are available now in 40-pin plastic and ceramic DIPs and 44-pin plastic leaded chip carriers (PLCCs).

Application Specific ICs

For additional Application Specific IC products, see pages 19 and 231.

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.

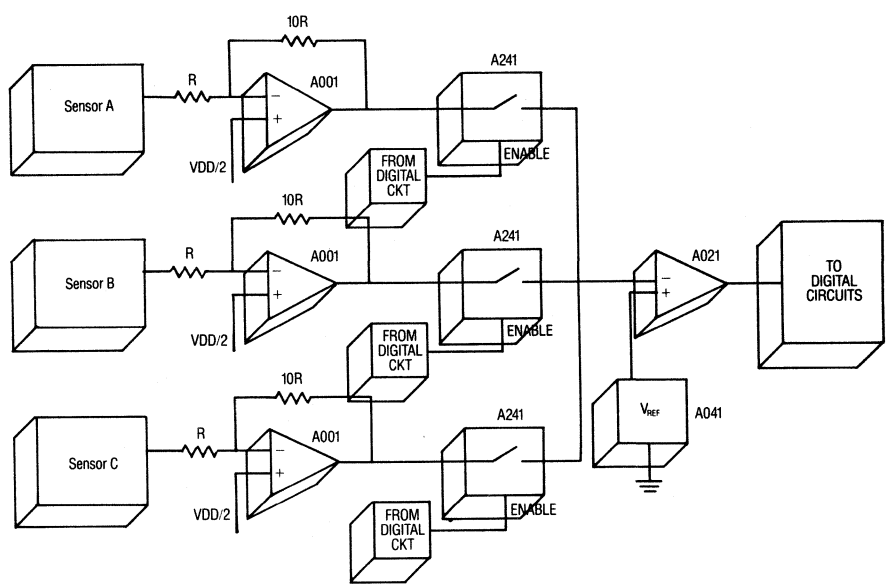
The eight analog functions include two comparators with different input common-mode ranges, three operational amplifiers with different gain-bandwidth products, a voltage reference, an analog switch and resistors.

The functions are based on National's advanced 2-micron M²CMOS process. This process is widely used across National's many product lines and has been optimized to operate from 5-Volt 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."



OPERATIONAL AMPLIFIERS

MACRO	GAIN BANDWIDTH	REMARKS
A001	0.75 MHz	VINCM: 0.3V
A002	1.5 MHz	TO VDD−1.5V
A003	.3 MHz	

RESISTORS

A331 TO A335	100Ω, 500Ω, 1KΩ, 2KΩ, & 20KΩ ±1% MATCH
A361 TO A365	1KΩ, 3KΩ, 5KΩ, 6KΩ, 100KΩ ±5% MATCH

COMPARATORS

MACRO	RESPONSE TIME	REMARKS
A021	250 NS WITH 10MV OVERDRIVE	VINCM: 1.5V TO VDD−0.5V
A022	180 NS WITH 10MV OVERDRIVE	VINCM: 0.3V TO VDD−1.5V

VOLTAGE REFERENCE

	BAND GAP REFERENCE
A041	2.5 VOLTS

ANALOG SWITCH

A241	ON RESISTANCE = 100 OHMS $T_{ON} = 30_{NS}$, $T_{OFF} = 30_{NS}$

FACT/FAST

For additional Logic products, see pages 89 and 273.

FAST™ Family Expansion Continues

The introduction of 18 new devices to the FAST (Fairchild Advanced Schottky-TTL) family of bipolar digital logic circuits ups the total number of available FAST products to 130.

The new device types encompass a wide variety of functions, including gates, buffers, latches, line drivers and flip-flops. Each of the new products operates over the standard commercial temperature range of 0°C to +70°C, with supply voltage tolerance (V_{CC}) guaranteed at 5V ±10%.

A Potpourri Of Products

The 74F841/843/845 are 10-bit buffer/line drivers that feature broadside pinouts. They provide high-performance bus-interface buffering for wide data/address paths or buses carrying parity for microprocessor applications.

The 74F841/843/845 are 10-, 9- and 8-bit transparent latches, respectively. They are designed to eliminate the extra packages required to buffer existing latches and provide extra data width for wider address/data paths.

The 74F821/823/825 are 10-, 9- and 8-bit D-type flip-flops featuring broadside pinouts. The 74F366/368, meanwhile, are high-speed bus-oriented hex inverter buffers with 3-state outputs capable of sinking 64 mA.

The 74F657 is an octal bidirectional transceiver with an 8-bit parity generator/checker and 3-state outputs for bus-oriented applications. It combines the functions of the 74F245 and 74F280A in one package. The device also features input diodes for termination effects, and its outputs are capable of sinking 64 mA.

DEVICE	FUNCTION
74F27	Triple 2-Input NOR Gate
74F30	8-Input NAND GATE
74F37	Quad 2-Input NAND Buffer
74F38	Quad 2-Input NAND Buffer (OC)
74F40	Dual 4-Input NAND Buffer
74F51	AND/OR Invert Gate
74F125	Quad Buffer
74F366	Hex Inverter/Buffer
74F368	Hex Inverter/Buffer
74F657	Octal Bidirectional Transceiver With Parity
74F821	10-Bit D Flip-Flop
74F823	9-Bit D Flip-Flop
74F825	8-Bit D Flip-Flop
74F827	10-Bit Buffer/Line Driver
74F828	10-Bit Buffer/Line Driver
74F841	10-Bit Transparent Latch
74F843	9-Bit Transparent Latch
74F845	8-Bit Transparent Latch

National Introduces 23 FACT™ Standard Military Drawings

Device	Pins	Designation	Description
54AC00	14	5962-97549	Quad 2-Input NAND Gate
54AC02	14	5962-87612	Quad 2-Input NOR Gate
54AC04	14	5962-87609	Hex Inverter
54AC08	14	5962-87615	Quad 2-Input NAND Gate
54AC10	14	5962-87610	Triple 3-Input NAND Gate
54AC11	14	5962-87611	Triple 3-Input AND Gate
54AC14	14	5962-87624	Hex Inverter Schmitt Trigger
54AC20	14	5962-87613	Dual 4-Input NAND Gate
54AC32	14	5962-87614	Quad 2-Input NOR Gate
54AC138	16	5962-87622	1-of-8 Decoder
54AC151	16	5962-87691	8-Input Multiplexer
54AC153	16	5962-87625	Dual 4-Input Multiplexer
54AC174	16	5962-87626	Hex D Flip-Flop with Reset
54AC240	20	5962-87550	Octal Buffer/Line Driver
54AC241	20	5962-87551	Octal Buffer/Line Driver
54AC244	20	5962-87552	Octal buffer/Line Driver
54AC251	16	5962-87692	8-Input Multiplexer/3-State
54AC253	16	5962-87693	Dual 4-Input Multiplexer/3-State
54AC373	20	5962-87555	Octal Latch
54ACT138	16	5962-87554	1-of-8 Decoder
54ACT139	16	5962-87553	1-of-4 Decoder
54ACT245	20	5962-87663	Octal Transceiver

Contact your local National Sales Office for more information.

FAST™ And FACT™ Receive Military Qualification

Twenty different FAST and FACT logic products from Fairchild have been qualified to MIL-STD-883C, opening the way for their use in applications over the full military temperature range.

Sixteen FACT (Fairchild Advanced CMOS Technology) devices and four FAST (Fairchild Advanced Schottky-TTL) products have been qualified to MIL-STD-883C.

With these developments, 77 FAST devices have received MIL-STD-883C qualification, 46 are qualified under JAN B and 38 have received JAN S QPL II certification. FACT, meanwhile, now offers 63 devices characterized over the military temperature range; 43 of those products are 883C-qualified and a number are available to Standard Military Drawings (SMDs).

FAST On Target

The four FAST devices recently 883C-qualified include the following:

54F365 Hex Buffer/Line Driver w/3-State Outputs–The 54F365 FAST device type offers tPLH at 14.0 ns maximum; tPHL is 9.0 ns maximum.

54F407 Data Access Register–This device performs memory address arithmetic for RAM-resident stack applications. Compatible with all TTL families, the 54F407 is expandable in 4-bit increments and can operate at a 30 MHz microinstruction rate on a 16-bit word.

54F827/828 Buffer/Line Drivers w/3-State Outputs–These two FAST products provide high-performance bus interface buffering for wide data/address paths or buses carrying parity. They are designed for use as memory address drivers, clock drivers and bus-oriented transmitter receivers.

DEVICE	FUNCTION
54AC74	Dual D-Type Positive Edge-Triggered Flip-Flop
54AC109	Dual JK Positive Edge-Triggered Flip-Flop
54AC163	Synchronous Presettable Binary Counter
54AC245	Octal Bidirectional Transceiver
54AC273	Octal D Flip-Flop
54AC540	Octal Buffer/Line Driver w/3-State Outputs
54ACT00	Quad 2-Input NAND Gate
54ACT74	Dual D-Type Positive Edge-Triggered Flip-Flop
54ACT109	Dual JK Positive Edge-Triggered Flip-Flop
54ACT153	Dual 4-Input Multiplexer
54ACT157	Quad 2-Input Multiplexer
54ACT240	Octal Buffer/Line Driver w/3-State Outputs
54ACT244	Octal Buffer/Line Driver w/3-State Outputs
54ACT245	Octal Bidirectional Transceiver w/3-State Inputs/Outputs
54ACT253	Dual 4-Input Multiplexer w/3-State Outputs
54ACT257	Quad 2-Input Multiplexer
54F365	Hex Buffer/Line Driver
54F407	Data Access Register
54F827	Buffer/Line Driver
54F828	Buffer/Line Driver

The FACT™ Family Grows: A Dozen New Devices Added

Fairchild's FACT (Fairchild Advanced CMOS Technology) family of advanced CMOS digital logic circuits has grown to encompass 73 devices with the addition of twelve new products in the 74AC/ACT series.

Like all members of the FACT family, the new devices feature power consumption levels as low as 0.1 mW per gate at a 1 MHz clock frequency. Each of them has identical output stages and is guaranteed to source or sink 24 mA, while featuring internal gate delays of 1 nanosecond and worst-case propagation delays of 5 ns.

The 74AC/ACT series is guaranteed to drive 50-ohm transmission lines. High DC and dynamic output drive currents make the family ideal for driving low-impedance transmission lines and highly capacitive nodes.

Freedom From Latch-Up

The FACT family is manufactured with a 1.2-micron silicon-gate CMOS process that makes high switching speeds possible while effectively eliminating the traditional latch-up phenomenon associated with earlier CMOS families.

The new AC devices all have CMOS-compatible inputs, while the ACT versions feature TTL-level inputs. Since they feature TTL-type input thresholds, the ACT versions can be used as direct replacements for standard and advanced low-power Schottky devices.

Each of the products is available over the −40°C to +85°C commercial temperature range. The 'AC00, 'AC74, 'AC163, 'ACT109, 'ACT299, 'ACT563 and 'ACT564 are also available over the military temperature range, −55°C to +125°C.

DEVICE TYPE	FUNCTION
74AC00	Quad 2-Input NAND Gate
74AC74	Dual D-Type Positive Edge-Triggered Flip-Flop
74AC163	4-Bit Binary Counter
74AC191	4-Bit Up/Down Binary Counter
74AC299	8-Input Universal Shift/Storage Register
74ACT109	Dual JK Positive Edge-Triggered Flip-Flop
74ACT161	4-Bit Binary Counter
74ACT163	4-Bit Binary Counter
74ACT299	8-Input Universal Shift/Storage Register
74ACT534	Octal D-Type Flip-Flop
74ACT563	Octal D Latch
74ACT564	Octal D Flip-Flop

FACT™ Family Expansion Continues

Five new commercial devices and four MIL-STD-883C-qualified devices have been added to the FACT family of standard logic products.

Counting the new additions, 76 FACT devices are now available with approval over the commercial temperature range, and 44 device types have met MIL-STD-883C qualification.

Commercial Qualifications

The FACT 74AC708 is an expandable FIFO memory organized as 64 words by 9 bits. An 85-MHz shift-in and 60-MHz shift-out data rate make it ideal for high-speed applications. This device is the fastest 64×9 CMOS-level FIFO available on the market.

The FACT 74AC161 is a high-speed synchronous binary counter. It is synchronously presettable for use in programmable dividers, with two types of count-enable inputs and a terminal-count output that provides flexibility in forming synchronous multistage counters.

The 74AC257 uses a common data-select input to present selected data from its four outputs in noninverted form. The outputs may be switched to a high-impedance state by placing a logic HIGH on the common output-enable input, allowing direct interface with bus-oriented systems.

The 74ACT323 is an 8-bit universal shift/storage register with 3-state outputs. Parallel load inputs and flip-flop outputs are multiplexed to minimize pin count. Four operation modes are possible: hold (store), shift left, shift right and parallel load.

The 74ACT399 is the logical equivalent of a quad 2-input multiplexer feeding into four edge-triggered flip-flops. A common select input determines which of the two 4-bit words is accepted. The selected data enter the flip-flop on the rising edge of the clock.

MIL-STD-883C Qualifications

The reversible 54AC191 binary counter features synchronous counting and asynchronous presetting. The preset feature allows the device to be used in programmable dividers, while the count-enable input, the terminal-count output and the ripple clock output make possible a variety of methods of implementing multistage counters.

The 54ACT151 high-speed 8-input digital multiplexer provides the ability to select one line of data from up to eight sources. It can be used to generate any logic function of four variables; both true and complementary outputs are provided.

The high-speed quad 2-input 54ACT158 multiplexer selects four bits of data from two sources using the common select and enable inputs. The four buffered outputs present the selected data in the inverted form. This device may also be used as a function generator.

The 54ACT299 is an 8-bit universal shift/storage register with 3-state outputs. Four modes of operation are possible: hold (store), shift left, shift right and load data. The parallel load inputs and flip-flop outputs are multiplexed to reduce the total number of package pins; additional outputs are provided for easy serial cascading.

Commercial FACT Devices

74AC708	64×9 FIFO Memory
74AC161	Synchronous Presettable Binary Counter
74AC257	Quad 2-Input Multiplexer/3-State
74ACT323	8-Bit Universal Shift/Storage Register
74ACT399	Quad 2-Port Register

MIL-STD-883C Qualifications

54AC191	Up/Down Binary Counter
54ACT151	1-of-8 Decoder/Demultiplexer
54ACT158	Quad 2-Input Multiplexer
54ACT299	8-Input Universal Shift/Storage Register

New FACT™ LSI 16 x 16 Multipliers Introduced

Fairchild's 74ACT1010 parallel multiplier/accumulator and 74ACT1016 multiplier are the first LSI circuits in the FACT digital logic family of products.

The new LSI devices are designed for use in applications in video processors, radar and digital signal processing, array and Fast Fourier Transform (FFT) processors, and computer hardware accelerators. The 74ACT1010 and 74ACT1016 are available in industry-standard pinouts, are TTL-compatible and offer a commercial temperature range of −40°C to +85°C.

The 74ACT1010 features selectable accumulation, subtraction, rounding and preloading with a 35-bit result. It is offered in two high-speed versions: 55 nanosecond and 65 ns maximum multiply/accumulate times. The clock multiply time of the 74ACT1016, meanwhile, is 70 ns maximum.

Low Power Consumption

The low power consumption of the 74ACT1010–typically less than 250 mW–is less than 1/15 the power of compatible bipolar designs and 1/7 the power of NMOS designs. Both devices feature power consumption levels as low as 0.1 mW per gate at 1 MHz clock frequency, internal gate delays of 1 ns and typical output register propagation delays of just 15 ns.

The 74ACT1010 and 74ACT1016 have identical output stages and are guaranteed to source or sink 8 mA. TTL-type input thresholds allow these FACT products to replace standard bipolar input-level devices. They are capable of driving 100-ohm transmission lines, thus lowering overall system costs by reducing the requirement of putting line drivers on all 35 outputs.

FAST™ Adds Three Device Types To JAN B QPL

The three device types are the 54F181 4-Bit Arithmetic Logic Unit and the 54F563/573 Octal D-Type Latches with 3-State Outputs. The 54F181 ALU performs all of the possible 16 logic operations on two variables and a variety of arithmetic operations. The 54F563 and 54F573 are high-speed octal latches with buffered common Latch-Enable and buffered common Output-Enable inputs.

In addition to the JAN B device types, JAN Class S QPL II reliability certification has been granted for the FAST 54F373 Octal Transparent Latch and the 54F521 8-Bit Identity Comparator. JAN S certification has also been granted for the Low-Power Schottky 54LS244 Octal Buffer/Line Driver and the 54LS273 8-Bit Register.

The JAN B device types are available in CDIP, flatpak and leadless chip carrier (LCC) packaging.

Device Type	Function
54F181	4-Bit Arithmetic Logic Unit
54F563	Octal D-Type Latch
54F573	Octal D-Type Latch

Linear

For additional Linear products, see pages 67 and 247.

Smart High-Side Driver Safely Switches Inductive Loads

The LM1951 combines complete protection with fault reporting for switching grounded loads.

The lack of a reliable switch to handle inductive loads has been a long-standing problem for systems designers; to design for all possible contingencies using discrete power devices consumes too much board space and is costly. In addition, protection from load faults (short or open) and transients must be part of the design.

Traditionally, circuit designers have used "low-side" drivers which switch between a "hot" load and ground. They provide a simple interface between 5V logic systems and discrete power devices. In many applications, however, hot loads present unacceptable safety problems.

First Of The Smart Switches

National's new monolithic LM1951 High-Side Driver offers a unique solution to this design dilemma. This 1-Amp switch is rated for operation to 26V and will withstand up to ±85V transients. Also on-board are over-voltage and thermal shutdown features, as well as complete short-circuit protection.

The LM1951 not only protects itself from a load fault but also alerts the system that the fault condition has occurred. The driver features a diagnostic flag which goes "low" and tells the system controller to take corrective action in the event of a load short, open or excessive die temperature.

The LM1951 is well-suited for applications where it is connected to a battery. It offers an extremely low typical quiescent current drain of 0.1 uA (10 uA max.) at room temperature and guarantees less than 100 uA maximum over the full junction operating temperature range (−40°C to +150°C).

Reverse Voltage Protection

Since the LM1951 is built with National's Deep Base bipolar process, reverse voltages on the output will not harm the device. Other high-side switches contain diodes which do not allow the output to go below ground.

The LM1951 comes in a 5-lead TO-220 package. Heat sinking is usually not necessary, since the drop across the device is guaranteed to be less than 1V at full-rated load current.

All input voltage thresholds are TTL-, CMOS- and LSTTL-compatible. They all feature 200-mV typical hysteresis for greater noise immunity.

New Reference Guarantees Wide Temperature Range

The LM169 is the first precision monolithic voltage reference to guarantee a temperature coefficient of 3 PPM/°C across a full −55°C to +125°C range.

The LM169 often surpasses its guarantee of 3PPM/°C, relying on special temperature compensation techniques to achieve a low *typical* temperature coefficient (Tempco) of 1 PPM/°C. This contrasts with previous methods, which incorporated a heater on the die.

This advance eliminates the need for additional power to run the heater. It also eliminates a prolonged warm-up time when the reference is first powered. Most important, the Tempco performance is not degraded when the temperature exceeds 85°C, the die temperature at which heated references regulate.

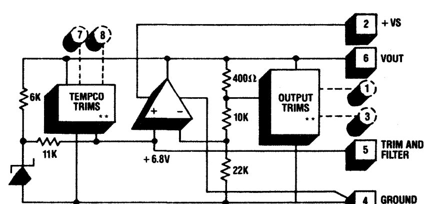
Guaranteed Accuracy

In Line with its superior performance, the LM169 typically achieves a V-out accuracy as low as 1 mV (0.01%) and guarantees an initial accuracy of 5mV (0.05%). The device also boasts a load regulation of 8PPM/mA and line regulation of 1PPM/V, the best in the industry on both specifications.

Potentiometer Trimming

The LM169 can also be trimmed with the addition of a potentiometer for any application demanding maximum accuracy. Trimming V-out does not adversely affect the temperature coefficient.

In applications like test and measurement equipment, the LM169 can be filtered with a small capacitor between a trim pin and ground to dramatically decrease output noise.



**PATENT PENDING

Low-Cost Quad Op Amp Offers High-Drive Capabilities

National's new LM837 quad op amp features a new type of output stage that allows it to outperform dual devices in signal conditioning circuits.

Although National's new LM837 quad op amp was primarily designed for audio circuitry performance, it is gaining widespread acceptance in many instrumentation, telecommunications, and other signal processing applications.

The LM837 features a new type of output stage which drives a 600 ohm load, making it ideal for a wide variety of amplification and signal conditioning circuits. Moreover, its low distortion of 0.0015% and low input noise of 0.5 uV are not affected by such loads.

Half The Board Space Of Duals

With a bandwidth of 15 MHz and a slew rate greater than 8 V/microsecond, the high-performance LM837 offers better price/performance than any competitive dual device on the market. It takes up half the board space of comparable dual performance, equals the reliability of these devices and lowers design costs.

Another inviting application for this low noise quad op amp is in active filter circuits, where noise is compounded with each successive cascaded stage. Performance in high-Q filter circuits is aided by the high (15MHz) gain bandwidth. In addition, the ±40mA output drive capability of the LM837 enhances its ability to drive low-impedance feedback networks.

Low Noise And Distortion

Low noise and low distortion levels give the LM837 quad op amp a design advantage in signal generators, where producing a clean signal is paramount. Its unity gain stability functions as another important feature in this respect.

The high current drive capability provides fast charging of holding capacitors for virtually any applications employing sample/hold, peak detection, AGC or data conversion techniques.

Easy System Upgrades

Upgrading an existing system requires little or no changes since the LM837 pin-out is compatible with most other standard quad op amps. By replacing many duals or lesser quad op amps, a significant improvement in the signal-to-noise ratio, signal handling capability and bandwidth can be expected.

Wideband Video Buffer Targeted For High-Speed Applications

The fast unity-gain LH4002 video driver is designed to offer OEMs high-current drive capability.

For high-speed video applications, nothing offers more high-current drive than National's new LH4002 Wideband Video Buffer. Designed to drive video signals from DC to 200 MHz with a guaranteed 100 MHz bandwidth, this high-speed voltage follower operates on just $\pm 5V$.

The LH4002 video amplifier fills a wide range of high-speed applications from video distribution to impedance transformations and load isolation with its ability to directly drive 50- and 75-ohm lines at slew rates in excess of 100 V/us.

Increased Output Current

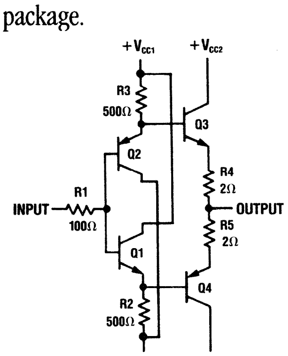
As a current booster in an op amp loop, the device will increase the output current of existing op amps by as much as threefold.

The LH4002 is also well-suited for raster graphic applications, with a phase linearity of 2 degrees and distortion less than 0.1 percent.

Since the frequency response is flat over the 100 MHz bandwidth, the pulse response overshoot is minimized. This makes the LH4002 an excellent cable driver for high-speed digital and analog signals.

Pin-Compatibility

This wideband video buffer is pin-compatible with the industry-standard LH0002. The LH4002 is available in a 10-pin plastic DIP, using a unique lead-frame construction which offers superior heat dissipation over a metal TO-5 package. The device is also available as a military version in the 8-pin TO-5 package.



SLIC Gets Smaller

National's new TP3200 bipolar IC uses magnetic compensation to reduce the size and cost of SLIC transformers.

Although Subscriber-Line Interface Circuit (SLIC) technology is evolving at a steady pace, most monolithic approaches have suffered from being too expensive or bulky. They also have been unable to handle high-ranging voltages and other performance demands of Central Office applications and trunk lines.

Ultimately, it is expected the semiconductor industry will produce a low-cost solution which offers high performance without requiring a transformer.

No Magnetic Saturation

For now, National's new magnetic compensated SLIC circuits are offering the telecommunications world an attractive interim answer in terms of price, size and performance.

Through a series of design innovations, the new magnetic-compensated TP3200 SLIC retains all the advantages of transformer performance without resorting to larger, more expensive transformers.

Magnetic compensation reduces the DC flux build-up in the SLIC transformer and thus allows the use of a small, accurately wound core with no air gaps. This small ferrite core transformer can provide the large inductance needed without creating side effects.

A Longitudinal Balancing Act

The SLIC circuit also provides an excellent longitudinal balance of 60 dB min. even in the face of an induced current from a nearby power line. Special Si-chrome thin film resistors help make this possible.

The reliability of the ring tripping circuitry is not a problem with this monolithic SLIC. In fact, a special latch pin is dedicated for the ringing relay.

By carefully timing the ringing synch signals, the relay contacts are not subject to voltage arcs and subsequent rapid wear. The two remaining latch pins can then be used for circuit testing or battery reversal.

Op Amps Offer High Current Output

The LH4104 and LH4105 wideband op amps offer 500 ns settling times, optimizing them for a wide range of data acquisition and test & measurement applications.

The fast settling times of the LH4104 and LH4105 (to 0.01% accuracy) make them ideal precision cable drivers, video buffers, waveform generators and DAC output amplifiers.

No Current Boosters Required

A high current output of ± 100 mA allows the op amps to drive 50 and 75 ohm loads, eliminating the need for added current boosters.

The LH4104 offers a guaranteed maximum input offset voltage of 5 mV, compared with a guaranteed maximum of 500 uV for the LH4105. Both of these unity-gain stable op amps contain internal supply bypass capacitors rather than requiring external compensation.

Key parameters for pulse amplifiers and high-speed video applications include a 40V/us slew rate and a full 18 MHz gain bandwidth.

Both operational amplifiers are available in 12-pin metal TO-8 packages. Full military-processed versions of the LH4104 and LH4105 are also available.

Closed-Loop Buffers Offer High-Gain Accuracy

National's LH4003 and LH4006 Precision RF Buffers exhibit a fast slew rate and easy design features.

Traditional open-loop buffers have typically suffered from poor gain accuracy. The new LH4003 Precision RF Closed-Loop Buffer corrects the problem with a high-gain accuracy of 0.95 into a 50-ohm load. The device also features a fast slew rate of 1000 V/us, along with unity-gain stability.

Intended for applications in video buffering, driving long cables and conditioning flash converter input signals, the LH4003 substantially eases the designer's task. The buffer has internal short-circuit protection and internal power-supply bypass capacitors (0.01 uF) to make it relatively immune to circuit-board layout problems.

Guaranteed Small-Signal Bandwidth

The LH4003 has a guaranteed 200-MHz small-signal bandwidth. A sister closed-loop buffer, the LH4006, comes with all the same performance features, plus a guaranteed bandwidth of 300 MHz.

The two buffers operate from ±6-Volt supplies. In their quiescent state, they typically draw 55 mA. Both buffers are available in a 24-pin ceramic DIP with full commercial and military operating temperature ranges.

Battery-Powered Comparator Sounds Alarm

National's LM1801 Low-Power Comparator is a complete, monolithic solution to a wide variety of sensing, monitoring and alarming applications.

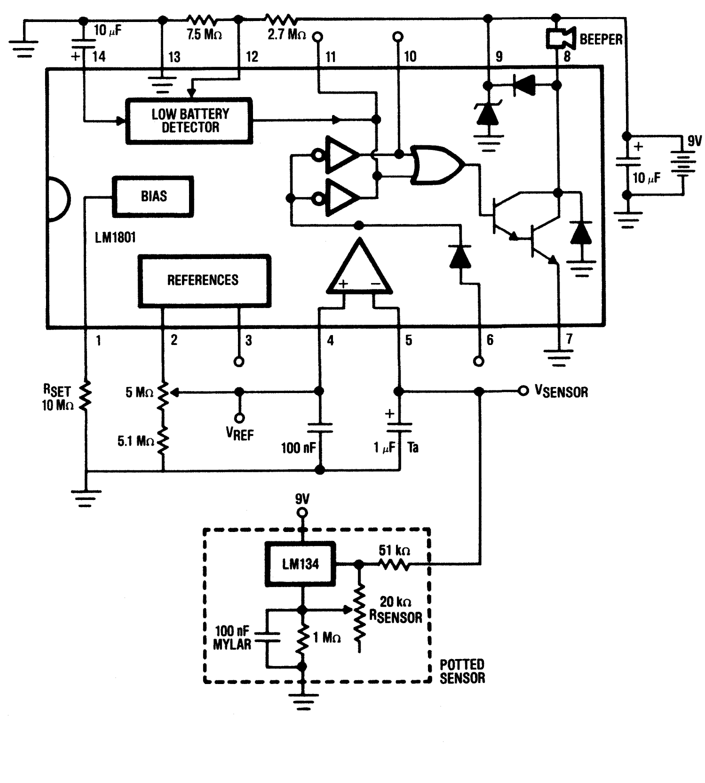
Powered by a single 9-volt battery, the LM1801 comparator will operate in a standby mode up to one year. The device will also run off any available power supply from 8 to 14 volts, using an on-board 14.5 zener clamp for supply regulation in line applications.

The LM1801 is packed with useful features. Two on-chip references serve as bias points for other circuit functions. A low-battery detector on-board will warn of circuit power failure. The device's 500mA output stage is sufficient to drive a beeper or buzzer in intrusion alarm systems.

Low Power Appetite

The LM1801 only consumes 6µA in a quiescent state, yet the comparator can source or sink a full 0.5A in a switched state.

For maximum utility, a parallel output enables up to nine LM1801 comparators to be tied to one alarm. In addition, a feedback pin provides a hysteresis feature to help prevent false alarms. A latching function is also available through the feedback pin to prevent the comparator from being accidentally turned off.



Memory

For additional Memory products, see pages 113 and 311.

National Enters OTP EPROM Market

National's new NMC27C64N CMOS One-Time Programmable (OTP) 64K-bit EPROM matches the reliability levels of ceramic parts while offering users considerable cost savings.

The device is the first CMOS EPROM to be offered by National in a molded plastic package. Unlike ceramic parts, it does not have the transparent lid used to expose the EPROM to ultraviolet light, thus optimizing it for high-voltage production applications. These include automotive engine control, anti-skid braking systems, computers, avionics systems and industrial control equipment.

Plastic Packaging: More to Come

The NMC27C64N 64-K bit CMOS EPROM is designed to operate with a single +5-volt power supply. It is available now in a 28-pin dual-in-line package (DIP) and will soon be offered in a 32-pin plastic leaded chip carrier (PLCC).

Plans are underway to offer National's entire comprehensive line of ultraviolet-erasable CMOS EPROMS in the new packages. The family includes 16K-, 32K-, 64K-, 128K-, 256K-, 512K-, and 1,024K-bit devices.

No Erasure Problems

OTP EPROMs are a natural choice during the manufacturing process because they offer users cost savings over ceramic EPROMs and are not susceptible to erasure.

Customers who use more than a few hundred CMOS EPROMs a year will benefit from the availability of the OTP unit. Ceramic windowed EPROMs would still be used during the development process until final, debugged programming code is completed.

New EEPROMs Packaged In Small 18-Pin DIPS

Three new CMOS EEPROMs feature multiplexed data and address lines that allow the devices to be packaged in small 18-pin dual in-line packages (DIPs), saving designers board space.

The NMC98C10, NMC98C20 and NMC98C40 1K, 2K and 4K EEPROMs are 5-volt programmable, non-volatile, parallel-access memories built with a CMOS floating-gate process. The devices meet the JEDEC pin-out for static RAMs with multiplexed address/data, allowing for simplified designs and systems flexibility. They can be directly interfaced with many industry-standard 8-bit and 16-bit microprocessors and microcontrollers.

The units are compatible with National's Series 32000 16/32-bit and NSC800 8-bit microprocessors and the HPC 16-bit microcontroller family.

Simplified Write Cycle

The write cycle of the devices is simplified by a self-timed erase-before-write circuit on the chip. The end of the write cycle can be determined by polling the data pins or allowing a minimum time between a write command and a subsequent command.

In order to prevent undesirable modification of the memory contents during system power-up or power-down, a lock-out circuit ignores write commands when V_{CC} is below prescribed levels.

The three EEPROMs also feature very low power dissipation and a minimum of 10,000 erase/write cycles.

Easy Storage and Retrieval

The NMC98C10/20/40 EEPROMs are targeted at the telecommunications, automotive, consumer, computer and industrial control industries. The family allows easy storage and retrieval of configuration parameters, security/password data, and PBS switch data, as well as wear parameters for self-adjusting machinery and retrieval of important data during power failure.

To assure availability, National has signed a non-exclusive, second-source agreement with Sierra Semiconductor covering the devices.

Microcontrollers

For additional Microcontroller products, see page 125.

National Introduces World's Fastest 16-Bit CMOS Microcontroller

The HPC 16083V30 runs at a clock rate of 30 MHz, optimizing it for many new speed-critical applications previously beyond the reach of microcontrollers.

The HPC16083V30's speed allows system designers to implement more features on-board with software rather than hardware, reducing overall system size and cutting costs.

Featuring an extremely fast instruction-cycle time of 134 nanoseconds, the device is more than 100 ns quicker than the 17 MHz version of the part, introduced last year. Its ability to gather and process information swiftly makes it ideally suited for near-future applications, such as microwave landing systems for airliners. It can also be used in automotive adaptive braking systems, laser and high-end dot matrix printers, and robotic control systems, where very high band-width-processing is required.

Software Benchmarks Tell the Tale

In software benchmark tests with other leading microcontrollers, the HPC16083V30 was clearly the fastest device. The benchmarks were based on 11 software operations, including a 512-byte block move, bubble sort, 16 by 16 multiply, 12 by 12 BCD multiply, I/O manipulation, 4-digit BCD add and 16-bit binary add.

Rated at 30 MHz, the HPC16083V30 features six working registers, a micro-instruction ROM, clock generator, four 16-bit timer/counters, control logic, WATCHDOG and reset circuitry and National's MICROWIRE/PLUS™ serial I/O bus interface.

Direct internal/external addressing through 64K-bytes of memory space allows interfacing to external memory, peripherals or other processors.

Newest Member of HPC Family

The HPC16083V30 is the latest member of National's 16-bit High Performance microController (HPC) family, which features a common-core architecture and very fast operating speeds. Based on the company's advanced CMOS technology, the family combines high speed with a modular design, allowing systems designers to select the microcontroller that best fits their application.

Each member of the HPC family has the same high-performance processor "core." Different selection of on-board memory, peripherals and I/O functions are built around the core to form specific products.

The HPC family is backed by a wide range of low-cost development tools, including high-level language compilers and assemblers for a variety of host computers.

HPC™ Software Support Package Aids Program Development

A new support package for National's family of 16-bit CMOS HPC microcontrollers features a relocatable assembler that improves the efficiency of software development.

The HPC Assembler/Linker/Librarian produces relocatable object modules from the HPC macro assembly-language instructions, which are linked and located to absolute memory locations. The absolute object module can be downloaded to the HPC MOLE™ (Microcontroller On-Line Emulator) development system for debugging.

The relocation procedure allows independent groups of programmers to work on separate sections of an assembly-language program at the same time. The modules can then be linked together to form a complete software program.

C Compiler: Part Of The Package

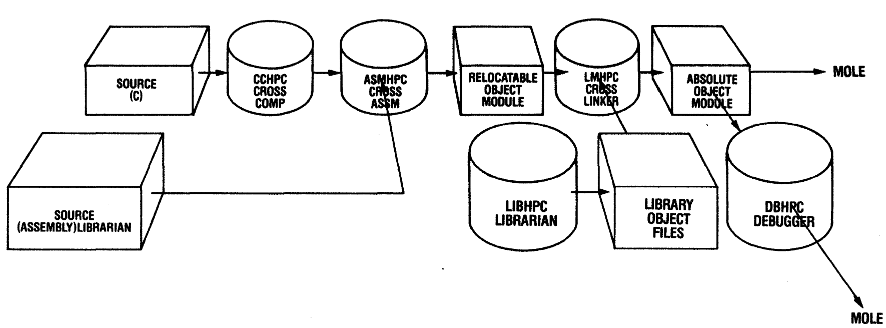
Along with the HPC Assembler/Linker/Librarian, an HPC C Compiler also comprises the software support package, which is offered on a variety of host computer systems. Versions are available for IBM PC XTs and ATs running PC DOS, and VAX™ minicomputers running the VMS and UNIX® operating systems.

The C Compiler generates assembly source code and may optionally pass symbolic information through the assembler and linker to the absolute object module. A source debugger then uses this information for C and assembly-language debugging on the host computer, in conjunction with the MOLE system.

The HPC C Compiler is a complete implementation of ANSI Draft Standard C, released in February 1986. It includes some variations that are required for microcontrollers and can be purchased separately from the HPC Software Support Package. An HPC C Compiler evaluation module is also offered at no charge which is identical to the full version but is limited to about 1,000 lines (3 kilobytes) of assembled code.

HPC Training Schools

As part of its HPC support program, National offers classes on all of its HPC microcontrollers and development tools. The classes include extensive coverage of the HPC Assembler/Linker Librarian and HPC C Compiler, and are taught by factory application engineers who have design experience in many application areas.



Low-Cost Design Kits For HPC Microcontrollers

Two low-cost HPC (High Performance microController) design kits available from National allow designers to easily integrate the world's fastest 16-bit CMOS microcontroller into system designs.

The kits, an evaluation package and a development package, are actually 16-bit microcontroller development systems used for program development and real-time emulation. An on-board HPC micro-controller executes monitor firmware and also acts as the target processor.

When used as a target processor, all HPC features, including up to 64K bytes of addressable memory, are available for use in the application.

Kit Contents

Both kits contain all of the components, manuals and software needed to design an HPC system. The only additional equipment required is an IBM PC or compatible system, a +5-volt power supply and RS232 cables.

The kits include an HPC evaluation board, an In-System Emulator (ISE) cable, development board communications software, a C Compiler software evaluation module, an HPC user's manual and data sheet and a Dial-A-Helper user's manual.

C Compiler Introduced for HPC Family Development

A new C compiler is now available for National's HPC family of CMOS 16-bit microcontrollers which can be used to develop HPC softeware on IBM PCs or compatibles running PC-DOS or MS-DOS.

The compiler supports the standard Kernighan and Ritchie C language, featuring several enhancements designed to make HPC programming easier and reduce the amount of compiled C code that is generated. These include the support of two non-standard statement types, LOOP and SWITCHF.

The LOOP statement is not in standard C, but has been introduced to allow programmers to save code space in tight loops by using the HPC's "decrement and skip if zero" instruction to control looping.

SWITCHF is a special type of SWITCH instruction that reduces assembled code by not generating code to check the bounds of the value being jumped. The C compiler also allows users to define the memory configuration of the HPC processor and include assembly code within the C language program.

Memory Definition

Because microcontrollers–unlike microprocessors–use ROM memory to store programs and RAM to hold data, compilers must define the memory configuration of the processor. This feature has been added to the compiler.

The HPC C compiler can also accept assembly language instructions along with high-level language instructions. This allows programmers to write very compact sections of code, reducing the amount of memory required to store it. Switching between standard C and HPC C is also allowed. Users can compile HPC C programs under standard C and run them under the UNIX™ operating system, for example.

The HPC C compiler is available from stock on IBM-compatible 5¼ inch disks for $595.

An evaluation module is offered at no charge. Called the HPC C Compiler Evaluation Module, it is identical to the full version but is limited to about 1,000 lines of assembled cose (3K bytes). It can be obtained through National sales offices or DIAL-A-HELPER, the company's on-line applications support service.

Core Concept Doubles Microcontroller Memory

The COP840C, the latest ROM-based member of the COP800 family, builds on National's COP800 core architecture. The result: a powerful microcontroller with twice the ROM and RAM memory of the COP820C.

Featuring 2K bytes of ROM and 128 bytes of RAM, the COP840C is perfectly suited for very complex microcontroller applications, including AC motor control, process control and heating-ventilation/air-conditioning (HV/AC) control.

According to Richard Sessions, product manager, the COP840C is designed for those complex uses. "The device will find its way into systems that require a very high level of performance from their microcontrollers," he notes.

Common At The Core

A common CPU serves as the brain of all members of the COP800 family, just as a common core is at the heart of National's 16-bit HPC microcontroller family. By adding a different mix of memory, on-board peripherals and I/O functions, users can match devices in the family to a wide range of specific applications.

The core consists of an arithmetic logic unit (ALU), five 8-bit working registers, three multi-sourced interrupts, one 16-bit timer/counter with an auto-reload/capture register, control logic and "watch-dog" circuitry. In addition, it features MICROWIRE PLUS,™ a serial synchronous communications interface that allows easy connection of external peripherals or other controllers (see this issue's application note for more on MICROWIRE).

Fabricated in the modern Arlington, Texas fabrication facility with National's 2-micron M²CMOS process, the COP840C operates over a voltage range of 2.5 to 6 volts.

Accurate Emulation

The microcontroller will operate in a "ROMless" mode to permit accurate emulation or the use of external program memory. A 15-bit program counter allows direct addressing for 32K bytes of memory. Other operating modes include single chip and test.

Addressing modes include register indirect, register indirect with auto-increment and decrement, direct, immediate and relative.

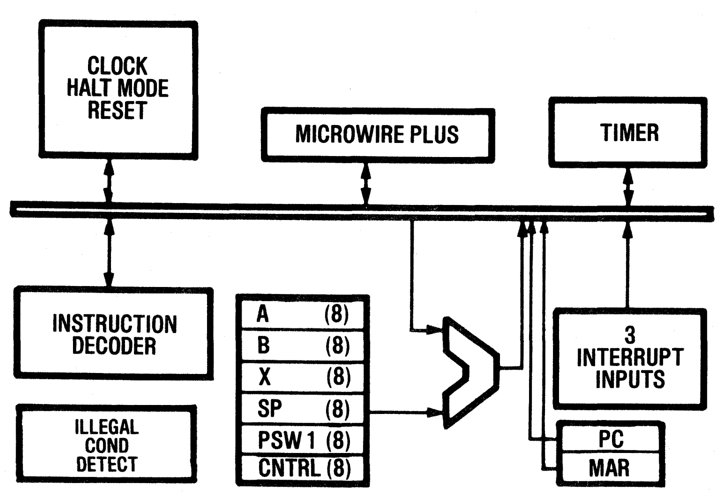
Single-byte, multi-function instructions make the COP device very code-efficient. In addition, because the COP840C features a 1 microsecond instruction-cycle time–and most instructions are single byte–the microcontroller executes all but a few of its instructions in only 1 microsecond.

Illegal-Condition Detection

The COP840C also features illegal-condition detection. Attempts to address "illegal" ROM or RAM or "overpop" the instruction stack cause a software interrupt to be generated. The interrupt can be used to set a recovery routine in motion that re-establishes the microcontroller process.

Like all members of the COP800 family, the COP840C is supported by MOLE,™ an inexpensive, PC-based development system. MOLE (Microcontroller On-Line Emulator) backs the microcontrollers from initial software development to final hardware emulation and ROM pattern submission.

The COP840C, with 24 input/output pins, is form-, fit- and function-compatible with the COP8720C and the ROM-based COP820C/21C/22C. It is available in 28-pin DIP and PCC packages. The COP841C (24 pins) is offered in DIP and SO packages.



New 16-Bit HPC Microcontroller Features Extra ROM On-Chip

With 8K bytes of on-chip ROM, the HPC16083 is ideal for automotive applications such as anti-skid braking systems and automotive-engine-control.

The HPC16083 microcontroller has a fourth input-capture register and features twice the ROM of other family members. It is suited for any general-purpose application requiring extra ROM; a ROMless version, the HPC16003, is also available.

The core processor, rated at a world-fastest microcontroller speed of 17 MHz over the full temperature range, is a 16-bit CPU with six working registers, a micro-instruction ROM, a clock generator, four 16-bit timer/counters, control logic, "watch-dog" circuitry and National's MICROWIRE/PLUS™ serial I/O bus interface.

The internal data paths and ALU are all 16 bits wide. Direct internal/external addressing through 64K bytes of memory allows interfacing to external memory, peripherals or other processors.

Three input-capture registers, 4K bytes of ROM and an on-chip UART were featured on the first HPC device, the HPC16040, introduced in March 1986.

Low-Cost Development Tools

The HPC family is supported by a wide range of low-cost development tools offered by National. These include high-level language compilers and assemblers for a variety of host computers, including PCs, the MOLE™ development system and an HPC evaluation board (see related stories).

A "PEARL" Of A Chip For HPC Applications

The HPC16900 Port Expansion and Re-creation Logic (PEARL) chip has an Emulator mode for use with external memory, giving designers a device that frees up I/O pins that are so crucial to microcontroller applications.

The CMOS PEARL support chip for National's HPC family of high-performance microcontrollers features two I/O modes, 36 multi-purpose I/O pins, and a wide voltage supply range of 3.0 to 5.5 volts. It also includes a Port-Expander mode to increase the number of system I/O ports.

When using external memory with an HPC, Port A and 4 bits of Port B on the HPC are used as multiplexed address/data and control lines. The HPC16900 can be used in emulator mode to regain the use of the ports by re-creating them. The PEARL chip entirely re-creates the HPC's Port A and 4 bits of Port B and provides all the logic needed to address external memory (PEARL Port E).

In Port-Expander mode, the HPC16900 provides 36 I/O pins that can be used as general purpose TRISTATE™ I/O.

Parallel Performance

The PEARL chip supports EXPANDED, EXPANDED ROMless, and EXPANDED UPI (Universal Peripheral Interface) HPC modes.

As many as four of the chips can be used in parallel without additional logic, for a total of 160 general purpose I/O lines.

The HPC16900 PEARL chip is available in 68-pin PLCC (plastic leaded chip carrier), LCC (leadless chip carrier), and PGA (pin grid array) packages.

New 8-Bit Microcontroller Has E²PROM in ROM and RAM

A new addition to National's 8-bit COP microcontroller family is ideally suited for prototyping applications or small production runs.

The COP8720C features 1K bytes of E²PROM in its ROM address space and 64 bytes of E²PROM in its RAM address space. The latter can be used to store information vital to the performance of process control, robotic and telecommunication equipment. The E² in ROM serves as program memory and may hold program instructions or constant data, such as look-up tables.

Because the COP8720C features a 1 microsecond instruction-cycle time, and most instructions are single byte, the controller executes all but a few of its instructions in just 1 microsecond. In addition, single-byte, multi-function instructions make the COP device very code-efficient.

For data memory, the 64 bytes of E²PROM in the RAM address space is supplemented with an additional 64 bytes of standard RAM. The data E²PROM can be accessed in the same way as the on-chip RAM.

Fault-Free Operation

In order to guarantee fault-free operation of the E²PROM modules, the microcontroller is provided with on-chip support circuits which generate all required high-voltage programming pulses. Fabricated with National's 2-micron M²CMOS process, the COP8720C operates over a voltage range of 2.7 to 6 volts. Operating modes include single chip and test. Addressing modes are registered indirect, register indirect with auto-increment and decrement, direct, immediate and relative.

The COP8720C is also equipped with MICROWIRE/PLUS,™ a serial synchronous communications interface that allows easy connection of external peripherals or other controllers. The interface consists of an 8-bit serial-shift register with serial-data input, serial-data output and a serial-shift clock. As an additional feature, the COP8720C microcontroller has an integrated on-chip 16-bit timer with an auto-reload/capture register.

Like all COP800 products, the 8720C features illegal-condition detection. Attempts to address "illegal" ROM or RAM or "over-pop" the instruction stack cause a software interrupt to be generated. This interrupt can be utilized to set a recovery routine in motion that re-establishes the microcontroller process.

The COP8720C is form-, fit- and function-compatible with the COP820C/21C/22C ROM-based versions of the 8-bit microcontroller family.

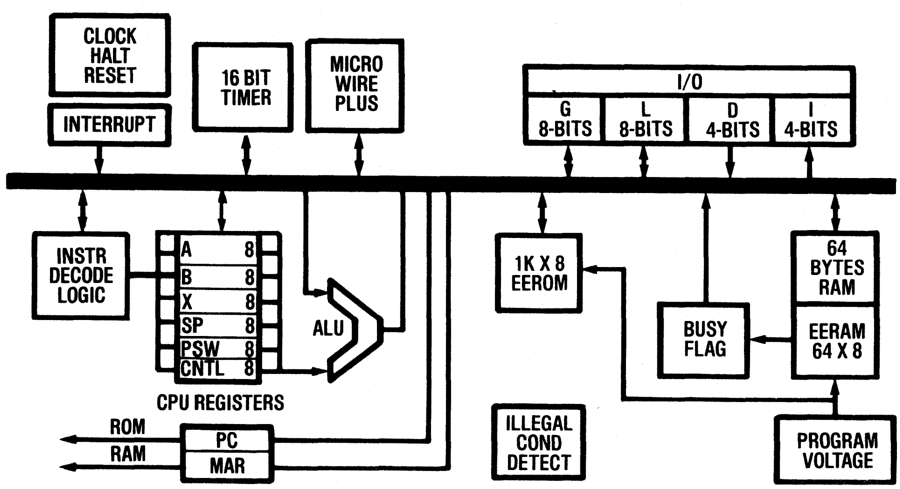
Common Core Flexibility

The new device embraces National's microcontroller "core" concept, where a common CPU serves as the brain of all members of a particular family. By adding a different mix of memory, on-board peripherals and I/O functions, users can match devices in the family to a wide range of specific applications.

The 8-bit microcontrollers have an arithmetic logic unit (ALU), five 8-bit working registers, three multi-sourced interrupts, one 16-bit timer/counter with auto reload/capture, control logic, "watch-dog" circuitry and a MICROWIRE/PLUS™ interface for connecting peripheral devices.

The COP8720C has 24 input/output pins. Two ports are 8-bit software-configurable. The D and I ports are 4-bit output and input ports, respectively.

8 BIT CORE
MODIFIED HARVARD ARCHITECTURE



HPC MathPack I: New HPC Software Support

Two new software packages for the HPC family of 16-bit CMOS microcontrollers support test equipment, instrumentation and digital signal processing applications.

One package implements a floating-point routine, and the other is a Fast-Fourier Transform (FFT) program. The floating-point package is written in HPC assembly code for compactness and speed, and can be used with the unit's C compiler. The compiler allows users to define the memory configuration of the HPC processor and include assembly code within the C language program (see related story in this issue).

The package features an ASCII-to-binary and binary-to-ASCII utility, which automatically converts characters and numbers entered from a keyboard into binary. ASCII characters are returned back from the program.

The program is a single-precision implementation based on the IEEE standard for binary floating-point arithmetic. In order to accommodate the HPC architecture, there are several differences between the version offered and the IEEE standard package. An application note available from National, numbered AN-486, lists the differences as well as the complete program.

Fast-Fourier Transform

The FFT program is set up to do Fast-Fourier Transforms of 2, 4, 8, 16, 32, 64, 128, and 256 inputs or bytes and can be easily modified to work with larger lengths. Another application note, numbered AN-487, details the package and provides a program listing.

Both software packages, called HPC MathPak I, save system designers time that would have been spent coding the mathematical functions. They can now download the code from National's Dial-A-Helper service and include it in application programs. Dual-A-Helper is an applications support service provided by National's Microcontroller Applications Group.

MathPaK for COP800C Family

For the COP800C family, COP800C MathPak I contains basic mathematical funtions that are written in CPO800C Assembler code. These include BCD and binary add and subtract; 8 by 8, 8 by 16 and 16 by 16 multiply; and 8 by 8, 16 by 8, 16 by 16, 24 by 16 and 32 by 16 divide. Also included are BCD-to-binary and binary to BDC conversions.

COP800C MathPak I is unique because code for all the routines is written in two ways: minimum code for higher ROM efficiency and optimized code for faster throughput. Programmers can chose either one to tailor system designs.

COP800C MathPak I is offered at no charge through Dial-A-Helper or from FAEs.

New Evaluation Board For HPC 16-Bit Microcontrollers

The MOLE-HPC-DB1 Board saves designers time and money by providing some of the emulation and debug capabilities offered on National's HPC MOLE™ system—at a lower cost.

The Evaluation Board can be operated from a single 5-volt power supply. It lets users take control of the HPC processor through an RS232 serial port and execute code from memory space, which is either 4K or 8K-bytes of ROM. Users can also assemble a program on a line-by-line basis, list the program memory in either mnueumonic or hex form and examine and modify the internal registers and RAM of the HPC.

The board consists of the HPC microcontroller with an on-chip UART, RAM for internal ROM replacement and monitor use, A PEARL (Port Expansion and Recreation Logic) chip to reconstruct the I/O, two RS232 connectors, monitor ROM, two 34-pin connectors that allow users to wire the HPC into a system and miscellaneous logic.

Easy Emulation

The board is connected to a target system through an emulation cable that is plugged directly into the user's application system. The HPC evaluation board "mimics" the HPC, letting the user's application circuit respond to the emulator the same way it would to the HPC. It attaches itself to the application circuit instead of the HPC chip, producing the same signals—with the same timing—as the final HPC chip.

Application development with the board is accomplished in four steps: a prototype application circuit is made, a C or Assembly program is written on the host system, the evaluation board's monitor executes the user program and the program is debugged.

Evaluation board firmware and hardware make debugging possible. A single-stepping feature, which uses breakpoints automatically set up by the monitor firmware, allows program execution to be stopped after each instruction. Because the program is being executed by an HPC chip, the evaluation board always knows which address is being accessed.

The HPC evaluation board supports emulation of systems which have expansion RAM external to the HPC chip. Users do not have to remove external memory while using board-emulation RAM, as long as the evaluation board jumpers are set properly.

The HPC evaluation board features 8K bytes of on-chip emulation RAM. Additional memory can be added on the target system, with the HPC running in either the EXPANDED or EXPANDED ROMless modes.

The 5-volt power supply and RS232 cables are supplied by users.

Microprocessors

For additional Microprocessor products, see pages 141 and 321.

CMOS Series 32000® Keeps Its Cool

National's Series 32000 CMOS 32-bit microprocessors dissipate less heat than competitive devices, giving them the edge in applications requiring low power consumption.

The inherent low-power characteristic of CMOS technology makes it the process of choice in applications where heat dissipation is critical. CMOS devices offer improved immunity to noise in harsh environments and help to smooth performance in extreme temperatures, giving them the edge in portable, battery-operated, military and industrial control applications.

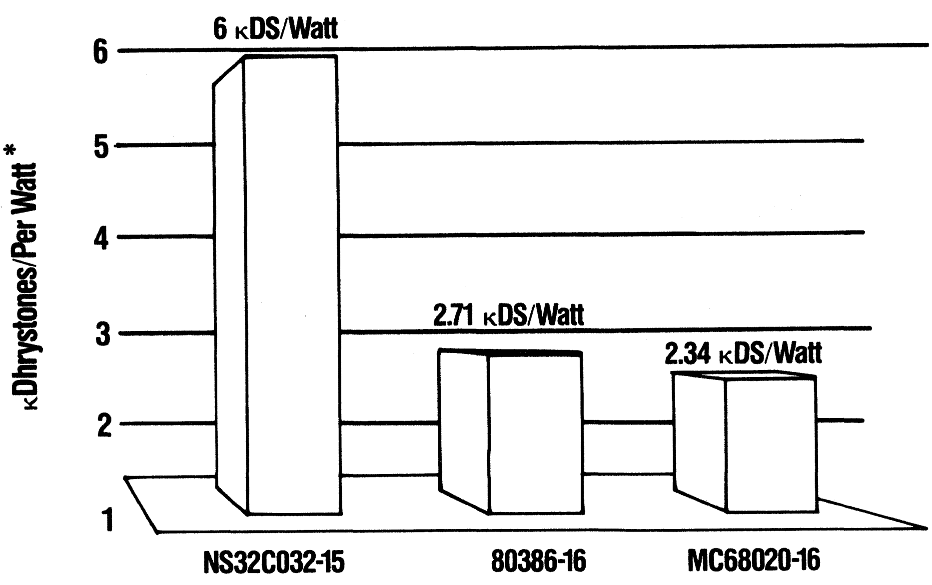
Less is More

National's CMOS Series 32000 32-bit microprocessors offer the lowest power consumption in the industry. For example, National's NS32C032, the industry's first full-CMOS 32-bit microprocessor, dissipates only 350 milliwatts. Competitive 32-bit devices, meanwhile, dissipate up to and beyond 2.0 watts.

This higher power consumption places these competitive microprocessors at a disadvantage in many CMOS applications where heat dissipation is the primary consideration. The NS32C032 offers an attractive performance/power ratio; benchmark studies show it performing at 6 kDhrystones for every watt consumed, a substantially better ratio than that offered by the other 32-bit CMOS microprocessors in the industry.

In addition, the NS32C032 is priced considerably less than its competitive counterparts.

The NS32C032 and NS32C016 are software-compatible with all other Series 32000 microprocessors.



***Calculated from Specifications Published in Industry Databooks**

New Development Board Accelerates Series 32000® Designs

The DB332-PLUS is a high-performance, 15MHz, NS32332-based board that enables designers to evaluate National's NS32332 computer cluster and Series 32000 family.

The Series 32000 instruction set, cycle timing, bus interfacing and internal architecture can be examined by using the DB332-PLUS. The board also provides a native debug and execution environment for programs developed on a host computer.

Computer Cluster On-Board

The on-board computer cluster consists of the NS32332 Central Processing Unit (CPU), NS32382 Memory Management Unit (MMU), NS32081 Floating Point Unit (FPU), NS32C201 Timing Control Unit (TCU) and NS32202 Interrupt Control Unit (ICU).

The 15MHz NS32332 is a 32-bit, virtual-memory microprocessor with a 4 GByte addressing capability. It is fully object-code compatible with other Series 32000 microprocessors and works in conjunction with the 32-bit slave processors in the Series 32000 family.

The MMU provides hardware support for demand-paged virtual memory management, while the FPU provides high-speed floating-point processing support and compatibility with the IEEE 754 standard for binary floating-point arithmetic.

Boarding The MULTIBUS® Architecture

The DB332-PLUS incorporates a MULTIBUS I interface, allowing users to configure larger systems. It may also be employed in a stand-alone mode when used with an RS232-compatible terminal and a power supply.

The board can be connected to another computer system or host. Here, Series 32000 software is developed on the host system and then downloaded via the RS232 communications link to the DB332-PLUS, which executes and debugs the software in a native environment.

The NS32532: Powerful 32-Bit Processing On The Horizon

National previews the forthcoming highest-integrated, highest-performance 32-bit microprocessor in the industry.

Specifications for the latest-generation Series 32000® microprocessor, the NS32532, have been announced to the public. Among the device's most prominent features: an on-chip, demand-paged, virtual memory management unit (MMU); on-chip instruction and data caches; and an 8-10 MIPs (VAX 780) average performance (with-up to 15 MIPS peak performance). The NS32532 also features broad real-time and multiprocessing versatility, and full software compatibility with previous Series 32000 processors and peripherals, including the NS32332 CPU and NS32383 MMU. Sampling of the NS32532 is due to begin in late 1987, with volume production scheduled immediately thereafter.

The new microprocessor has a full 32-bit architecture optimized for high-performance applications. With over 370,000 transistors, it features an extremely high level of integration. Its MMU offers a 64-entry, fully associative Translation Lookaside Buffer (TLB). Its instruction cache is a 512-byte, direct-mapped implementation, while its data cache is a 1,024-byte two-way set associative cache. In addition, the chip features a four-stage overlapping instruction execution pipeline.

The NS32532's current performance specs define a peak performance of 15 MIPS, with an average of 8-10 MIPS at a clock frequency of 30 MHz. It has an internal memory bandwidth of 240 Mbytes/second and an external bus bandwidth of 92 Mbytes/second. First release versions will have a 20 MHz clock rate, with higher-speed releases coming soon after as the design is scaled from a 1.5-micron double-metal process to a 1-micron line width. The CPU also addresses 4 gigabytes (billion bytes) of virtual and physical address space, and it is offered in a 175-pin-grid-array package.

The NS32532 is expected to open the door to a number of high-end applications which demand extremely fast execution times or have a critical need for hardware/software compatibility. In many cases, National's new CPU will make 32-bit technology accessible to applications that to date have not been a part of the 32-bit market–which is now focused mainly on personal computers and workstations.

Military applications, for example, can take advantage of the NS32532 in a variety of environments: fault-tolerant systems, high-performance parallel- and vector-processing systems, avionics and instrumentation, flight control systems, weapons delivery, simulators and other embedded control systems, and research and development projects.

High-end control applications can enjoy the same level of performance found in traditional bit-slice architectures, yet with the ease of standard software development and without the penalties associated with complex, non-standard developments.

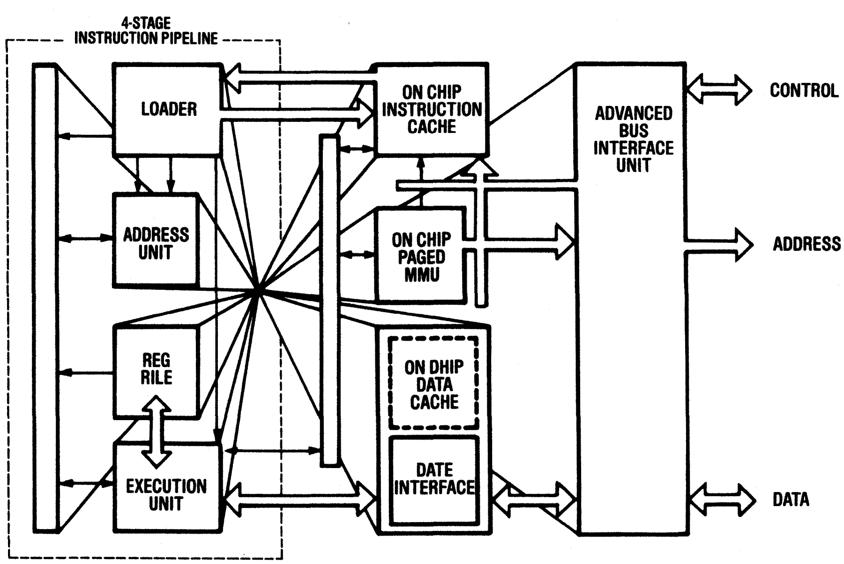
Real-Time, Multiprocessing Versatility

One of the major marketing issues National has focused on is the versatility of the NS32532–most significantly, its ability to function equally well in both real-time and multiprocessing environments.

For example, the NS32532 has an interrupt response (1.3 microseconds) and context switch time (3.6 microseconds) that is up to four times faster than any microprocessor currently available, making it appealing for real-time controller applications.

For multiprocessing, the 532 is also the sole 32-bit microprocessor on the market that can support an efficient bus-watcher mechanism to maintain internal cache coherency with multiple caches. For real-time applications, the NS32532 also has cache locking to keep key routines or data immediately available to the CPU.

The caches are accessed in parallel with address translation to optimize performance. The 64-entry Translation Lookaside Buffer (TLB) virtually guarantees (with greater



than 99 percent probability) that memory requests will already be located within the translation buffer (a "hit").

The integrated instruction and data caches, MMU, and TLB offer increased execution speed because of reduced external memory references. Cache size was critically engineered for efficiency to offer maximum probability of a cache hit.

Unique Hardware And Software Cache Invalidation

To maintain coherency between the CPU's caches and main memory, the NS32532 employs hardware cache invalidation mechanisms. These mechanisms invalidate cache entries, or the entire cache, to maintain coherency with corresponding memory locations. This avoids the performance compromises which result when the same cache monitoring and invalidation is done in software.

No other microprocessor offers both hardware and software cache invalidation. The NS32532 hardware cache invalidation does not degrade performance.

An external read to memory is initiated concurrently with the internal cache lookup so that memory references can be made immediately after a cache miss without having to wait another clock cycle. Cache invalidations take place in real-time, completely transparent to the software.

An integrated instruction pipeline is structured into four parallel stages: the loader, the address unit, the execution unit and the register file. Each stage buffer is kept as full as possible to maximize performance. Because each unit has one or more buffers holding the next instructions in the sequence, the pipeline can execute up to seven instructions simultaneously.

To further maximize performance, read operations are prioritized over write operations. But to maximize efficiency, National integrated an I/O detection mechanism which ensures that read and write operations with I/O devices are performed in the correct order and only when required.

Having such a high level of integration allows the NS32532 to take advantage of half-clock cycles for fast interleaved accesses. Virtual-to-physical address translations can be performed in parallel with other operations (such as the cache look-ups).

Compatible Design Philosophy

The hallmark of the entire Series 32000 family has been a common, 32-bit architectural base, making every CPU and peripheral upward and downward software-compatible.

The NS32532 is the ultimate expression of that design principle. It has been created to support high-level language, because HLL programmers can be more productive than assembly-language programmers–largely through the efficiencies of optimized compilers. National designed the Series 32000 architecture specifically to support HLL compilers.

In conjunction with its software and development tools, the NS32532 allows designers to migrate both vertically (through performance levels) and horizontally across a range of applications.

Because of this compatibility–and because it can be configured with hardware and software to meet a variety of specific design objectives–the NS32532 can deliver high-end computing power with far less up-front design time.

New GENIX Language Tools For Series 32000

National introduces the second release of the Series 32000® Native and Cross-Support (GNX™) Language Tools. Optional compilers generate high-quality code 30 to 200 percent faster than previous compilers.

The software development tools are based on AT&T's Common Object File Format (COFF).

According to Kim Ingram of National, code generated by the tools can be executed in any GENIX/V environment when used with appropriate command-line arguments and when linked with appropriate libraries.

In addition, the tools can be used to create operating system-independent code or code designed to run in conjunction with real-time kernels, such as National's EXEC and VRTX® Series 32000.

Optional Compilers

Optional compilers are available, including an optimizing C compiler, optimizing FORTRAN 77 compiler and Pascal compiler to ensure uniform portability to UNIX,™ VMS™ and native operating environments and to make the Series 32000 CPUs perform as fast as possible.

The optimizing C compiler is a complete implementation of the original C language definition. The FORTRAN compiler is a full ANSI-X3.9-1978 standard implementation with UNIX 177 extensions. And the Pascal product is a full ANSI/X3J9-1981, ISO level 1 implementation, including enhancements such as modular compilation capabilities.

Optimized for GENIX/V.3

The GNX tools are offered as an option for National's new GENIX/V.3, a port of AT&T's Unix System V, Release 3.0 operating system.

GENIX/V.3 is a multitasking, multiuser operating system that provides a large number of programs and utilities for text processing, program development and system administration.

Release Three carries forward all the enhancements from system V/Series 32000, such as demand-page virtual memory and file and record locking, while introducing significant new features that support local area networking.

Those features include streams–a general, flexible facility for the development of communications services within the UNIX operating system. Streams provide a consistent framework for the operation of network services.

Other new features are Remote File Sharing (RFS), a facility which allows a group of computers to be linked, and two libraries: Transport Level Interface (TLI) and Transport Provides Interface (TPI). These libraries help the protocol-developer produce protocols that conform to industry standards.

VME532: Highest VMEbus CPU Performance In The Industry

National's new VME532 board-level computer provides users with two to three times the performance of existing VME solutions while maintaining compatibility with UNIX® and VRTX® software.

The new board-level computer features National's NS32532 32-bit microprocessor and the high-end Series 32000® chip cluster. It executes up to 10 million instructions per second (MIPS), making it the highest performance VMEbus CPU currently available. The board functions as an off-the-shelf platform that offers performance comparable to that of high-end super-minicomputers such as the DEC VAX™ 8700, the Data General MV/20000 or the Prime 9955.

Solutions based on National's VME532 offer significant cost advantages when compared to minicomputer alternatives. Systems integrators need merely supply system packaging and I/O in conjunction with the board, which is priced under $10,000. This total outlay of between $25-50K contrasts sharply with the $500,000 investment that a typical high-end super-minicomputer entails.

Board-Level Design Alternative

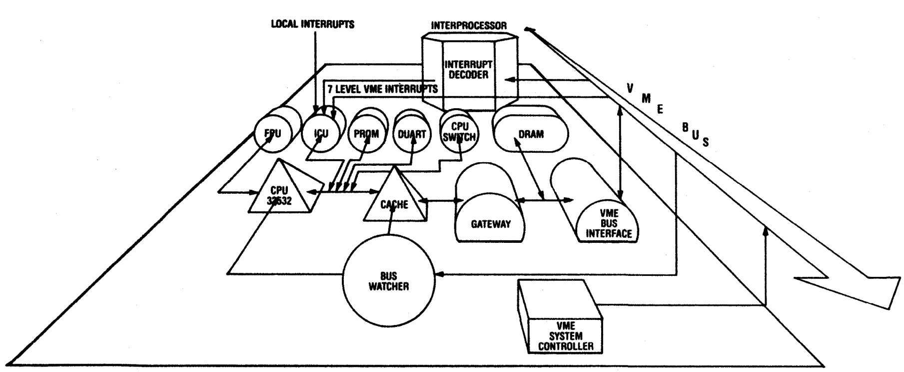
With the introduction of the VME532, National offers new alternatives to engineers developing Series 32000-based applications. Designers can now choose the appropriate level of CPU integration–chip or board–while retaining compatibility, through the industry-standard VMEbus, with a broad range of memory, mass storage and specialized I/O interfaces available from hundreds of third-party vendors.

The VME532 is designed and packaged specifically for organizations whose hardware and software engineering teams are integrating boards from multiple vendors into a volume end product. Choosing the VME532 can help such a product to reach the market more quickly, and with less design risk, than a solution engineered from the chip level.

The Multiuser Microprocessor

The VME532 is an ideal solution for systems integrators building high-performance UNIX System V-based multiuser systems that accommodate between 32 and 200 users. National's GENIX™ software, used in conjuntion with the VME532, supports Ethernet and TCP/IP networking in multiuser applications. GENIX also supports a suite of languages: PASCAL, FORTRAN77, C, Modula 2 and Ada.

The VME532 design easily accommodates multiprocessing applications. It supports both loosely and tightly coupled systems, and enables up to 16 processors to be installed within the overall system. This



optimizes it for other high-performance, board-level embeddedcontrol applications such as automated test equipment, factory automation, imaging applications and aircraft flight simulators.

The VME532 also opens the door to new applications in research labs. For one, it can be used to evaluate the architecture, timing and performance of the NS32532. It also provides a native debug and execution environment for programs developed on a host computer, and it is compatible with National's GNX™ software development tools package, including the family of optimizing compilers (see related story in this issue for more on the compilers).

Finally, the board's high performance and ability to execute Ada language programs in a native environment makes it an excellent choice for demanding military and aerospace embedded applications.

NS32532 On-Board

The VME532 consists of a two-level board incorporating National's 20-MHz NS32532 and members of the Series 32000 chip cluster, including a floating point unit and an interrupt control unit.

Featuring on-chip memory management, the NS32532 is the highest performance member of the Series 32000 family of 32-bit microprocessors. Plans call for a 30-MHz version of both this device and the VME532 to be introduced later this year.

Memory Hierarchy

The VME532 has a four-level memory hierarchy consisting of an on-chip instruction and data cache, external cache, local memory (on-board DRAM) and global memory (memory accessible through the system bus).

At the first level, the 512-byte instruction cache and 1-kilobyte data cache integrated within the NS32532 provide the CPU with an 80% internal cache hit rate, thus minimizing the number of external cache accesses.

At the second level of the memory hierarchy, wait-states are eliminated on over 90% of memory accesses–thanks to a 64-KByte external, direct-mapped, write-through cache. With up to 16 MB of DRAM on board, the VME532 provides a cacheable memory address range of up to 256 MBytes.

Level three consists of 4 MB of DRAM (expandable to 16 MB) configured as a local dual-port, parity-checking memory. This allows access through the system bus, as well as through an independent local bus. Finally, the fourth level in the memory hierarchy allows each processor's local memory to serve as global memory to other CPUs in a multiprocessing system.

Multiprocessing Features

By monitoring VMEbus write traffic and performing necessary local invalidations, the VME532 provides hardware cache coherency. Its local memory permits large numbers of high-performance CPUs in an application without saturating the VMEbus. In addition, the board supports up to 16 CPUs per VMEbus via a thumbwheel switch that sets memory mapping and register addresses.

Interrupts are controlled by an on-board NS32202 interrupt-control unit. This 16-channel device handles all on-board interrupts, all seven levels of VME interrupts and the inter-processor interrupts that are generated in multiprocessing systems.

Other features include two RS-232C serial ports with adjustable baud rates; an 8-bit DIP switch for software configuration; and support for block transfers, read-modify-write transfers and unaligned transfers.

New Series 32000® Development Package For PC/AT™ Environment

National's new SYS32/30 Development Package converts PC/ATs and compatibles into powerful UNIX® multiuser systems for the development of applications based on the Series 32000 microprocessor family.

The SYS32/30 package consists of an add-in coprocessor board containing the Series 32000 chip cluster, software and complete documentation. As an enhancement of National's popular SYS32/20 package, it is designed to support up to eight users by virtue of its added memory configurations and increased processing power. The resulting package allows programs to run on a PC/AT or compatible at speeds far greater than those provided by a VAX® 780 minicomputer.

Improved Programming Productivity

SYS32/30 provides users with increased throughput and increased responsiveness for development of their Series 32000-based programs. It accomplishes this task for *all* seven CPUs in the Series 32000 family, from the NS32008 on up to the new NS32532.

SYS32/30 employs National's 15-MHz NS32332 microprocessor, the NS32382 Memory Management Unit (MMU) and the NS32081 Floating Point Unit (FPU). While its precursor, SYS32/20, will continue to appeal to a wide range of users because of its attractive price/performance ratio, SYS32/30 takes the next logical step up the performance pathway provided by the Series 32000 family.

Concurrent UNIX And DOS

SYS32/30 includes a complete port of AT&T's UNIX System V.3. A dual-processor architecture enables the SYS32/30's CPU to function as the main processor for the system while the PC's CPU functions as an I/O resource. Specially developed software provides for concurrent operation of the UNIX and DOS operating systems, allowing users to switch between the two with a few simple keystrokes.

The software integrates National's GNX™ language tools, which include an assembler, linker, debuggers, math libraries, and a monitor. PASCAL, C and FORTRAN 77 compilers are supplied as optional software to allow the language to be individually selected for the application. In addition, an Ada compiler is available which allows users to transform their PCs into Ada software development workstations.

Memory For Multiuser Support

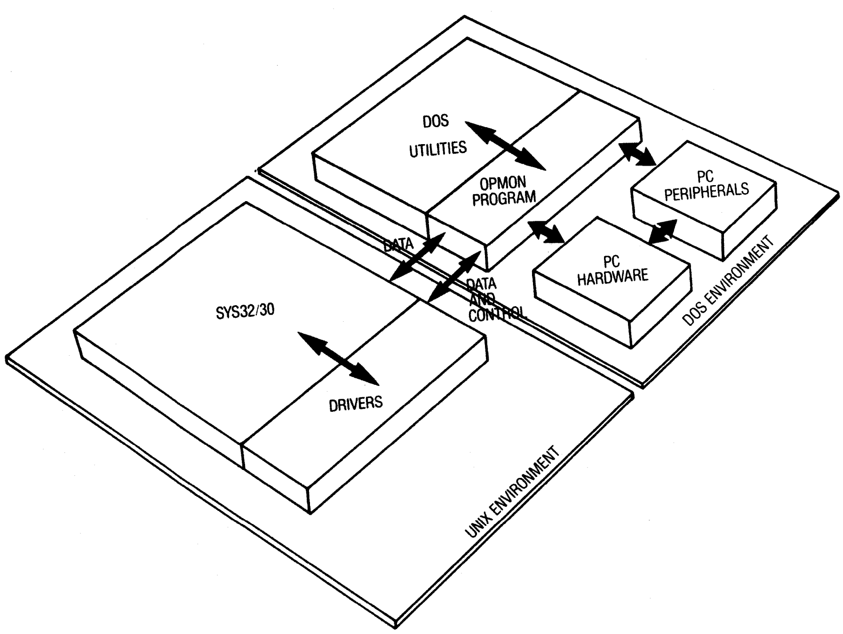
Several memory configuration options are included among the system's enhancements. SYS32/30 features on-board memory with zero wait-states, available on memory cards in either a 4-, 8-, or 16-MByte size.

These expanded memory options allow for more commonly used programs to remain resident in memory, thus bypassing any I/O constraints encountered by the PC/AT bus. More pages of user code and data can also reside in memory, reducing the paging load imposed on the I/O structure.

Another benefit provided by the SYS32/30 Development Package is the optional software support for the Ethernet networking protocols, enabling many PCs to be tied together to accommodate a wide network of multiple users.

Easy Installation

The SYS32/30 board plugs into the PC/AT bus and uses standard control and data signals, thus allowing the PC to process I/O commands while SYS32/30 continues with regular operation. Two slots in the PC are required to accommodate the piggybacked memory board that is attached to the co-processor board.



"SPLICE" Debugging Tool Joins Series 32000® Family

A new low-cost board solution allows users to interface Series 32000 target systems to a host computer for debugging, downloading code and examining target resources.

The SPLICE board is a versatile software debugging development tool that supports all Series 32000 32-bit microprocessors at their maximum rated frequencies, thanks to its ability to connect directly to the target CPU without buffering.

SPLICE is particularly cost-effective for debugging fast Series 32000 CPUs with clock speeds greater than 20MHz. It functions independently of specific CPU clock speeds, giving it the flexibility to debug different Series 32000 applications by adding only the appropriate CPU target cables. Independence from clock speeds also ensures that SPLICE will support all current and future higher-speed versions of specific CPUs in the Series 32000 family.

SPLICE connects to a variety of development system hosts, such as a DEC VAX® minicomputer or National's SYS32/20® PC-based development system. Connections to the host are implemented by means of RS232 serial ports with programmable baud rates.

On-Board Options

The base unit for SPLICE is a 7″×9″ circuit board that contains a monitor ROM, RAM and UART that allows communications with the host computer. This eliminates the necessity of including these components as part of the target design.

The system provides 256K-bytes of mappable static RAM; memory is expandable with optional 1M-byte expansion boards, up to a total of 8M-bytes. In the standard 256K-byte configuration, the on-board RAM is contained in eight 32K ×8-bit CMOS static RAMs.

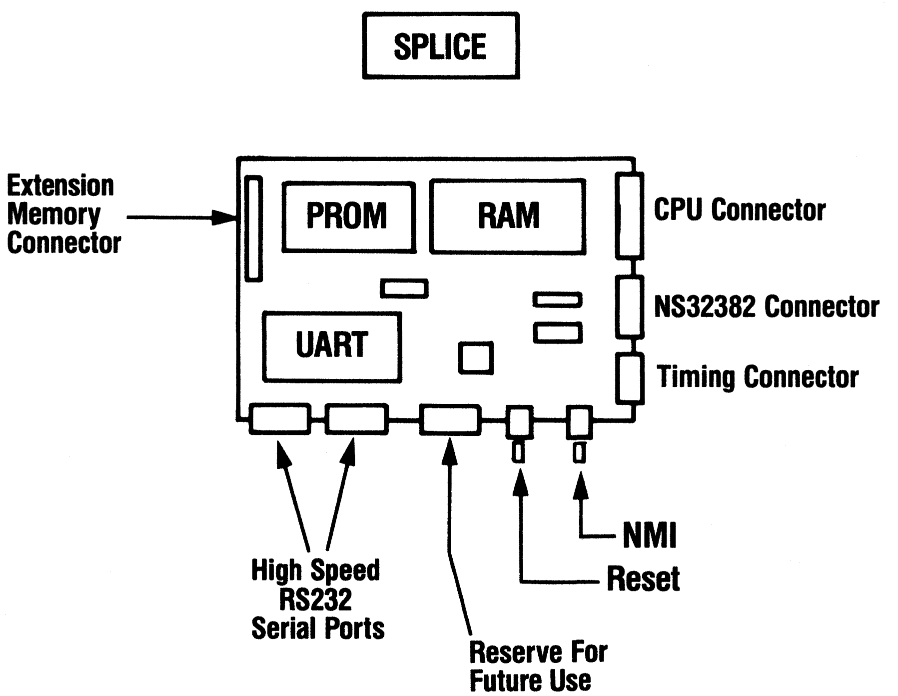
A total of 2K of the RAM is required for the monitor firmware, leaving the remaining RAM available to receive downloaded code. This allows software debugging in a target that is not fully completed, replacing non-existent target memory with SPLICE RAM memory.

Interface Made Easy

SPLICE connects to the target environment primarily through the CPU socket: the CPU is removed from the target socket and inserted in the SPLICE socket, while the SPLICE cable in turn is inserted into the target CPU socket.

SPLICE can be interfaced to the host computer in two ways. First, it can be connected in a flow-through mode, where it is positioned between a terminal and the host computer. The second technique calls for SPLICE to be connected only to the host, with all commands passed along the single serial line. This method is handy when the host system does not have a separate terminal connection.

SPLICE now supports all CPU members of the Series 32000 family, as well as the NS32382 Memory Management Unit (MMU). Plans call for a separate SPLICE unit that will support National's upcoming NS32532 microprocessor, the newest member of the Series 32000 family.



New Real-Time Software For Embedded Series 32000® Applications

National's VRTX® real-time operating system for Series 32000-based embedded applications is now complete with the addition of an input/output executive and a multitasking, real-time file manager.

The two new Series 32000 R&D packages are known as the IOX®/Series 32000 (Input/Output Executive) and the FMX®/Series 32000 (File Management Executive). When used in conjunction with the VRTX/Series 32000 executive and the TRACER™/Series 32000 interactive multi-tasking debugger, these software-in-silicon building blocks provide users with a complete, real-time operating system solution for Series 32000-based embedded applications.

IOX: The Input/Output Executive

The IOX package is a companion software component for the VRTX/Series 32000 which provides embedded microprocessor applications with a powerful set of input/output (I/O) facilities for use in a multi-tasking, real-time environment. Like VRTX, IOX is a silicon software component that makes no assumptions concerning its target environment and therefore can be used unchanged in a variety of custom applications.

IOX tasks can transfer data to or from devices in buffered or direct mode, using either sequential or random access. In buffered mode, IOX maintains one or more intermediate buffers that isolate applications tasks from the physical characteristics of devices. This allows serial devices such as terminals to coexist with random access devices such as disks, with mutual access provided by the same buffered IOX calls.

IOX's direct mode provides a set of services that can transfer data or perform device-specific control operations and synchronization in applications that require close control over device operations. The programmer is freed from hardware-dependent considerations such as device addresses, commmand codes and interrupt handling.

FMX: The File Management Executive

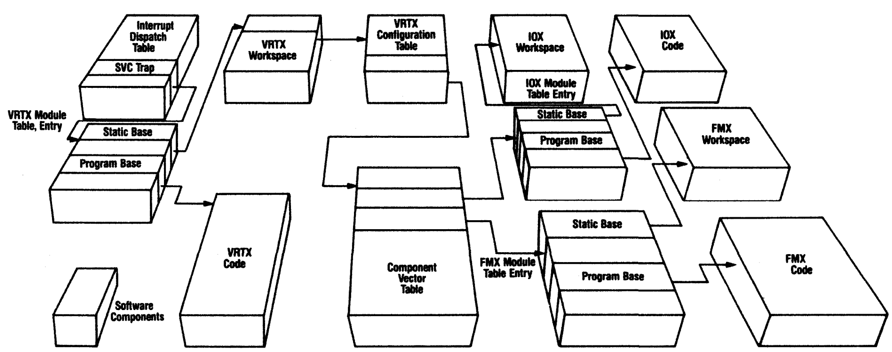
The FMX package is designed to provide disk file management services for VRTX- and IOX-based software systems. It permits the organization of related information into resources called files and allocates these resources to tasks. Like the VRTX and IOX packages, FMX/Series 32000 is software-in-silicon and thus makes no assumptions about the target environment.

FMX operations permit tasks to create and delete files, to assign attributes to those files, and to open IOX channels to them for subsequent use by IOX read and write operations. Along with other multi-tasking requirements, FMX supports con-current file accesses and both buffered and unbuffered direct read and write operations. Both sequential and random access methods are provided.

FMX has a facility for formatting disks which may be used to produce PC DOS-compatible formats. It supports a hierarchical file structure compatible with Version 2.0 of PC DOS.

Hot-Line Technical Support

National offers a one-year complete technical support period for all software components of the VRTX solution, including the IOX and FMX packages. Originally developed by Hunter and Ready Corporation (now known as Ready Systems, Inc.), all of the VRTX real-time software components were ported to the Series 32000 by National, which sells, services and supports the packages.



DOD Validates National's Ada Development Environment

National offers the first commercially available 32-bit Ada Cross-Development Environment on a personal computer, targeted for Series 32000®-based embedded systems applications.

National's version of the Ada Development Environment is the first Ada cross-compiler for Series 32000 applications to be validated by the Department of Defense. Used in conjunction with a Series 32000-based IBM PC coprocessor add-in board and the System V/Series 32000 operating system (collectively known as National's SYS 32/20 development system), National's solution allows users to develop embedded Series 32000 Ada applications on a PC for the first time.

National worked closely with Verdix Corporation of Chantilly, Virginia to develop the environment. Verdix, a computer system and software development company specializing in Ada, spent 18 months in research and development on the project. Verdix previously has developed native Ada products for several of National's Series 32000 customers.

Power To The PC

National's ADA Environment offers PC users a complete Ada applications program development capability that previously was available only on minicomputers and mainframes. This increases Ada productivity while decreasing related development and programming costs. The environment consists of an Ada compiler, tools, utilities, libraries and an embedded system run-time, offering a complete solution for Ada applications program development.

"The key to National's solution is that it opens the door to customers developing embedded Series 32000 Ada applications," says Bill Slusher, National's Ada Program Manager. "As the first host-to-target Series 32000 Ada cross-compiler, it addresses mission-critical, defense-oriented embedded systems and other real-world concerns. PC-hosted applications have their place, but its hardly practical to put a complete development system in an intelligent weapons system, for example."

Available For Minicomputer Hosts

National has also released a version of its ADA Development Environment for DEC VAX™ and MicroVAX/VMS™ systems which will also produce code for embedded "bare" Series 32000 microprocessor targets. By offering Ada products that support both micro and minicomputer host program development, National now provides an Ada solution for the majority of Ada engineering development environments, independent of host computer type.

Ada is the Department of Defense's mandated computer program language for mission-critical and defense-oriented embedded systems applications.

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FOR INDEX OF FAIRCHILD SEMICONDUCTOR PRODUCTS, SEE PG. 393