MAXIM

1989
Analog Switches and Multiplexers

Video Multiplexers
Fault Protected Multiplexers
Low Power Analog Switches
Single, Dual, Quad Analog Switches

Introduction

Maxim is a full line supplier of analog switches and multiplexers. These include improved versions of industry standard "DG", "HI" and "IH" series devices as well as several new proprietary designs. Maxim's goal is to develop products which continue to advance the state of the art in analog signal switching in applications such as data acquisition, signal processing, test systems, and communications.

Some of the significant product advances introduced in this data book include:

- Major improvements in the level of overvoltage protection provided by Maxim's new Fault Protected analog multiplexers (MAX358/59/68/69). Particularly significant is that Maxim's Fault Protected products continue to protect input and output signal sources even after power to the multiplexer has been removed.
- More switches per package which allows for reduced board space and increased reliability due to reduced component count (MAX333).
- Very fast switching speeds coupled with guaranteed break-before-make action (MAX334).
- New switch configurations which provide major increases in high frequency crosstalk rejection and off isolation for video switches and multiplexers (IH5341/52 and MAX310/311).
- Reduced power consumption and the elimination of extra logic power supplies on virtually all second source analog switch products.

Maxim will continue to serve data acquisition designers with new products offering the highest standards of performance, quality and reliability. We appreciate the opportunity to serve you.

The Maxim Advantage™

The "Maxim Advantage" on second source products signifies an up graded quality level. At no additional cost Maxim offers a second source device that is subjected to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters, and device enhancements, when needed, that result in improved performance without changing the functionality.

These Maxim Advantages are listed on the "Maxim Advantage" page (usually the third page of the data sheet) and are highlighted (shaded) in the Electrical Characteristics table. For reference purposes, the original manufacturer's Electrical Characteristics are reproduced on the page facing the "Maxim Advantage" page.

In addition to these advantages, Maxim provides enhanced Product Conditioning and Qualification at no additional cost, as described in the "Package Unit Process Flow" section (Page A-1).

Data Sheet Identifiers

IDENTIFIER	PRODUCT STATUS	COMMENTS
None	Full Production	Data Sheet Finalized
Introductory	Initial Production	Data Sheet based on limited number of devices
Advance Information	Samples Only	Data Sheet based on design goals

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Analog Multiplexers

Analog Switches

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A/D Converters

MAX130	3½ Digit A/D Converter with Bandgap Reference
MAX131	3½ Digit A/D Converter with Bandgap Reference
MAX133	3¾ Digit Digital Multimeter Circuit
MAX134	3¾ Digit μP Compatible DMM Circuit
MAX136	Low Power 3½ Digit A/D Converter with LCD Display Hold
MAX138	3½ Digit A/D Converter with Bandgap Reference and Charge Pump Voltage Converter
MAX139	3½ Digit A/D Converter with Bandgap Reference and Charge Pump Voltage Converter
MAX140	3½ Digit A/D Converter with Bandgap Reference and Charge Pump Voltage Converter
MAX150	CMOS 1.3μs 8 Bit A/D Converter with Voltage Reference and Track/Hold
MAX154	CMOS 2.0μs 8 Bit A/D Converter with 4 Channel Multiplexer
MAX158	CMOS 2.0μs 8 Bit A/D Converter with 8 Channel Multiplexer
MAX160	CMOS μP Compatible 4μs 8 Bit A/D Converter
MAX161	CMOS 20μs 8 Bit 8 Channel Data Acquisition System
MAX162	CMOS High Speed 3μs 12 Bit A/D Converter with Voltage Reference
MAX172	CMOS 10μs 12 Bit A/D Converter with Voltage Reference
MAX7129	4½ Digit Single-Chip A/D Converter with Multiplexed LCD Drivers
AD578	High Speed 3μs 12 Bit A/D Converter
AD7572	CMOS High Speed 5 & 12μs 12 Bit A/D Converter with Voltage Reference
AD7574	CMOS μP Compatible 8 Bit A/D Converter
AD7575	CMOS μP Compatible 5μs A/D Converter
AD7576	CMOS μP Compatible 10μs A/D Converter
AD7581	CMOS 8 Bit 8 Channel Data Acquisition System
AD7820	CMOS High Speed 8 Bit A/D Converter with Track/Hold
AD7824	CMOS High Speed 8 Bit A/D Converter with 4 Channel Multiplexer
AD7828	CMOS High Speed 8 Bit A/D Converter with 8 Channel Multiplexer
ADC0820	CMOS High Speed 8 Bit A/D Converter with Track/Hold
ICL7106	3½ Digit A/D Converter with Direct LCD Drivers
ICL7107	3½ Digit A/D Converter with Direct LCD Drivers
ICL7109	12 Bit A/D Converter with Three-State Binary Outputs
ICL7116	3½ Digit A/D Converter with LCD Display Hold
ICL7117	3½ Digit A/D Converter with LED Display Hold
ICL7126	Low Power, 3½ Digit A/D Converter with Direct LCD Drivers
ICL7129A	Low Noise, 4½ Digit Single-Chip A/D Converter with Multiplexed LCD Drivers
ICL7135	4½ Digit A/D Converter with Multiplexed BCD Outputs
ICL7136	Low Power, 3½ Digit A/D Converter with Direct LCD Drivers
ICL7137	Low Power, 3½ Digit A/D Converter with Direct LED Drivers

D/A Converters

MAX500	CMOS Quad, Serial Interface, 8 Bit D/A Converter
MAX7624	CMOS 8 Bit Buffered Multiplying D/A Converter
MAX7645	CMOS 12 Bit Buffered Multiplying D/A Converter
AD565A	High Speed 12 Bit Monolithic D/A Converter with Voltage Reference
AD566A	High Speed 12 Bit Monolithic D/A Converter
AD7224	CMOS Double Buffered 8 Bit D/A Converter with Voltage Output Amplifier
AD7225	CMOS Quad 8 Bit D/A Converter with Voltage Output Amplifier
AD7226	CMOS Quad 8 Bit D/A Converter with Voltage Output Amplifier
AD7228	CMOS Octal 8 Bit D/A Converter
AD7520	CMOS 10 Bit Multiplying D/A Converter
AD7521	CMOS 12 Bit Multiplying D/A Converter
AD7523	CMOS 8 Bit Multiplying D/A Converter
AD7524	CMOS 8 Bit Buffered Multiplying D/A Converter
AD7528	CMOS Dual 8 Bit Buffered Multiplying D/A Converter
AD7530	CMOS 10 Bit Multiplying D/A Converter

AD7531	CMOS 12 Bit Multiplying D/A Converter
AD7533	CMOS Low Cost 10 Bit Multiplying D/A Converter
AD7534	μP Compatible 14 Bit D/A Converter
AD7535	μP Compatible 14 Bit D/A Converter
AD7536	μP Compatible 14 Bit D/A Converter
AD7541	CMOS 12 Bit Multiplying D/A Converter
AD7541A	CMOS 12 Bit Multiplying D/A Converter
AD7542	CMOS 12 Bit μP-Compatible D/A Converter
AD7543	CMOS 12 Bit Serial Input D/A Converter
AD7545	CMOS 12 Bit Buffered Multiplying D/A Converter
AD7545A	CMOS 12 Bit Buffered Multiplying D/A Converter
AD7548	CMOS 8 Bit μP Compatible 12 Bit D/A Converter
AD7628	CMOS Dual 8 Bit Buffered Multiplying D/A Converter

Voltage References

MAX670	+10V Precision Kelvin Sensed Reference, 3 ppm/°C
MAX671	+10V Precision Kelvin Sensed Reference, 1 ppm/°C
MAX672	+10V Precision Voltage Reference, 5 ppm/°C
MAX673	+5V Precision Voltage Reference, 5 ppm/°C
AD580	Precision 2.5V Reference
AD581	Precision 10V Reference
AD584	Pin Programmable 10V, 7.5V, 5V, 2.5V Precision Voltage Reference
AD2700	+10 Volt Precision Reference, 3 ppm/°C
AD2701	-10 Volt Precision Reference, 3 ppm/°C
AD2710	+10 Volt Precision Reference, 1 ppm/°C
ICL8069	1.2V Voltage Reference
REF01	+10V Precision Voltage Reference
REF02	+5V Precision Voltage Reference

True RMS-to-DC Converters

AD536A	True RMS-to-DC Converter
AD636	True RMS-to-DC Converter

Operational Amplifiers and Buffers

MAX400	Ultra Low Offset Operational Amplifier
MAX420	±15V Chopper Stabilized Operational Amplifier
MAX421	±15V Chopper Stabilized Operational Amplifier
MAX422	Low Power, ±15V Chopper Stabilized Operational Amplifier
MAX423	Low Power, ±15V Chopper Stabilized Operational Amplifier
MAX430	±15V Chopper Stabilized Operational Amplifier
MAX432	Low Power, ±15V Chopper Stabilized Operational Amplifier
MAX450	10MHz CMOS Video Amplifier
MAX451	Low Bias Current 10MHz Video Amplifier
MAX452	50MHz CMOS Video Amplifier
MAX453	2 Channel Mux'ed 50MHz Video Amplifier
MAX454	4 Channel Mux'ed 50MHz Video Amplifier
MAX455	8 Channel Mux'ed 50MHz Video Amplifier
MAX457	Dual 70MHz CMOS Video Amplifier
MAX460	High Accuracy Fast Buffer
AD3554	Wideband, Fast-Settling Operational Amplifier
BB3553	Very Fast Buffer Amplifier
BB3554	Wideband, Fast Settling Operational Amplifier
ICL7611	Low Power, Single Operational Amplifier
ICL7612	Low Power, Single Operational Amplifier
iCL7614	Low Power, Single Operational Amplifier

ICL7616	Low Power, Single Operational Amplifier
ICL7621	Low Power, Dual Operational Amplifier
ICL7622	Low Power, Dual Operational Amplifier
ICL7631	Low Power, Triple Operational Amplifier
ICL7632	Low Power, Triple Operational Amplifier
ICL7641	Low Power, Quad Operational Amplifier
ICL7642	Low Power, Quad Operational Amplifier
ICL7650/B	Chopper Stabilized Operational Amplifier
ICL7652/B	Chopper Stabilized Operational Amplifier
LH0033/A	Fast Buffer Amplifier
LH0063	Very Fast Buffer Amplifier
LH0101	Power Operational Amplifier
LT1001	Low Offset Operational Amplifier
OP07	Precision Operational Amplifier
PGA100	Programmable Gain Amplifier

Power Supply Circuits

MAX600	Low Cost AC-DC Regulator (110/220VAC to 5VDC — Full Wave)
MAX601	Low Cost AC-DC Regulator (110/220VAC to 5VDC — Half Wave)
MAX602	Low Cost AC-DC Regulator (8V RMS to 5VDC — Full Wave)
MAX610	AC-DC Regulator (110/220VAC to 5VDC — Full Wave)
MAX611	AC-DC Regulator (110/220VAC to 5VDC — Half Wave)
MAX612	AC-DC Regulator (8V RMS to 5VDC — Full Wave)
MAX626	Dual Power MOSFET Driver
MAX627	Dual Power MOSFET Driver
MAX628	Dual Power MOSFET Driver
MAX630/4193	CMOS Micropower Step-up Switching Regulator
MAX631	CMOS +5V Fixed/Adjustable Output Step-up Switching Regulator
MAX632	CMOS +12V Fixed/Adjustable Output Step-up Switching Regulator
MAX633	CMOS +15V Fixed/Adjustable Output Step-up Switching Regulator
MAX634/4391	CMOS Micropower Inverting Switching Regulator
MAX635	CMOS -5V Fixed/Adjustable Output Inverting Switching Regulator
MAX636	CMOS -12V Fixed/Adjustable Output Inverting Switching Regulator
MAX637	CMOS -15V Fixed/Adjustable Output Inverting Switching Regulator
MAX638	CMOS +5V Fixed/Adjustable Step-down Switching Regulator
MAX641	CMOS +5V Fixed/Adjustable 10 Watt Step-up Switching Regulator
MAX642	CMOS +12V Fixed/Adjustable 10 Watt Step-up Switching Regulator
MAX643	CMOS +15V Fixed/Adjustable 10 Watt Step-up Switching Regulator
MAX644	CMOS 1V to +5V Output Step-up Switching Converter
MAX645	CMOS 2.5V to +5V Output Step-up Switching Converter
MAX646	CMOS Low Voltage, High Power +5V Output Step-up Switching Converter
MAX647	CMOS Low Voltage, High Power +3V Output Step-up Switching Converter
MAX663	CMOS +5V/Adjustable Micropower Positive Voltage Regulator
MAX664	CMOS -5V/Adjustable Micropower Negative Voltage Regulator
MAX666	CMOS +5V/Adjustable Voltage Regulator with Low Battery Detect
MAX680	+5V to ±10V Voltage Converter
MAX681	+5V to ±10V Voltage Converter
MAX690	Microprocessor Watchdog/Battery Switchover/Reset Generator
MAX691	Microprocessor Watchdog/Battery Switchover/Reset Generator
MAX692	Microprocessor Watchdog/Battery Switchover/Reset Generator
MAX693	Microprocessor Watchdog/Battery Switchover/Reset Generator
MAX694	Microprocessor Supervisory Circuit/Battery Switchover/Reset Generator
MAX695	Microprocessor Supervisory Circuit/Battery Switchover/Reset Generator
MAX696	Microprocessor Supervisory Circuit/Battery Switchover/Programmable Reset

MAX697	Microprocessor Supervisory Circuit/Programmable Reset
MAX8211	Programmable Voltage Detector
MAX8212	Programmable Voltage Detector
ICL7660	+5V to -5V Voltage Converter
ICL7662	+15V to -15V Voltage Converter
ICL7663	Low Power, Programmable Positive Voltage Regulator
ICL7664	Low Power, Programmable Negative Voltage Regulator
ICL7665	Low Power Under/Over-voltage Detector
ICL7667	Dual Power MOSFET Driver
Si7661	+15V to -15V Voltage Converter
TSC426	Dual Power MOSFET Driver
TSC427	Dual Power MOSFET Driver
TSC428	Dual Power MOSFET Driver

Display Drivers/Counters

MAX7231	8 Digit Triplexed LCD Decoder/Driver
MAX7232	10 Digit Triplexed LCD Decoder/Driver
MAX7233	4 Character Triplexed LCD Decoder/Driver
MAX7234	5 Character Triplexed LCD Decoder/Driver
ICM7211	4 Digit LCD Decoder/Driver
ICM7212	4 Digit LED Decoder/Driver
ICM7217	4 Digit LED Presettable Up/Down Counter
ICM7218	8 Digit Multiplexed LED Decoder/Driver
ICM7224	4½ Digit LCD High Speed Counter/Decoder/Driver
ICM7225	4½ Digit LED High Speed Counter/Decoder/Driver
ICM7228	8 Digit LED Display Driver
MM74C945	4 Digit Up/Down Counter/Decoder/Driver
MM74C947	4 Digit Up/Down Counter/Decoder/Driver

Timers/Counters

ICM7240	Programmable RC Timer/Counter
ICM7242	Fixed RC Timer/Counter
ICM7250	Programmable RC Timer/Counter
ICM7260	Programmable RC Timer/Counter
ICM7555	Low Power, General Purpose Timer
ICM7556	Low Power, General Purpose Dual Timer

Interface

MAX230	+5V Powered, Five RS-232 Transmitters with Power Shutdown
MAX231	+5V and +12V Powered, Dual RS-232 Transmitters and Receivers
MAX232	+5V Powered, Dual RS-232 Transmitters and Receivers
MAX232A	+5V Powered, Dual, High Slew Rate RS-232 Transmitters/Receivers
MAX233	No External Component +5V Powered, Dual RS-232 Transmitters and Receivers
MAX233A	No External Component +5V Powered, Dual, High Slew Rate RS-232 Transmitters/Receivers
MAX234	+5V Powered, Quad RS-232 Transmitters
MAX235	No External Component +5V Powered, Five RS-232 Transmitters and Receivers with Power Shutdown and Receiver Three-State Enable
MAX236	+5V Powered, Four RS-232 Transmitters and Three RS-232 Receivers with Power Shutdown and Receiver Three-State Enable
MAX237	+5V Powered, Five RS-232 Transmitters and Three RS-232 Receivers
MAX238	+5V Powered, Quad RS-232 Transmitters and Receivers
MAX239	+5V and +12V Powered, Three RS-232 Transmitters and Five RS-232 Receivers with Three-State Receiver Enable

MAX240	+5V Powered, Five RS-232 Transmitters and Receivers with Power Shutdown and Receiver Three-State Enable in Plastic Flatpack
MAX241	+5V Powered, Four Transmitters, Five Receivers with Power Shutdown and Receiver Three-State Enable in 28 Pin Small Outline
MAX242	+5V Powered Dual RS-232 Transmitters/Receivers with Shutdown and Receiver Three-State Enable
MAX243	+5V Powered RS-232 Transmitter/Receiver with Shutdown, One Receiver Has Negative Threshold
MAX250	Isolated, General Purpose Driver/Receiver/Power Supply
MAX251	Isolated, Dual RS-232 Drivers/Receivers
MAX1080	+5V Powered RS-232 Transmitter/Receiver with Shutdown

Switched Capacitor Filters

MAX260	µP Programmable Universal Switch Capacitor Filter
MAX261	µP Programmable Universal Switch Capacitor Filter
MAX262	µP Programmable Universal Switch Capacitor Filter
MAX263	Pin Programmable Universal Filter
MAX264	Pin Programmable Universal Filter
MAX265	Resistor/Pin Programmed Universal Active Filter
MAX266	Resistor/Pin Programmed Universal Active Filter
MAX267	Pin Programmable Bandpass Filter
MAX268	Pin Programmable Bandpass Filter
MAX280	5th Order, Zero DC Error, Lowpass Filter
LTC1062	5th Order, Zero DC Error, Lowpass Filter
MF10	Dual Second Order Universal Switch Capacitor Filter

Analog Multiplexers

MAX310	RF/Video 8 Channel Multiplexer/Demultiplexer
MAX311	RF/Video Differential 4 Channel Multiplexer/Demultiplexer
MAX358	Fault Protected 8 Channel Multiplexer
MAX359	Fault Protected Differential 4 Channel Multiplexer
MAX368	Fault Protected 8 Channel Multiplexer with Address Latches
MAX369	Fault Protected Differential 4 Channel Multiplexer with Address Latches
AD7506	16 Channel CMOS Analog Multiplexer
AD7507	Differential 8 Channel CMOS Analog Multiplexer
DG506A	16 Channel CMOS Analog Multiplexer
DG507A	Differential 8 Channel CMOS Analog Multiplexer
DG508A	8 Channel CMOS Analog Multiplexer
DG509A	Differential 4 Channel CMOS Analog Multiplexer
HI-508A	Fault Protected 8 Channel Multiplexer
HI-509A	Fault Protected Differential 4 Channel Multiplexer
IH5108	See MAX358
IH5208	See MAX359
IH6108	See DG508A
IH6116	See DG506A
IH6208	See DG509A
IH6216	See DG507A

Analog Switches

MAX331	Quad SPST Normally Closed CMOS Analog Switch
MAX332	Quad SPST Normally Open CMOS Analog Switch
MAX333	Quad SPDT CMOS Analog Switch
MAX334	High Speed Break-Before-Make Quad SPST Analog Switch
MAX341	Dual SPST High Voltage CMOS Analog Switch
MAX343	Dual SPDT High Voltage CMOS Analog Switch

MAX345	Dual DPST High Voltage CMOS Analog Switch
MAX348	Low Ron Dual SPST High Voltage CMOS Analog Switch
DG200/A	Dual SPDT CMOS Analog Switch
DG201A	Quad SPST Normally Closed CMOS Analog Switch
DG202	Quad SPST Normally Open CMOS Analog Switch
DG211	Quad SPST Normally Closed CMOS Analog Switch
DG212	Quad SPST Normally Open CMOS Analog Switch
DG300/A	TTL Compatible CMOS Analog Switch
DG301/A	TTL Compatible CMOS Analog Switch
DG302/A	TTL Compatible CMOS Analog Switch
DG303/A	TTL Compatible CMOS Analog Switch
DG304/A	CMOS Analog Switch
DG305/A	CMOS Analog Switch
DG306/A	CMOS Analog Switch
DG307/A	CMOS Analog Switch
DG381/A	General Purpose CMOS Analog Switch
DG384/A	General Purpose CMOS Analog Switch
DG387/A	General Purpose CMOS Analog Switch
DG390/A	General Purpose CMOS Analog Switch
IH5040	SPST Normally Open CMOS Analog Switch
IH5041	Dual SPST Normally Open CMOS Analog Switch
IH5042	SPDT CMOS Analog Switch
IH5043	Dual SPDT CMOS Analog Switch
IH5044	DPST Normally Open CMOS Analog Switch
IH5045	Dual DPST Normally Open CMOS Analog Switch
IH5048	Low Charge Injection Dual SPST Normally Open Analog Switch
IH5049	Low Charge Injection Dual DPST Normally Open Analog Switch
IH5050	Low Charge Injection SPDT Analog Switch
IH5051	Low Charge Injection Dual SPDT Analog Switch
IH5140	Low Power Fast SPST Normally Open CMOS Analog Switch
IH5141	Low Power Fast Dual SPST Normally Open CMOS Analog Switch
IH5142	Low Power Fast SPDT CMOS Analog Switch
IH5143	Low Power Fast Dual SPDT CMOS Analog Switch
IH5144	Low Power Fast DPST Normally Open CMOS Analog Switch
IH5145	Low Power Fast Dual DPST Normally Open CMOS Analog Switch
IH5341	Dual SPST Normally Open RF/Video Switch
IH5352	Quad SPST Normally Open RF/Video Switch

Analog Multiplexers

Part Number	Function	$r_{DS(ON)}$ (Ω max)	$I_{D(OFF)}$ (nA max)	$t_{(ON)}$ (μs max)	V_{IL}/V_{IH} (V)	Analog Signal Voltage Range	Features	Page No.
MAX358	1 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected to ±35V	1-9
MAX359	2 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected to ±35V	1-9
MAX368	1 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected w/ Latches	1-21
MAX369	2 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected w/ Latches	1-21
AD7506	1 of 16	400	5	1μs	0.8/2.4	±15V	Industry Standard	1-33
AD7507	2 of 16	400	5	1μs	0.8/2.4	±15V	Industry Standard	1-33
DG506A	1 of 16	400	5	1μs	0.8/2.4	±15V	Industry Standard	1-37
DG507A	2 of 16	400	5	1μs	0.8/2.4	±15V	Industry Standard	1-37
DG508A	1 of 8	300	2	1μs	0.8/2.4	±15V	Industry Standard	1-43
DG509A	2 of 8	300	2	1μs	0.8/2.4	±15V	Industry Standard	1-43
HI508A	1 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected	1-9
HI509A	2 of 8	1500	2	1μs	0.8/2.4	-12.5V to +13.5V	Fault Protected	1-9
IH5108	See MAX358							1-9
IH5208	See MAX359							1-9
IH6108	See DG508A							1-43
IH6116	See DG506A							1-37
IH6208	See DG509A							1-43
IH6216	See DG507A							1-37

Video Switching Products

Part Number	Function*	$r_{DS(ON)}$ (Ω max)	$I_{D(OFF)}$ (nA max)	$t_{(ON)}$ (μs max)	V_{IL}/V_{IH} (V)	Analog Signal Voltage Range	Features	Page No.
MAX310	1 of 8 Mux	250	10	1.5μs	0.8/2.4	+12/-15V	70dB Isolation at 10MHz	1-1
MAX311	2 of 8 Mux	250	10	1.5μs	0.8/2.4	+12/-15V	70dB Isolation at 10MHz	1-1
MAX453	1 of 2 Mux	Buffered Output	10	0.12μs	0.8/2.4	±2V	On-Chip Output Amp	Ask for
MAX454	1 of 4 Mux	Buffered Output	10	0.12μs	0.8/2.4	±2V	On-Chip Output Amp	Data
MAX455	1 of 8 Mux	Buffered Output	10	0.12μs	0.8/2.4	±2V	On-Chip Output Amp	Sheet
IH5341	2 SPST NO	75	0.5	300	150	0.8/2.4	70dB Isolation	2-67
IH5352	4 SPST NO	75	0.5	300	150	0.8/2.4	at 10MHz	2-67

* NO — Normally Open

Part Number	Function*	$r_{DS(ON)}$ (Ω max)	$I_{D(OFF)}$ (nA max)	$t_{(ON)}$ (ns max)	$t_{(OFF)}$ (ns max)	V_{IL}/V_{IH} (V)	Supply Current (I^+/I^- mA max)	Features	Page No.
MAX331	4 SPST NC	175	5	600	450	0.8/2.4	0.01/0.01	Improved DG201	2-1
MAX332	4 SPST NO	175	5	600	450	0.8/2.4	0.01/0.01	Improved DG202	2-9
MAX333	4 SPDT	175	5	1000	500	0.8/2.4	0.25/0.25	Most switches/pkg	2-17
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DG201A	4 SPST NC	175	5	600	450	0.8/2.4	0.1/0.1	Low Power	2-1
DG202	4 SPST NO	175	5	600	450	0.8/2.4	0.1/0.1	Normally Open	2-9
DG211	4 SPST NC	175	5	1000	500	0.8/2.4	0.1/0.1	No V_{LOGIC} Supply	2-1
DG212	4 SPST NO	175	5	1000	500	0.8/2.4	0.1/0.1	Normally Open	2-9
DG300/A	2 SPST NO	50	5	300	250	0.8/2.4	0.5/0.1	$2.4V_{IH}$, Low R_{ON}	2-37
DG301/A	SPDT	50	5	300	250	0.8/2.4	0.5/0.1	$2.4V_{IH}$, Low R_{ON}	2-37
DG302/A	2 SPST NO	50	5	300	250	0.8/2.4	0.5/0.1	$2.4V_{IH}$, Low R_{ON}	2-37
DG303/A	DPDT	50	5	300	250	0.8/2.4	0.5/0.1	$2.4V_{IH}$, Low R_{ON}	2-37
DG304/A	2 SPST NO	50	5	250	150	3.5/11	0.5/0.1	CMOS Logic levels,	2-43
DG305/A	SPDT	50	5	250	150	3.5/11	0.5/0.1	High speed,	2-43
DG306/A	2 DPST NO	50	5	250	150	3.5/11	0.5/0.1	Low R_{ON}	2-43
DG307/A	2 DPDT	50	5	250	150	3.5/11	0.5/0.1		2-43
DG381/A	2 SPST NC	50	5	300	250	0.8/4.0	0.5/0.1	Low R_{ON}	2-49
DG384/A	2 DPDT NO	50	5	300	250	0.8/4.0	0.5/0.1	Low R_{ON}	2-49
DG387/A	SPDT	50	5	300	250	0.8/4.0	0.5/0.1	Low R_{ON}	2-49
DG390/A	2 SPDT	50	5	300	250	0.8/4.0	0.5/0.1	Low R_{ON}	2-49
IH5040	SPST NO	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5041	2 SPST NO	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5042	SPDT	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5043	2 SPDT	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5044	DPST NO	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5045	2 DPST NO	80	5	400	200	0.8/2.4	0.01/0.01	Very Low Power	2-55
IH5048	SPDT NO	45	5	1000	500	0.8/2.4	0.01/0.01	Low Charge Injection	2-59
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IH5050	SPDT NO	45	5	1000	500	0.8/2.4	0.01/0.01	Low Charge Injection	2-59
IH5051	2 SPDT	45	5	1000	500	0.8/2.4	0.01/0.01	Low Charge Injection	2-59
IH5140	SPST NO	50	0.1	150	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63
IH5141	2 SPST NO	50	0.1	150	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63
IH5142	SPDT	50	0.1	200	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63
IH5143	2 SPDT	50	0.1	200	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63
IH5144	DPST NO	50	0.1	200	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63
IH5145	2 DPST NO	50	0.1	200	125	0.8/2.4	0.01/0.01	Fast; Low Power	2-63

High Voltage Analog Switches

Part Number	Function*	$r_{DS(ON)}$ (Ω max)	$I_{D(OFF)}$ (nA max)	$t_{(ON)}$ (ns max)	$t_{(OFF)}$ (ns max)	V_{IL}/V_{IH} (V)	Supply Current (I^+/I^- mA max)	Features	Page No.
MAX341	2 SPST NO	75	60	1000	750	3.5/12	0.3/0.02	High Voltage,	2-25
MAX343	2 SPDT	75	60	1000	750	3.5/12	0.3/0.02	±50V Operation	2-25
MAX345	2 DPST NO	75	60	1000	750	3.5/12	0.3/0.02	with ±50V	2-25
MAX348	2 SPST NO	45	60	1000	750	3.5/12	0.3/0.02	Analog Signal Range	2-25

* NC — Normally Closed, NO — Normally Open

MAXIM

Analog Multiplexers

1

Please see Analog Multiplexers and Video Multiplexers Selector Guides on page iii.

MAXIM

CMOS RF/Video Multiplexers

General Description

Maxim's MAX310 and MAX311 are CMOS monolithic analog multiplexer/demultiplexers designed for use with signal frequencies ranging from DC through video. The MAX310 is a 1-of-8 multiplexer while the MAX311 is for 2-of-8 (4 channel differential) applications.

A key feature of the MAX310/311 is extremely high off isolation at high frequencies. The isolation of each off channel to the output is guaranteed to be -66dB at 5MHz. The input signal range is +12V to -15V with ±15V power supplies while power consumption is typically 1.1mW.

All control inputs are fully compatible with TTL and CMOS logic. Decoding is in standard BCD format and an Enable input is also provided to simplify cascading of devices. The MAX310 and MAX311 will operate with nearly any power supply combination which totals less than 36V ($V^+ - V^-$) including single supply operation at +12V, +15V, and +28V with V^- connected to GND.

Applications

Video Switching and Crosspoint Systems

Automatic Test Equipment

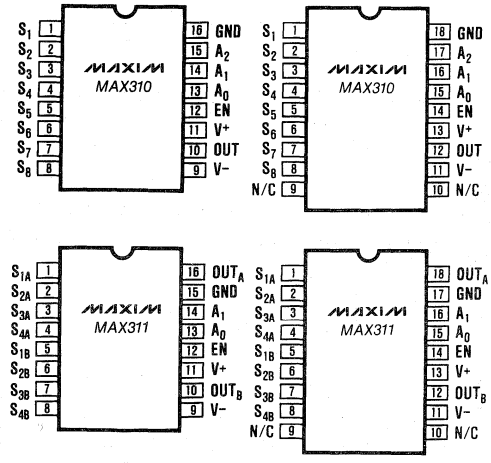
Medical Ultrasound Phased Array Systems

Data Logging of High Frequency Signals

Digital Signal Processing

Pin Configuration

Top View



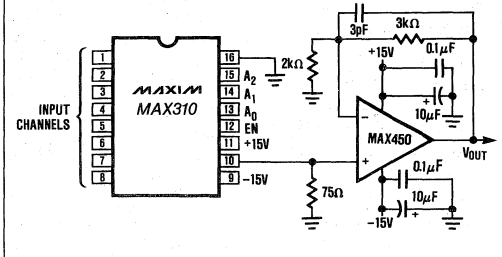
Features

- ♦ **-76dB Typical Off Isolation at 5MHz**
- ♦ **-63dB Typical "All Channel Off" Isolation at 5MHz**
- ♦ **Phase Shift Match Between Channels, <1° at 5MHz**
- ♦ **Break-Before-Make Switching**
- ♦ **Wide Supply Range, ±4.5V to ±16.5V and Single Supply**
- ♦ **Symmetrical, Bi-directional Operation**
- ♦ **Latch-Up Proof Construction**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX310C/D	0°C to +70°C	Dice
MAX310CPE	0°C to +70°C	16 Lead Plastic DIP
MAX310CWN	0°C to +70°C	18 Lead Wide SO
MAX310EPE	−40°C to +85°C	16 Lead Plastic DIP
MAX310EWN	−40°C to +85°C	18 Lead Wide SO
MAX310EJE	−40°C to +85°C	16 Lead CERDIP
MAX310MJE	−55°C to +125°C	16 Lead CERDIP
MAX311C/D	0°C to +70°C	Dice
MAX311CPE	0°C to +70°C	16 Lead Plastic DIP
MAX311CWN	0°C to +70°C	18 Lead Wide SO
MAX311EPE	−40°C to +85°C	16 Lead Plastic DIP
MAX311EWN	−40°C to +85°C	18 Lead Wide SO
MAX311EJE	−40°C to +85°C	16 Lead CERDIP
MAX311MJE	−55°C to +125°C	16 Lead CERDIP

Typical Operating Circuit



No Insertion Loss, 8 Channel Mux

CMOS RF/Video Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltage referenced to V^-
- V^+ ..... +36V
- GND ..... +24V
- Digital Inputs ..... V^- to V^+

Input Current
- S and COMMON OUT ..... ±50mA
- All pins except S and COM. OUT ..... ±30mA

Lead Temperature ..... +300°C
Storage Temperature ..... -65°C to +150°C

Operating Temperature Range
- MAX310C, MAX311C ..... 0°C to +70°C
- MAX310E, MAX311E ..... -40°C to +85°C
- MAX310M, MAX311M ..... -55°C to +125°C

Power Dissipation (16-Pin packages)
- CERDIP (derate 10mW/°C above +75°C) 750mW
- Plastic DIP (derate 7.35mW/°C above +75°C) 550mW
- Small Outline (derate 9mW/°C above +75°C) 550mW

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Over Temperature, V^+ = +15V, V^- = -15V, GND = 0V unless otherwise indicated)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Analog Signal Range		V^+, V^- = ±15V V^+, V^- = ±5V	-15 -5		+12 +2	V
Channel ON Resistance	R_{ON}	V_{IN} = ±5V, I_{OUT} = 10mA T_A = +25°C Over Temp.		150	250 300	Ω
ON Resistance Match	ΔR_{ON}	V_{IN} = ±5V, I_{OUT} = 10mA		6		%
OFF Input Leakage Current	$I_{S(OFF)}$	Figure 10, T_A = +25°C Over Temp		0.4 3	10 100	nA
OFF Output Leakage Current	$I_{D(OFF)}$	Figure 11, T_A = +25°C MAX310 Over Temp. MAX311 Over Temp.		0.8 20 10	10 100 50	nA
ON Channel Leakage Current	$I_{D(ON)}$	Figure 12, T_A = +25°C MAX310 Over Temp. MAX311 Over Temp.		1 30 15	10 200 100	nA
Input Low Threshold	V_{AL}	V^+/V^- = ±15V, ±5V			0.8	V
Input High Threshold	V_{AH}	V^+/V^- = ±15V, ±5V	2.4			V
Input Current (Logic)	I_A	V_A = 0V or 5V			±10	µA
Access Time	t_{ACC}	Figure 7; T_A = +25°C Over Temp.		0.6	1.5 2.0	µs
Enable Delay ON or OFF	$t_{EN(ON/OFF)}$	Figure 8; T_A = +25°C Over Temp.		0.3	1.0 2.0	µs
Break-Before-Make Delay	$t_{ON}-t_{OFF}$	Figure 9	30	100		ns
OFF Isolation, Single Channel to OUT	ISO_{SC}	Figure 3; T_A = +25°C	-66	-76		dB
OFF Isolation, All Channels to OUT	ISO_{AC}	Figure 4, 5, T_A = +25°C MUX Disabled, EN = +0.8V MUX Enabled, EN = +2.4V		-63 -58		dB
Adjacent Channel Crosstalk	ISO_X	Figure 6, T_A = +25°C		-72		dB
Channel Input Capacitance OFF State ON State	 $C_{S(OFF)}$ $C_{S(ON)}$	T_A = +25°C, V_{IN} = 10mV$_{RMS}$ 10 MHz		 5 45		pF
Channel Output Capacitance OFF State ON State	 $C_{D(OFF)}$ $C_{D(OFF)}$	T_A = +25°C; EN = +0.8V, MAX310 MAX311 EN = +2.4V, MAX310 MAX311		 38 20 57 40		pF
Charge Injection	Q	Figure 13, T_A = +25°C		110		pC
Supply Current; V^+ V^-	I^+ I^-	EN, A0, A1, A2 = 0V or +5V		75 0.1	200 100	µA
Supply Voltage Range		T_A = +25°C	±4.5		±16.5	V

Detailed Description

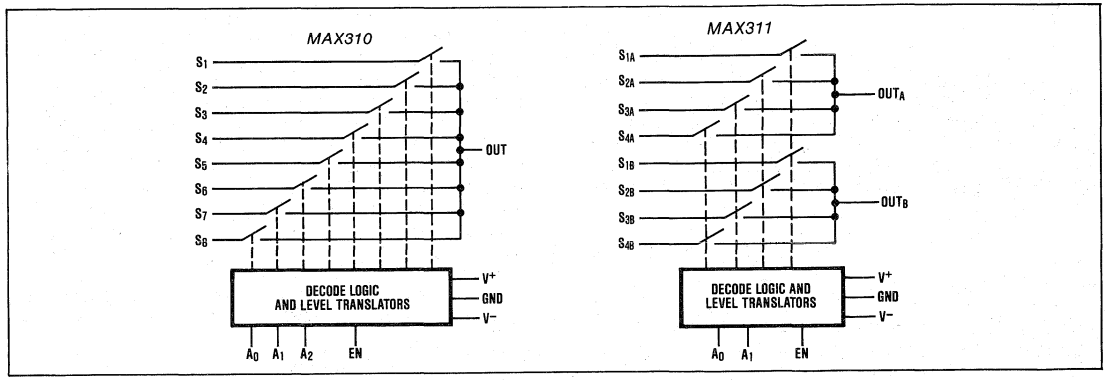


Figure 1. Functional Block Diagrams

The Maxim MAX310 and MAX311 contain 8 video switches combined with an address decoder and level translators (Figure 1). Each of the 8 video switches consists of 3 N-channel FETs configured as shown in Figure 2. This "T" configuration provides the high frequency OFF isolation required when switching wide-band video, audio, or digital signals.

N-channel FETs are used in the MAX310/311's "T" switches because of their low capacitance and consequently superior isolation characteristics. A side effect is that the N-channel ON resistance varies somewhat with the voltage difference between the analog input signal and V^+. This effect is shown in the Typical Operating Characteristics section.

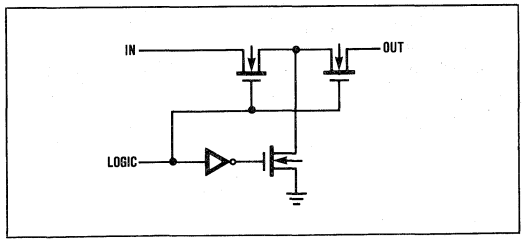


Figure 2. N-channel T Switch

Channel selection is performed by applying a binary input to the address inputs A_0, A_1 and A_2 (A_0 and A_1 only for MAX311). The address decoder selects channels as shown in the truth tables (Table 1). All digital inputs are compatible with TTL and CMOS logic levels.

Break-before-make switch timing is guaranteed for both multiplexers. This prevents momentary shorting of inputs when changing multiplexer channels.

The MAX310 and MAX311 are also fully bilateral and so can be used "backwards", as demultiplexers, with no loss in performance. Specifically, one input signal can be routed to one of several outputs.

TABLE 1. CHANNEL SELECTION INPUT CODES

MAX310					MAX311			
A_2	A_1	A_0	EN	ON Channel	A_1	A_0	EN	ON Channel
0	0	0	1	1	0	0	1	1A + 1B
0	0	1	1	2	0	1	1	2A + 2B
0	1	0	1	3	1	0	1	3A + 3B
0	1	1	1	4	1	1	1	4A + 4B
1	0	0	1	5	X	X	0	ALL OFF
1	0	1	1	6				
1	1	0	1	7				
1	1	1	1	8				
X	X	X	0	ALL OFF				

Application Hints

Maximizing Isolation

With all high frequency circuits, careful printed circuit board layout is essential for optimum performance. To maintain the high frequency isolation of the MAX310/311, signal paths should be of minimum length and ground plane should be used where possible, including between adjacent input pins. A ground or power supply trace between adjacent inputs will markedly improve isolation between channels.

Both V^+ and V^- should be bypassed to ground with 0.1μF ceramic capacitors. The leads of the capacitors should be kept as short as possible to minimize

series inductance. The bypass capacitors should also be located as physically close to the multiplexer as possible.

Input Capacitance

The capacitance of an input channel changes from about 5pF in the OFF state to around 45pF when ON. To minimize bandwidth reduction due to input capacitance, the inputs should be driven from a low impedance source. A 75Ω source impedance results in a 3dB frequency response of 47MHz when loaded with 45pF.

Charge Injection

With ±15V supplies, injected charge from the internal switch drive circuitry to the analog signal path is typically 110 picocoulombs. As shown in the Typical Characteristics graph, charge injection is relatively independent of the analog signal voltage.

Insertion Loss

With ±15V supplies and ±2V video signals, the 120Ω typical ON resistance of the MAX310/311 results in -8.3dB insertion loss when used with a 75Ω output load. This insertion loss is virtually constant from DC to over 20MHz.

TABLE 2. PHASE SHIFT AT 10MHz

INPUT CHANNEL MAX311	OUTPUT - INPUT PHASE SHIFT	
	R_L = 10kΩ	R_L = 75Ω
S_1	-22°	-12°
S_2	-21°	-11.5°
S_3	-20°	-11.5°
S_4	-20°	-11.2°
S_5	-20°	-11.2°
S_6	-20.5°	-11.4°
S_7	-20.7°	-11.5°
S_8	-20.4°	-11.5°

Test Conditions: V^+ = +15V, V^- = -15V, V_{IN} = 1.25V_{RMS} at 10MHz, OFF inputs terminated with 75Ω.

Operation with Power Supplies Other Than ±15V

Table 3 shows how different power supply voltages affect the MAX310/311's analog signal range and channel ON resistance (R_{ON}). This data is also shown graphically in the Typical Operating Characteristics section. Since N-channel FETs are used in the switches, R_{ON} is determined by the voltage difference between V^+ and the input voltage. For lowest R_{ON}, use a negative power supply (V^-) equal to the most negative input voltage, and a positive power supply (V^+) 30V above the negative supply. For example, if only positive signals need to be switched, use 0V for V^- and +30V for V^+ to achieve minimum R_{ON}. This also reduces ON resistance variation with analog signal level and input voltage dependent changes in insertion loss, which minimizes differential gain errors.

The digital input thresholds are nearly independent of V^+, remaining near +1.4V over the entire operating supply voltage range of ±4.5V to ±18V (9V to 36V single supply).

The MAX310/311 switching delay times vary somewhat with power supply voltage. Access time (see Figure 2) increases from typically 600ns with ±15V supplies to 3μs with ±5V supplies. Other switching times are also proportionately longer with ±5V power supplies.

Propagation Delay and Phase Shift

In Table 2, the typical phase shift for each channel is shown. Note that both the phase shift and the phase shift difference between channels are reduced with a 75Ω output load. At 10MHz, the channel-to-channel match is better than 1° with a 75Ω load and improves as the frequency is reduced.

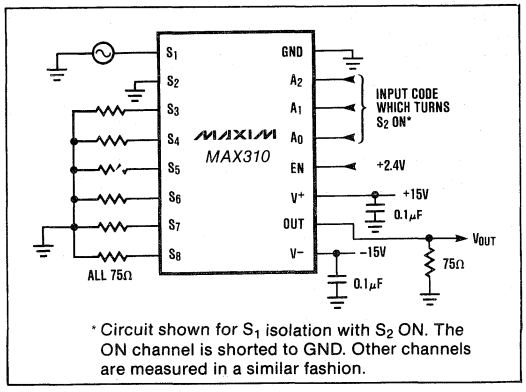
Phase shift measurements for the MAX311 are similar to those in Table 2. The data for the MAX310 channels 1 to 4 corresponds to MAX311 channels 1A to 4A, Channels 5 to 8 correspond to MAX311 channels 1B to 4B.

TABLE 3. SIGNAL RANGE AND R_{ON} vs SUPPLY VOLTAGE

SUPPLY VOLTAGE		SIGNAL RANGE	TYPICAL R_{ON} AT V_{IN}	
V^-	V^+		NEGATIVE	POSITIVE
-15	+15V	-15V to +12V	104Ω at -10V	265Ω at +10V
		-5V to +5V	115Ω at -5V	150Ω at +5V
GND	+15V	0V to +12V	120Ω at 0V	150Ω at +5V
GND	+30V	0V to +27V	90Ω at 0V	100Ω at +5V
-5V	+5V	-5V to +2V	240Ω at -2V	480Ω at +2V
-10V	+10V	-10V to +7V	140Ω at -5V	220Ω at +5V
-5V	+15V	-5V to +12V	115Ω at -5V	150Ω at +5V

OFF Isolation Measurements

Figure 3 is used to test and specify the MAX310/311's single channel OFF isolation. In the case illustrated, channel S_1 has signal applied while all other inputs are grounded through 75Ω except for the ON channel (S_2 in Figure 3). This is shorted directly to ground to prevent pickup from external wiring. Each channel meets this test to an isolation limit of -66dB at 5MHz.



* Circuit shown for S_1 isolation with S_2 ON. The ON channel is shorted to GND. Other channels are measured in a similar fashion.

Figure 3. Single Channel OFF Isolation (ISO_{SC}) Test Circuit

Figure 4 shows the test circuit for OFF isolation with all channels driven. The impedance of the source connected to the selected channel (in this case, S_4) significantly affects feedthrough. With a 75Ω source impedance the typical measured OFF isolation is -58dB at 5MHz. This increases to -63dB if the source impedance is reduced to 10Ω or less. OFF isolation also increases with decreasing frequency. For example, when the frequency is reduced from 10MHz to 1MHz the isolation improvement is typically -20dB. Figure 5 shows a similar circuit for testing all-channel isolation with the multiplexer disabled (EN low).

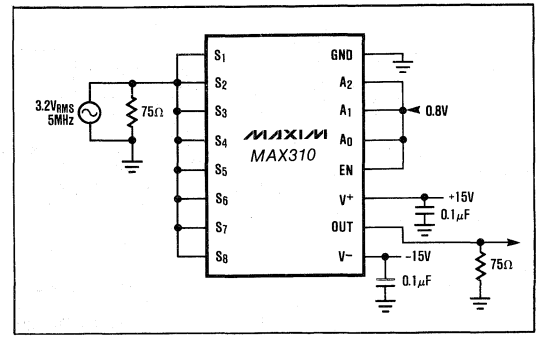
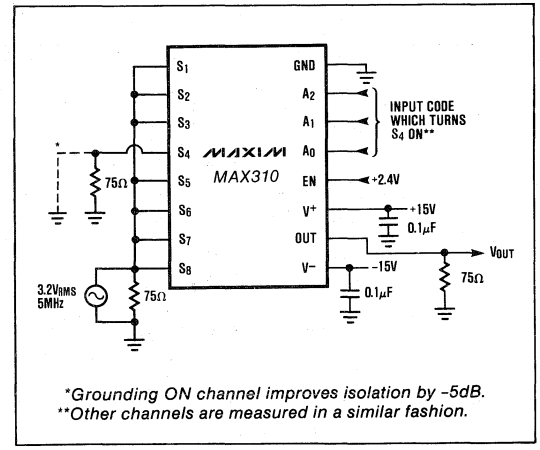


Figure 4. All Channel OFF Isolation (ISO_{AC}) Test Circuit (MUX Disabled)

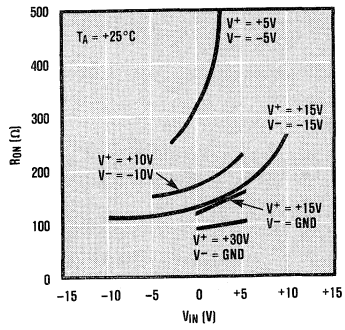


**Grounding ON channel improves isolation by -5dB.*
***Other channels are measured in a similar fashion.*

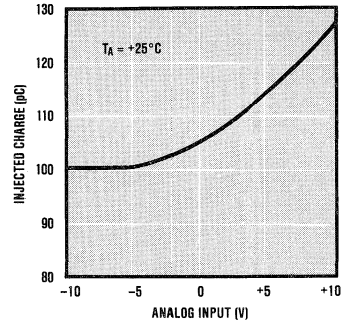
Figure 5. All Channel OFF Isolation (ISO_{AC}) Test Circuit (MUX Enabled)

Typical Operating Characteristics

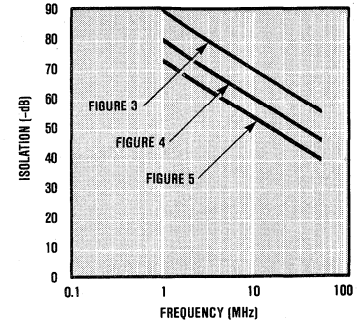
RON vs. SUPPLY VOLTAGE AND INPUT VOLTAGE



CHARGE INJECTION vs. ANALOG INPUT VOLTAGE



OFF ISOLATION vs. FREQUENCY



CMOS RF/Video Multiplexers

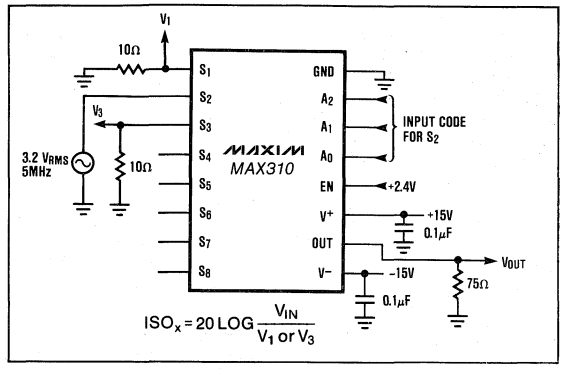


Figure 6. Adjacent Channel Crosstalk (ISO_X) Test Circuit

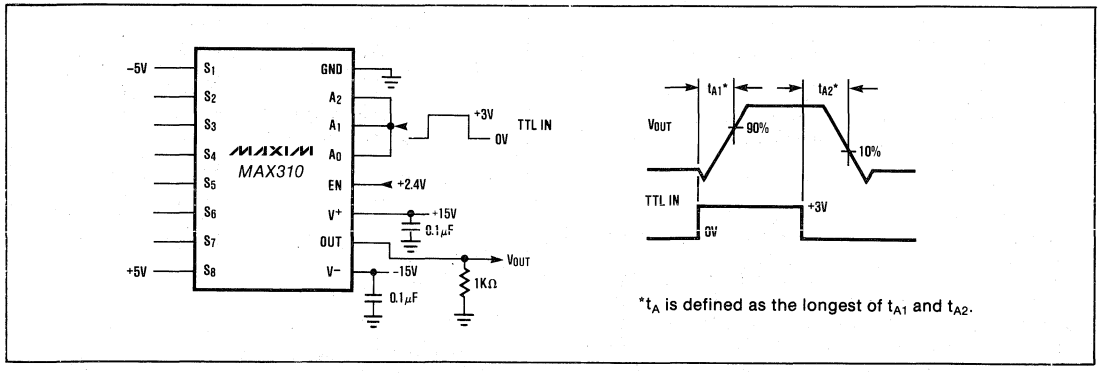


Figure 7. Access Time (t_A) Test Circuit.

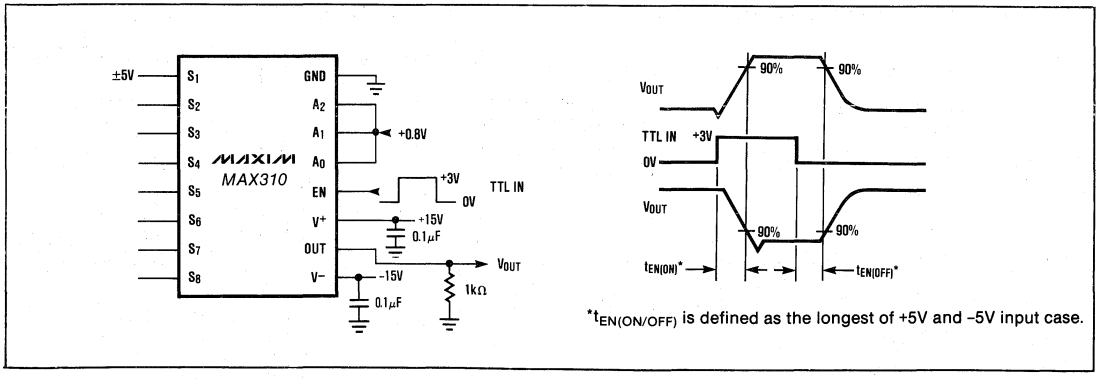


Figure 8. Enable Delay ($t_{EN(ON/OFF)}$) Test Circuit.

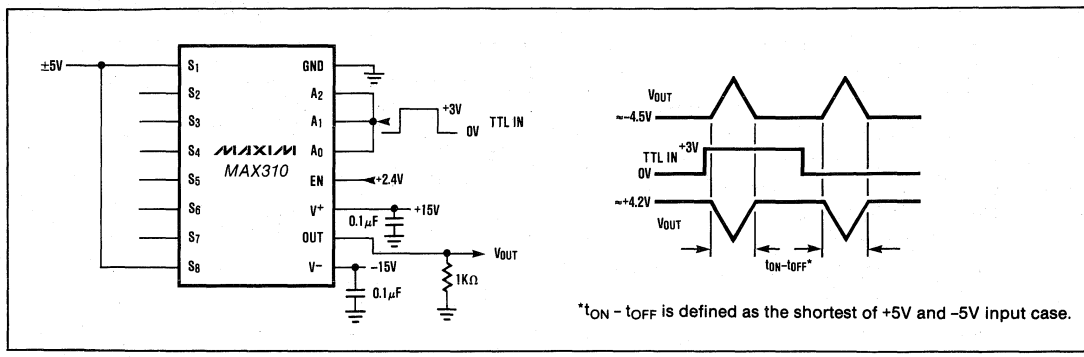


Figure 9. Break-Before-Make Delay (t_{ON}-t_{OFF}) Test Circuit.

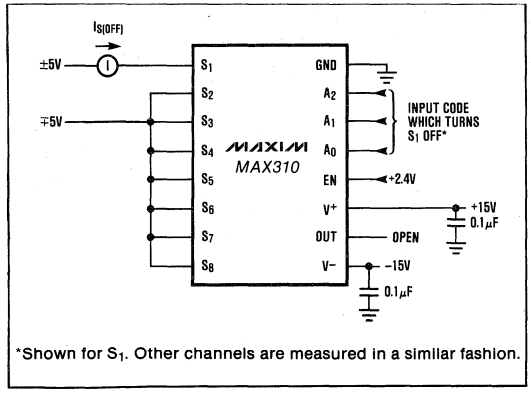


Figure 10. OFF Input Leakage Current Test Circuit.

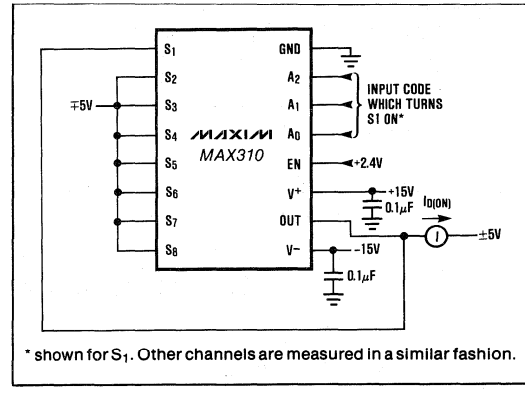


Figure 12. ON Output Leakage Current Test Circuit.

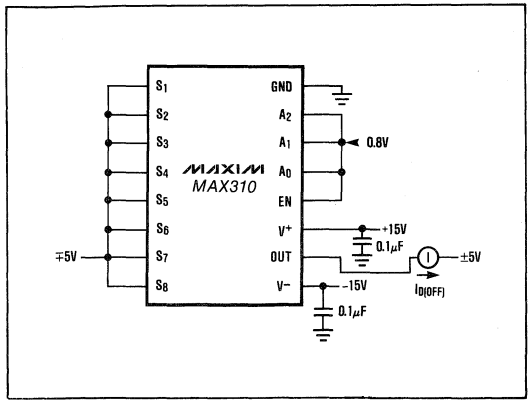


Figure 11. OFF Output Leakage Current Test Circuit.

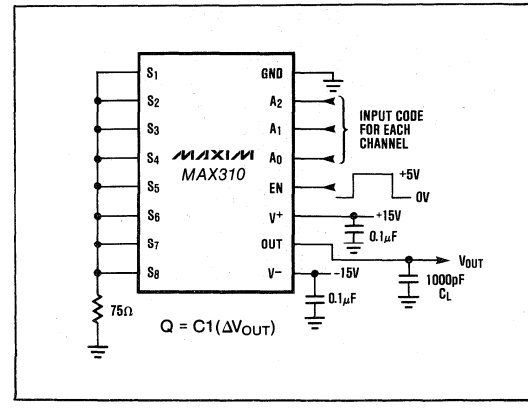


Figure 13. Charge Injection (Q) Test Circuit

CMOS RF/Video Multiplexers

Typical Applications

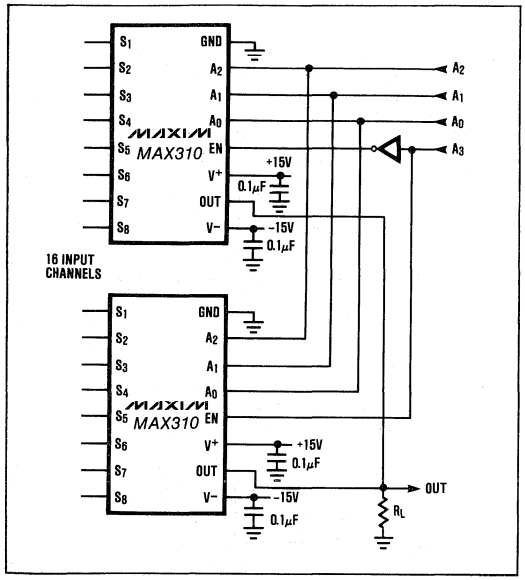


Figure 14. Cascading 2 MAX310s For 1 of 16 Multiplexer

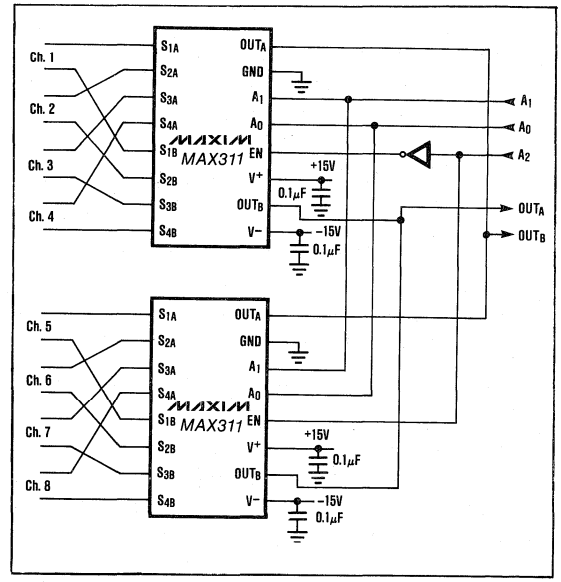
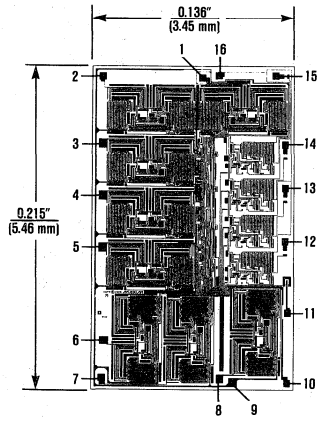


Figure 15. Cascading 2 MAX311s For 1 of 8 Differential Multiplexer.

Chip Topography



(See Pin Configurations for MAX310 and MAX311 pin functions)

Fault-Protected Analog Multiplexer

General Description

Maxim's HI-508A and MAX358 are 8 channel single-ended (1 of 8) multiplexers with fault protection. Maxim's HI-509A and MAX359 are 4 channel differential (2 of 8) multiplexers with fault protection. Using a series N-channel, P-channel, N-channel structure, these multiplexers provide significantly improved fault protection. If the power supplies to the Maxim fault-protected multiplexer are inadvertently turned off while input voltages are still applied, *all* channels in the multiplexer are turned off, and only a few nanoamperes of leakage current will flow into the inputs. This protects not only the multiplexer and the circuitry driven by the multiplexer, but also protects the sensors or signal sources which drive the multiplexer.

The Maxim series N-channel, P-channel, N-channel protection structure has two significant advantages over the simple current limiting protection scheme of the first generation fault protected multiplexers. First, the Maxim protection scheme limits fault currents to nanoamp leakage values rather than many milliamperes. This prevents damage to sensors or other sensitive signal sources. Second, the Maxim fault-protected multiplexers can withstand a *continuous* ±35V overvoltage, unlike the first generation which has a continuous overvoltage limitation of about ±10V imposed by power dissipation considerations.

All digital inputs have logic thresholds of 0.8V and 2.4V, ensuring both TTL and CMOS compatibility without requiring pullup resistors. Break-before-make operation is guaranteed. Power supply currents have been reduced and typical power dissipation is less than 2 milliwatts.

Applications

Data Acquisition Systems

Industrial and Process Control Systems

Avionics Test Equipment

Signal Routing between Systems

Features

- **Improved 2nd Source (See "Maxim Advantage" on 3rd and 5th page)**
- **All Switches Off with Power Supplies Off**
- **On Channel Turns OFF if Overvoltage Occurs**
- **Only Nanoamperes of Input Current under All Fault Conditions**
- **Latchup-proof Construction**
- **Operates from ±4.5 to ±18V Supplies**
- **All Digital Inputs are TTL and CMOS Compatible**

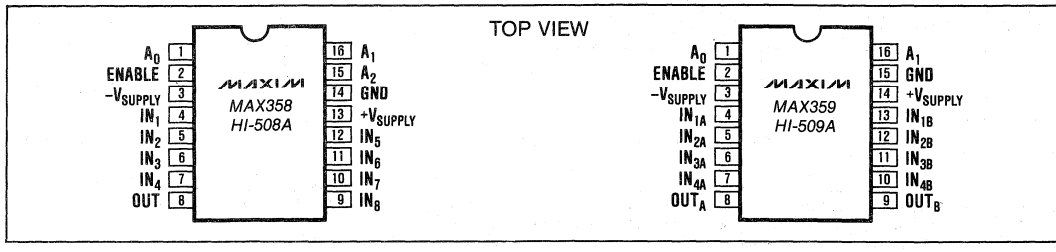
Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX358CPE	0°C to +75°C	16 Lead Plastic DIP
MAX358CWE	0°C to +75°C	16 Lead Wide SO
MAX358CJE	0°C to +75°C	16 Lead CERDIP
MAX358EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX358EWE	-40°C to +85°C	16 Lead Wide SO
MAX358EJE	-40°C to +85°C	16 Lead CERDIP
MAX358MJE	-55°C to +125°C	16 Lead CERDIP
MAX358C/D**	0°C to +75°C	Dice
MAX359CPE	0°C to +75°C	16 Lead Plastic DIP
MAX359CWE	0°C to +75°C	16 Lead Wide SO
MAX359CJE	0°C to +75°C	16 Lead CERDIP
MAX359EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX359EWE	-40°C to +85°C	16 Lead Wide SO
MAX359EJE	-40°C to +85°C	16 Lead CERDIP
MAX359MJE	-55°C to +125°C	16 Lead CERDIP
MAX359C/D**	0°C to +75°C	Dice

(Ordering Information is continued on last page.)

** The substrate may be allowed to float or be tied to V^+ (JI CMOS).

Pin Configuration



The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Fault-Protected Analog Multiplexer

ABSOLUTE MAXIMUM RATINGS

Voltage between Supply Pins ..... +44V
V^+ ..... +22V
V^- ..... -22V
Digital Input Overvoltage:
V_{EN}, V_A { $V_{Supply}(+)$ ..... +4V
{ $V_{Supply}(-)$ ..... -4V
Analog Input Overvoltage with Multiplexer Power On:
V_S { $V_{Supply}(+)$ ..... +20V
{ $V_{Supply}(-)$ ..... -20V
Analog Input Overvoltage with Multiplexer Power Off:
V_S { $V_{Supply}(+)$ ..... +35V
{ $V_{Supply}(-)$ ..... -35V

Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1ms, 10% duty cycle max) 40mA
Power Dissipation (Note 1) (CERDIP) 1.28W
Operating Temperature Range:
MAX358/359M; HI-508A/509A-2, -8 ..... -55°C to +125°C
MAX358/359C; HI-508A/509A-5 ..... 0°C to +75°C
MAX358/359E ..... -40°C to +85°C
Storage Temperature Range ..... -65°C to +150°C

Note 1: Derate 12.8mW/°C above T_A = +75°C

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS: HI-508A/509A (See facing page for MAX358/359.)

Supplies = +15V, -15V; V_{AH} (Logic Level High) = +4.0V, V_{AL} (Logic Level Low) = +0.8V (unless otherwise noted).

PARAMETER	SYMBOL	CONDITIONS	TEMP	-55°C to +125°C			0°C to +75°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
STATIC										
ON Resistance	$r_{DS(ON)}$	V_D = ±10V, I_S = 100μA V_{AL} = 0.8V, V_{AH} = 4V	+25°C Full		1.2 1.5	1.5 1.8		1.5 1.8	1.8 2.0	kΩ
OFF Input Leakage Current	$I_{S(OFF)}$	V_S = ±10V, V_D = ∓10V V_{EN} = 0.8V (Note 2)	+25°C Full		0.03	 50		0.03	 50	nA
OFF Output Leakage Current	$I_{D(OFF)}$	V_D = ±10V, V_S = ∓10V V_{EN} = 0.8V HI-508A (Note 2) HI-509A	+25°C Full Full		0.1	 200 100		0.1	 200 100	nA
ON Channel Leakage Current	$I_{D(ON)}$	$V_{S(ALL)}$ = V_D = ±10V (Note 2) V_{AH} = V_{EN} = 4V HI-508A V_{AL} = 0.8V HI-509A	+25°C Full Full		0.1	 200 100		0.1	 200 100	nA
Analog Signal Range	V_{AN}		Full	-15		+15	-15		+15	V
Differential, OFF Output Leakage Current	I_{DIFF}	(HI-509A only)	Full			50			50	nA
FAULT										
Output Leakage Current (with Overvoltage)	$I_{D(OFF)}$	V_D = 0V Analog Overvoltage = ±33V	+25°C Full		4.0	 2.0		4.0		nA μA
INPUT										
Input Low Threshold	V_{AL}	(Note 3)	Full			0.8			0.8	V
Input High Threshold	V_{AH}		Full	4.0			4.0			V
Input Leakage Current (High or Low)	I_A	V_A = 4V or 0V (Note 4)	Full			1.0			1.0	μA
DYNAMIC										
Access Time	t_A		+25°C		0.5	1.0		0.5	1.0	μs
Break-Before-Make Delay	t_{ON}-t_{OFF}	V_{EN} = +5V, V_{IN} = ±10V A_0, A_1, A_2 Strobed	+25°C	25	80		25	80		ns
Enable Delay (ON)	$t_{ON(EN)}$		+25°C Full		300	500 1000		300	 1000	ns
Enable Delay (OFF)	$t_{OFF(EN)}$		+25°C Full		300	500 1000		300	 1000	ns
Settling Time (0.1%) (0.01%)	t_{SETT}		+25°C		1.2 3.5			1.2 3.5		μs

Note 2: Ten nanoamps is the practical lower limit for high speed measurement in the production test environment.
Note 3: To drive from DTL/TTL Circuits, 1kΩ pull-up resistors to +5.0V supply are recommended.
Note 4: Digital input leakage is primarily due to the clamp diodes. Typical leakage is less than 1nA at +25°C.

Fault-Protected Analog Multiplexer

- ◆ Only Nanoamps of Leakage Under Fault Conditions
- ◆ All Switches OFF With Power Supplies Off
- ◆ Channel Turns OFF When Overvoltage Occurs
- ◆ TTL Compatible, No Pullups Required
- ◆ Significantly Reduced Power Consumption
- ◆ ±4.5V to ±18V Operation

ABSOLUTE MAXIMUM RATINGS: This device conforms to the Absolute Maximum Ratings on adjacent page.

ELECTRICAL CHARACTERISTICS: MAX358/359 (See facing page for HI-508A/509A.)

Specifications below satisfy or exceed all "tested" parameters on adjacent page.
Supplies = +15V, -15V; V_{AH} (Logic Level High) = +2.4V, V_{AL} (Logic Level Low) = +0.8V (unless otherwise noted).

PARAMETER	SYMBOL	CONDITIONS	TEMP	-55°C to +125°C			0°C to +75°C and -40°C to +85°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
STATIC										
ON Resistance	$r_{DS(ON)}$	V_D = ±10V, I_S = 100μA V_{AL} = 0.8V, V_{AH} = 2.4V	+25°C Full		1.2 1.5	1.5 1.8		1.5 1.8	1.8 2.0	kΩ
OFF Input Leakage Current	$I_{S(OFF)}$	V_S = ±10V, V_D = ∓10V V_{EN} = 0.8V	+25°C Full		0.03	0.5 50		0.03	1.0 50	nA
OFF Output Leakage Current	$I_{D(OFF)}$	V_D = ±10V, V_S = ∓10V V_{EN} = 0.8V MAX358 MAX359	+25°C Full Full		0.1	1.0 200 100		0.1	2.0 200 100	nA
ON Channel Leakage Current	$I_{D(ON)}$	$V_{S(ALL)}$ = V_D = ±10V (Note 2) V_{AH} = V_{EN} = 2.4V MAX358 V_{AL} = 0.8V MAX359	+25°C Full Full		0.1	2.0 200 100		0.1	5.0 200 100	nA
Analog Signal Range	V_{AN}	(Note 1)	Full	-15		+15	-15		+15	V
Differential, OFF Output Leakage Current	I_{DIFF}	MAX359 only	Full			50			50	nA
FAULT										
Output Leakage Current (with Overvoltage)	$I_{D(OFF)}$	V_D = 0V (Note 2) Analog Overvoltage = ±33V	+25°C Full		4.0	2.0		4.0		nA μA
Input Leakage Current (with Overvoltage)	$I_{S(OFF)}$	**V_{IN} = ±25V, V_O = ±10V (Note 2)**	**+25°C**			**5.0**			**10**	**μA**
Input Leakage Current (w. Power Supplies Off)	$I_{S(OFF)}$	**V_{IN} = ±25V, V_{EN} = V_O = 0V A_0 = A_1 = A_2 = 0V or 5V**	**+25°C**			**2.0**			**5.0**	**μA**
INPUT										
Input Low Threshold	V_{AL}		Full			0.8			0.8	V
Input High Threshold	V_{AH}		**Full**	**2.4**			**2.4**			**V**
Input Leakage Current (High or Low)	I_A	V_A = 4V or 0V (Note 4)	Full			1.0			1.0	μA
DYNAMIC										
Access Time	t_A	(Figure 1)	+25°C		0.5	1.0		0.5	1.0	μs
Break-Before-Make Delay (Figure 2)	t_{ON}-t_{OFF}	V_{EN} = +5V, V_{IN} = ±10V A_0, A_1, A_2 Strobed	+25°C	25	80		25	80		ns
Enable Delay (ON)	$t_{ON(EN)}$	(Figure 3)	+25°C Full		300	500 1000		300	 1000	ns
Enable Delay (OFF)	$t_{OFF(EN)}$	(Figure 3)	+25°C Full		300	500 1000		300	 1000	ns
Settling Time (0.1%) (0.01%)	t_{SETT}		+25°C		1.2 3.5			1.2 3.5		μs

Note 1: When the analog signal exceeds +13.5V or -12V the blocking action of Maxim's gate structure goes into operation. Only leakage currents flow and the channel on resistance rises to infinity.
Note 2: The value shown is the steady state value. The transient leakage is typically 10μA. See detailed description.
Note 3: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V are used.
Note 4: Digital input leakage is primarily due to the clamp diodes. Typical leakage is less than 1nA at +25°C.

ELECTRICAL CHARACTERISTICS: HI-508A/509A (continued)

Supplies = +15V, -15V; V_{AH} (Logic Level High) = +4.0V, V_{AL} (Logic Level Low) = +0.8V (unless otherwise noted).

PARAMETER	SYMBOL	CONDITIONS	TEMP	-55°C to +125°C			0°C to +75°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
DYNAMIC (continued)										
"OFF Isolation" (Note 5)	$OFF_{(ISO)}$	V_{EN} = 0.8V, R_L = 1kΩ, C_L = 15pF, V = 7V_{RMS}, f = 100kHz	+25°C	50	68		50	68		dB
Channel Input Capacitance	$C_{S(OFF)}$		+25°C		5			5		pF
Channel Output Capacitance	$C_{D(OFF)}$	HI-508A HI-509A	+25°C		25 12			25 12		pF
Digital Input Capacitance	C_A		+25°C		5			5		pF
Input to Output Capacitance	$C_{DS(OFF)}$		+25°C		0.1			0.1		pF
SUPPLY										
Positive Supply Current	I^+	V_{EN}, V_A = 0V or 4V	Full		0.5	2.0		0.5	2.0	mA
Negative Supply Current	I^-	V_{EN}, V_A = 0V or 4V	Full		0.02	1.0		0.02	1.0	mA

Note 5: Worst case isolation occurs on channel 4 due to proximity to the output pins.

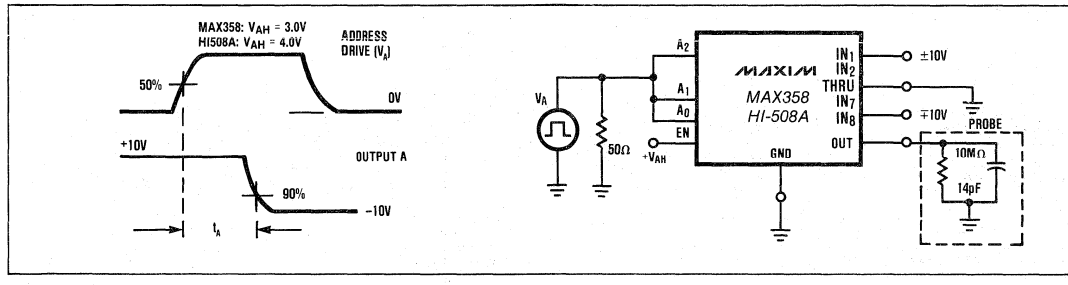


Figure 1. Access Time vs. Logic Level (High)

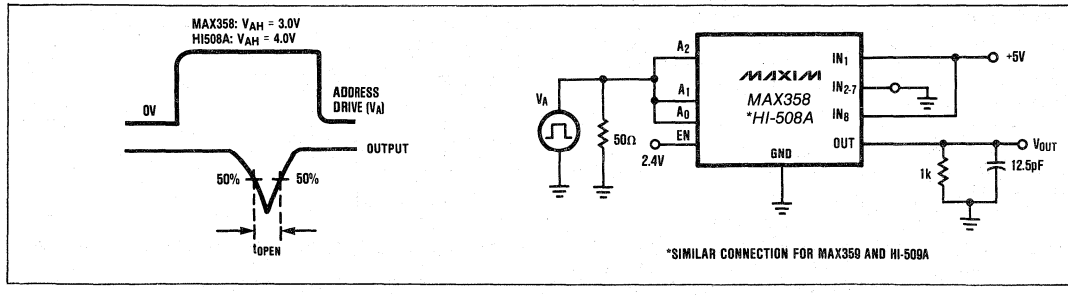


Figure 2. Break Before Make Delay (t_{OPEN})

ELECTRICAL CHARACTERISTICS: MAX358/359 (continued)

Supplies = +15V, -15V; V_{AH} (Logic Level High) = +2.4V, V_{AL} (Logic Level Low) = +0.8V (unless otherwise noted).

PARAMETER	SYMBOL	CONDITIONS	TEMP	-55°C to +125°C			0°C to +75°C and -40°C to +85°C			UNITS
				MIN	TYP	MAX	MIN	TYP	MAX	
DYNAMIC (continued)										
"OFF Isolation"	$OFF_{(ISO)}$	V_{EN} = 0.8V, R_L = 1kΩ, C_L = 15pF, V = $7V_{RMS}$, f = 100kHz	+25°C	50	68		50	68		dB
Channel Input Capacitance	$C_{S(OFF)}$		+25°C		5			5		pF
Channel Output Capacitance	$C_{D(OFF)}$	MAX358 MAX359	+25°C		25 12			25 12		pF
Digital Input Capacitance	C_A		+25°C		5			5		pF
Input to Output Capacitance	$C_{DS(OFF)}$		+25°C		0.1			0.1		pF
SUPPLY										
Positive Supply Current	I^+	**V_{EN} = 0.8V, or 2.4V All V_A = 0V or 5V**	**+25°C Full**		**0.1 0.3**	**0.6 0.7**		**0.2 0.5**	**1.0 1.0**	**mA**
Negative Supply Current	I^-	**V_{EN} = 0.8V or 2.4V All V_A = 0V or 5V**	**+25°C Full**		**0.01 0.02**	**0.1 0.2**		**0.01 0.02**	**0.1 0.1**	**mA**
Power Supply Range for Continuous Operation	V_{OP}	**(Note 5)**	**+25°C**	**±4.5**		**±18**	**±4.5**		**±18**	**V**

Note 5: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V are used.

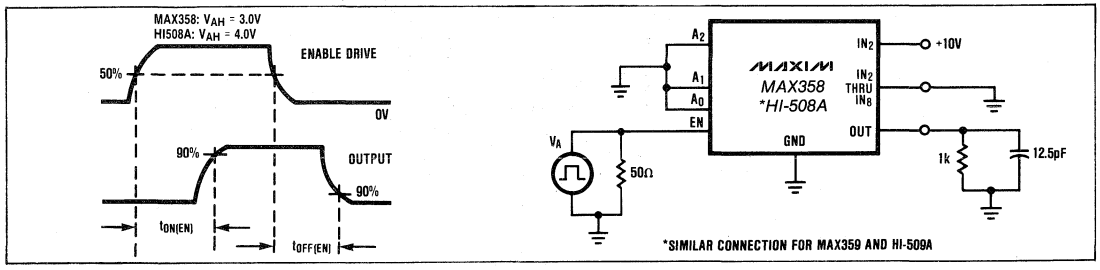


Figure 3. Enable Delay ($t_{ON(EN)}$, $t_{OFF(EN)}$)

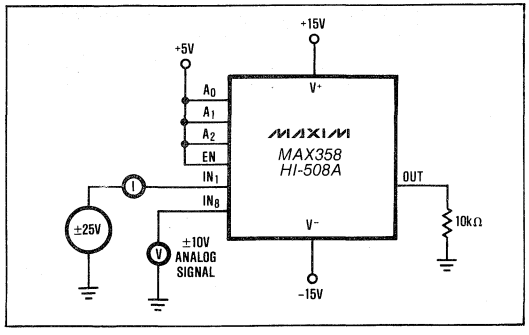


Figure 5. Input Leakage Current (Overvoltage)

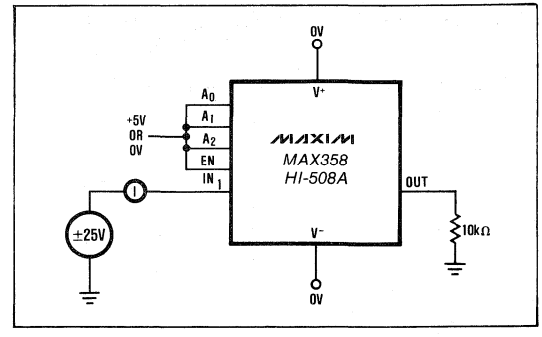
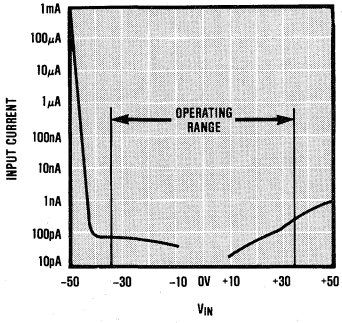


Figure 6. Input Leakage Current (with Power Supplies OFF)

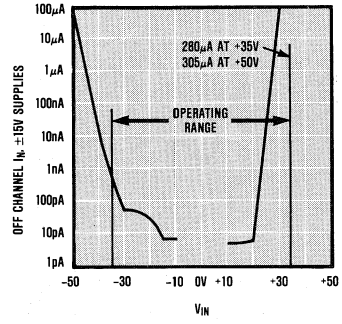
Fault-Protected Analog Multiplexer

Typical Operating Characteristics

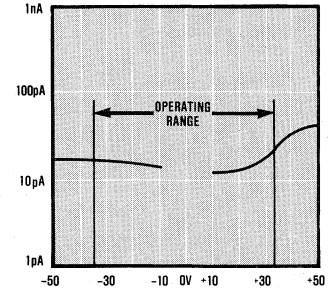
INPUT LEAKAGE VS. INPUT VOLTAGE WITH V+ = V- = 0V



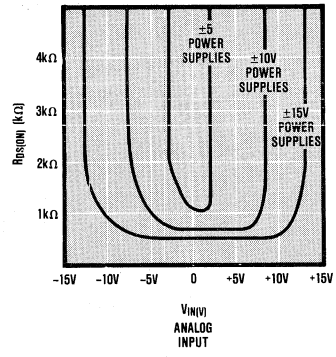
OFF CHANNEL LEAKAGE CURRENT VS. INPUT VOLTAGE WITH ±15V SUPPLIES



OUTPUT LEAKAGE VS. OFF CHANNEL OVERVOLTAGE WITH ±15V SUPPLIES



$R_{DS(ON)}$ VS. INPUT VOLTAGE



TRUTH TABLE—MAX358 AND HI-508A

A_2	A_1	A_0	EN	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

TRUTH TABLE—MAX359 AND HI-509A

A_1	A_0	EN	ON SWITCH
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

NOTE: Logic "0" = $V_{AL} \leq 0.8V$, Logic "1" = $V_{AH} \geq 2.4V$

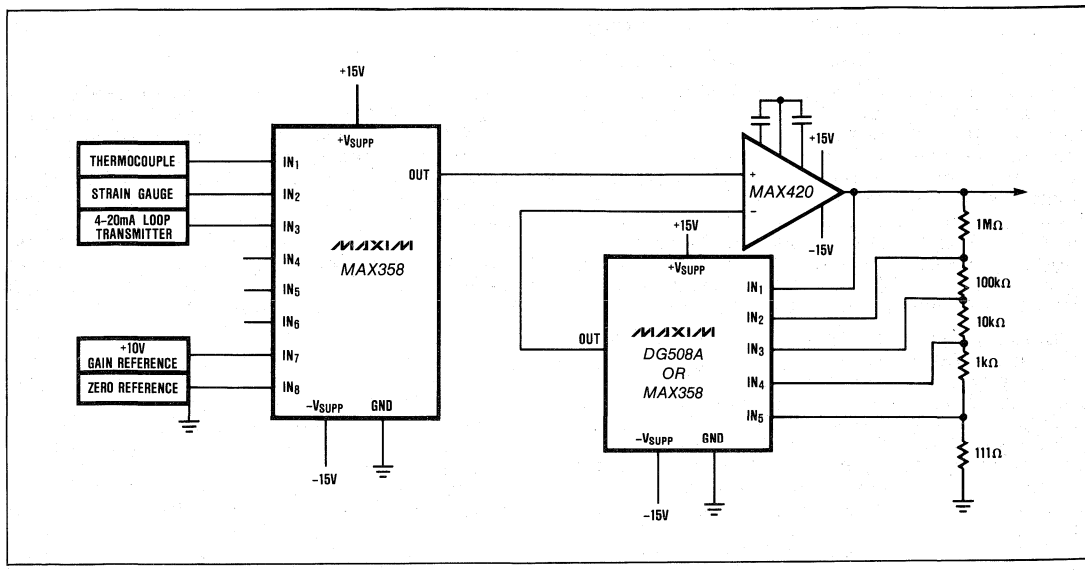


Figure 7. Typical Data Acquistion Front End

Typical Applications

Figure 7 shows a typical data acquisition system using the MAX358 multiplexer. Since the multiplexer is driving a high impedance input, its error is a function of its own resistance ($R_{DS(ON)}$) times the multiplexer leakage current ($I_{D(ON)}$) and the amplifier bias current (I_{BIAS}):

$$V_{ERR} = R_{DS(ON)} \times (I_{D(ON)} + I_{BIAS}\ (MAX420))$$
$$= 1.5k \times (2nA + 30pA)$$
$$= 3.05\mu V \text{ maximum error}$$

In most cases, this error is low enough that preamplification of input signals is not needed, even with very low level signals, such as 40μV/°C from type J thermocouples.

In systems with fewer than 8 inputs, an unused channel can be connected to the system ground reference point for software zero correction. A second channel connected to the system voltage reference allows gain correction of the entire data acquisition system as well.

A MAX 420 precision op-amp is connected as a programmable gain amplifier, with gains ranging from 1 to 10,000. The guaranteed 5μV unadjusted offset of the MAX420 maintains high signal accuracy, while programmable gain allows the output signal level to be scaled to the optimum range for the remainder of the data acquisition system, normally a Sample/Hold and A/D. Since the gain-changing multiplexer is not connected to the external sensors, it can be either a DG508A multiplexer or the fault protected MAX358.

Input switching, however, must be done with a fault protected MAX358 multiplexer if it is to provide the level of protection and isolation required with most data acquisition inputs. Since external signal sources may continue to supply voltage when the multiplexer and system power are turned off, non-fault protected multiplexers, or even first-generation fault protected devices, will allow many milliamps of fault current to flow from outside sources into the multiplexer. The result could be damage to either the sensors or the multiplexer. A non-fault protected multiplexer will also allow input overvoltages to appear at its output, perhaps damaging Sample/Holds or A/Ds. Such input overdrives may also cause input-to-input shorts, allowing the high current output of one sensor to possibly damage another.

The MAX358 eliminates all of the above problems since it not only limits its output voltage to safe levels, with or without power applied ($+V_{SUP}$ and $-V_{SUP}$), but also turns all channels off when power is removed, drawing only sub-microamp fault currents from the inputs, and maintaining isolation between inputs for continuous overvoltages up to ±35V.

Fault-Protected Analog Multiplexer

Detailed Description

Fault Protection Circuitry

Maxim's HI-508A/509A and MAX358/359 are fully fault-protected for continuous input voltages up to ±35V, whether or not the $+V_{SUP}$ and $-V_{SUP}$ power supplies are present. These devices use a "series FET" protection scheme which not only protects the multiplexer output from overvoltage, but also limits the input current to sub-microamp levels. This fault current is several orders of magnitude lower than the original manufacturer's HI-508A (several milliamps), which uses 1 to 2kΩ protection resistors in series with parasitic diodes connected to $+V_{SUP}$ and $-V_{SUP}$.

Figures 8 and 9 show how the series FET circuit protects against overvoltage conditions. When power is off, the gates of all three FETs are at ground. With a -25V input, N-channel FET Q1 is turned on by the +25V gate-to-source voltage. The P-channel device (Q2), however, has +25V V_{GS} and is turned off, thereby preventing the input signal from reaching the output. If the input voltage is +25V, Q1 has a negative V_{GS}, which turns it off. Similarly, only sub-microamp leakage currents can flow from the output back to the input, since any voltage will turn off either Q1 or Q2.

Figure 10 shows the condition of an OFF channel with $+V_{SUP}$ and $-V_{SUP}$ present. As with Figures 8 and 9, either an N-channel or a P-channel device will be off for any input voltage from -35V to +35V. The leakage current with negative overvoltages will immediately drop to a few nanoamps at 25°C. For positive overvoltages that fault current will initially be 10 or 20μA, decaying over a few seconds to the nanoamp level. The time constant of this decay is caused by the discharge of stored charge from internal nodes and does not compromise the fault protection scheme.

Figure 11 shows the condition of the ON channel with $+V_{SUP}$ and $-V_{SUP}$ present. With input voltages less than ±10V, all three FETs are on and the input signal appears at the output. If the input voltage exceeds $+V_{SUP}$ minus the N-channel threshold voltage (V_{TN}), then the N-channel FET will turn off. For voltages more negative than $-V_{SUP}$ minus the P-channel threshold (V_{TP}), the P-channel device will turn off. Since V_{TN} is typically 1.5V and V_{TP} is typically 3V, the multiplexer's output swing is limited to about -12V to +13.5V with ±15V supplies.

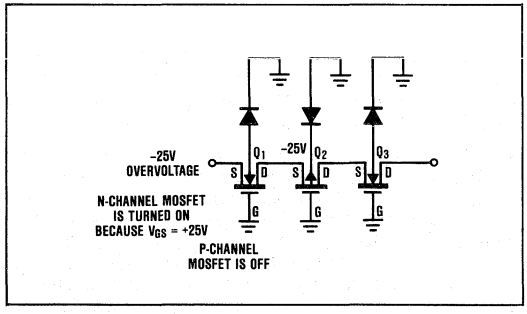


Figure 8. -25V Overvoltage with Multiplexer Power OFF

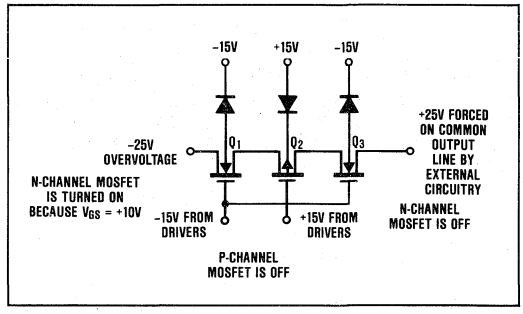


Figure 10. -25V Overvoltage on an OFF Channel with Multiplexer Power Supply ON

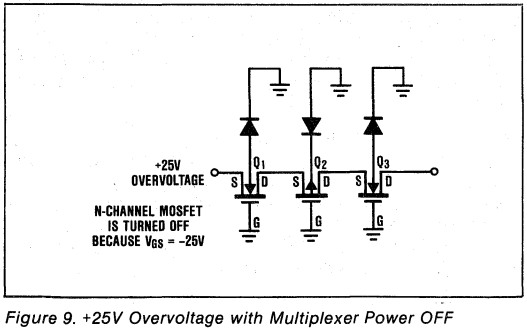


Figure 9. +25V Overvoltage with Multiplexer Power OFF

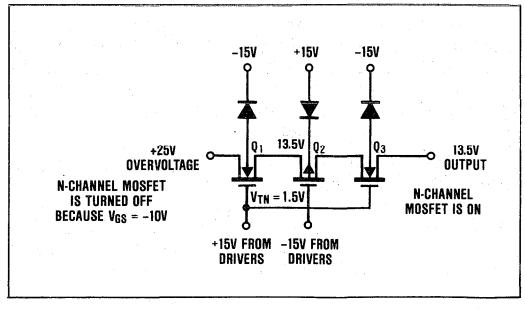


Figure 11. +25V Overvoltage Input to the ON Channel

The Typical Characteristics graphs show typical leakage vs. input voltage curves. Although the maximum rated overvoltage of these devices is ±35V, the MAX358/359 typically has excellent performance up to ±40V, providing additional margin for the unknown transients that exist in the real world. In summary, the MAX358/359 provides superior protection from all fault conditions, while using a standard, readily produced junction isolated CMOS process.

Switching Characteristics and Charge Injection

Table 1 shows typical charge injection levels vs. power supply voltages and analog input voltage. Note that since the channels are well matched, the differential charge injection for the MAX359/HI-509A is typically less than 5 picocoulombs. The charge injection that occurs during switching creates a voltage transient whose magnitude is inversely proportional to the capacitance on the multiplexer output.

The channel-to-channel switching time is typically 600ns, with about 200ns of break before make delay. This 200ns break-before-make delay prevents the input-to-input short that would occur if two input channels were simultaneously connected to the output. In a typical data acquisition system such as Figure 7, the dominant delay is not the switching time of the MAX358 multiplexer, but is the settling time of the following amplifiers and S/H. Another limiting factor is the RC time constant of the multiplexer $R_{DS(ON)}$ plus the signal source impedance multiplied by the load capacitance on the output of the multiplexer. Even with low signal source impedances, 100pF of capacitance on the multiplexer output will approximately double the settling time to 0.01% accuracy.

Operation with Supply Voltages Other than ±15V

The main effect of supply voltages other than ±15V is the reduction in output signal range. The MAX358 limits the output voltage to about 1.5V below $+V_{SUP}$ and about 3V above $-V_{SUP}$. In other words, the output swing is limited to +3.5V to -2V when operating from ±5V. The typical characteristics graphs show typical $R_{DS(ON)}$ for ±15V, ±10V, and ±5V power supplies. Maxim tests and guarantees the MAX358/359 for operation from ±4.5V to ±18V supplies. The switching delays are increased by about a factor of 2 at ±5V, but break-before-make action is preserved.

The MAX358/9 can be operated with a single +9V to +22V supply, as well as asymmetrical power supplies such at +15V and -5V. The digital threshold will remain approximately 1.6V above the Ground pin, and the analog characteristics such as $R_{DS(ON)}$ are determined by the total voltage difference between $+V_{SUP}$ and $-V_{SUP}$. Connect $-V_{SUP}$ to 0V when operating with a +9V to +22V single supply.

The MAX358 digital threshold is relatively independent of the power supply voltages, going from a typical 1.6V when $+V_{SUP}$ is 15V to 1.5V typical with a 5V $+V_{SUP}$. This means that Maxim HI-508/509A and MAX358/359 will operate with standard TTL logic levels, even with ±5V power supplies. In all cases, the threshold of the ENable pin is the same as the other logic inputs.

Digital Interface Levels

The typical digital threshold of both the address lines and the enable pin is 1.6V, with a temperature coefficient of about -3mV/°C. This ensures compatibility with 0.8V to 2.4V TTL logic swings over the entire temperature range. The digital threshold is relatively independent of the supply voltages, moving from 1.6V typical to 1.5V typical as the power supplies are reduced from ±15V to ±5V. In all cases, the digital threshold is referenced to the Ground pin.

The digital inputs can also be driven with CMOS logic

Table 1A. MAX358 AND HI-508A CHARGE INJECTION

Supply Voltage	Analog Input Level	Injected Charge
±5V	+1.7V 0V -1.7V	+100pC +70pC +45pC
±10V	+5V 0V -5V	+200pC +130pC +60pC
±15V	+10V 0V -10V	+300pC +180pC +50pC

Test Conditions: C_L = 1000pF on multiplexer output; the tabulated analog input level is applied to channel 1; channels 2 through 8 inputs are open circuited. EN = +5V, $A_1 = A_2 = 0V$, A_0 is toggled at 2kHz rate between 0V and 3V. +100 picocoulombs of charge creates a +100mV step when injected into a 1000pF load capacitance.

Table 1B. MAX359 AND HI-509A CHARGE INJECTION

Supply Voltage	Analog Input Level	Injected Charge		
		Out A	Out B	Differential A - B
±5V	+1.7V 0V -1.7V	+105pC +73pC +48pC	+107pC +74pC +50pC	-2pC -1pC -2pC
±10V	+5V 0V -5V	+215pC +135pC +62pC	+220pC +139pC +63pC	-5pC -4pC -1pC
±15V	+10V 0V -10V	+325pC +180pC +55pC	+330pC +185pC +55pC	-5pC -5pC 0pC

Test Conditions: C_L = 1000pF on Out A and Out B; the tabulated analog input level is applied to inputs 1A and 1B; channels 2 through 4 are open circuited. EN = +5V, A_1 = 0V, A_0 is toggled from 0V to 3V at a 2kHz rate.

levels swinging from either $+V_{SUP}$ to $-V_{SUP}$ or from $+V_{SUP}$ to Ground. The digital input current is just a few nanoamps of leakage at all input voltage levels, with a guaranteed maximum of 1μA. The digital inputs are protected from ESD by a 30V zener diode between the input and $+V_{SUP}$, and can be driven ±6V beyond the supplies without drawing excessive current.

Operation as a Demultiplexer

The MAX358/9 will function as a demultiplexer, where the input is applied to the Output pin, and the Input pins are used as outputs. The MAX358/9 provides both break-before-make action and full fault protection when operated as a demultiplexer, unlike earlier generations of fault protected multiplexers.

Channel-to-Channel Crosstalk, Off Isolation and Digital Feedthrough

At DC and low frequencies the channel-to-channel crosstalk is caused by variations in output leakage currents as the off channel input voltages are varied. The MAX358 output leakage varies only a few picoamps as all 7 off inputs are toggled from -10V to +10V. The output voltage change depends on the impedance level at the MAX358 output, which is $R_{DS(ON)}$ plus the input signal source resistance in most cases since the load driven by the MAX358 is usually a high impedance. For a signal source impedance of 10kΩ or lower, the DC crosstalk exceeds 120dB.

Table 2 shows typical AC crosstalk and off isolation performance. Digital feedthrough is masked by the analog charge injection when the output is enabled. When the output is disabled, the digital feedthrough is virtually unmeasureable, since the digital pins are physically isolated from the analog section by the Ground and $-V_{SUP}$ pins. The groundplane formed by these lines is continued onto the MAX358/9 die to provide over 100dB isolation between the digital and analog sections.

Table 2A. TYPICAL OFF ISOLATION REJECTION RATIO

Frequency	100kHz	500kHz	1MHz
One Channel Driven	74dB	72dB	66dB
All Channels Driven	64dB	48dB	44dB

Test Conditions: $V_{IN} = 20V_{PK-PK}$ at the tabulated frequency, $R_L = 1.5k$ between OUT and ground, EN = 0V.

$$OIRR = 20\ Log\ \frac{20V_{PK-PK}}{V_{OUT\ (PK-PK)}}$$

Table 2B. TYPICAL CROSSTALK REJECTION RATIO

Frequency	100kHz	500kHz	1MHz
R_L = 1.5k	70dB	68dB	64dB
R_L = 10k	62dB	46dB	42dB

Test Conditions: Specified R_L connected from OUT to ground, EN = +5V, $A_0 = A_1 = A_2 = +5V$ (Channel 1 selected). $20V_{PK-PK}$ at the tabulated frequency is applied to Channel 2. All other channels are open circuited. Similar crosstalk rejection can be observed between any two channels.

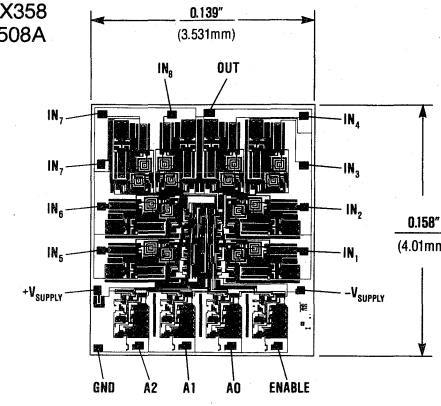
Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
HI1-0508A-2	-55°C to +125°C	16 Lead CERDIP
HI1-0508A-5*	0°C to +75°C	16 Lead CERDIP
HI3-0508A-5*	0°C to +75°C	16 Lead Plastic DIP
HI1-0509A-2	-55°C to +125°C	16 Lead CERDIP
HI1-0509A-5*	0°C to +75°C	16 Lead CERDIP
HI3-0509A-5*	0°C to +75°C	16 Lead Plastic DIP

* Maxim burns in all devices at 150°C. Maxim's -5 device is therefore equivalent to the original manufacturer's -7 product.

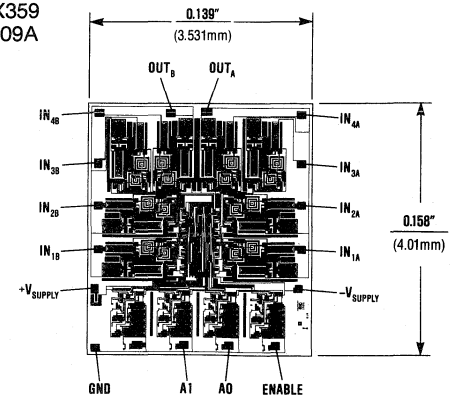
Chip Topographies

MAX358
HI-508A



Note: Connect substrate to $+V_{SUPPLY}$ or Leave It Floating

MAX359
HI-509A



Note: Connect substrate to $+V_{SUPPLY}$ or Leave It Floating

MAXIM

Fault-Protected Analog Multiplexer with Latch

General Description

Maxim's MAX368/369 are 8 channel single-ended (1 of 8) and 4 channel differential (2 of 8) fault-protected multiplexers with on-chip data latches. Using a series N-channel, P-channel, N-channel structure, these multiplexers provide significantly inproved fault protection over previous devices. If power to the multiplexers is removed while input voltages are still applied, all channels turn off, allowing only a few nanoamperes of leakage current to flow in the inputs. This not only protects the multiplexer and the circuitry connected to the output, but also protects the sensors or signal sources which drive the multiplexer inputs.

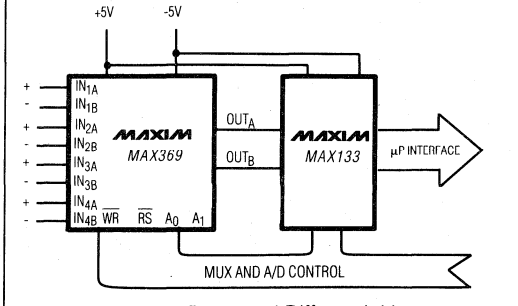
When an overvoltage signal of up to ±35V is applied to an analog input of a Maxim fault-protected multiplexer, that input channel turns off. If the overvoltage is applied to an on channel, the multiplexer output is clamped to less than its power supply voltage, thereby protecting sensitive circuitry that may be connected to the multiplexer output.

All channel selection and control inputs are fully compatible with both TTL and CMOS logic levels. In addition, break-before-make switch operation is guaranteed and typical power dissipation is less than 7 milliwatts, which makes the MAX 368/369 ideally suited for portable equipment usage.

Applications

Data Acquisition Systems
Industrial Process Control Systems
Avionics Test Equipment
Signal Routing Between Systems
Computer Controlled Analog Data Logging

Typical Operating Circuit



Input Protected Differential Input Data Acquisition System

Features

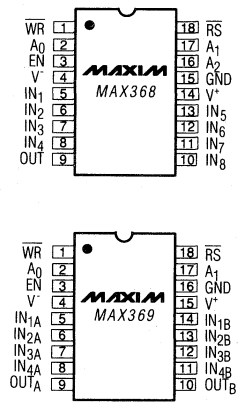
- ♦ All Switches Off with Power Supplies Off
- ♦ Overvoltage Protection up to ±35V
- ♦ Only Nanoamperes of Input Current under All Fault Conditions
- ♦ Latch-Up Proof Construction
- ♦ Operates from ±4.5 to ±18V Supplies
- ♦ All Digital Inputs are TTL and CMOS Compatible
- ♦ Internal Data Latches for Channel Selection

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX368C/D	0°C to +70°C	Dice
MAX368CPN	0°C to +70°C	18 Lead Plastic DIP
MAX368CJN	0°C to +70°C	18 Lead CERDIP
MAX368CWN	0°C to +70°C	18 Lead Wide SO
MAX368EPN	-40°C to +85°C	18 Lead Plastic DIP
MAX368EJN	-40°C to +85°C	18 Lead CERDIP
MAX368EWN	-40°C to +85°C	18 Lead Wide SO
MAX368MJN	-55°C to +125°C	18 Lead CERDIP
MAX369C/D	0°C to +70°C	Dice
MAX369CPN	0°C to +70°C	18 Lead Plastic DIP
MAX369CJN	0°C to +70°C	18 Lead CERDIP
MAX369CWN	0°C to +70°C	18 Lead Wide SO
MAX369EPN	-40°C to +85°C	18 Lead Plastic DIP
MAX369EJN	-40°C to +85°C	18 Lead CERDIP
MAX369EWN	-40°C to +85°C	18 Lead Wide SO
MAX369MJN	-55°C to +125°C	18 Lead CERDIP

Pin Configurations

Top View



Fault-Protected Analog Multiplexer with Latch

ABSOLUTE MAXIMUM RATINGS

Voltage between Supply Pins ..... +44V
V^+ ..... +22V
V^- ..... -22V
Digital Input Overvoltage:
V_{EN}, V_A { $V_{Supply}(+)$ ..... +4V; $V_{Supply}(-)$ ..... -4V
Analog Input Overvoltage with Multiplexer Power On:
V_S { $V_{Supply}(+)$ ..... +20V; $V_{Supply}(-)$ ..... -20V
Analog Input Overvoltage with Multiplexer Power Off:
V_S { $V_{Supply}(+)$ ..... +35V; $V_{Supply}(-)$ ..... -35V

Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1ms, 10% duty cycle max) 40mA
Power Dissipation (Note 1) (CERDIP) 1.28W
Operating Temperature Range:
MAX368/369C ..... 0°C to +70°C
MAX368/369E ..... -40°C to +85°C
MAX368/369M ..... -55°C to +125°C
Storage Temperature Range ..... -65°C to +150°C

Note 1: Derate 12.8mW/°C above T_A = +70°C

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V^- = -15V; GND = 0, $\overline{WR}$ = 0, $\overline{RS}$ = 2.4V unless otherwise noted.)

PARAMETER		SYMBOL	CONDITIONS		TEMP *	TYP	M SUFFIX MIN	M SUFFIX MAX	E, C SUFFIX MIN	E, C SUFFIX MAX	UNITS
ANALOG SWITCH											
Analog Signal Range		V_{ANALOG}	(Note 2)		1		-15	15	-15	15	V
Drain-Source ON Resistance		$r_{DS\ (ON)}$	V_D = ±10V, V_{AL} = 0.8V I_S = 100µA, V_{AH} = 2.4V		1, 3 2			1500 1800		1800 2000	Ω
Greatest Change in $r_{DS(ON)}$ Between Channels		$\Delta r_{DS\ (ON)}$	-10V < V_S < 10V		1	10					%
Source OFF Leakage Current		$I_{S\ (OFF)}$	V_{EN} = 0.8V	V_S = ±10V V_D = ∓10V	1 2	-0.005	-1 -50	1 50	-5 -50	-5 50	nA
Drain OFF Leakage Current	MAX368	$I_{D\ (OFF)}$	V_{EN} = 0.8V	V_D = ±10V V_S = ∓10V	1 2	-0.015	-2 -200	2 200	-5 -200	5 200	nA
	MAX369		V_{EN} = 0.8V	V_D = ±10V V_S = ∓10V	1 2	-0.008	-1 -100	1 100	-5 -100	5 100	nA
Drain ON Leakage Current	MAX368	$I_{D\ (ON)}$	V_S = V_D = ±10V V_{EN} = 2.4V V_{AL} = 0.8V V_{AH} = 2.4V		1 2	-0.03	-2 -200	2 200	-5 -200	5 200	nA
	MAX369				1 2	-0.015	-1 -100	1 100	-5 -100	5 100	nA
LOGIC INPUT											
Logic Input Current (Input Voltage High)		I_{AH}	V_A = 2.4V		1, 2, 3	-0.002	-1	1	-1	1	µA
			V_A = 14V		1, 2, 3	0.006	-1	1	-1	1	µA
Logic Input Current (Input Voltage Low)		I_{AL}	$\overline{EN}$ = 0 or 2.4V, V_A = 0V $\overline{RS}$ = 0V, $\overline{WR}$ = 0V		1, 2, 3	-0.002	-1	1	-1	1	µA
FAULT											
Output Leakage Current (with Overvoltage)		$I_{D\ (OFF)}$	V_D = 0V (Note 3) Analog Overvoltage = ±33V		1 2		-10 -2000	10 2000	-20 -2000	20 2000	nA
Input Leakage Current (with Overvoltage)		$I_{S\ (OFF)}$	V_{IN} = ±25V, V_D = ±10V (Note 3)		1		-5	5	-10	10	µA
Input Leakage Current (with Power Supplies Off)		$I_{D\ (OFF)}$	V_{IN} = ±25V, V_{EN} = V_0 = 0V A_0 = A_1 = A_2 = 0V or 5V		1		-2	2	-5	5	µA

*1 = 25°C, 2 = 125°C, 85°C, 70°C, 3 = -55°C, -40°C, 0°C

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V; GND = 0, $\overline{WR}$ = 0, $\overline{RS}$ = 2.4V unless otherwise noted.)

PARAMETER		SYMBOL	CONDITIONS		TEMP *	TYP	M SUFFIX		E,C SUFFIX		UNITS
							MIN	MAX	MIN	MAX	
DYNAMIC											
Switching Time of Multiplexer		t_{TRANS}	See Figure 2		1	0.6		1		1	µs
Break-Before-Make Interval		t_{OPEN}	See Figure 4		1	0.2					
Enable and Write Turn ON Time		$t_{ON\ (EN,\ \overline{WR})}$	See Figures 3 and 5		1	1		1.5		1.5	
Enable and Reset Turn OFF Time		$t_{OFF\ (EN,\ \overline{RS})}$	See Figures 3 and 6		1	0.4		1		1	
Charge Injection		Q	See Figure 7 and Tables 1A and 1B		1	55					pC
OFF Isolation		OIRR	V_{EN} = 0, R_L = 1kΩ C_L = 15pF, V_{IN} = $7V_{RMS}$ f = 100kHz		1	68					dB
Logic Input Capacitance with Switch OFF		C_{IN}	f = 1MHz		1	5					pF
Input Capacitance with Switch OFF		$C_{S(OFF)}$	V_{EN} = 0 f = 140kHz	V_{IN} = 0	1	5					pF
Output Capacitance with Switch OFF	MAX368	$C_{D(OFF)}$		V_{OUT} = 0	1	25					
	MAX369				1	12					
$\overline{WR}$ Pulse Width		t_{WW}	See Figure 1		1, 2, 3		300		300		ns
A_X, EN Data Valid to $\overline{WR}$		t_{DW}	Set-up Time See Figure 1		1, 2, 3		180		180		
A_X, EN Data Valid after $\overline{WR}$		t_{WD}	Hold Time See Figure 1		1, 2, 3	0	10		30		
$\overline{RS}$ Pulse Width		t_{RS}	V_{IN} = 5V See Figure 1		1, 2, 3		300		500		
SUPPLY											
Positive Supply Current		I+	V_{EN} = 2.4V, V_A = 0V/5V		1, 2, 3			1.25 1.5		1.5 2.0	mA
Negative Supply Current		I-			1, 2, 3		-0.1 -0.2		-0.1 -0.2		

*1 = 25°C, 2 = 125°C, 85°C, 70°C, 3 = -55°C, -40°C, 0°C

Note 2: When the analog signal exceeds +13.5V or -12V, the blocking action of Maxim's gate structure goes into operation. Only leakage currents flow and the channel on resistance rises to infinity.
Note 3: The value shown is the steady state value. The transient leakage is typically 10µA. See detailed description.
Note 4: Electrical Characteristics, such as ON Resistance will change when power supplies other than ±15V are used.
Note 5: Digital input leakage is primarily due to the clamp diodes. Typical leakage is less than 1nA at +25°C.

Fault-Protected Analog Multiplexer with Latch

TRUTH TABLE — MAX368

A_2	A_1	A_0	EN	$\overline{WR}$	$\overline{RS}$	ON SWITCH
Latching						
X	X	X	X	↑	1	Maintains previous switch condition
Reset						
X	X	X	X	X	0	NONE (latches cleared)
Transparent Operation						
X	X	X	0	0	1	NONE
0	0	0	1	0	1	1
0	0	1	1	0	1	2
0	1	0	1	0	1	3
0	1	1	1	0	1	4
1	0	0	1	0	1	5
1	0	1	1	0	1	6
1	1	0	1	0	1	7
1	1	1	1	0	1	8

TRUTH TABLE — MAX369

A_1	A_0	EN	$\overline{WR}$	$\overline{RS}$	ON SWITCH
Latching					
X	X	X	↑	1	Maintains previous switch condition
Reset					
X	X	X	X	0	NONE (latches cleared)
Transparent Operation					
X	X	0	0	1	NONE
0	0	1	0	1	1
0	1	1	0	1	2
1	0	1	0	1	3
1	1	1	0	1	4

NOTE: Logic "1" : $V_{AH} \geq 2.4V$, Logic "0" : $V_{AL} \leq 0.8V$.

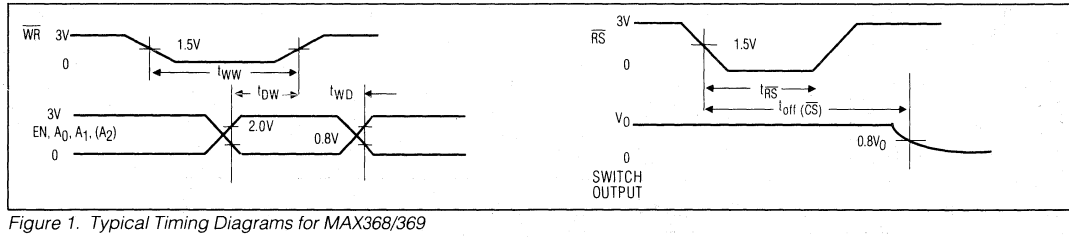


Figure 1. Typical Timing Diagrams for MAX368/369

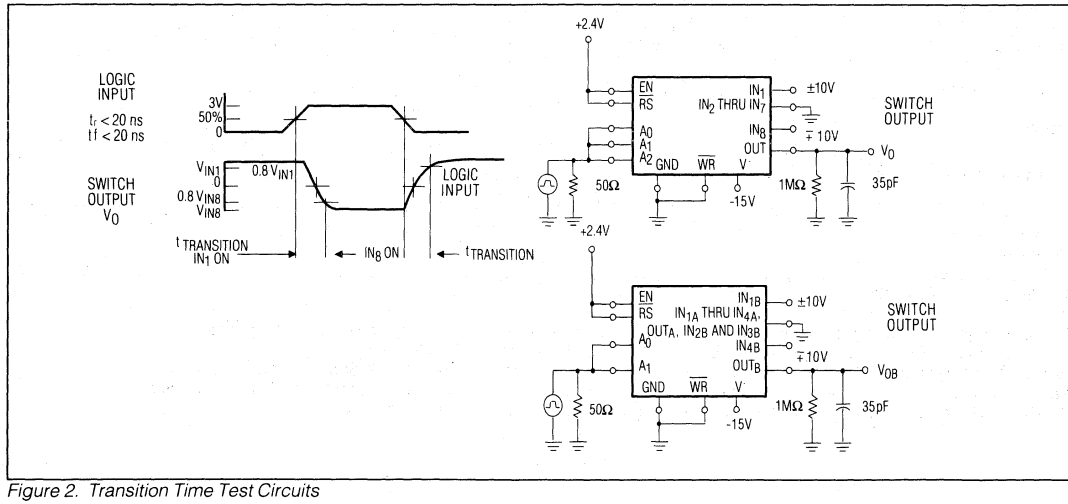


Figure 2. Transition Time Test Circuits

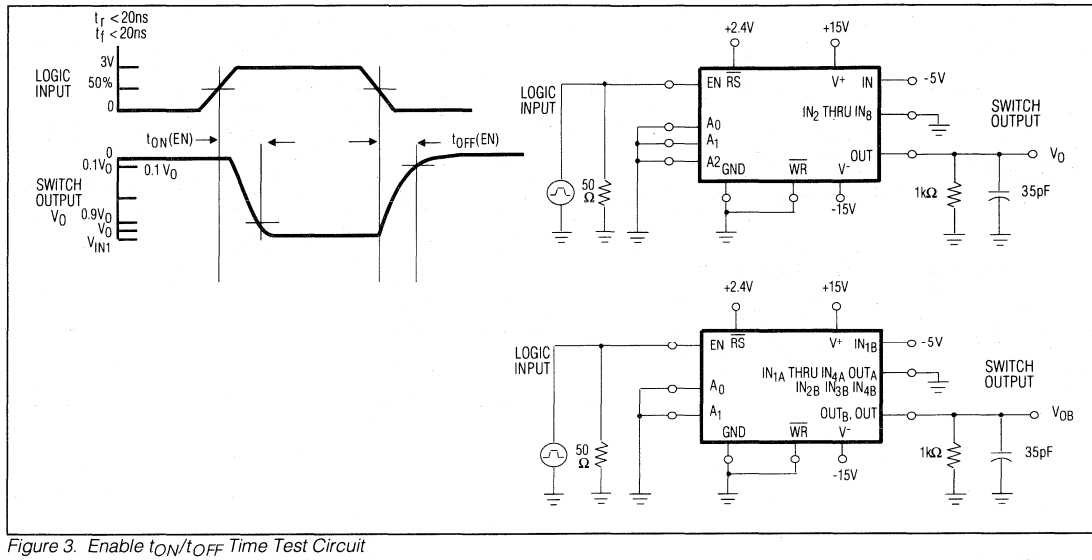


Figure 3. Enable t_{ON}/t_{OFF} Time Test Circuit

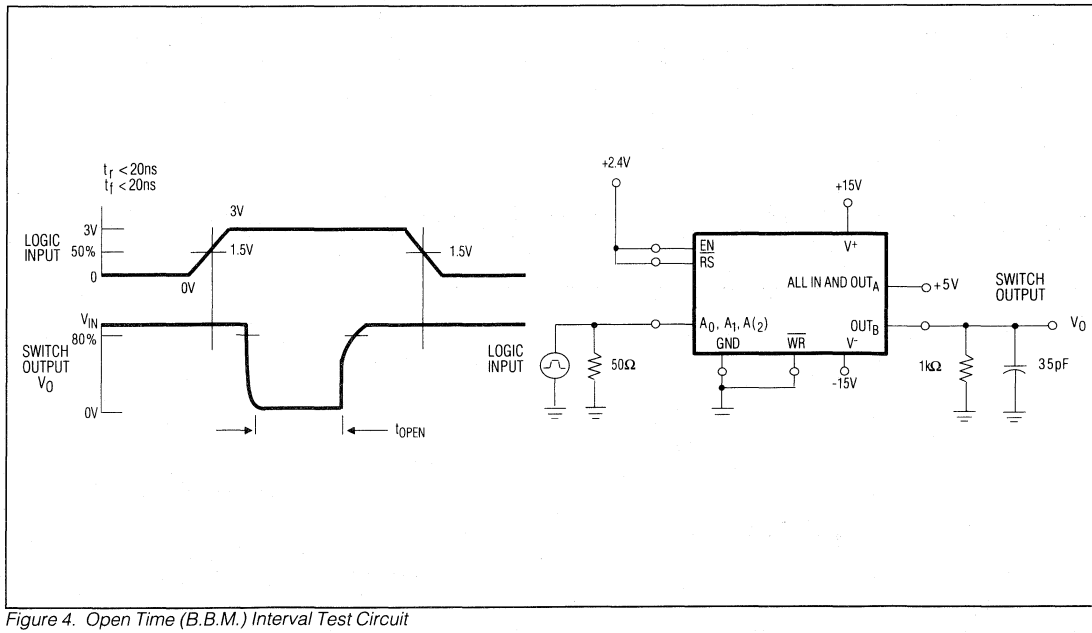


Figure 4. Open Time (B.B.M.) Interval Test Circuit

Fault-Protected Analog Multiplexer with Latch

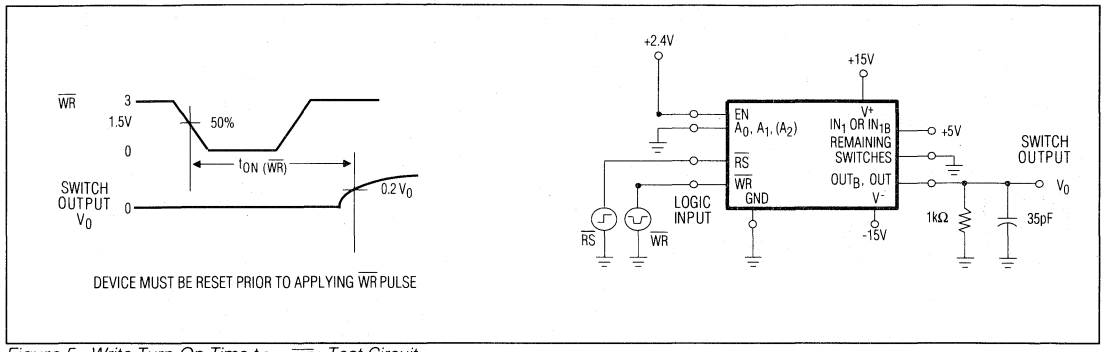


Figure 5. Write Turn-On Time $t_{ON(\overline{WR})}$ Test Circuit

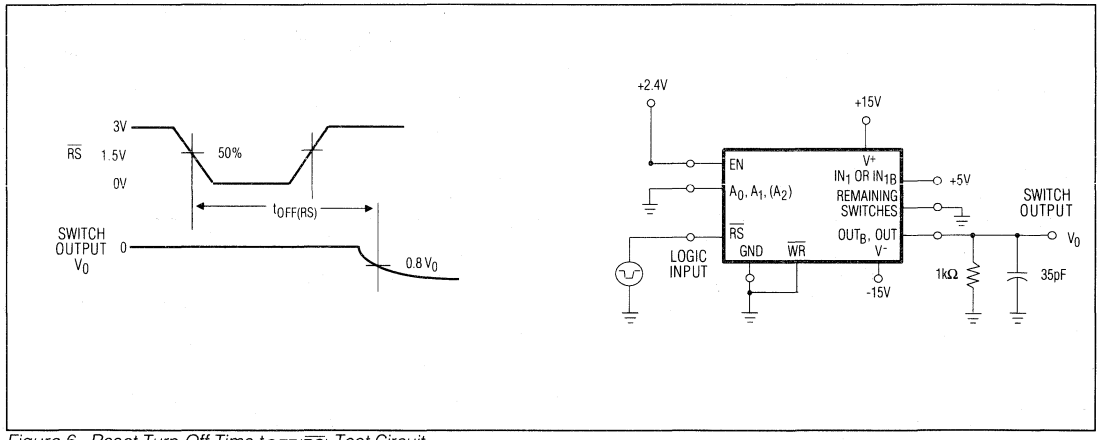


Figure 6. Reset Turn-Off Time $t_{OFF(\overline{RS})}$ Test Circuit

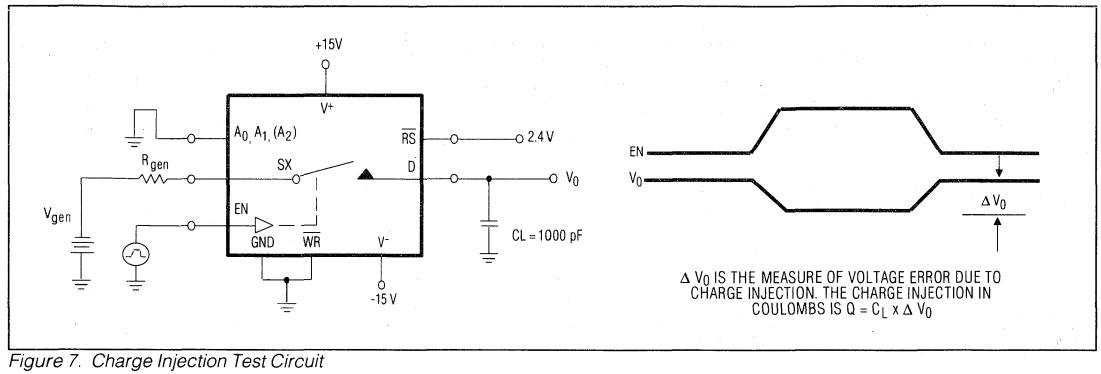


Figure 7. Charge Injection Test Circuit

Detailed Description

Fault Protection Circuitry

Maxim's MAX368/369 are fully fault-protected for continuous input voltages up to ±35V, whether or not the $+V_{SUP}$ and $-V_{SUP}$ power supplies are present. These devices use a "series FET" protection scheme which not only protects the multiplexer output from overvoltage, but also limits the input current to sub-microamp levels.

Figures 8 and 9 show how the series FET circuit protects against overvoltage conditions. When power is off, the gates of all the FETs are at ground. With a -25V input, N-channel FET Q1 is turned on by the +25V gate-to-source voltage. The P-channel device (Q2), however, has +25V V_{GS} and is turned off, thereby preventing the input signal from reaching the output. If the input voltage is +25V, Q1 has a negative V_{GS}, which turns it off. Similarly, only sub-microamp leakage currents can flow from the output back to the input, since any over voltage will turn off either Q1 or Q2.

Figure 10 shows the condition of an OFF channel with $+V_{SUP}$ and $-V_{SUP}$ present. As with Figures 8 and 9, either an N-channel or a P-channel device will be off for any input voltage from -35V to +35V. The leakage current with negative overvoltages will immediately drop to a few nanoamps at 25°C. For positive overvoltages the fault current will initially be 10 or 20µA, decaying over a few seconds to the nanoamp level. The time constant of this decay is caused by the discharge of stored charge from internal nodes and does not compromise the fault protection scheme.

Figure 11 shows the condition of the ON channel with $+V_{SUP}$ and $-V_{SUP}$ present. With input voltages less than ±10V, all three FETs are on and the input signal appears at the output. If the input voltage exceeds $+V_{SUP}$ minus the N-channel threshold voltage (V_{TN}), then the N-channel FET will turn off. For voltages more negative than $-V_{SUP}$ minus the P-channel threshold (V_{TP}), the P-channel device will turn off. Since V_{TN} is typically 1.5V and V_{TP} is typically 3V, the multiplexer's output swing is limited to about -12V to +13.5V with ±15V supplies

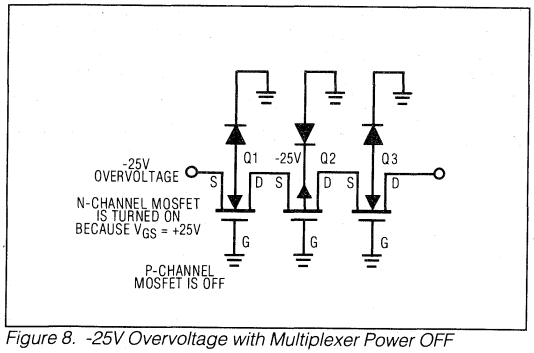


Figure 8. -25V Overvoltage with Multiplexer Power OFF

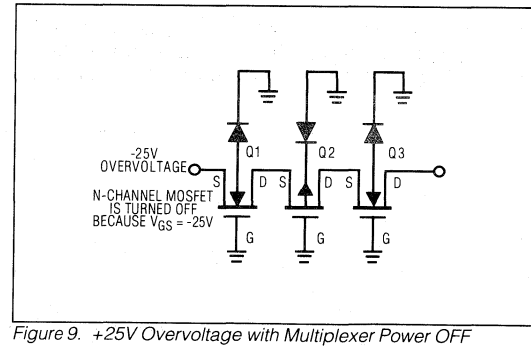


Figure 9. +25V Overvoltage with Multiplexer Power OFF

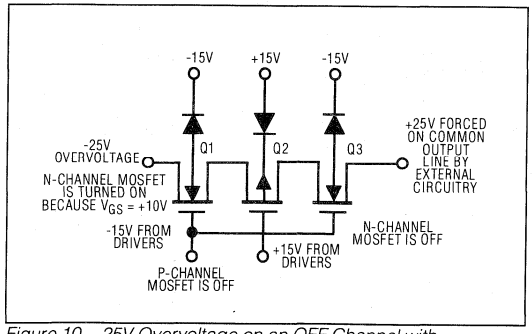


Figure 10. -25V Overvoltage on an OFF Channel with Multiplexer Power Supply ON

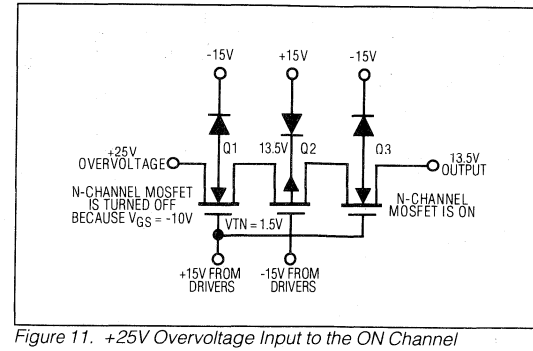


Figure 11. +25V Overvoltage Input to the ON Channel

Fault-Protected Analog Multiplexer with Latch

The Typical Operating Characteristics graphs show typical leakage vs. input voltage curves. Although the maximum rated overvoltage of these devices is ±35V, the MAX368/369 typically has excellent performance up to ±40V, providing additional margin for the unknown transients that exist in the real world. In summary, the MAX368/369 provides superior protection from all fault conditions, while using a standard, readily produced junction isolated CMOS process.

Digital Control Circuitry

The internal structure of the MAX368/369 includes translators for the A_0, A_1, A_2, EN, $\overline{RS}$, and $\overline{WR}$ digital inputs, latches, a decode section for channel selection (see Truth Tables on the fourth page of this data sheet). The gate structure consists of series N-channel/ P-channel/ N-channel MOSFETs (see Figure 12). This combination produces a very rugged, fault tolerant multiplexer with address latch capability, and does so with extremely low power dissipation.

Write ($\overline{WR}$), and Reset ($\overline{RS}$) strobes are provided for interfacing with microprocessor bus lines (Figure 13), alleviating the need for the microprocessor to provide constant address inputs to the MUX in order to hold on to a particular channel.

When the write strobe is in the low state (less than 0.8V), and the reset strobe is in the high state (greater than 2.4V), the MUXs are in the transparent mode; this means that the MUXs act similar to non-latching MUXs such as the MAX358/359 or the HI-508A/509A.

When the write input goes to the high state (>2.4V), the previous BCD address input will be latched and held in that state indefinitely. To pull the MUX out of this state, either the write input ($\overline{WR}$) must be taken low (0.8V), back to the transparent state, or the Reset ($\overline{RS}$) input taken low, turning off all channels.

The function of the Reset input is to allow for turning off all channels when the $\overline{RS}$ input is low (<0.8V); this has the dual function of resetting channel selection back to the channel 1 mode.

The MAX368/369 is designed to work with single as well as dual supplies, and good performance can be expected in the 9V to 22V single supply range. For example, with a single +15V power supply, analog signals in the range of +3.3V to +12V can be switched normally, and overvoltages up to ±35V can still be tolerated. If negative signals, around 0V are expected, a negative supply is needed. However, only -5V is needed to normally switch signals in the -2V to +12V range (-5V, +15V supplies). No current is drawn from the negative supply, so Maxim's MAX635 D/C to D/C converter does the job very nicely.

The EN latch allows all switches to be turned OFF under program control. This becomes useful when two or more MAX368s are cascaded to build 16-line and larger analog signal input multiplexers.

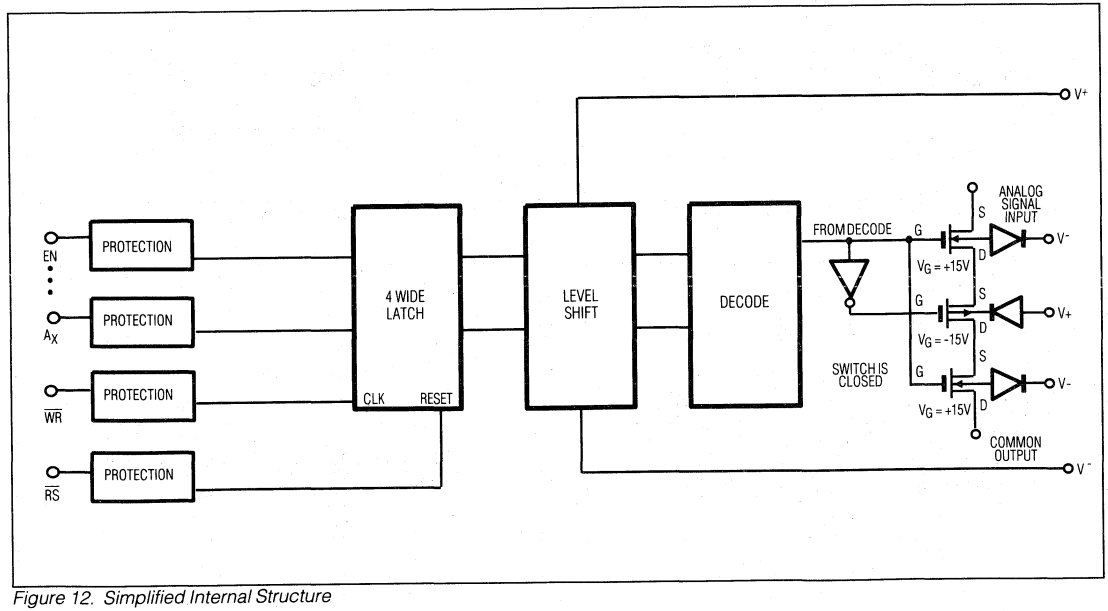
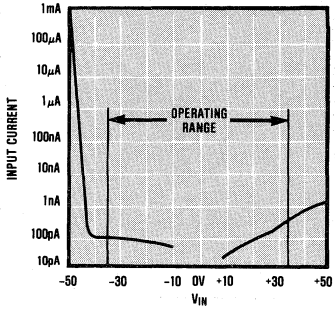


Figure 12. Simplified Internal Structure

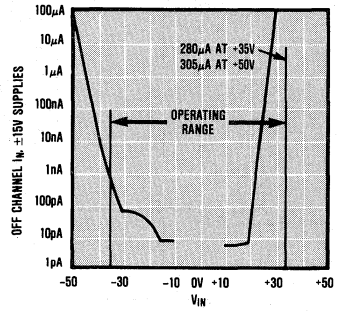
Fault-Protected Analog Multiplexer with Latch

Typical Operating Characteristics

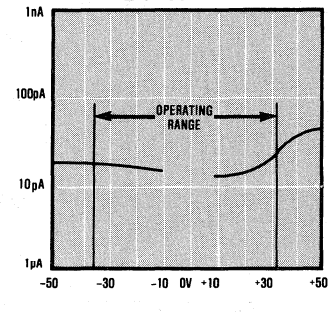
INPUT LEAKAGE VS. INPUT VOLTAGE WITH V+ = V- = 0V



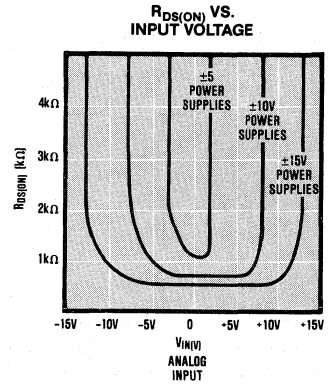
OFF CHANNEL LEAKAGE CURRENT VS. INPUT VOLTAGE WITH ±15V SUPPLIES



OUTPUT LEAKAGE VS. OFF CHANNEL OVERVOLTAGE WITH ±15V SUPPLIES



$R_{DS(ON)}$ VS. INPUT VOLTAGE



Applications

Operation with Supply Voltages Other than ±15V

The main effect of supply voltages other than ±15V is the reduction in output signal range. The MAX368/369 limits the output voltage to about 1.5V below $+V_{SUP}$ and about 3V above $-V_{SUP}$. In other words, the output swing is limited to +3.5V to -2V when operating from ±5V. The Typical Operating Characteristics graphs show typical $R_{DS(ON)}$ for ±15V, ±10V, and ±5V power supplies. Maxim guarantees the MAX368/369 for operation from ±4.5V to ±18V supplies. The switching delays increase by about a factor of 2 at ±5V, but break-before-make action is preserved.

The MAX368/369 can be operated with a single +9V to +22V supply, as well as asymmetrical power supplies such as +15V and -5V. The digital threshold will remain approximately 1.6V above the GROUND pin, and the analog characteristics such as $R_{DS(ON)}$ are determined by the total voltage difference between $+V_{SUP}$ and $-V_{SUP}$. Connect $-V_{SUP}$ to 0V when operating with a +9V to +22V single supply.

The MAX368/369 digital threshold is relatively independent of the power supply voltages, going from a typical 1.6V when $+V_{SUP}$ is 15V to 1.5V typical with a 5V $+V_{SUP}$. This means that Maxim's MAX368/369 will operate with standard TTL logic levels, even with ±5V power supplies. In all cases, the threshold of the Enable pin is the same as the other logic inputs.

Operation as a Demultiplexer

The MAX368/369 will function as a demultiplexer, where the input is applied to the Output pin, and the Input pins are used as outputs. The MAX368/369 provide both break-before-make action and full fault protection when operated as a demultiplexer, unlike earlier generations of fault protected multiplexers.

Fault-Protected Analog Multiplexer with Latch

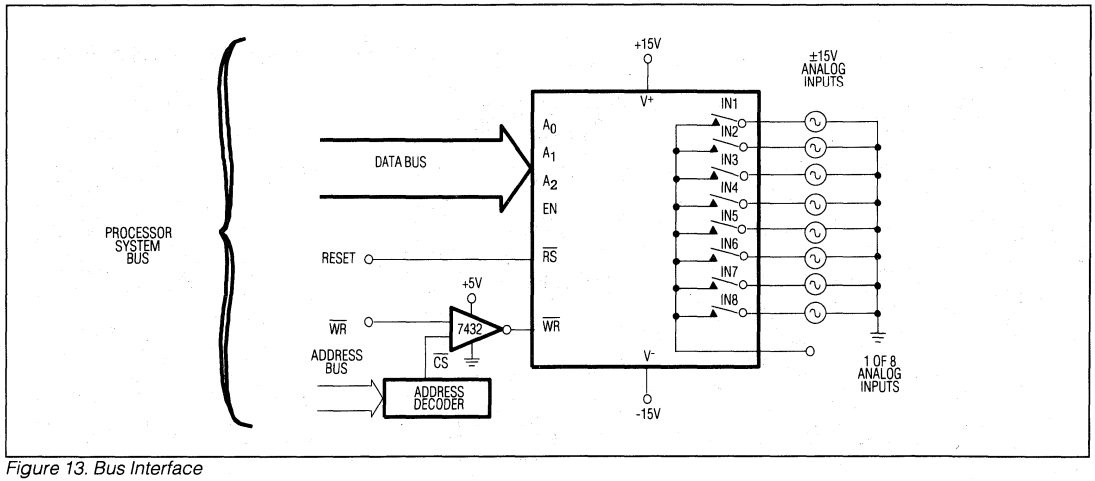


Figure 13. Bus Interface

Switching Characteristics and Charge Injection

Table 1 shows typical charge injection levels vs. power supply voltages and analog input voltage for the MAX368 and MAX369. Note that since the channels are well matched, the differential charge injection for the MAX368/369 is typically less than 5 picocoulombs. The charge injection that occurs during switching creates a voltage transient whose magnitude is inversely proportional to the capacitance on the multiplexer output.

The channel-to-channel switching time is typically 600ns, with about 200ns of break-before-make delay. This 200ns break-before-make delay prevents the input-to-input short that would occur if two input channels were simultaneously connected to the output. In a typical data acquisition system such as that shown in Figure 13, the dominant delay is not the switching time of the MAX368/MAX369 multiplexer but is the settling time of the following amplifier and sample/hold. Another limiting factor is the RC time constant of the multiplexer $R_{DS(ON)}$ plus the signal source impedance multiplied by the load capacitance on the output of the multiplexer. Even with low signal source impedances, 100pF of capacitance on the multiplexer output approximately doubles the settling time for 0.01% accuracy settling.

Digital Interface Levels

The typical digital threshold of both the address lines and the enable pin is 1.6V, with a temperature coefficient of approximately -3mV/°C. This ensures compatibility with 0.8V to 2.4V TTL logic swings over the entire temperature range. The digital threshold is relatively independent of the supply voltages, moving from 1.6V typical to 1.5V typical as the power supplies are reduced from ±15V to ±5V. In all cases, the digital threshold is referenced to the GROUND pin.

Table 1A. MAX368 CHARGE INJECTION

Supply Voltage	Analog Input Level	Injected Charge
±5V	+1.7V 0V -1.7V	+100pC +70pC +45pC
±10V	+5V 0V -5V	+200pC +130pC +60pC
±15V	+10V 0V -10V	+300pC +180pC +50pC

Test Conditions: C_L = 1000pF on multiplexer output; the tabulated analog input level is applied to channel 1; channels 2 through 8 inputs are open circuited. EN = +5V, $A_1 = A_2 = 0V$, A_0 is toggled at 2kHz rate between 0V and 3V. +100 picocoulombs of charge creates a +100mV step when injected into a 1000pF load capacitance.

Table 1B. MAX369 CHARGE INJECTION

Supply Voltage	Analog Input Level	Injected Charge		
		Out A	Out B	Differential A - B
±5V	+1.7V 0V -1.7V	+105pC +73pC +48pC	+107pC +48pC +50pC	-2pC -1pC -2pC
±10V	+5V 0V -5V	+215pC +135pC +62pC	+220pC +139pC +63pC	-5pC -4pC -1pC
±15V	+10V 0V -10V	+325pC +180pC +55pC	+330pC +185pC +55pC	-5pC -5pC 0pC

Test Conditions: C_L = 1000pF on Out A and Out B; the tabulated analog input level is applied to inputs 1A and 1B; channels 2 through 4 are open circuited. EN = +5V, A_1 = 0V, A_0 is toggled from 0V to 3V at a 2kHz rate.

The digital inputs can also be driven with CMOS logic levels swinging from either $+V_{SUP}$ to $-V_{SUP}$ or from $+V_{SUP}$ to Ground. The digital input current is just a few nanoamps of leakage at all input voltage levels, with a guaranteed maximum of 1µA. The digital inputs are protected from ESD by a 30V zener diode between the input and $+V_{SUP}$, and can be driven ±6V beyond the supplies without drawing excessive current.

Channel-to-Channel Crosstalk, Off Isolation and Digital Feedthrough

At DC and low frequencies, the channel-to-channel crosstalk is caused by variations in output leakage currents as the off channel input voltages are varied. The MAX368/369 output leakage varies only a few picoamps as all 7 off inputs are toggled from -10V to +10V. The output voltage change depends on the impedance level at the MAX368/369 output, which is $R_{DS(ON)}$ plus the input signal source resistance in most cases, since the load driven by the MAX368/369 is usually a high impedance. For a signal source impedance of 10kΩ or lower, the DC crosstalk exceeds 120dB.

Table 2 shows typical AC crosstalk and off isolation performance. Digital feedthrough is masked by the analog charge injection when the output is enabled.

When the output is disabled, the digital feedthrough is virtually unmeasurable, since the digital pins are physically isolated from the analog section by the GROUND and $-V_{SUP}$ pins. The groundplane formed by these lines is continued onto the MAX368/369 die to provide over 100dB isolation between the digital and analog sections.

Table 2A. TYPICAL OFF ISOLATION REJECTION RATIO

Frequency	100kHz	500kHz	1MHz
One Channel Driven	74dB	72dB	66dB
All Channels Driven	64dB	48dB	44dB

Test Conditions: $V_{IN} = 20V_{PK-PK}$ at the tabulated frequency, R_L = 1.5k between OUT and ground, EN = 0V.

$$OIRR = 20\ Log\ \frac{20\ V_{PK-PK}}{V_{OUT\ (PK-PK)}}$$

Table 2B. TYPICAL CROSSTALK REJECTION RATIO

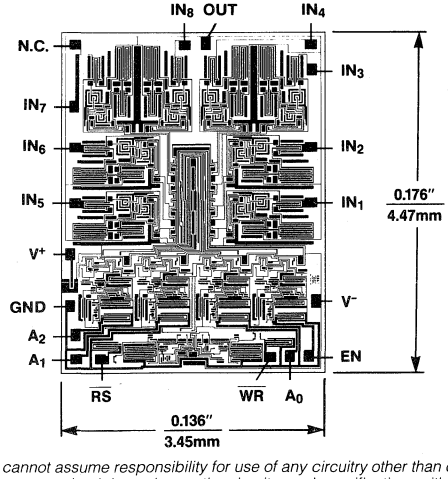
Frequency	100kHz	500kHz	1MHz
R_L = 1.5k	70dB	68dB	64dB
R_L = 10k	62dB	46dB	42dB

Test Conditions: Specified R_L connected from OUT to ground, EN = +5V, $A_0 = A_1 = A_2 = 0V$ (Channel 1 selected). $20V_{PK-PK}$ at the tabulated frequency is applied to Channel 2. All other channels are open circuited. Similar crosstalk rejection can be observed between any two channels.

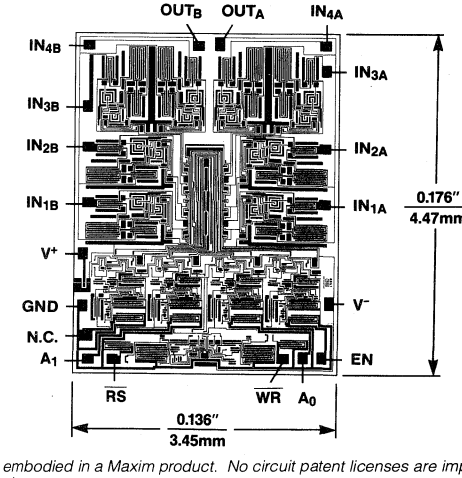
1

Chip Topographies

MAX368



MAX369



Monolithic CMOS Analog Multiplexers

General Description

Maxim's AD7506 and AD7507 are monolithic CMOS analog multiplexers. The AD7506 is a single 16 channel (1 of 16) multiplexer, and the AD7507 is a differential 8 channel (2 of 16) multiplexer.

Both devices feature break-before-make switching. Maxim guarantees that these multiplexers will not latch-up if the power supplies are turned off with the input signals still present, as long as absolute maximum ratings are not violated. The multiplexers operate over a wide range of power supplies from ±4.5V to ±18V.

Compared to the original manufacturer's devices, Maxim's AD7506 and AD7507 consume significantly less power, making them ideal for portable equipment.

Applications

Control Systems

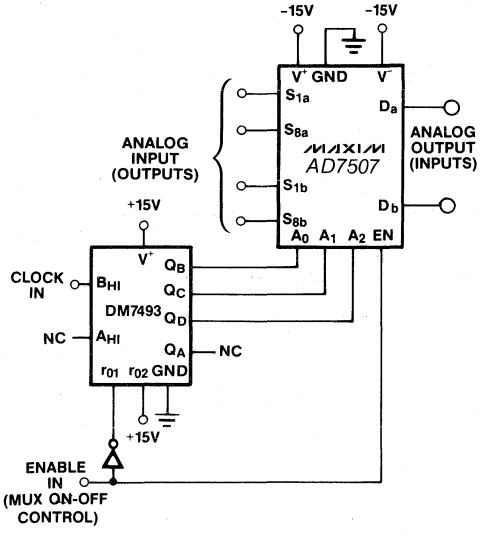
Data Logging Systems

Aircraft Heads Up Displays

Data Acquisition Systems

Signal Routing

Typical Operating Circuit



8 Channel Sequential Differential MUX/DEMUX

Features

- **Improved 2nd Source!**
- **Drop in Replacement for Analog Devices**
- **Operable with ±4.5V to ±18V Supplies**
- **Symmetrical, Bi-Directional Operation**
- **Logic and Enable inputs, TTL and CMOS Compatible**
- **Latch-Up Proof Construction**

Monolithic, Low-Power CMOS Design

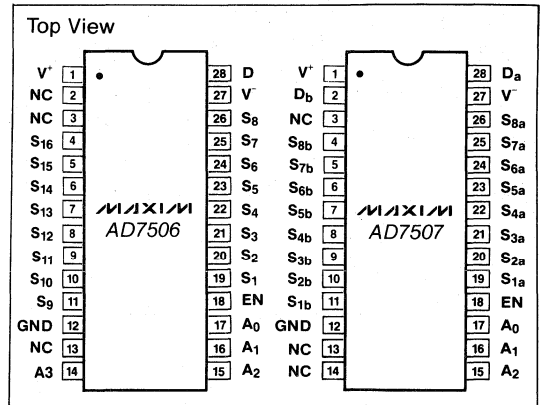
Ordering Information

PART	TEMP. RANGE	PACKAGE*
AD7506JN	0°C to +70°C	28 Lead Plastic DIP
AD7506KN	0°C to +70°C	28 Lead Plastic DIP
AD7506JQ	-25°C to +85°C	28 Lead CERDIP
AD7506KQ	-25°C to +85°C	28 Lead CERDIP
AD7506SQ	-55°C to +125°C	28 Lead CERDIP
AD7506TQ	-55°C to +125°C	28 Lead CERDIP
AD7507JN	0°C to +70°C	28 Lead Plastic DIP
AD7507KN	0°C to +70°C	28 Lead Plastic DIP
AD7507JQ	-25°C to +85°C	28 Lead CERDIP
AD7507KQ	-25°C to +85°C	28 Lead CERDIP
AD7507SQ	-55°C to +125°C	28 Lead CERDIP
AD7507TQ	-55°C to +125°C	28 Lead CERDIP

For Dice, Plastic Chip Carrier, Ceramic Leadless Chip Carrier and Ceramic Sidebraze DIP, contact factory.

**Maxim reserves the right to ship Ceramic Packages in lieu of CERDIP Packages.*

Pin Configurations



Monolithic CMOS Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS (T_A = 25°C unless otherwise noted.)

V_{DD}-GND ..... +17V
V_{SS}-GND ..... -17V
V Between Any Switch Terminals (Note 1) 25V
Digital Input Voltage Range ..... V_{DD} to GND
Overvoltage at V_{OUT} (V_S) ..... V_{SS}, V_{DD}
Switch Current (I_S, Continuous One Channel) 20mA
Switch Current (I_S, Surge One Channel)
1ms Duration, 10% Duty Cycle 35mA

Power Dissipation (Any Package)
Up to +50°C 1000mW
Derates above +50°C by ..... 10mW/°C
Operating Temperature
Commercial (JN, KN Versions) ..... 0°C to +70°C
Industrial (JQ, KQ Versions) ..... -25°C to +85°C
Extended (SQ, TQ Versions) ..... -55°C to +125°C
Storage Temperature ..... -65°C to +150°C

Note 1: Do not apply voltages higher than V_{DD} and V_{SS} to any other terminal, especially when V_{SS} = V_{DD} = 0V all other pins should be at 0V.

Note 2: The digital control inputs are diode protected; however, permanent damage may occur on unconnected units under high energy electrostatic fields. Keep unused units in conductive foam at all times.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = 15V, V^- = -15V, GND = 0V, unless otherwise noted.)

PARAMETER		SYMBOL	VERSION (Note 3)	SWITCH CONDITION	TEST CONDITIONS	+25°C MIN	+25°C TYP	+25°C MAX	OVER SPECIFIED TEMP. RANGE MIN	OVER SPECIFIED TEMP. RANGE TYP	OVER SPECIFIED TEMP. RANGE MAX	UNITS
ANALOG SWITCH												
Drain-Source ON Resistance		$r_{DS(ON)}$	J, K	ON	V_S = -10V to +10V, I_S = 1mA		300	450			550	Ω
			S, T	ON				400			500	
		$r_{DS(ON)}$ vs. V_S	All	ON			15					%
Tempco of ON Resistance		$r_{DS(ON)}$ vs. Temp.	All	ON	V_S = 0V, I_S = 1mA		0.5					%/°C
Difference in ON Resistance Between Channels		$\Delta r_{DS(ON)}$ Between Switches	All	ON	V_S = 0V, I_S = 1mA		4					%
		$\Delta r_{DS(ON)}$ vs. Temp. Between Switches	All	ON			0.05					%/°C
Source OFF Leakage Current		$I_{S(OFF)}$	J, K	OFF	V_S = -10V, V_D = +10V and V_S = +10V, V_D = -10V "Enable Low"		0.05	5			50	nA
			S, T	OFF			0.05	1			50	
Drain OFF Leakage Current	AD7506	$I_{D(OFF)}$	J, K	OFF			0.3	20			500	
			S, T	OFF			0.3	10			500	
	AD7507		J, K	OFF			0.3	10			250	
			S, T	OFF			0.3	5			250	
Channel ON Leakage Current $I_{D(ON)}$-I_S (Any Switch ON)	AD7506	$I_{D(ON)}$	J, K	ON	V_S = 0		0.3	20			500	nA
			S, T	ON			0.3	10			500	
	AD7507		J, K	ON			0.3	10			250	
			S, T	ON			0.3	5			250	

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = 15V, V^- = -15V, GND = 0V, unless otherwise noted.)

PARAMETER	SYMBOL	VERSION (Note 3)	SWITCH CONDITION	TEST CONDITIONS	+25°C MIN	+25°C TYP	+25°C MAX	OVER SPECIFIED TEMP. RANGE MIN	OVER SPECIFIED TEMP. RANGE TYP	OVER SPECIFIED TEMP. RANGE MAX	UNITS
DIGITAL CONTROL											
Address Input Threshold (Low)	V_{INL}									0.8	V
Address Input Threshold (High)	V_{INH}	J, S K, T		(Note 4)				3.0 2.4			V
Input Logic Current	I_{INL} or I_{INH}	All				10				30	μA
Address Input Capacitance	C_{IN}	All				3					pF
DYNAMIC CHARACTERISTICS (Note 5)											
Switching Time of Multiplexers	$t_{TRANSITION}$	J, S K, T		V_{IN}: 0 to 3.0V		700 700	 1000				ns
Break-Before-Make Interval	t_{OPEN}	All				100					
Enable Turn-ON Time	t_{ON} (EN)	J, S K, T		V_{EN}: 0 to 3.0V		0.8	1.5				μs
Enable Turn-OFF Time	t_{OFF} (EN)	J, S K, T				0.8	1				
OFF Isolation	OIRR	All		V_{EN} = 0, R_L = 200Ω, C_L = 3.0pF, V_S = 3.0V_{RMS}, f = 50kHz		70					dB
Source OFF Capacitance	$C_{S(OFF)}$	All	OFF			5					pF
Drain OFF Capacitance AD7506	$C_{D(OFF)}$	All	OFF			40					
Drain OFF Capacitance AD7507	$C_{D(OFF)}$	All	OFF			20					
Source to Drain Capacitance	C_{S-D}	All	OFF			0.5					
Capacitance Between Any Two Switches	C_{SS}	All	OFF			0.5					
POWER SUPPLY											
Positive Supply Current	I^+	J, K S, T	OFF OFF	All Digital Inputs Low		0.05 0.05	0.5 0.5			1	mA
Negative Supply Current	I^-	J, K S, T	OFF OFF			0.05 0.05	0.3 0.3			0.6	
Positive Supply Current	I^+	J, K S, T	ON ON	All Digital Inputs High		0.3 0.3	0.5 0.5			1	mA
Negative Supply Current	I^-	J, K S, T	ON ON			0.05 0.05	0.3 0.3			0.6	

Note 3: JN and KN versions specified for 0°C to +70°C; JQ and KQ versions for -25°C to +85°C; SQ and TQ versions for -55°C to +125°C.

Note 4: A pullup resistor, typically 1-2kΩ is required to make the J and S versions compatible with TTL/DTL. The maximum value is determined by the output leakage current of the driver gate when in the high state.

Note 5: AC parameters are sample tested to ensure conformance to specifications.

Monolithic CMOS Analog Multiplexers

Truth Tables

AD7506

A_3	A_2	A_1	A_0	EN	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

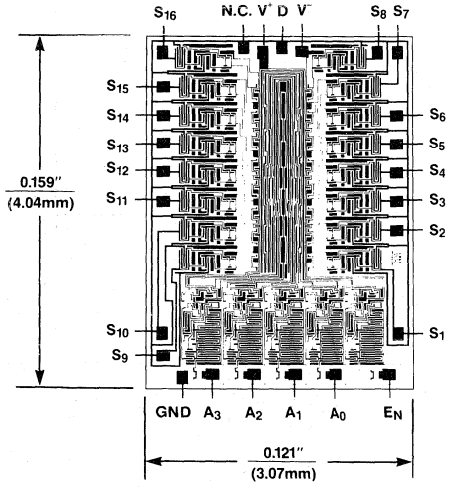
AD7507

A_2	A_1	A_0	EN	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

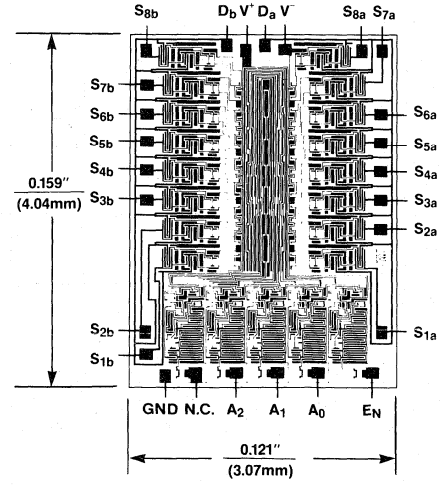
Logic "0" = $V_{AL} \leq 0.8V$ Logic "1" = $V_{AH} \geq 2.4V$ "0" = DON'T CARE

Chip Topography

AD7506



AD7507



Monolithic CMOS Analog Multiplexers

General Description

Maxim's DG506A and DG507A are monolithic CMOS analog multiplexers. The DG506A is a single 16 channel (1 of 16) multiplexer, and the DG507A is a differential 8 channel (2 of 16) multiplexer.

Both devices feature break-before-make switching. Maxim guarantees that these multiplexers will not latch-up if the power supplies are turned off with the input signals still present as long as absolute maximum ratings are not violated. The multiplexers operate over a wide range of power supplies from ±4.5V to ±18V.

Compared to the original manufacturer's devices, Maxim's DG506A and DG507A consume significantly less power, making them ideal for portable equipment.

Maxim's DG506A and DG507A meet or exceed the specifications of, and are drop-in replacements for, Intersil's IH6116 and IH6216, Siliconix's DG506A and DG507A, and Harris' HI506 and HI507.

Applications

Control Systems

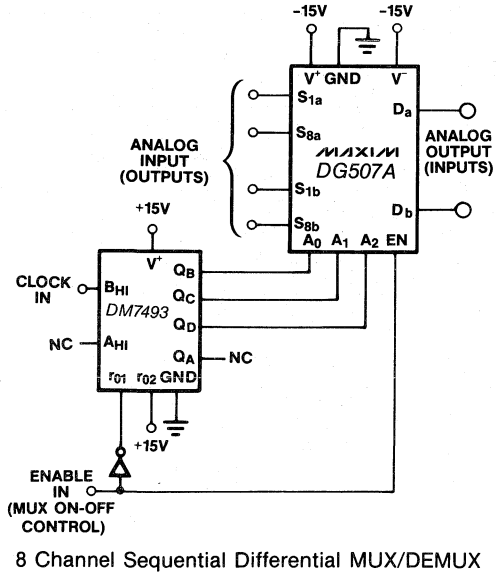
Data Logging Systems

Aircraft Heads Up Displays

Data Acquisition Systems

Signal Routing

Typical Operating Circuit



8 Channel Sequential Differential MUX/DEMUX

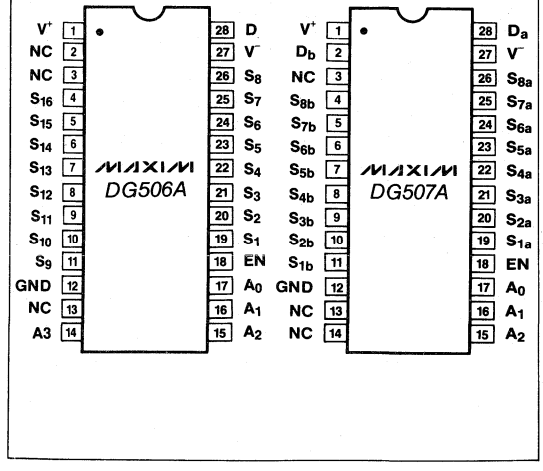
Features

- ◆ **Improved 2nd Source!**
- ◆ **Pin compatible with Harris, Siliconix, Intersil**
- ◆ **Operable with ±4.5V to ±18V Supplies**
- ◆ **Symmetrical, Bi-Directional Operation**
- ◆ **Logic and Enable inputs, TTL and CMOS Compatible**
- ◆ **Latch-Up Proof Construction**
- ◆ **Monolithic, Low-Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
DG506AAK	-55°C to +125°C	28 Lead CERDIP
DG506ABK	-20°C to +85°C	28 Lead CERDIP
DG506AC/D	0°C to +70°C	Dice
DG506ACJ	0°C to +70°C	28 Lead Plastic DIP
DG506ACK	0°C to +70°C	28 Lead CERDIP
DG506ACWI	0°C to +70°C	28 Lead Wide SO
DG507AAK	-55°C to +125°C	28 Lead CERDIP
DG507ABK	-20°C to +85°C	28 Lead CERDIP
DG507AC/D	0°C to +70°C	Dice
DG507ACJ	0°C to +70°C	28 Lead Plastic DIP
DG507ACK	0°C to +70°C	28 Lead CERDIP
DG507ACWI	0°C to +70°C	28 Lead Wide SO

Pin Configurations



Monolithic CMOS Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V^-
V^+ 44V
GND 25V
Digital Inputs V_S, V_D (Note 1) ..... -2V to (V^+ + 2V) or 20mA, whichever occurs first.
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1msec, 10% duty cycle max) 40mA
Storage Temperature (A & B Suffix) ..... -65°C to 150°C
(C Suffix) ..... -65°C to 125°C
Operating Temperature (A Suffix) ..... -55°C to 125°C
(B Suffix) ..... -25°C to 85°C
(C Suffix) ..... 0°C to 70°C
Power Dissipation (Package)*
28 Pin Ceramic DIP** 1200mW
28 Pin Plastic DIP*** 625mW

*All leads soldered or welded to PC board.
**Derate 16mW/°C above 75°C
***Derate 8.3mW/°C above 75°C

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (V^+ = 15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated.)

PARAMETER		SYMBOL	TEST CONDITIONS		DG506AA DG507AA MIN (Note 2)	DG506AA DG507AA TYP (Note 3)	DG506AA DG507AA MAX	DG506AB/C DG507AB/C MIN (Note 2)	DG506AB/C DG507AB/C TYP (Note 3)	DG506AB/C DG507AB/C MAX	UNITS
SWITCH											
Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
Drain-Source ON Resistance		$r_{DS(on)}$	Sequence Each Switch On V_{AL} = 0.8V, V_{AH} = 2.4V, V_{EN} = 2.4V	V_D = 10V, I_S = -200μA		270	400		270	450	Ω
				V_D = -10V, I_S = -200μA		230	400		230	450	
Greatest Change in Drain-Source ON Resistance Between Channels		$\Delta r_{DS(on)}$	$\Delta r_{DS(on)} = \left(\frac{r_{DS(on)}^{MAX} - r_{DS(on)}^{MIN}}{r_{DS(on)}^{AVE}}\right)$ $-10V \le V_S \le 10V$			6			6		%
Source OFF Leakage Current		$I_{S(off)}$	V_{EN} = 0.8V V_{AL} = 0.8V	V_S = 10V, V_D = -10V	-1	0.002	1	-5	0.002	5	nA
				V_S = -10V, V_D = 10V	-1	-0.005	1	-5	-0.005	5	
Drain OFF Leakage Current	DG506A	$I_{D(off)}$		V_D = 10V, V_S = -10V	-10	0.02	10	-20	0.02	20	
				V_D = -10V, V_S = 10V	-10	-0.03	10	-20	-0.03	20	
	DG507A			V_D = 10V, V_S = -10V	-5	0.007	5	-10	0.007	10	
				V_D = -10V, V_S = 10V	-5	-0.015	5	-10	-0.015	10	
Channel ON Leakage Current	DG506A	$I_{D(on)}$[4]	Sequence Each Switch On V_{AL} = 0.8V, V_{AH} = 2.4V, V_{EN} = 2.4V	$V_{S(all)}$ = V_D = 10V	-10	0.03	10	-20	0.03	20	
				$V_{S(all)}$ = V_D = -10V	-10	-0.06	10	-20	-0.06	20	
	DG507A			$V_{S(all)}$ = V_D = 10V	-5	0.015	5	-10	0.015	10	
				$V_{S(all)}$ = V_D = -10V	-5	-0.03	5	-10	-0.03	10	
INPUT											
Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-10	-0.002		-10	-0.002		μA
			V_A = 15V			0.006	10		0.006	10	
Address Input Current, Input Voltage Low		I_{AL}	All V_A = 0	V_{EN} = 2.4V	-10	-0.002		-10	-0.002		
				V_{EN} = 0	-10	-0.002		-10	-0.002		

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = 15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated.)

PARAMETER		SYMBOL	TEST CONDITIONS		DG506AA DG507AA			DG506AB/C DG507AB/C			UNITS
					MIN (Note 2)	TYP (Note 3)	MAX	MIN (Note 2)	TYP (Note 3)	MAX	
DYNAMIC											
Switching Time Of Multiplexer		$t_{transition}$	See Figure 1			0.6	1		0.6		μs
Break-Before-Make Interval		t_{open}	See Figure 3			0.2			0.2		μs
Enable Turn-ON Time		$t_{on(EN)}$	See Figure 2			1			1		μs
Enable Turn-OFF Time		$t_{off(EN)}$	See Figure 2			0.4			0.4		μs
OFF Isolation[2]		OIRR	V_{EN} = 0, R_L = 1kΩ, C_L = 15pF, V_S = 7Vrms, f = 500kHz			68			68		dB
Source OFF Capacitance		$C_{S(off)}$	V_{EN} = 0, f = 140kHz	V_S = 0		6			6		pF
Drain OFF Capacitance	DG506A	$C_{D(off)}$	V_{EN} = 0, f = 140kHz	V_D = 0		45			45		pF
	DG507A	$C_{D(off)}$	V_{EN} = 0, f = 140kHz	V_D = 0		23			23		pF
SUPPLY											
Positive Supply Current		I^+	V_{EN} = 0V or 5V, All V_A = 0			.13	.25		.13	.3	mA
Negative Supply Current		I^-	V_{EN} = 0V or 5V, All V_A = 0		-.15	-.07		-.25	-.07		mA

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum, is used in this data sheet.

Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 4: $I_{D(on)}$ is leakage from driver into "ON" switch.

Note 5: OFF isolation = $20 \log \frac{V_D}{V_S}$, V_S = input to "OFF" switch, V_D = output due to V_S.

Monolithic CMOS Analog Multiplexers

ELECTRICAL CHARACTERISTICS (Over Temperature)

(V^+ = 15V, V^- = -15V, GND = 0V, T_A = Over Temperature Range, unless otherwise indicated.)

PARAMETER		SYMBOL	TEST CONDITIONS		DG506AA DG507AA MIN (Note 2)	DG506AA DG507AA TYP (Note 3)	DG506AA DG507AA MAX	DG506AB/C DG507AB/C MIN (Note 2)	DG506AB/C DG507AB/C TYP (Note 3)	DG506AB/C DG507AB/C MAX	UNITS
SWITCH											
Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
Drain-Source ON Resistance		$r_{DS(on)}$	Sequence Each Switch On V_{AL} = 0.8V, V_{AH} = 2.4V, V_{EN} = 2.4V	V_D = 10V, I_S = -200μA		500			550		Ω
				V_D = -10V, I_S = -200μA		500			550		
Source OFF Leakage Current		$I_{S(off)}$	V_{EN} = 0.8V V_{AL} = 0.8V	V_S = 10V, V_D = -10V	-50		50	-50		50	nA
				V_S = -10V, V_D = 10V	-50		50	-50		50	
Drain OFF Leakage Current	DG506A	$I_{D(off)}$		V_D = 10V, V_S = -10V	-300		300	-300		300	
				V_D = -10V, V_S = 10V	-300		300	-300		300	
	DG507A			V_D = 10V, V_S = -10V	-200		200	-200		200	
				V_D = -10V, V_S = 10V	-200		200	-200		200	
Channel ON Leakage Current	DG506A	$I_{D(on)}$[4]	Sequence Each Switch On V_{AL} = 0.8V, V_{AH} = 2.4V, V_{EN} = 2.4V	$V_{S(all)}$ = V_D = 10V	-300		300	-300		300	
				$V_{S(all)}$ = V_D = -10V	-300		300	-300		300	
	DG507A			$V_{S(all)}$ = V_D = 10V	-200		200	-200		200	
				$V_{S(ALL)}$ = V_D = -10V	-200		200	-200		200	
INPUT											
Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-30			-30			μA
			V_A = 15V				30			30	
Address Input Current, Input Voltage Low		I_{AL}	All V_A = 0	V_{EN} = 2.4V	-30			-30			
				V_{EN} = 0			30			30	

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum, is used in this data sheet.

Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 4: $I_{D(on)}$ is leakage from driver into "ON" switch.

Note 5: OFF isolation = $20 \log \frac{V_D}{V_S}$, V_S = input to "OFF" switch, V_D = output due to V_S.

Truth Tables

DG506A

A_3	A_2	A_1	A_0	EN	ON SWITCH
X	X	X	X	0	NONE
0	0	0	0	1	1
0	0	0	1	1	2
0	0	1	0	1	3
0	0	1	1	1	4
0	1	0	0	1	5
0	1	0	1	1	6
0	1	1	0	1	7
0	1	1	1	1	8
1	0	0	0	1	9
1	0	0	1	1	10
1	0	1	0	1	11
1	0	1	1	1	12
1	1	0	0	1	13
1	1	0	1	1	14
1	1	1	0	1	15
1	1	1	1	1	16

DG507A

A_2	A_1	A_0	EN	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

Logic "0" = $V_{AL} \leq 0.8V$, Logic "1" = $V_{AH} \geq 2.4V$
"0" = DON'T CARE

Switching Time Test Circuit

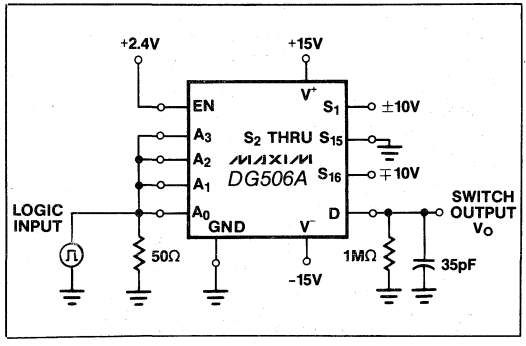


Figure 1A. Transition Switching Time

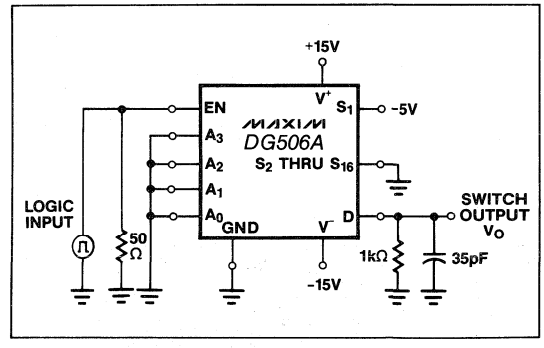


Figure 2A. Enable Switching Time

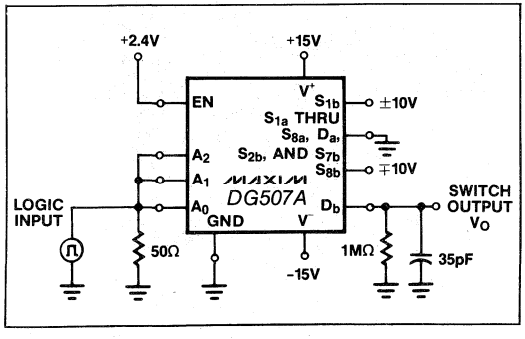


Figure 1B. Transition Switching Time

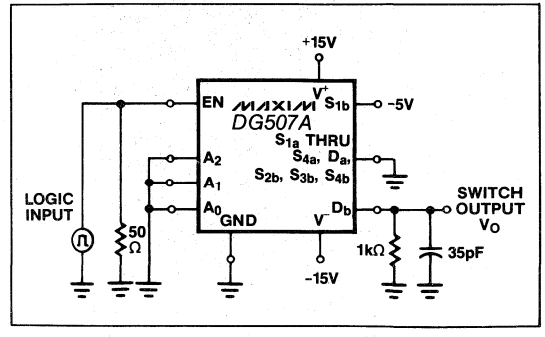


Figure 2B. Enable Switching Time

Monolithic CMOS Analog Multiplexers

Switching Time Test Circuit (continued)

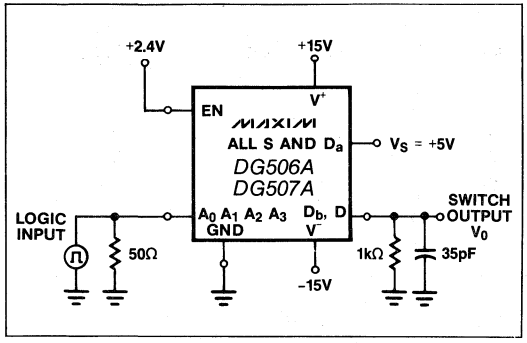


Figure 3. Break-Before-Make

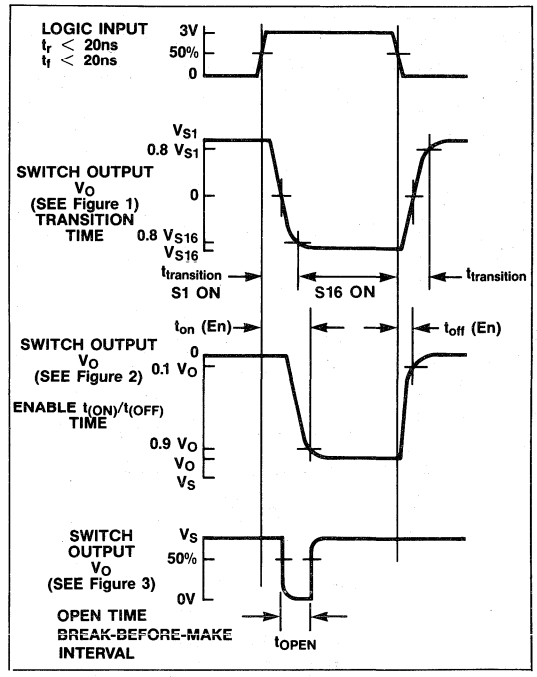
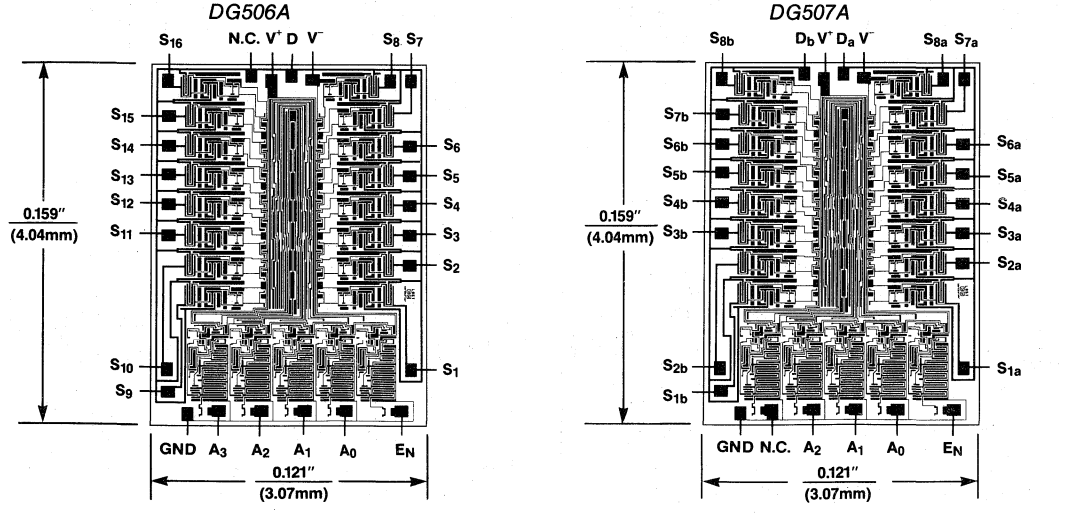


Figure 4. Timing Diagrams for Figures 1, 2, and 3

Chip Topography



MAXIM
Monolithic CMOS Analog Multiplexers

General Description

Maxim's DG508A and DG509A are monolithic CMOS analog multiplexers. The DG508A is a single 8 channel (1 of 8) multiplexer and the DG509A is a differential 4 channel (2 of 8) multiplexer.

Both devices guarantee break-before-make switching. Maxim guarantees that these multiplexers will not latch-up if the power supplies are turned-off with the input signals still present. Maxim also guarantees continuous operation when these devices are powered by supplies ranging from ±4.5V to ±18V.

Compared to the original manufacturer's devices, Maxim's DG508A and DG509A have lower on-resistance, faster enable switching times and significantly lower leakage currents. Maxim's devices also consume significantly lower power, making them ideal for portable equipment.

Maxim's DG508A and DG509A meet or exceed the specifications of, and are drop-in replacements for, Intersil IH6108 and IH6208 respectively.

Applications

Control Systems
Data Logging Systems
Aircraft Heads Up Displays
Data Acquisition Systems
Signal Routing

Features

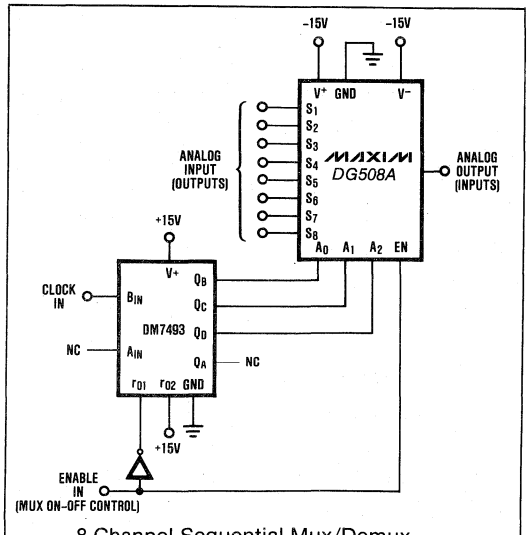
- ♦ **Improved 2nd Source! (See pages 3 and 5 for "Maxim Advantage™")**
- ♦ **Operable with ±4.5V to ±18V Supplies**
- ♦ **Symmetrical, Bi-Directional Operation**
- ♦ **Logic and Enable Inputs, TTL and CMOS Compatible**
- ♦ **Latch-Up Proof Construction**
- ♦ **Monolithic, Low-Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
DG508AAK	-55°C to +125°C	16 Lead CERDIP
DG508ABK	-20°C to +85°C	16 Lead CERDIP
DG508AC/D	0°C to +70°C	Dice
DG508ACJ	0°C to +70°C	16 Lead Plastic DIP
DG508ACWE	0°C to +70°C	16 Lead Wide SO
DG509AAK	-55°C to +125°C	16 Lead CERDIP
DG509ABK	-20°C to +85°C	16 Lead CERDIP
DG509AC/D	0°C to +70°C	Dice
DG509ACJ	0°C to +70°C	16 Lead Plastic DIP
DG509ACWE	0°C to +70°C	16 Lead Wide SO

(Contact factory for devices in ceramic flat packs.)

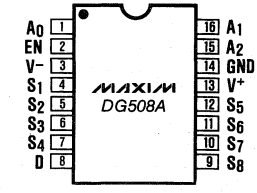
Typical Operating Circuit

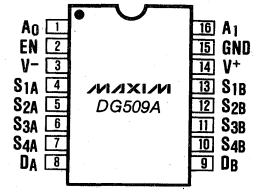


8 Channel Sequential Mux/Demux

Pin Configuration

Top View





The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Monolithic CMOS Analog Multiplexers

ABSOLUTE MAXIMUM RATINGS

Voltage Referenced to V⁻
V⁺ ..... +44V
GND ..... +25V
Digital Inputs (Note 1), V_S, V_D ..... -2V to (V⁺ +2V) or 20mA, whichever occurs first
Current (Any Terminal, Except S or D) 30mA
Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1msec, 10% Duty Cycle Max) 40mA
Storage Temperature ..... -65°C to +150°C

Power Dissipation (Package) (Note 2)
16 Pin Ceramic DIP (Note 3) 900mW
16 Pin Plastic DIP (Note 4) 470mW
16 Pin Wide SO (Note 5) 750mW

Note 1: Signals on S_X, D_X, or IN_X, exceeding V⁺ or V⁻ will be clamped by internal diodes. Limit forward diode current to maximum current ratings.
Note 2: All leads soldered or welded to PC board.
Note 3: Derate 12mW/°C above +75°C.
Note 4: Derate 6.3mW/°C above +75°C.
Note 5: Derate 10mW/°C above +75°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and funcional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C unless otherwise indicated)

	PARAMETER		SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508A B/C DG509A B/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
SWITCH	Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance		$r_{DS(on)}$	V_D = 10V, I_S = -200μA	Seq. Ea. Switch On V_{AL} = 0.8V, V_{AH} = 2.4V		270	400		270	450	Ω
				V_D = -10V, I_S = -200μA			230	400		230	450	
	Greatest Change In Drain Source ON Resistance Between Channels		$\Delta r_{DS(on)}$	$\Delta r_{DS(on)} = \left(\frac{r_{DS(on)}\ Max - r_{DS(on)}\ Min}{r_{DS(on)}\ Ave}\right)$ -10V ≤ V_S ≤ +10V			6			6		%
	Source OFF Leakage Current		$I_{S(off)}$	V_S = 10V, V_D = -10V	V_{EN} = 0V		0.002	1		0.002	5	nA
				V_S = -10V, V_D = 10V		-1	-0.005		-5	-0.005		
	Drain OFF Leakage Current	DG508A	$I_{D(off)}$	V_D = 10V, V_S = -10V			0.01	10		0.01	20	
				V_D = -10V, V_S = 10V		-10	-0.015		-20	-0.015		
		DG509A		V_D = 10V, V_S = -10V			0.005	10		0.005	20	
				V_D = -10V, V_S = 10V		-10	-0.008		-20	-0.008		
	Drain ON Leakage Current	DG508A	$I_{D(on)}$ (Note 8)	$V_{S(all)}$ = V_D = 10V	Seq. Ea. Switch On V_{AL} = 0.8V V_{AH} = 2.4V		0.015	10		0.015	20	
				$V_{S(all)}$ = V_D = -10V		-10	-0.03		-20	-0.03		
		DG509A		$V_{S(all)}$ = V_D = 10V			0.007	10		0.007	20	
				$V_{S(all)}$ = V_D = -10V		-10	-0.015		-20	-0.015		
INPUT	Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-10	-0.002		-10	-0.002		μA
				V_A = 15V			0.006	10		0.006	10	
	Address Input Current Input Voltage Low		I_{AL}	V_{EN} = 2.4V	All V_A = 0V	-10	-0.002		-10	-0.002		
				V_{EN} = 0V		-10	-0.002		-10	-0.002		

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 8: $I_{D(ON)}$ is leakage from driver into "ON" switch.

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Monolithic CMOS Analog Multiplexers

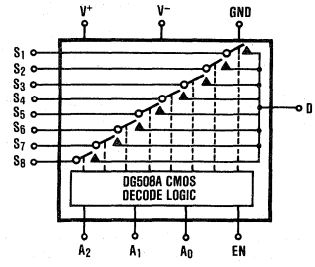
- **Significantly Reduced Leakage Currents**
- **Significantly Reduced Supply Currents**
- **Lower ON Resistance**
- **Faster Enable Switching Times**

ABSOLUTE MAXIMUM RATINGS: This device conforms to the Absolute Maximum Ratings on adjacent page.

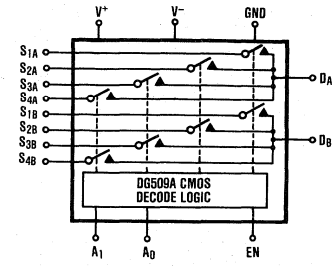
ELECTRICAL CHARACTERISTICS: Specifications below satisfy or exceed all "tested" parameters on adjacent page.
(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C unless otherwise indicated)

	PARAMETER		SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508AB/C DG509AB/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
SWITCH	Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance		$r_{DS(on)}$	V_D = 10V, I_S = -200μA	Seq. Ea. Switch On V_{AL} = 0.8V, V_{AH} = 2.4V		170	300		170	350	Ω
				V_D = -10V, I_S = -200μA			130	300		130	350	
	Greatest Change In Drain Source ON Resistance Between Channels		$\Delta r_{DS(on)}$	$\Delta r_{DS(on)} = \left(\frac{r_{DS(on)}\ Max - r_{DS(on)}\ Min}{r_{DS(on)}\ Ave}\right)$ -10V ≤ V_S ≤ +10V			6			6		%
	Source OFF Leakage Current		$I_{S(off)}$	V_S = 10V, V_D = -10V	V_{EN} = 0V		0.002	0.5		0.002	1	nA
				V_S = -10V, V_D = 10V		-0.5	-0.005		-1	-0.005		
	Drain OFF Leakage Current	DG508A	$I_{D(off)}$	V_D = 10V, V_S = -10V			0.01	2		0.01	5	
				V_D = -10V, V_S = 10V		-2	-0.015		-5	-0.015		
		DG509A		V_D = 10V, V_S = -10V			0.005	2		0.005	5	
				V_D = -10V, V_S = 10V		-2	-0.008		-5	-0.008		
	Drain ON Leakage Current	DG508A	$I_{D(on)}$ (Note 8)	$V_{S(all)}$ = V_D = 10V	Seq. Ea. Switch On V_{AL} = 0.8V, V_{AH} = 2.4V		0.015	2		0.015	5	
				$V_{S(all)}$ = V_D = -10V		2	-0.03		-5	-0.03		
		DG509A		$V_{S(all)}$ = V_D = 10V			0.007	2		0.007	5	
				$V_{S(all)}$ = V_D = -10V		-2	-0.015		-5	-0.015		
INPUT	Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-10	-0.002		-10	-0.002		μA
				V_A + 15V			0.006	10		0.006	10	
	Address Input Current Input Voltage Low		I_{AL}	V_{EN} = 2.4V	All V_A = 0V	-10	-0.002		-10	-0.002		
				V_{EN} = 0V		-10	-0.002		-10	-0.002		

Functional Diagrams



DG508A
8 Channel Single Ended Multiplexer



DG509A
Differential 4 Channel Multiplexer

Note: See page 6 for Truth Tables.

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C unless otherwise indicated)

	PARAMETER		SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508AB/C DG509AB/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
DYNAMIC	Switching Time Of Multiplexer		$t_{transition}$	See Figure 1			0.6	1		0.6		µs
	Break-Before-Make Interval		t_{open}	See Figure 3			0.2			0.2		µs
	Enable Turn-ON Time		$t_{on(EN)}$	See Figure 2			1	1.5		1		µs
	Enable Time-OFF Time		$t_{off(EN)}$				0.4	1		0.4		µs
	OFF Isolation (Note 8)		OIRR	V_{EN} = 0V, R_L = 1kΩ, C_L = 15pF, V_S = 7VRMS, f = 500kHz			68			68		dB
	Source OFF Capacitance		$C_{S(off)}$	V_S = 0V	V_{EN} = 0V, f = 140kHz		5			5		pF
	Drain OFF Capacitance	DG508A	$C_{D(off)}$	V_D = 0V			25			25		pF
		DG509A					12			12		pF
SUPPLY	Pos. Supply Current		I^+	V_{EN} = 2.4V	All V_A = 0V, or 2.4V		1.3	2.4		1.3	2.4	mA
	Neg. Supply Current		I^-			-1.5	-0.7		-1.5	-0.7		mA
	Pos. Supply Current		I^+Stdby	V_{EN} = 0V			1.3	2.4		1.3	2.4	mA
	Neg. Supply Current		I^-Stdby			-1.5	-0.7		-1.5	-0.7		mA

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 8: OFF isolation = 20 log $\frac{|V_S|}{|V_D|}$, V_S = input to "OFF" switch, V_D = output due to V_S.

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Switching Time Test Circuits

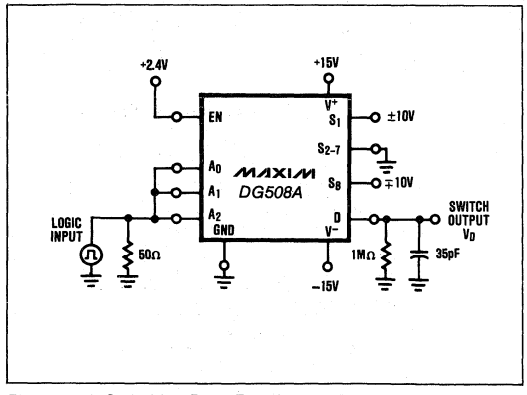

Figure 1(a). Switching Time Test Circuit (DG508A)

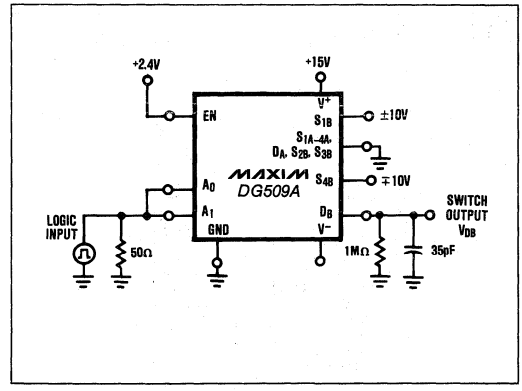

Figure 1(b). Switching Time Test Circuit (DG509A)

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508AB/C DG509AB/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
DYNAMIC	**Switching Time Of Multiplexer**	$t_{transition}$	**See Figure 1**			**0.6**	**1**		**0.6**	**1**	μs
	Break-Before-Make Interval	t_{open}	See Figure 3			0.2			0.2		
	Enable Turn-ON Time	$t_{on(EN)}$	**See Figure 2**			**0.4**	**1**		**0.4**	**1.5**	
	Enable Time-OFF Time	$t_{off(EN)}$				**0.2**	**0.7**		**0.2**	**1**	
	OFF Isolation (Note 9)	OIRR	V_{EN} = 0V, R_L = 1kΩ, C_L = 15pF V_S = 7VRMS, f = 500kHz			68			68		dB
	Source OFF Capacitance	$C_{S(off)}$	V_S = 0V	V_{EN} = 0V, f = 140kHz		5			5		pF
	Drain OFF Capacitance DG508A	$C_{D(off)}$	V_D = 0V			25			25		
	Drain OFF Capacitance DG509A					12			12		
SUPPLY	**Pos. Supply Current**	I^+	**V_{EN} = 2.4V**	**All V_A = 0V, or 2.4V**		**0.02**	**0.2**		**0.02**	**0.2**	mA
	Neg. Supply Current	I^-			**-0.1**	**-0.01**		**-0.1**	**-0.01**		
	Pos. Supply Current	I^+ **Stdby**	**V_{EN} = 0V**			**0.02**	**0.2**		**0.02**	**0.2**	
	Neg. Supply Current	I^- **Stdby**			**-0.1**	**-0.01**		**-0.1**	**-0.01**		
	Power Supply Range For Continuous Operation (Note 10)	V_{OP}			**±4.5**		**±18**	**±4.5**		**±18**	V

Note 10: Electrical characteristics, such as ON Resistance, will change when power supplies, other than ±15V, are used.

Switching Time Test Circuits

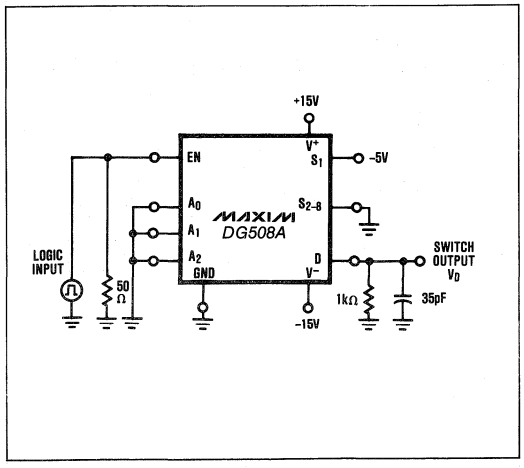

Figure 2(a). Enable Time Test Circuit (DG508A)

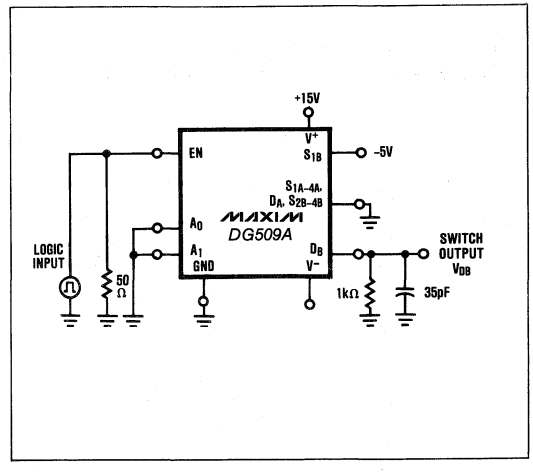

Figure 2 (b). Enable Time Test Circuit (DG509A)

Monolithic CMOS Analog Multiplexers

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V, Ground = 0V, T_A = Over Temperature Range unless otherwise noted)

	PARAMETER		SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508AB/C DG509AB/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
SWITCH	Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance		$r_{DS(on)}$	V_D = 10V, I_S = -200μA	Seq. Ea. Switch On V_{AL} = 0.8V, V_{AH} = 2.4V			500			550	Ω
				V_D = -10V, I_S = -200μA				500			500	
	Source OFF Leakage Current		$I_{S(off)}$	V_S = 10V, V_D = -10V	V_{EN} = 0V			50			50	nA
				V_S = -10V, V_D = 10V		-50			-50			
	Drain OFF Leakage Current	DG508A	$I_{D(off)}$	V_D = 10V, V_S = -10V				200			200	
				V_D = -10V, V_S = 10V		-200			-200			
		DG509A		V_D = 10V, V_S = -10V				100			100	
				V_D = -10V, V_S = 10V		-100			-100			
	Drain ON Leakage Current	DG508A	$I_{D(on)}$ (Note 8)	$V_{S(all)}$ = V_D = 10V	Seq. Ea. Switch On V_{AL} = 0.8V V_{AH} = 2.4V			200			200	
				$V_{S(all)}$ = V_D = -10V		-200			-200			
		DG509A		$V_{S(all)}$ = V_D = 10V				100			100	
				$V_{S(all)}$ = V_D = -10V		-100			-100			
INPUT	Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-30			-30			μA
				V_A = 15V				30			30	
	Address Input Current Input Voltage Low		I_{AL}	V_{EN} = 2.4V	All V_A = 0V	-30			-30			
				V_{EN} = 0V		-30			-30			

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 8: $I_{D(on)}$ is leakage from driver into "ON" switch.

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TRUTH TABLE—DG508A

A_2	A_1	A_0	EN	ON SWITCH
X	X	X	0	NONE
0	0	0	1	1
0	0	1	1	2
0	1	0	1	3
0	1	1	1	4
1	0	0	1	5
1	0	1	1	6
1	1	0	1	7
1	1	1	1	8

TRUTH TABLE—DG509A

A_1	A_0	EN	ON SWITCH
X	X	0	NONE
0	0	1	1
0	1	1	2
1	0	1	3
1	1	1	4

NOTE: Logic "0" = $V_{AL} \leq 0.8V$, Logic "1" = $V_{AH} \geq 2.4V$

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V, Ground = 0V, T_A = Over Temperature Range unless otherwise noted)

	PARAMETER		SYMBOL	TEST CONDITIONS		LIMITS DG508AA DG509AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG508AB/C DG509AB/C MIN (Note 6)	TYP (Note 7)	MAX	UNIT
SWITCH	Analog Signal Range		V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance		$r_{DS(on)}$	V_D = 10V, I_S = -200μA	Seq. Ea. Switch On V_{AL} = 0.8V, V_{AH} = 2.4V			400			450	Ω
				V_D = -10V, I_S = -200μA				400			450	
	Source OFF Leakage Current		$I_{S(off)}$	V_S = 10V, V_D = -10V	V_{EN} = 0V			50			50	nA
				V_S = -10V, V_D = 10V		-50			-50			
	Drain OFF Leakage Current	DG508A	$I_{D(off)}$	V_D = 10V, V_S = -10V				200			100	
				V_D = -10V, V_S = 10V		-200			-100			
		DG509A		V_D = 10V, V_S = -10V				100			100	
				V_D = -10V, V_S = 10V		-100			-100			
	Drain ON Leakage Current	DG508A	$I_{D(on)}$ (Note 8)	$V_{S(all)}$ = V_D = 10V	Seq. Ea. Switch On V_{AL} = 0.8V V_{AH} = 2.4V			200			100	
				$V_{S(all)}$ = V_D = -10V		-200			-100			
		DG509A		$V_{S(all)}$ = V_D = 10V				100			100	
				$V_{S(all)}$ = V_D = -10V		-100			-100			
INPUT	Address Input Current, Input Voltage High		I_{AH}	V_A = 2.4V		-30			-30			μA
				V_A = 15V				30			30	
	Address Input Current Input Voltage Low		I_{AL}	V_{EN} = 2.4V	All V_A = 0V	-30			-30			
				V_{EN} = 0V		-30			-30			

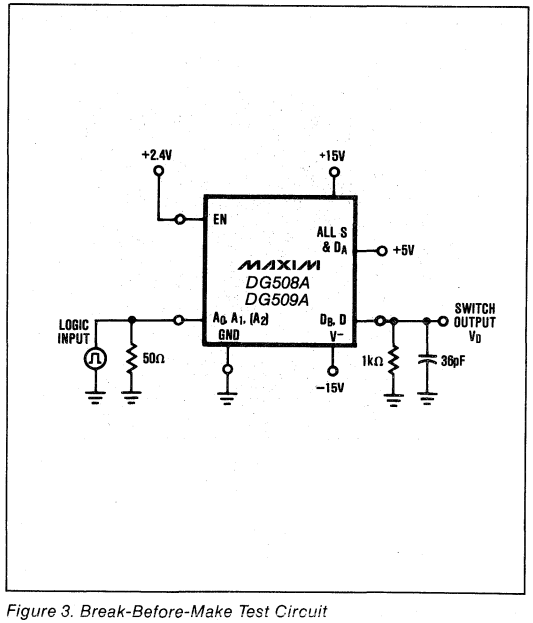


Figure 3. Break-Before-Make Test Circuit

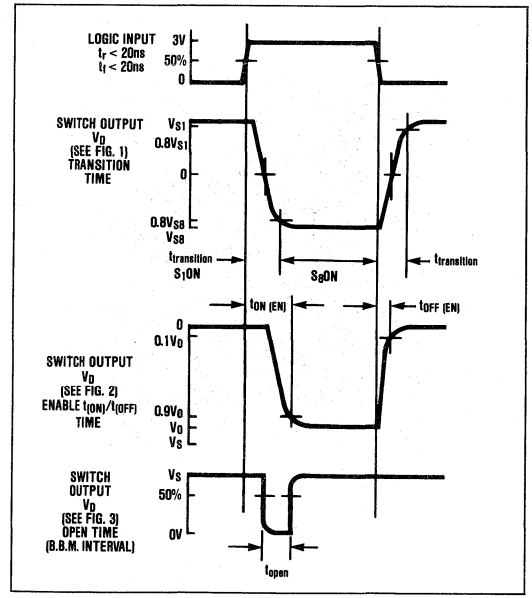
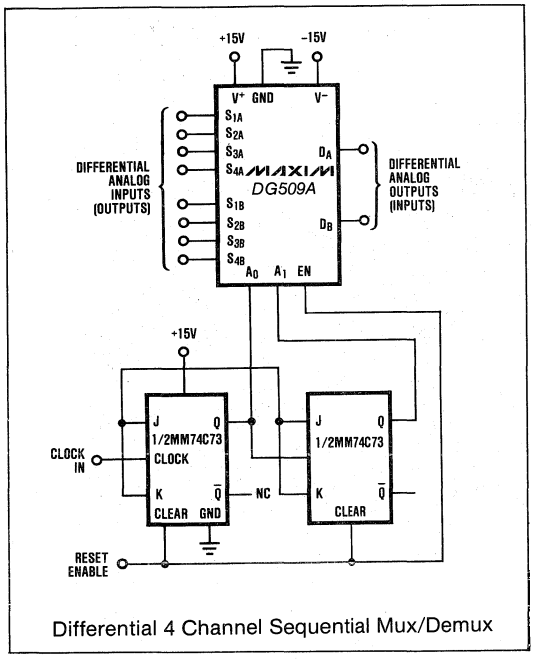


Figure 4. Timing Diagram For Figure 1, 2 & 3

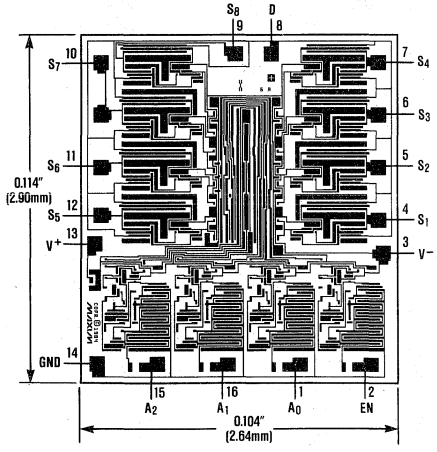
Monolithic CMOS Analog Multiplexers

Typical Operating Circuit

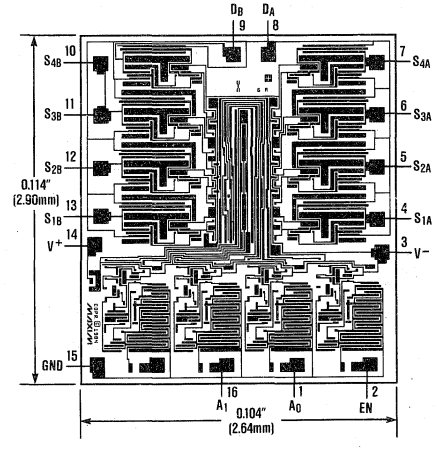


Differential 4 Channel Sequential Mux/Demux

Chip Topography



DG508A (IH6108)



DG509A (IH6208)

MAXIM

Analog Switches

Please see Analog Switches, Video Switches, and High Voltage Analog Switches Selector Guides on pages iii and iv.

MAXIM

Quad SPST CMOS Analog Switches

General Description

The MAX331, DG201A and DG211 are normally closed, quad single-pole-single-throw (SPST) analog switches. These CMOS switches can be continuously operated with power supplies ranging from ±4.5V to ±18V. Maxim guarantees that these switches will not latch-up if the power supplies are disconnected with input signals still connected.

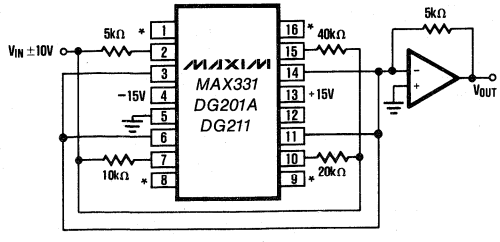
All three devices have guaranteed break-before-make switching. The MAX331 and DG201A differ with the DG211 primarily in switching speeds. The MAX331 and DG201A have a maximum turn-off time of 450ns and a maximum turn-on time of 600ns. The DG211 has a maximum turn-off time of 500ns and a maximum turn-on time of 1000ns.

Compared to the original manufacturer's products, Maxim's DG201A and DG211 consume significantly lower power, making them better suited for portable applications. By specifying the MAX331, the customer is guaranteed low power consumption units. Maxim has also eliminated the need for the third (V_L) power supply that is required for the operation of the original manufacturer's DG211.

Applications

Winchester Disk Drives
Test Equipment
Communications Systems
PBX, PABX
Guidance and Control Systems
Head up Displays
Military Radios

Typical Operating Circuit



Programmable Gain Amplifier

Note: * Pins 1, 8, 9 and 16 are logic control inputs.

Features

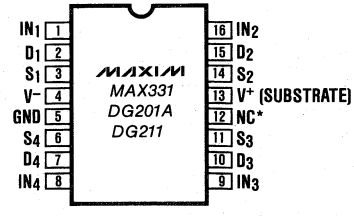
- **Improved 2nd Source! (See pages 3 and 5 for "MAXIM Advantage™")**
- **Guaranteed ±4.5V to ±18V Operation**
- **No V_L Supply Required**
- **Non-Latching with Supplies Turned-off and Input Signals Present**
- **CMOS and TTL Logic Compatible**
- **Monolithic, Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX331MJE	-55°C to +125°C	16 Lead CERDIP
DG201AAK	-55°C to +125°C	16 Lead CERDIP
DG201ABK	-25°C to +85°C	16 Lead CERDIP
DG201ACK	0°C to +70°C	16 Lead CERDIP
DG201ACJ	0°C to +70°C	16 Lead Plastic DIP
DG201ACSE	0°C to +70°C	16 Lead Small Outline
DG201C/D	0°C to +70°C	Dice
DG211CJ	0°C to +70°C	16 Lead Plastic DIP
DG211CSE	0°C to +70°C	16 Lead Small Outline
DG211C/D	0°C to +70°C	Dice

Pin Configuration

Top View



LOGIC	SWITCH
0	ON
1	OFF

Note: * Pin 12 can be left open or connected to a logic supply voltage.

2

The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG211)

V^+ to V^- 40V
V_{IN} to Ground ..... V^-, V^+
V_L to Ground ..... -0.3V, 25V
V_S or V_D to V^+ ..... 0, -40V
V_S or V_D to V^- 0, 40V
V^+ to Ground 25V
V^- to Ground ..... -25V
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1msec, 10% duty cycle max) 70mA

Storage Temperature ..... -65°C to +125°C
Operating Temperature ..... 0°C to +70°C
Power Dissipation (Note 1)
16 Pin Plastic DIP (Note 2) 470mW
16 Pin Small Outline (SE) (Note 3) 400mW

Note 1: Device mounted with all leads soldered to PC board.

Note 2: Derate 6.5mW/°C above +25°C.

Note 3: Derate 7mW/°C above +25°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (DG211)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain ON Leakage Current (Note 6)	$I_{D\ (on)}$	V_S = V_D = 14V, V_{IN} = 0.8V			0.1	5.0	
			V_S = V_D = -14V, V_{IN} = 0.8V		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit V_S = 2V, R_L = 1kΩ, C_L = 35pF			460	1000	ns
	Turn-OFF Time	t_{off1}				360	500	
		t_{off2}				450		
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 5V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$	V_D = 0V, V_{IN} = 5V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S\ (on)}$	V_D = V_S = 0V, V_{IN} = 0V, f = 1MHz			16		
	OFF Isolation (Note 7)	OIRR	V_{IN} = 5V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				90		
SUPPLY	Positive Supply Current	I^+	V_{IN} = 0V and 2.4V			0.35	0.48	mA
	Negative Supply Current	I^-				0.30	0.48	
	Logic Supply Current	I_L				0.5	1.2	

Note 4: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

Note 5: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 6: $I_{D(on)}$ is leakage from driver into "ON" switch.

Note 7: OFF Isolation = $20 \log \frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = output.

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Quad SPST CMOS Analog Switches

- ♦ Significantly Reduced Power Consumption
- ♦ Third (Logic) Supply Not Required
- ♦ Fault Protected

ABSOLUTE MAXIMUM RATINGS (DG211) This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (DG211): Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V^+ = +15V, V^- = −15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			−15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = −14V		0.01	5.0	nA
				V_S = −14V, V_D = 14V	−5.0	−0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = −14V		0.01	5.0	
				V_S = −14V, V_D = 14V	−5.0	−0.02		
	Drain ON Leakage Current (Note 6)	$I_{D\ (on)}$	V_S = V_D = 14V, V_{IN} = 0.8V			0.1	5.0	
			V_S = V_D = −14V, V_{IN} = 0.8V		−5.0	−0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		−1.0	−0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		−1.0	−0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit V_S = 2V, R_L = 1kΩ, C_L = 35pF			460	1000	ns
	Turn-OFF Time	t_{off1}				360	500	
		t_{off2}				450		
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 5V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$	V_D = 0V, V_{IN} = 5V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S\ (on)}$	V_D = V_S = 0V, V_{IN} = 0V, f = 1MHz			16		
	OFF Isolation (Note 8)	OIRR	V_{IN} = 5V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				90		
SUPPLY	**Positive Supply Current**	**I^+**	**V_{IN} = 0V and 2.4V**			**0.02**	**0.1**	**mA**
	Negative Supply Current	**I^-**				**0.01**	**0.1**	
	Logic Supply Current	**I_L**				**0.0**	**0.0**	
	Power Supply Range for Continuous Operation	**V_{OP}**			**±4.5**		**±18**	**V**

Note 8: Electrical characteristics, such as ON Resistance, will change when power supplies, other than ±15V, are used.

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (MAX331, DG201A)

Voltages Referenced to V⁻
- V^+ 44V
- GND 25V

Digital Inputs (Note 1), V_S, V_D ..... -2V to (V^+ +2V) or 20mA, whichever occurs first

Current, Any Terminal Except S or D 30mA

Continuous Current, S or D 20mA

Peak Current, S or D
- (Pulsed at 1msec, 10% duty cycle max.) 70mA

Operating Temperature
- DG201A (A Suffix) ..... -55°C to +125°C
- (B Suffix) ..... -25°C to +85°C
- (C Suffix) ..... 0°C to +70°C
- MAX331MJE ..... -55°C to +125°C

Storage Temperature ..... -65°C to +150°C

Power Dissipation (Note 2)
- 16 Pin CERDIP (Note 3) 900mW
- 16 Pin Plastic DIP (Note 4) 470mW
- 16 Pin Small Outline (SE) (Note 5) 400mW

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- on Maxim's MAX331 and DG201A will be clamped by internal diodes, and are also internally current limited to 25mA.
Note 2: Device mounted with all leads soldered to PC board.
Note 3: Derate 12mW/°C above +75°C.
Note 4: Derate 6.5mW/°C above +25°C.
Note 5: Derate 7mW/°C above +25°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (DG201A)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG201AA MIN (Note 6)	DG201AA TYP (Note 7)	DG201AA MAX	LIMITS DG201AB,C MIN (Note 6)	DG201AB,C TYP (Note 7)	DG201AB,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain ON Leakage Current (Note 8)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 0.8V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 0.8V		-1.0	-0.15		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0		0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off_1}				370	450		370	450	
	Charge Injection	Q	C_L = 1000pF, V_{GEN} = 0V, R_{GEN} = 0Ω			20			20		pC
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 5V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$				5			5		
	Channel ON Capacitance	$C_{D\ (on)}$ + $C_{S\ (on)}$	V_D = V_S = 0V, V_{IN} = 0V			16			16		
	OFF Isolation		V_{IN} = 5V, Z_L = 75Ω			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
SUPPLY	Positive Supply Current	I^+	All Channels ON or OFF			0.9	2		0.9	2	mA
	Negative Supply Current	I^-			-1	-0.3		-1	-0.3		

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 8: $I_{D(on)}$ is leakage from driver into "ON" switch.

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Quad SPST CMOS Analog Switches

- ♦ Significantly Reduced Power Consumption
- ♦ Lower Input Current Over Temperature
- ♦ No Input Current Spike

ABSOLUTE MAXIMUM RATINGS (MAX331, DG201A)

This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (MAX331, DG201A):

Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MAX331/DG201AA MIN (Note 6)	TYP (Note 7)	MAX	LIMITS DG201AB,C MIN (Note 6)	TYP (Note 7)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 9)	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain ON Leakage Current (Note 8)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 0.8V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 0.8V		-1.0	-0.15		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		-1.0	-0.0004		µA
			V_{IN} = 15V			0.003	1.0		0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off_1}				370	450		370	450	
	Charge Injection	Q	C_L = 1000pF, V_{GEN} = 0V, R_{GEN} = 0Ω			20			20		pC
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 5V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$				5			5		
	Channel ON Capacitance	$C_{D\ (on)}$ + $C_{S\ (on)}$	V_D = V_S = 0V, V_{IN} = 0V			16			16		
	OFF Isolation		V_{IN} = 5V, Z_L = 75Ω			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
SUPPLY	**Positive Supply Current**	**I^+**	**All Channels ON or OFF**			**0.02**	**0.1**		**0.02**	**0.1**	mA
	Negative Supply Current	**I^-**	**All Channels ON or OFF**		**-0.1**	**-0.01**		**-0.1**	**-0.01**		
	Power Supply Range for Continuous Operation	**V_{OP}**			**±4.5**		**±18**	**±4.5**		**±18**	V

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 8: $I_{D(on)}$ is leakage from driver into "ON" switch.
Note 9: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V, are used.

Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (DG201A)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = Full Operating Temperature Range)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG201AA MIN (Note 6)	DG201AA TYP	DG201AA MAX (Note 7)	DG201AB,C MIN (Note 6)	DG201AB,C TYP	DG201AB,C MAX (Note 7)	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 0.8V				200			200	
			V_D = 14V, V_{IN} = 0.8V		-200			-200			
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0			-10			μA
			V_{IN} = 15V				-10			-10	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-10			-10			

Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.

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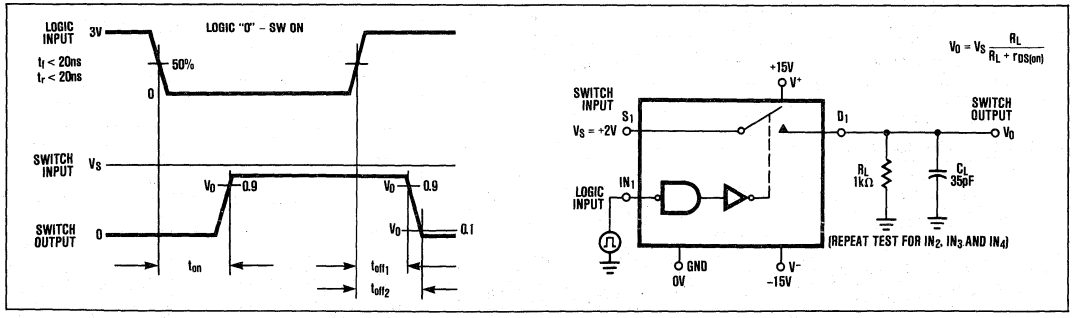
Switching Time Test Circuit

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be +ve or -ve as per switching times test circuit.

V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.



Typical $R_{DS(ON)}$ vs. Power Supplies for Maxim's MAX331, DG201A and DG211

POWER SUPPLIES	$R_{DS(ON)}$ AT ANALOG SIGNAL LEVEL -5V	+5V	-10V	+10V	-15V	+15V
±5V	350Ω	380Ω				
±10V			165Ω	250Ω		
±15V			125Ω	160Ω	135Ω	155Ω

ELECTRICAL CHARACTERISTICS (MAX331, DG201A):

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = full operating temperature range)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MAX331/DG201AA MIN (Note 6)	MAX331/DG201AA TYP (Note 7)	MAX331/DG201AA MAX	DG201AB,C MIN (Note 6)	DG201AB,C TYP (Note 7)	DG201AB,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 11)	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 0.8V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D(off)}$	V_{IN} = 2.4V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D(on)}$	V_S = -14V, V_{IN} = 0.8V				200			200	
			V_D = 14V, V_{IN} = 0.8V		-200			-200			
INPUT	**Input Current With Input Voltage High**	I_{INH}	**V_{IN} = 2.4V**		**-1.0**			**-1.0**			µA
			V_{IN} = 15V				**1.0**			**1.0**	
	Input Current With Input Voltage Low	I_{INL}	**V_{IN} = 0V**		**-1.0**			**-1.0**			

Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.
Note 11: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V, are used.

Protecting Against Fault Conditions

Fault conditions occur when power supplies are turned off when input signals are still present or when over voltages occur at the inputs during normal operation. In either case, source-to-body diodes can be forward biased and conduct current from the signal source. If this current is required to be kept to low (µA) levels then the addition of external protection diodes is recommended.

To provide protection for over-voltages up to 20V above the supplies, a 1N4001 or 1N914 type diode should be placed in series with the positive and negative supplies as shown in Fig. 1. The addition of these diodes will reduce the analog signal range to 1 volt below the positive supply and 1 volt above the negative supply.

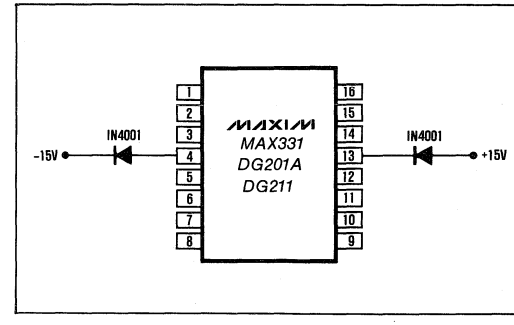
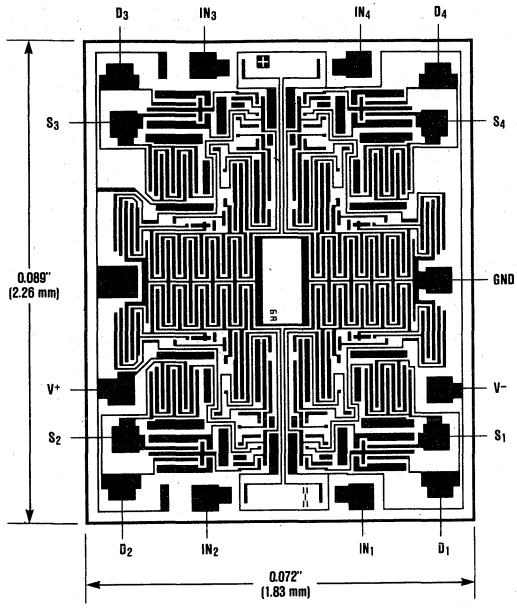


Figure 1. Protection Against Fault Conditions

Quad SPST CMOS Analog Switches

Chip Topography



Quad SPST CMOS Analog Switches

General Description

Maxim's MAX332, DG202 and DG212 are normally open, quad single-pole-single-throw (SPST) analog switches. These CMOS switches can be continuously operated with power supplies ranging from ±4.5V to ±18V. Maxim guarantees that the MAX332 and DG202/212 will not latch up if their power supplies are disconnected with input signals still connected.

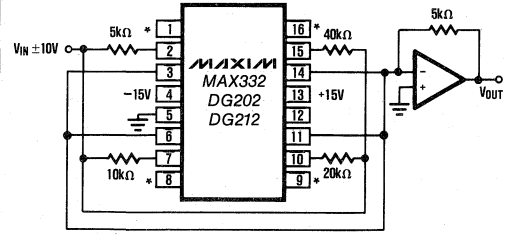
The MAX332 and DG202/DG212 are similar to the DG201 and DG211 except for inverted control inputs. All devices have guaranteed break-before-make switching as well as essentially constant on resistance over the analog signal range. All switches conduct current in either direction and add no offset to the output signal.

Compared to the original manufacturers products, Maxim's MAX332 and DG202/DG212 consume very little power, making them ideally suited for portable applications. Maxim has also eliminated the need for the third logic power supply (V_L), required when operating the original manufacturer's DG212, without sacrificing compatibility.

Applications

Analog Multiplexers
Programmable Gain Amplifiers
Communications Systems
Sample/Holds
Automatic Test Equipment
PBX, PABX

Typical Operating Circuit



Programmable Gain Amplifier

Note: *Pins 1, 8, 9 and 16 are logic control inputs.

Features

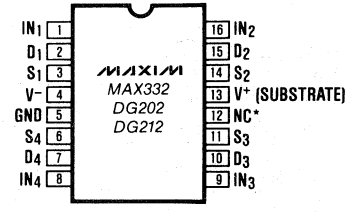
- **Improved 2nd Source! (See pages 3 and 5 for "MAXIM Advantage™")**
- **Guaranteed ±4.5V to ±18V Operation**
- **No V_L Supply Required**
- **Non-Latching with Supplies Turned-off and Input Signals Present**
- **CMOS and TTL Logic Compatible**
- **Monolithic, Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX332MJE	-55°C to +125°C	16 Lead CERDIP
DG202C/D	0°C to +70°C	Dice
DG202CJ	0°C to +70°C	16 Lead Plastic DIP
DG202CSE	0°C to +70°C	16 Lead Small Outline
DG202CK	0°C to +70°C	16 Lead CERDIP
DG202BSE	-25°C to +85°C	16 Lead Small Outline
DG202BK	-25°C to +85°C	16 Lead CERDIP
DG202AK	-55°C to +125°C	16 Lead CERDIP
DG212C/D	0°C to +70°C	Dice
DG212CJ	0°C to +70°C	16 Lead Plastic DIP
DG212CSE	0°C to +70°C	16 Lead Small Outline

Pin Configuration

Top View



LOGIC	SWITCH
0	OFF
1	ON

Note: *Pin 12 can be left open or connected to a logic supply voltage.

The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG212)

V^+ to V^- 40V
V_{IN} to Ground ..... V^-, V^+
V_L to Ground ..... -0.3V, 25V
V_S or V_D to V^+ ..... 0, -40V
V_S or V_D to V^- 0, 40V
V^+ to Ground 25V
V^- to Ground ..... -25V
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 20mA
Peak Current, S or D
(Pulsed at 1msec, 10% duty cycle max) 70mA

Storage Temperature ..... -65°C to +125°C
Operating Temperature ..... 0°C to +70°C
Power Dissipation (Note 1)
16 Pin Plastic DIP (Note 2) 470mW
16 Pin Small Outline (SE) (Note 3) 400mW

Note 1: Device mounted with all leads soldered to PC board.
Note 2: Derate 6.5mW/°C above +25°C.
Note 3: Derate 7mW/°C above +25°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (DG212)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain ON Leakage Current (Note 6)	$I_{D(on)}$	V_S = V_D = 14V, V_{IN} = 2.4V			0.1	5.0	
			V_S = V_D = -14V, V_{IN} = 2.4V		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit V_S = 2V, R_L = 1kΩ, C_L = 35pF			460	1000	ns
	Turn-OFF Time	t_{off1}				360	500	
		t_{off2}				450		
	Source OFF Capacitance	$C_{S(off)}$	V_S = 0V, V_{IN} = 0V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D(off)}$	V_D = 0V, V_{IN} = 0V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S(on)}$	V_D = V_S = 5V, V_{IN} = 0V, f = 1MHz			16		
	OFF Isolation (Note 7)	OIRR	V_{IN} = 0V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				90		
SUPPLY	Positive Supply Current	I^+	V_{IN} = 0V and 2.4V			0.35	0.48	mA
	Negative Supply Current	I^-				0.30	0.48	
	Logic Supply Current	I_L				0.5	1.2	

Note 4: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 5: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 6: $I_{D(on)}$ is leakage from driver into "ON" switch.
Note 7: OFF Isolation = $20 \log \frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = output.

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Quad SPST CMOS Analog Switches

- ♦ Significantly Reduced Power Consumption
- ♦ Third (Logic) Supply Not Required
- ♦ Fault Protected

ABSOLUTE MAXIMUM RATINGS (DG212): This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (DG212): Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MIN (Note 4)	LIMITS TYP (Note 5)	LIMITS MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02		
	Drain ON Leakage Current (Note 6)	$I_{D\ (on)}$	V_S = V_D = 14V, V_{IN} = 2.4V			0.1	5.0	
			V_S = V_D = -14V, V_{IN} = 2.4V		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit V_S = 2V, R_L = 1kΩ, C_L = 35pF			460	1000	ns
	Turn-OFF Time	t_{off1}				360	500	
		t_{off2}				450		
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 0V, f = 1MHz			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$	V_D = 0V, V_{IN} = 0V, f = 1MHz			5		
	Channel ON Capacitance	$C_{D+S(on)}$	V_D = V_S = 0V, V_{IN} = 5V, f = 1MHz			16		
	OFF Isolation (Note 8)	OIRR	V_{IN} = 0V, R_L = 1kΩ, C_L = 15pF, V_S = 1VRMS, f = 100kHz			70		dB
	Crosstalk (Channel to Channel)	CCRR				90		
SUPPLY	**Positive Supply Current**	**I^+**	**V_{IN} = 0V and 2.4V**			**0.02**	**0.1**	**mA**
	Negative Supply Current	**I^-**				**0.00001**	**0.1**	
	Logic Supply Current	**I_L**				**0.0**	**0.0**	
	Power Supply Range for Continuous Operation	**V_{OP}**			**±4.5**		**±18**	**V**

Note 8: Electrical characteristics, such as ON Resistance, will change when power supplies, other than ±15V, are used.

Quad SPST CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS (DG202)

Voltages Referenced to V⁻
- V⁺ 44V
- GND 25V

Digital Inputs (Note 1), V_S, V_D ..... -2V, to (V^+ +2V) or 20mA, whichever occurs first

Current, Any Terminal Except S or D 30mA

Continuous Current, S or D 20mA

Peak Current, S or D
(Pulsed at 1msec, 10% duty cycle max.) 70mA

Operating Temperature
- DG202 (A Suffix) ..... -55°C to +125°C
- (B Suffix) ..... -25°C to +85°C
- (C Suffix) ..... 0°C to +70°C
- MAX332MJE ..... -55°C to +125°C

Storage Temperature ..... -65°C to +150°C

Power Dissipation (Note 2)
- 16 Pin CERDIP (Note 3) 900mW
- 16 Pin Plastic DIP (Note 4) 470mW
- 16 Pin Small Outline (SE) (Note 5) 400mW

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- on Maxim's MAX332 and DG202 will be clamped by internal diodes, and are also internally current limited to 25mA.
Note 2: Device mounted with all leads soldered to PC board.
Note 3: Derate 12mW/°C above +75°C.
Note 4: Derate 6.5mW/°C above +25°C.
Note 5: Derate 7mW/°C above +25°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (DG202)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG202A MIN (Note 6)	DG202A TYP (Note 7)	DG202A MAX	LIMITS DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-5.0	-0.02					
	Drain ON Leakage Current (Note 8)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 2.4V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 2.4V		-1.0	-0.15		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0		0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off}				370	450		370	450	
	Charge Injection	Q	C_L = 1000pF, V_{GEN} = 0V, R_{GEN} = 0Ω			20			20		pC
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 0V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$				5			5		
	Channel ON Capacitance	$C_{D\ (on)}$ + $C_{S\ (on)}$	V_D = V_S = 0V, V_{IN} = 5V			16			16		
	OFF Isolation		V_{IN} = 0V, Z_L = 75kΩ			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
SUPPLY	Positive Supply Current	I^+	All Channels ON or OFF			0.9	2		0.9	2	mA
	Negative Supply Current	I^-	All Channels ON or OFF		-1	-0.3		-1	-0.3		

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 8: $I_{D(on)}$ is leakage from driver into "ON" switch.

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Quad SPST CMOS Analog Switches

- ♦ Significantly Reduced Power Consumption
- ♦ Lower Input Current Over Temperature
- ♦ No Input Current Spike

ABSOLUTE MAXIMUM RATINGS (MAX332, DG202): This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS (MAX332, DG202): Specifications below satisfy or exceed all "tested" parameters on adjacent page.

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = +25°C, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MAX332/DG202A MIN (Note 6)	MAX332/DG202A TYP (Note 7)	MAX332/DG202A MAX	DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 9)	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA			115	175		115	200	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	nA
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V		0.01	1.0		0.01	5.0	
				V_S = -14V, V_D = 14V	-1.0	-0.02		-5.0	-0.02		
	Drain ON Leakage Current (Note 8)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 2.4V			0.1	1.0		0.1	5.0	
			V_D = 14V, V_{IN} = 2.4V		-1.0	-0.15		-5.0	-0.15		
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0	-0.0004		-1.0	-0.0004		μA
			V_{IN} = 15V			0.003	1.0		0.003	1.0	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-1.0	-0.0004		-1.0	-0.0004		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			480	600		480	600	ns
	Turn-OFF Time	t_{off_1}				370	450		370	450	
	Charge Injection	Q	C_L = 1000pF, V_{GEN} = 0V, R_{GEN} = 0Ω			20			20		pC
	Source OFF Capacitance	$C_{S\ (off)}$	V_S = 0V, V_{IN} = 0V	f = 140kHz		5			5		pF
	Drain OFF Capacitance	$C_{D\ (off)}$				5			5		
	Channel ON Capacitance	$C_{D\ (on)}$ + $C_{S\ (on)}$	V_D = V_S = 0V, V_{IN} = 5V			16			16		
	OFF Isolation		V_{IN} = 0V, Z_L = 75kΩ			70			70		dB
	Crosstalk (Channel to Channel)		V_S = 2.0V, f = 100kHz			90			90		
SUPPLY	**Positive Supply Current**	**I^+**	**All Channels ON or OFF**			**0.02**	**0.1**		**0.02**	**0.1**	**mA**
	Negative Supply Current	**I^-**	**All Channels ON or OFF**		**-0.1**	**-0.01**		**-0.1**	**-0.01**		
	Power Supply Range for Continuous Operation	**V_{OP}**			**±4.5**		**±18**	**±4.5**		**±18**	**V**

Note 6: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 7: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.
Note 8: $I_{D(on)}$ is leakage from driver into "ON" switch.
Note 9: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V, are used.

Quad SPST CMOS Analog Switches

ELECTRICAL CHARACTERISTICS (DG202)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = Full Operating Temperature Range)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG202A MIN (Note 6)	DG202A TYP (Note 7)	DG202A MAX	LIMITS DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS\ (on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D\ (off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D\ (on)}$	V_S = -14V, V_{IN} = 2.4V				200			200	
			V_D = 14V, V_{IN} = 2.4V		-200			-200			
INPUT	Input Current With Input Voltage High	I_{INH}	V_{IN} = 2.4V		-1.0			-10			μA
			V_{IN} = 15V				-10			-10	
	Input Current With Input Voltage Low	I_{INL}	V_{IN} = 0V		-10			-10			

Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.

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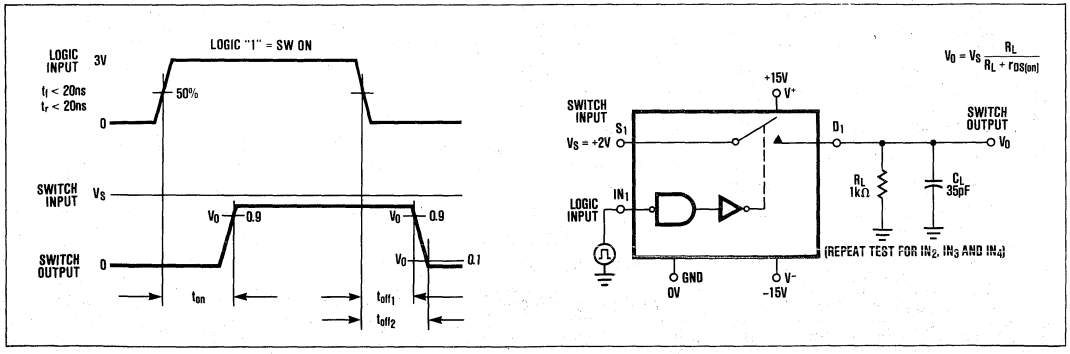
Switching Time Test Circuit

Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be +ve or -ve as per switching times test circuit.

V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.



Typical $R_{DS(ON)}$ vs. Power Supplies for Maxim's MAX332, DG202/DG212

POWER SUPPLIES	$R_{DS(ON)}$ AT ANALOG SIGNAL LEVEL					
	-5V	+5V	-10V	+10V	-15V	+15V
±5V	350Ω	380Ω				
±10V			165Ω	250Ω		
±15V			125Ω	160Ω	135Ω	155Ω

ELECTRICAL CHARACTERISTICS (MAX332, DG202):

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = full operating temperature range)

	PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS MAX332/DG202A MIN (Note 6)	MAX332/DG202A TYP (Note 7)	MAX332/DG202A MAX	LIMITS DG202B,C MIN (Note 6)	DG202B,C TYP (Note 7)	DG202B,C MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}			-15		15	-15		15	V
	Drain-Source ON Resistance (Note 11)	$r_{DS(on)}$	V_D = ±10V, V_{IN} = 2.4V, I_S = 1mA				250			250	Ω
	Source OFF Leakage Current	$I_{S(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D(off)}$	V_{IN} = 0.8V	V_S = 14V, V_D = -14V			100			100	
				V_S = -14V, V_D = 14V	-100			-100			
	Drain ON Leakage Current (Note 10)	$I_{D(on)}$	V_S = -14V, V_{IN} = 2.4V				200			200	
			V_D = 14V, V_{IN} = 2.4V		-200			-200			
INPUT	**Input Current With Input Voltage High**	I_{INH}	**V_{IN} = 2.4V**		**-1.0**			**-1.0**			µA
			V_{IN} = 15V				**1.0**			**1.0**	
	Input Current With Input Voltage Low	I_{INL}	**V_{IN} = 0V**		**-1.0**			**-1.0**			

Note 10: $I_{D(on)}$ is leakage from driver into "ON" switch.
Note 11: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V, are used.

Protecting Against Fault Conditions

Fault conditions occur when power supplies are turned off when input signals are still present or when over voltages occur at the inputs during normal operation. In either case, source-to-body diodes can be forward biased and conduct current from the signal source. If this current is required to be kept to low (µA) levels then the addition of external protection diodes is recommended.

To provide protection for over-voltages up to 20V above the supplies, a 1N4001 or 1N914 type diode should be placed in series with the positive and negative supplies as shown in Fig. 1. The addition of these diodes will reduce the analog signal range to 1 volt below the positive supply and 1 volt above the negative supply.

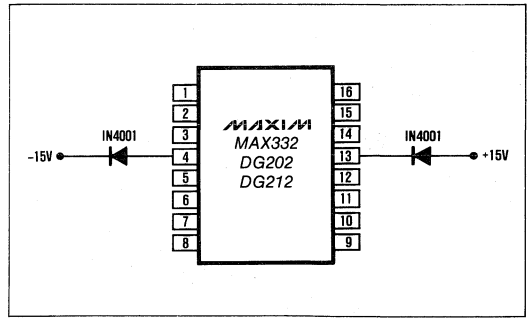
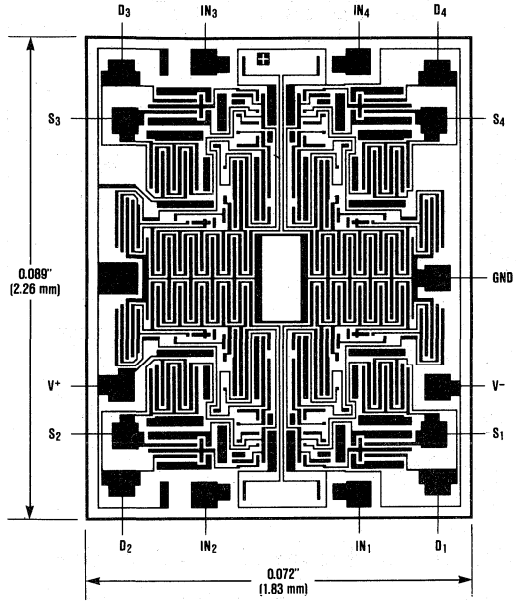


Figure 1. Protection Against Fault Conditions

2

Quad SPST CMOS Analog Switches

Chip Topography



MAXIM

Quad SPDT CMOS Analog Switch

General Description

The MAX333 is a quad single-pole-double-throw (SPDT) analog switch. These four independent switches can be operated with bipolar power supplies ranging from ±5V to ±18V, or single-ended power supplies of +10V to +30V.

The MAX333 has break-before-make switching, (200ns typical), a maximum turn-off time of 500ns, and a maximum turn-on time of 1000ns.

The MAX333 is ideal for portable operation since quiescent current is only 250μA maximum with all inputs high, and less with all inputs low.

Logic inputs are fully TTL and CMOS compatible and guaranteed over a +0.8V to +2.4V range, regardless of supply voltage. Logic inputs and switched analog signals can range anywhere between the supply voltages without damage. The MAX333 is a low-cost replacement for a DG211/DG212 pair when used as a quad SPDT switch.

Applications

Winchester Disk Drives

Test Equipment

Communications Systems

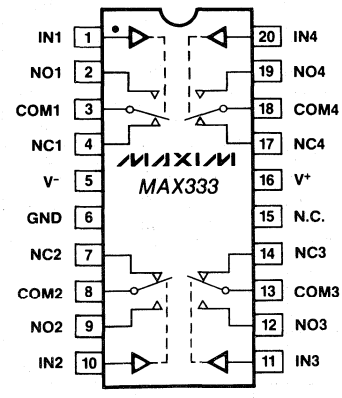
PBX, PABX

Head up Displays

Portable Instruments

Pin Configuration

TOP VIEW



SWITCHES ARE SHOWN WITH LOGICAL 0 INPUT

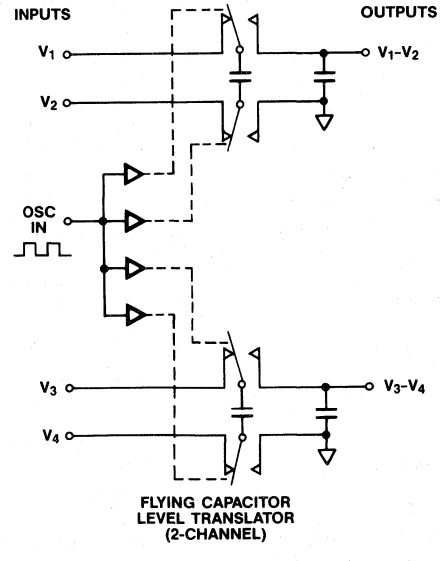
Features

- ◆ **Low Cost Per Channel**
- ◆ **Four Independent SPDT Switches**
- ◆ **Break-Before-Make Switching**
- ◆ **Guaranteed ±5V to ±18V Operation**
- ◆ **Guaranteed +10V to +30V Operation (Single Supply)**
- ◆ **No Separate Logic Supply Required**
- ◆ **CMOS and TTL Logic Compatible**
- ◆ **Monolithic, Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX333CPP	0°C to +70°C	20 Lead Plastic DIP
MAX333C/D	0°C to +70°C	Dice
MAX333EPP	-40°C to +85°C	20 Lead Plastic DIP
MAX333MJP	-55°C to +125°C	20 Lead CERDIP
MAX333CWP	0°C to +70°C	20 Lead Wide SO
MAX333EWP	-40°C to +85°C	20 Lead Wide SO

Typical Operating Circuit



FLYING CAPACITOR LEVEL TRANSLATOR (2-CHANNEL)

Quad SPDT CMOS Analog Switch

ABSOLUTE MAXIMUM RATINGS

V^+ to V^- 36V
V_{IN}, V_{COM}, V_{NO} or V_{NC} ..... V^- to V^+
$|V_{NO} - V_{NC}|$ 32V
V^+ to Ground 30V
V^- to Ground ..... -30V
Current, Any Terminal Except V_{COM}, V_{NO}, or V_{NC} .. 30mA
Continuous Current, V_{COM}, V_{NO} or V_{NC} 20mA
Peak Current, V_{COM}, V_{NO} or V_{NC}
(Pulsed at 1msec, 10% duty cycle max) 70mA

Storage Temperature ..... -65°C to +150°C
Power Dissipation (Note 1)
20 Pin CERDIP (Note 2) 900mW
20 Pin Plastic DIP (Note 3) 600mW
20 Pin Small Outline (WE) (Note 4) 800mW

Note 1: Device mounted with all leads soldered to PC board.
Note 2: Derate 11.1mW/°C above 70°C.
Note 3: Derate 8mW/°C above 70°C.
Note 4: Derate 10mW/°C above 70°C.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(GND = 0V, V^+ = +15V, V^- = -15V, T_A = +25°C, unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS MIN (Note 5)	LIMITS TYP (Note 6)	LIMITS MAX	UNITS
SUPPLY						
Positive Supply Current	I^+			0.13	0.25	mA
Supply Voltage Range	V^+/V^-	Dual Supply; $\|V^+\| = \|V^-\|$	±5		±18	V
Supply Voltage Range	V^+	Single Supply; V^- = GND	+10		+30	V
Negative Supply Current	I^-			0.01	0.25	mA
LOGIC INPUT						
Input Voltage Low	V_{IL}		V^-		+0.8	V
Input Voltage High	V_{IH}		2.4		V^+	V
Input Current	I_{IN}	V_{IN} = V^-, V^+	-10	0.0001	+10	µA
SWITCH						
Analog Signal Range	V_{ANA}		V		V^+	V
ON Circuit Resistance	R_{ON}	V_{ANA} = +10V; I_{COM} = 1mA V_{ANA} = -10V; I_{COM} = 1mA		140 125	175 175	Ω Ω
ON Circuit Leakage Current	I_{ONL}	V_{ANA} = +14V; V_{OFF} = -14V V_{ANA} = -14V; V_{OFF} = +14V	-5 -5	0.1 0.2	+5 +5	nA nA
OFF Circuit Leakage Current	I_{OFF}	V_{ANA} = +14V; V_{OFF} = -14V V_{ANA} = -14V; V_{OFF} = +14V	-5 -5	0.01 0.02	+5 +5	nA nA
DYNAMIC						
Turn-off Time	t_{OFF}	(See Switching Time Test Circuit)		50	500	ns
Turn-on Time	t_{ON}			460	1000	ns
Break-before-make Time	t_{OPEN}		50	200		ns
Off Capacitance	C_{OFF}	V_{ANA} = 0V		5		pF
On Capacitance	C_{ON}	V_{ANA} = 0V		5		pF
Off Isolation	OIRR	f = 1MHz, Rl = 75Ω V_{ANA} = $2.3V_{RMS}$		72		dB
Crosstalk	CCRR			78		dB

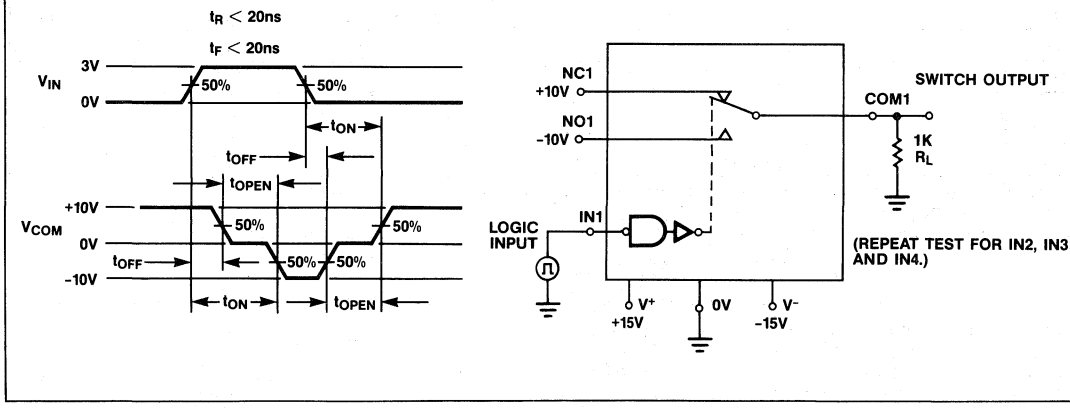
Note 5: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.
Note 6: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

ELECTRICAL CHARACTERISTICS

(GND = 0V, V^+ = +15V, V^- = -15V, T_A = Full Operating Temperature Range, unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS MIN (Note 5)	LIMITS TYP (Note 6)	LIMITS MAX	UNITS
LOGIC INPUT						
Input Voltage Low	V_{IL}		V^-		+0.8	V
Input Voltage High	V_{IH}		2.4		V^+	V
Input Current	I_{IN}	V_{IN} = V^-, V^+	-10	0.0001	+10	μA
SWITCH						
Analog Signal Range	V_{ANA}		V^-		V^+	V
ON Circuit Resistance	R_{ON}	V_{ANA} = +10V; I_{COM} = 1mA V_{ANA} = -10V; I_{COM} = 1mA		200 180	250 250	Ω Ω
ON Circuit Leakage Current	I_{ONL}	V_{ANA} = +15V; V_{OFF} = -15V V_{ANA} = -15V; V_{OFF} = +15V		200 200		nA nA
OFF Circuit Leakage Current	I_{OFF}	V_{ANA} = +15V; V_{OFF} = -15V V_{ANA} = -15V; V_{OFF} = +15V		100 100		nA nA

Switching Time Test Circuit



TYPICAL RDS(ON) & SUPPLY CURRENT VS. POWER SUPPLY VOLTAGE

Power Supply Voltage	R_{ON} at Analog Signal Levels (Ω) -15V	-10V	-5V	0V	+5V	+10V	+15V	Quiescent Supply Current (μA)	Charge Injection (pC)
V^- = -15V, V^+ = +15V	117			109			153	130	12
V^- = -10V, V^+ = +10V		158		156		171		80	10
V^- = -5V, V^+ = +5V			297	303	288			30	8
V^- = GND, V^+ = +15V				200			212	115	
V^- = GND, V^+ = +10V				300	312	303		30	

Quad SPDT CMOS Analog Switch

ELECTRICAL CHARACTERISTICS (Single Supply)

(GND = 0V, V^+ = +12V, V^- = 0V, T_A = 25°C, unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS MIN (Note 5)	LIMITS TYP (Note 6)	LIMITS MAX	UNITS
SUPPLY						
Supply Voltage Range	V^+	Single Supply; V^- = GND	+10		+30	V
Positive Supply Current	I^+			0.11	0.25	mA
INPUT						
Input Voltage Low	V_{INLO}		0		+0.8	V
Input Voltage High	V_{INHI}		2.4		V^+	V
Input Current	I_{IN}	V_{IN} = V^+, 0V			1	μA
SWITCH						
Analog Signal Range	V_{ANA}		V^-		V^+	V
ON Circuit Resistance	R_{ON}	V_{ANA} = +10V; I_{COM} = 1mA V_{ANA} = 0V; I_{COM} = 1mA		250 240	350 350	Ω Ω
ON Circuit Leakage Current	I_{ONL}	V_{ANA} = V^+; V_{OFF} = 0V V_{ANA} = 0V; V_{OFF} = V^+		0.05 0.05		nA nA
OFF Circuit Leakage Current	I_{OFF}	V_{ANA} = V^+ V_{ANA} = 0V		0.01 0.01		nA nA
DYNAMIC						
Turn-off Time	t_{OFF}	(See Switching Time Test Circuit)		65		ns
Turn-on Time	t_{ON}			700		ns
Break-before-make Time	t_{OPEN}			200		ns
Off Isolation	OIRR	f = 1MHz, Rl = 75Ω V_{ANA} = 2.3V_{RMS}		70		dB
Crosstalk	CCRR			72		dB

Note 5: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

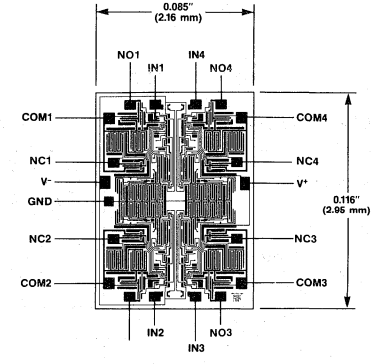
Note 6: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Protecting Against Fault Conditions

Fault conditions occur when power supplies are turned off when input signals are still present or when over voltages occur at the inputs during normal operation. In either case, source-to-body diodes can be forward biased and conduct current from the signal source. If this current is required to be kept to low (μA) levels then the addition of external protection diodes is recommended.

To provide protection for over-voltages up to 20V above the supplies, 1N4001 or 1N914 type diodes should be placed in series with the positive and negative supplies. The addition of these diodes will reduce the analog signal range to 1 volt below the positive supply and 1 volt above the negative supply.

Chip Topography



NOTE: NCx IS CONNECTED TO COMx WHEN INx IS LOW.

High Speed Quad SPST Analog Switch

General Description

The MAX334 is a quad single-pole-single-throw, normally closed (SPST, NC) analog switch, pin compatible with the Harris HI-201HS and Siliconix DG271. The MAX334 has guaranteed break-before-make switching ($t_{OFF} < t_{ON}$), while featuring fast switching speeds. Turn-on time is less than 100ns and turn-off time is less than 50ns; channel on resistance is 50 ohms maximum. CMOS inputs provide reduced input loading and very low leakage currents.

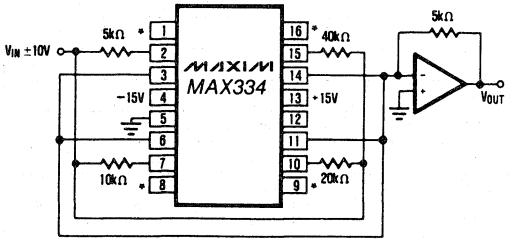
The MAX334 is also a direct replacement for the DG201 and DG211, featuring ¼ the on resistance and five times the speed.

The MAX334 may be used with split supplies (±5V to ±15V) or single positive supplies (+5V to +30V) while retaining CMOS and TTL logic compatible inputs, and maintaining high switching speed.

Applications

Sample and Hold Circuits
Winchester Disk Drives
Test Equipment
Communications Systems
PBX, PABX
Guidance and Control Systems
Heads-up Displays
Military Radios

Typical Operating Circuit



Programmable Gain Amplifier

Note: * Pins 1, 8, 9 and 16 are logic control inputs.

Features

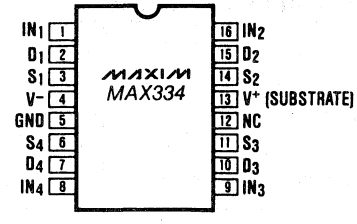
- **$R_{ds(ON)}$ 50Ω (max.)**
- **Guaranteed Break-Before-Make Switching**
- **Single or Bipolar Supply Operation**
- **CMOS and TTL Logic Compatible**
- **Faster, Lower R_{ON} Replacement for DG201 and DG211**

Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX334CPE	0°C to +70°C	16 Lead Plastic DIP
MAX334CWE	0°C to +70°C	16 Lead Wide SO
MAX334C/D	0°C to +70°C	Dice
MAX334CJE	0°C to +70°C	16 Lead CERDIP
MAX334EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX334EJE	-40°C to +85°C	16 Lead CERDIP
MAX334EWE	-40°C to +85°C	16 Lead Wide SO
MAX334MJE	-55°C to +125°C	16 Lead CERDIP

Pin Configuration

Top View



LOGIC	SWITCH
0	ON
1	OFF

High Speed Quad SPST Analog Switch

ABSOLUTE MAXIMUM RATINGS

Supply Voltage (Between Pins 4 and 13) 36V
Digital Input Voltage (Pins 1, 8, 9, 16) ..... $+V_{SUPPLY}$ +4V
$-V_{SUPPLY}$ -4V
Analog Input Voltage (S to D) ..... $+V_{SUPPLY}$ +2.0V
Pins 2, 3, 6, 7, 10, 11, 14, 15 ..... $-V_{SUPPLY}$ -2.0V
Peak Current, S or D 80mA
Total Power Dissipation (Note 1) 750mW

Maximum Junction Temperature ..... 175°C
Operating Temperature
MAX334M ..... -55°C to +125°C
MAX334E ..... -40°C to +85°C
MAX334C ..... 0°C to +70°C
Storage Temperature ..... -65°C to +150°C

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to Absolute Maximum Ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V^- = -15V, V_{AH} (Logic Level High) = 3.0V, V_{AL} (Logic Level Low) = +0.8V, GND = 0V, unless otherwise specified.)

PARAMETER		TEMPERATURE	MAX334M/E			MAX334C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
ANALOG SWITCH CHARACTERISTICS									
V_S, Analog Signal Range		Full	-15		+15	-15		+15	V
R_{ON}, On Resistance (Note 2)		+25°C		30	50		30	50	Ω
		Full			75			75	
R_{ON} Match		+25°C		3			3		%
$I_{S(OFF)}$, Off Input Leakage Current	V_S = 14V, V_D = -14V	+25°C	-1	.3	1	-1	.3	1	nA
	V_S = -14V, V_D = 14V	Full	-100		100	-50		50	
$I_{D(OFF)}$, Off Output Leakage Current	V_D = 14V, V_S = -14V	+25°C	-1	.3	1	-1	.3	1	nA
	V_D = -14V, V_S = 14V	Full	-100		100	-50		50	
$I_{D(ON)}$, On Leakage Current	V_D = V_S = 14V	+25°C	-1	.1	1	-1	.1	1	nA
	V_D = V_S = -14V	Full	-100		100	-50		50	
DIGITAL INPUT CHARACTERISTICS									
V_{AL} Input Low		+25°C							V
		Full			0.8			0.8	
V_{AH} Input High		+25°C							V
		Full	3.0			3.0			
I_{AL}, Input Leakage Current (Low)		+25°C	-1.0	0.1	1.0	-1.0	0.1	1.0	μA
		Full	-10		10	-10		10	
I_{AH}, Input Leakage Current (High)		+25°C	-1.0	0.1	1.0	-1.0	0.1	1.0	μA
		Full	-10		10	-10		10	

Note 1: Derate 8mW/°C above T_A = 75°C, θ_{JA} = 100°C/W, θ_{JC} = 60°C/W
Note 2: V_{OUT} = ±10V, I_{OUT} = 1mA
Note 3: R_L = 1kΩ, C_L = 35pF, V_{IN} = +10V, V_A = +3V (See Switching Waveforms)
Note 4: V_A = 3V, R_L = 1kΩ, C_L = 10pF, V_{IN} = 3Vrms, f = 100kHz
Note 5: V_A = 3V, R_L = 1kΩ, f = 100kHz, V_{IN} = 3Vrms
Note 6: C_L = 1000pF, V_{IN} = 0V, R_{IN} = 0Ω, $\Delta Q = C_L \times \Delta V_O$
Note 7: V_A = 3V or V_A = 0 for all switches
Note 8: t_{BBM} is fastest turn-on time (of the four switches) minus the slowest turn-off time.

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = +15V, V^- = -15V, V_{AH} (Logic Level High) = 3.0V, V_{AL} (Logic Level Low) = +0.8V, GND = 0V, unless otherwise specified.)

PARAMETER		TEMPERATURE	MAX334M/E			MAX334C			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	
SWITCHING CHARACTERISTICS									
t_{ON}, Switch ON Time (Note 3)		+25°C		70	100		70	120	ns
t_{ON}, Switch ON Time (Note 3)		Full		100			125		ns
t_{OFF1}, Switch OFF Time (Note 3)		+25°C		40	50		40	75	ns
t_{OFF1}, Switch OFF Time (Note 3)		Full		50			75		ns
t_{OFF2}, Switch OFF Time (Note 3)		+25°C		150			150		ns
Output Settling Time 0.1%		+25°C		180			180		ns
t_{BBM}, Break-Before-Make (Note 8)		+25°C	10	30			30		ns
"Off Isolation" (Note 4)		+25°C		72			72		dB
Crosstalk (Note 5)		+25°C		86			86		dB
Charge Injection (Note 6)		+25°C		10			10		pC
$C_{S(OFF)}$, Input Switch Capacitance		+25°C		10			10		pF
Output Switch Capacitance	$C_{D(OFF)}$	+25°C		10			10		pF
	$C_{D(ON)}$	+25°C		30			30		
C_A, Digital Input Capacitance		+25°C		18			18		pF
$C_{DS(OFF)}$, Drain-to-Source Capacitance		+25°C		.5			.5		pF
POWER REQUIREMENTS (Note 7)									
P_D, Power Dissipation		+25°C		120			120		mW
		Full							
I^+, Current (Pin 13)		+25°C		4.5			4.5		mA
		Full			10.0			10.0	
I^-, Current (Pin 4)		+25°C		3.5			3.5		mA
		Full			6			6	

Typical Single Supply Operation (V^- = GND, V_S = +10V, R_L = 1000 Ohms)

V^+	$R_{DS(ON)}$ (Ohms)	T_{ON} (ns)	T_{OFF} (ns)	TTL Compatible?	I_{V+} with TTL_{IN} = 3V on all switches
+5*	200	360	25	Yes	6.0μA
+10	85	150	30	Yes	1.5mA
+12	75	140	25	Yes	2.0mA
+15	65	100	25	Yes	4.5mA
+20	55	70	25	Yes	7.0mA
+25	50	50	30	V_{AH} = 4V	10.0mA
+30	45	45	40	V_{AH} = 4V	14.0mA

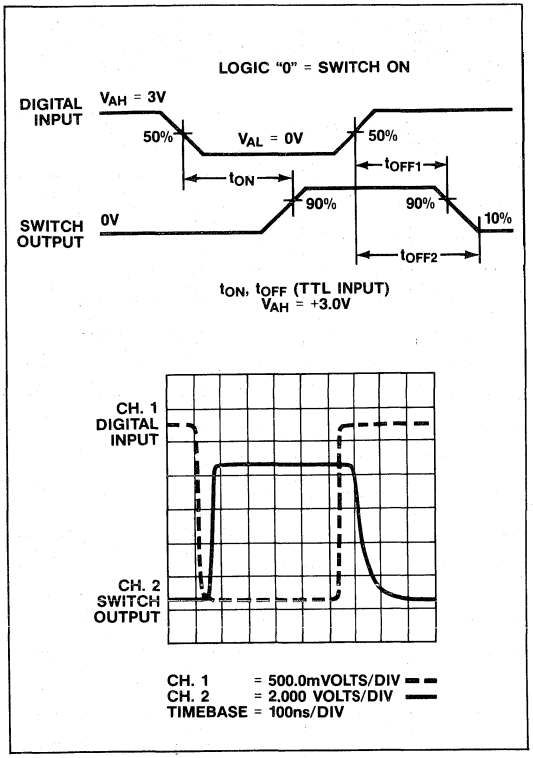
*V_S = +5V, for this case.

Typical Single Supply Charge Injection (C_L = 1000pF)

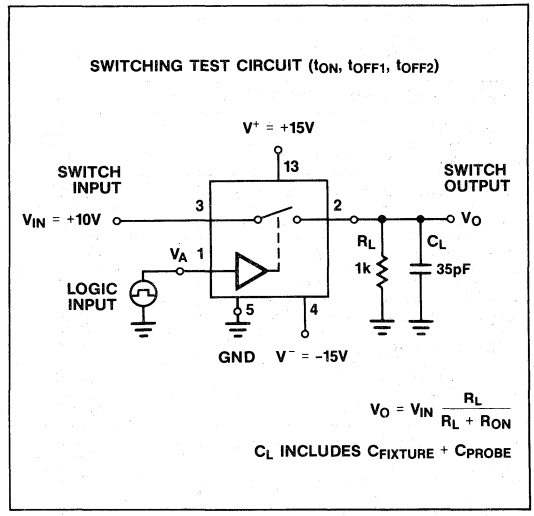
V_{ANALOG}	V^+ SUPPLY VOLTAGE				
	+5V	+10V	+15V	+20V	+30V
0V	7pC	10pC	10pC	6pC	12pC
V^+	4pC	6pC	6pC	6pC	14pC

High Speed Quad SPST Analog Switch

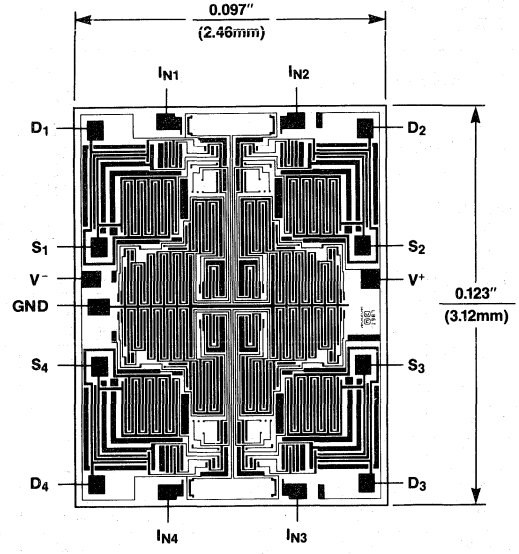
Switching Waveforms



Test Circuit



Chip Topography



MAXIM

High Voltage CMOS/DMOS Analog Switches

General Description

The MAX341/43/45/48 are CMOS/DMOS analog switches intended for high voltage use as well as high reliability general purpose applications. The operating supply range is ±20V to ±50V or +20V to +60V when using a single power supply. Signal handling capability extends from the negative to the positive supply voltage, i.e. over a 100V peak-to-peak range with ±50V power supplies.

The switch control inputs can be driven with CMOS or other high level logic signals. All switches are normally closed, i.e. an input "0" level turns the switch ON. The MAX341 and MAX348 are dual SPST switches, the MAX343 is a dual SPDT switch, and the MAX345's configuration is dual DPST. The MAX348 is a reduced R_{ON} version of the MAX341.

Positive supply current for all devices is less than 300μA and negative supply current is less than 100μA with ±50V power supplies. When using a single power supply and logic input levels equal to the supply value, the power supply currents are less than 20μA.

Applications

Medical Ultrasound Equipment
Automatic Test Equipment
Diagnostic Systems
48 Volt Telecom Systems
Stepper and DC Motor Drivers

Features

- ±20V to ±50V and Single Supply Operation
- R_{ON} Less than 55Ω (MAX348)
- -70dB Typical OFF Isolation at 1MHz
- Input Voltage Range Includes Power Supplies
- 100V peak-to-peak Signal Handling Capability
- Guaranteed Break-Before-Make Operation
- Completely Latchup-Proof Construction

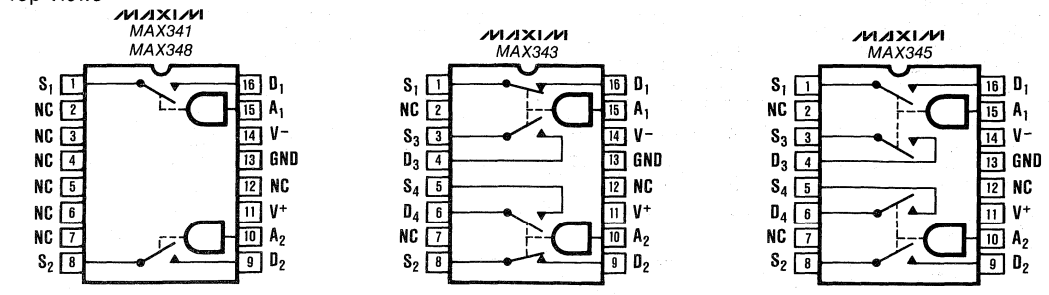
Ordering Information

PART	TEMP. RANGE	PACKAGE
MAX341C/D	0°C to +70°C	Dice
MAX341CPE	0°C to +70°C	16 Lead Plastic DIP
MAX341CWE	0°C to +70°C	16 Lead Wide SO
MAX341EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX341EWE	-40°C to +85°C	16 Lead Wide SO
MAX341EJE	-40°C to +85°C	16 Lead CERDIP
MAX341MJE	-55°C to +125°C	16 Lead CERDIP
MAX343C/D	0°C to +70°C	Dice
MAX343CPE	0°C to +70°C	16 Lead Plastic DIP
MAX343CWE	0°C to +70°C	16 Lead Wide SO
MAX343EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX343EWE	-40°C to +85°C	16 Lead Wide SO
MAX343EJE	-40°C to +85°C	16 Lead CERDIP
MAX343MJE	-55°C to +125°C	16 Lead CERDIP

(Ordering Information Continued on Last Page.)

Pin Configurations

Top Views



Dual SPST | Dual SPDT | Dual DPST

Switch States are for Logic "1" Input.

High Voltage CMOS/DMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

V^+ to V^- Voltage ..... +120V
V^+ to GND Voltage ..... +65V
Digital Input Voltage ..... V^- to V^+
Input Current
S and D ..... +200mA
All pins except S and D ..... ±30mA
Lead Temperature (Soldering 10 sec) ..... +300°C
Storage Temperature ..... -65°C to +150°C

Operating Temperature Range
MAX34XC ..... 0°C to +70°C
MAX34XE ..... -40°C to +85°C
MAX34XM ..... -55°C to +125°C
Power Dissipation (16 pin packages)
CERDIP (derate 10mW/°C above +75°C) 750mW
Plastic DIP (derate 7.35mW/°C above +75°C) 550mW
Small Outline (derate 9mW/°C above +75°C) 680mW

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation at these or any other conditions above those indicated in the operations section of the specifications is not implied. Exposure to absolute maximum ratings for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(Over Temperature, V^+ = +50V, V^- = -50V, GND = 0V unless otherwise indicated)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Analog Signal Range	V_S, V_D		V^+		V^-	V
Channel ON Resistance MAX341/43/45 MAX341/43/45 MAX348 MAX348	R_{ON}	V_S = ±50V, I_S = 10mA T_A = +25°C Over Temp. T_A = +25°C Over Temp		80 35 	110 160 55 80	Ω
ON Resistance Match	ΔR_{ON}	V_S = ±50V, I_S = 10mA		7		%
OFF Leakage Current (Figure 7)	$I_{D(OFF)}$, $I_{S(OFF)}$	V_S = ±50V, V_D = ∓50V T_A = +25°C Over Temp.		10 1000	50 5000	nA
ON Output Leakage Current (Figure 8)	$I_{D(ON)}$, $I_{S(ON)}$	V_S = V_D = ±50V T_A = +25°C Over Temp.		10 1000	60 5000	nA
Input Low Threshold	V_{AL}				3.5	V
Input High Threshold	V_{AH}		12			V
Input Current (Logic)	I_A	V_A = 0V to +15V		0.1	10	µA
Turn-On Time (Figure 9)	t_{ON}	T_A = +25°C Over Temp.		0.5	1.0 1.5	µs
Turn-Off Time (Figure 9)	t_{OFF}	T_A = 25°C Over Temp.		0.4	0.75 1.0	µs
OFF Isolation (Figure 4)	ISO_{OFF}	T_A = +25°C, 1MHz, R_L = 75Ω		-70		dB
Channel-Channel Crosstalk (Figure 5)	ISO_X	T_A = +25°C, 1MHz, R_L = 75Ω		-75		dB
Channel Input Capacitance OFF State, C to Gnd OFF State, C to Out ON State, C to Gnd	$C_{S(OFF)}$ $C_{SD(OFF)}$ $C_{S(ON)}$	T_A = +25°C, V_S = 0V		17 1 38		pF
Charge Injection (Figure 6)	Q	V_S = +50V V_S = 0V V_S = -50V		100 240 480		pC
Supply Current V^+ Current	I^+	T_A = +25°C Over Temp.		 200	300 600	µA
Supply Current V^- Current	I^-	T_A = +25°C Over Temp.		40 55	100 200	µA
Supply Voltage Range Split Supplies Single Supply		 GND = 0V V^- = GND = 0V	 ±20 +20		 ±50 +60	V

Detailed Description

Analog Signal Range

The MAX341 family's analog signal range is equal to the power supply value, up to ±50V with split power supplies and +60V with a single power supply (V^- connected to GND). An ON switch is also capable of passing up to 0.5A on a peak current basis. Maximum continuous current is limited only by the package power dissipation (see Absolute Maximum Ratings)

ON Resistance

The ON resistance of the MAX341 series switches is typically 40Ω. R_{ON} does, however increase as the switch voltage (V_S) approaches V^+. For example, with ±50V supplies and a +50V analog signal, R_{ON} will be typically less than 100Ω (50Ω for the MAX348), and 45Ω (25Ω for the MAX348) for -50V signals. With ±50V power supplies, and ±40V switch voltages, R_{ON} is about 40Ω for the +40V case and 30Ω for the -40V case. ON resistance can be reduced and current handling capacity can be increased by connecting switches in parallel. This is especially useful in power switching applications. Table 1 and the graph in the Typical Characteristics section further describe the relation between R_{ON} and V^+.

Table 1: ON Resistance

V^+/V^-	R_{ON} AT $V_S = V^+$	R_{ON} AT $V_S = V^-$
+20V/-20V	127Ω	39Ω
+30V/-30V	105Ω	36Ω
+40V/-40V	92Ω	32Ω
+50V/-50V	84Ω	30Ω
+40V/GND	127Ω	39Ω
+60V/GND	105Ω	36Ω

Note:
Typical R_{ON} for the MAX348 is approximately one half of the above values.

Power Supply Current

The maximum supply current for V^+ and V^- at 25°C is 300μA and 100μA respectively. However, the positive supply current (I^+) is partly dependent on the input logic level and can be reduced if control signals of a larger amplitude than 0V and +15V are used. If the control inputs swing to within 4V of V^+ and V^- then I^+ drops to a typical value of 20μA.

Control Inputs

15V logic level inputs are required to turn switches on or off, but the control inputs can also accept levels up to V^+ and V^-. A input greater than 12V constitutes a "1" state (switch OFF), and an input less than 3.5V will constitute a "0" state (switch ON).

Standard TTL logic can be used with MAX341 series switches if a level shifter such as the MC14504 is used to drive the control inputs as shown in in figure 1. Open collector drivers, with external pull-up resistors, can be used in a similar fashion as well.

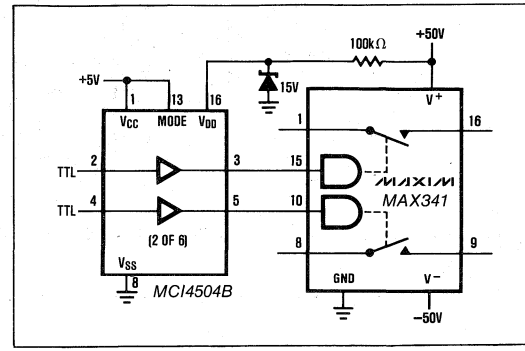


Figure 1. Using TTL Control Levels.

Applications

Flying Capacitor Input

A "flying capacitor" differential to single-ended converter takes advantage of the MAX343's wide input voltage range, which allows large common mode inputs to be rejected. As shown in Figure 2, a capacitor is alternately charged by the differential input signal and then is connected to an op-amp or A-to-D input. An instrumentation amplifier is not required since the output signal can be referenced to ground. Sample-hold operation is also built in to the design and the MAX343's break-before-make operation ensures that the output sees only the differential portion of the input signal. A similar approach can also be used for single-ended to differential signal conversion as well.

Parallel Switches

In designs where power switching ability is needed, any of the MAX341 series switches can be connected in parallel to increase current handling capability and reduce ON resistance. Applications such as ultrasonics, RF power, and DC motor drive are areas where this is often important. A MAX348 is shown in a parallel configuration in figure 3. The resulting SPST switch has a typical R_{ON} of 12Ω (5Ω for signals more than 10V below V^+) and can handle pulsed loads of up to 0.5 Amps. With ±50V power supplies, the peak-to-peak signal range is still 100V and 10MHz signals can be switched while maintaining typically -50dB of isolation.

High Voltage CMOS/DMOS Analog Switches

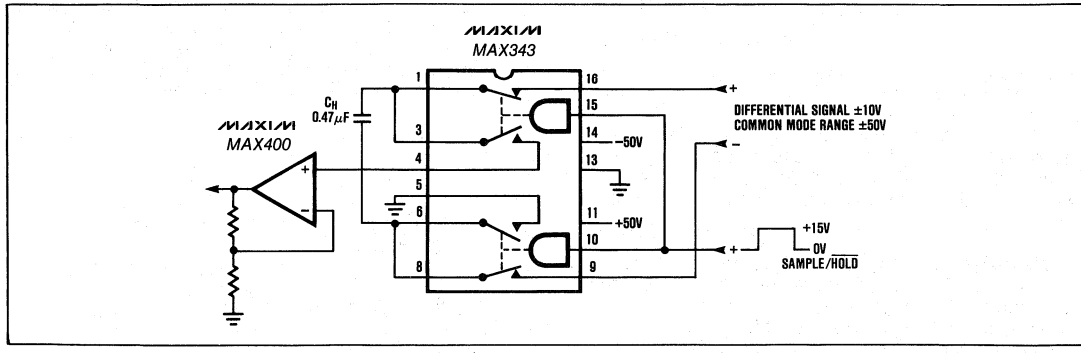


Figure 2. Flying Capacitor Differential to Single-Ended Converter with ±50V Common-Mode Range.

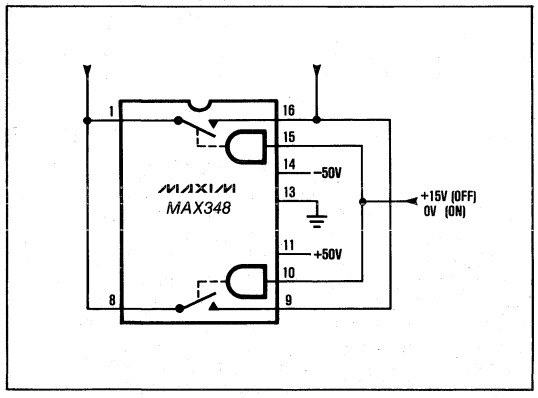


Figure 3. Minimum R_{ON} (5 to 10Ω typ.) High Voltage Switch.

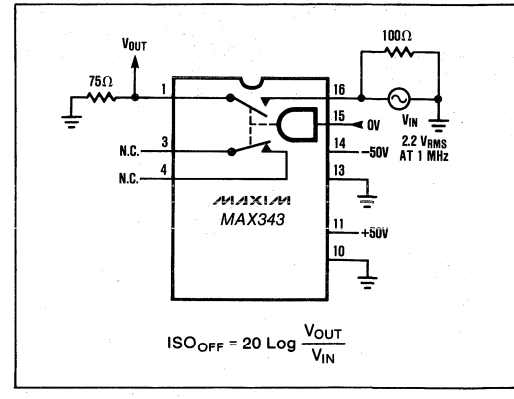


Figure 4. OFF Isolation Test Circuit.

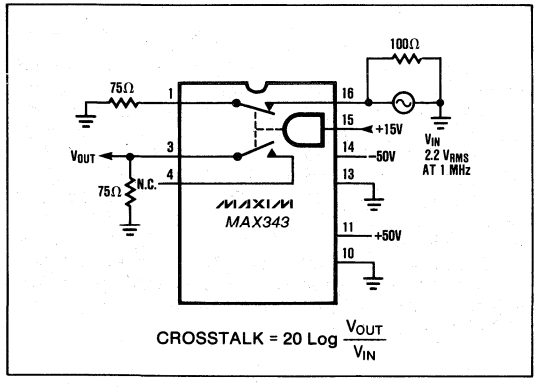


Figure 5. Channel-Channel Crosstalk Test Circuit.

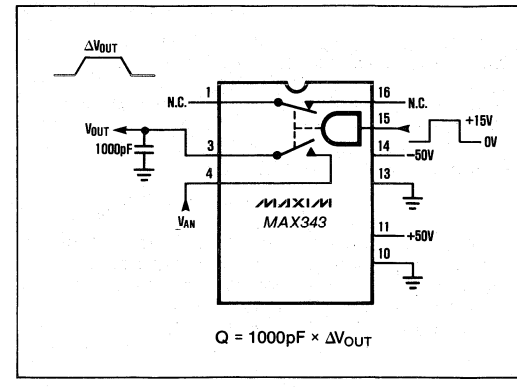
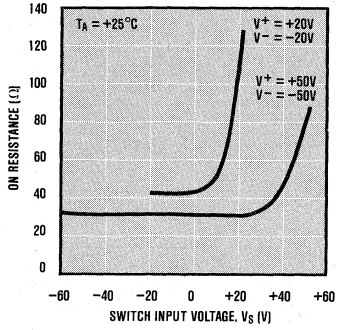


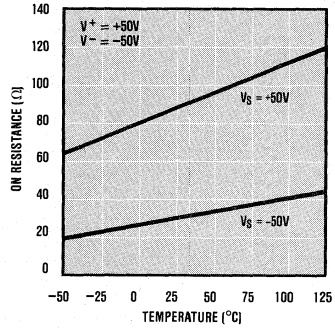
Figure 6. Charge Injection Test Circuit.

Typical Operating Characteristics

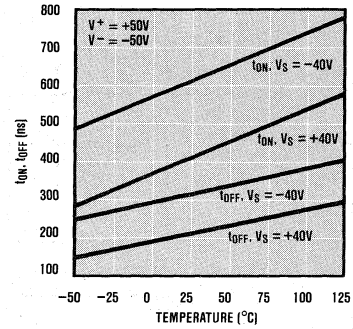
ON RESISTANCE vs. SWITCH INPUT VOLTAGE



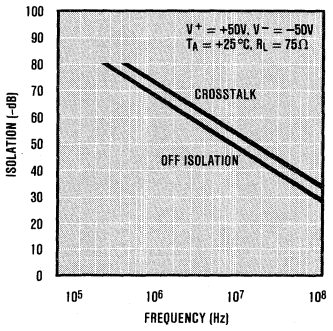
ON RESISTANCE vs. TEMPERATURE



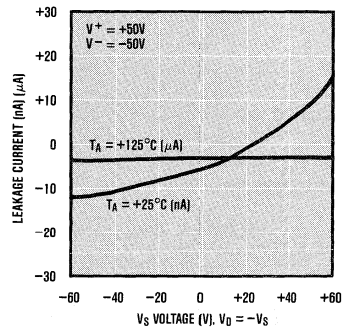
SWITCHING TIME vs. TEMPERATURE



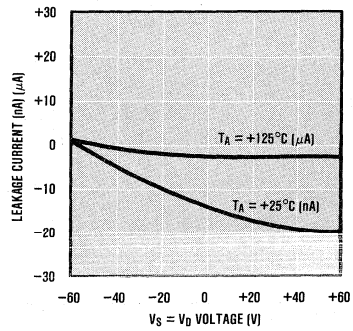
OFF ISOLATION AND CROSSTALK vs. FREQUENCY



OFF LEAKAGE vs. SWITCH VOLTAGE



ON LEAKAGE vs. SWITCH VOLTAGE



Test Circuits

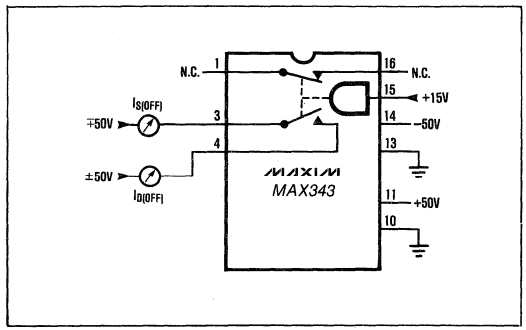


Figure 7. OFF Leakage Test Circuit.

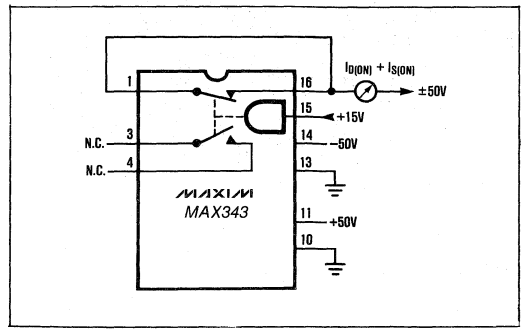


Figure 8. ON Leakage Test Circuit.

High Voltage CMOS/DMOS Analog Switches

Test Circuit

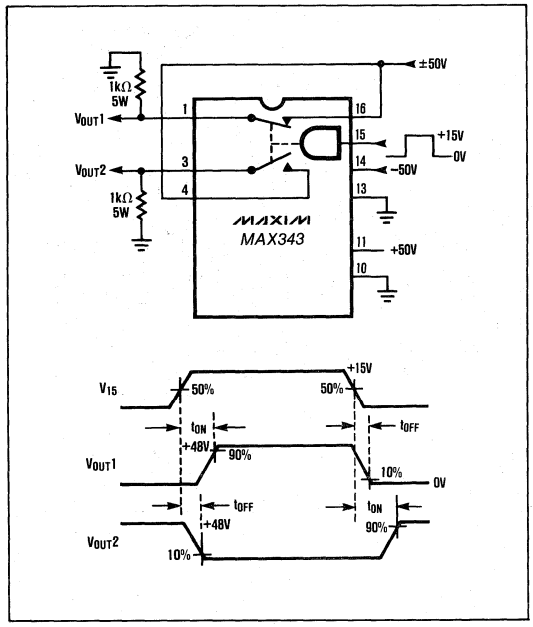
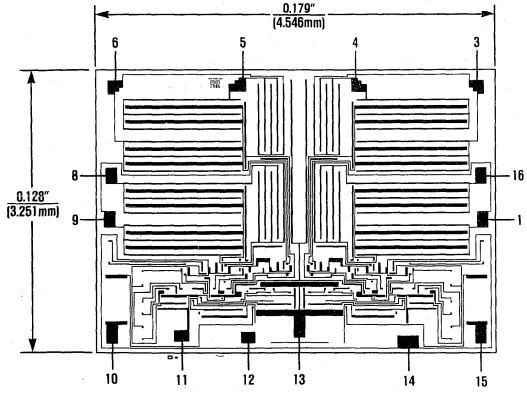


Figure 9. Switching Time Test Circuit.

Chip Topography



See Pin Configurations for pin functions.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
MAX345C/D	0°C to +70°C	Dice
MAX345CPE	0°C to +70°C	16 Lead Plastic DIP
MAX345CWE	0°C to +70°C	16 Lead Wide SO
MAX345EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX345EWE	-40°C to +85°C	16 Lead Wide SO
MAX345EJE	-40°C to +85°C	16 Lead CERDIP
MAX345MJE	-55°C to +125°C	16 Lead CERDIP
MAX348C/D	0°C to +70°C	Dice
MAX348CPE	0°C to +70°C	16 Lead Plastic DIP
MAX348CWE	0°C to +70°C	16 Lead Wide SO
MAX348EPE	-40°C to +85°C	16 Lead Plastic DIP
MAX348EWE	-40°C to +85°C	16 Lead Wide SO
MAX348EJE	-40°C to +85°C	16 Lead CERDIP
MAX348MJE	-55°C to +125°C	16 Lead CERDIP

MAXIM

Dual Monolithic SPST CMOS Analog Switch

General Description

The DG200A is a dual, normally closed, single-pole-single-throw (SPST) analog switch. This CMOS switch can be operated with power supplies ranging from ±4.5V to ±18V. The DG200A has guaranteed break-before-make switching. Its maximum turn-off time is 500ns, and its maximum turn-on time is 100ns.

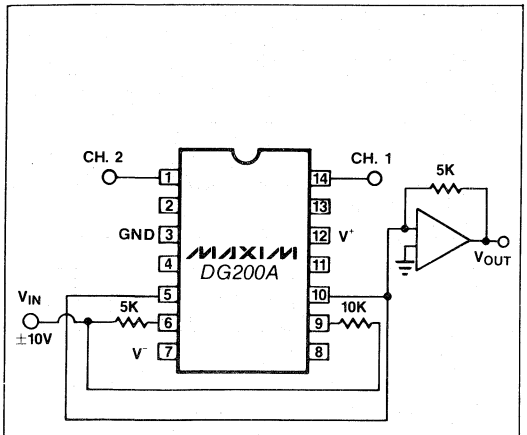
Maxim guarantees that the DG200A will not latch-up if the power supplies are turned off with input signals still connected as long as absolute maximum ratings are not violated.

Compared to the original manufacturer's product, Maxim's DG200A consumes significantly lower power, making it better suited for portable applications.

Applications

Winchester Disk Drives
Test Equipment
Communications Systems
PBX, PABX
Guidance and Control Systems
Head up Displays
Military Radios

Typical Operating Circuit



Programmable Gain Amplifier

Features

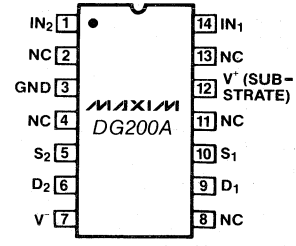
- **Improved 2nd Source! Power Supply Current <300μA**
- **Wide Supply Range ±4.5V to ±18V**
- **Single Supply Operation**
- **Non-Latching with Supplies Turned-off and Input Signals Present**
- **CMOS and TTL Logic Compatible**
- **Monolithic, Low Power CMOS Design**

Ordering Information

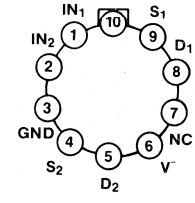
PART	TEMP. RANGE	PACKAGE
DG200AAK	-55°C to +125°C	14 Lead CERDIP
DG200ABK	-25°C to +85°C	14 Lead CERDIP
DG200ACK	0°C to +70°C	14 Lead CERDIP
DG200ACJ	0°C to +70°C	14 Lead Plastic DIP
DG200ACY	0°C to +70°C	14 Lead Small Outline
DG200AC/D	0°C to +70°C	Dice
DG200AAA	-55°C to +125°C	10 Pin Metal Can
DG200ABA	-25°C to +85°C	10 Pin Metal Can
DG200ACA	0°C to +70°C	10 Pin Metal Can

Pin Configuration

Top View



V+ (SUBSTRATE AND CASE)



Dual Monolithic SPST CMOS Analog Switch

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V^-
V^+ 44V
GND 25V
Digital Inputs V_S, V_D (Note 1) ..... -2V to (V^+ + 2V) or 20mA, whichever occurs first.
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 20mA
(Pulsed at 1msec, 10% duty cycle max) 100mA
Storage Temperature (A & B Suffix) ..... -65 to 150°C
(C Suffix) ..... -65 to 125°C
Operating Temperature (A Suffix) ..... -55 to 125°C
(B Suffix) ..... -25 to 85°C
(C Suffix) ..... -25 to 85°C
Power Dissipation (Package)*
Metal Can** 450mW
14 Pin Ceramic DIP*** 825mW
14 Pin Plastic DIP**** 470mW
*All leads soldered or welded to PC board.
**Derate 6mW/°C above 75°C.
***Derate 11mW/°C above 75°C.
****Derate 6.5mW/°C above 25°C.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated.)

PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS DG200A MIN (Note 2)	DG200A TYP (Note 3)	DG200A MAX	LIMITS DG200 B/C/D MIN (Note 2)	DG200 B/C/D TYP (Note 3)	DG200 B/C/D MAX	UNITS
SWITCH										
Analog Signal Range (Note 1)	V_{ANALOG}			-15		15	-15		15	V
Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{in} = 0.8V, I_S = 1mA			45	70		45	80	Ω
Source OFF Leakage Current	$I_{S(off)}$	V_{in} = 2.4V	V_S = 14V, V_D = -14V		0.01	2.0		0.01	5.0	nA
			V_S = -14V, V_D = 14V	-2.0	-0.02		-5.0	-0.02		
Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		0.01	2.0		0.01	5.0	
			V_S = 14V, V_D = -14V	-2.0	-0.02		-5.0	-0.02		
Drain ON Leakage Current (Note 4)	$I_{D(on)}$	V_{in} = 0.8V	V_S = V_D = 14V		0.1	2.0		0.1	5.0	
			V_S = V_D = -14V	-2.0	-0.1		-5.0	-0.1		
INPUT										
Input Current with Input Voltage High	I_{INH}	V_{in} = 2.4V, V_{in} = 15V		-1.0	0.0009		-1.0	0.0009		μA
					0.005	1.0		0.005	1.0	
Input Current with Input Voltage Low	I_{INL}	V_{in} = 0V		-1.0	-0.0015		-1.0	-0.0015		
DYNAMIC										
Turn-ON Time	t_{on}	See Switching Time Test Circuit (Figure 1)			440	1000		440	1000	ns
Turn-OFF Time	t_{off}				70	500		70	500	
Charge Injection	Q	C_L = 1000pF, V_{GEN} = 0V, R_{GEN} = 0Ω (Figure 2)			10			10		pC
Source OFF Capacitance	$C_{S(off)}$	f = 140kHz, V_{in} = 5V or V_S = 0V	V_S = 0V		9.0			9.0		pF
Drain OFF Capacitance	$C_{D(off)}$		V_D = 0V		9.0			9.0		
Channel ON Capacitance	$C_{D(on)}$ + $C_{S(on)}$		V_D = V_S = 0V		25			25		
OFF Isolation Figure 3 (Note 5)		V_{in} = 5V, Z_L = 75Ω, V_S = 2.0V, f = 1MHz			75			75		dB
Crosstalk Figure 4 (Channel to Channel)					90			90		

ELECTRICAL CHARACTERISTICS (continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated.)

PARAMETER	SYMBOL	TEST CONDITIONS	LIMITS						UNITS
			DG200A			DG200 B/C/D			
			MIN (Note 2)	TYP (Note 3)	MAX	MIN (Note 2)	TYP (Note 3)	MAX	
SUPPLY									
Positive Supply Current	I+	Both Channels ON or OFF V_{in} = 0 and 2.4V		180	300		200	500	μA
Negative Supply Current	I-		-10	-0.1		-100	-0.1		

ELECTRICAL CHARACTERISTICS (Over Temperature)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = Over Temperature Range, unless otherwise indicated.)

PARAMETER	SYMBOL	TEST CONDITIONS		LIMITS					UNITS
				DG200A			DG200 B/C		
				MIN (Note 2)	TYP (Note 3)	MAX	MIN (Note 2)	TYP (Note 3)	MAX	
SWITCH										
Analog Signal Range (Note 1)	V_{ANALOG}			-15		15	-15		15	V
Drain-Source ON Resistance	$r_{DS(on)}$	V_D = ±10V, V_{in} = 0.8V, I_S = 1mA			100			100		Ω
Source OFF Leakage Current	$I_{S(off)}$	V_{in} = 2.4V	V_S = 14V, V_D = -14V		100			100		nA
			V_S = -14V, V_D = 14V	-100			-100			
Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		100			100		
			V_S = 14V, V_D = -14V	-100			-100			
Drain ON Leakage Current (Note 4)	$I_{D(on)}$	V_{in} = 0.8V	V_S = V_D = 14V		200			200		
			V_S = V_D = -14V	-200			-200			
INPUT										
Input Current/ Voltage High	I_{INH}	V_{in} = 2.4V, V_{in} = 15V		-10			-10			μA
						10			10	
Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-10			-10			

Note 1: Signals on S_X, D_X, or IN_X, exceeding V^- or V^+ will be clamped by internal diodes. LIMIT FORWARD DIODE CURRENT to maximum current ratings.

Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive is a maximum, is used in this data sheet.

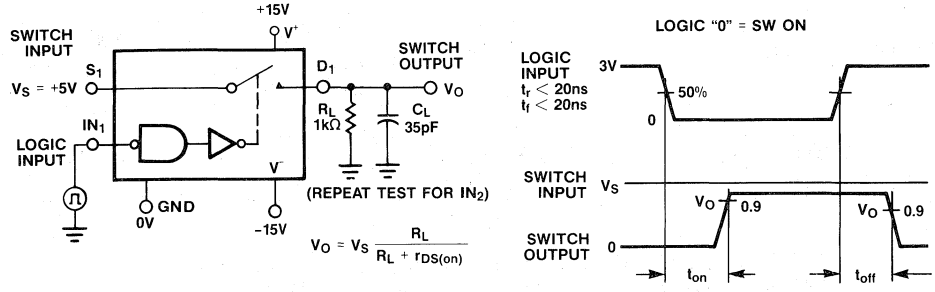
Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

Note 4: $I_{D(on)}$ is leakage from driver into "ON" switch.

Note 5: "OFF" isolation = 20 log V_S/V_D, V_S = input to OFF switch, V_D = output.

Dual Monolithic SPST CMOS Analog Switch

Test Circuits



NOTE: Switch output waveform shown for V_S = constant with logic input waveform as shown. Note that V_S may be + or – as per switching time test circuit. V_O is the steady state output with switch on. Feedthrough via gate capacitance may result in spikes at leading and trailing edge of output waveform.

Figure 1. Switching Time Test Circuit

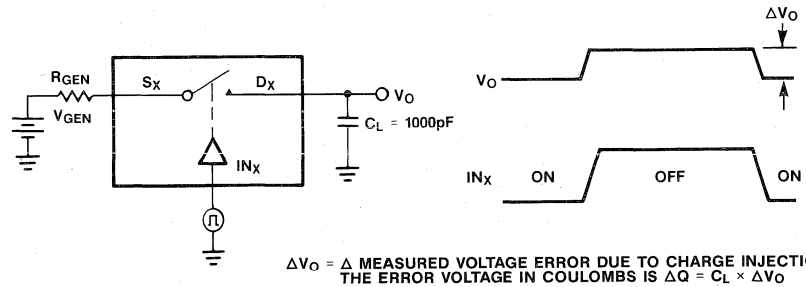


Figure 2. Charge Injection Test Circuit

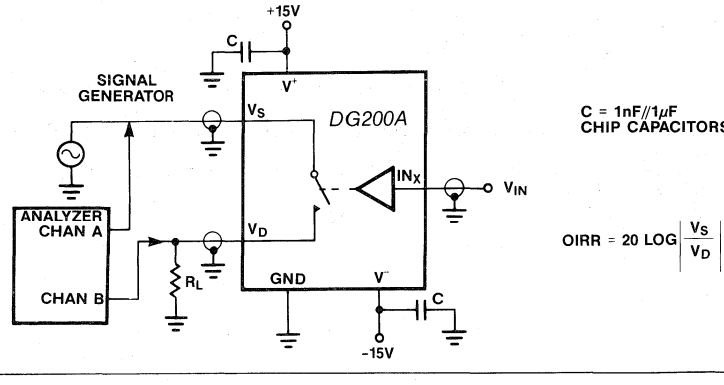


Figure 3. OFF Isolation Test Circuit

Test Circuits (continued)

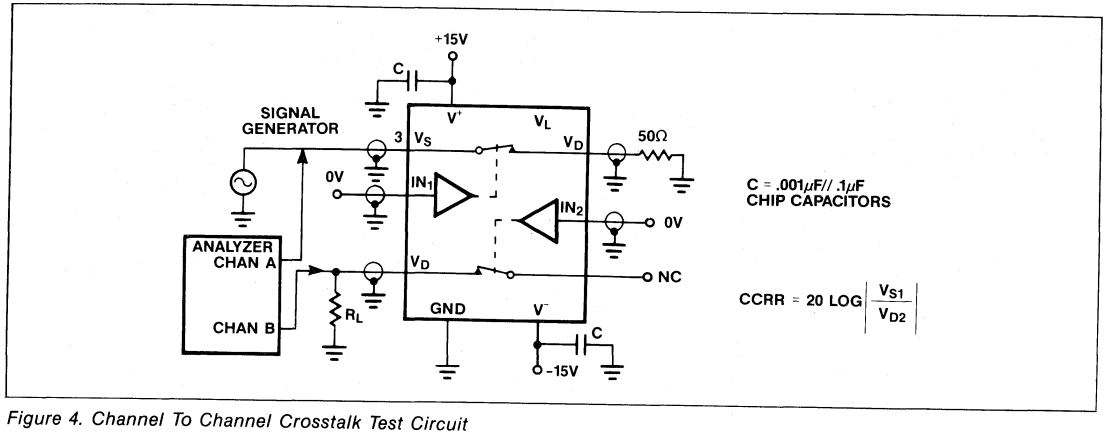
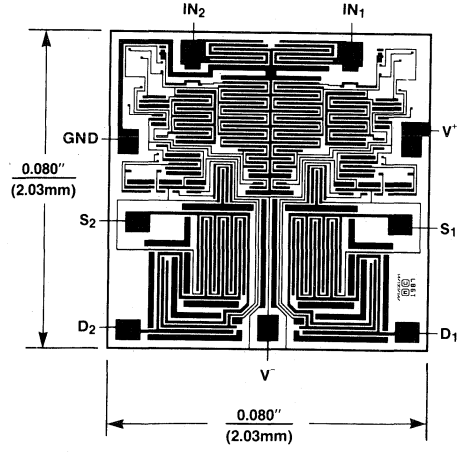


Figure 4. Channel To Channel Crosstalk Test Circuit

Chip Topography



TTL Compatible CMOS Analog Switches

General Description

Maxim's DG300-DG303 and DG300A-DG303A CMOS dual and quad analog switches combine low power operation with fast switching times and superior DC and AC switch characteristics. On resistance is less than 50Ω and is essentially constant over the analog signal range. Device specifications are ideal for battery powered circuitry.

These switches are available in a variety of formats as outlined below in the Pin Configurations section. The switch control logic inputs are fully TTL and CMOS compatible. Also featured are "break-before-make" switching and low charge injection.

Maxim's DG300-DG303 and DG300A-DG303A families are electrically compatible and pin compatible with the original manufacturer's devices. All devices will operate with power supplies ranging from ±5V to ±18V. Single supply operation is implemented by connecting V^- to GND.

Applications

Portable Instruments
Low Power Sample/Holds
Power Supply Switching
Programmable Gain Amplifiers
SPDT and DPDT Functions
Process Control and Telemetry

Features

- **Monolithic Low Power CMOS**
- **Latch-Up Proof Construction**
- **Fully Compatible 2nd Source**
- **Low On Resistance, <50Ω**
- **Fast Switching Time**
- **V^+ to V^- Analog Signal Range**
- **Single Supply Capability**

Ordering Information

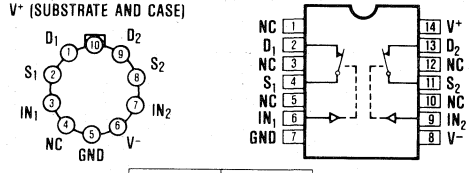
PART	TEMP. RANGE	PACKAGE
DG300C/D	0°C to +70°C	Dice
DG300CJ	0°C to +70°C	14 Lead Plastic DIP
DG300CWE	0°C to +70°C	16 Lead Wide SO
DG300CK	0°C to +70°C	14 Lead CERDIP
DG300BWE	-25°C to +85°C	16 Lead Wide SO
DG300BK	-25°C to +85°C	14 Lead CERDIP
DG300BA	-25°C to +85°C	10 Lead Metal Can
DG300AK	-55°C to +125°C	14 Lead CERDIP
DG300AA	-55°C to +125°C	10 Lead Metal Can

(Ordering Information is continued on last page.)

Pin Configurations

Top View

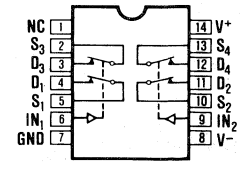
*Dual SPST DG300/DG300A



LOGIC	SWITCH
0	OFF
1	ON

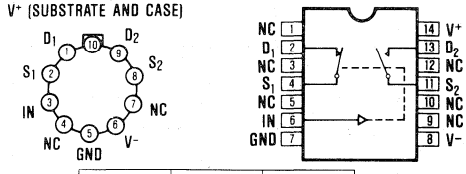
*Note: Pins 8 and 9 of the 16-lead Wide Small Outline Package are not connected.

*Dual DPST DG302/DG302A



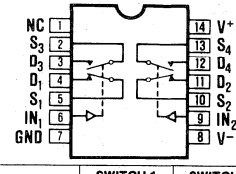
LOGIC	SWITCH
0	OFF
1	ON

*SPDT DG301/DG301A



LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

*Dual SPDT DG303/DG303A



LOGIC	SWITCH 1 SWITCH 2	SWITCH 3 SWITCH 4
0	OFF	ON
1	ON	OFF

Switch states are for Logic "1" Inputs (Positive Logic).

TTL Compatible CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V^-
V^+ (DG300-DG303) 36V
V^+ (DG300A-DG303A) 44V
GND 25V
Digital Inputs, V_S, V_D (Note 1) ..... -4V to (V^+ + 4V) or 30mA, whichever occurs first.
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 30mA
(Pulsed at 1msec, 10% duty cycle max) 100mA
Storage Temperature (A & B Suffix) ..... -65°C to 150°C
(C Suffix) ..... -65°C to 125°C
Operating Temperature (A Suffix) ..... -55°C to 125°C
(B Suffix) ..... -25°C to 85°C
(C Suffix) ..... 0°C to 70°C
Lead Temperature (Soldering 10 sec.) ..... +300°C
Power Dissipation*
Cerdip (K) (Derate 11mW/°C above 75°C) 825mW
Plastic DIP (J) (Derate 6.5mW/°C above 25°C) .. 470mW
Metal Can (A) (Derate 6mW/°C above 75°C) 450mW

* Device mounted with all leads soldered or welded to PC board.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG300-DG303A DG300A-DG303AA MIN (Note 2)	TYP (Note 3)	MAX	DG300-DG303B/C DG300A-DG303AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 0.8V or 4.0V		-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 0.8V or V_{in} = 4.0V	I_S = -10mA, V_D = 10V		30	50		30	50	Ω
				I_S = 10mA, V_D = -10V		30	50		30	50	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V		0.1	1		0.1	5	nA
				V_S = -14V, V_D = 14V	-1	-0.1		-5	-0.1		
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		0.1	1		0.1	5	
				V_S = 14V, V_D = -14V	-1	-0.1		-5	-0.1		
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V		0.1	1		0.1	5	
				V_D = V_S = -14V	-2	-0.1		-5	-0.1		
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1	-0.001		-1	-0.001		μA
			V_{in} = 15V			0.001	1		0.001	1	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1	-0.001		-1	-0.001		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			150	300		150	300	ns
	Turn-OFF Time	t_{off}				130	250		130	250	
	Break-Before-Make Interval	t_{on}-t_{off}	See Break-Before-Make Time Test Circuit DG301(A)/DG303(A) Only			50			50		
	Charge Injection	Q	C_L = 10nF, R_{gen} = 0Ω, V_{gen} = 0V			12			12		pC
	Source OFF Capacitance	$C_{S(off)}$	f = 1MHz, V_{in} = 0.8V or V_{in} = 4.0V	V_S = 0V		14			14		pF
	Drain OFF Capacitance	$C_{D(off)}$		V_D = 0V		14			14		
	Channel ON Capacitance	$C_{D(on)}$ + $C_{S(on)}$		V_S = V_D = 0V		40			40		
	Input Capacitance	C_{in}	f = 1MHz	V_{in} = 0V		6			6		
				V_{in} = 15V		7			7		
	Off Isolation (Note 4)		V_{in} = 0V, R_L = 1kΩ V_S = 1 V_{RMS}, f = 500kHz			62			62		dB
	Crosstalk (Channel to Channel)					74			74		

(See Notes next page).

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG300-DG303A DG300A-DG303AA MIN (Note 2)	TYP (Note 3)	MAX	DG300-DG303B/C DG300A-DG303AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SUPPLY	Positive Supply Current	I^+	V_{in} = 4V (One Input) (All Others = 0)		0.23	0.5		0.23	0.5	mA
	Negative Supply Current	I^-		-10	-0.001		-10	-0.001		μA
	Positive Supply Current	I^+	V_{in} = 0.8V (All Inputs)		0.001	10		0.001	10	
	Negative Supply Current	I^-		-10	-0.001		-10	-0.001		

ELECTRICAL CHARACTERISTICS (Over Temperature)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = Over Temperature Range, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG300-DG303A DG300A-DG303AA MIN (Note 2)	TYP (Note 3)	MAX	DG300-DG303B/C DG300A-DG303AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 0.8V or 4.0V		-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 0.8V or V_{in} = 4.0V	I_S = -10mA, V_D = 10V			75			75	Ω
				I_S = 10mA, V_D = -10V			75			75	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V			100			100	
				V_S = 14V, V_D = -14V	-100			-100			
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V			100			100	
				V_D = V_S = -14V	-200			-200			
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1			-10			μA
			V_{in} = 15V				1			10	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1			-10			
SUPPLY	Positive Supply Current	I^+	V_{in} = 4V (One Input) (All Others = 0)				1			1	mA
	Negative Supply Current	I^-			-100			-200			μA
	Positive Supply Current	I^+	V_{in} = 0.8V (All Inputs)				100			200	
	Negative Supply Current	I^-			-100			-200			

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- will be clamped by internal diodes. Limit diode forward current to maximum current ratings.

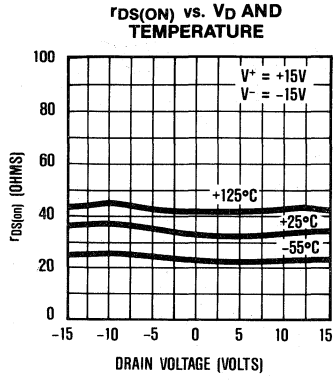
Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum is used in this data sheet.

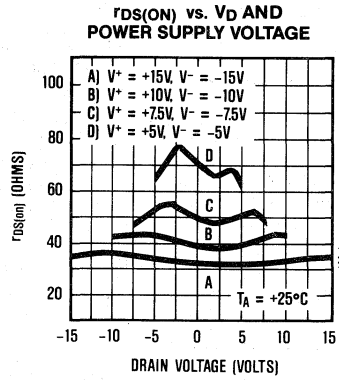
Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

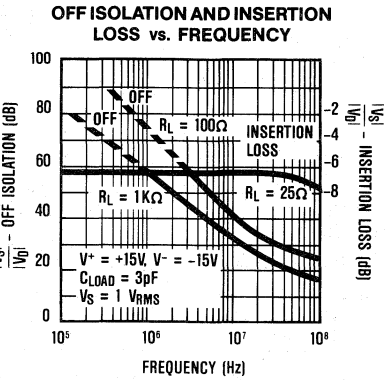
Note 4: OFF isolation = $20 \log \frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = Output.

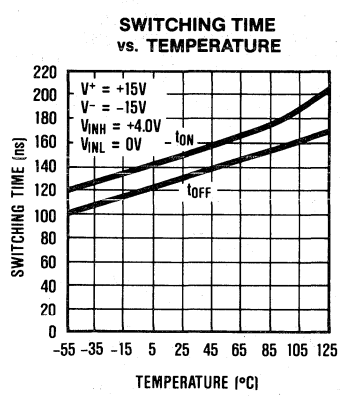
TTL Compatible CMOS Analog Switches

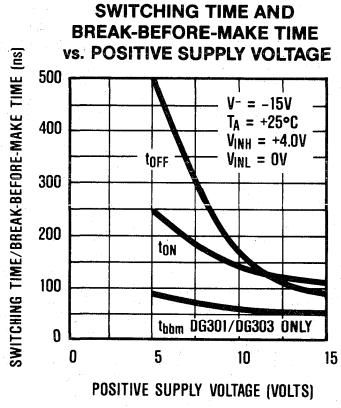
Typical Operating Characteristics

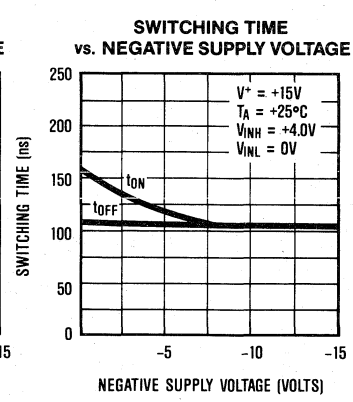




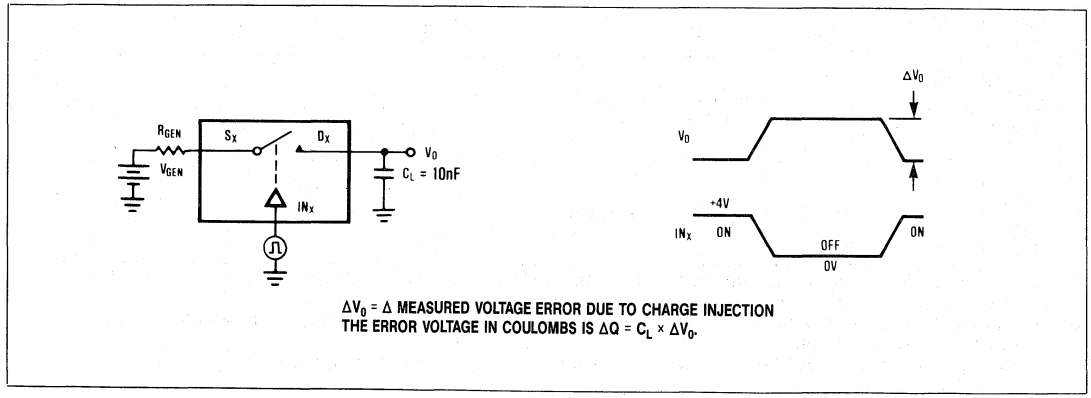








Test Circuits



ΔV_O = Δ MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION
THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = C_L \times \Delta V_O$.

Figure 1. Charge Injection Test Circuit.

Test Circuits (Continued)

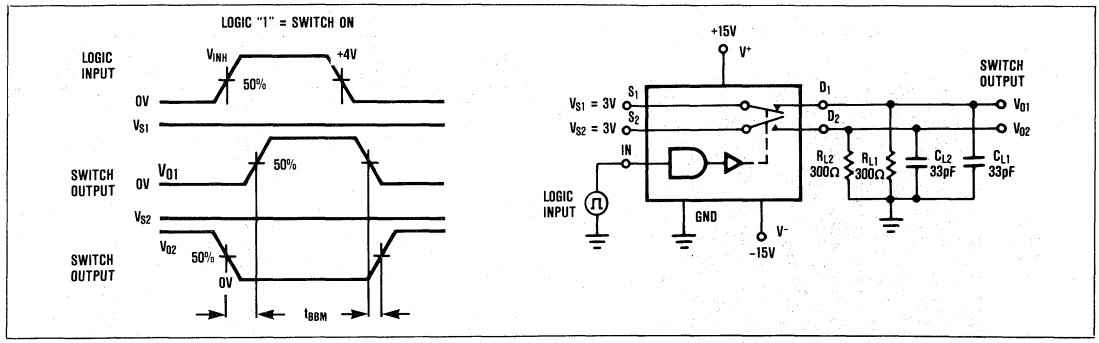


Figure 2. Break-Before-Make Time Test Circuit SPDT (DG301(A), DG303(A)).

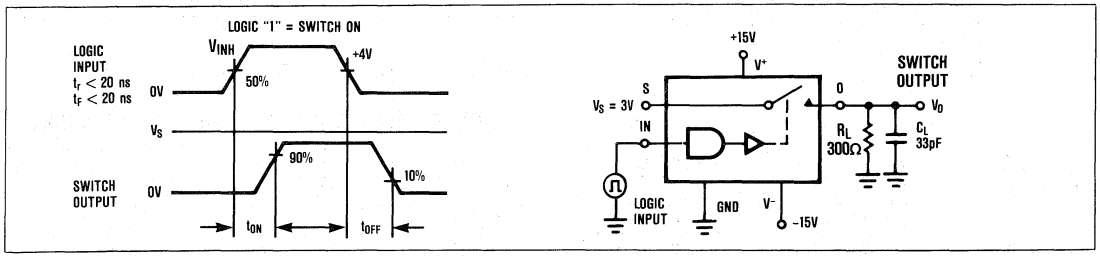


Figure 3. Switching Time Test Circuit.

Application Information

All DG300 family switches will operate with ±5 to ±15V power supplies. They can also be used with single ended power supplies ranging from +10V to +30V where the V^- terminal is connected to ground. In either case analog signals ranging from V^+ to V^- can be switched.

The on resistance variation with analog signal and supply voltage is shown in the Typical Operating Characteristics graphs. The temperature coefficient of R_{ON} is typically 0.5%/°C. Typical on resistance matching from channel to channel is 10%. In addition, Table 1 outlines some typical parameters for single supply operation.

Table 1. Typical Single Supply Parameters

	V^+ SUPPLY VOLTAGE (V^- = 0V)			
	+10V	+15V	+20V	+30V
Switching Time (R_L = 1kΩ)				
t_{ON}	190ns	150ns	110ns	70ns
t_{OFF}	40ns	40ns	40ns	40ns
On Resistance				
V_{SIGNAL} = +1V	71Ω	51Ω	42Ω	31Ω
V_{SIGNAL} = $V^+/2$	77Ω	54Ω	43Ω	30Ω
V_{SIGNAL} = V^+	84Ω	63Ω	54Ω	43Ω
Input Logic Levels	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.5V

The charge injection test circuit is shown in Figure 1. Table 2 lists the typical injected charge for DG300 series switches with various input voltages.

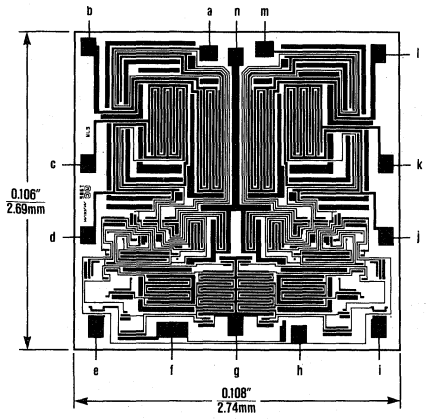
Table 2. Charge Injection (±15V Supplies)

ANALOG INPUT	INJECTED Q
+10V	4pC
+5V	8pC
0V	12pC
-5V	8pC
-10V	5pC

TTL Compatible CMOS Analog Switches

Chip Topography

DG300/1/2/3 ONLY



DIE PAD	DG300 DG300A	DG301 DG301A	DG302/303 DG302A/303A
a	N.C.	N.C.	S3
b	D1	D1	D3
c	D1	S1	D1
d	S1	IN1	S1
e	IN1	IN1	IN1
f	V^+	V^+	V^+
g	GND	GND	GND
h	V^-	V^-	V^-
i	IN2	GND	IN2
j	S2	V^-	S2
k	D2	S2	D2
l	D2	D2	D4
m	N.C.	N.C.	S4
n	V^+	V^+	V^+

For DG300A/1A/2A/3A Chip Topography, contact Factory.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DG300AC/D	0°C to +70°C	Dice
DG300ACJ	0°C to +70°C	14 Lead Plastic DIP
DG300ACWE	0°C to +70°C	16 Lead Wide SO
DG300ACK	0°C to +70°C	14 Lead CERDIP
DG300ABWE	-25°C to +85°C	16 Lead Wide SO
DG300ABK	-25°C to +85°C	14 Lead CERDIP
DG300ABA	-25°C to +85°C	10 Lead Metal Can
DG301C/D	0°C to +70°C	Dice
DG301CJ	0°C to +70°C	14 Lead Plastic DIP
DG301CWE	0°C to +70°C	16 Lead Wide SO
DG301CK	0°C to +70°C	14 Lead CERDIP
DG301BWE	-25°C to +85°C	16 Lead Wide SO
DG301BK	-25°C to +85°C	14 Lead CERDIP
DG301BA	-25°C to +85°C	10 Lead Metal Can
DG301AK	-55°C to +125°C	14 Lead CERDIP
DG301AA	-55°C to +125°C	10 Lead Metal Can
DG301AC/D	0°C to +70°C	Dice
DG301ACJ	0°C to +70°C	14 Lead Plastic DIP
DG301ACWE	0°C to +70°C	16 Lead Wide SO
DG301ACK	0°C to +70°C	14 Lead CERDIP
DG301ABWE	-25°C to +85°C	16 Lead Wide SO
DG301ABK	-25°C to +85°C	14 Lead CERDIP
DG301ABA	-25°C to +85°C	10 Lead Metal Can
DG302C/D	0°C to +70°C	Dice
DG302CJ	0°C to +70°C	14 Lead Plastic DIP

PART	TEMP. RANGE	PACKAGE
DG302CWE	0°C to +70°C	16 Lead Wide SO
DG302CK	0°C to +70°C	14 Lead CERDIP
DG302BWE	-25°C to +85°C	16 Lead Wide SO
DG302BK	-25°C to +85°C	14 Lead CERDIP
DG302AK	-55°C to +125°C	14 Lead CERDIP
DG302AC/D	0°C to +70°C	Dice
DG302ACJ	0°C to +70°C	14 Lead Plastic DIP
DG302ACWE	0°C to +70°C	16 Lead Wide SO
DG302ACK	0°C to +70°C	14 Lead CERDIP
DG302ABWE	-25°C to +85°C	16 Lead Wide SO
DG302ABK	-25°C to +85°C	14 Lead CERDIP
DG303C/D	0°C to +70°C	Dice
DG303CJ	0°C to +70°C	14 Lead Plastic DIP
DG303CWE	0°C to +70°C	16 Lead Wide SO
DG303CK	0°C to +70°C	14 Lead CERDIP
DG303BWE	-25°C to +85°C	16 Lead Wide SO
DG303BK	-25°C to +85°C	14 Lead CERDIP
DG303AK	-55°C to +125°C	14 Lead CERDIP
DG303AC/D	0°C to +70°C	Dice
DG303ACJ	0°C to +70°C	14 Lead Plastic DIP
DG303ACWE	0°C to +70°C	16 Lead Wide SO
DG303ACK	0°C to +70°C	14 Lead CERDIP
DG303ABWE	-25°C to +85°C	16 Lead Wide SO
DG303ABK	-25°C to +85°C	14 Lead CERDIP

MAXIM

CMOS Analog Switches

General Description

Maxim's DG304-DG307 and DG304A-DG307A CMOS dual and quad analog switches combine low power operation with fast switching times and superior DC and AC switch characteristics. On resistance is less than 50Ω and is essentially constant over the analog signal range. Device specifications are ideal for battery powered circuitry.

These switches are available in a variety of formats as outlined below in the Pin Configurations section. The switch control logic inputs are compatible with CMOS logic. Also featured are "break-before-make" switching and low charge injection.

Maxim's DG304-DG307 and DG304A-DG307A families are electrically compatible and pin compatible with the original manufacturer's devices. All devices will operate with power supplies ranging from ±5V to ±18V. Single supply operation is implemented by connecting V^- to GND.

Applications

Portable Instruments

Low Power Sample/Holds

Power Supply Switching

Programmable Gain Amplifiers

SPDT and DPDT Functions

Process Control and Telemetry

Features

- **Monolithic Low Power CMOS**
- **Latch-Up Proof Construction**
- **Fully Compatible 2nd Source**
- **Low On Resistance, <50Ω**
- **Fast Switching Time**
- **V^+ to V^- Analog Signal Range**
- **Single Supply Capability**

Ordering Information

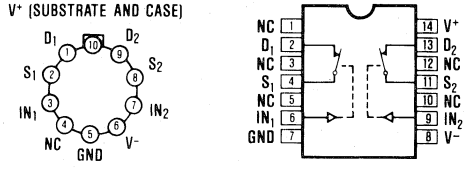
PART	TEMP. RANGE	PACKAGE
DG304C/D	0°C to +70°C	Dice
DG304CJ	0°C to +70°C	14 Lead Plastic DIP
DG304CWE	0°C to +70°C	16 Lead Wide SO
DG304CK	0°C to +70°C	14 Lead CERDIP
DG304BWE	-25°C to +85°C	16 Lead Wide SO
DG304BK	-25°C to +85°C	14 Lead CERDIP
DG304BA	-25°C to +85°C	10 Lead Metal Can
DG304AK	-55°C to +125°C	14 Lead CERDIP
DG304AA	-55°C to +125°C	10 Lead Metal Can

(Ordering Information is continued on last page.)

Pin Configurations

Top View

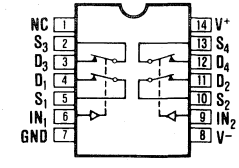
*Dual SPST DG304/DG304A



LOGIC	SWITCH
0	OFF
1	ON

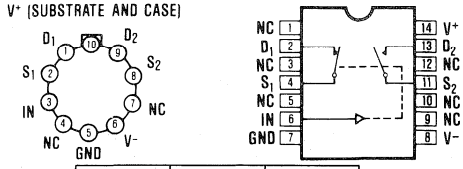
*Note: Pins 8 and 9 of the 16-lead Wide Small Outline Package are not connected.

*Dual DPST DG306/DG306A



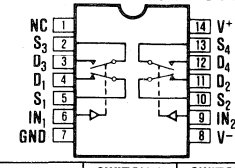
LOGIC	SWITCH
0	OFF
1	ON

*SPDT DG305/DG305A



LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

*Dual SPDT DG307/DG307A



LOGIC	SWITCH 1 SWITCH 2	SWITCH 3 SWITCH 4
0	OFF	ON
1	ON	OFF

Switch states are for Logic "1" Inputs (Positive Logic).

CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V^-
V^+ (DG304-DG307) 36V
V^+ (DG304A-DG307A) 44V
GND 25V
Digital Inputs, V_S, V_D (Note 1) ..... -4V to (V^+ + 4V) or 30mA, whichever occurs first.
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 30mA
(Pulsed at 1msec, 10% duty cycle max) 100mA
Storage Temperature (A & B Suffix) ..... -65°C to 150°C
(C Suffix) ..... -65°C to 125°C
Operating Temperature (A Suffix) ..... -55°C to 125°C
(B Suffix) ..... -25°C to 85°C
(C Suffix) ..... 0°C to 70°C
Lead Temperature (Soldering 10 sec.) ..... +300°C
Power Dissipation*
Cerdip (K) (Derate 11mW/°C above 75°C) 825mW
Plastic DIP (J) (Derate 6.5mW/°C above 25°C) .. 470mW
Metal Can (A) (Derate 6mW/°C above 75°C) 450mW

* Device mounted with all leads soldered or welded to PC board.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG304-DG307A DG304A-DG307AA MIN (Note 2)	TYP (Note 3)	MAX	DG304-DG307B/C DG304A-DG307AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 3.5V or 11.0V		-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 3.5V or V_{in} = 11.0V	I_S = -10mA, V_D = 10V		30	50		30	50	Ω
				I_S = 10mA, V_D = -10V		30	50		30	50	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V		0.1	1		0.1	5	nA
				V_S = -14V, V_D = 14V	-1	-0.1		-5	-0.1		
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		0.1	1		0.1	5	
				V_S = 14V, V_D = -14V	-1	-0.1		-5	-0.1		
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V		0.1	1		0.1	5	
				V_D = V_S = -14V	-2	-0.1		-5	-0.1		
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1	-0.001		-1	-0.001		μA
			V_{in} = 15V			0.001	1		0.001	1	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1	-0.001		-1	-0.001		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			110	250		110	250	ns
	Turn-OFF Time	t_{off}				70	150		70	150	
	Break-Before-Make Interval	t_{on}-t_{off}	See Break-Before-Make Time Test Circuit DG305(A)/DG307(A) Only			50			50		
	Charge Injection	Q	C_L = 10nF, R_{gen} = 0Ω, V_{gen} = 0V			12			12		pC
	Source OFF Capacitance	$C_{S(off)}$	f = 1MHz, V_{in} = 3.5V or V_{in} = 11.0V	V_S = 0V		14			14		pF
	Drain OFF Capacitance	$C_{D(off)}$		V_D = 0V		14			14		
	Channel ON Capacitance	$C_{D(on)}$ + $C_{S(on)}$		V_S = V_D = 0V		40			40		
	Input Capacitance	C_{in}	f = 1MHz	V_{in} = 0V		6			6		
				V_{in} = 15V		7			7		
	Off Isolation (Note 4)		V_{in} = 0V, R_L = 1kΩ V_S = 1 V_{RMS}, f = 500kHz			62			62		dB
	Crosstalk (Channel to Channel)					74			74		

(See Notes next page).

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG304-DG307A DG304A-DG307AA MIN (Note 2)	TYP (Note 3)	MAX	DG304-DG307B/C DG304A-DG307AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SUPPLY	Positive Supply Current	I^+	V_{in} = 15.0V (All Inputs)		0.001	10		0.001	10	μA
	Negative Supply Current	I^-		-10	-0.001		-10	-0.001		
	Positive Supply Current	I^+	V_{in} = 0V (All Inputs)		0.001	10		0.001	10	
	Negative Supply Current	I^-		-10	-0.001		-10	-0.001		

ELECTRICAL CHARACTERISTICS (Over Temperature)

(V^+ = +15V, GND = 0V, T_A = Over Temperature Range, unless otherwise noted)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG304-DG307A DG304A-DG307AA MIN (Note 2)	TYP (Note 3)	MAX	DG304-DG307B/C DG304A-DG307AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 3.5V or 11.0V		-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 3.5V or V_{in} = 11.0V	I_S = -10mA, V_D = 10V			75			75	Ω
				I_S = 10mA, V_D = -10V			75			75	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V			100			100	nA
				V_S = -14V, V_D = 14V	-100			-100			
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V			100			100	
				V_S = 14V, V_D = -14V	-100			-100			
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V			100			100	
				V_D = V_S = -14V	-200			-200			
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1			-10			μA
			V_{in} = 15V				1			10	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1			-10			
SUPPLY	Positive Supply Current	I^+	V_{in} = 15.0V (All Inputs)				100			200	μA
	Negative Supply Current	I^-			-100			-200			
	Positive Supply Current	I^+	V_{in} = 0V (All Inputs)				100			200	
	Negative Supply Current	I^-			-100			-200			

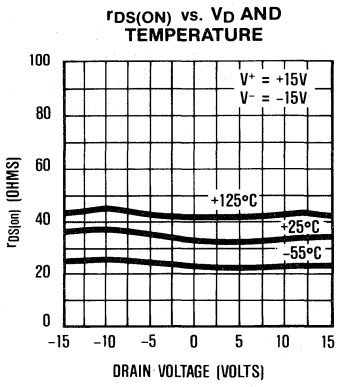
Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- will be clamped by internal diodes. Limit diode forward current to maximum current ratings.

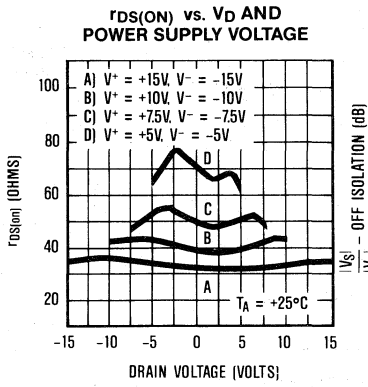
Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum is used in this data sheet.

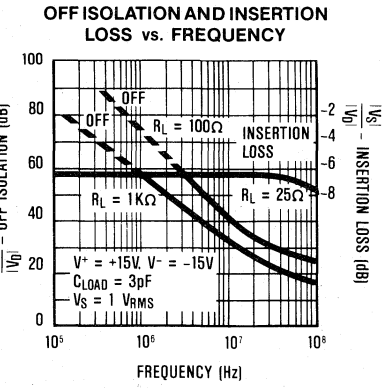
Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

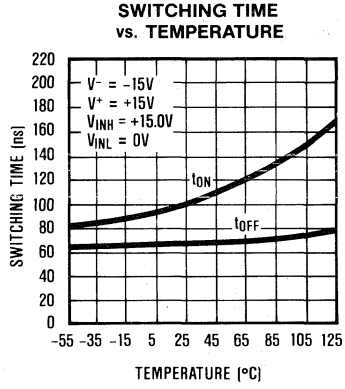
Note 4: OFF isolation = $20 \log \frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = Output.

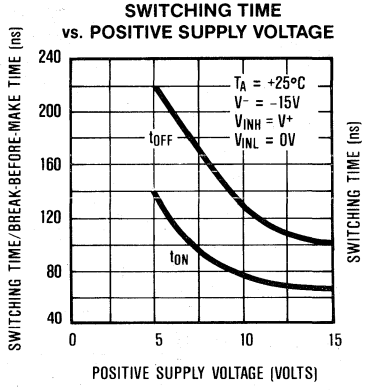
Typical Operating Characteristics

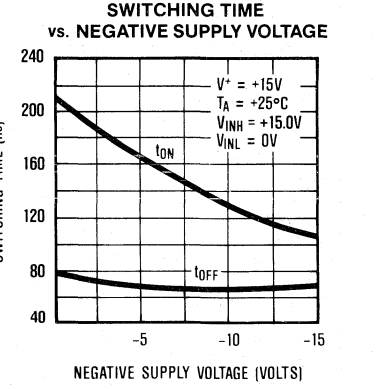












Test Circuits

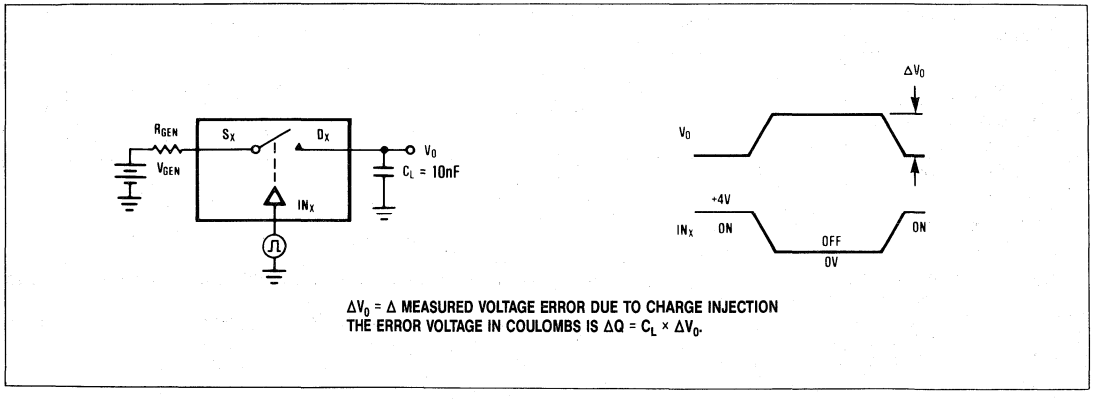


Figure 1. Charge Injection Test Circuit.

Test Circuits (Continued)

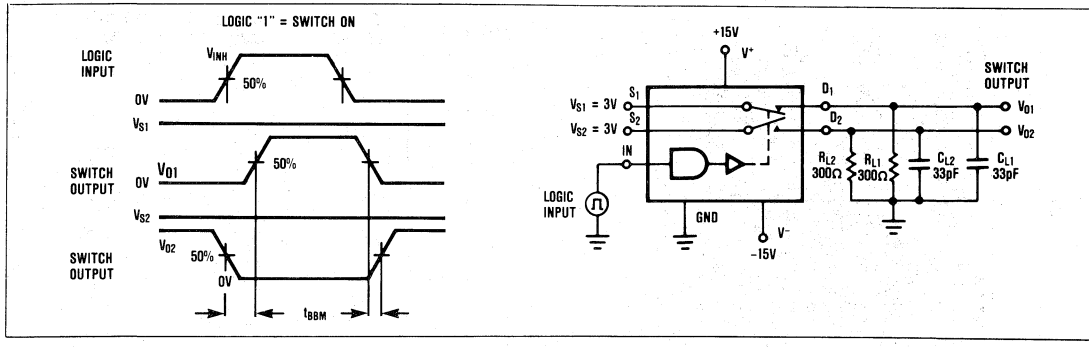


Figure 2. Break-Before-Make Time Test Circuit SPDT DG305(A), DG307(A).

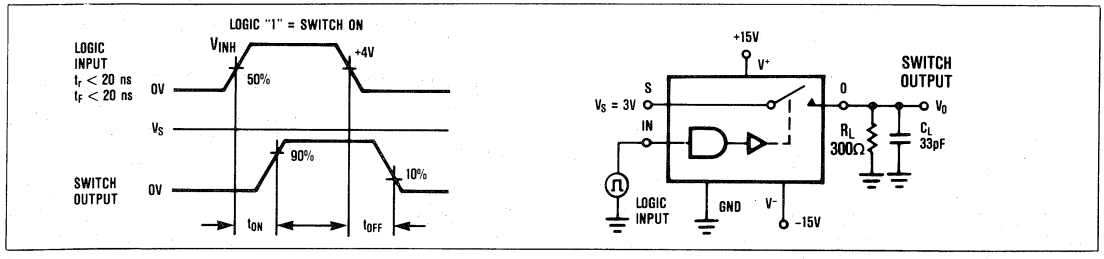


Figure 3. Switching Time Test Circuit.

Application Information

All DG304 family switches will operate with ±5 to ±15V power supplies. They can also be used with single ended power supplies ranging from +10V to +30V where the V^- terminal is connected to ground. In either case analog signals ranging from V^+ to V^- can be switched.

The on resistance variation with analog signal and supply voltage is shown in the Typical Operating Characteristics graphs. The temperature coefficient of R_{ON} is typically 0.5%/°C. Typical on resistance matching from channel to channel is 10%. In addition, Table 1 outlines some typical parameters for single supply operation.

Table 1. Typical Single Supply Parameters

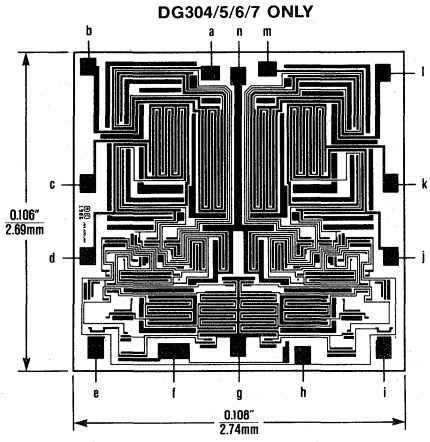
	V^+ SUPPLY VOLTAGE (V^- = 0V)			
	+10V	**+15V**	**+20V**	**+30V**
Switching Time (R_L = 1kΩ)				
t_{ON}	220ns	180ns	165ns	110ns
t_{OFF}	60ns	40ns	30ns	20ns
On Resistance				
V_{SIGNAL} = +1V	71Ω	51Ω	42Ω	31Ω
V_{SIGNAL} = $V^+/2$	77Ω	54Ω	43Ω	30Ω
V_{SIGNAL} = V^+	84Ω	63Ω	54Ω	43Ω
Input Logic Levels	3.5V, 11.0V	3.5V, 11.0V	3.5V, 12.5V	3.5V, 22.0V

The charge injection test circuit is shown in Figure 1. Table 2 lists the typical injected charge for DG304 series switches with various input voltages.

Table 2. Charge Injection (±15V Supplies)

ANALOG INPUT	INJECTED Q
+10V	4pC
+5V	8pC
0V	12pC
-5V	8pC
-10V	5pC

Chip Topography



DIE PAD	DG304 DG304A	DG305 DG305A	DG306/307 DG306A/307A
a	N.C.	N.C.	S3
b	D1	D1	D3
c	D1	S1	D1
d	S1	IN1	S1
e	IN1	IN1	IN1
f	V^+	V^+	V^+
g	GND	GND	GND
h	V^-	V^-	V^-
i	IN2	GND	IN2
j	S2	V^-	S2
k	D2	S2	D2
l	D2	D2	D4
m	N.C.	N.C.	S4
n	V^+	V^+	V^+

For DG304A/5A/6A/7A Chip Topography, contact Factory.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DG304AC/D	0°C to +70°C	Dice
DG304ACJ	0°C to +70°C	14 Lead Plastic DIP
DG304ACWE	0°C to +70°C	16 Lead Wide SO
DG304ACK	0°C to +70°C	14 Lead CERDIP
DG304ABWE	-25°C to +85°C	16 Lead Wide SO
DG304ABK	-25°C to +85°C	14 Lead CERDIP
DG304ABA	-25°C to +85°C	10 Lead Metal Can
DG305C/D	0°C to +70°C	Dice
DG305CJ	0°C to +70°C	14 Lead Plastic DIP
DG305CWE	0°C to +70°C	16 Lead Wide SO
DG305CK	0°C to +70°C	14 Lead CERDIP
DG305BWE	-25°C to +85°C	16 Lead Wide SO
DG305BK	-25°C to +85°C	14 Lead CERDIP
DG305BA	-25°C to +85°C	10 Lead Metal Can
DG305AK	-55°C to +125°C	14 Lead CERDIP
DG305AA	-55°C to +125°C	10 Lead Metal Can
DG305AC/D	0°C to +70°C	Dice
DG305ACJ	0°C to +70°C	14 Lead Plastic DIP
DG305ACWE	0°C to +70°C	16 Lead Wide SO
DG305ACK	0°C to +70°C	14 Lead CERDIP
DG305ABWE	-25°C to +85°C	16 Lead Wide SO
DG305ABK	-25°C to +85°C	14 Lead CERDIP
DG305ABA	-25°C to +85°C	10 Lead Metal Can

PART	TEMP. RANGE	PACKAGE
DG306C/D	0°C to +70°C	Dice
DG306CJ	0°C to +70°C	14 Lead Plastic DIP
DG306CWE	0°C to +70°C	16 Lead Wide SO
DG306CK	0°C to +70°C	14 Lead CERDIP
DG306BWE	-25°C to +85°C	16 Lead Wide SO
DG306BK	-25°C to +85°C	14 Lead CERDIP
DG306AK	-55°C to +125°C	14 Lead CERDIP
DG306AC/D	0°C to +70°C	Dice
DG306ACJ	0°C to +70°C	14 Lead Plastic DIP
DG306ACWE	0°C to +70°C	16 Lead Wide SO
DG306ACK	0°C to +70°C	14 Lead CERDIP
DG306ABWE	-25°C to +85°C	16 Lead Wide SO
DG306ABK	-25°C to +85°C	14 Lead CERDIP
DG307C/D	0°C to +70°C	Dice
DG307CJ	0°C to +70°C	14 Lead Plastic DIP
DG307CWE	0°C to +70°C	16 Lead Wide SO
DG307CK	0°C to +70°C	14 Lead CERDIP
DG307BWE	-25°C to +85°C	16 Lead Wide SO
DG307BK	-25°C to +85°C	14 Lead CERDIP
DG307AK	-55°C to +125°C	14 Lead CERDIP
DG307AC/D	0°C to +70°C	Dice
DG307ACJ	0°C to +70°C	14 Lead Plastic DIP
DG307ACWE	0°C to +70°C	16 Lead Wide SO
DG307ACK	0°C to +70°C	14 Lead CERDIP
DG307ABWE	-25°C to +85°C	16 Lead Wide SO
DG307ABK	-25°C to +85°C	14 Lead CERDIP

General Purpose CMOS Analog Switches

General Description

Maxim's DG381-DG390 and DG381A-DG390A CMOS dual and quad analog switches combine low power operation with fast switching times and superior DC and AC switch characteristics. On resistance is less than 50Ω and is essentially constant over the analog signal range. Device specifications are ideal for battery powered circuitry.

These switches are available in a variety of formats as outlined below in the Pin Configurations section. The switch control logic inputs are fully TTL and CMOS compatible. Also featured are "break-before-make" switching and low charge injection.

Maxim's DG381-DG390 and DG381A-DG390A families are electrically compatible and pin compatible with the original manufacturer's devices. All devices will operate with power supplies ranging from ±5V to ±18V. Single supply operation is implemented by connecting V^- to GND.

Applications

Portable Instruments

Low Power Sample/Holds

Power Supply Switching

Programmable Gain Amplifiers

SPDT and DPDT Functions

Process Control and Telemetry

Features

- **Monolithic Low Power CMOS**
- **Latch-Up Proof Construction**
- **Fully Compatible 2nd Source**
- **Low On Resistance, <50Ω**
- **Fast Switching Time**
- **V^+ to V^- Analog Signal Range**
- **Single Supply Capability**

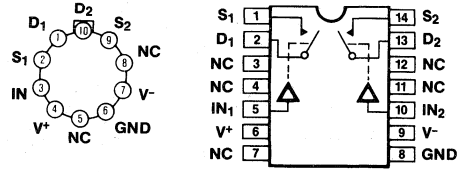
Ordering Information

PART	TEMP. RANGE	PACKAGE
DG381C/D	0°C to +70°C	Dice
DG381CJ	0°C to +70°C	14 Lead Plastic DIP
DG381CWE	0°C to +70°C	16 Lead Wide SO
DG381CK	0°C to +70°C	14 Lead CERDIP
DG381BWE	-25°C to +85°C	16 Lead Wide SO
DG381BK	-25°C to +85°C	14 Lead CERDIP
DG381BA	-25°C to +85°C	10 Lead Metal Can
DG381AK	-55°C to +125°C	14 Lead CERDIP
DG381AA	-55°C to +125°C	10 Lead Metal Can

(Ordering Information is continued on last page.)

Pin Configurations

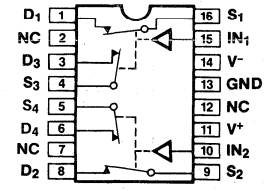
*Dual SPST DG381/DG381A Top View



*Note: Pins 8 and 9 of the 16-lead Wide Small Outline Package are not connected.

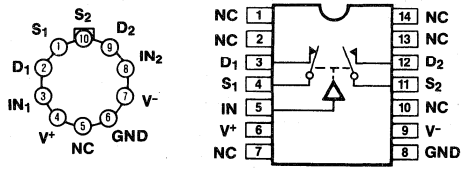
LOGIC	SWITCH
0	ON
1	OFF

Dual DPST DG384/DG384A



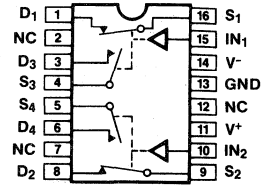
LOGIC	SWITCH
0	OFF
1	ON

*SPDT DG387/DG387A



LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

Dual SPDT DG390/DG390A



LOGIC	SWITCH 1 SWITCH 2	SWITCH 3 SWITCH 4
0	OFF	ON
1	ON	OFF

Switch states are for Logic "1" Inputs (Positive Logic).

General Purpose CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to V^-
V^+ (DG381-DG390) 36V
V^+ (DG381A-DG390A) 44V
GND 25V
Digital Inputs, V_S, V_D (Note 1) ..... -4V to (V^+ + 4V) or 30mA, whichever occurs first.
Current, Any Terminal Except S or D 30mA
Continuous Current, S or D 30mA
(Pulsed at 1msec, 10% duty cycle max) 100mA
Storage Temperature (A & B Suffix) ..... -65°C to 150°C
(C Suffix) ..... -65°C to 125°C
Operating Temperature (A Suffix) ..... -55°C to 125°C
(B Suffix) ..... -25°C to 85°C
(C Suffix) ..... 0°C to 70°C
Lead Temperature (Soldering 10 sec.) ..... +300°C
Power Dissipation*
Cerdip (K) (Derate 11mW/°C above 75°C) 825mW
Plastic DIP (J) (Derate 6.5mW/°C above 25°C) .. 470mW
Metal Can (A) (Derate 6mW/°C above 75°C) 450mW

* Device mounted with all leads soldered or welded to PC board.

Stresses listed under "Absolute Maximum Ratings" may be applied (one at a time) to devices without resulting in permanent damage. These are stress ratings only, and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum ratings conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS (V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG381-DG390A DG381A-DG390AA MIN (Note 2)	TYP (Note 3)	MAX	DG381-DG390B/C DG381A-DG390AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 0.8V or 4.0V		-15		15	-15		15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 0.8V or V_{in} = 4.0V	I_S = -10mA, V_D = 10V		30	50		30	50	Ω
				I_S = 10mA, V_D = -10V		30	50		30	50	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V		0.1	1		0.1	5	nA
				V_S = -14V, V_D = 14V	-1	-0.1		-5	-0.1		
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		0.1	1		0.1	5	
				V_S = 14V, V_D = -14V	-1	-0.1		-5	-0.1		
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V		0.1	1		0.1	5	
				V_D = V_S = -14V	-2	-0.1		-5	-0.1		
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1	-0.001		-1	-0.001		μA
			V_{in} = 15V			0.001	1		0.001	1	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1	-0.001		-1	-0.001		
DYNAMIC	Turn-ON Time	t_{on}	See Switching Time Test Circuit			150	300		150	300	ns
	Turn-OFF Time	t_{off}				130	250		130	250	
	Break-Before-Make Interval	t_{on}-t_{off}	See Break-Before-Make Time Test Circuit DG387(A)/DG390(A) Only			50			50		
	Charge Injection	Q	C_L = 10nF, R_{gen} = 0Ω, V_{gen} = 0V			12			12		pC
	Source OFF Capacitance	$C_{S(off)}$	f = 1MHz, V_{in} = 0.8V or V_{in} = 4.0V	V_S = 0V		14			14		pF
	Drain OFF Capacitance	$C_{D(off)}$		V_D = 0V		14			14		
	Channel ON Capacitance	$C_{D(on)}$ + $C_{S(on)}$		V_S = V_D = 0V		40			40		
	Input Capacitance	C_{in}	f = 1MHz	V_{in} = 0V		6			6		
				V_{in} = 15V		7			7		
	Off Isolation (Note 4)		V_{in} = 0V, R_L = 1kΩ V_S = 1 V_{RMS}, f = 500kHz			62			62		dB
	Crosstalk (Channel to Channel)					74			74		

(See Notes next page).

ELECTRICAL CHARACTERISTICS (Continued)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = 25°C, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS	DG381-DG390A DG381A-DG390AA MIN (Note 2)	TYP (Note 3)	MAX	DG381-DG390B/C DG381A-DG390AB/C MIN (Note 2)	TYP (Note 3)	MAX	UNITS
SUPPLY	Positive Supply Current	I^+	V_{in} = 4V (One Input) (All Others = 0)		0.23	0.5		0.23	0.5	mA
	Negative Supply Current	I^-		-10	-0.001		-100	-0.001		μA
	Positive Supply Current	I^+	V_{in} = 0.8V (All Inputs)		0.001	10		0.001	100	
	Negative Supply Current	I^-		-10	-0.001		-100	-0.001		

ELECTRICAL CHARACTERISTICS (Over Temperature)

(V^+ = +15V, V^- = -15V, GND = 0V, T_A = Over Temperature Range, unless otherwise indicated)

	PARAMETER	SYMBOL	TEST CONDITIONS		DG381-DG390A DG381A-DG390AA MIN (Note 2)	MAX	DG381-DG390B/C DG381A-DG390AB/C MIN (Note 2)	MAX	UNITS
SWITCH	Analog Signal Range	V_{ANALOG}	I_S = 10mA, V_{in} = 0.8V or 4.0V		-15	15	-15	15	V
	Drain-Source ON Resistance	$r_{DS(on)}$	V_{in} = 0.8V or V_{in} = 4.0V	I_S = -10mA, V_D = 10V		75		75	Ω
				I_S = 10mA, V_D = -10V		75		75	
	Source OFF Leakage Current	$I_{S(off)}$		V_S = 14V, V_D = -14V		100		100	nA
				V_S = -14V, V_D = 14V	-100		-100		
	Drain OFF Leakage Current	$I_{D(off)}$		V_S = -14V, V_D = 14V		100		100	
				V_S = 14V, V_D = -14V	-100		-100		
	Drain ON Leakage Current	$I_{D(on)}$		V_D = V_S = 14V		100		100	
				V_D = V_S = -14V	-200		-200		
INPUT	Input Current/ Voltage High	I_{INH}	V_{in} = 5.0V		-1		-10		μA
			V_{in} = 15V			1		10	
	Input Current/ Voltage Low	I_{INL}	V_{in} = 0V		-1		-10		
SUPPLY	Positive Supply Current	I^+	V_{in} = 4V (One Input) (All Others = 0)			1		1.5	mA
	Negative Supply Current	I^-			-100		-200		μA
	Positive Supply Current	I^+	V_{in} = 0.8V (All Inputs)			100		200	
	Negative Supply Current	I^-			-100		-200		

Note 1: Signals on S_X, D_X, or IN_X exceeding V^+ or V^- will be clamped by internal diodes. Limit diode forward current to maximum current ratings.

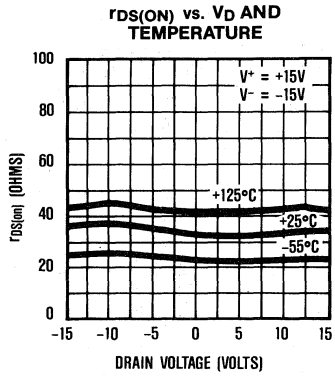
Note 2: The algebraic convention whereby the most negative value is a minimum, and the most positive value is a maximum is used in this data sheet.

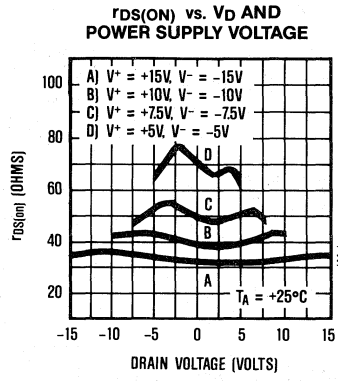
Note 3: Typical values are for DESIGN AID ONLY, not guaranteed nor subject to production testing.

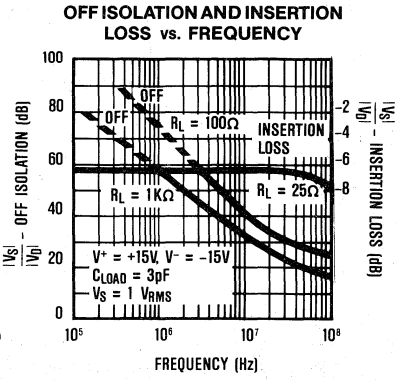
Note 4: OFF isolation = $20 \log \frac{V_S}{V_D}$, V_S = input to OFF switch, V_D = Output.

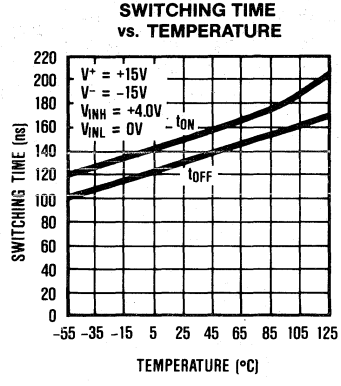
General Purpose CMOS Analog Switches

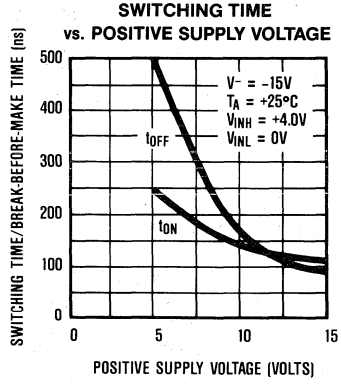
Typical Operating Characteristics

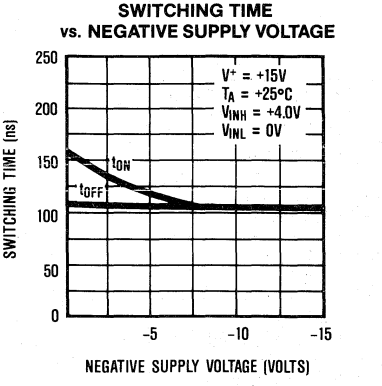




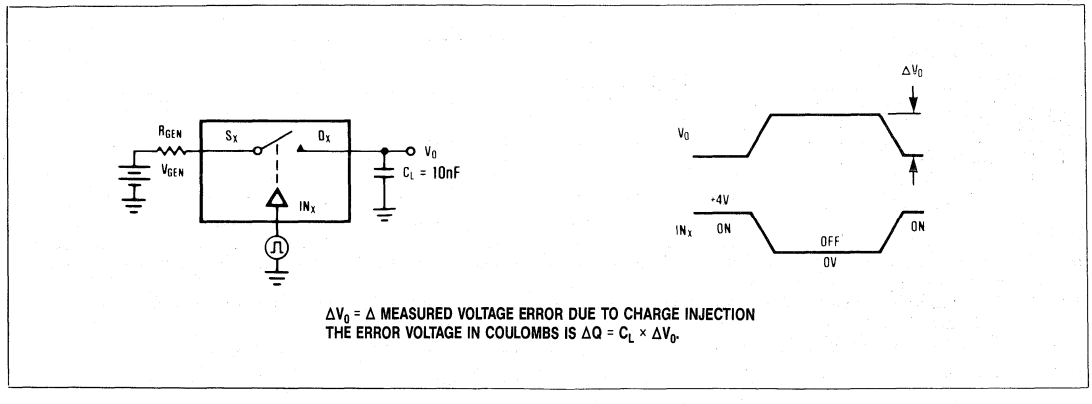








Test Circuits



ΔV_O = Δ MEASURED VOLTAGE ERROR DUE TO CHARGE INJECTION
THE ERROR VOLTAGE IN COULOMBS IS $\Delta Q = C_L \times \Delta V_O$.

Figure 1. Charge Injection Test Circuit.

Test Circuits (Continued)

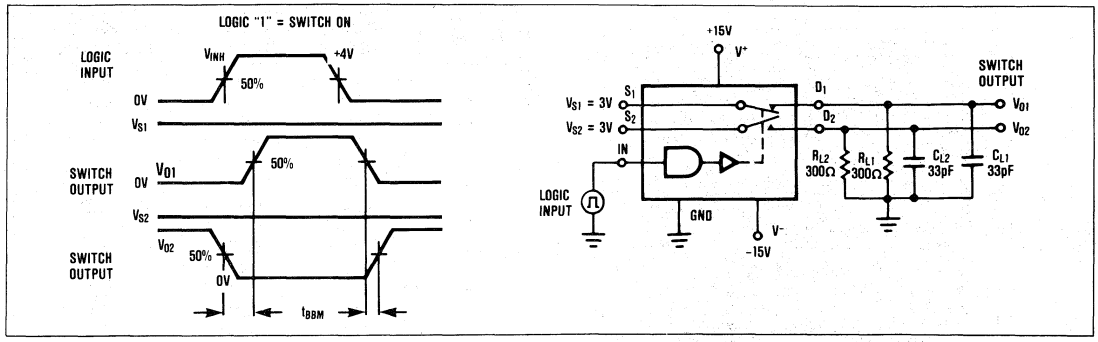


Figure 2. Break-Before-Make Time Test Circuit SPDT (DG387(A)/DG390(A)).

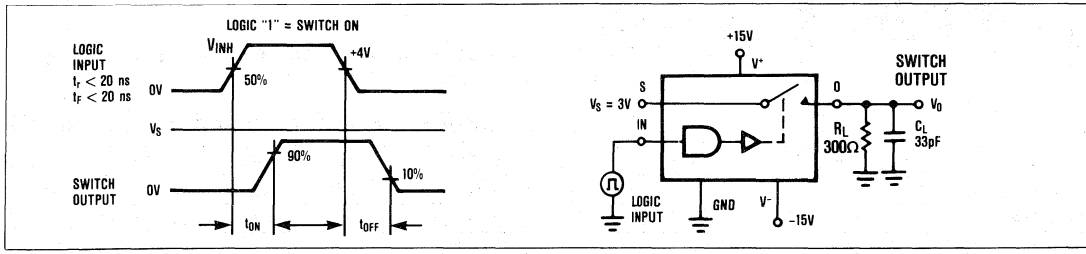


Figure 3. Switching Time Test Circuit.

Application Information

All DG381 family switches will operate with ±5 to ±15V power supplies. They can also be used with single ended power supplies ranging from +10V to +30V where the V^- terminal is connected to ground. In either case analog signals ranging from V^+ to V^- can be switched.

The on resistance variation with analog signal and supply voltage is shown in the Typical Operating Characteristics graphs. The temperature coefficient of R_{ON} is typically 0.5%/°C. Typical on resistance matching from channel to channel is 10%. In addition, Table 1 outlines some typical parameters for single supply operation.

Table 1. Typical Single Supply Parameters

	V^+ SUPPLY VOLTAGE (V^- = 0V)			
	+10V	+15V	+20V	+30V
Switching Time (R_L = 1kΩ)				
t_{ON}	190ns	150ns	110ns	70ns
t_{OFF}	40ns	40ns	40ns	40ns
On Resistance				
V_{SIGNAL} = +1V	71Ω	51Ω	42Ω	31Ω
V_{SIGNAL} = $V^+/2$	77Ω	54Ω	43Ω	30Ω
V_{SIGNAL} = V^+	84Ω	63Ω	54Ω	43Ω
Input Logic Levels	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.0V	0.8V, 4.5V

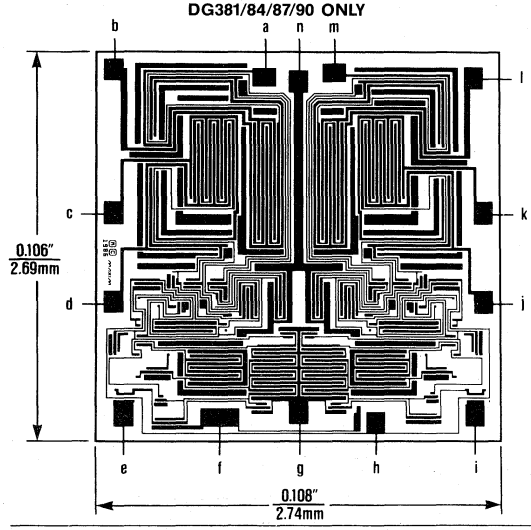
The charge injection test circuit is shown in Figure 1. Table 2 lists the typical injected charge for DG381 series switches with various input voltages.

Table 2. Charge Injection (±15V Supplies)

ANALOG INPUT	INJECTED Q
+10V	4pC
+5V	8pC
0V	12pC
-5V	8pC
-10V	5pC

General Purpose CMOS Analog Switches

Chip Topography



Ordering Information (continued)

DIE PAD	DG381 DG381A	DG387 DG387A	DG384/390 DG384A/390A
a	N.C.	N.C.	S3
b	D1	D1	D3
c	D1	S1	D1
d	S1	IN1	S1
e	IN1	IN1	IN1
f	V^+	V^+	V^+
g	GND	GND	GND
h	V^-	V^-	V^-
i	IN2	GND	IN2
j	S2	V^-	S2
k	D2	S2	D2
l	D2	D2	D4
m	N.C.	N.C.	S4
n	V^+	V^+	V^+

For DG381A/84A/87A/90A Chip Topography, contact Factory.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DG381AC/D	0°C to +70°C	Dice
DG381ACJ	0°C to +70°C	14 Lead Plastic DIP
DG381ACWE	0°C to +70°C	16 Lead Wide SO
DG381ACK	0°C to +70°C	14 Lead CERDIP
DG381ABWE	-25°C to +85°C	16 Lead Wide SO
DG381ABK	-25°C to +85°C	14 Lead CERDIP
DG381ABA	-25°C to +85°C	10 Lead Metal Can
DG384C/D	0°C to +70°C	Dice
DG384CJ	0°C to +70°C	16 Lead Plastic DIP
DG384CWE	0°C to +70°C	16 Lead Wide SO
DG384CK	0°C to +70°C	16 Lead CERDIP
DG384BWE	-25°C to +85°C	16 Lead Wide SO
DG384BK	-25°C to +85°C	16 Lead CERDIP
DG384AK	-55°C to +125°C	16 Lead CERDIP
DG384AC/D	0°C to +70°C	Dice
DG384ACJ	0°C to +70°C	16 Lead Plastic DIP
DG384ACWE	0°C to +70°C	16 Lead Wide SO
DG384ACK	0°C to +70°C	16 Lead CERDIP
DG384ABWE	-25°C to +85°C	16 Lead Wide SO
DG384ABK	-25°C to +85°C	16 Lead CERDIP
DG387C/D	0°C to +70°C	Dice
DG387CJ	0°C to +70°C	14 Lead Plastic DIP
DG387CWE	0°C to +70°C	16 Lead Wide SO
DG387CK	0°C to +70°C	14 Lead CERDIP
DG387BWE	-25°C to +85°C	16 Lead Wide SO

PART	TEMP. RANGE	PACKAGE
DG387BK	-25°C to +85°C	14 Lead CERDIP
DG387BA	-25°C to +85°C	10 Lead Metal Can
DG387AK	-55°C to +125°C	14 Lead CERDIP
DG387AA	-55°C to +125°C	10 Lead Metal Can
DG387AC/D	0°C to +70°C	Dice
DG387ACJ	0°C to +70°C	14 Lead Plastic DIP
DG387ACWE	0°C to +70°C	16 Lead Wide SO
DG387ACK	0°C to +70°C	14 Lead CERDIP
DG387ABWE	-25°C to +85°C	16 Lead Wide SO
DG387ABK	-25°C to +85°C	14 Lead CERDIP
DG387ABA	-25°C to +85°C	10 Lead Metal Can
DG390C/D	0°C to +70°C	Dice
DG390CJ	0°C to +70°C	16 Lead Plastic DIP
DG390CWE	0°C to +70°C	16 Lead Wide SO
DG390CK	0°C to +70°C	16 Lead CERDIP
DG390BWE	-25°C to +85°C	16 Lead Wide SO
DG390BK	-25°C to +85°C	16 Lead CERDIP
DG390AK	-55°C to +125°C	16 Lead CERDIP
DG390AC/D	0°C to +70°C	Dice
DG390ACJ	0°C to +70°C	16 Lead Plastic DIP
DG390ACWE	0°C to +70°C	16 Lead Wide SO
DG390ACK	0°C to +70°C	16 Lead CERDIP
DG390ABWE	-25°C to +85°C	16 Lead Wide SO
DG390ABK	-25°C to +85°C	16 Lead CERDIP

General Purpose CMOS Analog Switches

General Description

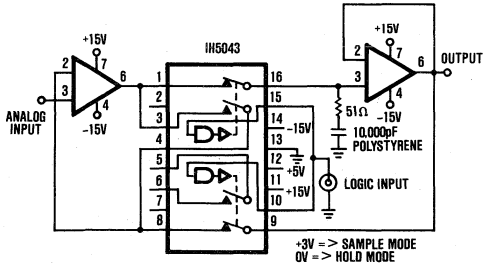
The IH5040 family consists of six CMOS analog switches that are intended for general purpose applications. These switches are latch-up proof, break-before-make single and dual versions of all the popular switch formats — SPST, SPDT, and DPST. Key features of the family include low leakage current of 1nA and quiescent current of less than 1μA.

Maxim IH5040 family has faster switching times than the original manufacturer's devices. All devices are bi-directional and maintain almost constant ON resistance throughout their operating range. These devices are guaranteed to operate from ±4.5V to ±18V, and will switch input signals that include the supplies.

Applications

PBX, PABX
Disc Drives
Guidance and Control Systems
Test Equipment
Sample and Holds
Military Radios

Typical Operating Circuit



Improved Sample & Hold
Using IH5043

Features

- **Improved 2nd Source! (See 3rd page for "Maxim Advantage™").**
- **Guaranteed ±4.5V to ±18V Operation**
- **Input Voltage Range Includes Supplies**
- **Latch-Up Proof Construction**
- **TTL, CMOS Logic Compatible**
- **Quiescent Current Less Than 1μA**
- **Monolithic Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
SINGLE POLE SINGLE THROW (SPST)		
IH5040C/D	0°C to +70°C	DICE
IH5040CJE	0°C to +70°C	16 Lead CERDIP
IH5040CPE	0°C to +70°C	16 Lead Plastic DIP
IH5040CWE	0°C to +70°C	16 Lead Wide SO
IH5040M/D	-55°C to +125°C	DICE
IH5040MJE	-55°C to +125°C	16 Lead CERDIP
DUAL SINGLE POLE SINGLE THROW (DUAL SPST)		
IH5041C/D	0°C to +70°C	DICE
IH5041CJE	0°C to +70°C	16 Lead CERDIP
IH5041CPE	0°C to +70°C	16 Lead Plastic DIP
IH5041CTW	0°C to +70°C	10 Lead Metal Can
IH5041CWE	0°C to +70°C	16 Lead Wide SO
IH5041M/D	-55°C to +125°C	DICE
IH5041MJE	-55°C to +125°C	16 Lead CERDIP
IH5041MTW	-55°C to +125°C	10 Lead Metal Can
SINGLE POLE DOUBLE THROW (SPDT)		
IH5042C/D	0°C to +70°C	DICE
IH5042CJE	0°C to +70°C	16 Lead CERDIP
IH5042CPE	0°C to +70°C	16 Lead Plastic DIP
IH5042CWE	0°C to +70°C	16 Lead Wide SO
IH5042M/D	-55°C to +125°C	DICE
IH5042MJE	-55°C to +125°C	16 Lead CERDIP
DUAL SINGLE POLE DOUBLE THROW (DUAL SPDT)		
IH5043C/D	0°C to +70°C	DICE
IH5043CJE	0°C to +70°C	16 Lead CERDIP
IH5043CPE	0°C to +70°C	16 Lead Plastic DIP
IH5043CWE	0°C to +70°C	16 Lead Wide SO
IH5043M/D	-55°C to +125°C	DICE
IH5043MJE	-55°C to +125°C	16 Lead CERDIP

(Ordering information continued on fourth page.)

The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

ABSOLUTE MAXIMUM RATINGS

Current (Any Terminal) ..... < 30mA
Storage Temperature ..... -65°C to +150°C
Operating Temperature ..... -55°C to +125°C
Power Dissipation 450mW
(All Leads Soldered to a P.C. Board)
Derate 6mW/°C Above +70°C
Lead Temperature (Soldering, 10 sec) ..... 300°C
Voltages
$V^+ - V^-$ ..... < 38V
$V^+ - V_D$ ..... < 30V
$V_D - V^-$ ..... <30V
$V_D - V_S$ ..... < ±22V
$V_L - V^-$ ..... < 33V
$V_L - V_{IN}$ ..... < 30V
V_L - GND ..... < 20V
V_{IN} - GND ..... < 20V
Digital Inputs ..... $(V^+ + 0.3V)$ to $(V^+ - 38V)$
V_S or V_D ..... -0.3V to $(V^+ + 0.3V)$ (Note 1)

Note 1: Signals on S, D and digital inputs which exceed V^- or V^+ will be clamped by internal diodes. Limit forward diode current to 30mA maximum.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V^- = -15V, V_L = +5V, T_A = +25°C unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN./MAX. LIMITS						UNITS
			MILITARY			COMMERCIAL			
			-55°C	+25°C	+125°C	0°C	+25°C	+70°C	
Input Logic Current	$I_{IN(ON)}$	V_{IN} = 2.4V (Note 3)	±1	±1	10	±1	±1	10	µA
Input Logic Current	$I_{IN(OFF)}$	V_{IN} = 0.8V (Note 3)	±1	±1	10	±1	±1	10	µA
Drain-Source On Resistance	$r_{DS(ON)}$	I_S = 10mA, V_{ANALOG} = -10V to +10V	75	75	150	80	80	130	Ω
Channel to Channel $r_{DS(ON)}$ Match	$\Delta r_{DS(ON)}$			25 (typ)			30 (typ)		Ω
Minimum Analog Signal Handling Capability	V_{ANALOG}			±11 (typ)			±10 (typ)		V
Switch OFF Leakage Current	$I_D/I_{S(OFF)}$	V_{ANALOG} = -10V to +10V		±1	100		±5	100	nA
Switch ON Leakage Current	$I_{D(ON)} + I_{S(ON)}$	$V_D = V_S$ = -10V to +10V		±2	200		±10	100	nA
Switch "ON" Time	t_{ON}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V.		750			1000		ns
Switch "OFF" Time	t_{OFF}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V.		350			500		ns
Charge Injection	$Q_{(INJ.)}$			15 (typ)			20 (typ)		mV
Minimum Off Isolation Rejection Ratio	OIRR	f = 1MHz, R_L = 100Ω, $C_L \leq$ 5pF		54 (typ)			50 (typ)		dB
V^+ Power Supply Quiescent Current	I^+_Q		1	1	10	10	10	100	µA
V^- Power Supply Quiescent Current	I^-_Q	V^+ = +15V, V^- = -15V, V_L = +5V	1	1	10	10	10	100	µA
+5V Supply Quiescent Current	I^-_{LQ}		1	1	10	10	10	100	µA
Ground Supply Quiescent Current	I_{GND}		1	1	10	10	10	100	µA
Minimum Channel to Channel Cross Coupling Rejection Ratio	CCRR	One Channel Off.		54 (typ)			50 (typ)		dB

The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted 1986 Component Data Catalog. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excerpts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.

General Purpose CMOS Analog Switches

- ♦ Guaranteed ±4.5V to ±18V Operation
- ♦ Guaranteed To Switch Signals Up To Either Supply
- ♦ Faster Switching Speeds

ABSOLUTE MAXIMUM RATINGS: This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS: Specifications below satisfy or exceed all "tested" parameters on adjacent page.
(V^+ = +15V, V^- = -15V, V_L = +5V, T_A = +25°C unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN./MAX. LIMITS						UNITS
			MILITARY			COMMERCIAL			
			-55°C	+25°C	+125°C	0°C	+25°C	+70°C	
Input Logic Current	$I_{IN(ON)}$	V_{IN} = 2.4V	±1	±1	10	±1	±1	10	µA
Input Logic Current	$I_{IN(OFF)}$	V_{IN} = 0.8V	±1	±1	10	±1	±1	10	µA
Input Logic Low	V_{IL}		0.8	0.8	0.8	0.8	0.8	0.8	V
Input Logic High	V_{IH}		2.4	2.4	2.4	2.4	2.4	2.4	V
Drain-Source On Resistance	$r_{DS(ON)}$	I_S = 10mA, V_{ANALOG} = -10V to +10V	75	75	150	80	80	130	Ω
Channel to Channel $r_{DS(ON)}$ Match	$\Delta r_{DS(ON)}$			3 (typ)			5 (typ)		Ω
Minimum Analog Signal Handling Capability	V_{ANALOG}			**±15**			**±15**		**V**
Switch OFF Leakage Current	$I_D/I_{S(OFF)}$	V_{ANALOG} = -10V to +10V		±1	100		±5	100	nA
Switch ON Leakage Current	$I_{D(ON)}$ + $I_{S(ON)}$	V_D = V_S = -10V to +10V		±2	200		±10	100	nA
Switch "ON" Time	t_{ON}	**Fig. A**		**400**			**400**		**ns**
Switch "OFF" Time	t_{OFF}	**Fig. A**		**200**			**200**		**ns**
Charge Injection	$Q_{(INJ.)}$	Fig. B (Note 2)		15			20		mV
Minimum Off Isolation Rejection Ratio	OIRR	Fig. C, C_L < 5pF		54 (typ)			50 (typ)		dB
V^+ Quiescent Current	I^+_Q		1	1	10	10	10	100	µA
V^- Quiescent Current	I^-_Q		-1	-1	-10	-10	-10	-100	µA
+5V Quiescent Current	I_{LQ}		1	1	10	10	10	100	µA
Ground Quiescent Current	I_{GND}		1	1	10	10	10	100	µA
Min. Channel to Channel Cross Coupling Rej. Ratio	CCRR	One Channel Off (Note 2)		54 (typ)			50 (typ)		dB
Power Supply Range For Continuous Operation	V_{OP}	**Min. (Note 3)** **Max. (Note 3)**		**±4.5** **±18**			**±4.5** **±18**		**V**

Note 2: Not tested in production.
Note 3: Electrical characteristics, such as ON Resistance, will change when power supplies other than ±15V are used.

Test Circuits

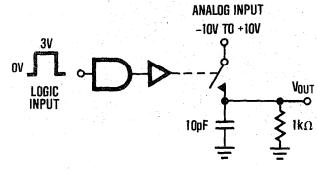


Figure A. Switching Time

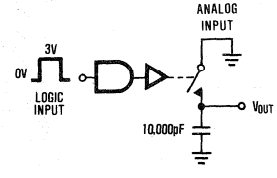


Figure B. Charge Injection

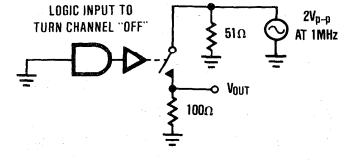
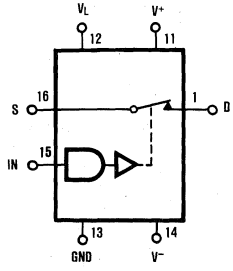


Figure C. Off Isolation Rejection Ratio

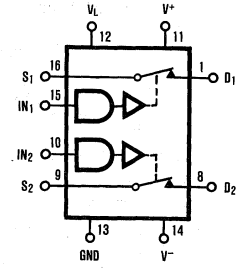
General Purpose CMOS Analog Switches

Pin Configuration & Switching State Diagrams

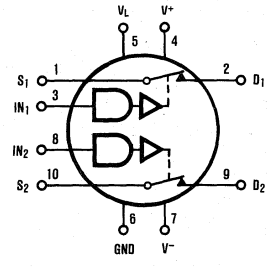
IH5040 SPST
DIP (JE, PE, WE)



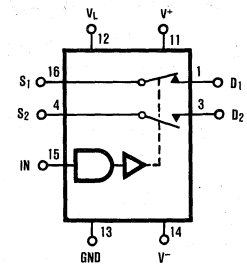
IH5041 Dual SPST
DIP (JE, PE, WE)



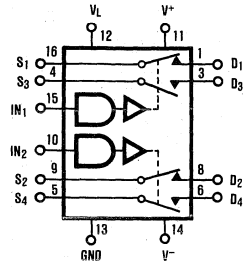
IH5041 Dual SPST
T0-100 Metal Can



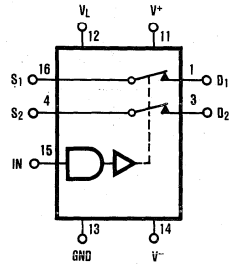
IH5042 SPDT
DIP (JE, PE, WE)



IH5043 Dual SPDT
DIP (JE, PE, WE)



IH5044 DPST
DIP (JE, PE, WE)



IH5045 Dual DPST
DIP (JE, PE, WE)

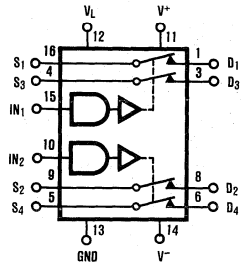


Table 1. USING THE 5040 FAMILY WITH ONLY 2 SUPPLIES

(V_L tied to V^+)

SUPPLY VOLTAGES	MIN. LOGIC I/P FOR "1" STATE
±15V	+12.6V
±12V	+9.6V
±10V	+7.6V
±5V	+2.6V

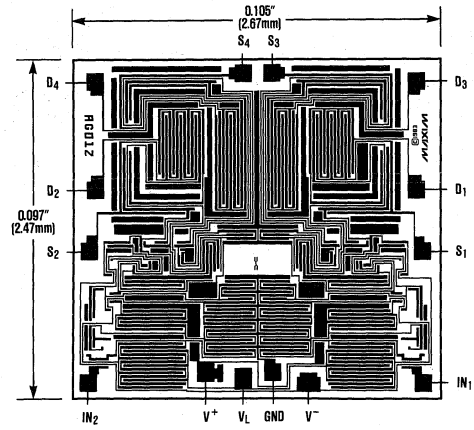
Note: Switch states are for logic "1" input.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DOUBLE POLE SINGLE THROW (DPST)		
IH5044C/D	0°C to +70°C	DICE
IH5044CJE	0°C to +70°C	16 Lead CERDIP
IH5044CPE	0°C to +70°C	16 Lead Plastic DIP
IH5044CWE	0°C to +70°C	16 Lead Small Outline
IH5044M/D	-55°C to +125°C	DICE
IH5044MJE	-55°C to +125°C	16 Lead CERDIP
DUAL DOUBLE POLE SINGLE THROW (DUAL DPST)		
IH5045C/D	0°C to +70°C	DICE
IH5045CJE	0°C to +70°C	16 Lead CERDIP
IH5045CPE	0°C to +70°C	16 Lead Plastic DIP
IH5045CWE	0°C to +70°C	16 Lead Small Outline
IH5045M/D	-55°C to +125°C	DICE
IH5045MJE	-55°C to +125°C	16 Lead CERDIP

For the IH5042 and IH5044 in 10 Lead Metal Can Package Contact Factory. For all devices in Ceramic Flat Package Contact Factory.

Chip Topography



Low Charge Injection CMOS Analog Switches

General Description

Maxim's IH5048 Series of analog switches are designed for low charge injection and low leakage. They feature extremely low on resistance (35Ω typical) as well as quiescent power supply current below 1μA. The switch control inputs are fully compatible with both CMOS and TTL logic.

These switches are pin-for-pin replacements of the original manufacturer's devices with specification improvements in analog signal range and switch ON and OFF times. They are also compatible with the IH5040 family of analog switches. The IH5048 series is supplied in 16 pin Dual-In-Line and Small Outline packages.

Applications

Precision Sample/Hold Circuits

Transducer and Sensor Switching

Low Level Signal Conditioning

Battery Powered Instrumentation

Programmable Gain Amplifiers

Features

- **Low Charge Injection (10pC Typ.)**
- **Quiescent Current Below 1μA**
- **TTL and CMOS Compatible**
- **Low On Resistance (40Ω Max.)**
- **Latch-Up Proof Construction**

Ordering Information

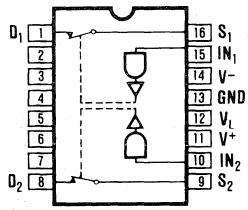
PART	TEMP. RANGE	PACKAGE
IH5048C/D	0°C to +70°C	Dice
IH5048CPE	0°C to +70°C	16 Lead Plastic DIP
IH5048CWE	0°C to +70°C	16 Lead Wide SO
IH5048CJE	0°C to +70°C	16 Lead CERDIP
IH5048M/D	-55°C to +125°C	Dice
IH5048MJE	-55°C to +125°C	16 Lead CERDIP

(Ordering Information is continued on last page.)

Pin Configurations

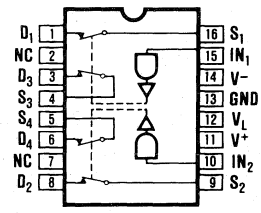
Top View

IH5048 - Dual SPST



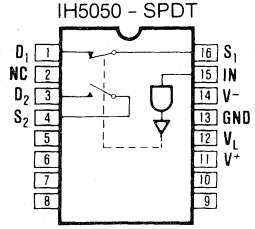
LOGIC	SWITCH
0	OFF
1	ON

IH5049 - Dual DPST



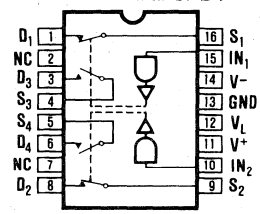
LOGIC	SWITCH
0	OFF
1	ON

IH5050 - SPDT



LOGIC	SWITCH 1	SWITCH 2
0	OFF	ON
1	ON	OFF

IH5051 - Dual SPDT



LOGIC	SWITCH 1 SWITCH 2	SWITCH 3 SWITCH 4
0	OFF	ON
1	ON	OFF

Switch states are for Logic "1" Inputs (Positive Logic).

The "Maxim Advantage™" signifies an upgraded quality level. At no additional cost we offer a second-source device that is subject to the following: guaranteed performance over temperature along with tighter test specifications on many key parameters; and device enhancements, when needed, that result in improved performance without changing the functionality.

Low Charge Injection CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Voltages
- $V^+ - V^-$ 36V
- $V^+ - V_D$ 30V
- $V_D - V^-$ 30V
- $V_D - V_S$ ..... ±28V
- $V_L - V^-$ 33V
- $V_L - V_{IN}$ 30V
- V_L - GND 20V
- V_{IN} - GND 20V
- Digital Inputs ..... $(V^+ + 0.3V)$ to $(V^+ - 38V)$
- V_S or V_D ..... -0.3V to $(V^+ + 0.3V)$ (Note 1)

Current (Any Terminal) 30mA
Storage Temperature ..... -65°C to +150°C
Operating Temperature ..... -55°C to +125°C
Power Dissipation 450mW
(All Leads Soldered to a P.C. Board)
Derate 6mW/°C Above +70°C
Lead Temperature (Soldering, 10 sec) ..... 300°C

Note 1: Signals on S, D and digital inputs which exceed V^- or V^+ will be clamped by internal diodes. Limit forward diode current to 30mA maximum.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V^- = -15V, V_L = +5V, T_A = 25°C unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN./MAX. LIMITS						UNITS
			MILITARY			COMMERCIAL			
			-55°C	+25°C	+125°C	0°C	+25°C	+70°C	
Input Logic Current	$I_{IN(ON)}$	V_{IN} = 2.4V	±1	±1	10	±1	±1	10	µA
Input Logic Current	$I_{IN(OFF)}$	V_{IN} = 0.8V	±1	±1	10	±1	±1	10	µA
Drain-Source On Resistance	$r_{DS(ON)}$	I_S = 10mA V_{ANALOG} = -10V to +10V		40	60		45	75	Ω
Channel to Channel $r_{DS(ON)}$ Match	$\Delta r_{DS(ON)}$			15 (typ)			15 (typ)		Ω
Minimum Analog Signal Handling Capability	V_{ANALOG}			±10			±10		V
Switch OFF Leakage Current	$I_D/I_{S(OFF)}$	V_{ANALOG} = -10V to +10V		±1	100		±5	100	nA
Switch ON Leakage Current	$I_{D(ON)} + I_{S(ON)}$	$V_D = V_S$ = -10V to +10V		±2	200		±10	200	nA
Switch "ON" Time	t_{ON}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V		500			1000		ns
Switch "OFF" Time	t_{OFF}	R_L = 1kΩ, V_{ANALOG} = -10V to +10V		250			500		ns
Charge Injection	$Q_{(INJ)}$			1 (typ)			2 (typ)		mV
Minimum Off Isolation Rejection Ratio	OIRR	f = 1MHz, R_L = 100Ω, $C_L \leq$ 5pF		54 (typ)			50 (typ)		dB
V^+ Power Supply Quiescent Current	I^+_Q		1	1	10	10	10	100	µA
V^- Power Supply Quiescent Current	I^-_Q	V^+ = +15V, V^- = -15V, V_L = +5V	-1	-1	-10	-10	-10	-100	µA
+5V Supply Quiescent Current	I^-_{LQ}		1	1	10	10	10	100	µA
Ground Supply Quiescent Current	I_{GND}		1	1	10	10	10	100	µA
Minimum Channel to Channel Cross Coupling Rejection Ratio	CCRR	One Channel Off		54 (typ)			50 (typ)		dB

The electrical characteristics above are a reproduction of a portion of Intersil's copyrighted 1987 Component Data Catalog. This information does not constitute any representation by Maxim that Intersil's products will perform in accordance with these specifications. The "Electrical Characteristics Table" along with descriptive excepts from the original manufacturer's data sheet have been included in this data sheet solely for comparative purposes.

Low Charge Injection CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS: This device conforms to the Absolute Maximum Ratings on the adjacent page.

ELECTRICAL CHARACTERISTICS: Specifications below satisfy or exceed all "tested" parameters on adjacent page.
(V^+ = +15V, V^- = -15V, V_L = +5V, T_A = 25°C unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN./MAX. LIMITS						UNITS
			MILITARY			COMMERCIAL			
			-55°C	+25°C	+125°C	0°C	+25°C	+70°C	
Input Logic Current	$I_{IN(ON)}$	V_{IN} = 2.4V	±1	±1	10	±1	±1	10	μA
Input Logic Current	$I_{IN(OFF)}$	V_{IN} = 0.8V	±1	±1	10	±1	±1	10	μA
Input Logic Low	**V_{IL}**		**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**V**
Input Logic High	**V_{IH}**		**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**2.4**	**V**
Drain-Source On Resistance	$r_{DS(ON)}$	I_S = 10mA V_{ANALOG} = -10V to +10V	40	40	60	45	45	75	Ω
Channel to Channel $r_{DS(ON)}$ Match	$\Delta r_{DS(ON)}$		8 (typ)			8 (typ)			Ω
Minimum Analog Signal Handling Capability	**V_{ANALOG}**		**±14**	**±14**	**±14**	**±14**	**±14**	**±14**	**V**
Switch OFF Leakage Current	$I_D/I_{S(OFF)}$	V_{ANALOG} = -10V to +10V		±1	100		±5	100	nA
Switch ON Leakage Current	$I_{D(ON)}$ + $I_{S(ON)}$	V_D = V_S = -10V to +10V		±2	200		±10	200	nA
Switch "ON" Time	**t_{ON}**	**Fig. A**		**400**			**600**		**ns**
Switch "OFF" Time	**t_{OFF}**	**Fig. A**		**200**			**300**		**ns**
Charge Injection	Q_{INJ}	Fig. B (Note 2)	10 (typ)			10 (typ)			pC
Minimum Off Isolation Rejection Ratio	OIRR	Fig. C, C_L < 5pF	54 (typ)			50 (typ)			dB
V^+ Quiescent Current	I^+_Q	V_{IN} = 0.8V or 2.4V V^+ = +15V, V^- = -15V, V_L = +5V	1	1	10	10	10	100	μA
V^- Quiescent Current	I^-_Q		-1	-1	-10	-10	-10	-100	μA
+5V Quiescent Current	I^-_{LQ}		1	1	10	10	10	100	μA
Ground Quiescent Current	I_{GND}		1	1	10	10	10	100	μA
Minimum Channel to Channel Cross Coupling Rejection Ratio	CCRR	One Channel Off (Note 2)	54 (typ)			50 (typ)			dB

Note 2: Not tested in production.

Test Circuits

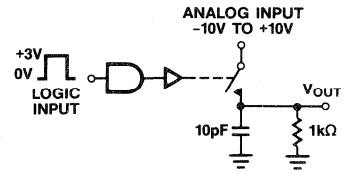


Figure A. Switching Time

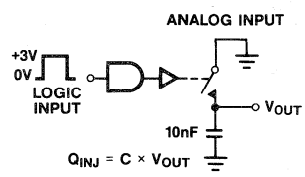


Figure B. Charge Injection

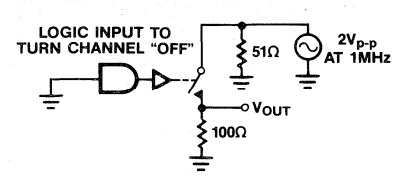
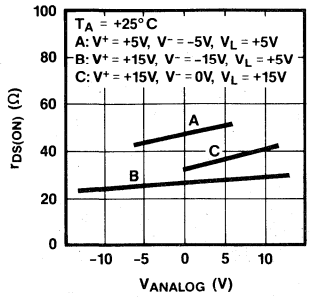


Figure C. Off Isolation Rejection Ratio

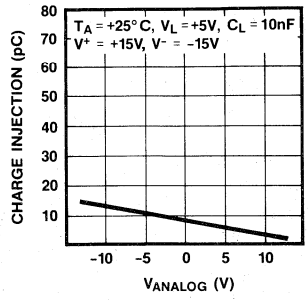
Low Charge Injection CMOS Analog Switches

Typical Operating Characteristics

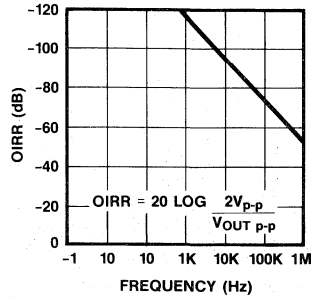
$r_{DS(ON)}$ vs. ANALOG SIGNAL



CHARGE INJECTION vs. V_{ANALOG} (See Fig. B)



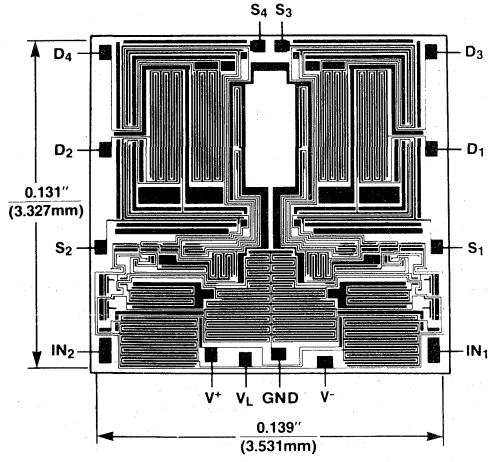
OFF ISOLATION REJECTION RATIO (OIRR) (See Fig. C)



Logic Inputs

The IH5048 family operates with plus/minus as well as single ended power supplies (with V^- = 0V). Full TTL compatibility is maintained for the control inputs over a wide power supply range when V_L = +5V. When V_L is connected to voltages other than +5V, the logic input thresholds are +0.8V for a logic LOW and V_L - 1V for a logic HIGH. This means that when V_L is connected to V^+ at voltages other than 5V, CMOS logic levels should be used.

Chip Topography



Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
IH5049C/D	0°C to +70°C	Dice
IH5049CPE	0°C to +70°C	16 Lead Plastic DIP
IH5049CWE	0°C to +70°C	16 Lead Wide SO
IH5049CJE	0°C to +70°C	16 Lead CERDIP
IH5049M/D	-55°C to +125°C	Dice
IH5049MJE	-55°C to +125°C	16 Lead CERDIP
IH5050C/D	0°C to +70°C	Dice
IH5050CPE	0°C to +70°C	16 Lead Plastic DIP
IH5050CWE	0°C to +70°C	16 Lead Wide SO
IH5050CJE	0°C to +70°C	16 Lead CERDIP
IH5050M/D	-55°C to +125°C	Dice
IH5050MJE	-55°C to +125°C	16 Lead CERDIP
IH5051C/D	0°C to +70°C	Dice
IH5051CPE	0°C to +70°C	16 Lead Plastic DIP
IH5051CWE	0°C to +70°C	16 Lead Wide SO
IH5051CJE	0°C to +70°C	16 Lead CERDIP
IH5051M/D	-55°C to +125°C	Dice
IH5051MJE	-55°C to +125°C	16 Lead CERDIP

Contact factory for devices in Flat Pack packages.

Low Power Fast CMOS Analog Switches

General Description

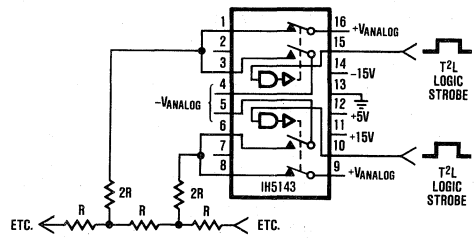
The IH5140 family consists of six CMOS analog switches that are intended for high speed general purpose applications. These switches are latch-up proof, break-before-make single and dual versions of all the popular switch formats — SPST, SPDT, and DPST. Key features of the family include toggle rates in excess of 1MHz, t_{ON} times of 80ns typical and t_{OFF} times of 50ns. OFF leakage current is less than 100pA maximum at +25°C and quiescent currents are 1μA maximum, making the switches ideal for portable equipment.

Maxim has significantly improved the design of these switches versus the original manufacturer. Maxim's switches are guaranteed to operate from ±4.5V to ±18V, and will switch input signals that include the supplies.

Applications

High Speed Test Equipment
Sample and Hold Circuits
Guidance and Control Systems
Radar Systems
Aircraft Head-Up Displays
Military Radios

Typical Operating Circuit



Using the CMOS Switch to Drive an R/2R Ladder Network (2 Legs)

Features

- ♦ Pin for Pin 2nd Source!
- ♦ Break-Before-Make Switching Action
- ♦ Fast t_{ON} (80ns typ.) and t_{OFF} (50ns)
- ♦ Input Signal Range Includes Supply Rails
- ♦ Guaranteed ±4.5V to ±18V Operation
- ♦ Low OFF Leakage Current — 100pA max.
- ♦ Greater than 1MHz Toggle Rate
- ♦ TTL and CMOS Compatible

Ordering Information

PART	TEMP. RANGE	PACKAGE
SINGLE POLE SINGLE THROW (SPST)		
IH5140C/D	0°C to +70°C	DICE
IH5140CJE	0°C to +70°C	16 Lead CERDIP
IH5140CPE	0°C to +70°C	16 Lead Plastic DIP
IH5140CWE	0°C to +70°C	16 Lead Wide SO
IH5140M/D	-55°C to +125°C	DICE
IH5140MJE	-55°C to +125°C	16 Lead CERDIP
DUAL SINGLE POLE SINGLE THROW (DUAL SPST)		
IH5141C/D	0°C to +70°C	DICE
IH5141CJE	0°C to +70°C	16 Lead CERDIP
IH5141CPE	0°C to +70°C	16 Lead Plastic DIP
IH5141CTW	0°C to +70°C	10 Lead Metal Can
IH5141CWE	0°C to +70°C	16 Lead Wide SO
IH5141M/D	-55°C to +125°C	DICE
IH5141MJE	-55°C to +125°C	16 Lead CERDIP
IH5141MTW	-55°C to +125°C	10 Lead Metal Can
SINGLE POLE DOUBLE THROW (SPDT)		
IH5142C/D	0°C to +70°C	DICE
IH5142CJE	0°C to +70°C	16 Lead CERDIP
IH5142CPE	0°C to +70°C	16 Lead Plastic DIP
IH5142CWE	0°C to +70°C	16 Lead Wide SO
IH5142M/D	-55°C to +125°C	DICE
IH5142MJE	-55°C to +125°C	16 Lead CERDIP
DUAL SINGLE POLE DOUBLE THROW (DUAL SPDT)		
IH5143C/D	0°C to +70°C	DICE
IH5143CJE	0°C to +70°C	16 Lead CERDIP
IH5143CPE	0°C to +70°C	16 Lead Plastic DIP
IH5143CWE	0°C to +70°C	16 Lead Wide SO
IH5143M/D	-55°C to +125°C	DICE
IH5143MJE	-55°C to +125°C	16 Lead CERDIP

(Ordering information continued on fourth page.)

Low Power Fast CMOS Analog Switches

ABSOLUTE MAXIMUM RATINGS

Current (Any Terminal) ..... < 30mA
Storage Temperature ..... -65°C to +150°C
Operating Temperature ..... -55°C to +125°C
Power Dissipation 450mW
(All Leads Soldered to a P.C. Board)
Derate 6mW/°C Above +70°C
Lead Temperature (Soldering, 10 sec) ..... 300°C
Voltages
$V^+ - V^-$ ..... < 38V
$V^+ - V_D$ ..... < 30V
$V_D - V^-$ ..... <30V
$V_D - V_S$ ..... < ±22V
$V_L - V^-$ ..... < 33V
$V_L - V_{IN}$ ..... < 30V
V_L - GND ..... < 20V
V_{IN} - GND ..... < 20V
Digital Inputs ..... $(V^+ + 0.3V)$ to $(V^+ - 38V)$
V_S or V_D ..... -0.3V to $(V^+ + 0.3V)$ (Note 1)

Note 1: Signals on S, D and digital inputs which exceed V^- or V^+ will be clamped by internal diodes. Limit forward diode current to 30mA maximum.

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(All Parameters with $V^+ = +15V$, $V^- = -15V$, $V_L = +5V$, unless otherwise indicated)

PARAMETER	SYMBOL	TEST CONDITIONS	MIN./MAX. LIMITS						UNITS
			MILITARY			COMMERCIAL			
			-55°C	+25°C	+125°C	0°C	+25°C	+70°C	
Input Logic Current	I_{INH}	V_{IN} = 2.4V (Note 2)	±1	±1	10	±1	±1	10	µA
Input Logic Current	I_{INL}	V_{IN} = 0.8V (Note 2)	±1	±1	10	±1	±1	10	µA
Drain-Source On Resistance	$r_{DS(ON)}$	I_S = -10mA V_{ANALOG} = -10V to +10V	50	50	75	75	75	100	Ω
Channel to Channel $r_{DS(ON)}$ Match	$\Delta r_{DS(ON)}$			3 (typ)			5 (typ)		Ω
Minimum Analog Signal Handling Capability	V_{ANALOG}			±15			±15		V
Switch OFF Leakage Current	$I_{D(OFF)}$ + $I_{S(OFF)}$	V_D = +10V, V_S = -10V V_D = -10V, V_S = +10V		±0.5 ±0.5	100 100		±5 ±5	100 100	nA
Switch ON Leakage Current	$I_{D(ON)}$ + $I_{S(ON)}$	$V_D = V_S$ = -10V to +10V		±1	200		±2	200	nA
Switch "ON" Time Switch "OFF" Time	t_{ON} t_{OFF}		See switching time specifications and timing diagrams.						
Charge Injection	$Q_{(INJ.)}$	(Note 3)		10 (typ)			15 (typ)		pC
Minimum Off Isolation Rejection Ratio	OIRR	f = 1MHz, R_L = 100Ω, $C_L \leq$ 5pF (Note 3)		54 (typ)			50 (typ)		dB
+ Power Supply Quiescent Current	I^+	V^+ = +15V, V^- = -15V, V_L = +5V	1.0	1.0	10.0	10	10	100	µA
- Power Supply Quiescent Current	I^-		-1.0	-1.0	-10.0	-10	-10	-100	µA
+5V Supply Quiescent Current	I_L		1.0	1.0	10.0	10	10	100	µA
Ground Supply Quiescent Current	I_{GND}		1.0	1.0	10.0	10	10	100	µA
Minimum Channel to Channel Cross Coupling Rejection Ratio	CCRR	One Channel Off (Note 3)		54 (typ)			50 (typ)		dB
Power Supply Range for Continuous Operation	V_{OP}	(Note 4)		±4.5 (min) ±18V (max)			±4.5 (min) ±18V (max)		V

Note:
2. Some channels are turned on by high (1) logic inputs and other channels are turned on by low (0) inputs; however, 0.8V to 2.4V describes the minimum range for switching properly. Refer to logic diagrams to find logical value of logic input required to produce ON or OFF state.
3. Typical values are for design aid only, not guaranteed and not subject to production testing.
4. Electrical characteristics, such as ON Resistance, will change when power supplies, other than ±15V, are used.

SWITCHING TIME SPECIFICATIONS

(t_{on}, t_{off} are maximum specifications and t_{on}-t_{off} is minimum specifications)

PART NUMBER	CHARACTERISTICS	SYMBOL	TEST CONDITIONS	MILITARY -55°C	MILITARY +25°C	MILITARY +125°C	COMMERCIAL 0°C	COMMERCIAL +25°C	COMMERCIAL +70°C	UNITS
IH5140-5141	Switch "ON" time	t_{on}	Figure 1		100*			150		ns
	Switch "OFF" time	t_{off}			75*			125		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
	Switch "ON" time	t_{on}	Figure 2		150			175		ns
	Switch "OFF" time	t_{off}			125			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
IH5142-5143	Switch "ON" time	t_{on}	Figure 1		175*			250		ns
	Switch "OFF" time	t_{off}			125*			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
	Switch "ON" time	t_{on}	Figure 2		200			300		ns
	Switch "OFF" time	t_{off}			125			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
	Switch "ON" time	t_{on}	Figure 3		175*			250		ns
	Switch "OFF" time	t_{off}			125*			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
	Switch "ON" time	t_{on}	Figure 4		200			300		ns
	Switch "OFF" time	t_{off}			125			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
IH5144-5145	Switch "ON" time	t_{on}	Figure 1		175*			250		ns
	Switch "OFF" time	t_{off}			125*			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		
	Switch "ON" time	t_{on}	Figure 2		200			300		ns
	Switch "OFF" time	t_{off}			125			150		
	Break-before-make	t_{on}-t_{off}			10* TYP			5		

Note: Switching times are measured at 90% points.

* Guaranteed but not subjected to production testing.

Switching Time Test Circuits

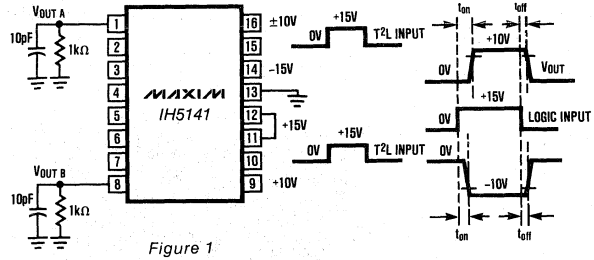


Figure 1

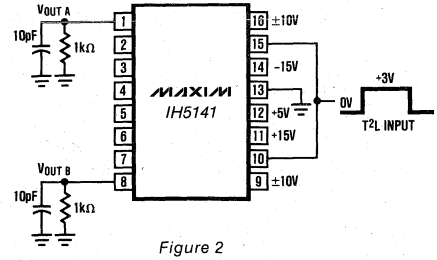


Figure 2

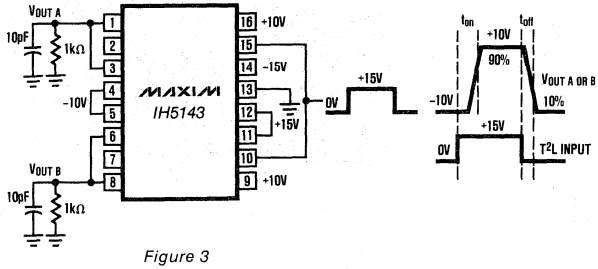


Figure 3

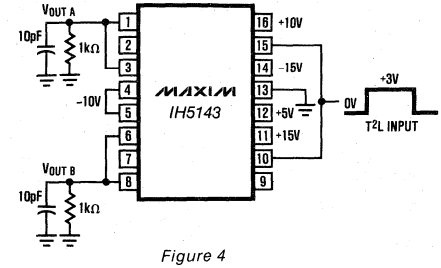
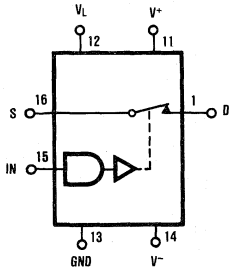


Figure 4

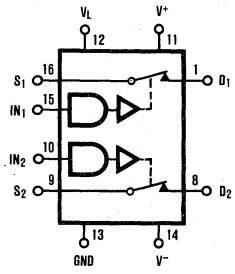
Low Power Fast CMOS Analog Switches

Pin Configuration and Switching State Diagrams

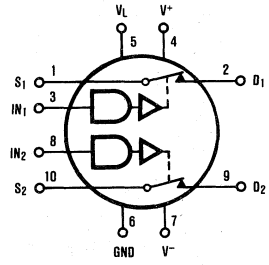
IH5140 SPST
DIP (JE, PE, WE)



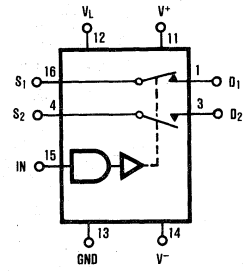
IH5141 Dual SPST
DIP (JE, PE, WE)



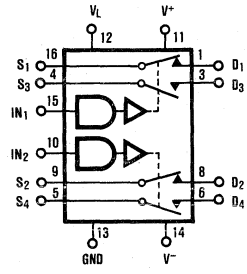
IH5141 Dual SPST
TO-100 Metal Can



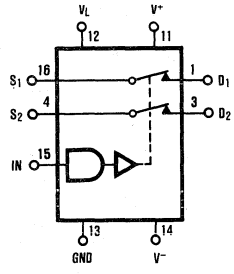
IH5142 SPDT
DIP (JE, PE, WE)



IH5143 Dual SPDT
DIP (JE, PE, WE)



IH5144 DPST
DIP (JE, PE, WE)



IH5145 Dual DPST
DIP (JE, PE, WE)

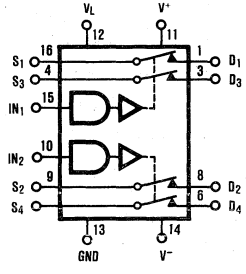


Table 1. USING THE 5140 FAMILY WITH ONLY 2 SUPPLIES

(V_L tied to V^+)

SUPPLY VOLTAGES	MIN. LOGIC I/P FOR "1" STATE
±15V	+12.6V
±12V	+9.6V
±10V	+7.6V
±5V	+2.6V

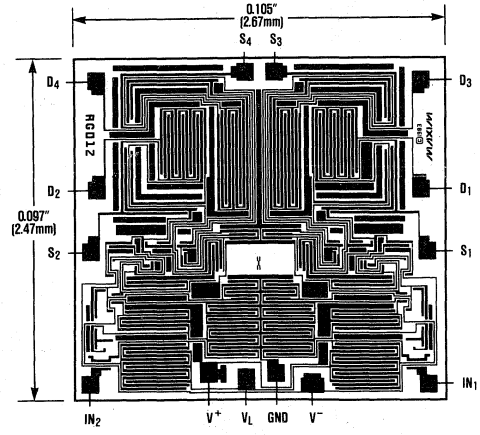
Note: Switch states are for logic "1" input.

Ordering Information (continued)

PART	TEMP. RANGE	PACKAGE
DOUBLE POLE SINGLE THROW (DPST)		
IH5144C/D	0°C to +70°C	DICE
IH5144CJE	0°C to +70°C	16 Lead CERDIP
IH5144CPE	0°C to +70°C	16 Lead Plastic DIP
IH5144CWE	0°C to +70°C	16 Lead Wide SO
IH5144M/D	-55°C to +125°C	DICE
IH5144MJE	-55°C to +125°C	16 Lead CERDIP
DUAL DOUBLE POLE SINGLE THROW (DUAL DPST)		
IH5145C/D	0°C to +70°C	DICE
IH5145CJE	0°C to +70°C	16 Lead CERDIP
IH5145CPE	0°C to +70°C	16 Lead Plastic DIP
IH5145CWE	0°C to +70°C	16 Lead Wide SO
IH5145M/D	-55°C to +125°C	DICE
IH5145MJE	-55°C to +125°C	16 Lead CERDIP

For the IH5142 and IH5144 in 10 Lead Metal Can package contact factory. For all devices in Ceramic Flat Package contact factory.

Chip Topography



Dual/Quad RF/Video Switches

General Description

The IH5341 and the IH5352 are dual and quad, single pole single throw (SPST) switches designed specifically for switching RF and video signals. Maxim's IH5341 and IH5352 incorporate an enhanced series-shunt-series structure, providing 70dB of OFF isolation and cross coupling rejection (an additional 10dB compared with other manufacturers' products).

Both devices can be operated with supplies ranging from ±5V to ±15V. The switches typically have a t_{ON} = 160ns and a t_{OFF} = 70ns, assuring break-before-make switching. The channel thruput resistance of 50Ω provides excellent matching to video impedances. In the D.C. state, with switches being either on or off, power supply quiescent currents are typically 100nA. This limits the quiescent current drain to 3μ watts—ideal for portable equipment.

Applications

These devices are used in applications requiring the routing, blocking or switching of video or RF signals such as:

Winchester Disk Drives
Commercial TV Cameras
Video Special Effects
Low Power RF Switching
Radar Switching
Mil and Space Communications

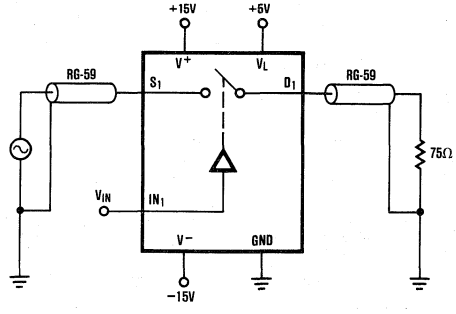
Features

- **"OFF" Isolation ≥ 70dB @ 10MHz**
- **Cross Coupling Isolation ≥ 70dB @ 10MHz**
- **$r_{ds(on)}$ < 75Ω, < 3dB Loss from DC to 100 MHz**
- **±5V to ±15V Operating Supply Range**
- **Supply Currents < 1μA**
- **Fast, Break-Before-Make Switching (70ns/160ns typ.)**
- **Monolithic, Low Power CMOS Design**

Ordering Information

PART	TEMP. RANGE	PACKAGE
IH5341CPD	0°C to +70°C	14 Lead Plastic DIP
IH5341IJD	-20°C to +85°C	14 Lead CERDIP
IH5341ITW	-20°C to +85°C	10 Lead TO-100
IH5341MJD	-55°C to +125°C	14 Lead CERDIP
IH534IMTW	-55°C to +125°C	10 Lead TO-100
IH5341C/D	0°C to 70°C	Dice
IH5352CPE	0°C to +70°C	16 Lead Plastic DIP
IH5352IJE	-20°C to +85°C	16 Lead
IH5352MJE	-55°C to +125°C	16 Lead CERDIP
IH5352C/D	0°C to 70°C	Dice

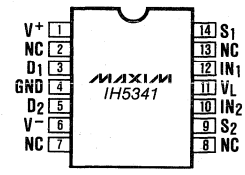
Typical Operating Circuit



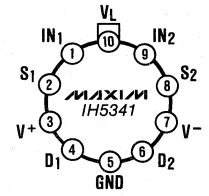
75Ω Video Switch
(Only one channel shown)

Pin Configuration

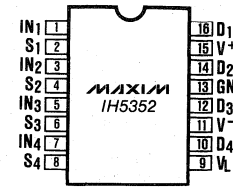
Top View



14 Lead DIP



10 Lead TO-100



16 Lead DIP

Dual/Quad RF/Video Switches

ABSOLUTE MAXIMUM RATINGS

Supply Voltages V^+ and V^- ..... ±17V
Current in any Terminal 50mA
Analog Input Voltage ..... V^+ to V^-
Operating Temperature Range
(M Version) -55°C to +125°C
(I Version) -20°C to +85°C
(C Version) 0°C to +70°C

Power Dissipation 250mW
(Derate 7.5mW/°C above 25°C)
Storage Temperature Range ..... -65°C to +150°C
Logic Control Voltage ..... V^+ to V^-
Voltage on V_L Pin ..... V^+ to V^-
Lead Temperature (Soldering, 10 sec.) ..... +300°C

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

ELECTRICAL CHARACTERISTICS

(V^+ = +15V, V_L = +5V, V^- = -15V, T_A = 25°C unless otherwise specified)

PARAMETER	SYMBOL	CONDITIONS	TYP (Note 1)	M GRADE DEVICE			I/C GRADE DEVICE			UNITS
				-55°C	+25°C	+125°C	-20/ 0°C	+25°C	+85/ +70°C	
Supply Voltage Ranges Positive Supply Logic Supply Negative Supply	 V^+ V_L V^-	(Note 3)	 4.5 > 16 4.5 > V^+ -4 > -16		 5 to 15 5 to V^+ -5 to -15			 5 to 15 5 to V^+ -5 to -15		V
Switch "ON" Resistance (Note 4)	$r_{ds(ON)}$	V_D = -5V to +5V		75	75	100	75	75	100	Ω
		I_S = 10 mA, V_{IN} = 2.4V V_D = -10V to +10V		125	125	175	150	150	175	
Switch "ON" Resistance	$r_{ds(ON)}$	$V^+ = V_L$ = 5V, V_{IN} = 3V V^- = -5V, V_D = ±3V		250	250	350	300	300	350	
On Resistance Match		I_S = 10mA, V_D = ±5V	5							
Switch "OFF" Leakage (Notes 2 and 4)	$I_{D(OFF)}$	$V_{S/D}$ = +5V to -5V V_{IN} = 0.8V			±1	50		±2	100	nA
	or $I_{S(OFF)}$	$V_{S/D}$ = +14V to -14V			±1	50		±2	100	
Switch "ON" Leakage	$I_{D(ON)}$ + $I_{S(ON)}$	V_D = +5V or -5V V_{IN} = 2.4V			±1	100		±2	100	
		V_D = +14V to -14V			±1	100		±2	100	
Input Logic Current	I_{IN}	V_{IN} > 2.4V or < 0	0.001	1	1	10	1	1	10	µA
Positive Supply Quiescent Current	I^+	V_{IN} = 0V or +5V (Note 5)	0.01	1	1	10	1	1	10	
Negative Supply Quiescent Current	I^-	V_{IN} = 0V or +5V (Note 5)	0.01	1	1	10	1	1	10	
Logic Supply Quiescent Current	I_L	V_{IN} = 0V or +5V (Note 5)	0.01	1	1	10	1	1	10	

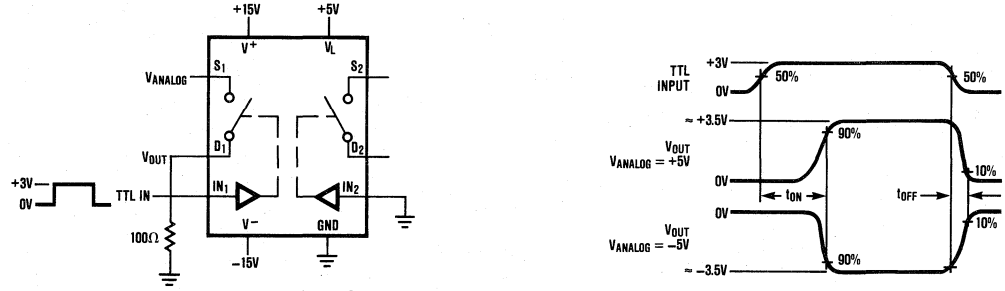
AC ELECTRICAL CHARACTERISTICS

V^+ = +15V, V_L = +5V, V^- = 0V, T_A = +25°C

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Switch "ON" Time	t_{ON}	See Figure 1		160	300	ns
Switch "OFF" Time	t_{OFF}	See Figure 1		70	150	
"OFF" Isolation Rejection Ratio	OIRR	See Figure 2 (Note 6)	70	80		dB
Cross Coupling Rejection Ratio	CCRR	Figure 3 (Note 6) IH5341 IH5352	70 66	80 72		
Frequency where $r_{ds(ON)}$ = 0.7 x DC		(Note 6)	100			MHz

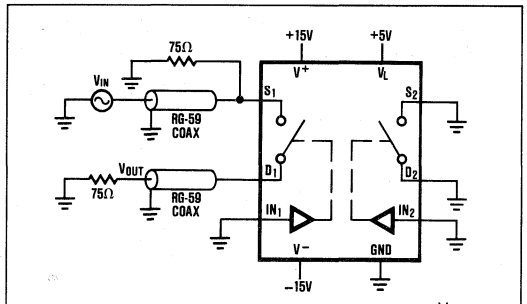
Note 1: Typical values are not tested in production. They are given as a design aid only.
Note 2: Positive and negative voltages applied to opposite sides of switch, in both directions successively.
Note 3: These are the operating voltages at which the other parameters are tested, and are not directly tested.
Note 4: The logic inputs are either greater than or equal to 2.4V or less than or equal to 0.8V, as required, for this test.
Note 5: Maximum values shown are for the dual (IH5341). They are doubled for the quad (IH5352).
Note 6: All AC parameters are sample tested only. Test circuits should be built on copper clad ground plane board, with correctly terminated coax leads, etc.

Test Circuits



Note: Only one channel shown. Others act identically.

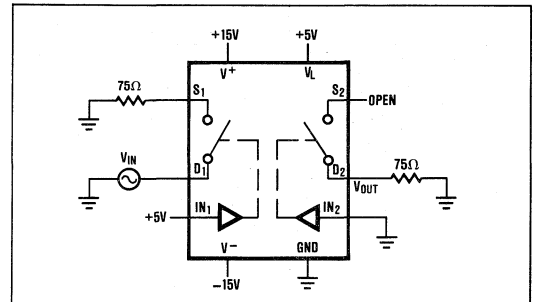
Figure 1. Switching Time Test Circuit and Waveforms



V_{IN} = ±5V (10V_{p-p}) @ f = 10MHz OIRR = 20 log$\frac{V_{IN}}{V_{OUT}}$

Note: Only one channel shown. Others act identically.

Figure 2. OFF Isolation Test Circuit



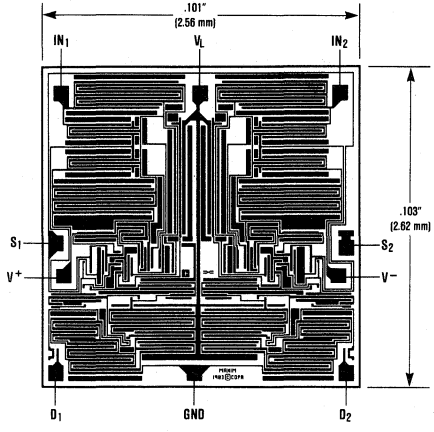
V_{IN} 225mVrms @ f = 10MHz

CCRR = 20 log$\frac{V_{IN}}{V_{OUT}}$

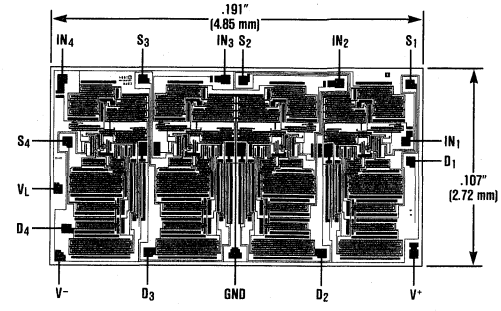
Figure 3. Cross-Coupling Rejection Test Circuit

2

Chip Topography



IH5341 (Dual SPST)



IH5352 (Quad SPST)

Appendix

A

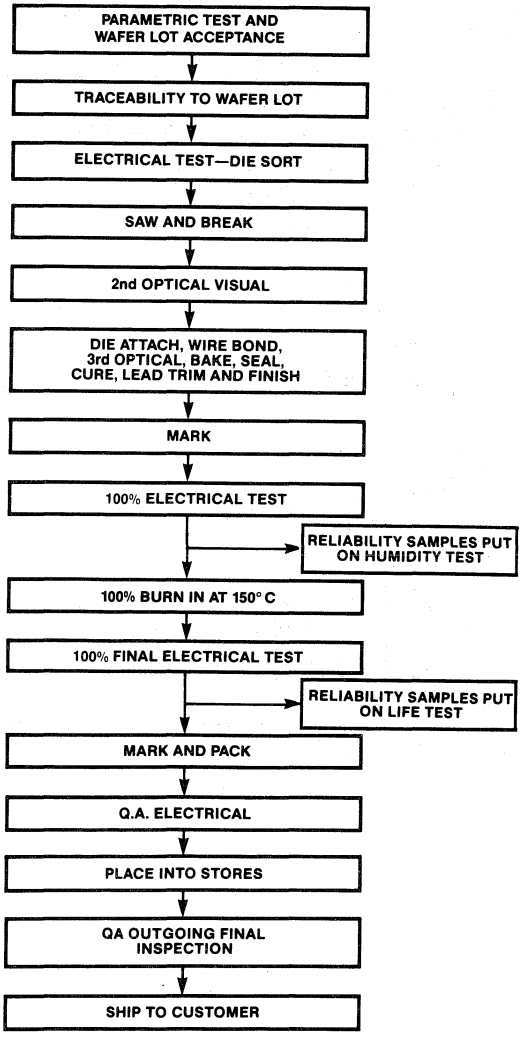
Package Unit Process Flow

Wafer Inspection

All wafers are fabricated using specifically developed processes with extremely tight control. Each must pass numerous in-process check-points for oxide thickness, critical dimensions, pin hole densities, and other requirements, and must comply with Maxim's demanding Electrical and Physical Specifications.

Finished wafers are inspected optically to detect any physical defects. Then they are parametrically tested to insure full conformity to Maxim's specifications. Our parametric measurement capability has been specially designed by Maxim to make the precision measurements which are mandatory to insure reliability and reproducibility in analog circuits. We believe this quality control technology to be the best in the industry, capable of resolving below IpA current levels, and less than IpF capacitance. Maxim's proprietary software allows automatic measurement of subthreshold characteristics, fast surface state density, and other parameters which are crucial to predicting long term stability and reliability.

Every Maxim wafer is subject to this rigorous screening at no premium to our customers.



Testing

After wafer parametric inspection, each die is 100% tested prior to assembly. Once assembled, units are tested *over temperature.* This is not a common practice in the industry. By using the latest high speed automatic handling equipment, Maxim is able to offer "at temperature" testing for no additional cost.

Sophisticated testing is an integral part of delivering the highest quality data acquisition products. Maxim's analog test capability represents an order of magnitude improvement in accuracy, noise performance, and speed when compared to current industry standards. This provides the customer with total assurance that he will receive the part he paid for every time, without fail.

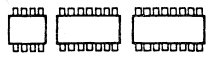
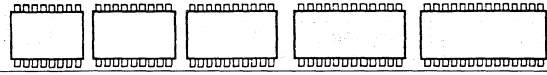
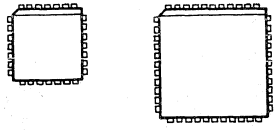
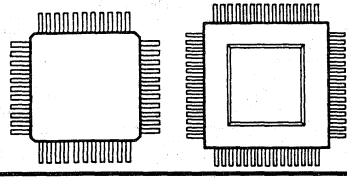
Product Conditioning and Qualification

Reliability of Maxim's products is further assured by subjecting parts to qualification cycles that include accelerated life tests equivalent to 20 million operating hours, as well as pressure and humidity (85°C/85%) cycles. In addition, *every unit shipped has been burned-in* (with the exception of reversed lead and Surface Mount Products—see below) to further reduce the possibility of field failure.

Products processed to this level are normally available from other manufacturers at a price premium, by ordering special process flows. *Maxim provides this testing and conditioning, including a 100% burn-in, at no additional cost.*

A

Maxim is committed to providing high quality, high reliability 8 to 60 lead plastic surface mount products. With few exceptions, every monolithic product will be offered in a surface mount package. These products are processed through the same manufacturing flow as the dual-in-line (DIP) plastic devices and are tested to the same stringent electrical and visual AQL levels, with the exception of 100% burn-in and cold test. They receive the same product conditioning and lot qualification as the DIPs. Maxim still assures the reliability of every lot by subjecting a sample from each lot to a long term life test prior to shipment.

PACKAGE	PKG ALPHA	LEAD COUNTS AVAILABLE
0.150" JEDEC SOIC	S	8 14 16 
0.300" JEDEC SOIC	W	16 18 20 24 28 
CERAMIC LEADLESS CHIP CARRIER (LCC)	L	20 
QUAD PACK JEDEC PLCC	Q	28 44 
FLAT PACK (PFP) 0.8 mm LEAD CENTERS	M	44 60 

Pin Convention

0.150" JEDEC SOIC (S) parts have the same pinout as in the 0.300" DIP package equivalents.

0.300" JEDEC SOIC (W) parts also have the same pinout as in the 0.300" DIP package except for selected products in the 16 lead. 14 lead products that are too large for the 0.150" 14 lead (S) package are made available in the 0.300" 16 lead (W) package.

Flatpack Pin Convention

No fixed convention exists for 40-lead products assembled in either 44-lead or 60-lead flatpack. Consult product marketing for specific pin-outs.

Quad Pack Pin Convention

1.) Devices in the 28 Lead Quad Pack are pin for pin number compatible with the DIP package. That is to say, pin 1 on the 28L Quad will be the same function as pin 1 on the DIP package.

2.) All 40 Lead devices planned for the 44 Lead Quad pack will have the following pin convention:

DIP PIN#	QUAD PIN#	DIP PIN#	QUAD PIN#	DIP PIN#	QUAD PIN#	DIP PIN#	QUAD PIN#
	1 N/C		12 N/C		23 N/C		34 N/C
1	2	11	13	21	24	31	35
2	3	12	14	22	25	32	36
3	4	13	15	23	26	33	37
4	5	14	16	24	27	34	38
5	6	15	17	25	28	35	39
6	7	16	18	26	29	36	40
7	8	17	19	27	30	37	41
8	9	18	20	28	31	38	42
9	10	19	21	29	32	39	43
10	11	20	22	30	33	40	44

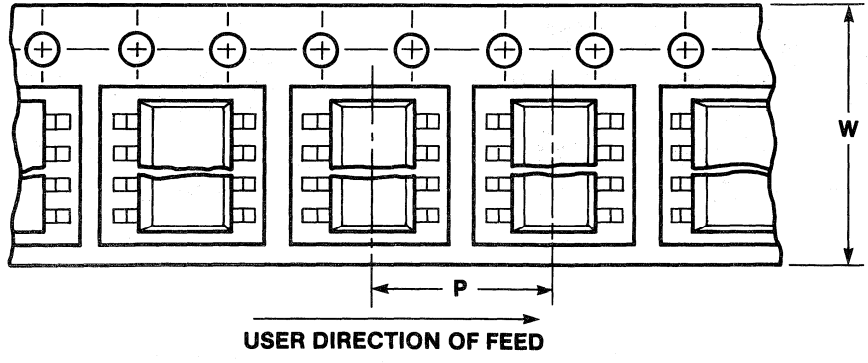
Surface Mount Packages In Reeled Tape

Maxim surface mount packages are normally shipped in antistatic plastic rails. They are also available mounted in pockets on embossed tape for customers using automatic placement systems. The tape is wound and shipped on reels.

The following table and diagrams indicate the tape sizes used for the various package types and the basic orientation convention used. Further tape and reel specifications can be found in the Electronic Industries Association (EIA) standard 481.

COMPONENT		TAPE SIZE mm (W)	PART PITCH mm (P)
SOIC	8L	12	8
	14L	16	8
	16L	16	8
SOIC	16L	16	12
	18L	24	12
	20L	24	12
	24L	24	12
	28L	24	12
PLCC	28L	24	16
	44L	32	24
PFP	44L	24	16
	60L	44	32

SOIC DEVICES



A

All of Maxim's standard products are available in die and wafer form. Every diffusion lot committed to die/wafer sales is qualified through a die sample assembled into packaged units. This sample is then subjected to "Packaged Unit Process Flow" the standard to ensure lot quality and reliability.

Electrical Specifications

All material committed to die/wafer sales is 100% electrically probed using Maxim's sophisticated test equipment. Most parameters tested are checked to limits that are more stringent than the data sheet 25°C worst case parameters.

Generally, the parameters or parameter limits listed in the packaged unit data sheets are tested during electrical probe. However some parameters are impossible to test or test with absolute accuracy on unassembled product. Information regarding any of these parameters/parameter limits may be obtained from the factory.

Physical Specifications

PARAMETER	3"	4"	UNITS
Chip Thickness Backlapped wafers	13 ± 1	15 ± 1	mils
Die length/width tolerance	± 1		mils
Bonding pads dimensions (minimum)	4.0 x 4.0		mils
Bonding pad and interconnect material thickness	10K-15K		A
Storage temperature	-40 to +150		°C
Operating temperature	-20 to +70		°C

Die and wafers are visually inspected according to MIL-STD-883, Method 2010.2, Condition B with modifications reflecting CMOS requirements.

Each die surface is protected by a planar passivation layer and additional surface glassivation except for bonding pads and scribe lines. The surface passivation is removed from the bonding pad areas by HF etching or by plasma etching. The bonding pads may appear discolored at low magnification due to surface roughness of the aluminum caused by the etchant.

Maxim guarantees die and wafer AQL levels as follows:

Visual	1.0%
Functional Electrical Testing	0.65%
Parametric DC Testing	2.5%
Untested Parameters	6.5%

Assembly Procedures

Handling

Maxim recommends that die and wafers be stored in a clean, dry ambient—preferably inert gas. Extreme care should be taken when handling die. Both electrical and visual damage can occur as a result of an unclean environment or harsh handling techniques.

Die Attach

To prevent oxidization the die attach operation should be done under a gaseous nitrogen ambient atmosphere. If an eutectic die attach is used, it is recommended that a 98% gold/2% silicon preform be used at a die attach temperature between 385°C and 435°C. If an epoxy die attach is used, the epoxy cure temperature should not exceed 150°C.

Bonding

Thermosonic or thermocompression gold ball bonding may be used with 1.0 or 1.3 mil diameter 99.99% pure gold wire. Ultrasonic bonding may be used with 1.0 or 1.25 mil diameter 99% aluminum/1% silicon wire.

Standard Die and Wafer Carrier Package

Die and wafers are packaged as shown in Figures 1 and 2, respectively.

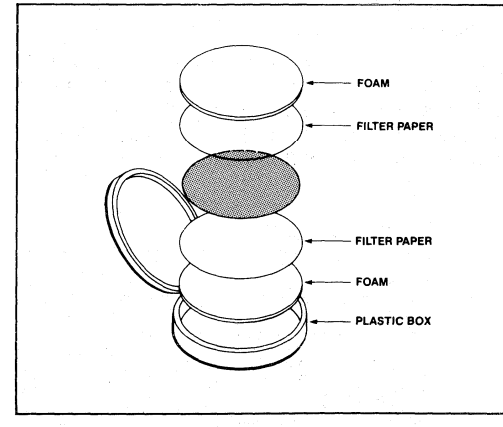


Figure 1. Wafer Carrier Package

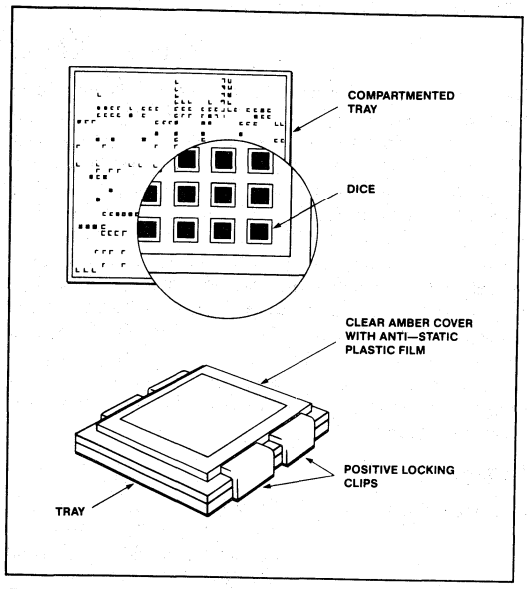


Figure 2. Die Carrier Package

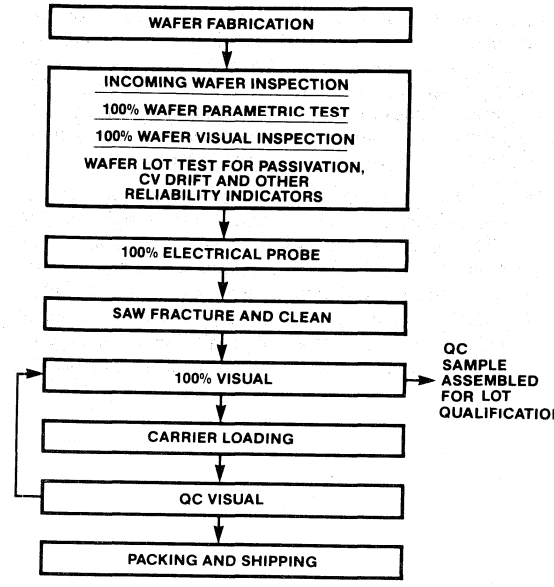
Changes

Maxim reserves the right to improve device geometries and manufacturing processes without prior notice. Although these improvements may result in slight geometry changes, they will not affect die electrical limits, pad layouts, or maximum die sizes.

User Responsibility

Written notification of any non-conformance by Maxim or Maxim's dice specifications must be made within 75 days of the shipment date of the die to the user. Maxim assumes no responsibility for the dice after 75 days or after further user processing such as, but not limited to, chip mounting or wire bonding.

Dice Process Flow



Ordering Information

Die orders are identified by a /D suffix.
Example: ICL7109C/D

When ordering die in wafer form replace "D" in the part numbers with a "W"
Example: MAX7231C/D Die = MAX7231C/W Wafer.

A

Maxim's /883 and /HR Program

883 PROGRAM

As of July 1st, 1988, Maxim is a certified manufacturer of Mil-Std-883, Class B, Rev. C product. Becoming a manufacturer capable of processing product to 883 requirements entails operator training, equipment calibration, documentation, design baselines etc., that are intangible and transparent for the product. In addition to factory certification, every device must be individually certified and qualified.

In summary, this program produces devices that are tested to operate over the military temperature range (-55°C to +125°C) and are meticulously processed per Mil. Method 5004. Finally, the 883 device manufacturing lots are subjected to Quality Conformance inspection per Mil. Method 5005 (Groups A, B, C, and D testing). Once a manufacturing lot has been processed through these two stringent methods, it is ready for sale as /883 compliant product.

HR PROGRAM

Prior to the inception of the 883 program, Maxim offered its products in an /HR (High Reliability) Flow. Maxim will continue to offer this highly successful processing program for customers requiring military grade product, but who do not want to pay the substantial cost added for certified product in full compliance to Mil-Std-883. The /HR program offers device processing which emulates Mil. Method 5004 processing, including full material traceability and process genealogy from Incoming Raw Materials through Final Shipment. However, full QCI testing will not be performed unless requested. Only Group A of Mil. Method 5005 will be done per lot. Groups B, C, and D must be specifically requested during order placement. This is done simply by placing a single letter suffix (B, C, or D) at the end of the ordered part number (see chart).

Ordered Part #	Processing
MAX358MJE/HR	Device will be processed through the full /HR Flow emulating Mil Method 5004 and QCI tested to Group A of Mil Method 5005.
MAX358MJE/HRB	Same as above with the addition of Mil Method 5005 Group B testing. QCI contains both Group A and B.
MAX358MJE/HRC	Same as above except now QCI includes Group C. QCI now contains Groups A, B, and C.
MAX358MJE/HRD	Same as above except now QCI includes Group D. QCI now contains Groups A, B, C, and D.

To order /883 or /HR devices, contact the Maxim sales representative or distributor in your area.

Maxim /HR Flow
Hybrid Components

- FULL MATERIAL TRACEABILITY AND PROCESS GENEALOGY
- DEVICE ASSEMBLY
- PRESEAL INTERNAL VISUAL
  MIL-STD-883, METHOD 2017, CLASS B 100%
- SEAL 100%
- STABILIZATION BAKE
  MIL-STD-883, METHOD 1008, CONDITION C 100%
- TEMPERATURE CYCLING
  MIL-STD-883, METHOD 1010, CONDITION C 100%
- CONSTANT ACCELERATION
  MIL-STD-883, METHOD 2001, CONDITION E (Y1 only 100%)*
- FINE LEAK TEST
  MIL-STD-883, METHOD 1014, CONDITION B 100%
- GROSS LEAK TEST
  MIL-STD-883, METHOD 1014, CONDITION C 100%
- 25°C ELECTRICAL TEST 100%
- BURN IN
  160 HOURS AT 125°C (OR EQUIVALENT) 100%
- ELECTRICAL TEST
  25°C, 125°C, -55°C 100%
- QA ACCEPTANCE PER APPLICABLE DEVICE SPECIFICATION
  MIL-STD-883, METHOD 5005, GROUP A
- LOT QUALIFICATION
  MIL-STD-883, METHOD 5008, GROUP B, C & D
  (OPTIONAL FOR /HR PROGRAM)
- EXTERNAL VISUAL
  MIL-STD-883, METHOD 2009 100%
- BOX STOCK

* If seal perimeter is greater than 2.0 inches, Condition A applies.

Maxim /883 /HR Flow
Monolithic ICs

- FULL MATERIAL TRACEABILITY AND PROCESS GENEALOGY
- WAFER FABRICATION AND DEVICE ASSEMBLY
- PRESEAL INTERNAL VISUAL
  MIL-STD-883, METHOD 2010, CLASS B 100%
- SEAL 100%
- STABILIZATION BAKE
  MIL-STD-883, METHOD 1008, CONDITION C 100%
- TEMPERATURE CYCLING
  MIL-STD-883, METHOD 1010, CONDITION C 100%
- CONSTANT ACCELERATION
  MIL-STD-883, METHOD 2001, CONDITION E (Y1 only 100%)
- FINE LEAK TEST
  MIL-STD-883, METHOD 1014, CONDITION B 100%
- GROSS LEAK TEST
  MIL-STD-883, METHOD 1014, CONDITION C 100%
- 25°C ELECTRICAL TEST 100%
- BURN IN
  160 HOURS AT 125°C (OR EQUIVALENT) 100%
- ELECTRICAL TEST
  25°C, 125°C, -55°C 100%
- QA ACCEPTANCE PER APPLICABLE DEVICE SPECIFICATION
  MIL-STD-883, METHOD 5005, GROUP A
- LOT QUALIFICATION
  MIL-STD-883, METHOD 5005, GROUP B, C & D
  (OPTIONAL FOR /HR PROGRAM)
- EXTERNAL VISUAL
  MIL-STD-883, METHOD 2009 100%
- BOX STOCK

Proprietary and Second Source Numbering System

Maxim's Proprietary Numbering System

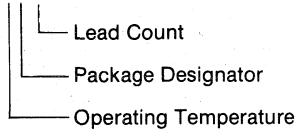
Maxim's proprietary product introductions are increasing at a significant rate. The devices are grouped by their functions into certain categories. Maxim presently uses a "MAX" as the prefix to the device's unique number. The categories are as follows:

MAX100-199	Analog-to-Digital Converters
MAX200-299	Interface
MAX300-399	Analog Switches and Multiplexers
MAX400-499	Op-Amps, Buffers and Video Amplifiers
MAX500-599	Digital-to-Analog Converters
MAX600-699	Power Supply Circuits and Voltage References
MAX700-799	μP Peripherals and Display Drivers
MAX800-899	Open
MAX900-999	Open

Within each category, blocks of numbers are reserved for sub-groups.

3 Letter Suffixes

EXAMPLE: MAX358CPD



Temperature Range

"C"	0°C to +70°C
"I"	-20°C to +85°C
"E"	-40°C to +85°C
"M"	-55°C to +125°C

Package

"A"	TO-237
"C"	TO-220
"D"	Ceramic Sidebraze
"F"	Ceramic Flat-Pack
"H"	TO-66
"J"	CERDIP Dual-In-Line
"K"	TO-3
"L"	Leadless, Ceramic
"M"	Plastic Flat Pack
"N"	Narrow Plastic Dual-In-Line
"P"	Plastic Dual-In-Line
"Q"	Plastic Chip Carrier (Quad Pak)
"R"	Narrow CERDIP
"S"	Small Outline, Slim (8 or more leads), 150 mil
"S"	TO-52 (2 or 3 leads)
"T"	TO-5 Type (also TO-78, TO-99, TO-100)
"U"	TO-72 Type (also TO-18, TO-71)
"V"	TO-39
"W"	Small Outline, Wide (300 mil)
"Z"	TO-92
"/D"	Dice
"/W"	Wafer
"-1"	On Package Information Indicates Hybrid Circuit

Number of Pins

"A"	8	"P"	20
"B"	10	"Q"	2
"C"	12	"R"	3
"D"	14	"S"	4
"E"	16	"T"	6
"F"	22	"U"	60
"G"	24	"V"	8 (0.200" pin circle, isolated case)
"H"	44		
"I"	28	"W"	10 (0.230" pin circle, isolated case)
"J"	32		
"K"	35	"Y"	8 (0.200" pin circle, case to pin 4)
"L"	40		
"M"	48	"Z"	10 (0.230" pin circle, case to pin 5)
"N"	18		

4 Letter Suffixes

The first letter of the suffix is used to denote product grade, for example, MAX631ACPA means 5% output accuracy (A), the remaining 3 letters denote temperature range, package type and number of leads. Therefore, the MAX631ACPA operates over the 0°C to +70°C and is in a Plastic Dual-in-Line package and has 8 leads.

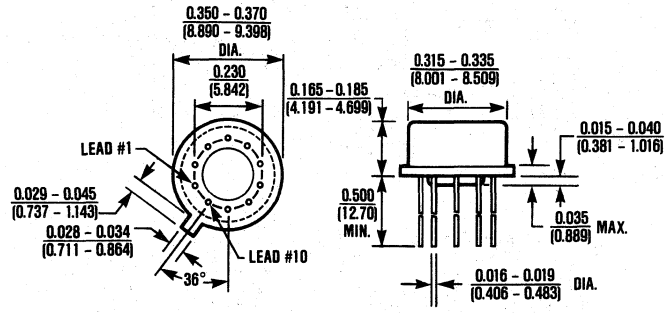
Second Source Products

In most cases, Maxim's part number for a multiple source product follows the numbering system that is most widely accepted in the industry for that particular part, rather than our own convention. This includes original designators for package type, temperature range, and performance grades as well as the most commonly recognized prefix.

Multiple source products are frequently supplied by Maxim in packages or temperature ranges that are not supplied by other manufacturers. Whenever possible, such a device is given the part number that it would have if the original numbering convention were followed. For example, if a military temperature grade of a product is not supplied by other sources but is available from Maxim, the original manufacturer's designation for military temperature will be used. As a result, a specific part number supplied by Maxim may not be listed by the "original" manufacturer.

Package Information

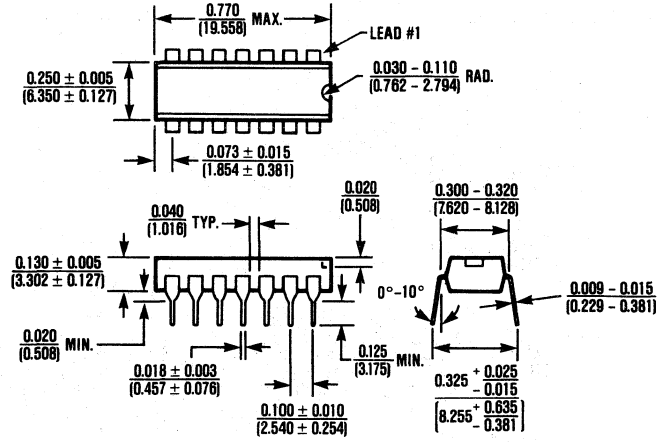
This section contains physical dimensions and thermal data for all packages currently supplied by Maxim. Each drawing is followed by a two letter code which indicates package type (Plastic DIP, Small Outline, etc.) and number of leads. This code is also used, along with indicators for temperature range and device grade (where appropriate) in the part number suffix for each of Maxim's proprietary devices.



10 Lead TO-100 Can (TW)

θ_{JA} = 150°C/W

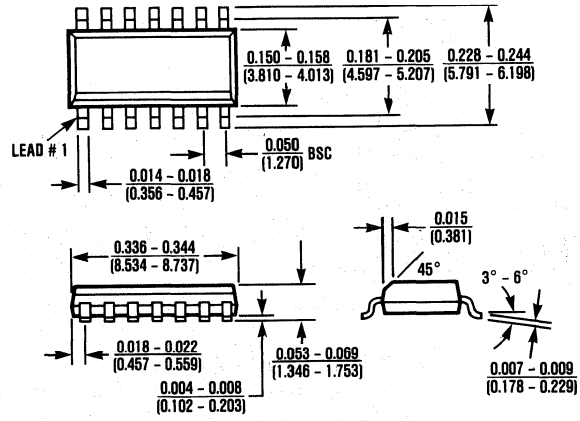
θ_{JC} = 45°C/W



14 Lead Plastic DIP (PD)

θ_{JA} = 140°C/W

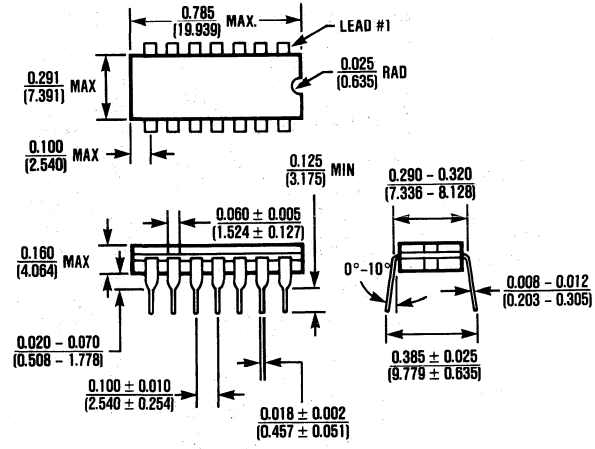
θ_{JC} = 70°C/W



14 Lead Small Outline (SD)

θ_{JA} = 115°C/W

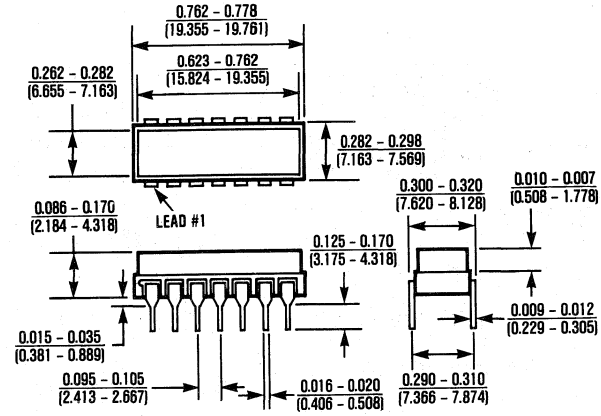
θ_{JC} = 60°C/W



14 Lead CERDIP (JD)

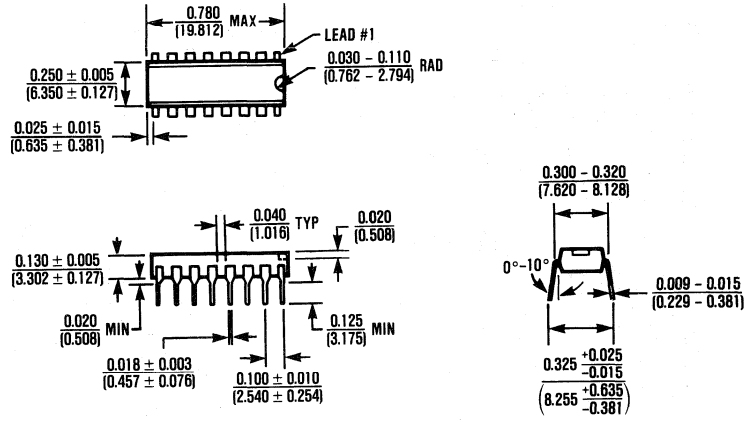
θ_{JA} = 105°C/W

θ_{JC} = 50°C/W



14 Lead Ceramic Sidebraze (DD) -1

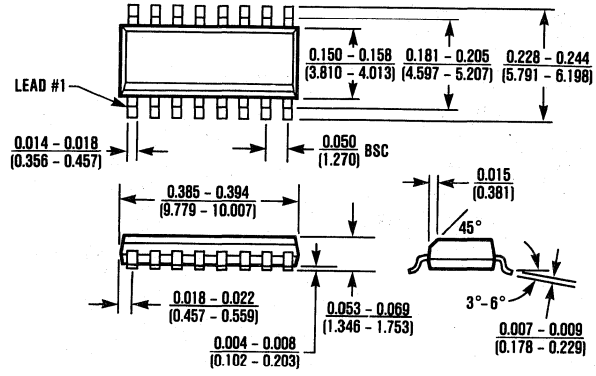
θ_{JA} = 100°C/W
θ_{JC} = 45°C/W



16 Lead Plastic DIP (PE)

θ_{JA} = 135°C/W
θ_{JC} = 65°C/W

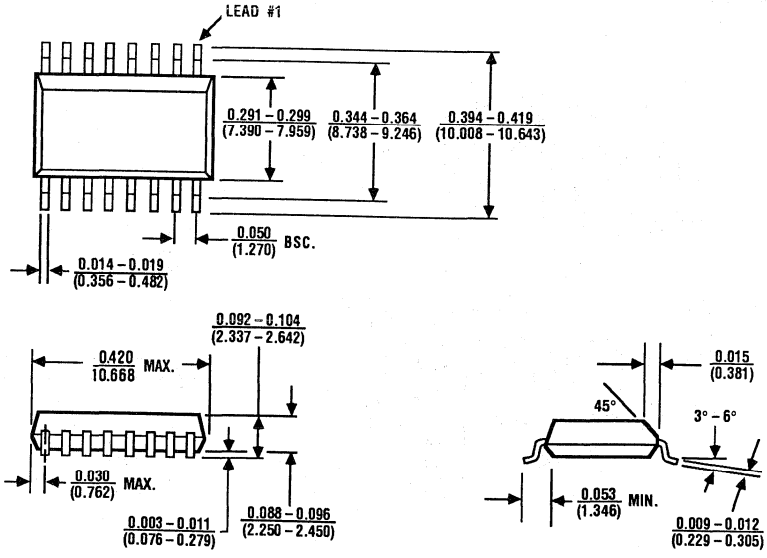
A



16 Lead Small Outline (SE)

θ_{JA} = 110°C/W

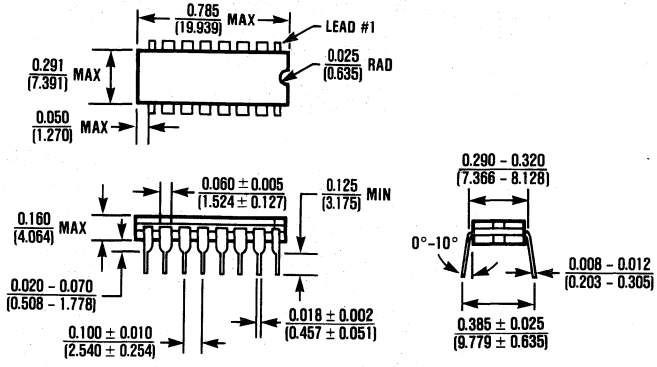
θ_{JC} = 60°C/W



16 Lead Small Outline, Wide (WE)

θ_{JA} = 105°C/W

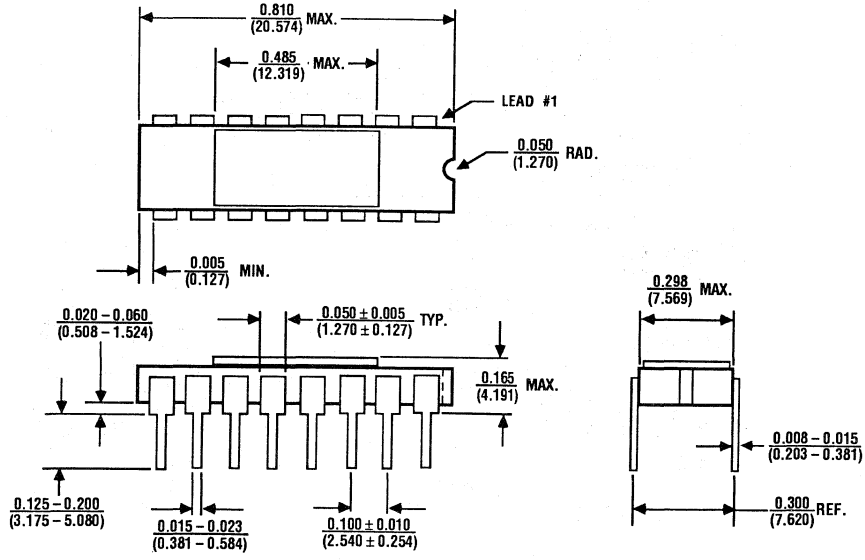
θ_{JC} = 60° C/W



16 Lead CERDIP (JE)

θ_{JA} = 100°C/W

θ_{JC} = 50°C/W

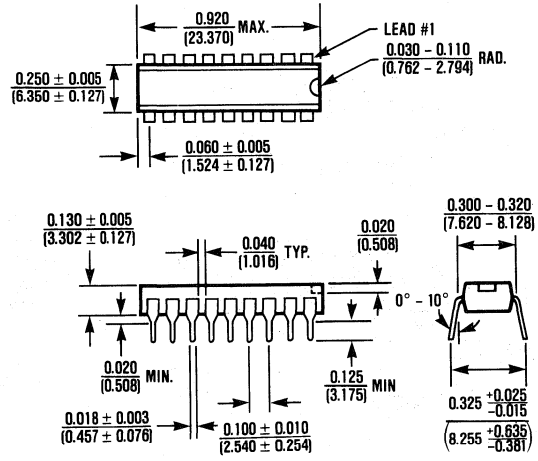


16 Lead Ceramic Sidebraze (DE)

θ_{JA} = 95°C/W

θ_{JC} = 45°C/W

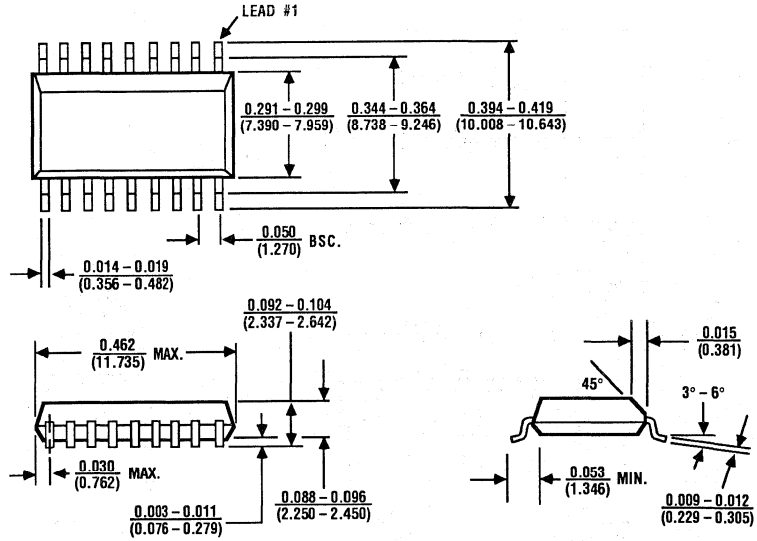
A



18 Lead Plastic DIP (PN)

θ_{JA} = 130°C/W

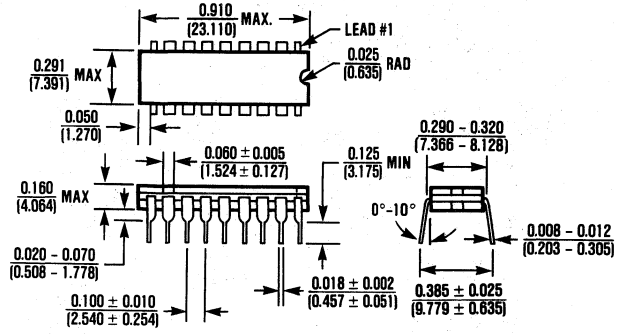
θ_{JC} = 60°C/W



18 Lead Small Outline, Wide (WN)

θ_{JA} = 105°C/W

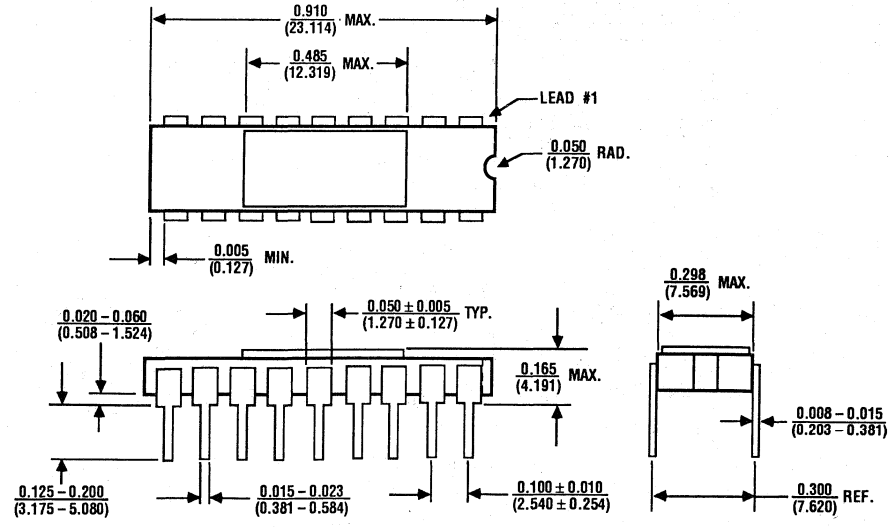
θ_{JC} = 60° C/W



18 Lead CERDIP (JN)

θ_{JA} = 90°C/W

θ_{JC} = 45°C/W

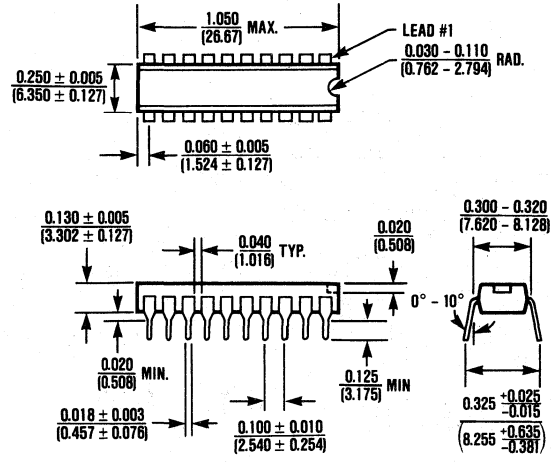


18 Lead Ceramic Sidebraze (DN)

θ_{JA} = 90°C/W

θ_{JC} = 40°C/W

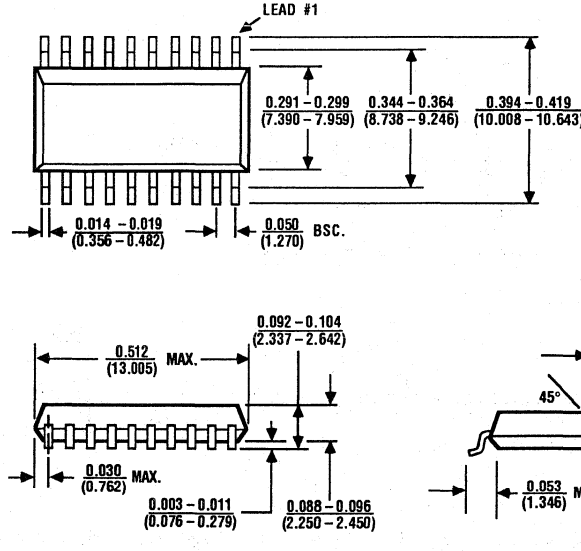
A



20 Lead Plastic DIP (PP)

θ_{JA} = 125°C/W

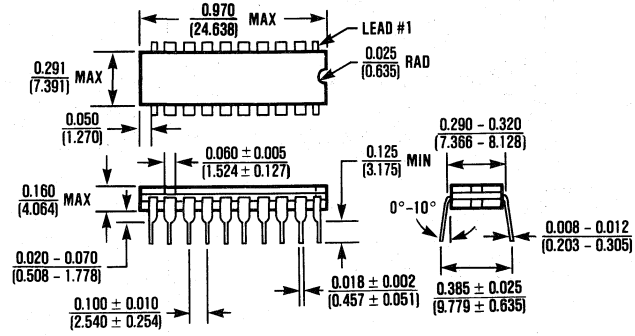
θ_{JC} = 60°C/W



20 Lead Small Outline, Wide (WP)

θ_{JA} = 100°C/W

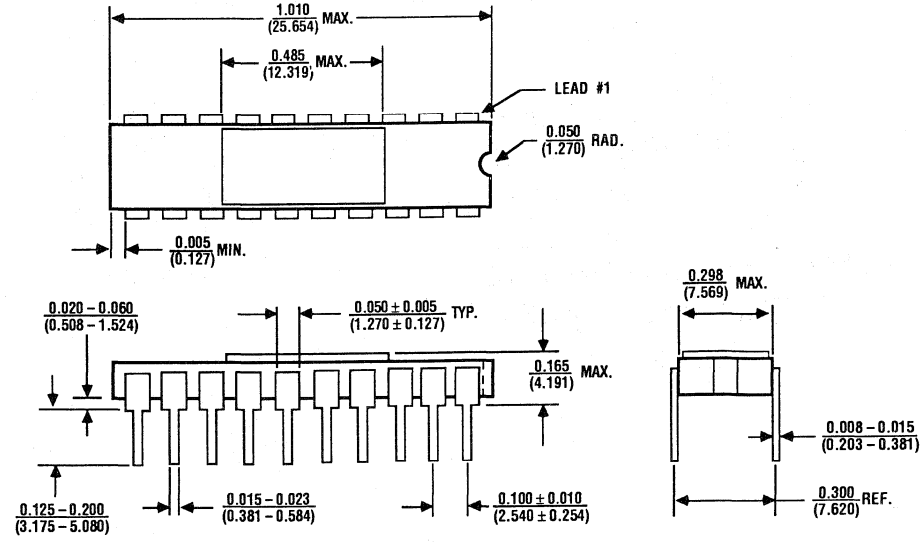
θ_{JC} = 50° C/W



20 Lead CERDIP (JP)

θ_{JA} = 90°C/W

θ_{JC} = 40°C/W

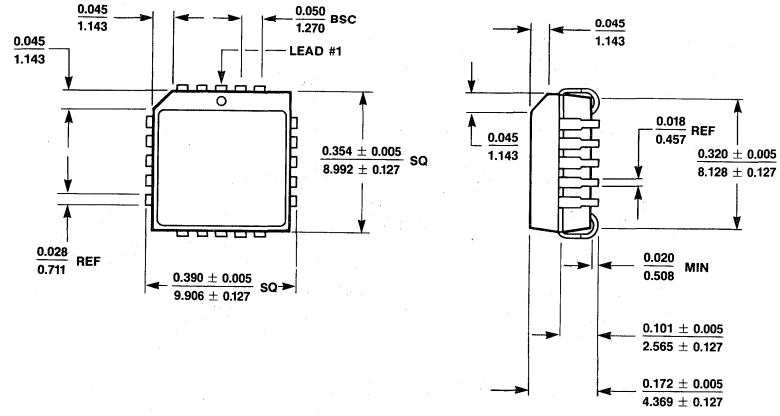


20 Lead Ceramic Sidebraze (DP)

θ_{JA} = 85°C/W

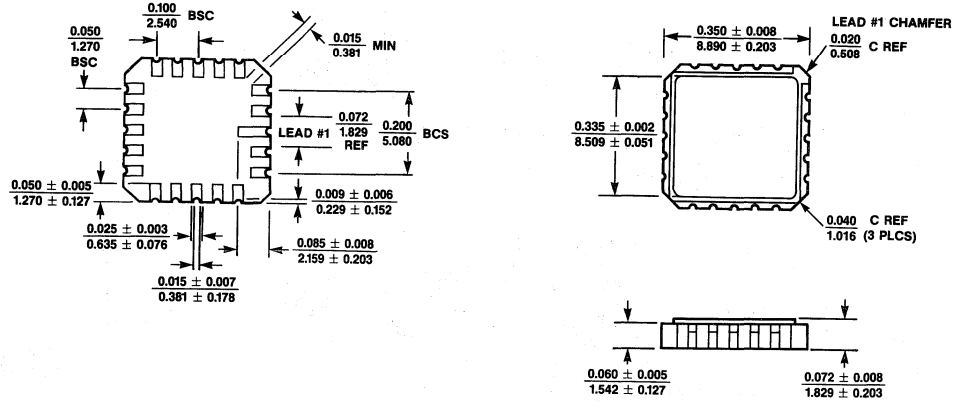
θ_{JC} = 35°C/W

A



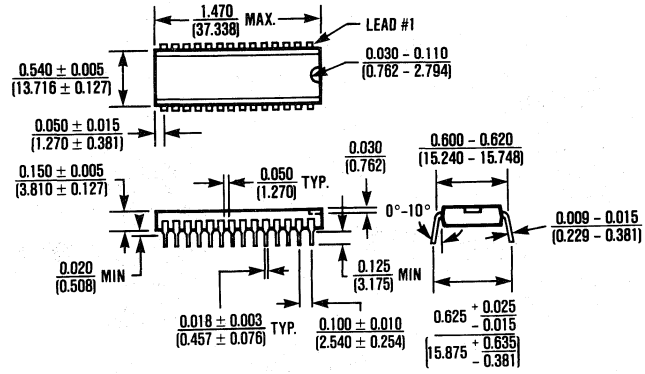
20 Lead Plastic Chip Carrier (Quad Pak) (QP)

θ_{JA} = 110°C/W
θ_{JC} = 50°C/W



20 Leadless Chip Carrier (LP)

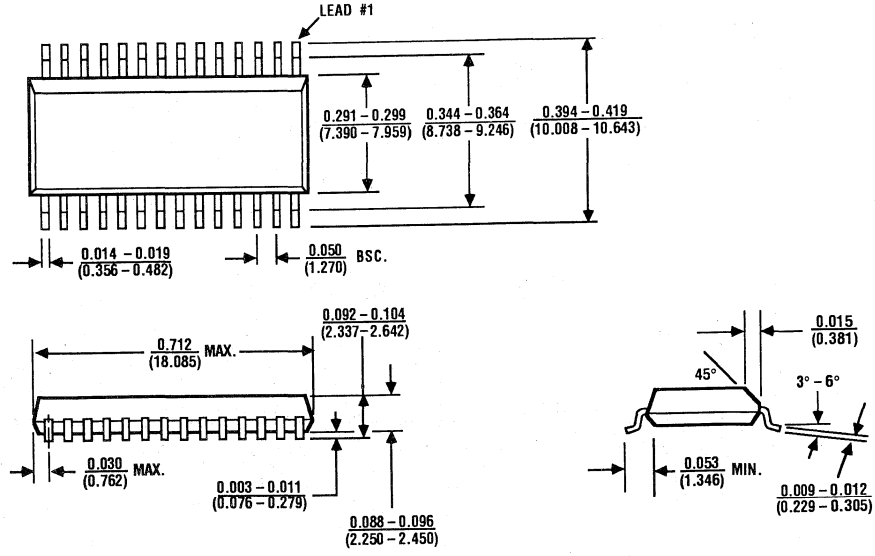
θ_{JA} = 140°C/W
θ_{JC} = 45°C/W



28 Lead Plastic DIP (PI)

θ_{JA} = 110°C/W

θ_{JC} = 50°C/W

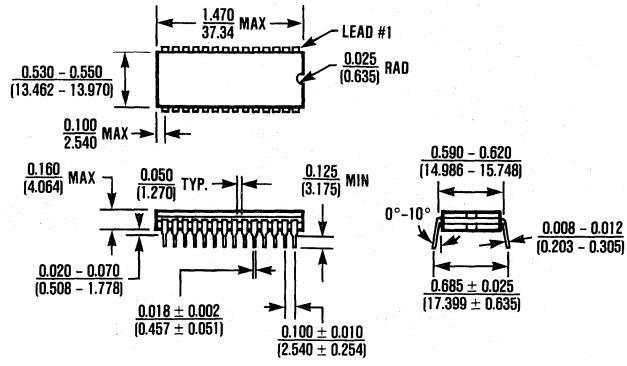


28 Lead Small Outline, Wide (WI)

θ_{JA} = 80°C/W

θ_{JC} = 45°C/W

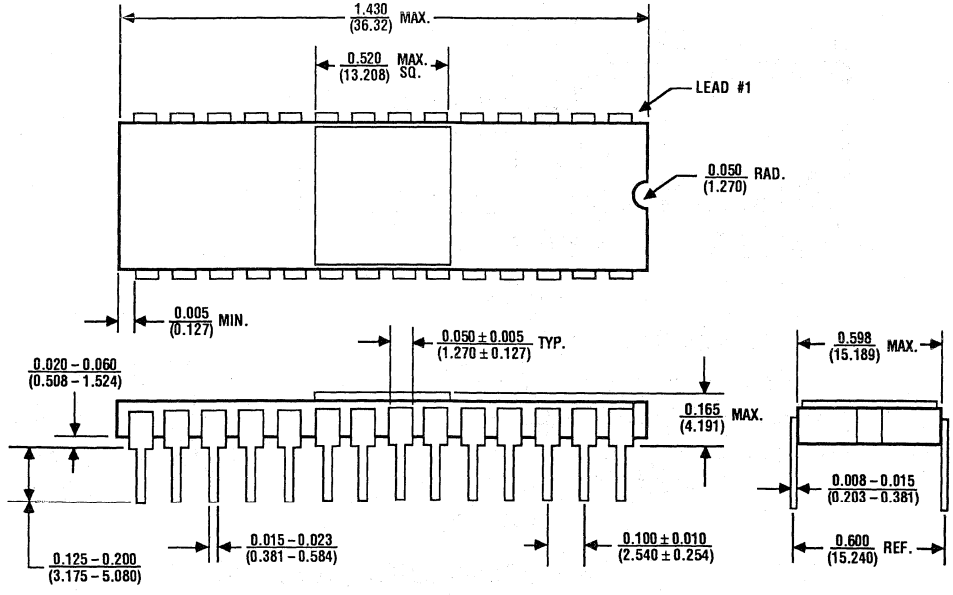
A



28 Lead CERDIP (JI)

θ_{JA} = 55°C/W

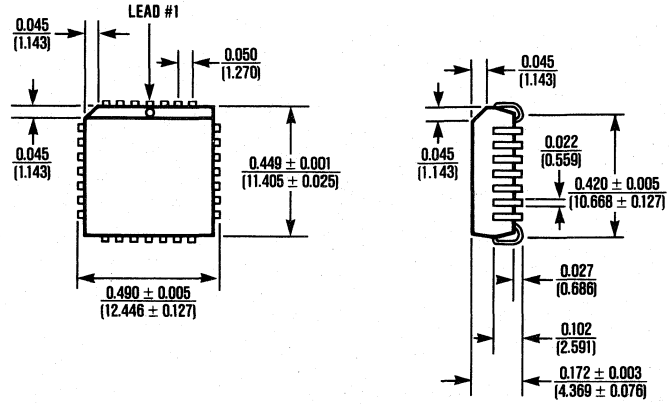
θ_{JC} = 20°C/W



28 Lead Ceramic Sidebraze (DI)

θ_{JA} = 50°C/W

θ_{JC} = 15°C/W



28 Lead Plastic Chip Carrier (Quad Pak) (QI)

θ_{JA} = 100°C/W

θ_{JC} = 45°C/W

A

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West Tennessee
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