

# SGM4588/9

## 8-CH/Dual 4-CH High-Performance CMOS Analog Multiplexers

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### GENERAL DESCRIPTION

The SGM4588 is an 8-channel single-ended analog multiplexer designed to connect one of eight inputs to a common output as determined by a 3-bit binary address ( $A_0, A_1, A_2$ ). The SGM4589 is a dual 4-channel differential analog multiplexer designed to connect one of four differential inputs to a common dual output as determined by its 2-bit binary address ( $A_0, A_1$ ). Break-before-make switching action protects against momentary crosstalk between adjacent channels.

An on channel conducts current equally well in both directions. In the off state each channel blocks voltages up to the power supply rails. An enable (EN) function allows the user to reset the multiplexer/demultiplexer to all switches off for stacking several devices. All control inputs, address ( $A_x$ ) and enable (EN) are 1.8V control logic over the full specified operating temperature range.

Applications for the SGM4588, SGM4589 include high speed data acquisition, audio signal switching and routing, ATE systems and avionics. High performance and low power dissipation make them ideal for battery operated and remote instrumentation applications.

SGM4588 and SGM4589 are available in Green SOIC-16 and TSSOP-16 packages. It is specified  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  temperature range.

### FEATURES

- **Low On-Resistance:  $22\Omega$**
- **Low Charge Injection:  $15\text{pC}$**
- **Fast Transition Time:  $160\text{ns}$**
- **Single Supply Capability**
- **40V Supply Max Rating**
- **1.8V Control Logic**
- **Reduced Switching Errors**
- **Reduced Glitching**
- **Improved Data Throughput**
- **Reduced Power Consumption**
- **Increased Ruggedness**
- **Wide Supply Ranges:  $\pm 4.5\text{V}$  to  $\pm 20\text{V}$**
- **$-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$  Operating Temperature Range**
- **Available in Green SOIC-16 and TSSOP-16 Packages**

### APPLICATIONS

Data Acquisition Systems  
Audio Signal Routing  
ATE Systems  
Battery Powered Systems  
Single Supply Systems  
Medical Instrumentation

# 8-CH/Dual 4-CH High-Performance CMOS Analog Multiplexers

## PACKAGE/ORDERING INFORMATION

MODEL	PACKAGE DESCRIPTION	SPECIFIED TEMPERATURE RANGE	ORDERING NUMBER	PACKAGE MARKING	PACKAGE OPTION
SGM4588	SOIC-16	-40°C to +85°C	SGM4588YS16G/TR	SGM4588YS16 XXXXX	Tape and Reel, 2500
	TSSOP-16	-40°C to +85°C	SGM4588YTS16G/TR	SGM4588 YTS16 XXXXX	Tape and Reel, 4000
SGM4589	SOIC-16	-40°C to +85°C	SGM4589YS16G/TR	SGM4589YS16 XXXXX	Tape and Reel, 2500
	TSSOP-16	-40°C to +85°C	SGM4589YTS16G/TR	SGM4588 YTS16 XXXXX	Tape and Reel, 4000

NOTE: XXXXX = Date Code and Vendor Code.

## ABSOLUTE MAXIMUM RATINGS

Voltages Referenced to  $V_{EE}$

$V_{CC}$ .....	44V
GND .....	25V
Digital Inputs <sup>(1)</sup> , $V_S$ , $V_D$ ( $V_{EE} - 0.3V$ ) to ( $V_{CC} + 0.3V$ ) or 20mA, whichever occurs first	
Current (Any terminal).....	30mA
Peak Current, S or D (Pulsed at 1ms, 10% duty cycle max.).....	100mA
Operating Temperature Range .....	-40°C to +85°C
Storage Temperature Range .....	-65°C to +150°C
Junction Temperature .....	150°C
Lead Temperature (Soldering, 10s).....	260°C

### NOTES:

1. Signals on  $S_x$ ,  $D_x$  or  $IN_x$  exceeding  $V_{CC}$  or  $V_{EE}$  will be clamped by internal diodes. Limit forward diode current to maximum current ratings.

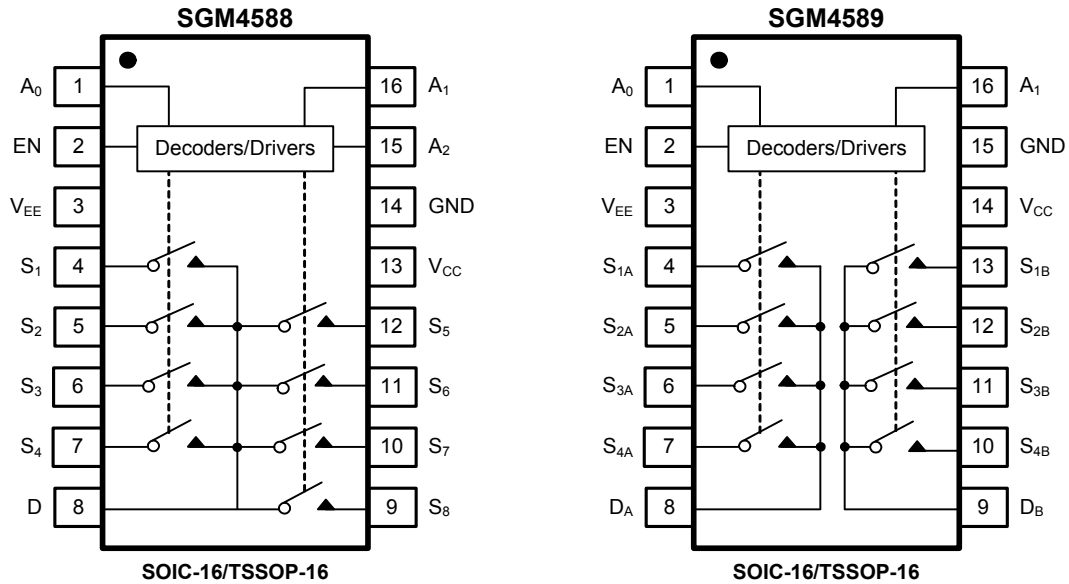
2. Stresses beyond those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure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

## CAUTION

This integrated circuit can be damaged by ESD if you don't pay attention to ESD protection. SGMICRO recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage. ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

SGMICRO reserves the right to make any change in circuit design, specification or other related things if necessary without notice at any time. Please contact SGMICRO sales office to get the latest datasheet.

PIN CONFIGURATIONS (TOP VIEW)



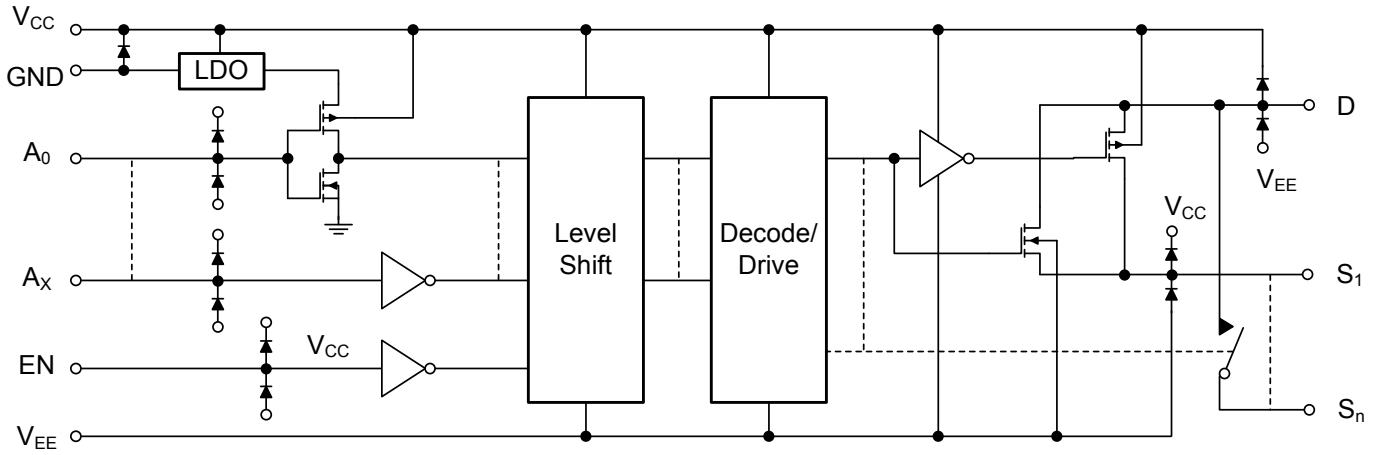
FUNCTION TABLE

TRUTH TABLE (SGM4588)				
A <sub>2</sub>	A <sub>1</sub>	A <sub>0</sub>	EN	ON SWITCH
X	X	X	0	None
0	0	0	1	S <sub>1</sub>
0	0	1	1	S <sub>2</sub>
0	1	0	1	S <sub>3</sub>
0	1	1	1	S <sub>4</sub>
1	0	0	1	S <sub>5</sub>
1	0	1	1	S <sub>6</sub>
1	1	0	1	S <sub>7</sub>
1	1	1	1	S <sub>8</sub>

TRUTH TABLE (SGM4589)			
A <sub>1</sub>	A <sub>0</sub>	EN	ON SWITCH
X	X	0	None
0	0	1	S <sub>1A</sub> , S <sub>1B</sub>
0	1	1	S <sub>2A</sub> , S <sub>2B</sub>
1	0	1	S <sub>3A</sub> , S <sub>3B</sub>
1	1	1	S <sub>4A</sub> , S <sub>4B</sub>

- NOTES:
- Logic "0" ≤ 0.2V.
  - Logic "1" ≥ 1.8V.
  - X = Do not care.

**SCHEMATIC DIAGRAM (TYPICAL CHANNEL)**



**ELECTRICAL CHARACTERISTICS**(V<sub>CC</sub> = 15V, V<sub>EE</sub> = -15V, V<sub>INH</sub> = 1.8V, V<sub>INL</sub> = 0.2V. Typical values are at T<sub>A</sub> = +25°C, Full = -40°C to +85°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>ANALOG</sub>		Full	-15		15	V
Drain-Source On-Resistance	R <sub>DS(ON)</sub>	V <sub>D</sub> = ±10V, I <sub>S</sub> = 10mA	+25°C		22		Ω
On-Resistance Match	ΔR <sub>DS(ON)</sub>	V <sub>D</sub> = ±10V, I <sub>S</sub> = 10mA	+25°C		2		Ω
Source Off Leakage Current	I <sub>S(OFF)</sub>	V <sub>S</sub> = ±10V, V <sub>D</sub> = ±10V	+25°C		±0.1		μA
Drain Off Leakage Current	I <sub>D(OFF)</sub>	V <sub>D</sub> = ±10V, V <sub>S</sub> = ±10V	+25°C		±0.1		μA
Drain On Leakage Current	I <sub>D(ON)</sub>	V <sub>S</sub> = V <sub>D</sub> = ±10V	+25°C		±0.1		μA
<b>DIGITAL CONTROL</b>							
Logic High Input Voltage	V <sub>INH</sub>		+25°C	1.8			V
Logic Low Input Voltage	V <sub>INL</sub>		+25°C			0.2	
Logic Input Current	I <sub>INL</sub> OR I <sub>INH</sub>	V <sub>INH</sub> OR V <sub>INL</sub>	+25°C		5		μA
Logic Input Capacitance	C <sub>IN</sub>		+25°C		11		pF
<b>DYNAMIC CHARACTERISTICS</b>							
Transition Time	t <sub>TRANS</sub>	Test Circuit 1	+25°C		160		ns
Enable Turn-On Time	t <sub>ON(EN)</sub>	Test Circuit 2	+25°C		40		ns
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		+25°C		250		
Break-Before-Make Interval	t <sub>OPEN</sub>	Test Circuit 3	+25°C		70		ns
-3dB Bandwidth	BW	Signal = 0dBm, R <sub>L</sub> = 50Ω, C <sub>L</sub> = 5pF	+25°C		170		MHz
Charge Injection	Q	C <sub>L</sub> = 1nF, V <sub>S</sub> = 0V, R <sub>S</sub> = 0, Test Circuit 4	+25°C		15		pC
Off Isolation <sup>(1)</sup>	O <sub>ISO</sub>	V <sub>EN</sub> = 0V, R <sub>L</sub> = 1kΩ, f = 1MHz, Test Circuit 5	+25°C		-70		dB
Source Off Capacitance	C <sub>S(OFF)</sub>	V <sub>EN</sub> = 0V, V <sub>S</sub> = 0V, f = 1MHz	+25°C		7		pF
Drain Off Capacitance	C <sub>D(OFF)</sub>	V <sub>EN</sub> = 0V, V <sub>D</sub> = 0V, f = 1MHz	+25°C		35		pF
Drain On Capacitance	C <sub>D(ON)</sub>		+25°C		35		
<b>POWER SUPPLIES</b>							
Positive Supply Current	I <sub>CC</sub>	V <sub>EN</sub> = 0V, V <sub>A</sub> = 0V or 5V	+25°C		400		μA
Negative Supply Current	I <sub>EE</sub>				-150		
Positive Supply Current	I <sub>CC</sub>	V <sub>EN</sub> = 5V, V <sub>A</sub> = 0V or 5V	+25°C		450		μA
Negative Supply Current	I <sub>EE</sub>				-200		
Power Supply Range for Continuous Operation	V <sub>OP</sub>		Full	±4.5		±20	V

## NOTE:

1. Worst case isolation occurs on channel 4 due to proximity to the drain pin.

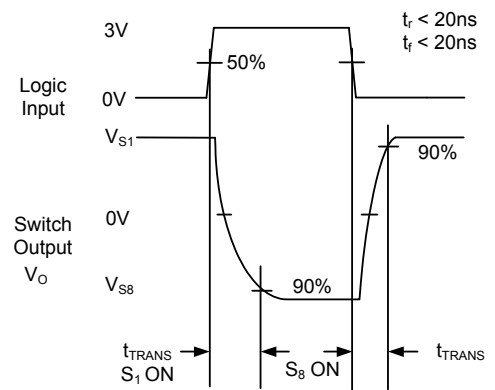
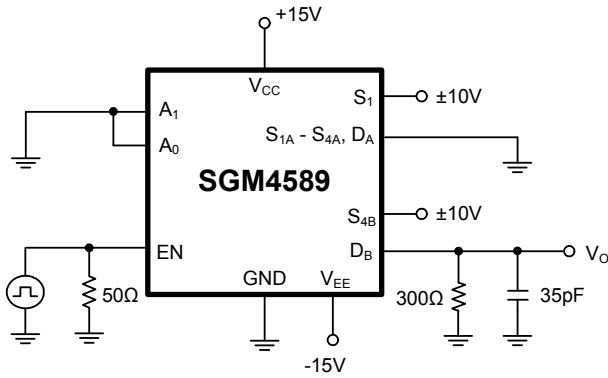
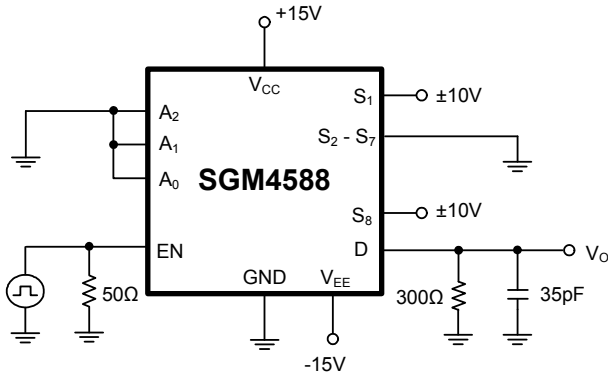
**ELECTRICAL CHARACTERISTICS**(V<sub>CC</sub> = 12V, V<sub>EE</sub> = 0V, V<sub>INH</sub> = 1.8V, V<sub>INL</sub> = 0.2V. Typical values are at T<sub>A</sub> = +25°C, Full = -40°C to +85°C, unless otherwise noted.)

PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>ANALOG</sub>		Full	0		12	V
Drain-Source On-Resistance	R <sub>DS(ON)</sub>	V <sub>D</sub> = 3V or 8V, I <sub>S</sub> = 10mA	+25°C		22		Ω
<b>DYNAMIC CHARACTERISTICS</b>							
Switching Time of Multiplexer	t <sub>TRANS</sub>	V <sub>S1</sub> = 8V, V <sub>S8</sub> = 0V, V <sub>IN</sub> = 2.4V	+25°C		220		ns
Enable Turn-On Time	t <sub>ON(EN)</sub>	V <sub>INH</sub> = 2.4V, V <sub>INL</sub> = 0V, V <sub>S1</sub> = 5V	+25°C		40		ns
Enable Turn-Off Time	t <sub>OFF(EN)</sub>		+25°C		250		ns
Charge Injection	Q	C <sub>L</sub> = 1nF, V <sub>S</sub> = 0V, R <sub>S</sub> = 0	+25°C		15		pC

**ELECTRICAL CHARACTERISTICS**(V<sub>CC</sub> = 40V, V<sub>EE</sub> = 0V, V<sub>INH</sub> = 1.8V, V<sub>INL</sub> = 0.2V. Typical values are at T<sub>A</sub> = +25°C, Full = -40°C to +85°C, unless otherwise noted.)

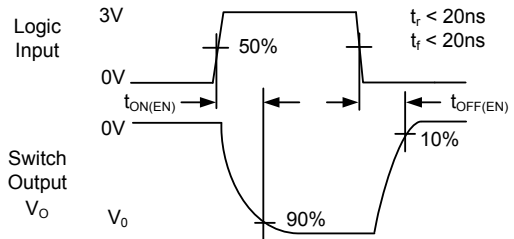
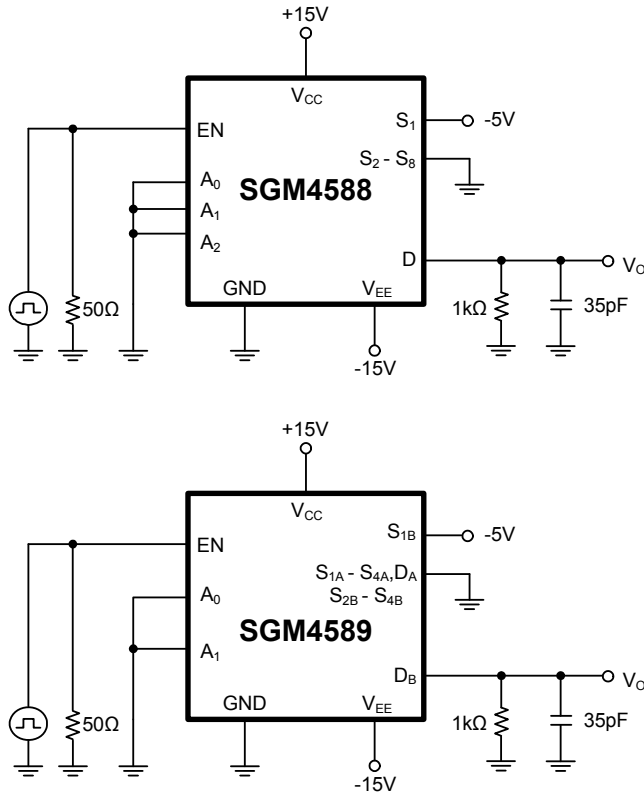
PARAMETER	SYMBOL	CONDITIONS	TEMP	MIN	TYP	MAX	UNITS
<b>ANALOG SWITCH</b>							
Analog Signal Range	V <sub>ANALOG</sub>		Full	0		40	V
Drain-Source On-Resistance	R <sub>DS(ON)</sub>	V <sub>D</sub> = 20V, I <sub>S</sub> = 10mA	+25°C		22		Ω
<b>DYNAMIC CHARACTERISTICS</b>							
Positive Supply Current	I <sub>CC</sub>	V <sub>EN</sub> = 0V, V <sub>A</sub> = 0V or 5V	+25°C		650		μA
Negative Supply Current	I <sub>EE</sub>				-250		
Positive Supply Current	I <sub>CC</sub>	V <sub>EN</sub> = 5V, V <sub>A</sub> = 0V or 5V	+25°C		700		μA
Negative Supply Current	I <sub>EE</sub>				-300		

TEST CIRCUITS

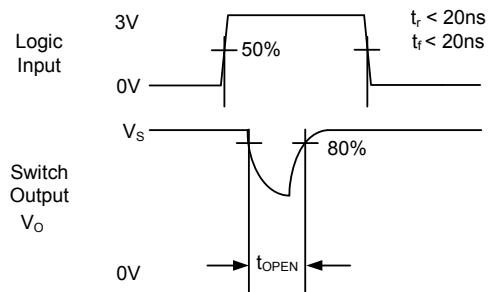
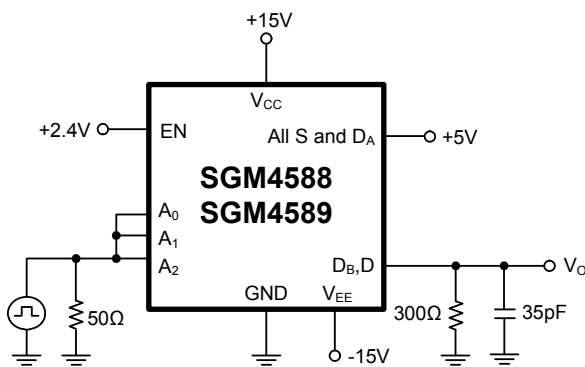


Test Circuit 1. Transition Time

TEST CIRCUITS



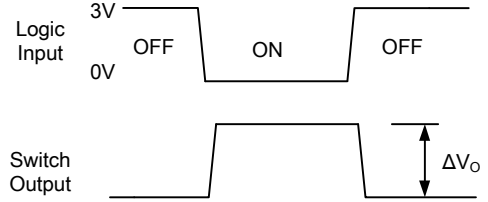
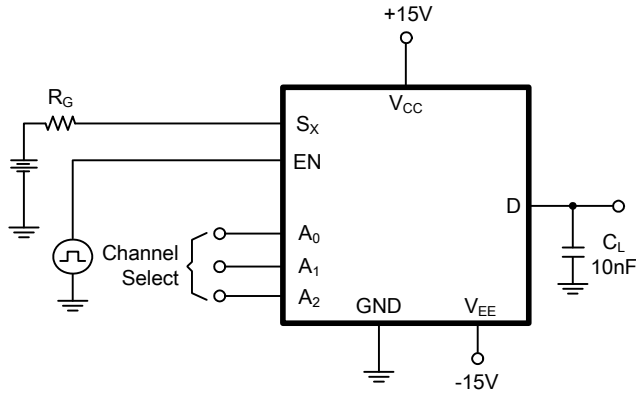
Test Circuit 2. Enable Switching Time



Test Circuit 3. Break-Before-Make Interval

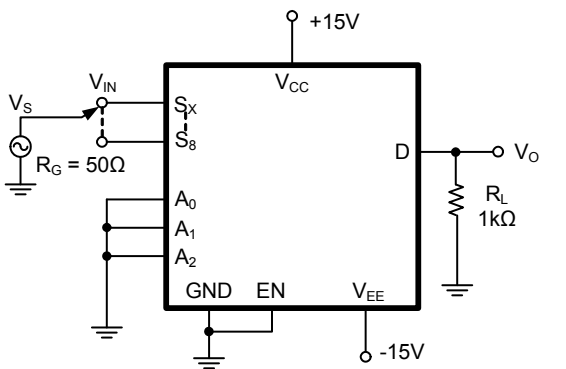


TEST CIRCUITS



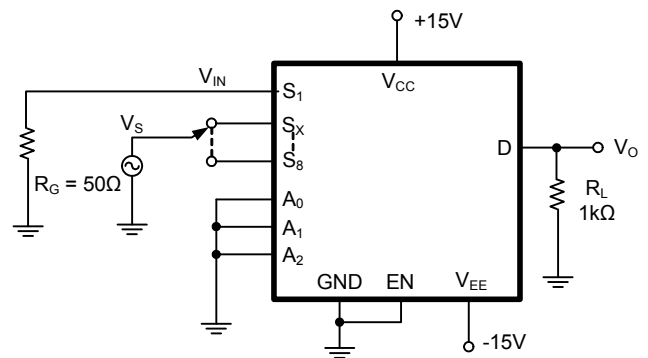
$\Delta V_0$  is the measured voltage due to charge transfer error  $Q$ , when the channel turns off.  
 $Q = C_L \times \Delta V_0$

Test Circuit 4. Charge Injection



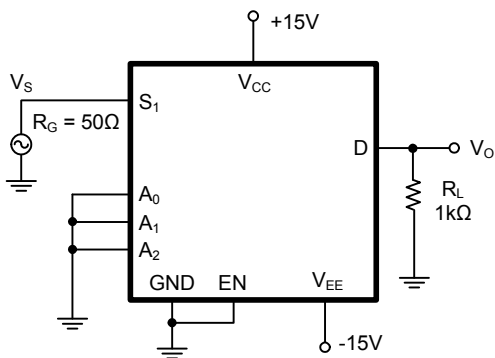
Off Isolation =  $20 \times \log V_{OUT}/V_{IN}$

Test Circuit 5. Off Isolation



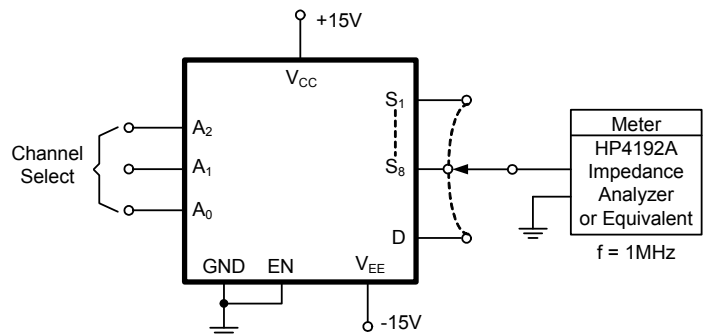
Channel to Channel Crosstalk =  $20 \times \log V_{OUT}/V_{IN}$

Test Circuit 6. Channel-to-Channel Crosstalk



Insertion Loss =  $20 \times \log V_{OUT}/V_{IN}$

Test Circuit 7. Insertion Loss

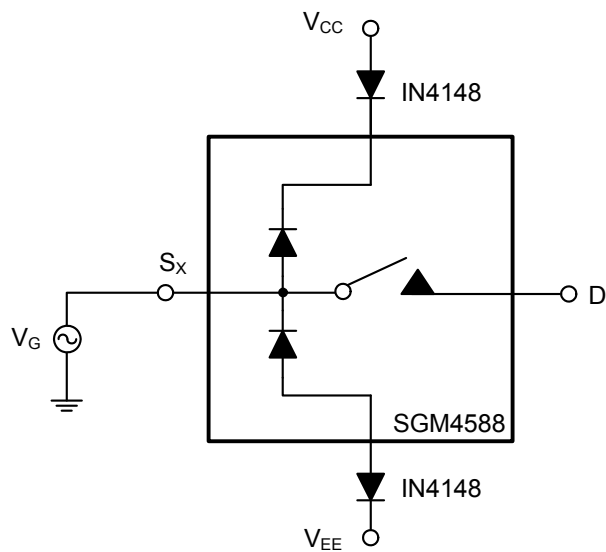


Test Circuit 8. Source Drain Capacitance

## APPLICATION INFORMATION

### Overvoltage Protection

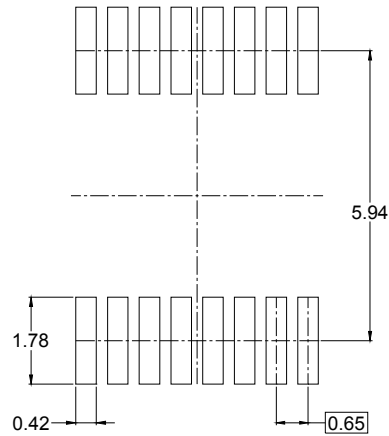
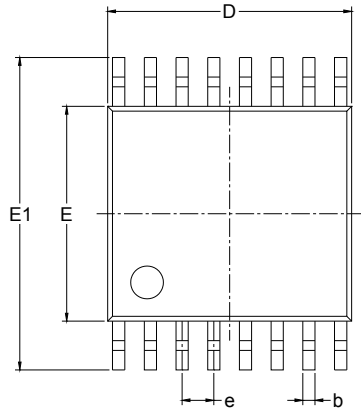
A very convenient form of overvoltage protection consists of adding two small signal diodes (1N4148, 1N914 type) in series with the supply pins (see Test Circuit 9). This arrangement effectively blocks the flow of reverse currents. It also floats the supply pin above or below the normal  $V_{CC}$  or  $V_{EE}$  value. In this case the overvoltage signal actually becomes the power supply of the IC. From the point of view of the chip, nothing has changed, as long as the difference  $V_S - (V_{EE})$  does not exceed +44V. The addition of these diodes will reduce the analog signal range to 1V below  $V_{CC}$  and 1V above  $V_{EE}$ , but it preserves the low channel resistance and low leakage characteristics.



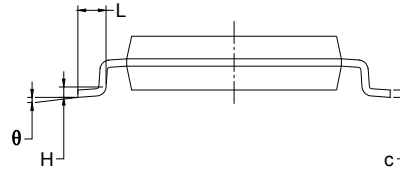
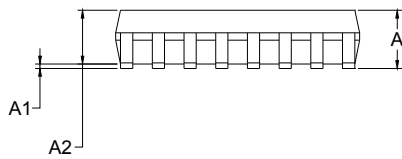
Test Circuit 9. Over-Voltage Protection Using Blocking Diodes

PACKAGE OUTLINE DIMENSIONS

TSSOP-16



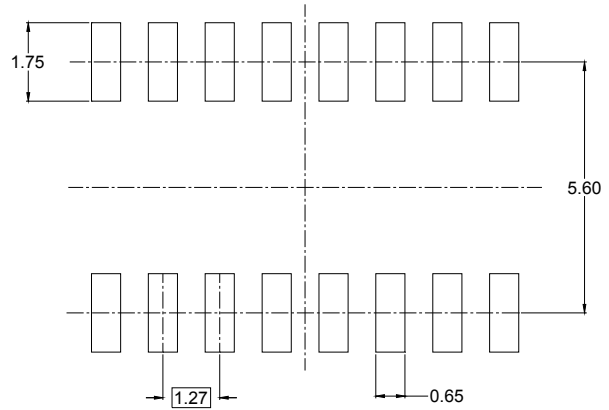
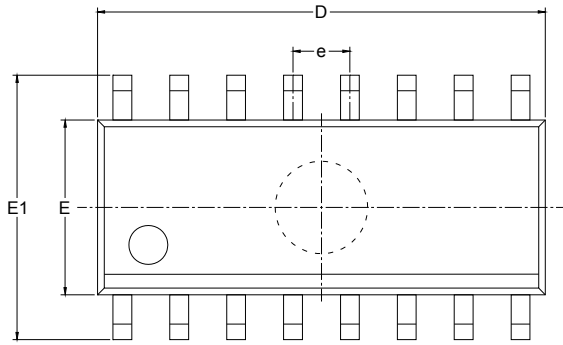
RECOMMENDED LAND PATTERN (Unit: mm)



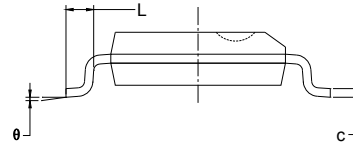
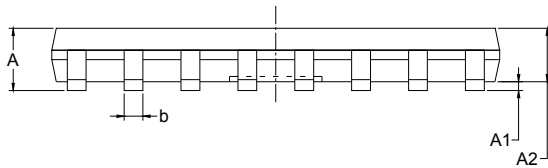
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A		1.100		0.043
A1	0.050	0.150	0.002	0.006
A2	0.800	1.000	0.031	0.039
b	0.190	0.300	0.007	0.012
c	0.090	0.200	0.004	0.008
D	4.900	5.100	0.193	0.201
E	4.300	4.500	0.169	0.177
E1	6.250	6.550	0.246	0.258
e	0.650 BSC		0.026 BSC	
L	0.500	0.700	0.02	0.028
H	0.25 TYP		0.01 TYP	
theta	1°	7°	1°	7°

PACKAGE OUTLINE DIMENSIONS

SOIC-16



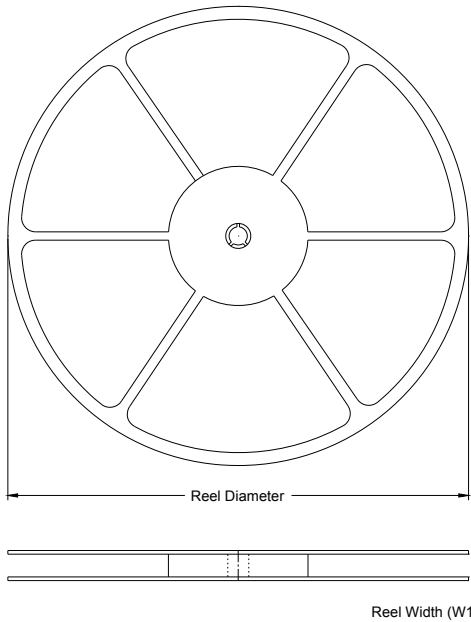
RECOMMENDED LAND PATTERN (Unit: mm)



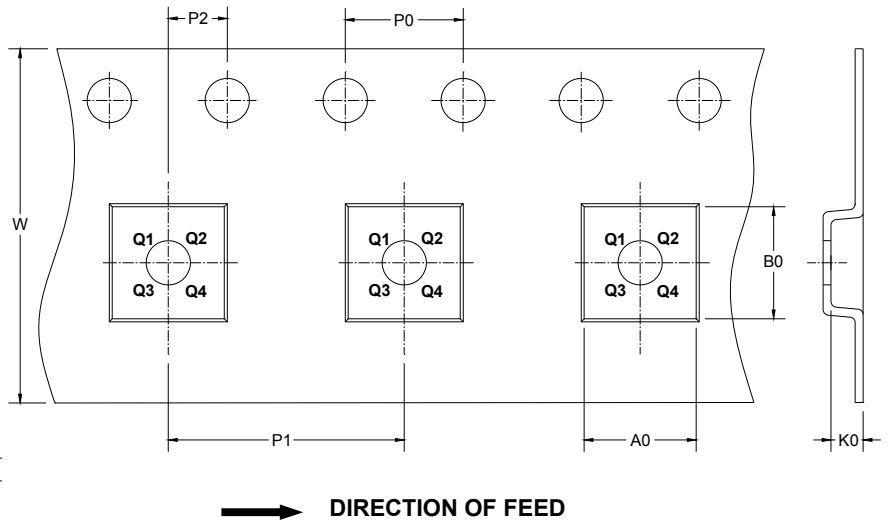
Symbol	Dimensions In Millimeters		Dimensions In Inches	
	MIN	MAX	MIN	MAX
A	1.350	1.750	0.053	0.069
A1	0.100	0.250	0.004	0.010
A2	1.350	1.550	0.053	0.061
b	0.330	0.510	0.013	0.020
c	0.170	0.250	0.006	0.010
D	9.800	10.200	0.386	0.402
E	3.800	4.000	0.150	0.157
E1	5.800	6.200	0.228	0.244
e	1.27 BSC		0.050 BSC	
L	0.400	1.270	0.016	0.050
θ	0°	8°	0°	8°

**TAPE AND REEL INFORMATION**

**REEL DIMENSIONS**



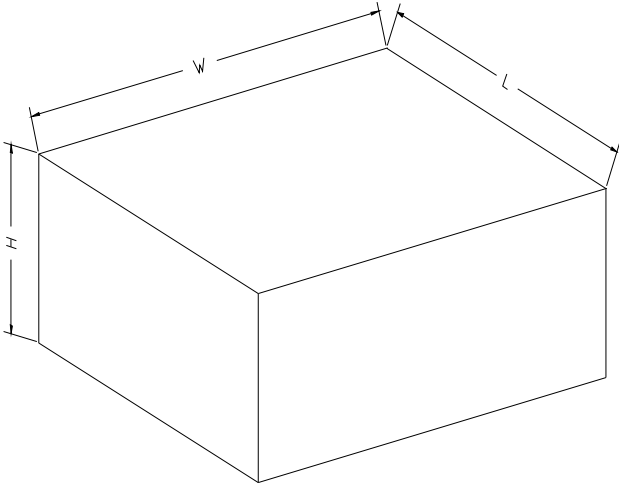
**TAPE DIMENSIONS**



NOTE: The picture is only for reference. Please make the object as the standard.

**KEY PARAMETER LIST OF TAPE AND REEL**

Package Type	Reel Diameter	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P0 (mm)	P1 (mm)	P2 (mm)	W (mm)	Pin1 Quadrant
SOIC-16	13"	16.4	6.5	10.3	2.1	4.0	8.0	2.0	16.0	Q1
TSSOP-16	13"	12.4	6.9	5.6	1.2	4.0	8.0	2.0	12.0	Q1

**CARTON BOX DIMENSIONS**

NOTE: The picture is only for reference. Please make the object as the standard.

**KEY PARAMETER LIST OF CARTON BOX**

Reel Type	Length (mm)	Width (mm)	Height (mm)	Pizza/Carton
13"	386	280	370	5