MC14016B

Quad Analog Switch/ Quad Multiplexer

The MC14016B quad bilateral switch is constructed with MOS P–channel and N–channel enhancement mode devices in a single monolithic structure. Each MC14016B consists of four independent switches capable of controlling either digital or analog signals. The quad bilateral switch is used in signal gating, chopper, modulator, demodulator and CMOS logic implementation.

- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Linearized Transfer Characteristics
- Low Noise — 12 nV/$\sqrt{\text{Cycle}}$, f ≥ 1.0 kHz typical
- Pin–for–Pin Replacements for CD4016B, CD4066B (Note improved transfer characteristic design causes more parasitic coupling capacitance than CD4016)
- For Lower R_{ON}, Use The HC4016 High–Speed CMOS Device or The MC14066B
- This Device Has Inputs and Outputs Which Do Not Have ESD Protection. Antistatic Precautions Must Be Taken.

MAXIMUM RATINGS (Voltages Referenced to V_{SS}) (Note 2.)

Symbol	Parameter	Value	Unit
V_{DD}	DC Supply Voltage Range	–0.5 to +18.0	V
V_{in}, V_{out}	Input or Output Voltage Range (DC or Transient)	–0.5 to V_{DD} + 0.5	V
I_{in}	Input Current (DC or Transient) per Control Pin	±10	mA
I_{SW}	Switch Through Current	±25	mA
P_D	Power Dissipation, per Package (Note 3.)	500	mW
T_A	Ambient Temperature Range	–55 to +125	°C
T_{stg}	Storage Temperature Range	–65 to +150	°C
T_L	Lead Temperature (8–Second Soldering)	260	°C

2. Maximum Ratings are those values beyond which damage to the device may occur.
3. Temperature Derating:
   Plastic “P and D/DW” Packages: – 7.0 mW/°C From 65°C To 125°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high–impedance circuit. For proper operation, V_{in} and V_{out} should be constrained to the range $V_{SS} \le (V_{in}$ or $V_{out}) \le V_{DD}$.

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.

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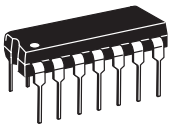
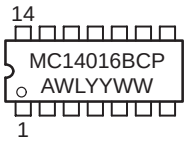
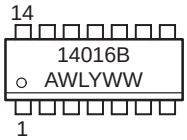
MARKING DIAGRAMS

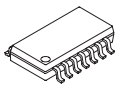


PDIP–14
P SUFFIX
CASE 646

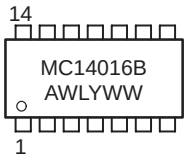


SOIC–14
D SUFFIX
CASE 751A





SOEIAJ–14
F SUFFIX
CASE 965



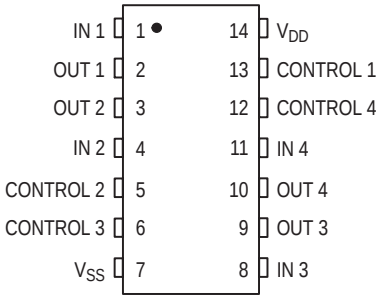
A = Assembly Location
WL or L = Wafer Lot
YY or Y = Year
WW or W = Work Week

ORDERING INFORMATION

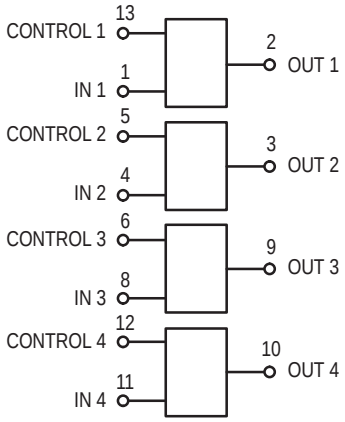
Device	Package	Shipping
MC14016BCP	PDIP–14	2000/Box
MC14016BD	SOIC–14	55/Rail
MC14016BDR2	SOIC–14	2500/Tape & Reel
MC14016BF	SOEIAJ–14	See Note 1.
MC14016BFEL	SOEIAJ–14	See Note 1.

1. For ordering information on the EIAJ version of the SOIC packages, please contact your local ON Semiconductor representative.

PIN ASSIGNMENT



BLOCK DIAGRAM

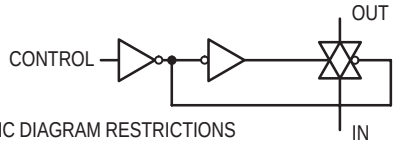


V_{DD} = PIN 14
V_{SS} = PIN 7

Control	Switch
0 = V_{SS}	Off
1 = V_{DD}	On

LOGIC DIAGRAM

(1/4 OF DEVICE SHOWN)



LOGIC DIAGRAM RESTRICTIONS

$V_{SS} \le V_{in} \le V_{DD}$

$V_{SS} \le V_{out} \le V_{DD}$

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS})

Characteristic	Figure	Symbol	V_{DD} Vdc	– 55°C		25°C			125°C		Unit
				Min	Max	Min	Typ (4.)	Max	Min	Max	
Input Voltage Control Input	1	V_{IL}	5.0 10 15	— — —	— — —	— — —	1.5 1.5 1.5	0.9 0.9 0.9	— — —	— — —	Vdc
		V_{IH}	5.0 10 15	— — —	— — —	3.0 8.0 13	2.0 6.0 11	— — —	— — —	— — —	Vdc
Input Current Control	—	I_{in}	15	—	±0.1	—	±0.00001	±0.1	—	± 1.0	µAdc
Input Capacitance Control Switch Input Switch Output Feed Through	—	C_{in}	 — — — —	 — — — —	 — — — —	 — — — —	 5.0 5.0 5.0 0.2	 — — — —	 — — — —	 — — — —	pF
Quiescent Current (Per Package) (5.)	2,3	I_{DD}	5.0 10 15	— — —	0.25 0.5 1.0	— — —	0.0005 0.0010 0.0015	0.25 0.5 1.0	— — —	7.5 15 30	µAdc
"ON" Resistance ($V_C = V_{DD}$, R_L = 10 kΩ) (V_{in} = + 5.0 Vdc) (V_{in} = – 5.0 Vdc) V_{SS} = – 5.0 Vdc (V_{in} = ± 0.25 Vdc) (V_{in} = + 7.5 Vdc) (V_{in} = – 7.5 Vdc) V_{SS} = – 7.5 Vdc (V_{in} = ± 0.25 Vdc) (V_{in} = + 10 Vdc) (V_{in} = + 0.25 Vdc) V_{SS} = 0 Vdc (V_{in} = + 5.6 Vdc) (V_{in} = + 15 Vdc) (V_{in} = + 0.25 Vdc) V_{SS} = 0 Vdc (V_{in} = + 9.3 Vdc)	4,5,6	R_{ON}	 5.0 7.5 10 15	 — — — — — — — — — — — —	 600 600 600 360 360 360 600 600 600 360 360 360	— — — — — — — — — — — — — — — —	 300 300 280 240 240 180 260 310 310 260 260 300	 660 660 660 400 400 400 660 660 660 400 400 400	— — — — — — — — — — — — — — — —	 840 840 840 520 520 520 840 840 840 520 520 520	Ohms
Δ "ON" Resistance Between any 2 circuits in a common package ($V_C = V_{DD}$) (V_{in} = ± 5.0 Vdc, V_{SS} = – 5.0 Vdc) (V_{in} = ± 7.5 Vdc, V_{SS} = – 7.5 Vdc)	—	ΔR_{ON}	 5.0 7.5	 — —	 — —	 — —	 15 10	 — —	 — —	 — —	Ohms
Input/Output Leakage Current ($V_C = V_{SS}$) (V_{in} = + 7.5, V_{out} = – 7.5 Vdc) (V_{in} = – 7.5, V_{out} = + 7.5 Vdc)	—	—	 7.5 7.5	 — —	 ±0.1 ±0.1	 — —	 ±0.0015 ±0.0015	 ±0.1 ± 0.1	 — —	 ± 1.0 ± 1.0	µAdc

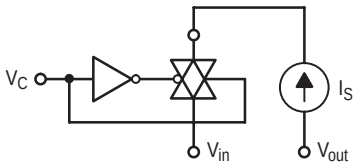
NOTE: All unused inputs must be returned to V_{DD} or V_{SS} as appropriate for the circuit application.

4. Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.
5. For voltage drops across the switch (ΔV_{switch}) > 600 mV (> 300 mV at high temperature), excessive V_{DD} current may be drawn; i.e., the current out of the switch may contain both V_{DD} and switch input components. The reliability of the device will be unaffected unless the Maximum Ratings are exceeded. (See first page of this data sheet.) Reference Figure 14.

ELECTRICAL CHARACTERISTICS [6.] (C_L = 50 pF, T_A = 25°C)

Characteristic	Figure	Symbol	V_{DD} Vdc	Min	Typ [7.]	Max	Unit
Propagation Delay Time (V_{SS} = 0 Vdc) V_{in} to V_{out} (V_C = V_{DD}, R_L = 10 kΩ)	7	t_{PLH}, t_{PHL}	5.0 10 15	— — —	15 7.0 6.0	45 15 12	ns
Control to Output (V_{in} ≤ 10 Vdc, R_L = 10 kΩ)	8	t_{PHZ}, t_{PLZ}, t_{PZH}, t_{PZL}	 5.0 10 15	 — — —	 34 20 15	 90 45 35	ns
Crosstalk, Control to Output (V_{SS} = 0 Vdc) (V_C = V_{DD}, R_{in} = 10 kΩ, R_{out} = 10 kΩ, f = 1.0 kHz)	9	—	5.0 10 15	— — —	30 50 100	— — —	mV
Crosstalk between any two switches (V_{SS} = 0 Vdc) (R_L = 1.0 kΩ, f = 1.0 MHz, $\text{crosstalk} = 20\log_{10}\frac{V_{out1}}{V_{out2}}$)	—	—	5.0	—	– 80	—	dB
Noise Voltage (V_{SS} = 0 Vdc) (V_C = V_{DD}, f = 100 Hz) (V_C = V_{DD}, f = 100 kHz)	10,11	—	5.0 10 15 5.0 10 15	— — — — — —	24 25 30 12 12 15	— — — — — —	nV/$\sqrt{\text{Cycle}}$
Second Harmonic Distortion (V_{SS} = – 5.0 Vdc) (V_{in} = 1.77 Vdc, RMS Centered @ 0.0 Vdc, R_L = 10 kΩ, f = 1.0 kHz)	—	—	5.0	—	0.16	—	%
Insertion Loss (V_C = V_{DD}, V_{in} = 1.77 Vdc, V_{SS} = – 5.0 Vdc, RMS centered = 0.0 Vdc, f = 1.0 MHz) $I_{loss} = 20\log_{10}\frac{V_{out}}{V_{in}}$) ($R_L$ = 1.0 kΩ) (R_L = 10 kΩ) (R_L = 100 kΩ) (R_L = 1.0 MΩ)	12	—	5.0	 — — —	 2.3 0.2 0.1 0.05	 — — —	dB
Bandwidth (– 3.0 dB) (V_C = V_{DD}, V_{in} = 1.77 Vdc, V_{SS} = – 5.0 Vdc, RMS centered @ 0.0 Vdc) (R_L = 1.0 kΩ) (R_L = 10 kΩ) (R_L = 100 kΩ) (R_L = 1.0 MΩ)	12,13	BW	5.0	 — — —	 54 40 38	 — — —	MHz
OFF Channel Feedthrough Attenuation (V_{SS} = – 5.0 Vdc) (V_C = V_{SS}, $20\log_{10}\frac{V_{out}}{V_{in}}$ = –50 dB) (R_L = 1.0 kΩ) (R_L = 10 kΩ) (R_L = 100 kΩ) (R_L = 1.0 MΩ)	—	—	5.0	 — — —	 1250 140 18	 — — —	kHz

6. The formulas given are for typical characteristics only at 25°C.
7. Data labelled “Typ” is not to be used for design purposes but is intended as an indication of the IC’s potential performance.



V_{IL}: V_C is raised from V_{SS} until $V_C = V_{IL}$.
at $V_C = V_{IL}$: $I_S = \pm 10$ μA with $V_{in} = V_{SS}$, $V_{out} = V_{DD}$ or $V_{in} = V_{DD}$, $V_{out} = V_{SS}$.

V_{IH}: When $V_C = V_{IH}$ to V_{DD}, the switch is ON and the R_{ON} specifications are met.

Figure 1. Input Voltage Test Circuit

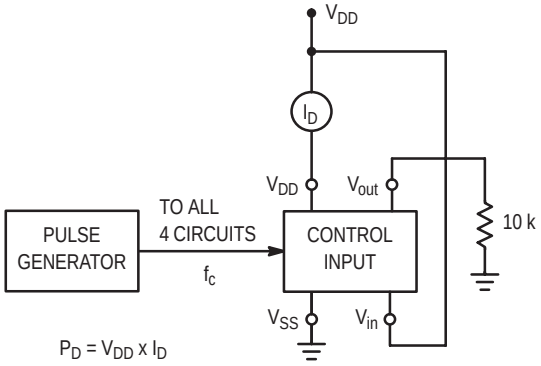


Figure 2. Quiescent Power Dissipation Test Circuit

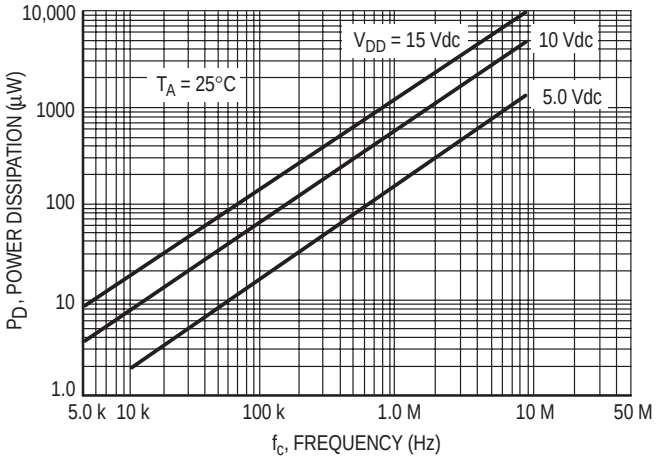


Figure 3. Typical Power Dissipation per Circuit (1/4 of device shown)

TYPICAL R_{ON} versus INPUT VOLTAGE

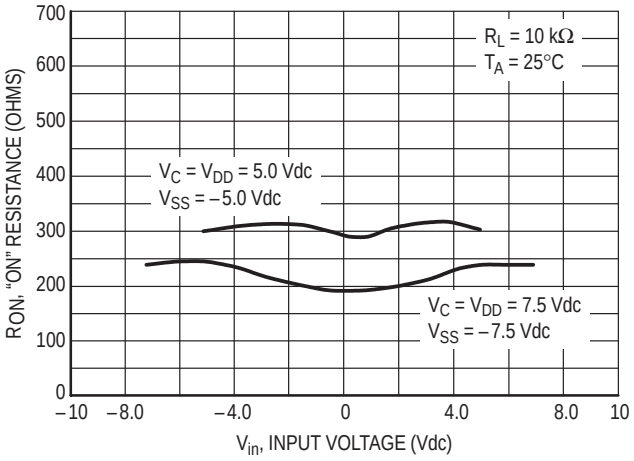


Figure 4. V_{SS} = – 5.0 V and – 7.5 V

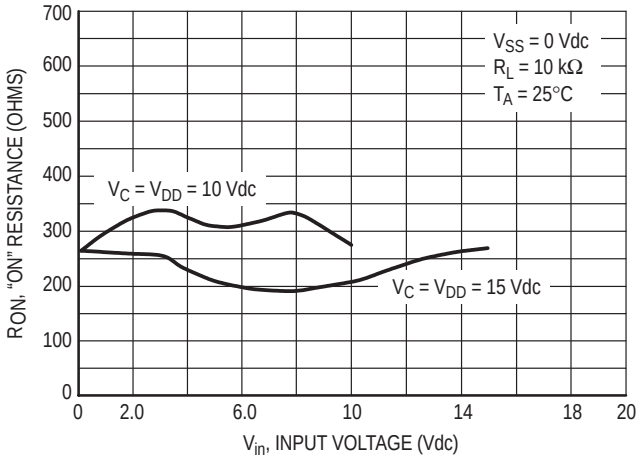


Figure 5. V_{SS} = 0 V

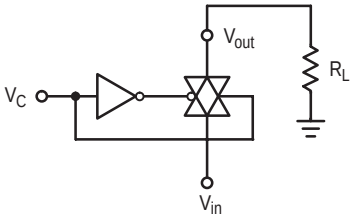


Figure 6. R_{ON} Characteristics Test Circuit

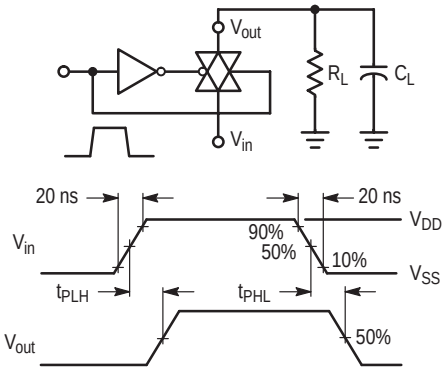


Figure 7. Propagation Delay Test Circuit and Waveforms

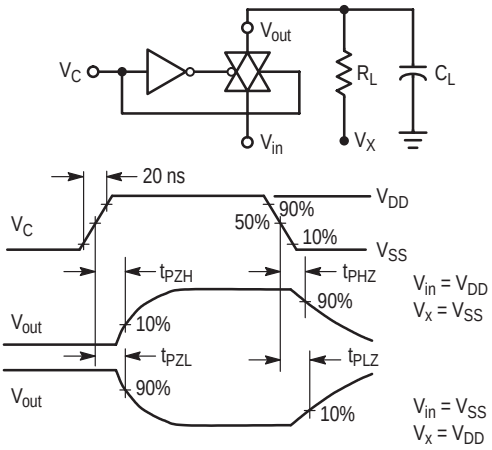


Figure 8. Turn–On Delay Time Test Circuit and Waveforms

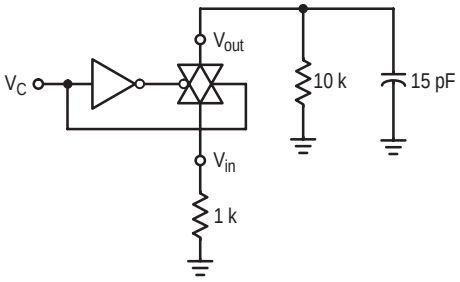


Figure 9. Crosstalk Test Circuit

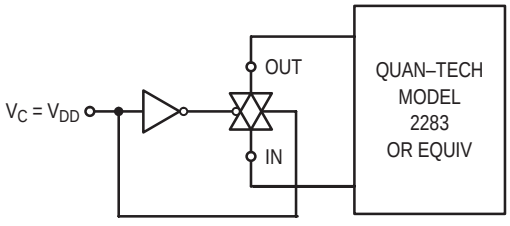


Figure 10. Noise Voltage Test Circuit

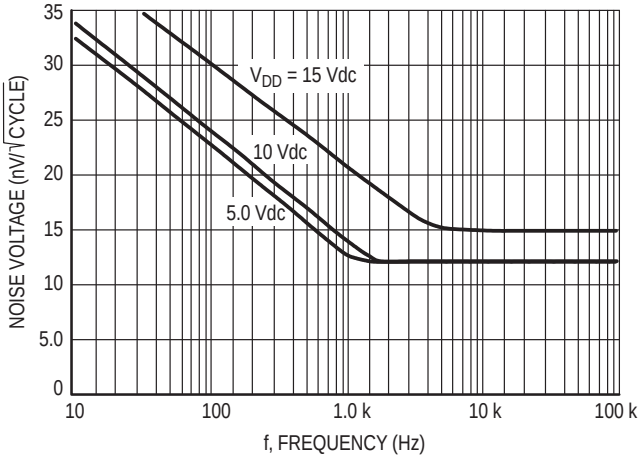


Figure 11. Typical Noise Characteristics

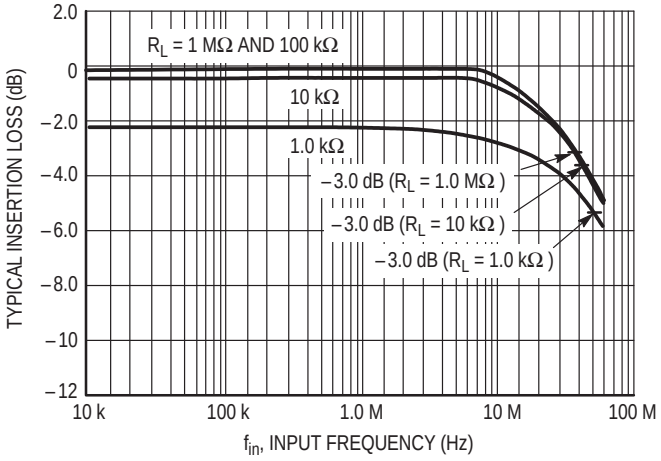


Figure 12. Typical Insertion Loss/Bandwidth Characteristics

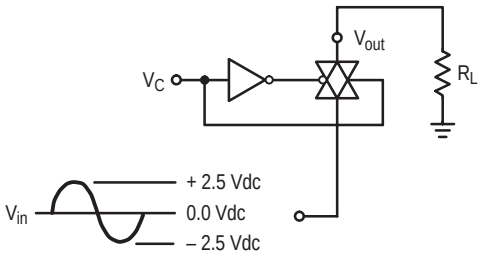


Figure 13. Frequency Response Test Circuit

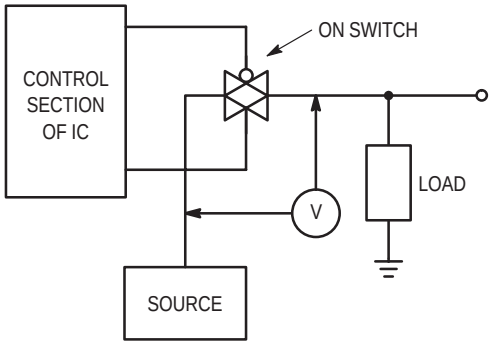


Figure 14. ΔV Across Switch

APPLICATIONS INFORMATION

Figure A illustrates use of the Analog Switch. The 0–to–5 V Digital Control signal is used to directly control a 5 V_{p-p} analog signal.

The digital control logic levels are determined by V_{DD} and V_{SS}. The V_{DD} voltage is the logic high voltage; the V_{SS} voltage is logic low. For the example, V_{DD} = +5 V logic high at the control inputs; V_{SS} = GND = 0 V logic low.

The maximum analog signal level is determined by V_{DD} and V_{SS}. The analog voltage must not swing higher than V_{DD} or lower than V_{SS}.

The example shows a 5 V_{p-p} signal which allows no margin at either peak. If voltage transients above V_{DD} and/or below V_{SS} are anticipated on the analog channels, external diodes (D_x) are recommended as shown in Figure B. These diodes should be small signal types able to absorb the maximum anticipated current surges during clipping.

The *absolute* maximum potential difference between V_{DD} and V_{SS} is 18.0 V. Most parameters are specified up to 15 V which is the *recommended* maximum difference between V_{DD} and V_{SS}.

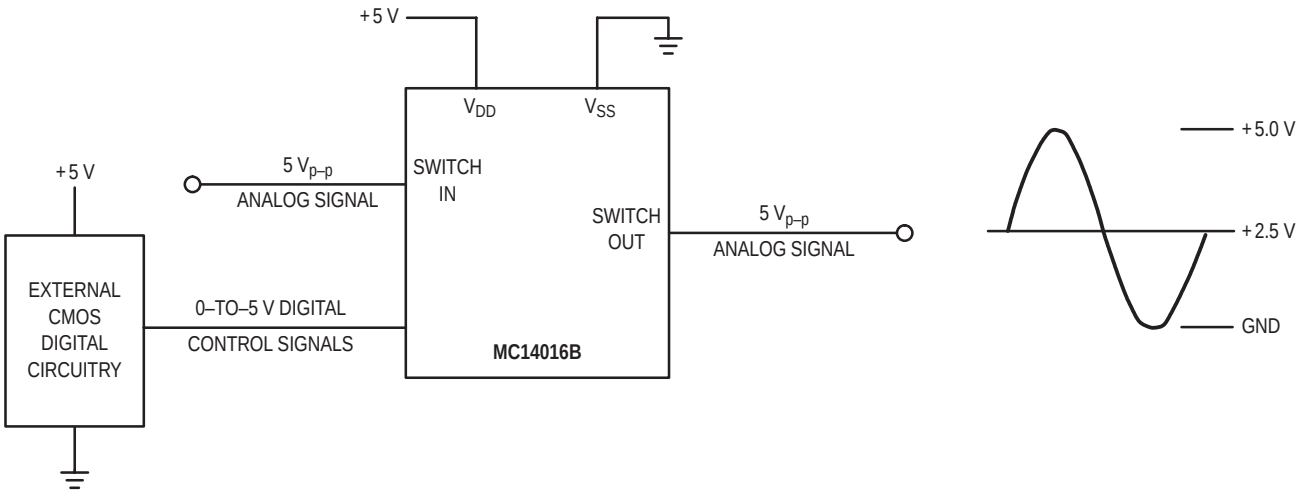


Figure A. Application Example

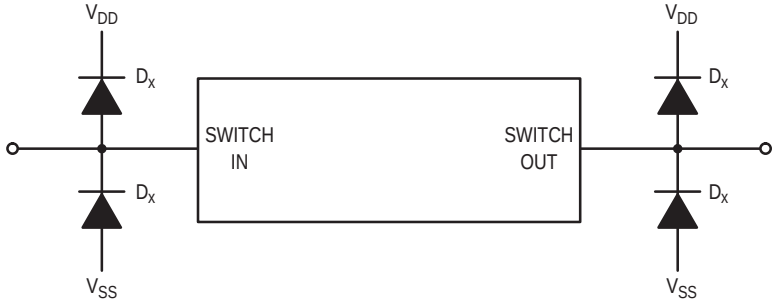
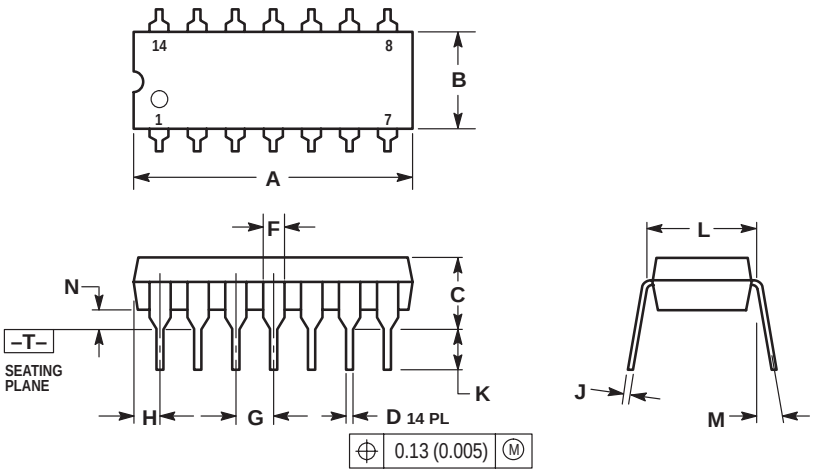


Figure B. External Germanium or Schottky Clipping Diodes

PACKAGE DIMENSIONS

P SUFFIX
PLASTIC DIP PACKAGE
CASE 646–06
ISSUE M

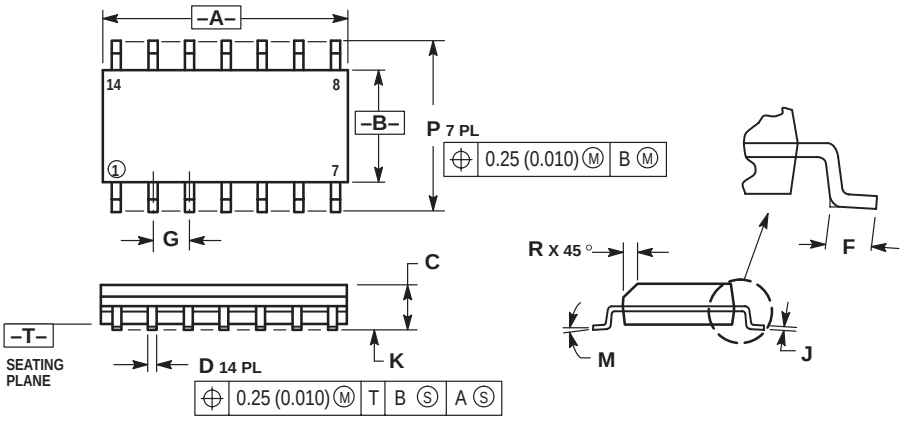


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	18.80
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.290	0.310	7.37	7.87
M	—	10°	—	10°
N	0.015	0.039	0.38	1.01

PACKAGE DIMENSIONS

D SUFFIX
PLASTIC SOIC PACKAGE
CASE 751A–03
ISSUE F

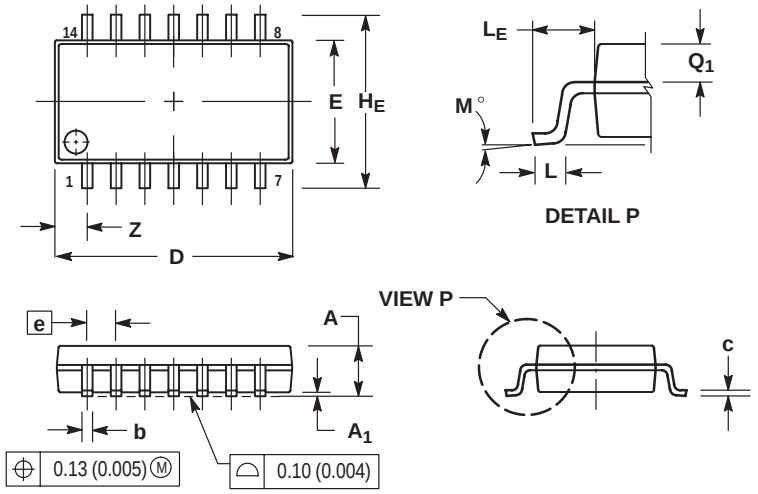


NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0 °	7 °	0 °	7 °
P	5.80	6.20	0.228	0.244
R	0.25	0.50	0.010	0.019

PACKAGE DIMENSIONS

F SUFFIX
PLASTIC EIAJ SOIC PACKAGE
CASE 965–01
ISSUE O



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

	MILLIMETERS		INCHES	
DIM	MIN	MAX	MIN	MAX
A	—	2.05	—	0.081
A_1	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.18	0.27	0.007	0.011
D	9.90	10.50	0.390	0.413
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H_E	7.40	8.20	0.291	0.323
0.50	0.50	0.85	0.020	0.033
L_E	1.10	1.50	0.043	0.059
M	0 °	10 °	0 °	10 °
Q_1	0.70	0.90	0.028	0.035
Z	—	1.42	—	0.056

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