

January 1989

DPDT CMOS Analog Switch

Features

- This Circuit is Processed in Accordance to Mil-Std-883 and is Fully Conformant Under the Provisions of Paragraph 1.2.1.
- Wide Analog Signal Range $\pm 15V$
- Low "ON" Resistance
 - ▶ HI-5046 50Ω (Typ) 150Ω (Max)
 - ▶ HI-5046A 25Ω (Typ) 50Ω (Max)
- High Current Capability $70mA$ (Max)
- Break-Before-Make Switching
 - ▶ Turn-On Time $370ns$ (Typ) $800ns$ (Max)
 - ▶ Turn-Off Time $280ns$ (Typ) $400ns$ (Max)
- No Latch-Up
- Input MOS Gates Are Protected From Electrostatic Discharge
- DTL, TTL, CMOS, PMOS Compatible

Applications

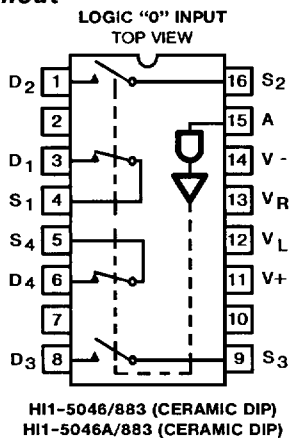
- High Frequency Switching
- Sample and Hold
- Digital Filters
- Operational Amplifier Gain Switching

Description

These CMOS analog switches offer low-resistance switching performance for analog voltages up to the supply rails and for signal currents up to $70mA$. "ON" resistance is low and stays reasonably constant over the full range of operating signal voltage and current. R_{ON} remains exceptionally constant for input voltages between $+5V$ and $-5V$ and currents up to $50mA$. Switch impedance also changes very little over temperature, particularly between $0^\circ C$ and $+75^\circ C$. R_{ON} is nominally 50Ω for the HI-5046/883 and 25Ω for the HI-5046A/883.

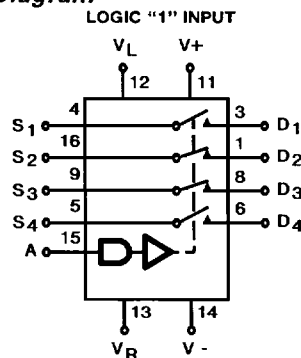
These devices provide break-before-make switching and are TTL and CMOS compatible for maximum application versatility. Performance is further enhanced by Dielectric Isolation processing which insures latch-free operation with very low input and output leakage currents ($0.8nA$ at $+25^\circ C$). They also feature very low power operation ($1.5mW$ at $+25^\circ C$). The HI-5046/883 and HI-5046A/883 are available in a 16 pin Ceramic DIP and operate over the $-55^\circ C$ to $+125^\circ C$ temperature range.

Pinout

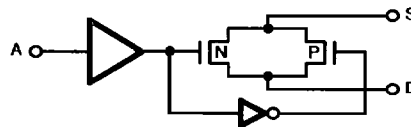


NOTE: Unused pins may be internally connected. Ground all unused pins.

Functional Diagram



TYPICAL SWITCH



NOTE: Source and Drain are arbitrarily depicted as Analog Input and Output respectively. They may be interchanged without affecting performance.

Specifications HI-5046/883 HI-5046A/883

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals	36V
$\pm V_{SUPPLY}$ to Ground (V+, V-)	$\pm 18V$
V_R to Ground	- V_{SUPPLY}
V_L to Ground	+ V_{SUPPLY}
Digital and Analog Input Voltage (V_A , V_S , V_D)	+ V_{SUPPLY} +4V
	- V_{SUPPLY} -4V
Peak Current (Source to Drain) (Pulse at 1ms, 10% Duty Cycle Max)	70mA
Continuous Current (Any Pin)	20mA
Junction Temperature	+175°C
Storage Temperature Flange	-65°C to +150°C
ESD Rating	<2000V
Lead Temperature (Soldering 10 sec.)	300°C

Thermal Information

Thermal Resistance	θ_{ja}	θ_{jc}
Ceramic DIP Package	82°C/W	20°C/W
Package Power Dissipation at +75°C		
Ceramic DIP Package	1.0W	
Package Power Dissipation Derating Factor Above +75°C		
Ceramic DIP Package	12.3mW/°C	

CAUTION: Absolute maximum ratings are limiting values, applied individually, beyond which the serviceability of the circuit may be impaired. Functional operability under any of these conditions is not necessarily implied.

Recommended Operating Conditions

Operating Temperature Range	-55°C to +125°C	Analog Input Voltage (V_S)	$\pm V_{SUPPLY}$
Operating Supply Voltage	$\pm 15V$	Address Low Level (V_{AL})	0V to 0.8V
Logic Supply Voltage (V_L)	+5.0V	Address High Level (V_{AH})	2.4V to +5.0V
Logic Reference Voltage (V_R)	0.0V		

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: Supply Voltage = $\pm 15V$, V_L = +5.0V, V_R = 0.0V, V_{AH} = 2.4V, V_{AL} = +0.8V, Unused Pins are Grounded, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Switch "ON" Resistance For HI-5046/883	RDS1	$V_D = -10V, I_S = 10mA$ S1/S2/S3/S4	1	+25°C	-	75	Ω
			2, 3	-55°C to +125°C	-	150	Ω
		$V_D = 10V, I_S = -10mA$ S1/S2/S3/S4	1	+25°C	-	75	Ω
			2, 3	-55°C to +125°C	-	150	Ω
Switch "ON" Resistance For HI-5046A/883	RDS2	$V_D = -10V, I_S = 10mA$ S1/S2/S3/S4	1	+25°C	-	45	Ω
			2, 3	-55°C to +125°C	-	50	Ω
		$V_D = 10V, I_S = -10mA$ S1/S2/S3/S4	1	+25°C	-	45	Ω
			2, 3	-55°C to +125°C	-	50	Ω
Source "OFF" Leakage Current	$I_{S(OFF)}$	$V_S = -10V, V_D = 10V$ S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		$V_S = 10V, V_D = -10V$ S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Drain "OFF" Leakage Current	$I_{D(OFF)}$	$V_D = -10V, V_S = 10V$ S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		$V_D = 10V, V_S = -10V$ S1/S2/S3/S4	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Channel "ON" Leakage Current	$I_{D(ON)}$	$V_D = V_S = 10V$ S1/S2/S3/S4	1	+25°C	-2	2	nA
			2, 3	-55°C to +125°C	-200	200	nA
		$V_D = V_S = -10V$ S1/S2/S3/S4	1	+25°C	-2	2	nA
			2, 3	-55°C to +125°C	-200	200	nA

CAUTION: This device is sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS (Continued)

Device Tested at: Supply Voltage = $\pm 15V$, $V_L = +5.0V$, $V_R = 0.0V$, $V_{AH} = 2.4V$, $V_{AL} = +0.8V$, Unused Pins are Grounded, Unless Otherwise Specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Low Level Address Current	I_{AL}	$V_A = 0V$	1	+25°C	-1	1	μA
			2, 3	-55°C to +125°C	-10	1	μA
High Level Address Current	I_{AH}	$V_A = 2.4V, 5V$	1	+25°C	-1	1	μA
			2, 3	-55°C to +125°C	-1	10	μA
Positive Supply Current	$+I_{CC}$	$V_A = 0V, 5V$	1	+25°C	-	200	μA
			2, 3	-55°C to +125°C	-	300	μA
Negative Supply Current	$-I_{CC}$	$V_A = 0V, 5V$	1	+25°C	-200	-	μA
			2, 3	-55°C to +125°C	-300	-	μA
Logic Supply Current	$+I_L$	$V_A = 0V, 5V$	1	+25°C	-	200	μA
			2, 3	-55°C to +125°C	-	300	μA
Reference Supply Current	$+I_R$	$V_A = 0V, 5V$	1	+25°C	-200	-	μA
			2, 3	-55°C to +125°C	-300	-	μA

TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: Supply Voltage = $\pm 15V$, $V_L = +5.0V$, $V_R = 0.0V$, $V_{AH} = +5.0V$, $V_{AL} = +0.0V$, Unused Pins are Grounded, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUP	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
Turn "ON" Time	t_{ON}	$V_S = 10V, -10V$ $C_L = 10pF$ $R_L = 1k\Omega$	11	-55°C	-	450	ns
			9	+25°C	-	500	ns
			10	+125°C	-	800	ns
Turn "OFF" Time	t_{OFF}	$V_S = 10V, -10V$ $C_L = 10pF$ $R_L = 1k\Omega$	11	-55°C	-	350	ns
			9	+25°C	-	450	ns
			10	+125°C	-	600	ns

HI-5046/883 HI-5046A/883

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)

Device Characterized at: Supply Voltage = $\pm 15V$, $V_L = +5.0V$, $V_R = 0.0V$, $V_{AH} = 4.0V$, $V_{AL} = 0.8V$, Unused Pins are Grounded, Unless Otherwise Specified.

PARAMETERS	SYMBOL	CONDITIONS	NOTES	TEMPERATURE	LIMITS		UNITS
					MIN	MAX	
"On" Resistance Match (Channel to Channel) for HI-5046/883	R_{ON1} Match	$V_D = \pm 10V$ $I_D = 10mA$	1	+25°C	-	10	Ω
"On" Resistance Match (Channel to Channel) for HI-5046A/883	R_{ON2} Match	$V_D = \pm 10V$ $I_D = 10mA$	1	+25°C	-	10	Ω
Address Capacitance	C_A	$V_A = 0V, 5V$	1	+25°C	-	45	pF
Switch Input Capacitance	$C_{S(OFF)}$	Switch Off: $V_A = 0V$	1	+25°C	-	60	pF
Switch Output Capacitance	$C_{D(OFF)}$	Switch Off: $V_A = 0V$	1	+25°C	-	60	pF
	$C_{D(ON)}$	Switch On: $V_A = 5V$	1	+25°C	-	60	pF
Drain to Source Capacitance	$C_{DS(OFF)}$	Switch Off: $V_A = 0V$	1	+25°C	-	10	pF
Off Isolation	V_{ISO}	$V_S = 2V_{p-p}$ @ $f = 100kHz$ $R_L = 100\Omega$	1	+25°C	-	60	dB
Crosstalk	V_{CT}	$V_S = 2V_{p-p}$ @ $f = 100kHz$ $R_L = 100\Omega$	1	+25°C	-	60	dB
Charge Transfer Error	V_{CTE}	$V_S = GND$, $C_L = 10,000pF$ $V_A = 0$ to $4V$ @ $f = 200kHz$	1	+25°C	-	30	mV

NOTE 1. Parameters listed in Table 3 are controlled via design or process parameters and are not directly tested at final production. These parameters are lab characterized upon initial design release, or upon design changes. These parameters are guaranteed by characterization based upon data from multiple production runs which reflect lot to lot and within lot variation.

TABLE 4. ELECTRICAL TEST REQUIREMENTS

MIL-STD-883 TEST REQUIREMENTS	SUBGROUPS (SEE TABLES 1 & 2)
Interim Electrical Parameters (Pre Burn-in)	1
Final Electrical Test Parameters	1*, 2, 3, 9, 10, 11
Group A Test Requirements	1, 2, 3, 9, 10, 11
Groups C & D Endpoints	1

* FDA applies to Subgroup 1 only.

Test Circuits

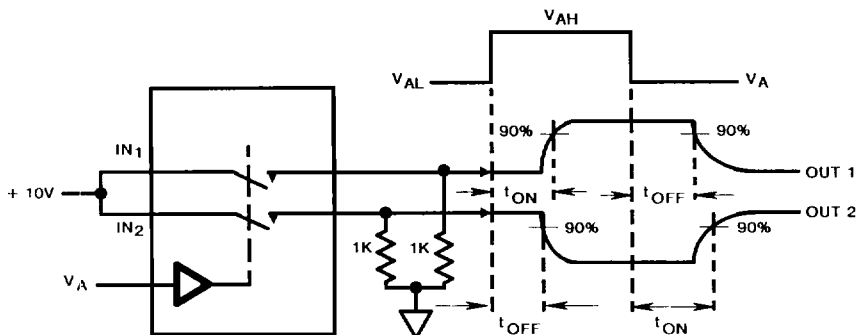
<p>R_{DS}</p>	<p>$I_S(OFF)$</p>	<p>$I_D(OFF)$</p>
<p>$I_D(ON)$</p>	<p>ADDRESS CURRENT</p>	<p>SUPPLY CURRENTS</p>
<p>OFF ISOLATION</p> <p>*OFF* ISOLATION = 20 LOG ($\frac{V_{IN}}{V_{OUT}}$)</p>	<p>CROSSTALK</p> <p>*CROSSTALK* = 20 LOG ($\frac{V_{IN}}{V_{OUT}}$)</p>	<p>CHARGE TRANSFER</p>

NOTE: Applies only to DUAL or DOUBLE THROW switches.

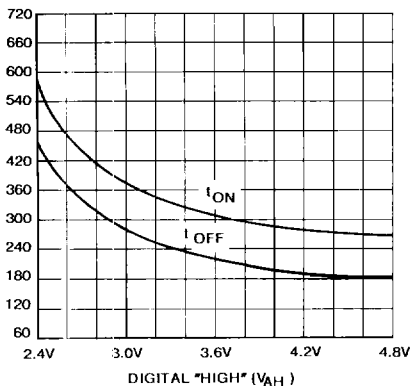
NOTE: V_{CTE} may be a positive or negative value.

Test Characteristics

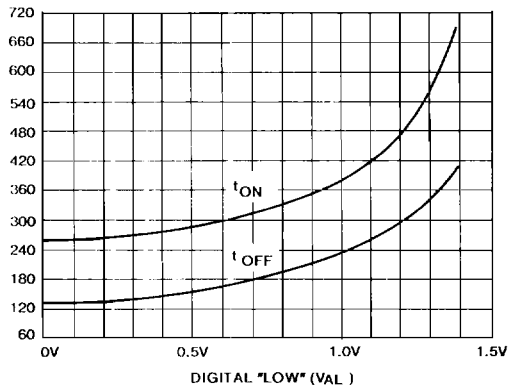
ON/OFF SWITCH TIME (t_{ON} , t_{OFF})



SWITCHING TIMES FOR POSITIVE DIGITAL TRANSITION

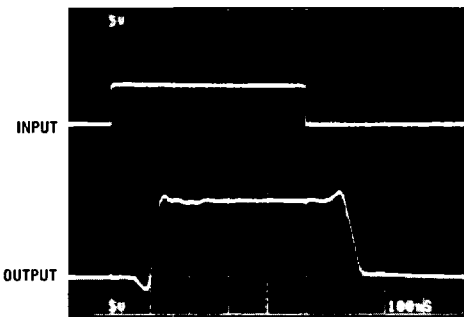


SWITCHING TIMES FOR NEGATIVE DIGITAL TRANSITION

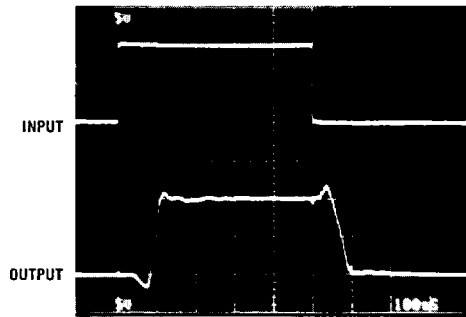


Test Waveforms

Vertical Scale: Input = 5V/Div., (TTL; $V_{AH} = 5V$, $V_{AL} = 0V$)
 Output = 5V/Div.
 Horizontal Scale: 100ns/Div.

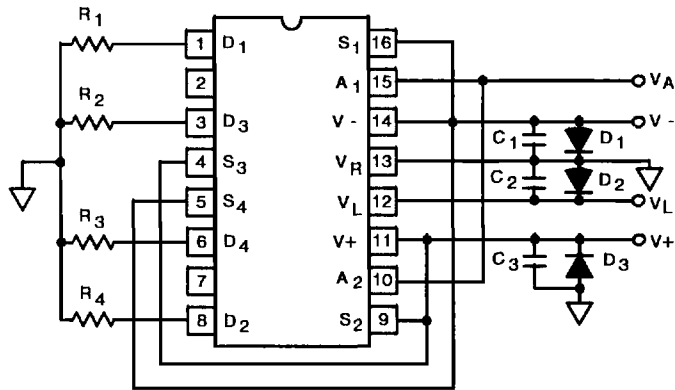


Vertical Scale: Input = 5V/Div., (CMOS; $V_{AH} = 10V$, $V_{AL} = 0V$)
 Output = 5V/Div.
 Horizontal Scale: 100ns/Div.



Burn-In Circuit

HI-5046/883 HI-5046A/883 CERAMIC DIP

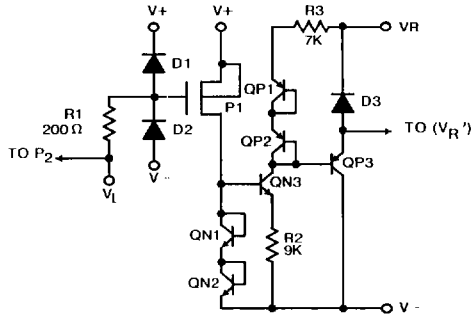


NOTES:

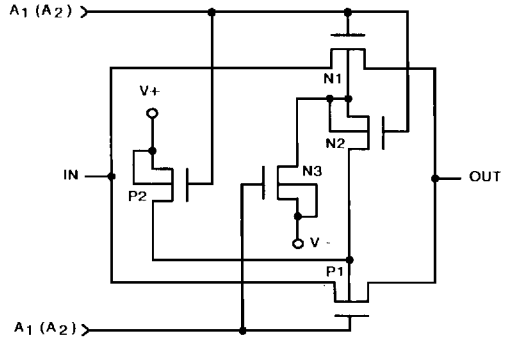
- R₁ thru R₄ = 10kΩ, ±5%, 1/4W (Min)
- C₁, C₂, C₃ = 0.01μF/Socket (Min) or 0.1μF/Row, (Min)
- D₁, D₂, D₃ = IN4002 or Equivalent/Board
- V_L = 5.5 ± 0.5V
- A₁ = A₂ = 5.5 ± 0.5V
- |V₊ - V₋| = 30V

Schematic Diagram

TTL/CMOS REFERENCE CIRCUIT *

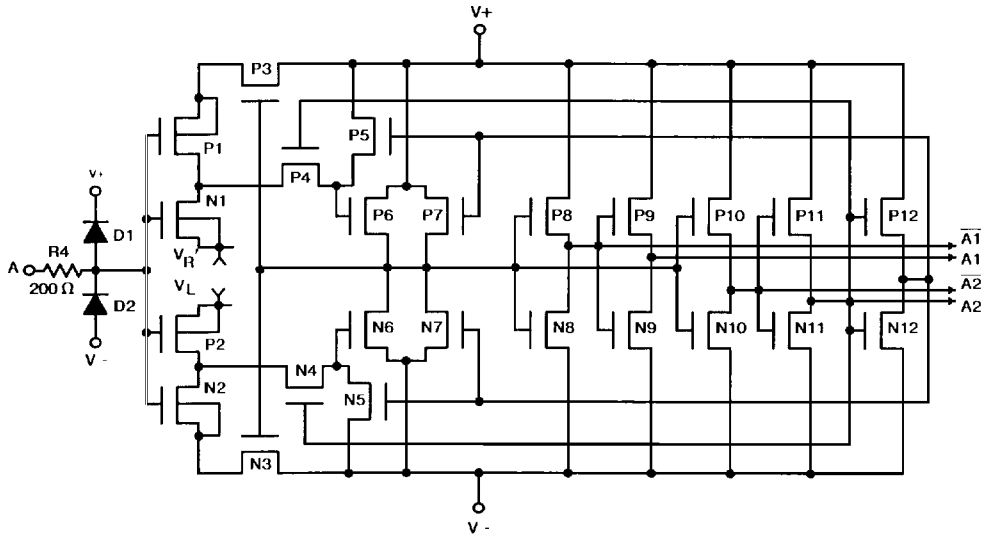


SWITCH CELL



* Connect $V+$ to V_L for minimizing power consumption when driving from CMOS circuits.

DIGITAL INPUT BUFFER AND LEVEL SHIFTER



All N-Channel Bodies to $V-$
 All P-Channel Bodies to $V+$
 Except as Shown

Die Characteristics

DIE DIMENSIONS:

96 x 81 x 19mils
(2430 x 2050 x 480µm)

METALLIZATION:

Type: Aluminum
Thickness: $16k\text{Å} \pm 2k\text{Å}$

GLASSIVATION:

Type: Nitride over Silox
Silox Thickness: $12k\text{Å} \pm 2k\text{Å}$
Nitride Thickness: $3.5k\text{Å} \pm 1k\text{Å}$

SUBSTRATE POTENTIAL (Powered-up): V-

DEVICE COUNT: 82

DIE ATTACH:

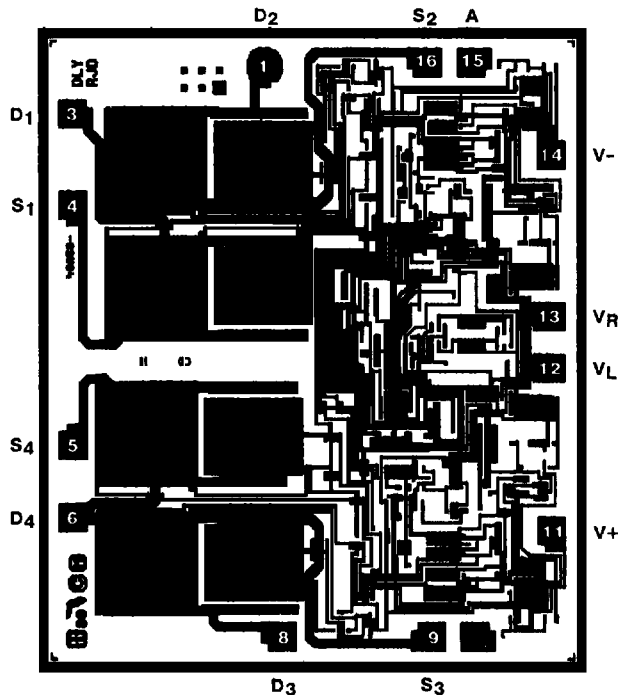
Material: Gold/Silicon Eutectic Alloy
Temperature: Ceramic DIP — 460°C (Max)

WORST CASE CURRENT DENSITY:

$1.0 \times 10^5 \text{A/cm}^2$ @ 20mA

Metallization Mask Layout

HI-5046/883 HI-5046A/883

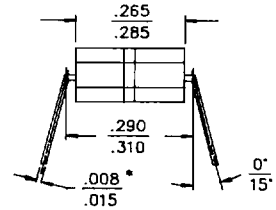
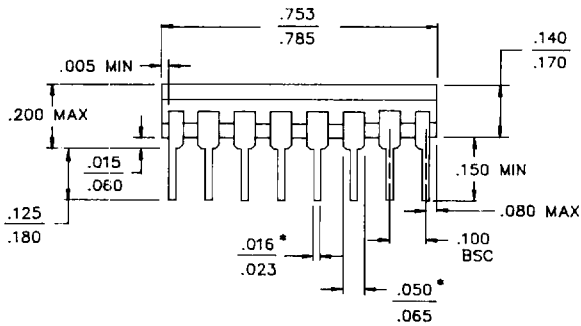


NOTE: Pin Numbers Correspond to DIP Package Only. Unused Pins May Be Connected. Ground All Unused Pins.

4
CMOS ANALOG SWITCHES

Packaging†

16 PIN CERAMIC DIP



* INCREASE MAX LIMIT BY .003 INCHES MEASURED AT CENTER OF FLAT FOR SOLDER FINISH

LEAD MATERIAL: Type B
LEAD FINISH: Type A
PACKAGE MATERIAL: Ceramic, 90% Alumina
PACKAGE SEAL:
 Material: Glass Frit
 Temperature: $450^\circ\text{C} \pm 10^\circ\text{C}$
 Method: Furnace Seal

INTERNAL LEAD WIRE:
 Material: Aluminum
 Diameter: 1.25 Mil
 Bonding Method: Ultrasonic
COMPLIANT OUTLINE: 38510 D-2

NOTE: All Dimensions are $\frac{\text{Min}}{\text{Max}}$, Dimensions are in inches.

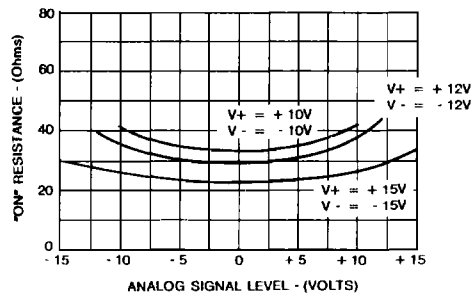
† Mil-M-38510 Compliant Materials, Finishes, and Dimensions.

DESIGN INFORMATION
DPDT CMOS Analog Switch

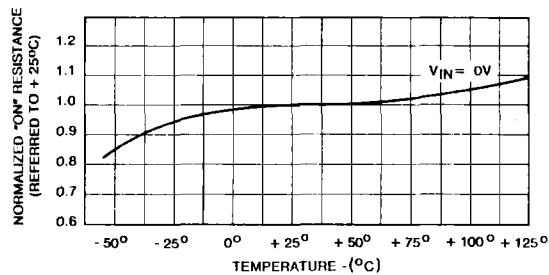
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design aid only. These characteristics are not 100% tested and no product guarantee is implied.

Typical Performance Curves Unless Otherwise Specified: $T_A = +25^\circ\text{C}$, $V_{\text{SUPPLY}} = \pm 15\text{V}$

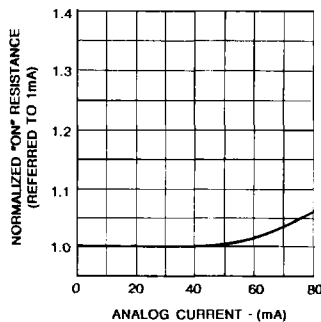
"ON" RESISTANCE vs. ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE



NORMALIZED "ON" RESISTANCE vs. TEMPERATURE



NORMALIZED "ON" RESISTANCE vs. ANALOG CURRENT

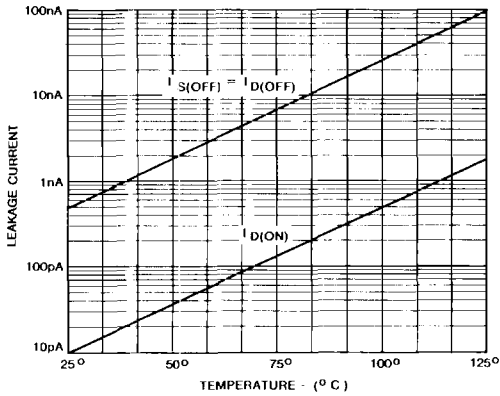


DESIGN INFORMATION (Continued)

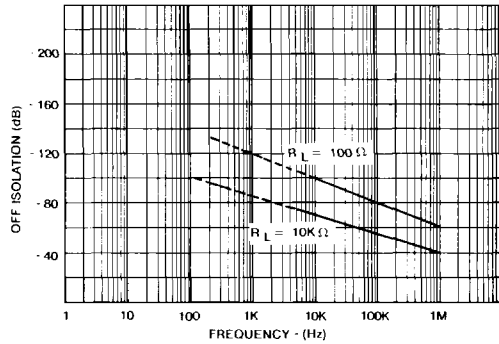
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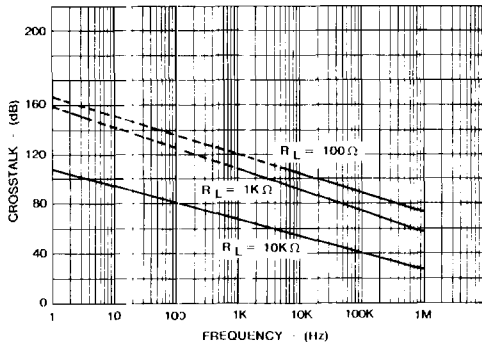
ON/OFF LEAKAGE CURRENT vs. TEMPERATURE



"OFF" ISOLATION vs. FREQUENCY



CROSSTALK vs. FREQUENCY



POWER CONSUMPTION vs. FREQUENCY

