

# DPDT CMOS Analog Switch

## HI-5046A/883

This CMOS analog switch offers 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°C and +75°C.  $R_{ON}$  is nominally 25Ω for the HI-5046A/883.

This device provides break-before-make switching and is 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°C). The HI-5046A/883 also features very low power operation (1.5mW at +25°C). The HI-5046A/883 is available in a 16 Ld CerDIP package and is specified over the temperature range of -55°C to +125°C.

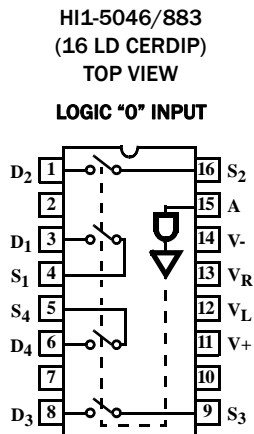
## Features

- 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 ..... ±15V
- Low "On" Resistance ..... 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 Analog
- Sample and Hold
- Digital Filters
- Operational Amplifier Gain Switching

## Pin Configuration

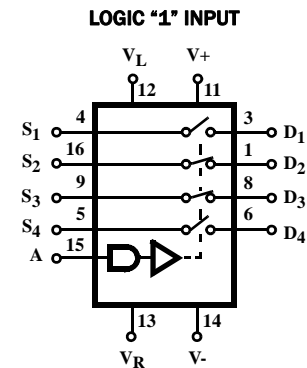


NOTE: Unused pins may be internally connected. Ground all unused pins.

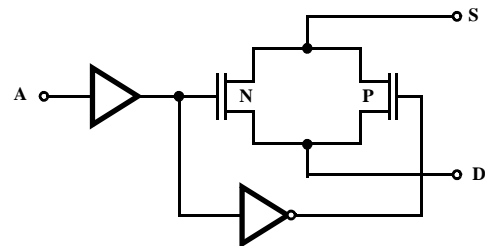
## Ordering Information

PART NUMBER	PART MARKING	TEMP. RANGE (°C)	PACKAGE	PKG. DWG. #
HI1-5046A/883	HI1-5046A/883	-55 to +125	16 Ld CerDIP	F16.3

## Functional Diagram



TYPICAL SWITCH



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

# HI-5046A/883

## Absolute Maximum Ratings

Voltage Between V+ and V- Terminals	36V
$\pm V_{\text{SUPPLY}}$ to Ground (V+, V-)	$\pm 18\text{V}$
$V_{\text{R}}$ to Ground	$-V_{\text{SUPPLY}}$
$V_{\text{L}}$ to Ground	$+V_{\text{SUPPLY}}$
Digital and Analog Input Voltage ( $V_{\text{A}}$ , $V_{\text{S}}$ , $V_{\text{D}}$ )	$+V_{\text{SUPPLY}}$ +4V $-V_{\text{SUPPLY}}$ -4V
Peak Current (Source to Drain) (Pulse at 1ms, 10% Duty Cycle Max)	70mA
Continuous Current Any Pin	20mA
ESD Rating	<2000V

## Thermal Information

Thermal Resistance	$\theta_{\text{JA}}$ ( $^{\circ}\text{C}/\text{W}$ )	$\theta_{\text{JC}}$ ( $^{\circ}\text{C}/\text{W}$ )
CerDIP Package	82	20
Package Power Dissipation at +75 $^{\circ}\text{C}$		
CerDIP Package	1.0W	
Package Power Dissipation Derating Factor above +75 $^{\circ}\text{C}$		
CerDIP Package	12.3mW/ $^{\circ}\text{C}$	
Junction Temperature	+175 $^{\circ}\text{C}$	
Storage Temperature Range	-65 $^{\circ}\text{C}$ to +150 $^{\circ}\text{C}$	
Lead Temperature (Soldering 10s)	+300 $^{\circ}\text{C}$	

## Recommended Operating Conditions

Operating Temperature Range	-55 $^{\circ}\text{C}$ to +125 $^{\circ}\text{C}$
Operating Supply Voltage Range	$\pm 15\text{V}$
Logic Supply Voltage ( $V_{\text{L}}$ )	+5.0V
Logic Reference Voltage ( $V_{\text{R}}$ )	0.0V
Analog Input Voltage ( $V_{\text{S}}$ )	$\pm V_{\text{SUPPLY}}$
Address Low Level ( $V_{\text{AL}}$ )	0V to 0.8V
Address High Level ( $V_{\text{AH}}$ )	2.4V to +5.0V

**CAUTION:** Do not operate at or near the maximum ratings listed for extended periods of time. Exposure to such conditions may adversely impact product reliability and result in failures not covered by warranty.

**TABLE 1. D.C. ELECTRICAL PERFORMANCE SPECIFICATIONS**

Device Tested at: Supply Voltage =  $\pm 15\text{V}$ ,  $V_{\text{L}}$  = +5.0V,  $V_{\text{R}}$  = 0.0V,  $V_{\text{AH}}$  = 2.4V,  $V_{\text{AL}}$  = +0.8V, unused pins are grounded, unless otherwise specified.

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE ( $^{\circ}\text{C}$ )	MIN	MAX	UNITS
Switch "ON" Resistance	$R_{\text{DS2}}$	$V_{\text{D}} = -10\text{V}$ , $I_{\text{S}} = 10\text{mA}$ S1/S2/S3/S4	1	+25	-	45	$\Omega$
			2, 3	-55 to +125	-	50	$\Omega$
		$V_{\text{D}} = 10\text{V}$ , $I_{\text{S}} = -10\text{mA}$ S1/S2/S3/S4	1	+25	-	45	$\Omega$
			2, 3	-55 to +125	-	50	$\Omega$
Source "OFF" Leakage Current	$I_{\text{S(OFF)}}$	$V_{\text{S}} = -10\text{V}$ , $V_{\text{D}} = 10\text{V}$ S1/S2/S3/S4	1	+25	-1	1	nA
			2, 3	-55 to +125	-100	100	nA
		$V_{\text{S}} = 10\text{V}$ , $V_{\text{D}} = -10\text{V}$ S1/S2/S3/S4	1	+25	-1	1	nA
			2, 3	-55 to +125	-100	100	nA
Drain "OFF" Leakage Current	$I_{\text{D(OFF)}}$	$V_{\text{D}} = -10\text{V}$ , $V_{\text{S}} = 10\text{V}$ S1/S2/S3/S4	1	+25	-1	1	nA
			2, 3	-55 to +125	-100	100	nA
		$V_{\text{D}} = 10\text{V}$ , $V_{\text{S}} = -10\text{V}$ S1/S2/S3/S4	1	+25	-1	1	nA
			2, 3	-55 to +125	-100	100	nA
Channel "ON" Leakage Current	$I_{\text{D(ON)}}$	$V_{\text{D}} = V_{\text{S}} = 10\text{V}$ S1/S2/S3/S4	1	+25	-2	2	nA
			2, 3	-55 to +125	-200	200	nA
		$V_{\text{D}} = V_{\text{S}} = -10\text{V}$ S1/S2/S3/S4	1	+25	-2	2	nA
			2, 3	-55 to +125	-200	200	nA
Low Level Address Current	$I_{\text{AL}}$	$V_{\text{A}} = 0\text{V}$	1	+25	-1	1	$\mu\text{A}$
			2, 3	-55 to +125	-10	1	$\mu\text{A}$
High Level Address Current	$I_{\text{AH}}$	$V_{\text{A}} = 2.4\text{V}, 5\text{V}$	1	+25	-1	1	$\mu\text{A}$
			2, 3	-55 to +125	-1	10	$\mu\text{A}$
Positive Supply Current	$+I_{\text{CC}}$	$V_{\text{A}} = 0\text{V}, 5\text{V}$	1	+25	-	200	$\mu\text{A}$
			2, 3	-55 to +125	-	300	$\mu\text{A}$
Negative Supply Current	$-I_{\text{CC}}$	$V_{\text{A}} = 0\text{V}, 5\text{V}$	1	+25	-200	-	$\mu\text{A}$
			2, 3	-55 to +125	-300	-	$\mu\text{A}$

# HI-5046A/883

**TABLE 1. D.C. ELECTRICAL PERFORMANCE SPECIFICATIONS (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 SUBGROUPS	TEMPERATURE (°C)	MIN	MAX	UNITS
Logic Supply Current	$+I_L$	$V_A = 0V, 5V$	1	+25	-	200	$\mu A$
			2, 3	-55 to +125	-	300	$\mu A$
Reference Supply Current	$+I_R$	$V_A = 0V, 5V$	1	+25	-200	-	$\mu A$
			2, 3	-55 to +125	-300	-	$\mu A$

**TABLE 2. A.C. ELECTRICAL PERFORMANCE SPECIFICATIONS**

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

**TABLE 3. ELECTRICAL PERFORMANCE SPECIFICATIONS (NOTE 1)**

Device Characterized at:  $+V_{SUPPLY} = +15V$ ,  $-V_{SUPPLY} = -15V$ ,  $GND = 0V$

PARAMETERS	SYMBOL	CONDITIONS	NOTE	TEMPERATURE (°C)	MIN	MAX	UNITS
"ON" Resistance Match (Channel to Channel)	$r_{ON2}$ Match	$V_D = \pm 10V$ $I_D = 10mA$	1	+25	-	10	$\Omega$
Address Capacitance	$C_A$	$V_A = 0V, 5V$	1	+25	-	45	pF
Switch Input Capacitance	$C_{S(OFF)}$	Switch Off: $V_A = 0V$	1	+25	-	60	pF
Switch Output Capacitance	$C_{D(OFF)}$	Switch Off: $V_A = 0V$	1	+25	-	60	pF
	$C_{D(ON)}$	Switch On: $V_A = 5V$	1	+25	-	60	pF
Drain to Source Capacitance	$C_{DS(OFF)}$	Switch Off: $V_A = 0V$	1	+25	-	10	pF
Off Isolation	$V_{ISO}$	$V_S = 2V_{P-P}$ @ $f = 100kHz$ , $R_L = 100\Omega$	1	+25	1	60	dB
Crosstalk	$V_{CT}$	$V_S = 2V_{P-P}$ @ $f = 100kHz$ , $R_L = 100\Omega$	1	+25	1	60	dB
Charge Transfer Error	$V_{CTE}$	$V_S = GND$ , $C_L = 0.01\mu F$ $V_A = 0V$ to $4V$ @ $f = 200kHz$	1	+25	-	30	mV

NOTE:

- 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 (Tables 1 and 2)
Interim Electrical Parameters (Pre Burn-in)	1
Final Electrical Test Parameters	1 (Note 2), 2, 3, 9, 10, 11
Group A Test Requirements	1, 2, 3, 9, 10, 11
Groups C & D Endpoints	1

NOTE:

- PDA applies to Subgroup 1 only.

Test Circuits

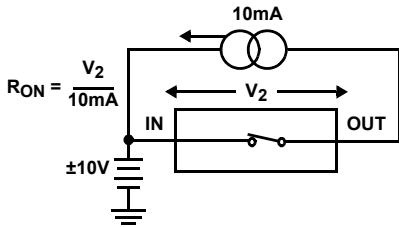


FIGURE 1.  $R_{DS}$

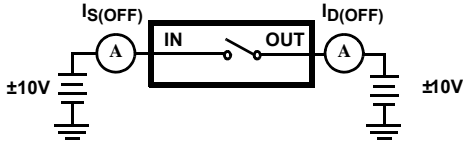


FIGURE 2.  $I_{S(OFF)}$

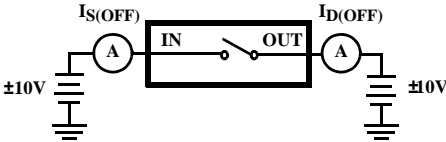


FIGURE 3.  $I_{D(OFF)}$

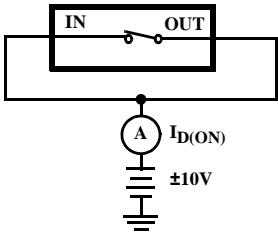


FIGURE 4.  $I_{D(ON)}$

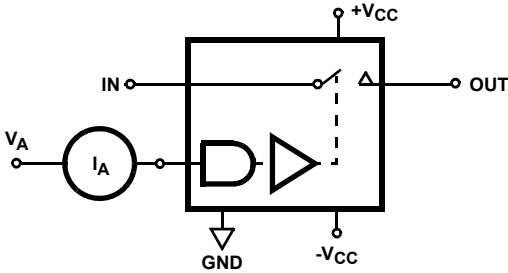


FIGURE 5. ADDRESS CURRENTS

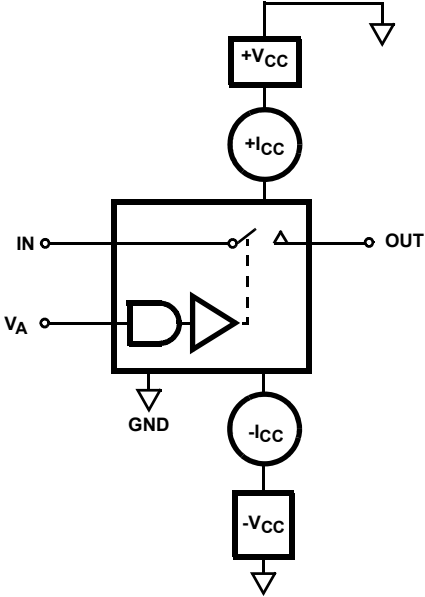


FIGURE 6. SUPPLY CURRENTS

**Test Circuits (Continued)**

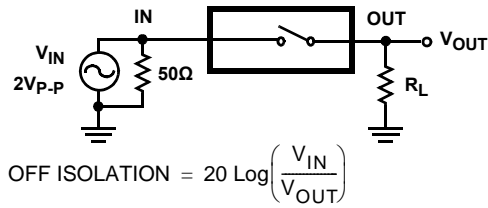
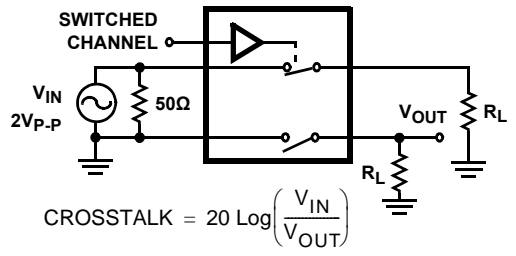
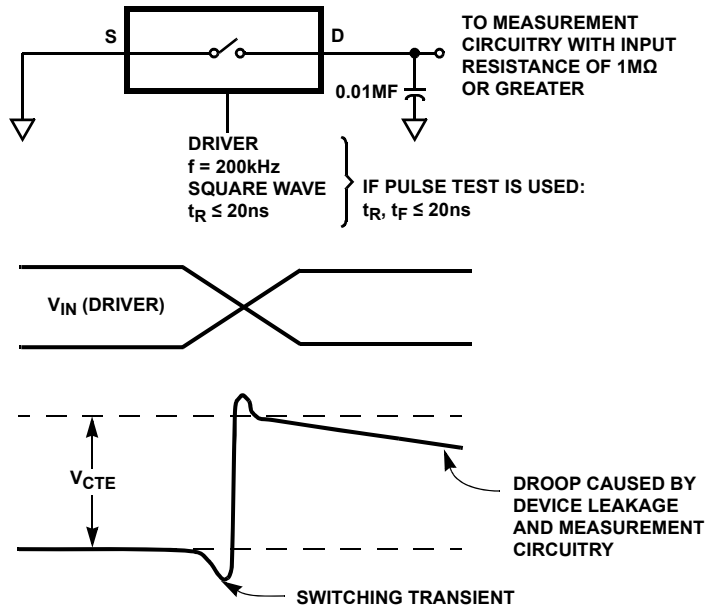


FIGURE 7. OFF ISOLATION



NOTE: Applies only to dual or double throw switches.

FIGURE 8. CROSSTALK



NOTE: V<sub>CTE</sub> may be a positive or negative value.

FIGURE 9. CHARGE TRANSFER

**Test Characteristics**

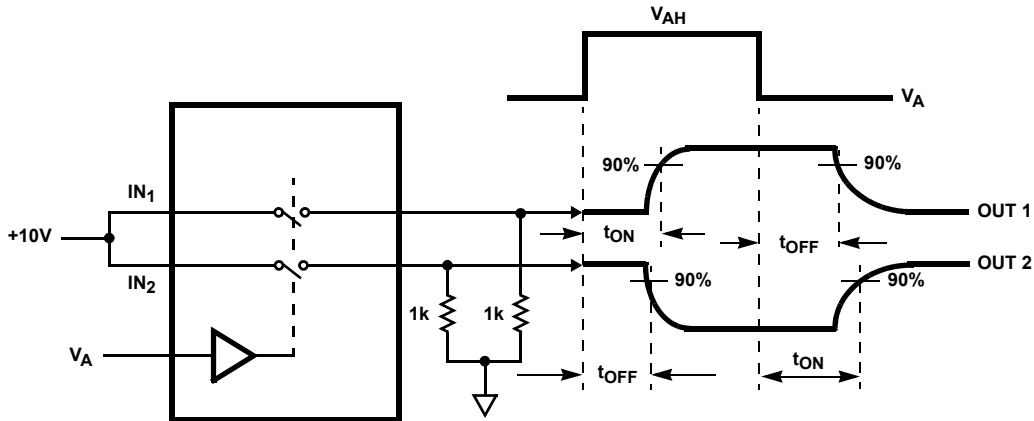


FIGURE 10. ON/OFF SWITCH TIME (t<sub>ON</sub>, t<sub>OFF</sub>)

**Test Characteristics** (Continued)

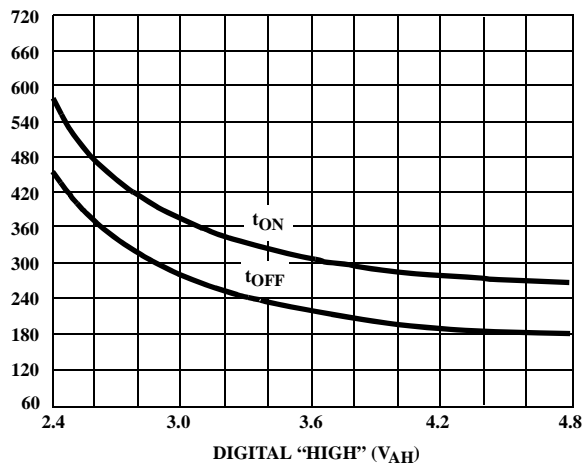


FIGURE 11. SWITCHING TIMES FOR DIGITAL TRANSITION

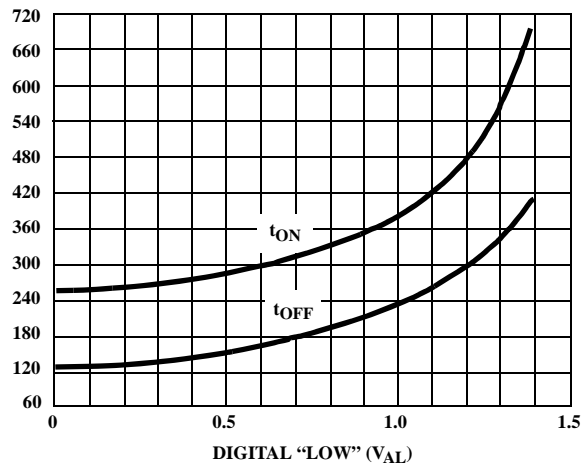
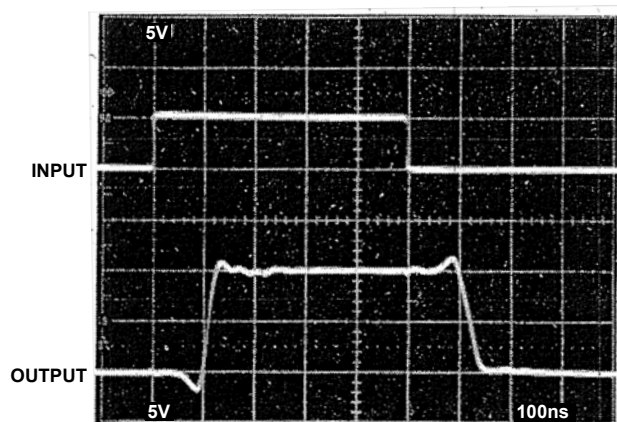


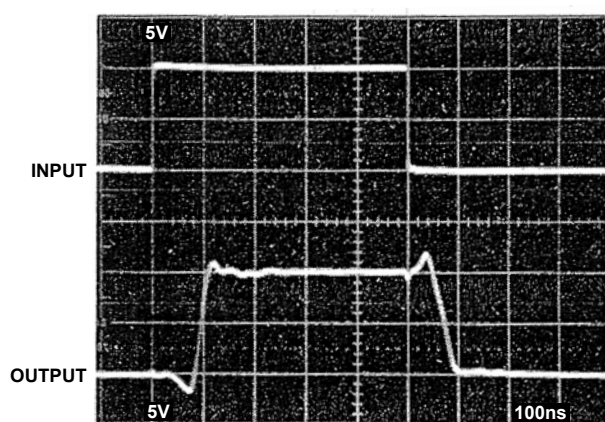
FIGURE 12. SWITCHING TIMES FOR NEGATIVE DIGITAL TRANSITION

**Test Waveforms**



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

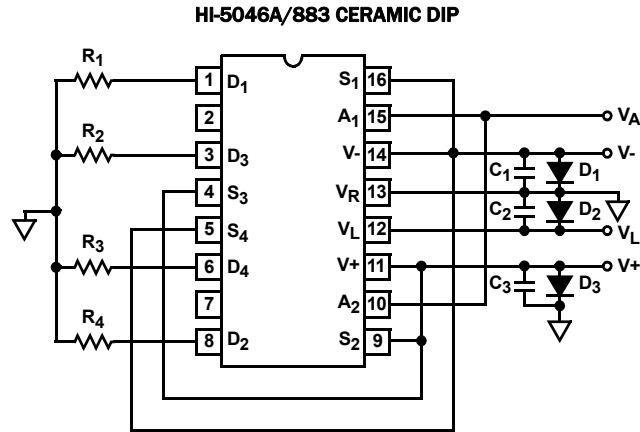
FIGURE 13.



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

FIGURE 14.

## Burn-In Circuit



**NOTES:**

$R_1$  thru  $R_4 = 10k\Omega, \pm 5\%, 1/4W$  (Min)

$C_1, C_2, C_3 = 0.01\mu F/\text{Socket}$  (Min) or  $0.1\mu F/\text{Row}$ , (Min)

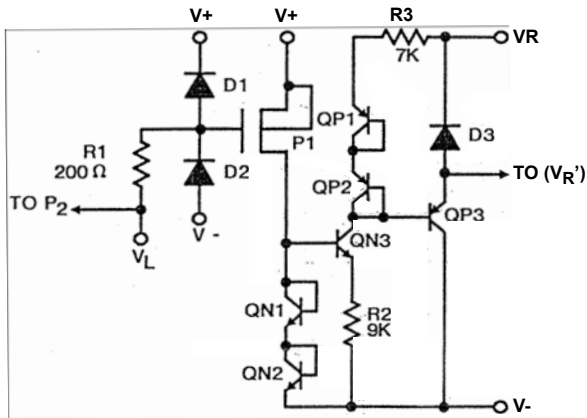
$D_1, D_2, D_3 = 1N4002$  or Equivalent/Board

$V_L = 5.5V \pm 0.5V$

$A_2 = A_2 = 5.5V \pm 0.5V$

$|(V+) - (V-)| = 30V$

Schematic Diagrams



NOTE: Connect V+ to V<sub>L</sub> for minimizing power consumption when driving from CMOS circuits.

FIGURE 15. TTL/CMOS REFERENCE CIRCUIT

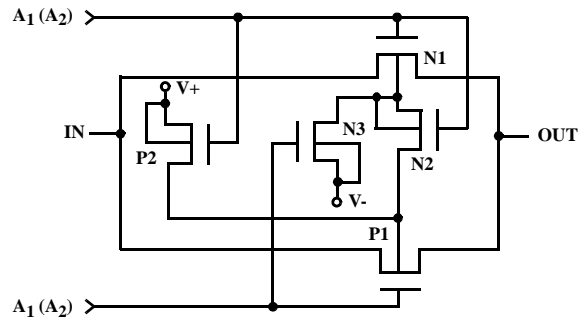
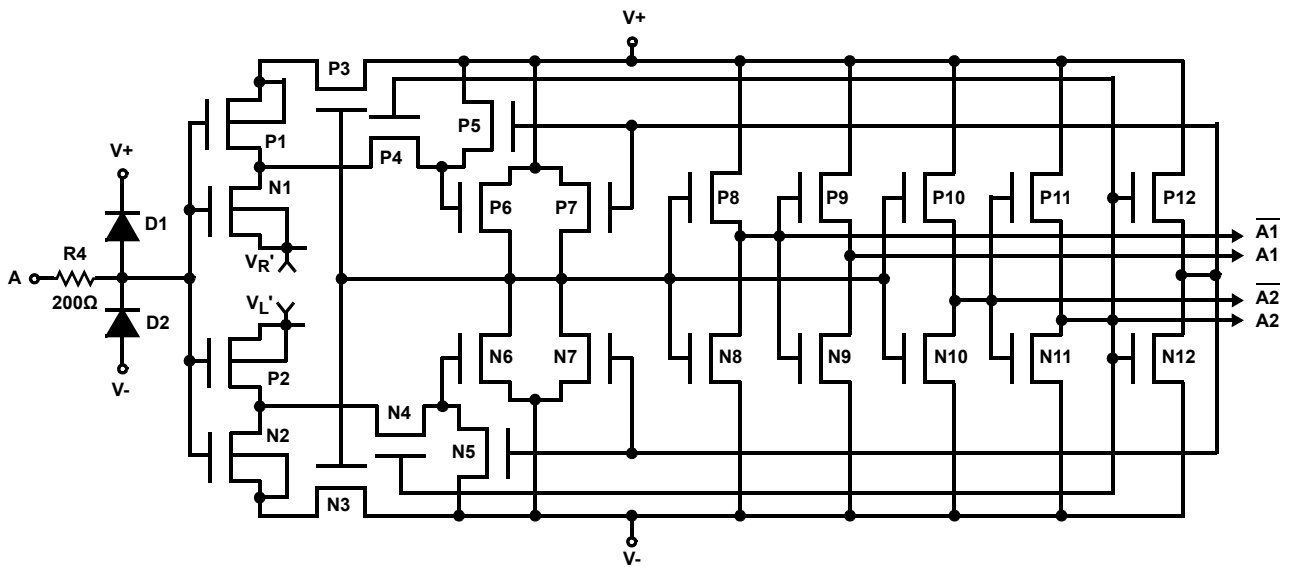


FIGURE 16. SWITCH CELL



All N-Channel bodies to V-, all P-Channel bodies to V+, except as shown.

DIGITAL INPUT BUFFER AND LEVEL SHIFTER



# HI-5046A/883

## Die Characteristics

### DIE DIMENSIONS:

96mils x 81mils x 19mils  
(2430 $\mu$ m x 2050 $\mu$ m x 480 $\mu$ m)

### METALLIZATION:

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

### GLASSIVATION:

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

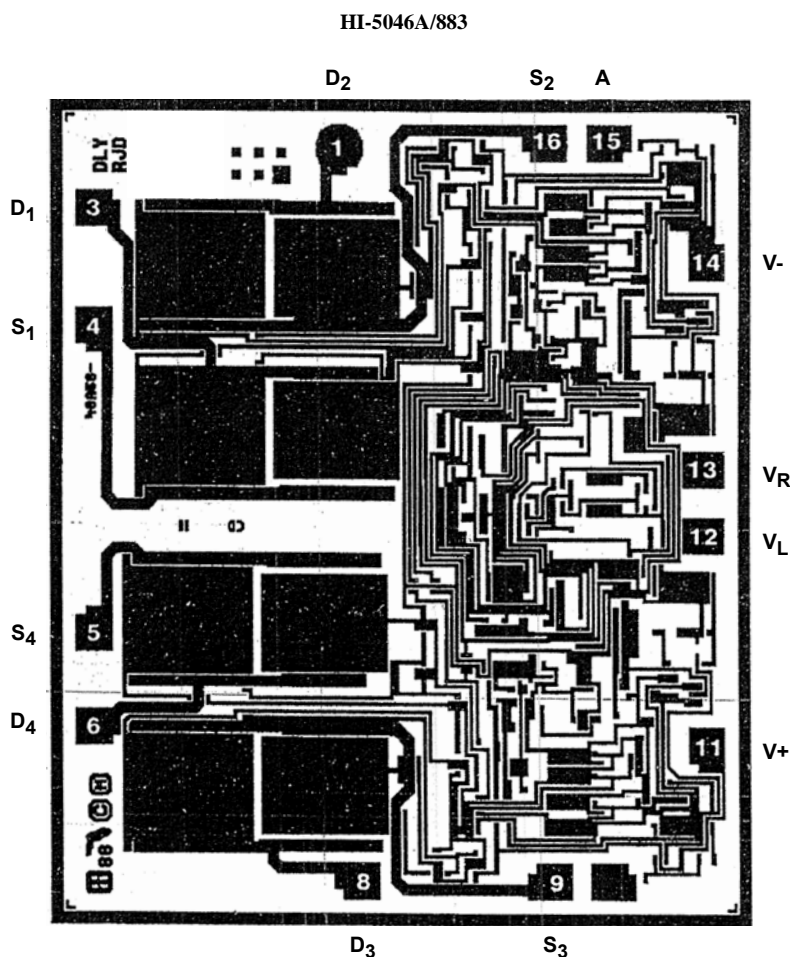
**SUBSTRATE POTENTIAL** (Powered-up): V-

**DEVICE COUNT:** 82

### WORST CASE CURRENT DENSITY:

1.0 x 10<sup>5</sup>A/cm<sup>2</sup> at 20mA

## Metallization Mask Layout



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

## Design Information

The information contained in this section has been developed through characterization and is for use as application and design information only. No guarantee is implied.

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

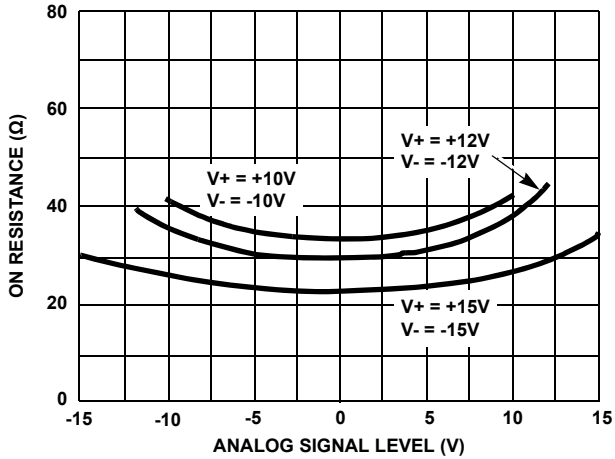


FIGURE 17. ON RESISTANCE vs ANALOG SIGNAL LEVEL AND POWER SUPPLY VOLTAGE

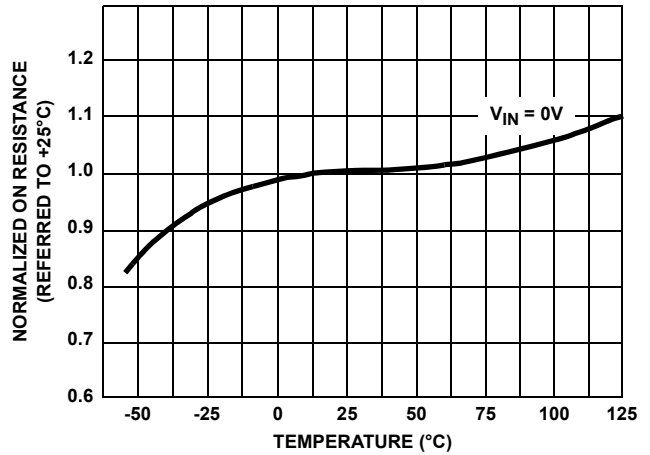


FIGURE 18. NORMALIZED ON RESISTANCE vs TEMPERATURE

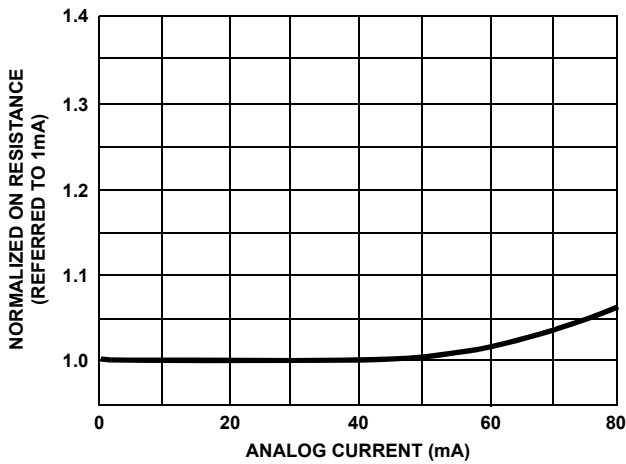


FIGURE 19. NORMALIZED ON RESISTANCE vs ANALOG CURRENT

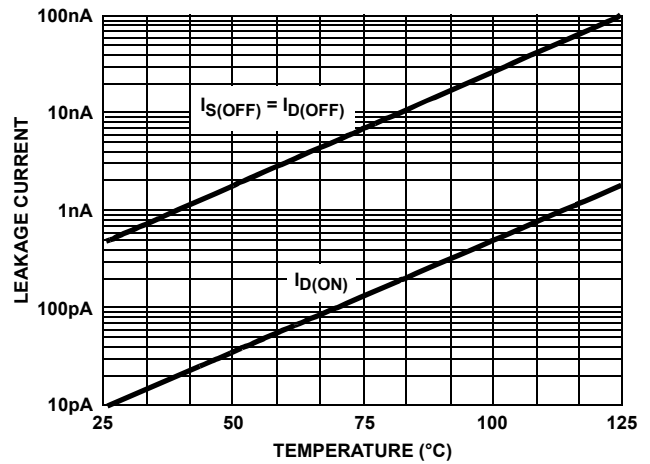


FIGURE 20. ON/OFF LEAKAGE CURRENTS vs TEMPERATURE

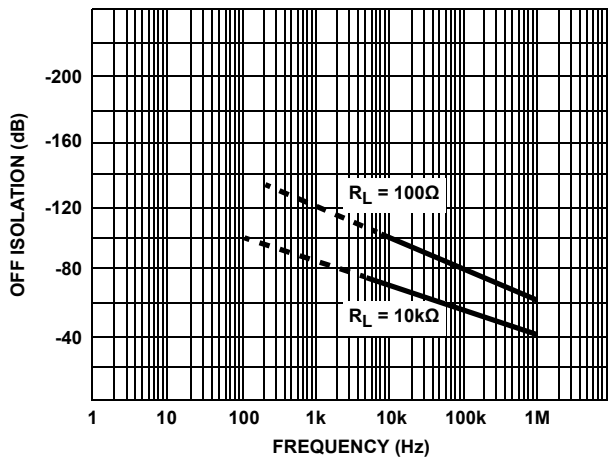


FIGURE 21. OFF ISOLATION vs FREQUENCY

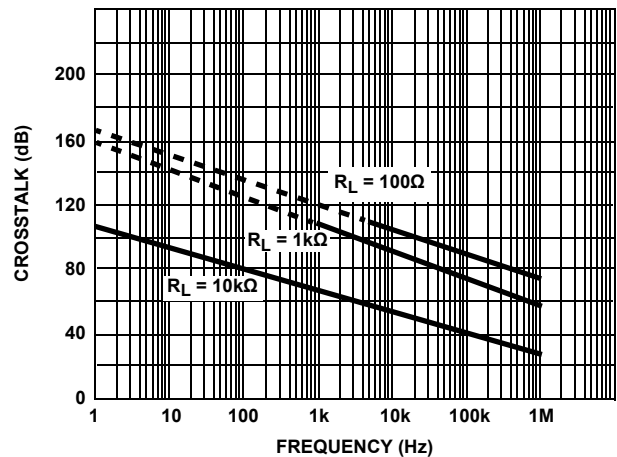
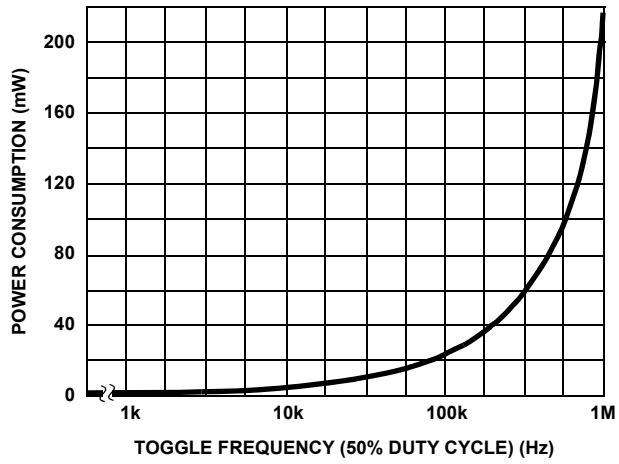


FIGURE 22. CROSSTALK vs FREQUENCY

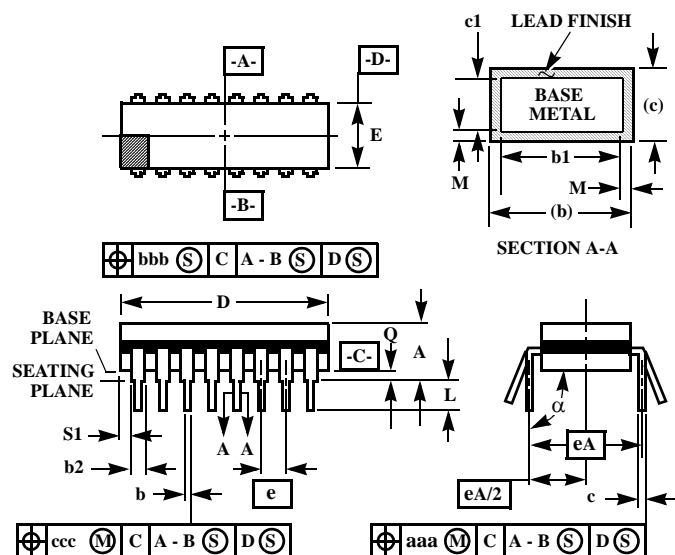
**Design Information** The information contained in this section has been developed through characterization and is for use as application and design information only. No guarantee is implied.

**Typical Performance Curves**  $T_A = +25^\circ\text{C}$ ,  $V_{\text{SUPPLY}} = \pm 15\text{V}$  (Continued)



**FIGURE 23. POWER CONSUMPTION vs FREQUENCY**

## Ceramic Dual-In-Line Frit Seal Packages (CERDIP)



### NOTES:

1. Index area: A notch or a pin one identification mark shall be located adjacent to pin one and shall be located within the shaded area shown. The manufacturer's identification shall not be used as a pin one identification mark.
2. The maximum limits of lead dimensions b and c or M shall be measured at the centroid of the finished lead surfaces, when solder dip or tin plate lead finish is applied.
3. Dimensions b1 and c1 apply to lead base metal only. Dimension M applies to lead plating and finish thickness.
4. Corner leads (1, N, N/2, and N/2+1) may be configured with a partial lead paddle. For this configuration dimension b3 replaces dimension b2.
5. This dimension allows for off-center lid, meniscus, and glass overrun.
6. Dimension Q shall be measured from the seating plane to the base plane.
7. Measure dimension S1 at all four corners.
8. N is the maximum number of terminal positions.
9. Dimensioning and tolerancing per ANSI Y14.5M - 1982.
10. Controlling dimension: INCH.

**F16.3 MIL-STD-1835 GDIP1-T16 (D-2, CONFIGURATION A)  
16 LEAD CERAMIC DUAL-IN-LINE FRIT SEAL PACKAGE**

SYMBOL	INCHES		MILLIMETERS		NOTES
	MIN	MAX	MIN	MAX	
A	-	0.200	-	5.08	-
b	0.014	0.026	0.36	0.66	2
b1	0.014	0.023	0.36	0.58	3
b2	0.045	0.065	1.14	1.65	-
b3	0.023	0.045	0.58	1.14	4
c	0.008	0.018	0.20	0.46	2
c1	0.008	0.015	0.20	0.38	3
D	-	0.840	-	21.34	5
E	0.220	0.310	5.59	7.87	5
e	0.100 BSC		2.54 BSC		-
eA	0.300 BSC		7.62 BSC		-
eA/2	0.150 BSC		3.81 BSC		-
L	0.125	0.200	3.18	5.08	-
Q	0.015	0.060	0.38	1.52	6
S1	0.005	-	0.13	-	7
$\alpha$	90°	105°	90°	105°	-
aaa	-	0.015	-	0.38	-
bbb	-	0.030	-	0.76	-
ccc	-	0.010	-	0.25	-
M	-	0.0015	-	0.038	2, 3
N	16		16		8

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