HARRIS

HI-301/883

January 1989

SPDT 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.**
- **Analog Signal Range (±15V Supplies) ..... ±15V**
- **Low Leakage (+25°C) ..... 1nA (Max)**
- **Low Leakage (+125°C) ..... 100nA (Max)**
- **Low ON Resistance ..... 50Ω (Max)**
- **Charge Injection ..... 30pC (Typ)**
- **TTL Compatible**
- **Symmetrical Switch Elements**
- **Low Operating Power**
- **Compatible with DG301**

Applications

- **Sample and Hold, i.e. Low Leakage Switching**
- **Op Amp Gain Switching, i.e. Low ON Resistance**
- **Portable, Battery Operated Circuits**
- **Low Level Switching Circuits**
- **Dual or Single Supply Systems**

Description

The HI-301/883 switch is monolithic devices fabricated using CMOS technology and the Harris Dielectric Isolation process. This switch features break-before-make switching, low and nearly constant ON resistance over the full analog signal range, and low power dissipation.

The HI-301/883 is TTL compatible and has a logic "0" condition with an input less than 0.8V and a logic "1" condition with an input greater than 4.0V.

The HI-301/883 is pin-for-pin compatible with the industry standard Siliconix DG301. The device is available in a 14 pin Ceramic DIP and in a 10 pin Metal Can. The HI-301/883 operates over the -55°C to +125°C temperature range.

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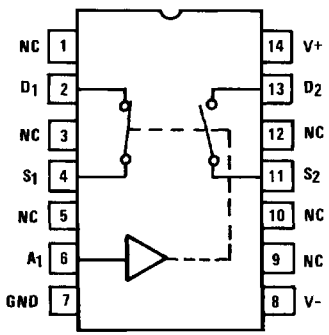
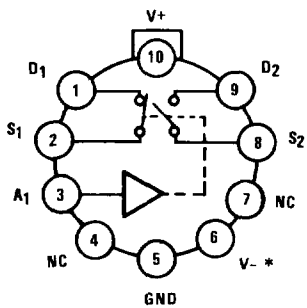
CMOS ANALOG SWITCHES

Pinouts

HI1-301/883 (CERAMIC DIP)
TOP VIEW



HI2-301/883 (METAL CAN)
TOP VIEW



LOGIC	SW 1	SW 2
0	OFF	ON
1	ON	OFF

*The substrate and case are internally tied to V-. (The case should not be used as the V- connection, however.)

Absolute Maximum Ratings

Voltage Between V+ and V- Terminals 44V
$\pm V_{SUPPLY}$ to Ground (V+, V-) ..... $\pm$22V
Analog Input Voltage $+V_S$ ..... $+V_{SUPPLY}$ +1.5V
$-V_S$ ..... $-V_{SUPPLY}$ -1.5V
Digital Input Voltage $+V_A$ ..... $+V_{SUPPLY}$ +4V
$-V_A$ ..... $-V_{SUPPLY}$ -4V
Peak Current (S or D)
(Pulse at 1ms, 10% Duty Cycle Max) 40mA
Continuous Current 30mA
Junction Temperature ..... +175°C
Storage Temperature Range ..... -65°C to +150°C
Lead Temperature (Soldering 10 sec) ..... ≤275°C

Thermal Information

Thermal Resistance	θ_{ja}	θ_{jc}
Ceramic DIP Package	98°C/W	30°C/W
Metal Can Package	117°C/W	35°C/W

Package Power Dissipation at +75°C
Ceramic DIP Package 0.77W
Metal Can Package 0.64W
Package Power Dissipation Derating Factor Above +75°C
Ceramic DIP Package ..... 10.32mW/°C
Metal Can Package ..... 8.56mW/°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
Operating Supply Voltage ($\pm V_{SUPPLY}$) ..... $\pm$15V
Analog Input Voltage (V_S) ..... $\pm V_{SUPPLY}$
Logic Low Level (V_{AL}) ..... 0V to 0.8V
Logic High Level (V_{AH}) ..... 4.0V to $+V_{SUPPLY}$

TABLE 1. D.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, GND = 0V, Unless Otherwise Specified

D.C. PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Switch "ON" Resistance	R_{DS}	V_A = 4.0V, V_D = 10V, I_S = -10mA S1/S2	1	+25°C	-	50	Ω
			2, 3	-55°C to +125°C	-	75	Ω
		V_A = 4.0V, V_D = -10V, I_S = 10mA S1/S2	1	+25°C	-	50	Ω
			2, 3	-55°C to +125°C	-	75	Ω
Source "OFF" Leakage Current	$I_{S(OFF)}$	V_S = +14V, V_D = -14V, V_A = 0.8V S1/S2	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		V_S = -14V, V_D = +14V, V_A = 0.8V S1/S2	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Drain "OFF" Leakage Current	$I_{D(OFF)}$	V_S = +14V, V_D = -14V, V_A = 0.8V S1/S2	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		V_S = -14V, V_D = +14V, V_A = 0.8V S1/S2	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 = +14V, V_A = 4.0V S1/S2	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
		V_D = V_S = -14V, V_A = 4.0V S1/S2	1	+25°C	-1	1	nA
			2, 3	-55°C to +125°C	-100	100	nA
Low Level Input Current	I_{AL}	All Channels V_A = 0.8V	1	+25°C	-1.0	1.0	µA
			2, 3	-55°C to +125°C	-1.0	1.0	µA
High Level Input Current	I_{AH}	All Channels V_A = 4.0V	1	+25°C	-1.0	1.0	µA
			2, 3	-55°C to +125°C	-1.0	1.0	µA
Supply Current	$+I_{CC}$	All Channels V_A = 0.8V	1	+25°C	-	10	µA
			2, 3	-55°C to +125°C	-	100	µA
		V_A = 4.0V	1	+25°C	-	0.5	mA
			2, 3	-55°C to +125°C	-	1.0	mA
Supply Current	$-I_{CC}$	All Channels V_A = 0.8V	1	+25°C	-10	-	µA
			2, 3	-55°C to +125°C	-100	-	µA
		V_A = 4.0V	1	+25°C	-10	-	µA
			2, 3	-55°C to +125°C	-100	-	µA

CAUTION: These devices are sensitive to electrostatic discharge. Proper I.C. handling procedures should be followed.

TABLE 2. A.C. ELECTRICAL PERFORMANCE CHARACTERISTICS

Device Tested at: $+V_{SUPPLY}$ = +15V, $-V_{SUPPLY}$ = -15V, GND = 0V, Unless Otherwise Specified

PARAMETERS	SYMBOL	CONDITIONS	GROUP A SUBGROUPS	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Turn "ON" Time	$t_{(ON)}$	C_L = 33pF, R_L = 300Ω	9	+25°C	-	300	ns
			10, 11	-55°C, +125°C	-	500	ns
Turn "OFF" Time	$t_{(OFF)}$	C_L = 33pF, R_L = 300Ω	9	+25°C	-	250	ns
			10, 11	-55°C, +125°C	-	450	ns

TABLE 3. ELECTRICAL PERFORMANCE CHARACTERISTICS (NOTE 1)

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

PARAMETERS	SYMBOL	CONDITIONS	NOTE	TEMPERATURE	LIMITS MIN	LIMITS MAX	UNITS
Switch Input Capacitance	$C_{IS(OFF)}$	Measured Source to GND	1	+25°C	-	28	pF
Driver Input Capacitance	C_{C1}	V_A = 0V	1	+25°C	-	10	pF
	C_{C2}	V_A = 15V	1	+25°C	-	10	pF
Switch Output Capacitance	C_{OS}	Measured Drain to GND	1	+25°C	-	28	pF
Off Isolation	V_{ISO}	f = 1MHz, V_{GEN} = $1V_{p-p}$	1	+25°C	40	-	dB
Crosstalk	V_{CT}	f = 1MHz, V_{GEN} = $1V_{p-p}$	1	+25°C	40	-	dB
Charge Transfer	V_{CTE}	V_S = GND, C_L = 0.01µF	1	+25°C	-	15	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.

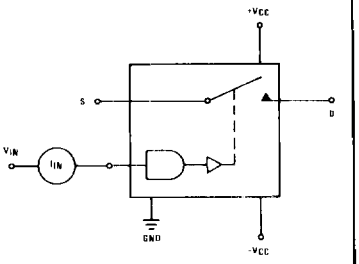
TABLE 4. ELECTRICAL TEST REQUIREMENTS

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

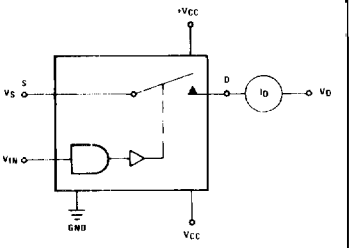
* PDA applies to Subgroup 1 only.

Test Circuits

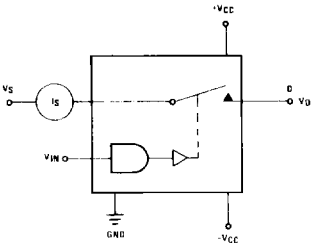
INPUT LEAKAGE CURRENT



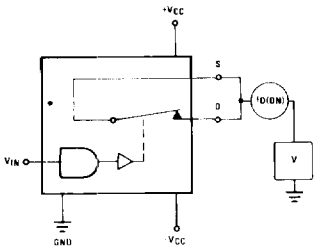
$I_{D(OFF)}$



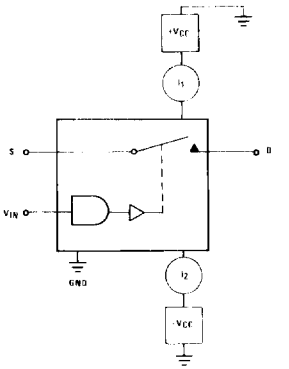
$I_{S(OFF)}$



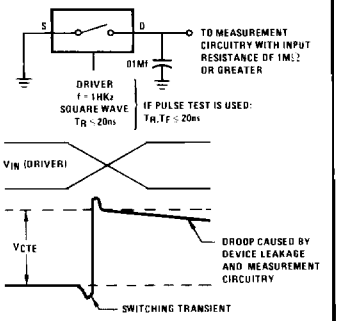
$I_{D(ON)}$



SUPPLY CURRENTS

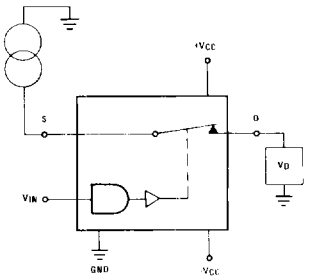


CHARGE TRANSFER ERROR

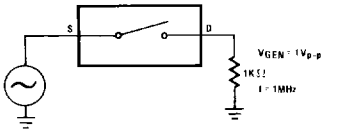


NOTE: V_{CTE} may be a positive or negative value

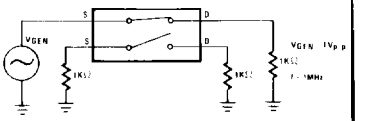
R_{DS}



OFF CHANNEL ISOLATION

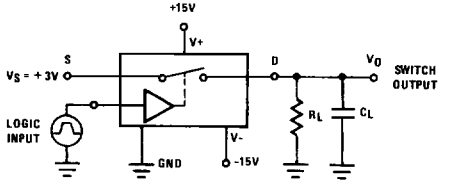


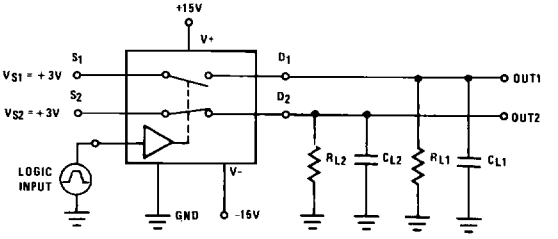
CROSSTALK BETWEEN CHANNELS

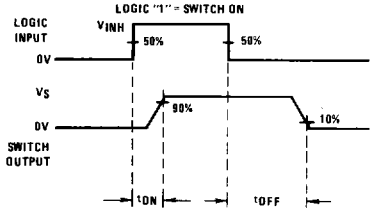


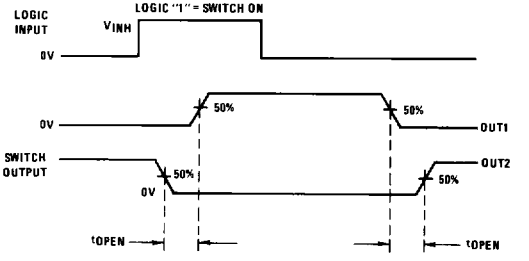
For Detail Information Refer to HI-301/883 Test Tech Brief

Test Waveforms







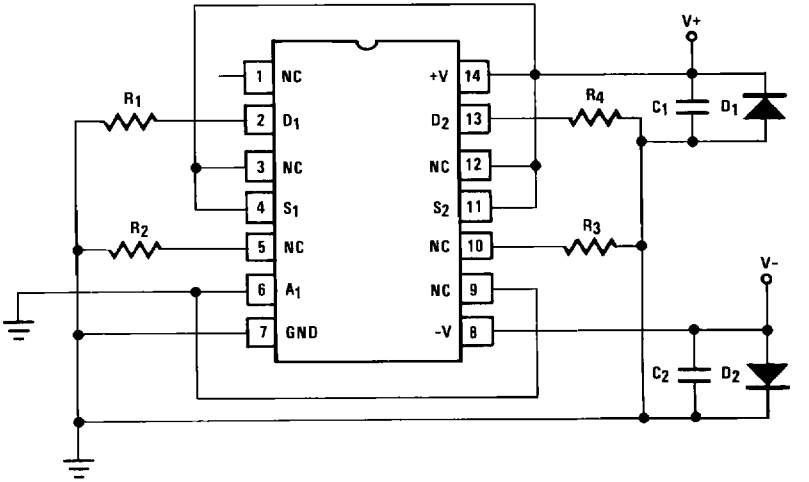


NOTES:

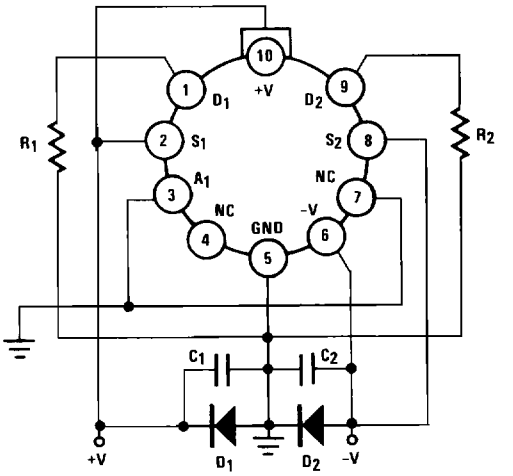
1. $R_L = R_L1 = R_L2 = 300\Omega$; $C_L = C_L1 = C_L2 = 33pF$
2. $V_{INH} = 4V$
   RISETIME (0.4V to 3.6V) $\leq$ 20ns
   FALLTIME (3.6V to 0.4V) $\leq$ 20ns

Burn-In Circuits

HI-301/883 CERAMIC DIP



HI-301/883 METAL CAN

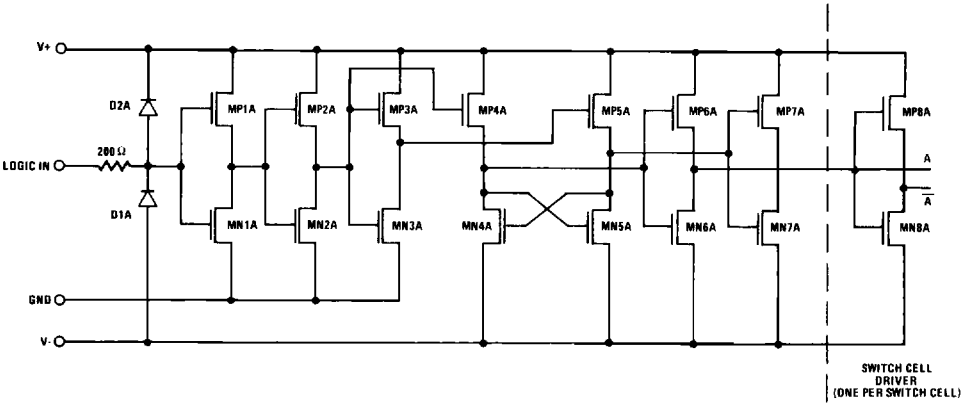


NOTES:

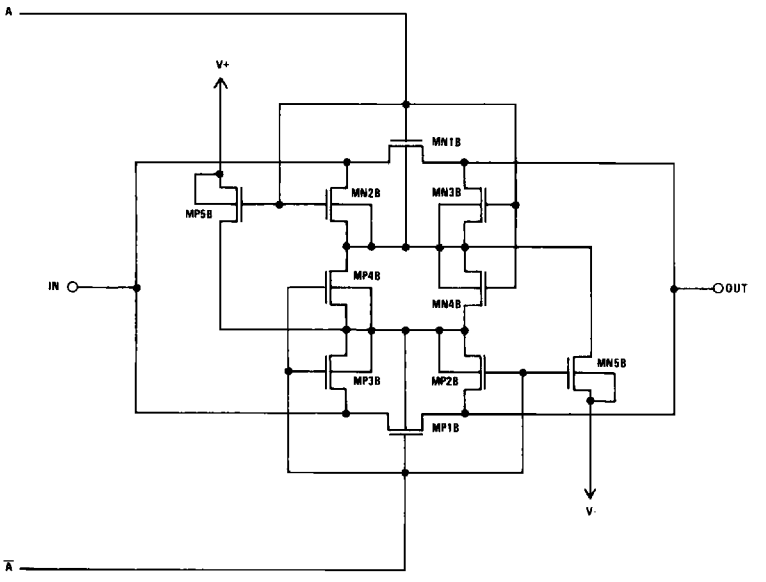
$R_1 = R_2 = R_3 = R_4 = 10K\Omega, \pm 5\%$ (per socket)
$C_1 = C_2 = 0.01\mu F$ (per socket) or $0.1\mu F$ (per row)
$D_1 = D_2 =$ IN4002 or Equivalent/Board
$|(V+) - (V-)| = 30V$

Schematic Diagram

DIGITAL INPUT BUFFER AND LEVEL SHIFTER



SWITCH CELL



Die Characteristics

DIE DIMENSIONS:
76 x 60.6 x 19 mils

METALLIZATION:
Type: Aluminum
Thickness: 16kÅ ± 2kÅ

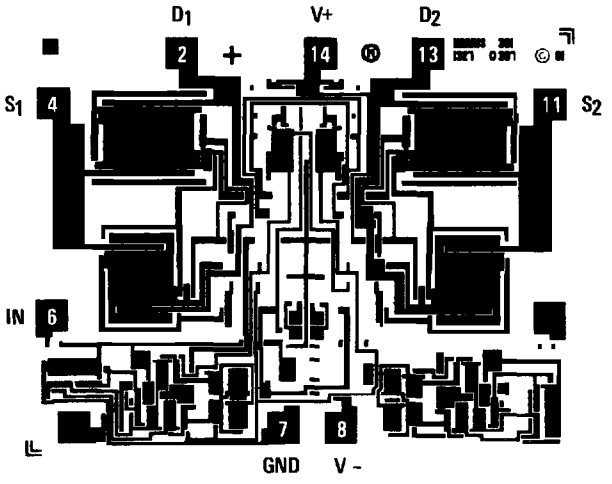
GLASSIVATION:
Type: Nitride
Thickness: 7kÅ ± 0.7kÅ

DIE ATTACH:
Material: Gold/Silicon Eutectic Alloy
Temperature: Ceramic DIP — 460°C (Max)
Metal Can — 420°C (Max)

WORST CASE CURRENT DENSITY:
$3.9 \times 10^5 A/cm^2$ at 30mA
This device meets Glassivation Integrity Test requirement per Mil-Std-883 Method 2021 and Mil-M-38510 paragraph 3.5.5.4.

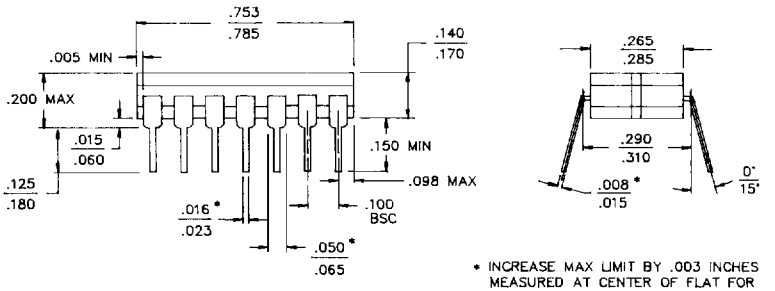
Metallization Mask Layout

HI-301/883



Packaging†

14 PIN CERAMIC DIP

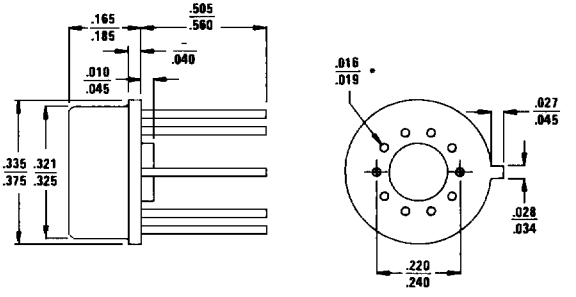


* INCREASE MAX LIMIT BY .003 INCHES MEASURED AT CENTER OF FLAT FOR SOLDER FINISH

LEAD MATERIAL: Type B
LEAD FINISH: Type A
PACKAGE MATERIAL: Ceramic, 90% Alumina
PACKAGE SEAL:
Material: Glass Frit
Temperature: 450°C ± 10°C
Method: Furnace Seal

INTERNAL LEAD WIRE:
Material: Aluminum
Diameter: 1.25 Mil
Bonding Method: Ultrasonic
COMPLIANT OUTLINE: 38510 D-1

10 PIN METAL CAN



* Maximum Limits are Increased by 0.003 inches for Solder Dip Finish.

LEAD MATERIAL: Type A
LEAD FINISH: Type C
PACKAGE MATERIAL: Kovar Header with Nickel Can
PACKAGE SEAL:
Material: No Seal Material
Temperature: Room Temperature
Method: Resistance Weld

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

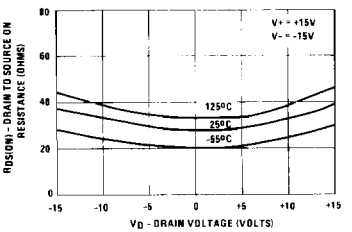
NOTE: All Dimensions are $\frac{\text{Min}}{\text{Max}}$, Dimensions are in inches.

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

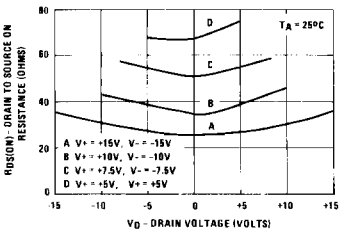
The information contained in this section has been developed through characterization by Harris Semiconductor and is for use as application and design data only. No guarantee is implied.

Typical Performance Characteristics Unless Otherwise Specified: V+ = +15V, V- = -15V, T_A = +25°C

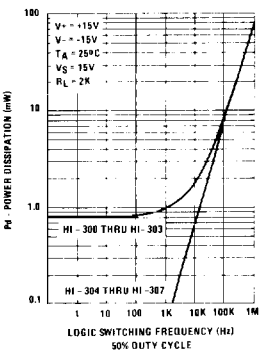
$R_{DS(ON)}$ vs. V_D AND TEMPERATURE



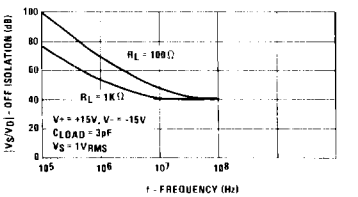
$R_{DS(ON)}$ vs. V_D AND POWER SUPPLY VOLTAGE



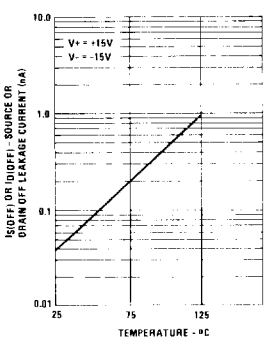
DEVICE POWER DISSIPATION vs. SWITCHING FREQUENCY SIGNAL LOGIC INPUT



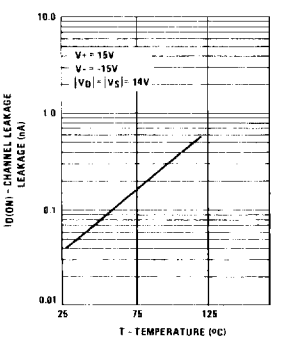
OFF ISOLATION vs. FREQUENCY



$I_{S(OFF)}$ or $I_{D(OFF)}$ vs. TEMPERATURE*



$I_{D(ON)}$ vs. TEMPERATURE*



* The net leakage into the source or drain is the N-channel leakage minus the P-channel leakage. This difference can be positive, negative, or zero depending on the analog voltage and temperature, and will vary greatly from unit to unit.

DESIGN INFORMATION (Continued)

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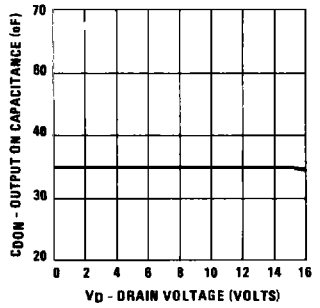
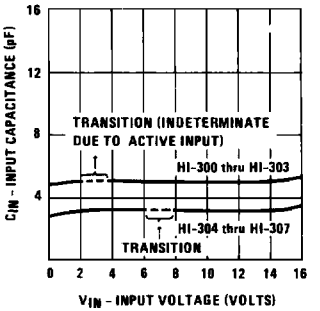
Typical Performance Characteristics Unless Otherwise Specified: V+ = +15V, V- = -15V, T_A = +25°C

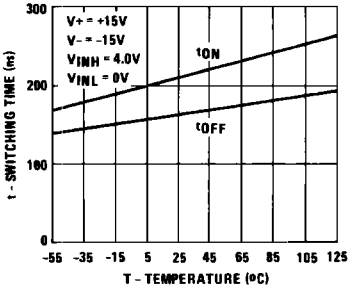
OUTPUT ON CAPACITANCE vs. DRAIN VOLTAGE



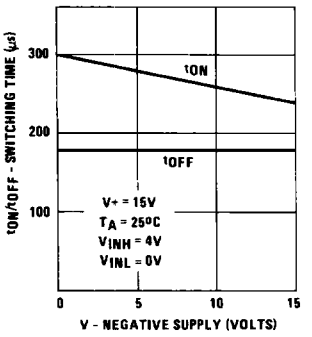
DIGITAL INPUT CAPACITANCE vs. INPUT VOLTAGE



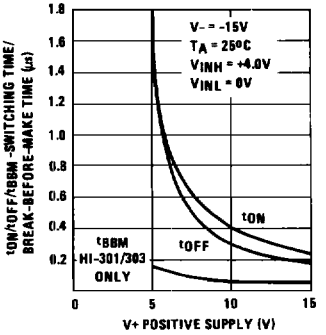
SWITCHING TIME vs. TEMPERATURE



SWITCHING TIME vs. NEGATIVE SUPPLY VOLTAGE



SWITCHING TIME AND BREAK BEFORE MAKE TIME vs. POSITIVE SUPPLY VOLTAGE



INPUT SWITCHING TIME THRESHOLD vs. POSITIVE SUPPLY VOLTAGE