

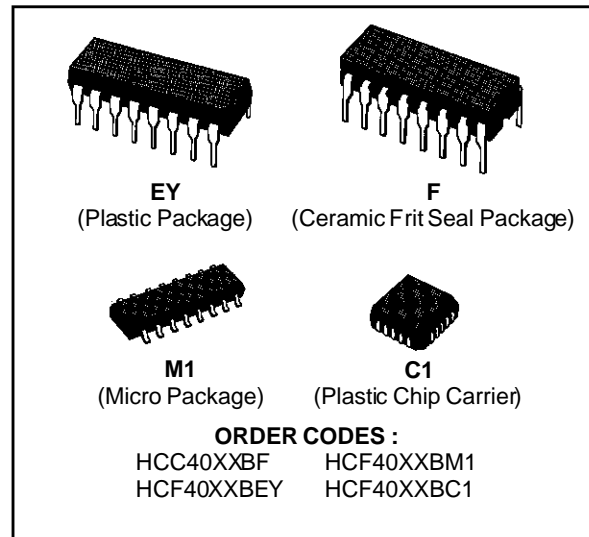
ANALOG MULTIPLEXERS-DEMULTIPLEXERS

4051B - SINGLE 8-CHANNEL

4052B - DIFFERENTIAL 4-CHANNEL

4053B - TRIPLE 2-CHANNEL

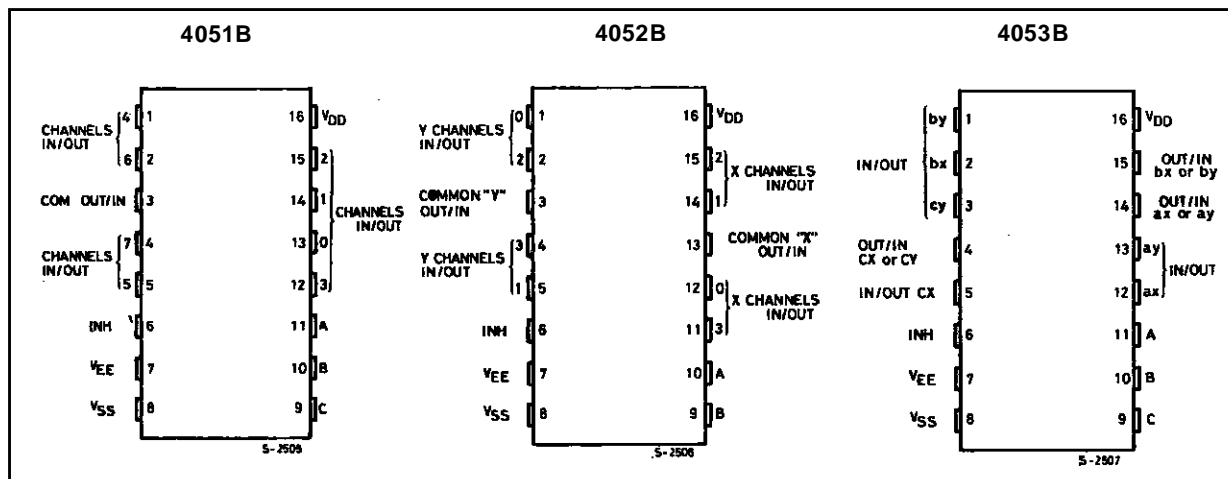
- QUIESCENT CURRENT SPECIFIED TO 20V FOR HCC DEVICE
- LOW "ON" RESISTANCE : 125Ω (typ.) OVER 15V p.p. SIGNAL-INPUT RANGE FOR $V_{DD} - V_{EE} = 15V$
- HIGH "OFF" RESISTANCE : CHANNEL LEAKAGE $\pm 100pA$ (typ.) $V_{DD} - V_{EE} = 18V$
- BINARY ADDRESS DECODING ON CHIP
- VERY LOW QUIESCENT POWER DISSIPATION UNDER ALL DIGITAL CONTROL INPUT AND SUPPLY CONDITIONS : 0.2 μW (typ.), $V_{DD} - V_{SS} = V_{DD} - V_{EE} = 10V$
- MATCHED SWITCH CHARACTERISTICS : $R_{ON} = 5\Omega$ (typ.) for $V_{DD} - V_{EE} = 15V$
- WIDE RANGE OF DIGITAL AND ANALOG SIGNAL LEVELS : DIGITAL 3 TO 20V, ANALOG TO 20V p.p.
- 5V, 10V, AND 15V PARAMETRIC RATINGS
- INPUT CURRENT OF 100mA AT 18V AND 25°C FOR HCC DEVICE
- 100% TESTED FOR QUIESCENT CURRENT
- MEETS ALL REQUIREMENTS OF JEDEC TENTATIVE STANDARD N° 13A, "STANDARD SPECIFICATIONS FOR DESCRIPTION OF "B" SERIES CMOS DEVICES"



DESCRIPTION

The **HCC 4051B, 4052B** and **4053B** (extended temperature range) and **HCF4051B, 4052B** and **4053B** (intermediate temperature range) are monolithic integrated circuits, available in 16-lead dual in-line plastic or ceramic package and plastic micropackage. **HCC/HCF4051B, HCC/HCF4052B,** and **HCC/HCF4053B** analog multiplexers/demultiplexers are digitally controlled analog switches having low ON impedance and very low OFF leakage

PIN CONNECTIONS



HCC/HCF4051B/52B/53B

current. These multiplexer circuits dissipate extremely low quiescent power over the full $V_{DD} - V_{SS}$ and $V_{DD} - V_{EE}$ supply-voltage ranges, independent of the logic state of the control signals. When a logic "1" is present at the inhibit input all channels are off. The **HCC/HCF4051B** is a single 8-channel multiplexer having three binary control inputs, A, B, and C, and an inhibit input. The three binary signals select 1 of 8 channels to be turned on, and connect one of the 8 inputs to the output. The **HCC/HCF4052B** is a differential 4-channel multi-

plexer having two binary control inputs, A and B, and an inhibit input. The two binary input signals select 1 of 4 pairs of channels to be turned on and connect the analog inputs to the outputs. The **HCC/HCF4053B** is a triple 2-channel multiplexer having three separate digital control inputs, A, B, and C, and an inhibit input. Each control input selects one of a pair of channels which are connected in a singlepole double-throw configuration.

FUNCTIONAL DIAGRAMS AND TRUTH TABLES

4051B

B-16411

| Input States | | | | "On" Channel (S) |
|--------------|---|---|---|------------------|
| Inhibit | C | B | A | |
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | X | X | X | None |

5-2299

ALL INPUTS ARE PROTECTED BY COS/MOS PROTECTION NETWORK

4052B

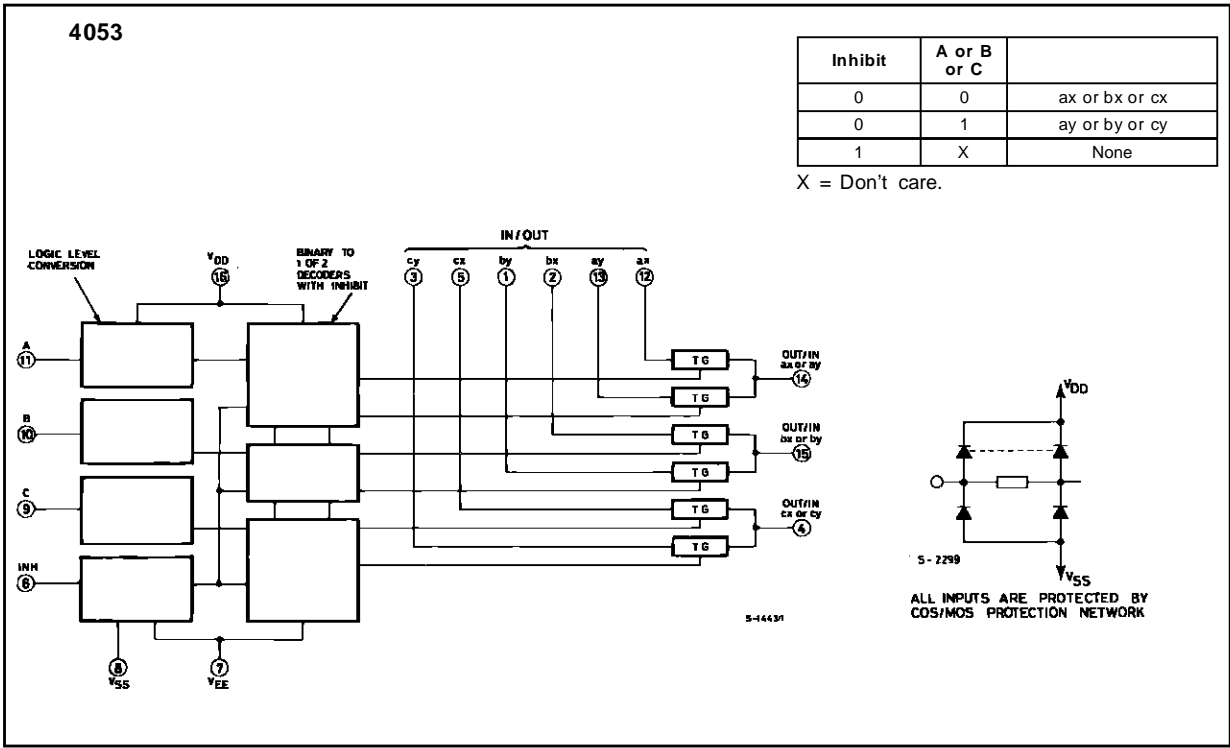
S-144521

| Inhibit | B | A | |
|---------|---|---|--------|
| 0 | 0 | 0 | 0x, 0y |
| 0 | 0 | 1 | 1x, 1y |
| 0 | 1 | 0 | 2x, 2y |
| 0 | 1 | 1 | 3x, 3y |
| 1 | X | X | None |

5-2299

ALL INPUTS ARE PROTECTED BY COS/MOS PROTECTION NETWORK

FUNCTIONAL DIAGRAMS AND TRUTH TABLES (continued)



ABSOLUTE MAXIMUM RATINGS

| Symbol | Parameter | Value | Unit |
|------------|---|--------------------------------|----------------------------|
| V_{DD}^* | Supply Voltage : HCC Types HCF Types | - 0.5 to + 20 - 0.5 to + 18 | V V |
| V_i | Input Voltage | - 0.5 to $V_{DD} + 0.5$ | V |
| I_i | DC Input Current (any one input) | ± 10 | mA |
| P_{tot} | Total Power Dissipation (per package) Dissipation per Output Transistor for T_{op} = Full Package-temperature Range | 200 100 | mW mW |
| T_{op} | Operating Temperature : HCC Types HCF Types | - 55 to + 125 - 40 to + 85 | $^{\circ}C$ $^{\circ}C$ |
| T_{stg} | Storage Temperature | - 65 to + 150 | $^{\circ}C$ |

Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for external periods may affect device reliability.

* All voltage values are referred to V_{SS} pin voltage.

RECOMMENDED OPERATING CONDITIONS

| Symbol | Parameter | Value | Unit |
|----------|--|-------------------------------|----------------------------|
| V_{DD} | Supply Voltage : HCC Types HCF Types | 3 to 18 3 to 15 | V V |
| V_i | Input Voltage | 0 to V_{DD} | V |
| T_{op} | Operating Temperature : HCC Types HCF Types | - 55 to + 125 - 40 to + 85 | $^{\circ}C$ $^{\circ}C$ |

HCC/HCF4051B/52B/53B

STATIC ELECTRICAL CHARACTERISTICS (over recommended operating conditions)

| Symbol | Parameter | | Test Conditions | | | | Value | | | | | | Unit | | | | | | | | | | | | |
|-------------------------------------|---|-----------|--------------------------------------|---|------------------------|------------------------|--------------------|-------|-------|------------------------|-------|---------------------|-------|----------------------------------|-----------|-------------------|-------|----|-----|-----|-------|-----|--|------|----|
| | | | V _{IS} (V) | V _{EE} (V) | V _{SS} (V) | V _{DD} (V) | T _{Low} * | | 25 °C | | | T _{High} * | | | | | | | | | | | | | |
| | | | | | | | Min. | Max. | Min. | Typ. | Max. | Min. | | Max. | | | | | | | | | | | |
| I _L | Quiescent Device Current | HCC Types | | | | 5 | | 5 | 0.04 | 5 | | 150 | μA | | | | | | | | | | | | |
| | | | | | | 10 | | 10 | 0.04 | 10 | | 300 | | | | | | | | | | | | | |
| | | | | | | 15 | | 20 | 0.04 | 20 | | 600 | | | | | | | | | | | | | |
| | | | | | | 20 | | 100 | 0.08 | 100 | | 3000 | | | | | | | | | | | | | |
| | | HCF Types | | | | 5 | | 20 | 0.04 | 20 | | 150 | | | | | | | | | | | | | |
| | | | | | | 10 | | 40 | 0.04 | 40 | | 300 | | | | | | | | | | | | | |
| | | | | | | 15 | | 80 | 0.04 | 80 | | 600 | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | |
| SWITCH | | | | | | | | | | | | | | | | | | | | | | | | | |
| ON | Resistance | HCC Types | 0 ≤ V _I ≤ V _{DD} | 0 | 0 | 5 | | 880 | | 470 | 1050 | 1200 | Ω | | | | | | | | | | | | |
| | | | | | | 10 | | 310 | | 180 | 400 | 580 | | | | | | | | | | | | | |
| | | | | | | 15 | | 220 | | 125 | 280 | 400 | | | | | | | | | | | | | |
| | | HCF Types | | | | 5 | | 880 | | 470 | 1050 | 1200 | | | | | | | | | | | | | |
| | | | | | | 10 | | 330 | | 180 | 400 | 520 | | | | | | | | | | | | | |
| | | | | | | 15 | | 230 | | 125 | 280 | 360 | | | | | | | | | | | | | |
| ΔON | Resistance ΔR _{ON} (between any 2 channels) | | | 0 | 0 | 5 | | | | 10 | | | Ω | | | | | | | | | | | | |
| | | | | | | 10 | | | | 10 | | | | | | | | | | | | | | | |
| | | | | | | 15 | | | | 5 | | | | | | | | | | | | | | | |
| OFF (●) Channel Leakage Current | Any Channel OFF | HCC Types | | 0 | 0 | 18 | | 100 | ± 0.1 | 100 | | 1000 | nA | | | | | | | | | | | | |
| | | | | | | | | | | | | | | All Channels OFF (common OUT/IN) | HCC Types | 0 | 0 | 18 | | 100 | ± 0.1 | 100 | | 1000 | nA |
| | Any Channel OFF | HCF Types | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | All Channels OFF (common OUT/IN) | HCF Types | 0 | 0 | 15 | | 300 | ± 0.1 | 300 | | 1000 | nA |
| C Capacitance | Input | | | | | | | | | | | | pF | | | | | | | | | | | | |
| | | | | | | | | | | | | | | Output 4051 | | | | | | | | | | | |
| | | | | | | | | | | | | | | Output 4052 | | | | | | | | | | | |
| | | | | | | | | | | | | | | Output 4053 | | | | | | | | | | | |
| | | | | | | | | | | | | | | Feedthrough | | | | | | | | | | | |
| CONTROL (Address or Inhibit) | | | | | | | | | | | | | | | | | | | | | | | | | |
| V _{IL} | Input Low Voltage | | = V _{DD} Thru 1KΩ | V _{EE} = V _{SS} R _L = 1KΩ to V _{SS} I _{IS} < 2μA (on all off channels) | | | 5 | | 1.5 | | | 1.5 | 1.5 | V | | | | | | | | | | | |
| | | | | | | | 10 | | 3 | | | 3 | 3 | | | | | | | | | | | | |
| | | | | | | | 15 | | 4 | | | 4 | 4 | | | | | | | | | | | | |
| | | | | | | | 5 | 3.5 | | 3.5 | | | 3.5 | | | | | | | | | | | | |
| V _{IH} | Input High Voltage | | | | | | 10 | 7 | | 7 | | | 7 | V | | | | | | | | | | | |
| | | | | | | | 15 | 11 | | 11 | | | 11 | | | | | | | | | | | | |
| I _{IH} , I _{IL} | Input Leakage Current | HCC Types | V _I = 0/18V | | | 18 | | ± 0.1 | | ±10 ⁻³ | ± 0.1 | | ± 1 | μA | | | | | | | | | | | |
| | | HCF Types | | | | | | | | V _I = 0/15V | 15 | | ± 0.3 | | | ±10 ⁻³ | ± 0.3 | | ± 1 | | | | | | |
| C _I | Input Capacitance | | Any Address or Inhibit Input | | | | | | | 5 | 7.5 | | pF | | | | | | | | | | | | |


(●) Determined by minimum feasible leakage measurement for automatic testing.

(*) T_{Low} = - 55°C for HCC device : - 40°C for HCF device.

(*) T_{High} = + 125°C for HCC device : + 85°C for HCF device.

DYNAMIC ELECTRICAL CHARACTERISTICS

($T_{amb} = 25^{\circ}C$, $C_L = 50pF$ all input square wave rise and fall time = 20ns)

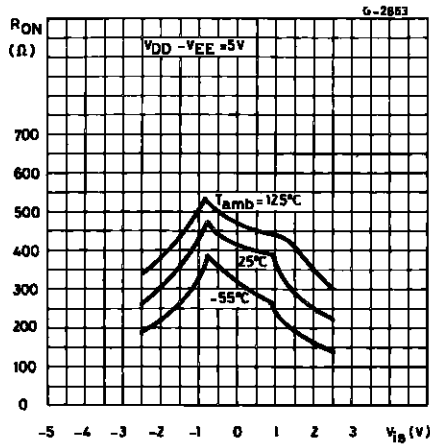
| Parameter | Test Conditions | | | | | | Value | | Unit | | | | | |
|---|-----------------|------------------------|----------------|---|-----------------|-----------------|---|--|-------|-----|-----|------------|---|-------|
| | V_{EE} (V) | R_L (k Ω) | f_i (kHz) | V_{IS} (V) | V_{SS} (V) | V_{DD} (V) | Typ. | Max. | | | | | | |
| SWITCH | | | | | | | | | | | | | | |
| t_{pd} Propagation Delay Time (signal input to output) | | 200 | | 10 V  | | 5 | | 30 | 30 | ns | | | | |
| | | | | | | 10 | | 15 | 60 | | | | | |
| | | | | | | 15 | | 11 | 20 | | | | | |
| Frequency Response Channel "ON" (sine wave input) at $20 \text{ Log } \frac{V_o}{V_i} = -3\text{dB}$ | $= V_{SS}$ | 1 | | 5 (●) | | 10 | V_o at Common OUT/IN | 4053B | 30 | MHz | | | | |
| | | | | | | | | 4052B | 25 | | | | | |
| | | | | | | | | 4051B | 20 | | | | | |
| | | | | | | | V_o at any Channel | 60 | | | | | | |
| Feedthrough (all channels OFF) at $20 \text{ Log } \frac{V_o}{V_i} = -40\text{dB}$ | $= V_{SS}$ | 1 | | 5 (●) | | 10 | V_o at Common OUT/IN | 4053 | 8 | MHz | | | | |
| | | | | | | | | 4052 | 10 | | | | | |
| | | | | | | | | 4051 | 12 | | | | | |
| | | | | | | | V_o at any Channel | 8 | | | | | | |
| Frequency Signal Crosstalk at $20 \text{ Log } \frac{V_o}{V_i} = -40\text{dB}$ | $= V_{SS}$ | 1 | | 5 (●) | | 10 | Between any 2 Channels | | 3 | MHz | | | | |
| | | | | | | | Between Sections 4052B only | measured on common | 6 | | | | | |
| | | | | | | | | measured on any channel | 10 | | | | | |
| | | | | | | | Between any 2 Sections 4053B only | in Pin 2 out Pin 14 | 2.5 | | MHz | | | |
| in Pin 15 out Pin 14 | 6 | | | | | | | | | | | | | |
| Sine Wave Distortion $f_{is} = 1\text{kHz}$ Sine Wave | $= V_{SS}$ | 10 | 1 | 2 (●) | | 5 | | | 0.3 | % | | | | |
| | | | | | | | 10 | 1 | 3 (●) | | 10 | | | 0.2 |
| | | | | | | | | | | | | 10 | 1 | 5 (●) |
| CONTROL (Address or Inhibit) | | | | | | | | | | | | | | |
| Propagation Delay Time : Address-to Signal OUT Channels ON or OFF | 0 | | | | | 0 | 5 | | | 360 | 720 | ns | | |
| | | | | | | | | | | 160 | 320 | | | |
| | | | | | | | | | | 120 | 240 | | | |
| | | | | | | | | | | 225 | 450 | | | |
| Propagation Delay Time : Inhibit to Signal OUT (channel turning ON) | 0 | 10 | | | | 0 | 5 | | | 360 | 720 | ns | | |
| | | | | | | | | | | 160 | 320 | | | |
| | | | | | | | | | | 120 | 240 | | | |
| | | | | | | | | | | 200 | 400 | | | |
| Propagation Delay Time : Inhibit to Signal OUT (channel turning OFF) | 0 | 0.3 | | | | | 5 | | | 200 | 450 | ns | | |
| | | | | | | | | | | 90 | 210 | | | |
| | | | | | | | | | | 70 | 160 | | | |
| | | | | | | | | | | 130 | 300 | | | |
| Address or Inhibit to Signal Crosstalk | 0 | 10* | | | | 0 | 10 | $V_C = V_{DD} - V_{SS}$ (square wave) | | 65 | | mV peak | | |

(●) Peak to peak voltage symmetrical about $\frac{V_{DD}-V_{EE}}{2}$

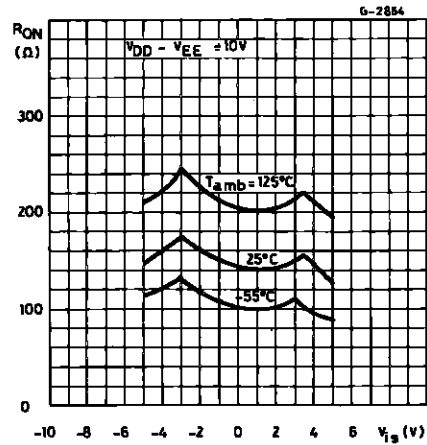
(*) Both ends of channel.

HCC/HCF4051B/52B/53B

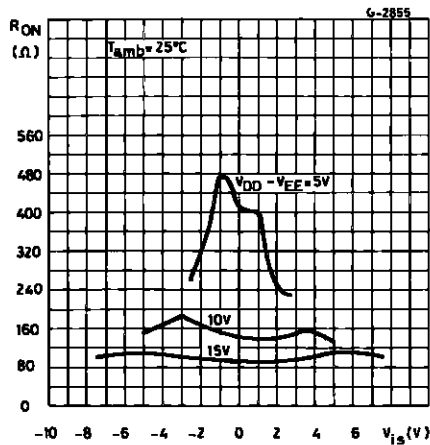
Typical Channel ON Resistance vs. Input Signal Voltage (all types).



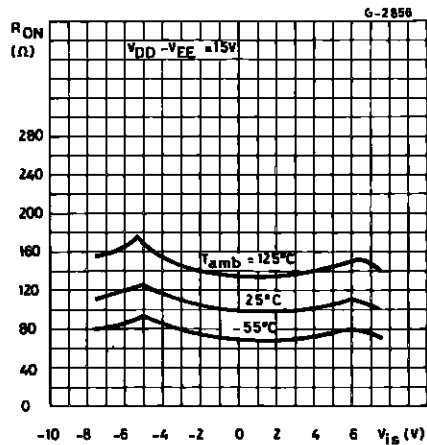
Typical Channel ON Resistance vs. Input Signal Voltage (all types).



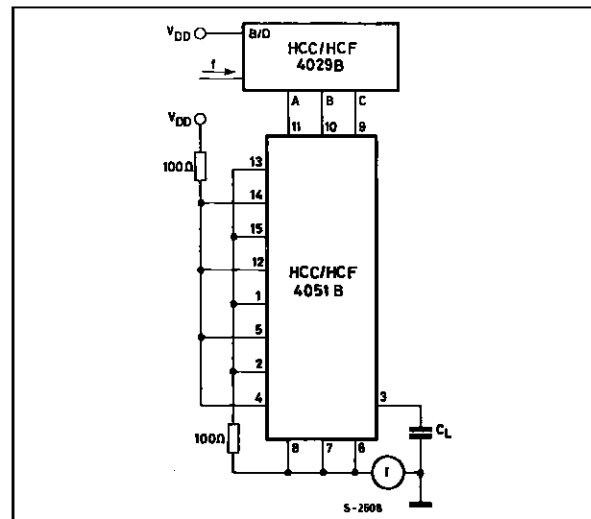
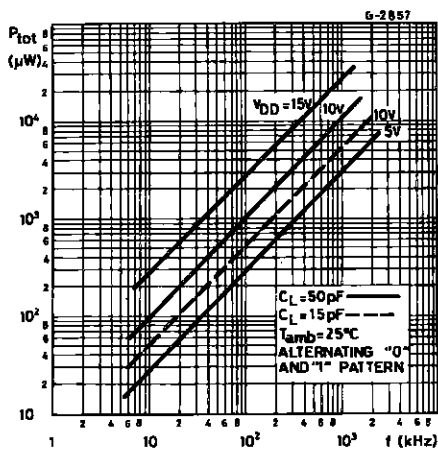
Typical Channel ON Resistance vs. Input Signal Voltage (all types).



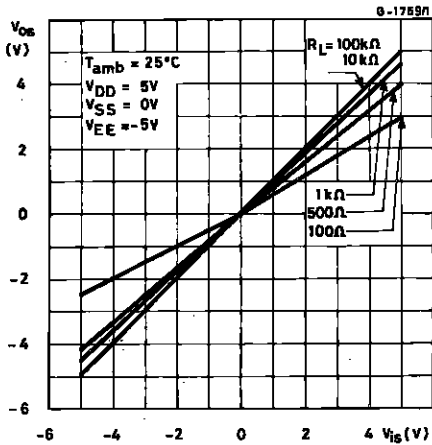
Typical Channel ON Resistance vs. Input Signal Voltage (all types).



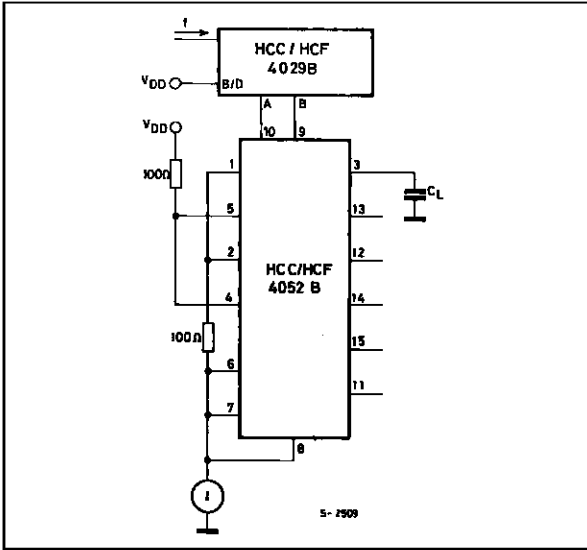
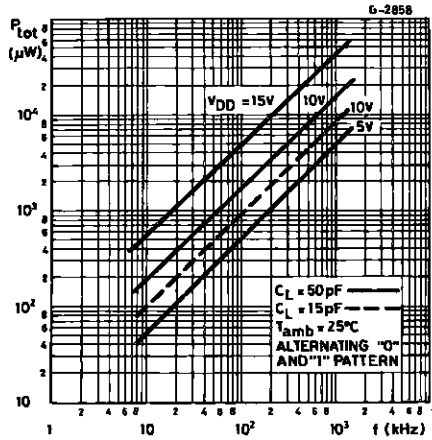
Typical Dynamic Power Dissipation/Package vs. Switching Frequency and Test Circuit (4051B).



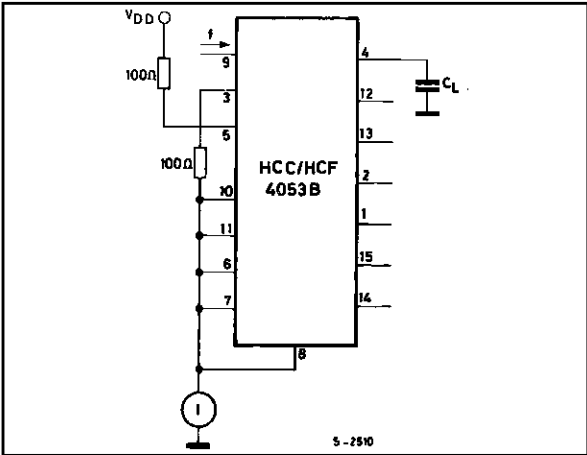
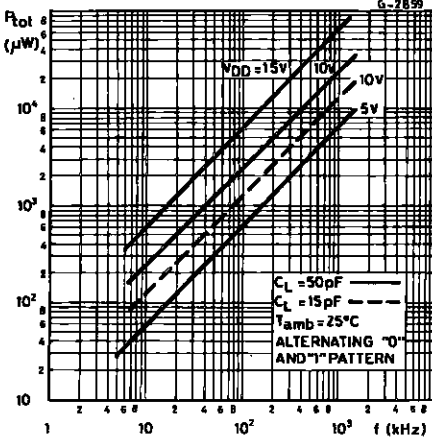
Typical ON Characteristics for 1 of 8 Channels (4051B).



Typical Dynamic Power Dissipation/Package vs. Switching Frequency and Test Circuit (4052B).

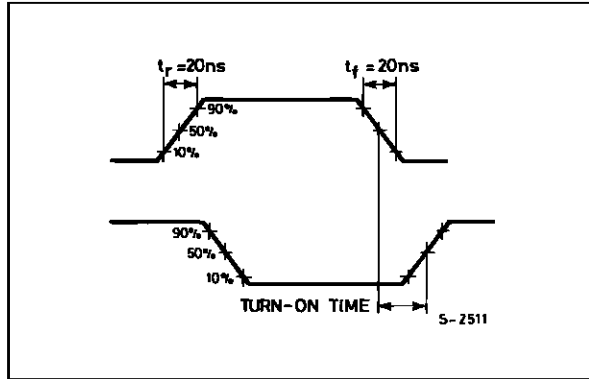


Typical Dynamic Power Dissipation/Package vs. Switching Frequency and Test Circuit (4053B).

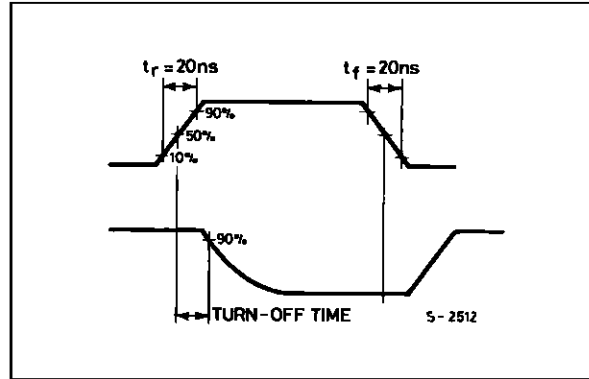


WAVEFORMS

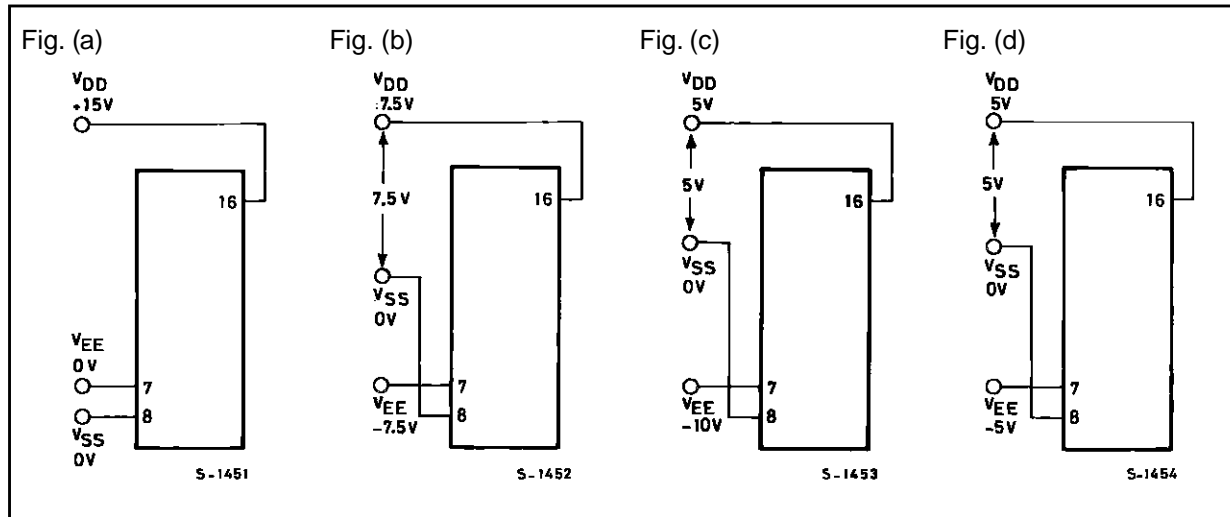
Channel Being Turned ON ($R_L = 10K\Omega$).



Channel Being Turned OFF ($R_L = 300K\Omega$).



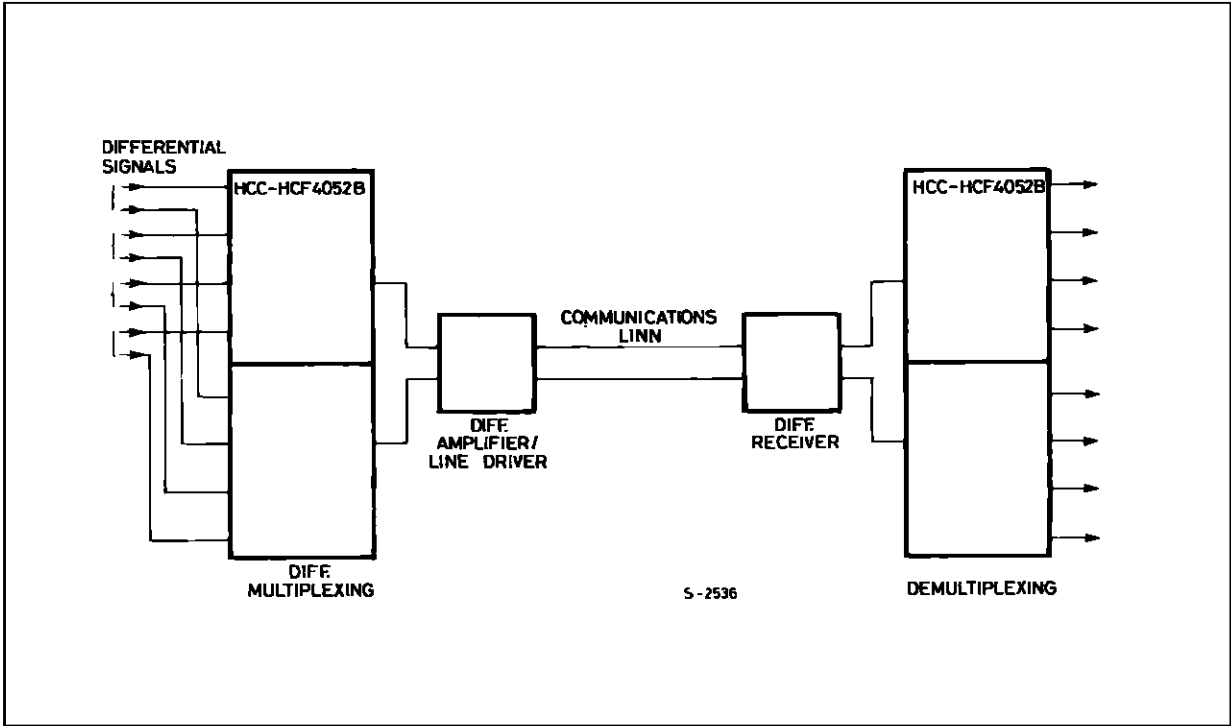
TYPICAL BIAS VOLTAGES



The ADDRESS (digital-control inputs) and INHIBIT logic levels are : "0"= V_{SS} and "1"= V_{DD} . The analog signal (through the TG) may swing from V_{EE} to V_{DD} .

TYPICAL APPLICATIONS

TYPICAL TIME-DIVISION APPLICATION OF THE 4052B



SPECIAL CONSIDERATIONS

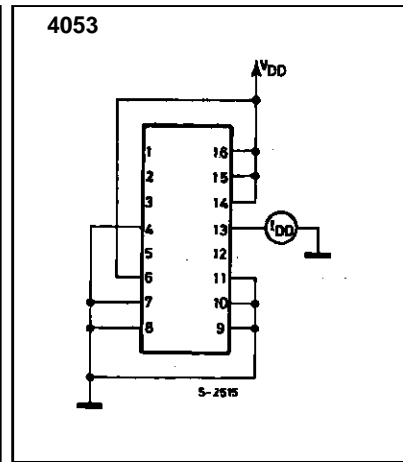
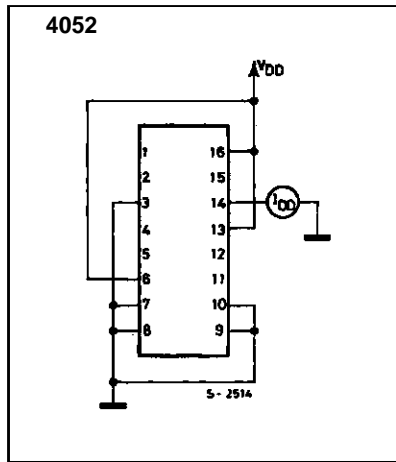
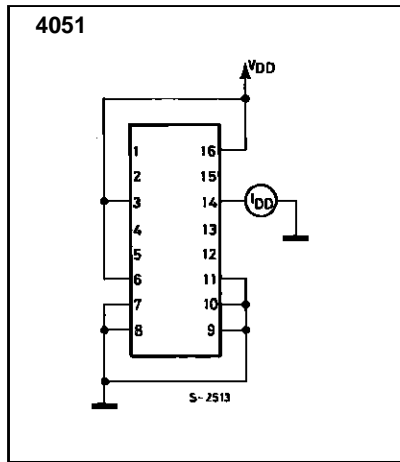
Control of analog signals up to 20V peak-to-peak can be achieved by digital signal amplitudes of 4.5 to 20V (if $V_{DD} - V_{SS} = 3V$, a $V_{DD} - V_{EE}$ of up to 13V can be controlled ; for $V_{DD} - V_{EE}$ level differences above 13V, a $V_{DD} - V_{SS}$ of at least 4.5V is required). For example, if $V_{DD} = +5V$, $V_{SS} = 0$, and $V_{EE} = -13.5V$, analog signals from $-13.5V$ to $+4.5V$ can be controlled by digital inputs of 0 to 4.5V. In certain applications, the external load-resistor current may include both V_{DD} and signal-line components. To

avoid drawing V_{DD} current when switch current flows into the transmission gate inputs, the voltage drop across the bidirectional switch must not exceed 0,8 volt (valculated from R_{ON} values shown in ELECTRICAL CHARACTERISTICS CHART). No V_{DD} current will flow through R_L if the switch current flows into lead 3 on the **HCC/HCF4051** ; leads 3 and 13 on the **HCC/HCF4052** ; leads 4, 14, and 15 on the **HCC/HCF4053**.

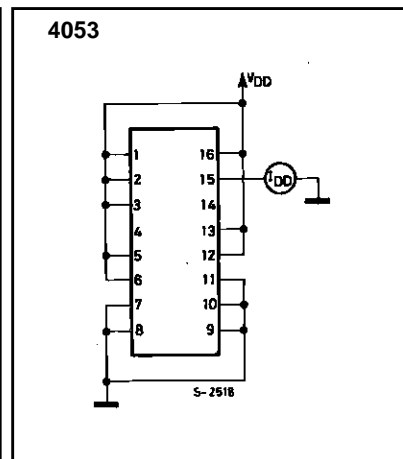
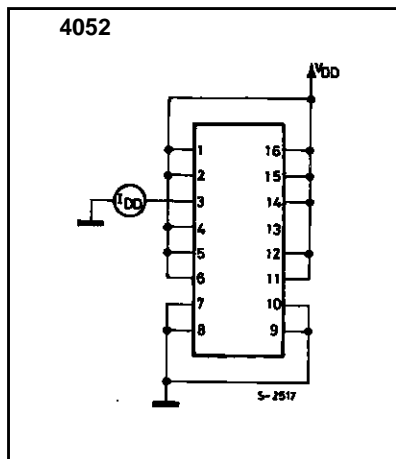
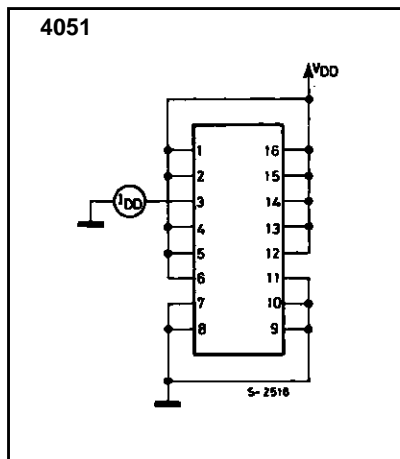
HCC/HCF4051B/52B/53B

TEST CIRCUITS

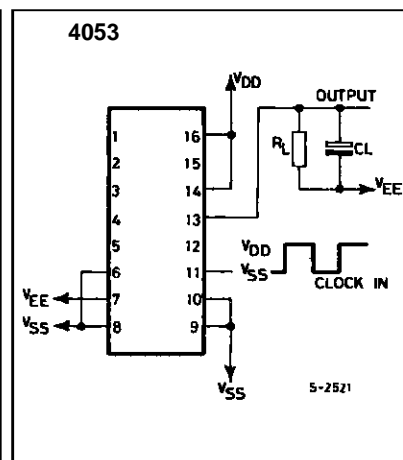
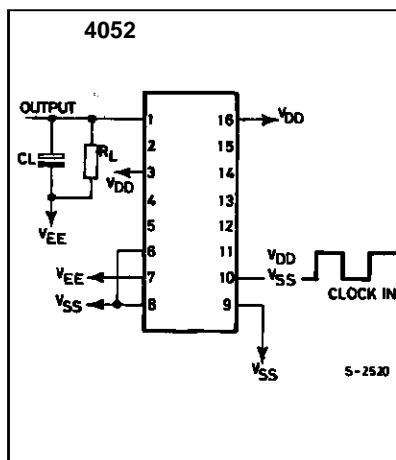
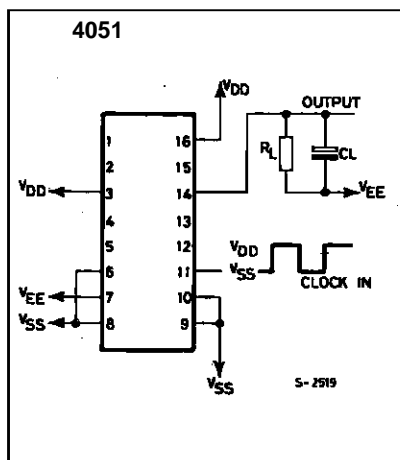
Off Channel Leakage Current-any Channel OFF.



Off Channel Leakage Current-all Channel OFF.

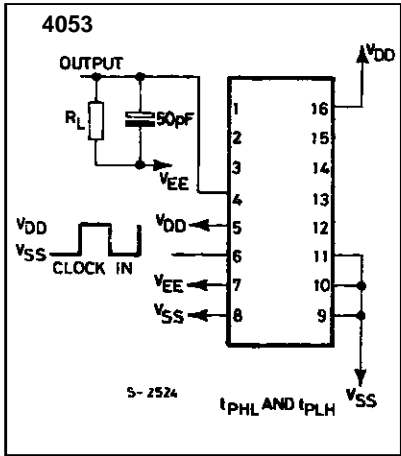
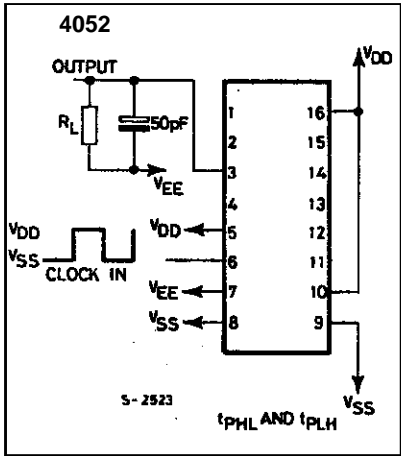
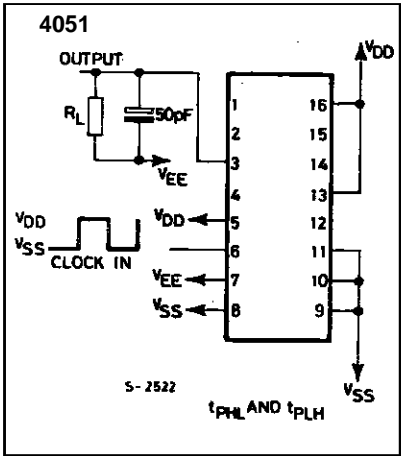


Propagation Delay-adress Input to Signal Output.

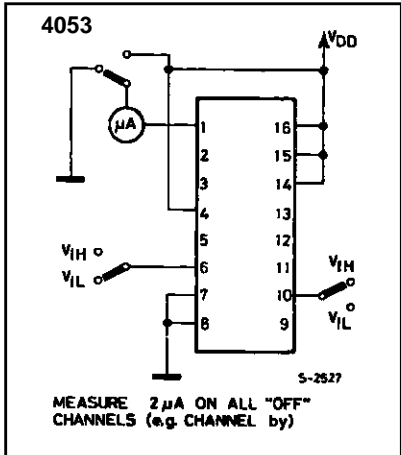
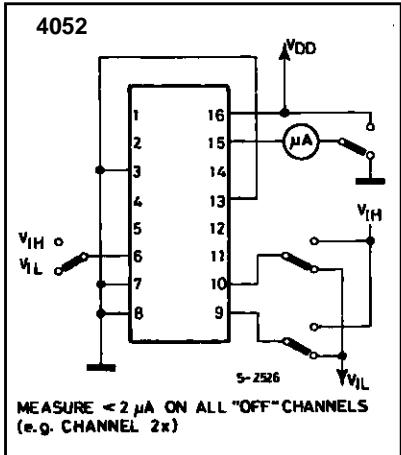
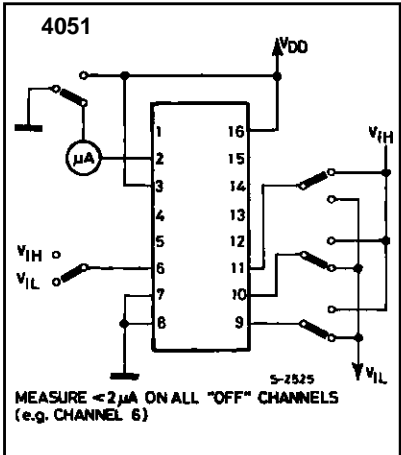


TEST CIRCUITS (continued)

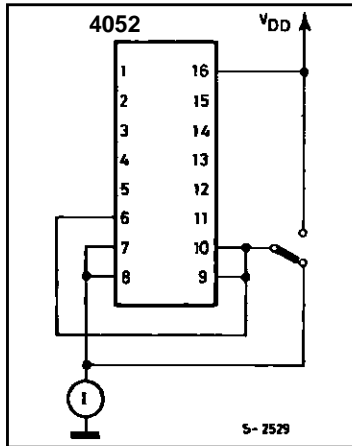
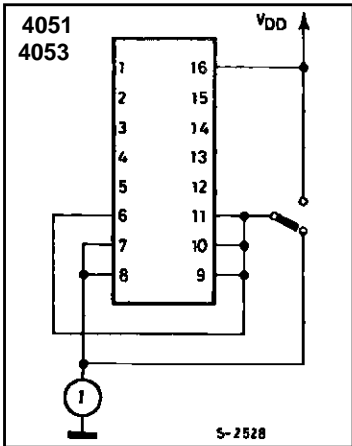
Propagation Delay-Inhibit Input to Signal Output.



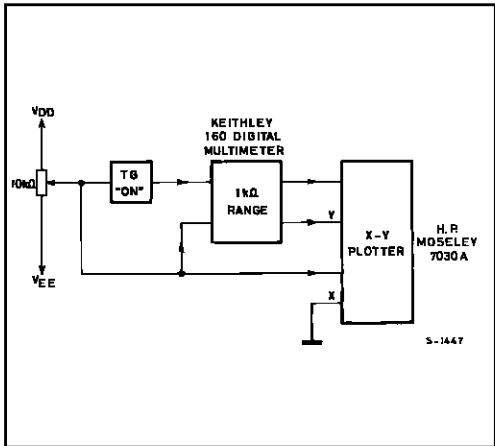
Input Voltage.



Quiescent Device Current.

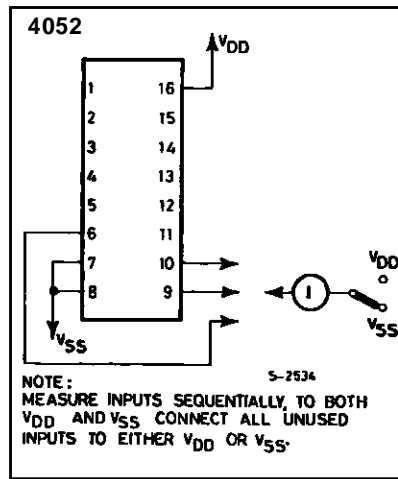
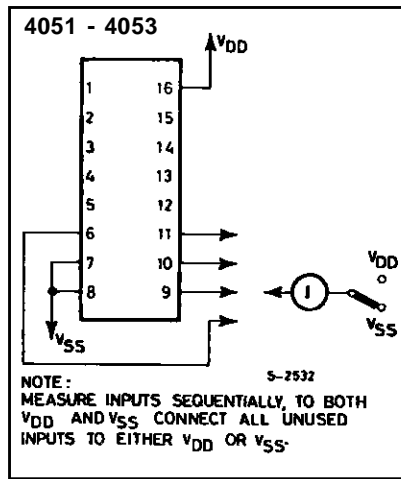


Channel ON Resistance Measurement Circuit.

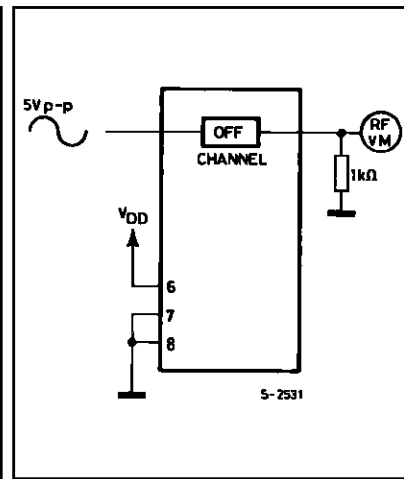


TEST CIRCUITS (continued)

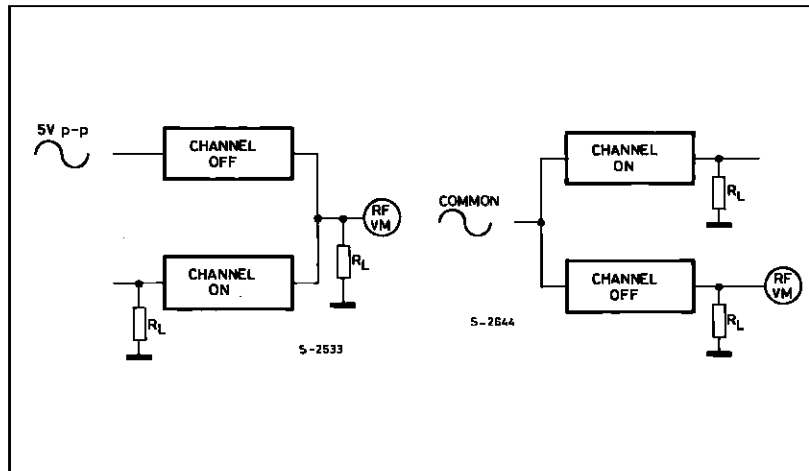
Input Current.



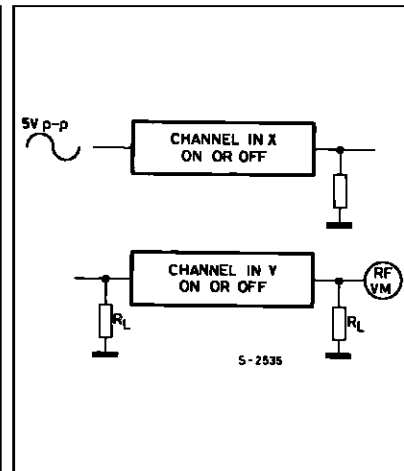
Feedthrough (All Types).



Crosstalk Between any two Channels (All Types).

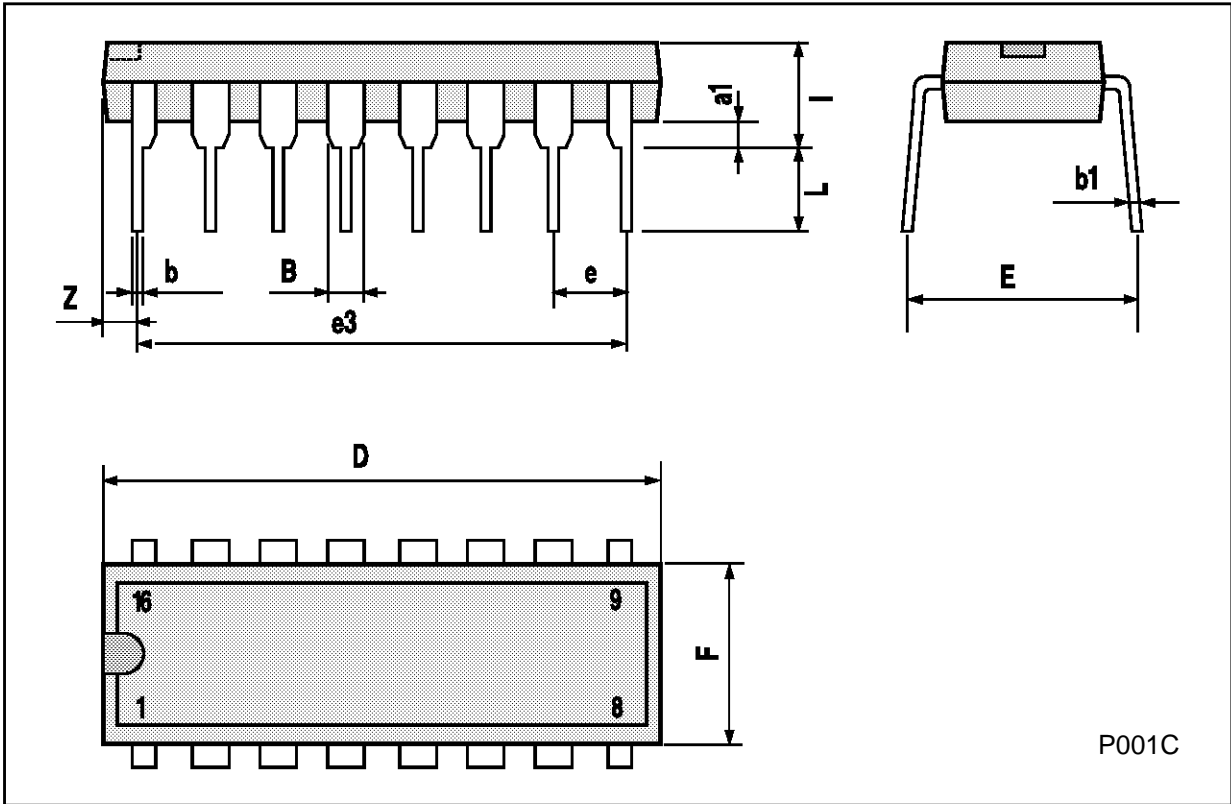


Crosstalk Between Duals or Triplets (4052-4053).



Plastic DIP16 (0.25) MECHANICAL DATA

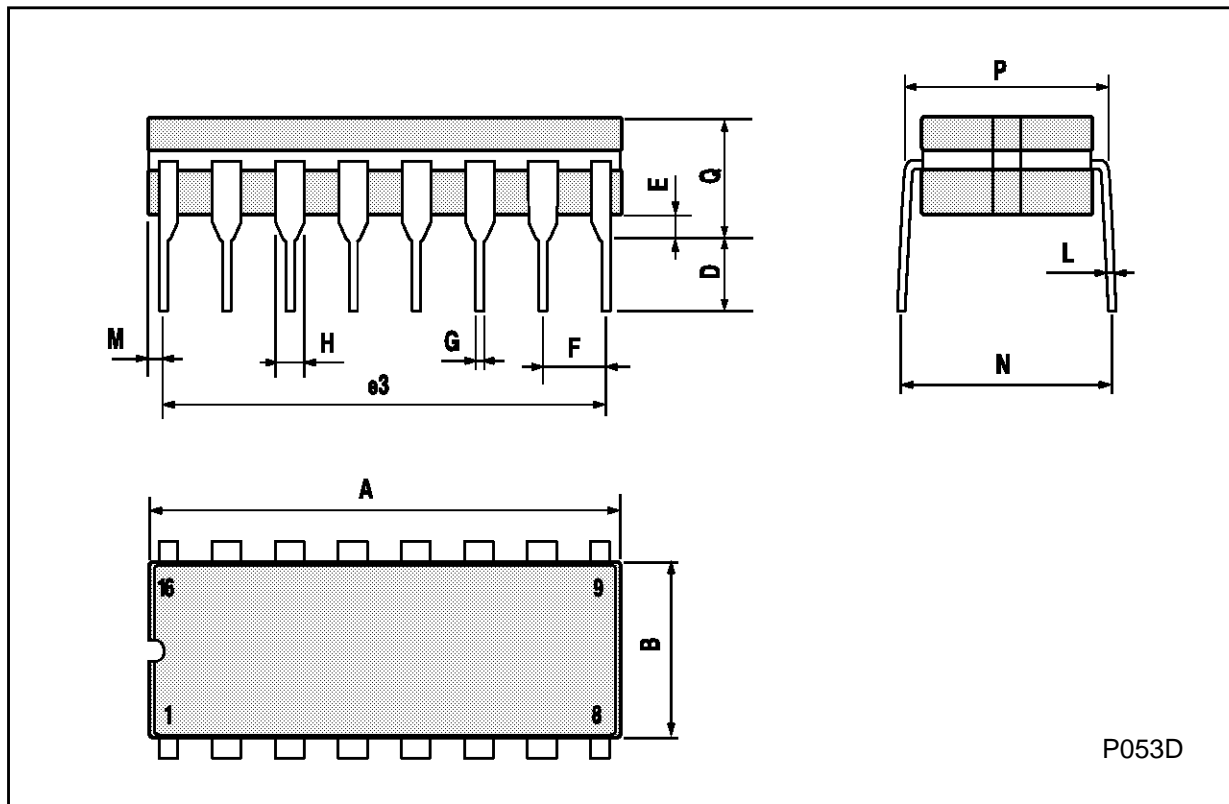
| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| a1 | 0.51 | | | 0.020 | | |
| B | 0.77 | | 1.65 | 0.030 | | 0.065 |
| b | | 0.5 | | | 0.020 | |
| b1 | | 0.25 | | | 0.010 | |
| D | | | 20 | | | 0.787 |
| E | | 8.5 | | | 0.335 | |
| e | | 2.54 | | | 0.100 | |
| e3 | | 17.78 | | | 0.700 | |
| F | | | 7.1 | | | 0.280 |
| l | | | 5.1 | | | 0.201 |
| L | | 3.3 | | | 0.130 | |
| Z | | | 1.27 | | | 0.050 |



P001C

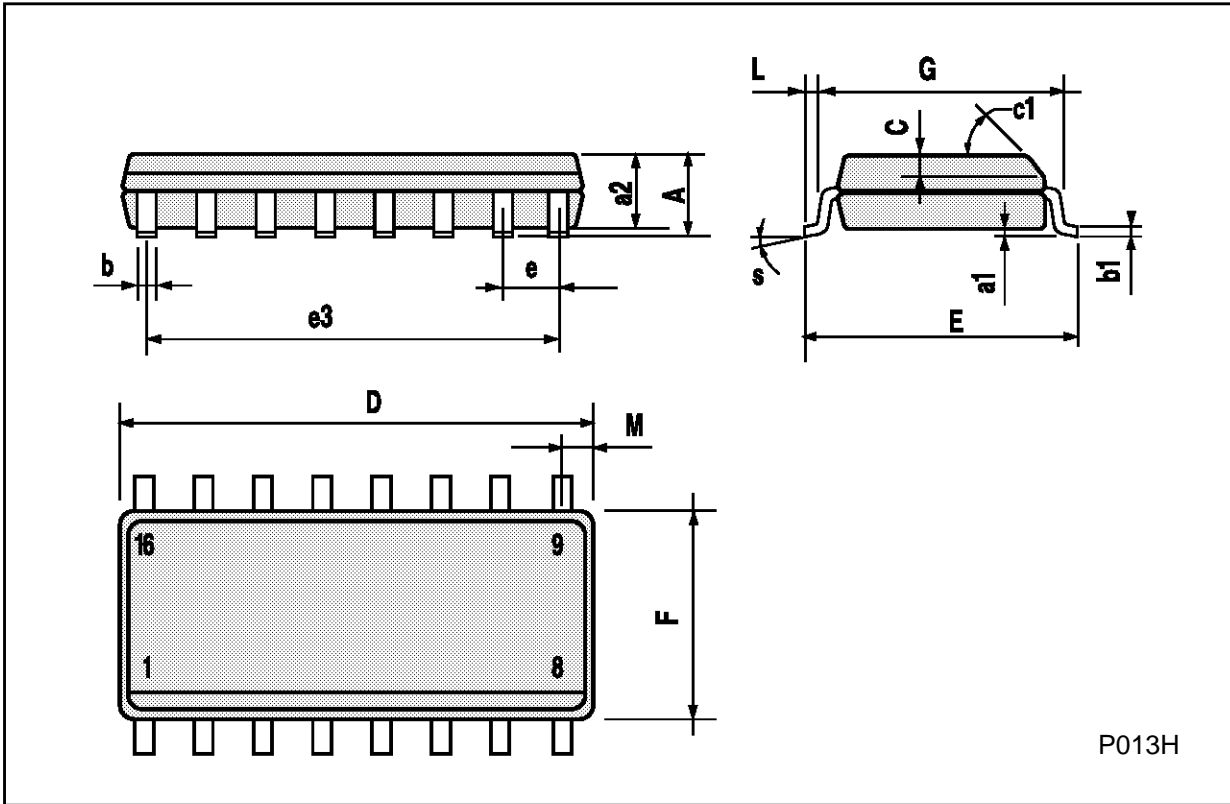
Ceramic DIP16/1 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|-------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 20 | | | 0.787 |
| B | | | 7 | | | 0.276 |
| D | | 3.3 | | | 0.130 | |
| E | 0.38 | | | 0.015 | | |
| e3 | | 17.78 | | | 0.700 | |
| F | 2.29 | | 2.79 | 0.090 | | 0.110 |
| G | 0.4 | | 0.55 | 0.016 | | 0.022 |
| H | 1.17 | | 1.52 | 0.046 | | 0.060 |
| L | 0.22 | | 0.31 | 0.009 | | 0.012 |
| M | 0.51 | | 1.27 | 0.020 | | 0.050 |
| N | | | 10.3 | | | 0.406 |
| P | 7.8 | | 8.05 | 0.307 | | 0.317 |
| Q | | | 5.08 | | | 0.200 |



SO16 (Narrow) MECHANICAL DATA

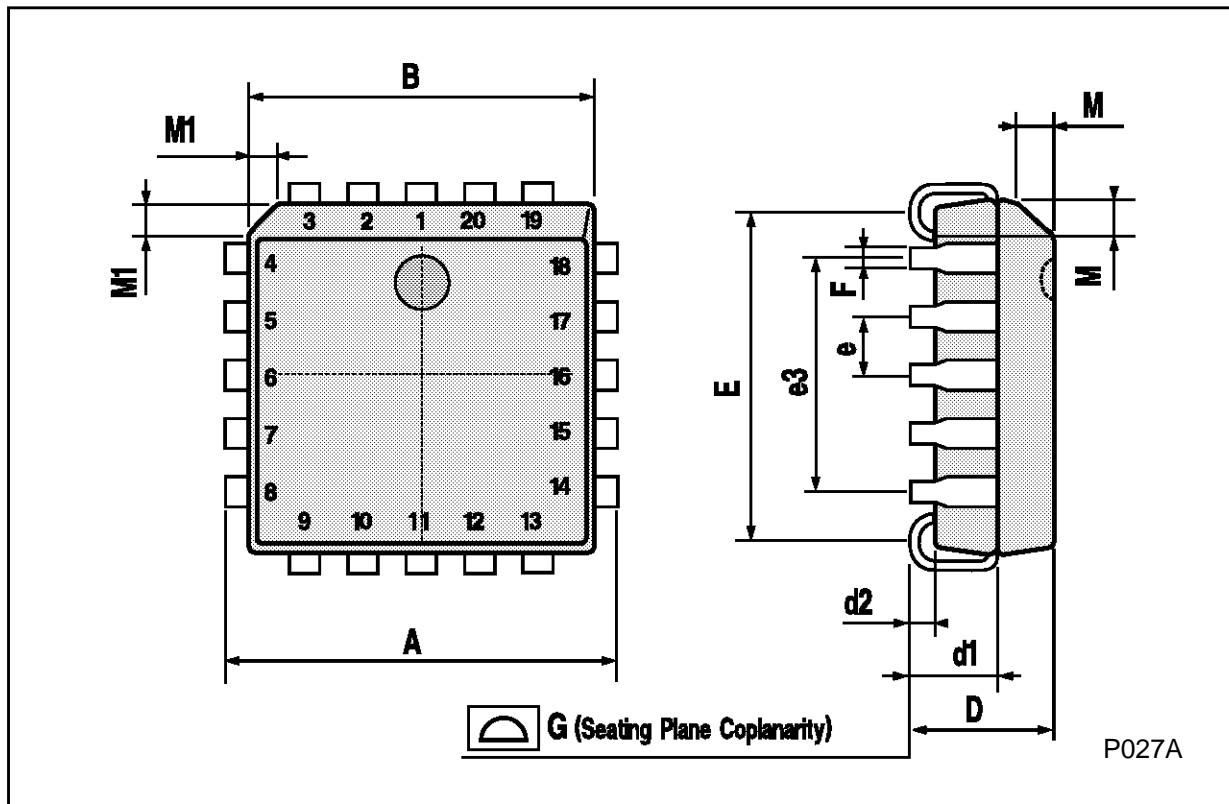
| DIM. | mm | | | inch | | |
|------|------------|------|------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | | | 1.75 | | | 0.068 |
| a1 | 0.1 | | 0.2 | 0.004 | | 0.007 |
| a2 | | | 1.65 | | | 0.064 |
| b | 0.35 | | 0.46 | 0.013 | | 0.018 |
| b1 | 0.19 | | 0.25 | 0.007 | | 0.010 |
| C | | 0.5 | | | 0.019 | |
| c1 | 45° (typ.) | | | | | |
| D | 9.8 | | 10 | 0.385 | | 0.393 |
| E | 5.8 | | 6.2 | 0.228 | | 0.244 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 8.89 | | | 0.350 | |
| F | 3.8 | | 4.0 | 0.149 | | 0.157 |
| G | 4.6 | | 5.3 | 0.181 | | 0.208 |
| L | 0.5 | | 1.27 | 0.019 | | 0.050 |
| M | | | 0.62 | | | 0.024 |
| S | 8° (max.) | | | | | |



P013H

PLCC20 MECHANICAL DATA

| DIM. | mm | | | inch | | |
|------|------|------|-------|-------|-------|-------|
| | MIN. | TYP. | MAX. | MIN. | TYP. | MAX. |
| A | 9.78 | | 10.03 | 0.385 | | 0.395 |
| B | 8.89 | | 9.04 | 0.350 | | 0.356 |
| D | 4.2 | | 4.57 | 0.165 | | 0.180 |
| d1 | | 2.54 | | | 0.100 | |
| d2 | | 0.56 | | | 0.022 | |
| E | 7.37 | | 8.38 | 0.290 | | 0.330 |
| e | | 1.27 | | | 0.050 | |
| e3 | | 5.08 | | | 0.200 | |
| F | | 0.38 | | | 0.015 | |
| G | | | 0.101 | | | 0.004 |
| M | | 1.27 | | | 0.050 | |
| M1 | | 1.14 | | | 0.045 | |



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