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# ANALOG MULTIPLEXERS-DEMULTIPLEXERS:

## 4051 SINGLE 8-CHANNEL
## 4052 DIFFERENTIAL 4-CHANNEL
## 4053 TRIPLE 2-CHANNEL

## GENERAL DESCRIPTION

The MMC 4051, MMC 4052 and MMC 4053 are monolithic integrated circuits, available in 16-lead dual-in-line plastic or ceramic package. MMC 4051, MMC 4052 and MMC 4053 analog multiplexers/demultiplexers are digitally controlled analog switches having low ON impedance and very low OFF leakage 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 terminal all channel are off. The MMC 4051 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 MMC 4052 is a differential 4-channel multiplexer 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 MMC 4053 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.

## FEATURES

- Low „ON" resistance: 125 ohm (typ.) over 15 Vp.p. signal-input range for $V_{DD}$—$V_{EE}$ = 15 V
- High „OFF" resistance: channel leakage ± 100 pA (typ.) $V_{DD}$—$V_{EE}$ = 18 V
- Binary address decoding on chip
- Very low quiescent power dissipation under all digital control input and supply conditions: 0.2/uW (typ.), $V_{DD}$—$V_{SS}$ = $V_{DD}$—$V_{EE}$ = 10 V
- Matched switch characteristics: $R_{ON}$ = 5 ohm (typ.) for $V_{DD}$—$V_{EE}$ = 15 V
- Wide range of digital and analog signal levels: digital 3 to 20 V, analog to 20 Vp.p.

## ABSOLUTE MAXIMUM RATINGS

| | | | | |
|---|---|---|---|---|
| $V_{DD}$* | Supply voltage: G and H types | -0.5 to | 20 | V |
| | E and F types | -0.5 to | 18 | 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) | | 200 | mW |
| | Dissipation per output transistor for $T_A$ = full package-temperature range | | 100 | mW |
| $T_A$ | Operating temperature: G and H types | -55 to | 125 | °C |
| | E and F types | -40 to | 85 | °C |
| $T_{stg}$ | Storage temperature | -65 to | 150 | °C |

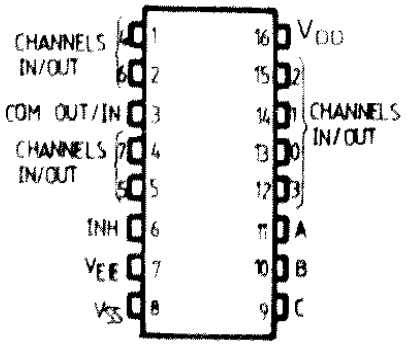
* All voltage values are referred to $V_{SS}$ pin voltage

## RECOMMENDED OPERATING CONDITIONS

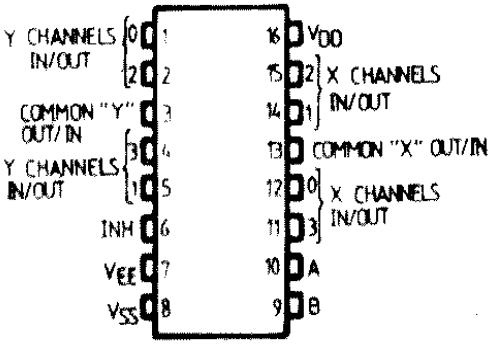
| | | | | |
|---|---|---|---|---|
| $V_{DD}$* | Supply voltage: G and H types | 3 to | 18 | V |
| | E and F types | 3 to | 15 | V |
| $V_i$ | Input voltage | 0 to | $V_{DD}$ | V |
| $T_A$ | Operating temperature: G and H types | -55 to | 125 | °C |
| | E and F types | -40 to | 85 | °C |

## CONNECTION DIAGRAMS

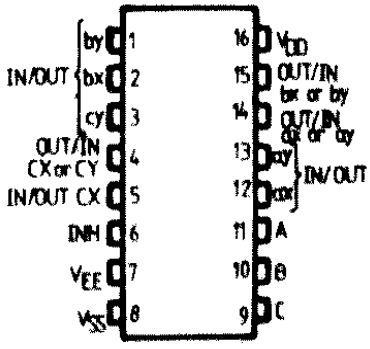
### MMC 4051




### MMC 4052




### MMC 4053



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## STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

| PARAMETER | | | TEST CONDITIONS | | | | VALUES | | | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | $V_{IS}$ (V) | $V_{EE}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | $T^*_{LOW}$ min. | $T^*_{LOW}$ max. | 25°C min. | 25°C typ. | 25°C max. | $T^*_{HIGH}$ min. | $T^*_{HIGH}$ max. | |
| $I_L$ quiescent device current | G, H types | | | | | 5 | | 5 | | 0.04 | 5 | | 150 | |
| | | | | | | 10 | | 10 | | 0.04 | 10 | | 300 | |
| | | | | | | 15 | | 20 | | 0.04 | 20 | | 600 | |
| | | | | | | 20 | | 100 | | 0.08 | 100 | | 3000 | |
| | E, F types | | | | | 5 | | 20 | | 0.04 | 20 | | 150 | µA |
| | | | | | | 10 | | 40 | | 0.04 | 40 | | 300 | |
| | | | | | | 15 | | 80 | | 0.04 | 80 | | 600 | |
| **Switch** | | | | | | | | | | | | | | |
| ON-resistance | G, H types | $0 \le V_I \le V_{DD}$ | 0 | 0 | | 5 | | 880 | | 470 | 1050 | | 1200 | |
| | | | | | | 10 | | 310 | | 180 | 400 | | 580 | |
| | | | | | | 15 | | 220 | | 125 | 280 | | 400 | |
| | E, F types | $0 \le V_I \le V_{DD}$ | 0 | 0 | | 5 | | 880 | | 470 | 1050 | | 1200 | Ω |
| | | | | | | 10 | | 330 | | 180 | 400 | | 520 | |
| | | | | | | 15 | | 230 | | 125 | 280 | | 360 | |
| Δ ON-resistance (between any 2 channels) | | | 0 | 0 | | 5 | | | | 10 | | | | |
| | | | | | | 10 | | | | 10 | | | | Ω |
| | | | | | | 15 | | | | 5 | | | | |
| OFF (•) channel leakage current | Any channel OFF | G, H types | 0 | 0 | | 18 | | 100 | | ±0.1 | 100 | | 1000 | nA |
| | All channels OFF (common OUT/IN) | G, H types | 0 | 0 | | 18 | | 100 | | ±0.1 | 100 | | 1000 | nA |
| | Any channel OFF | E, F types | 0 | 0 | | 15 | | 300 | | ±0.1 | 300 | | 1000 | nA |
| | All channels OFF (common OUT/IN) | E, F types | 0 | 0 | | 15 | | 300 | | ±0.1 | 300 | | 1000 | nA |
| C-capacitance | Input | | | | | | | | | 5 | | | | |
| | Output 4051 | | | | | | | | | 30 | | | | |
| | Output 4052 | | | −5 | −5 | 5 | | | | 18 | | | | pF |
| | Output 4053 | | | | | | | | | 9 | | | | |
| | Feedthrough | | | | | | | | | 0.2 | | | | |
| **Control (Address or Inhibit)** | | | | | | | | | | | | | | |
| $V_{IL}$ Input low voltage | | = $V_{DD}$ thru 1KΩ | $V_{EE} = V_{SS}$ $R_I$ = 1KΩ to $V_{SS}$ | | | 5 | | 1.5 | | | 1.5 | | 1.5 | |
| | | | | | | 10 | | 3 | | | 3 | | 3 | V |
| | | | | | | 15 | | 4 | | | 4 | | 4 | |
| $V_{IH}$ Input high voltage | | | $I_{IS} > 2\mu A$ (on all OFF channels) | | | 5 | 3.5 | | 3.5 | | | 3.5 | | |
| | | | | | | 10 | 7 | | 7 | | | 7 | | V |
| | | | | | | 15 | 11 | | 11 | | | 11 | | |

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## STATIC ELECTRICAL CHARACTERISTICS

(over recommended operating conditions)

| PARAMETER | | TEST CONDITIONS $V_{IS}$ (V) | $V_{EE}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | VALUES $T^*_{LOW}$ min. | $T^*_{LOW}$ max. | 25°C min. | 25°C typ. | 25°C max. | $T^*_{HIGH}$ min. | $T^*_{HIGH}$ max. | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $I_{IH}$, $I_{IL}$ Input leakage current | G, H types | $V_I$ = 0/18 V | | | 18 | | ±0.1 | | $±10^{-3}$ | ±0.1 | | ±1 | µA |
| | E, F types | $V_I$ = 0/15 V | | | 15 | | ±0.3 | | $±10^{-3}$ | ±0.3 | | ±1 | |
| $C_I$ Input capacitance | | Any address or inhibit input | | | | | | | 5 | 7.5 | | | pF |

(o) Determined by minimum feasible leakage measurement for automatic testing

(*) $T_{Low}$ = −55° C for G, H device; −40°C for E, F device.
$T_{High}$ = +125° C for G, H device; +85°C for E, F device.

## DYNAMIC ELECTRICAL CHARACTERISTICS

($T_A$ = 25°C, $C_L$ = 50 pF, all input square wave rise and fall time = 20 ns)

| PARAMETER | TEST CONDITIONS $V_{EE}$ (V) | $R_L$ (KΩ) | $f_i$ (KHz) | $V_{IS}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | | | VALUES typ. | VALUES max. | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Switch** | | | | | | | | | | | |
| $t_{pd}$-Propagation delay time (Signal Input to output) | | 200 | | 10 V | | 5<br>10<br>15 | | | 30<br>15<br>11 | 30<br>60<br>20 | ns |
| Frequency response channel „ON" (Sine wave Input) at $20 \log \frac{V_O}{V_I} = -3$ dB | = $V_{SS}$ | 1 | | 5(•) | | 10 | $V_O$ at common OUT/IN | 4053<br>4052<br>4051 | 30<br>25<br>20 | | MHz |
| | | | | | | | $V_O$ at any channel | | 60 | | MHz |
| Feedthrough (all channels OFF) at $20 \log \frac{V_O}{V_I}$ = −40 dB | = $V_{SS}$ | 1 | | 5(•) | | 10 | $V_O$ at common OUT/IN | 4053<br>4052<br>4051 | 8<br>10<br>12 | | MHZ |
| | | | | | | | $V_O$ at any channel | | 8 | | MHz |
| Frequency signal crosstalk at $20 \log \frac{V_O}{V_I} = -40$ dB | = $V_{SS}$ | 1 | | 5(•) | | 10 | Between any 2 channels | | 3 | | MHz |
| | | | | | | | Between sections 4052 only | Measured on common | 6 | | |
| | | | | | | | | Measured on any channel | 10 | | |
| | | | | | | | Between any 2 sections 4053 only | In pin 2 out pin 14 | 2.5 | | |
| | | | | | | | | In pin 15 out pin 14 | 6 | | |
| Sine wave distortion $f_{IS}$ = 1 KHz sine wave | = $V_{SS}$ | 10<br>10<br>10 | 1<br>1<br>1 | 2(•)<br>3(•)<br>5(•) | | 5<br>10<br>15 | | | 0.3<br>0.2<br>0.12 | | % |

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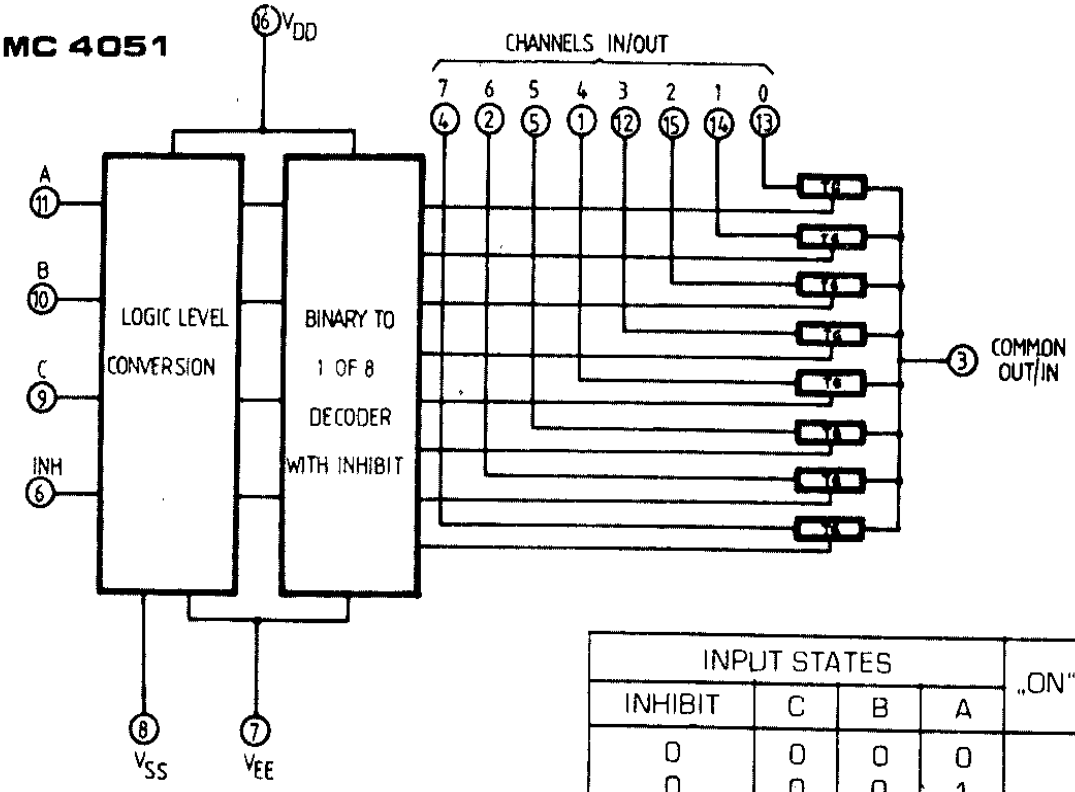
| PARAMETER | TEST CONDITIONS $V_{EE}$ (V) | $R_L$ (K) | $f_i$ (KHz) | $V_{IS}$ (V) | $V_{SS}$ (V) | $V_{DD}$ (V) | | VALUES typ. | VALUES max. | UNIT |
|---|---|---|---|---|---|---|---|---|---|---|
| **Control (address or inhibit)** | | | | | | | | | | |
| Propagation delay time: Address-to signal OUT channels ON or OFF | 0<br>0<br>0<br>– 5 | | | | 0<br>0<br>0<br>0 | 5<br>10<br>15<br>5 | | 360<br>160<br>120<br>225 | 720<br>320<br>240<br>450 | ns |
| Propagation delay time: Inhibit to signal OUT (channel turning ON) | 0<br>0<br>0<br>– 10 | 10 | | | 0<br>0<br>0<br>0 | 5<br>10<br>15<br>5 | | 360<br>160<br>120<br>200 | 720<br>320<br>240<br>400 | ns |
| Propagation delay time: Inhibit to signal OUT (channel turning OFF) | 0<br>0<br>0<br>– 10 | 0.3 | | | | 5<br>10<br>15<br>5 | | 200<br>90<br>70<br>130 | 450<br>210<br>160<br>300 | ns |
| 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 symetrical about $\frac{V_{DD} - V_{EE}}{2}$

(✲) Both ends of channel.

## FUNCTIONAL DIAGRAMS AND TRUTH TABLES

### MMC 4051

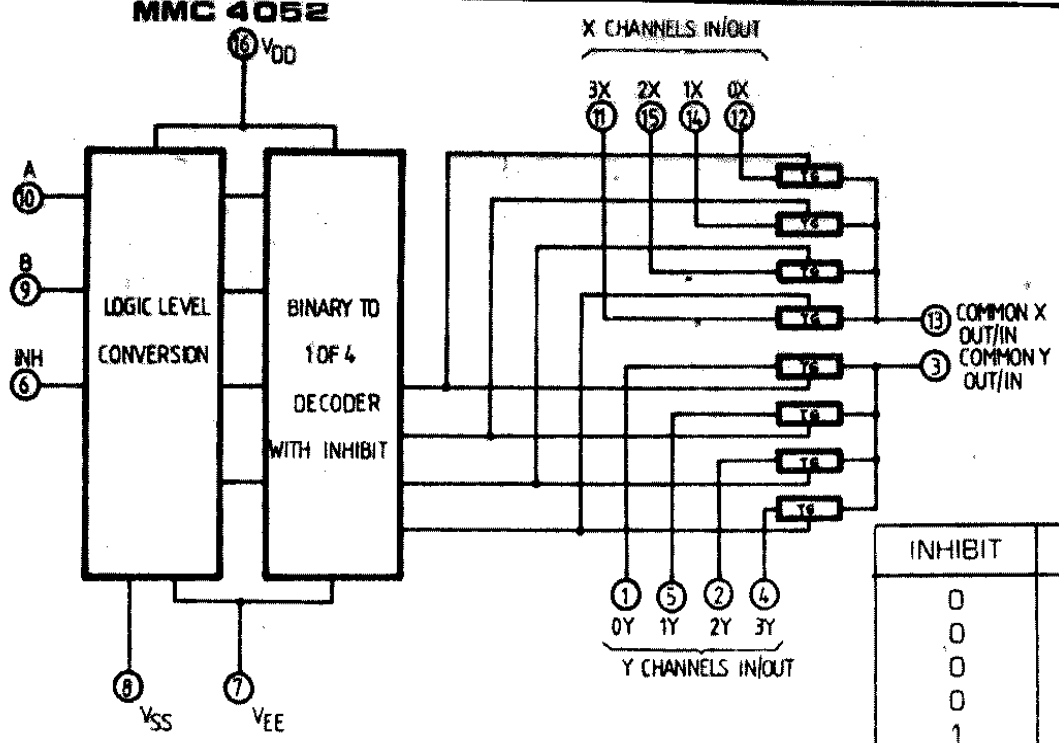



| INPUT STATES INHIBIT | C | B | A | „ON" CHANNEL(S) |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0 | 0 | 0 | 1 | 1 |
| 0 | 0 | 1 | 0 | 2 |
| 0 | 0 | 1 | 1 | 3 |
| 0 | 1 | 0 | 0 | 4 |
| 0 | 1 | 0 | 1 | 5 |
| 0 | 1 | 1 | 0 | 6 |
| 0 | 1 | 1 | 1 | 7 |
| 1 | X | X | X | NONE |

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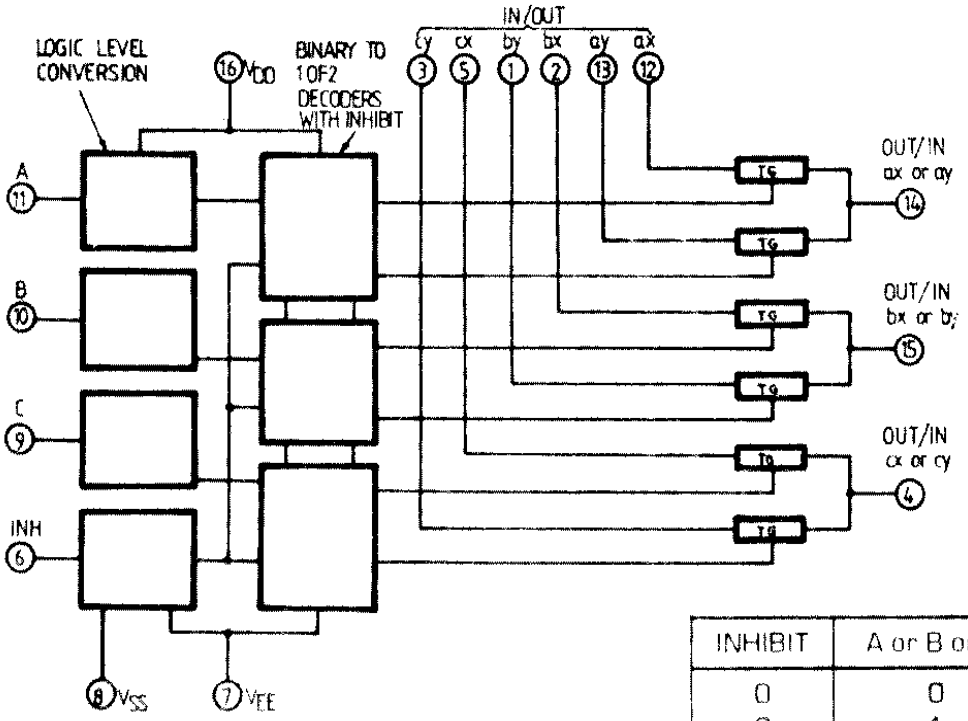


## MMC 4052




| 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 |

## MMC 4053




| INHIBIT | A or B or C | |
|---|---|---|
| 0 | 0 | ax or bx or cx |
| 0 | 1 | ay or by or cy |
| 1 | X | NONE |

## SPECIAL CONSIDERATIONS

Control of analog signals up to 20 V peak-to-peak can be achieved by digital signal amplitudes of 4.5 to 20 V (if $V_{DD}$ - $V_{SS}$ = 3 V a $V_{DD}$ - $V_{EE}$ of up to 13 V can be controlled; for $V_{DD}$ - $V_{EE}$ level differences above 13 V, 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. No $V_{DD}$ current will flow through $R_L$ if the switch current flows into lead 3 on the MMC 4051; leads 3 and 13 on the MMC 4052; leads 4, 14, 15 on the MMC 4053.