

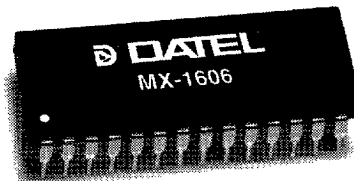
# MX/MXD Series

## 4/8/16-Channel, Input Protected CMOS, Analog Multiplexers



### FEATURES

- 200kHz sampling rates
- $\pm 0.01\%$  accuracy
- Dielectrically isolated CMOS technology
- Break-before-make switching
- Single-ended or differential inputs
- Overvoltage protection,  $\pm 35V$
- DTL/TTL/CMOS compatible
- 7.5mW standby power



### GENERAL DESCRIPTION

The MX and MXD Series analog multiplexers are 4, 8, and 16-channel monolithic devices manufactured with a dielectrically isolated complementary MOS process. The circuits incorporate analog and digital input protection which protects the units from both overvoltage and loss of power. The digital inputs are DTL/TTL/CMOS compatible and address the proper channel by means of a 2, 3, or 4-bit binary code. An inhibit input enables or disables the entire device and thus permits expansion of the number of channels by using several devices together. Another important feature of these multiplexers is the use of break-before-make switching to ensure that no two channels are ever momentarily shorted together.

Transfer accuracies of  $\pm 0.01\%$  can be achieved at channel sampling rates up to 200kHz and over  $\pm 10V$  signal ranges. These multiplexers are ideal for multichannel data acquisition systems where the multiplexer operates into a high-impedance load such as a sample-and-hold, buffer amplifier, or instrumentation amplifier.

Power consumption is only 7.5mW at standby and 15mW at 100kHz switching rates. Power supply range is  $\pm 5V$  to  $\pm 20V$ . The devices are packaged in 16 or 28-pin DIP's and operate over the 0 to  $+70^\circ C$  temperature range.

### INPUT/OUTPUT CONNECTIONS

| PIN | FUNCTION |         | PIN | FUNCTION |         |
|-----|----------|---------|-----|----------|---------|
|     | MX-808   | MXD-409 |     | MX-808   | MXD-409 |
| 1   | CA1      | CA1     | 16  | CA2      | CA2     |
| 2   | INHIBIT  | INHIBIT | 15  | CA4      | GND     |
| 3   | $-V_S$   | $-V_S$  | 14  | GND      | $+V_S$  |
| 4   | 1 IN     | 1A IN   | 13  | $+V_S$   | 1B IN   |
| 5   | 2 IN     | 2A IN   | 12  | 5 IN     | 2B IN   |
| 6   | 3 IN     | 3A IN   | 11  | 6 IN     | 3B IN   |
| 7   | 4 IN     | 4A IN   | 10  | 7 IN     | 4B IN   |
| 8   | OUT      | A OUT   | 9   | 8 IN     | B OUT   |

| PIN | FUNCTION |         | PIN | FUNCTION |         |
|-----|----------|---------|-----|----------|---------|
|     | MX-1606  | MXD-807 |     | MX-1606  | MXD-807 |
| 1   | $+V_S$   | $+V_S$  | 28  | OUT      | A OUT   |
| 2   | N.C.     | B OUT   | 27  | $-V_S$   | $-V_S$  |
| 3   | N.C.     | N.C.    | 26  | 8 IN     | 8A IN   |
| 4   | 16 IN    | 8B IN   | 25  | 7 IN     | 7A IN   |
| 5   | 15 IN    | 7B IN   | 24  | 6 IN     | 6A IN   |
| 6   | 14 IN    | 6B IN   | 23  | 5 IN     | 5A IN   |
| 7   | 13 IN    | 5B IN   | 22  | 4 IN     | 4A IN   |
| 8   | 12 IN    | 4B IN   | 21  | 3 IN     | 3A IN   |
| 9   | 11 IN    | 3B IN   | 20  | 2 IN     | 2A IN   |
| 10  | 10 IN    | 2B IN   | 19  | 1 IN     | 1A IN   |
| 11  | 9 IN     | 1B IN   | 18  | INHIBIT  | INHIBIT |
| 12  | GND      | GND     | 17  | CA1      | CA1     |
| 13  | $V_R$    | $V_R$   | 16  | CA2      | CA2     |
| 14  | CA8      | N.C.    | 15  | CA4      | CA4     |

NOTES: CA = Channel address  
 $V_R$  = Reference voltage  
 $V_S$  = Supply voltage  
N.C. = No connection

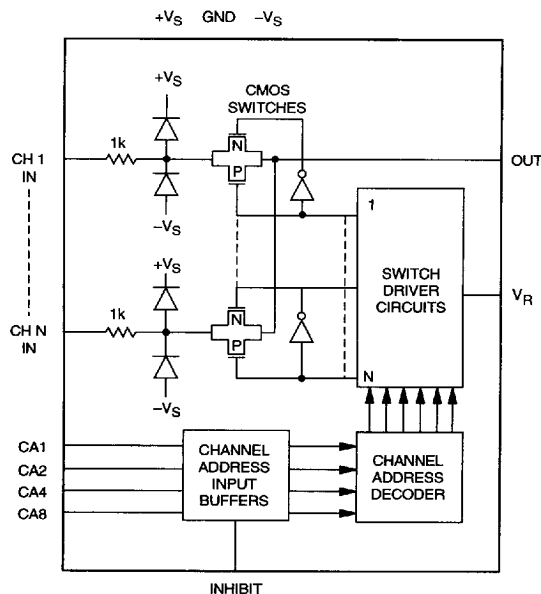


Figure 1. MX Series Functional Block Diagram

2651561 0003621 688

**ABSOLUTE MAXIMUM RATINGS**

| PARAMETERS                                                               | MX-808                             | MX-1606                            | MXD-409                            | MXD-807                            |
|--------------------------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|
| Voltage Between Supply Pins<br>V <sub>REF</sub> to Ground, V + to Ground | 40V<br>+20V                        | 40V<br>+20V                        | 40V<br>+20V                        | 40V<br>+20V                        |
| Input Overvoltage                                                        |                                    |                                    |                                    |                                    |
| Digital                                                                  | ±V <sub>S</sub> + 4V <sub>I</sub>  | ±V <sub>S</sub> + 4V <sub>I</sub>  | ±V <sub>S</sub> + 4V <sub>I</sub>  | ±V <sub>S</sub> + 4V <sub>I</sub>  |
| Analog                                                                   | ±V <sub>S</sub> + 20V <sub>I</sub> | ±V <sub>S</sub> + 20V <sub>I</sub> | ±V <sub>S</sub> + 20V <sub>I</sub> | ±V <sub>S</sub> + 20V <sub>I</sub> |
| Power Dissipation                                                        | 725mW                              | 1200mW                             | 725mW                              | 1200mW                             |

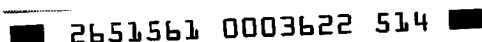
**FUNCTIONAL SPECIFICATIONS**

(Typical at +25°C, ±15V supplies and R source &lt;1k, unless otherwise noted.)

| ANALOG INPUTS                         | MX-808        | MX-1606       | MXD-409       | MXD-807       |
|---------------------------------------|---------------|---------------|---------------|---------------|
| Number of Channels                    | 8             | 16            | 4             | 8             |
| Type                                  | Single-ended  | Single-ended  | Differential  | Differential  |
| Input Voltage Range                   | ±15V          | ±15V          | ±15V          | ±15V          |
| Channel ON                            |               |               |               |               |
| Resistance                            | 1.5kΩ         | 1.5kΩ         | 1.5kΩ         | 1.5kΩ         |
| Resistance Over Temperature (maximum) | 2kΩ           | 2kΩ           | 2kΩ           | 2kΩ           |
| Leakage                               | 100pA         | 100pA         | 100pA         | 100pA         |
| Channel OFF                           |               |               |               |               |
| Input Leakage                         | 30pA          | 30pA          | 30pA          | 30pA          |
| Output Leakage                        | 0.1nA         | 0.1nA         | 0.1nA         | 0.1nA         |
| Input Capacitance                     | 12pF          | 12pF          | 12pF          | 12pF          |
| Output Capacitance                    | 25pF          | 50pF          | 12pF          | 30pF          |
| DIGITAL INPUTS ①                      |               |               |               |               |
| Logic "0" Threshold (maximum)         | +0.8V         | +0.8V         | +0.8V         | +0.8V         |
| Logic "1" Threshold, TTL (minimum) ②  | +4.0V         | +4.0V         | +4.0V         | +4.0V         |
| Logic "1" Threshold, CMOS (minimum) ③ | —             | +6.0V         | —             | +6.0V         |
| Input Current (maximum, high or low)  | 5μA           | 5μA           | 5μA           | 5μA           |
| Channel Address Coding                | 3 bits        | 4 bits        | 2 bits        | 3 bits        |
| Channel Inhibit (all channels OFF)    | Logic "0"     | Logic "0"     | Logic "0"     | Logic "0"     |
| PERFORMANCE                           |               |               |               |               |
| Transfer Error (maximum)              | ±0.01%        | ±0.01%        | ±0.01%        | ±0.01%        |
| Crosstalk (1kHz)                      | 0.005%        | 0.005%        | 0.005%        | 0.005%        |
| Common Mode Rejection                 | —             | —             | 120dB         | 120dB         |
| Settling Time (20V to ±0.1%) ④        | 1.2μs         | 1.2μs         | 1.2μs         | 1.2μs         |
| Settling Time (20V to ±0.01%) ④       | 3.5μs         | 3.5μs         | 3.5μs         | 3.5μs         |
| Turn ON Time                          | 500ns         | 500ns         | 500ns         | 500ns         |
| Turn OFF Time                         | 300ns         | 300ns         | 300ns         | 300ns         |
| Inhibit/Enable Delay                  | 300ns         | 300ns         | 300ns         | 300ns         |
| Break-Before-Make Delay               | 80ns          | 80ns          | 80ns          | 80ns          |
| POWER REQUIREMENTS                    |               |               |               |               |
| Rated Power Supply Voltage            | ±15V          | ±15V          | ±15V          | ±15V          |
| Power Supply Voltage Range            | ±5 to ±20V    | ±5 to ±20V    | ±5 to ±20V    | ±5 to ±20V    |
| Quiescent Current (maximum)           | +2, -1mA      | +2, -1mA      | +2, -1mA      | +2, -1mA      |
| Power Consumption (10kHz sampling)    | 7.5mW         | 7.5mW         | 7.5mW         | 7.5mW         |
| PHYSICAL/ENVIRONMENTAL                |               |               |               |               |
| Operating Temperature Range           | 0 to +70°C    | 0 to +70°C    | 0 to +70°C    | 0 to +70°C    |
| Storage Temperature Range             | -65 to +150°C | -65 to +150°C | -65 to +150°C | -65 to +150°C |
| Package                               | 16-pin DIP    | 28-pin DIP    | 16-pin DIP    | 28-pin DIP    |

**Footnotes:**

- ① The digital inputs are the channel address inputs and the inhibit input.
- ② To drive from DTL/TTL circuits, 1k pull-up resistors to +5V are recommended. With models MX-1606 and MXD-807, pin 13 should be left open.
- ③ For a +6.0V threshold with models MX-1606 and MXD-807, pin 13 is connected to +10V.
- ④ With a load impedance of >100 megohms in parallel with 2pF.



## TECHNICAL NOTES

1. The transfer accuracy of these multiplexers depends on both the source resistance and the load resistance. With zero source resistance, and assuming 2k Ohms maximum channel ON resistance, the load impedance should be at least 20 megohms to achieve 0.01% accuracy. In practice, it is recommended that a load impedance of at least 100 megohms be used to minimize errors. This can be done by using a good high-gain, high-CMR operational amplifier (such as DATEL's AM 462) as a buffer. Source resistance should be kept as low as possible so that accuracy is not affected; less than 1k Ohms is recommended. Higher source resistance, in addition to affecting accuracy, will degrade the settling time of the multiplexer.
2. For differential operation, two buffer amplifiers or a good quality instrumentation amplifier should be used. To maintain high CMR, source impedance unbalance should be kept to a minimum, the highest possible load impedance should be used, and an amplifier with high CMR should be chosen.
3. Channel expansion is accomplished using the inhibit input of the multiplexer. A logic "0" on this input disables the multiplexer. The expansion technique shown in Figure 2 applies to all of the multiplexer models.
4. The reference terminal ( $V_R$ ) sets the noise immunity level of the input logic for models MX-1606 and MXD-807. In most cases, this terminal is left open (TTL inputs). For higher level inputs (+6V minimum), this terminal should be connected to +10V. When addressing from DTL/TTL logic, use 1k Ohm pull-up resistors to the +5V supply.

## CHANNEL ADDRESSING

MX-1606

| CA<br>8 4 2 1 | Inhibit | ON<br>Channel |
|---------------|---------|---------------|
| X X X X       | 0       | None          |
| 0 0 0 0       | 1       | 1             |
| 0 0 0 1       | 1       | 2             |
| 0 0 1 0       | 1       | 3             |
| 0 0 1 1       | 1       | 4             |
| 0 1 0 0       | 1       | 5             |
| 0 1 0 1       | 1       | 6             |
| 0 1 1 0       | 1       | 7             |
| 0 1 1 1       | 1       | 8             |
| 1 0 0 0       | 1       | 9             |
| 1 0 0 1       | 1       | 10            |
| 1 0 1 0       | 1       | 11            |
| 1 0 1 1       | 1       | 12            |
| 1 1 0 0       | 1       | 13            |
| 1 1 0 1       | 1       | 14            |
| 1 1 1 0       | 1       | 15            |
| 1 1 1 1       | 1       | 16            |

MX-808, MXD-807

| CA<br>4 2 1 | Inhibit | ON<br>Channel |
|-------------|---------|---------------|
| X X X       | 0       | None          |
| 0 0 0       | 1       | 1             |
| 0 0 1       | 1       | 2             |
| 0 1 0       | 1       | 3             |
| 0 1 1       | 1       | 4             |
| 1 0 0       | 1       | 5             |
| 1 0 1       | 1       | 6             |
| 1 1 0       | 1       | 7             |
| 1 1 1       | 1       | 8             |

MXD-409

| CA<br>2 1 | Inhibit | ON<br>Channel |
|-----------|---------|---------------|
| X X       | 0       | None          |
| 0 0       | 1       | 1             |
| 0 1       | 1       | 2             |
| 1 0       | 1       | 3             |
| 1 1       | 1       | 4             |

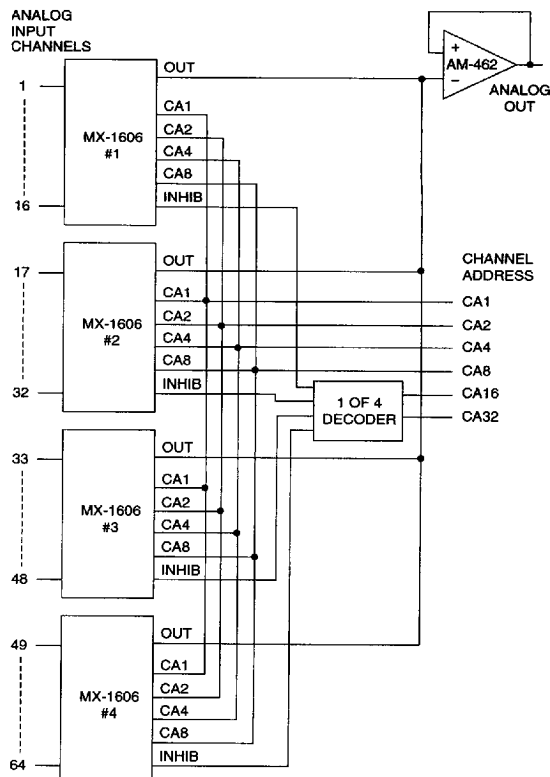


Figure 2. Expansion to 64 Channels

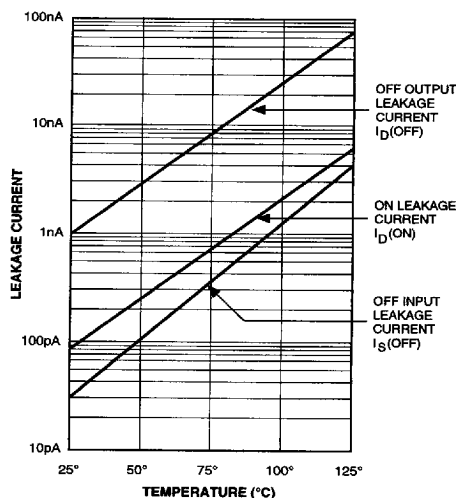


Figure 3. Leakage Current vs. Temperature

2651561 0003623 450

**PERFORMANCE GRAPHS**

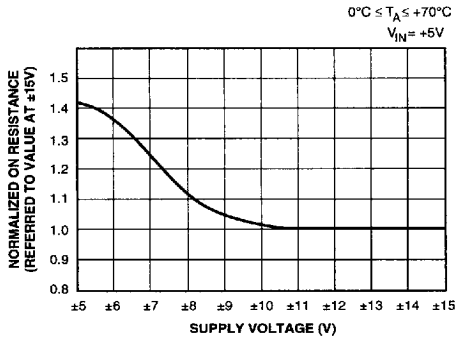


Figure 4. Normalized ON Resistance vs. Supply Voltage

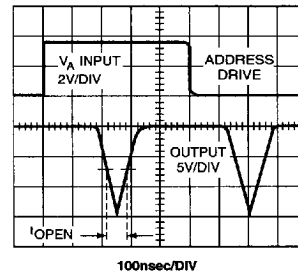


Figure 6. Break-Before-Make Delay ( $t_{\text{OPEN}}$ )

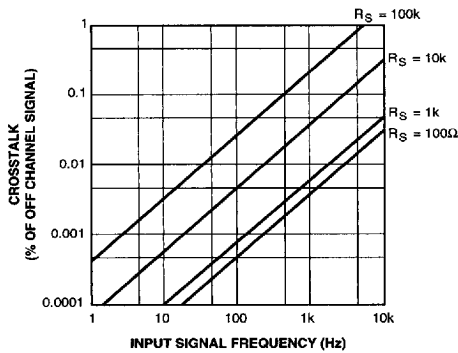


Figure 5. Crosstalk vs. Frequency of Input Signal

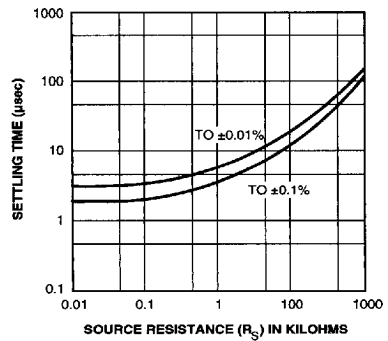


Figure 7. Settling Time vs. Source Resistance (20V Step)

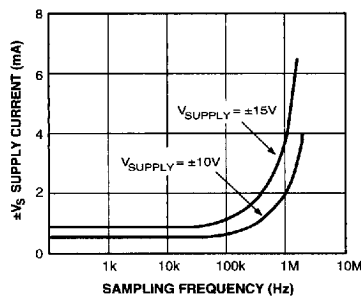
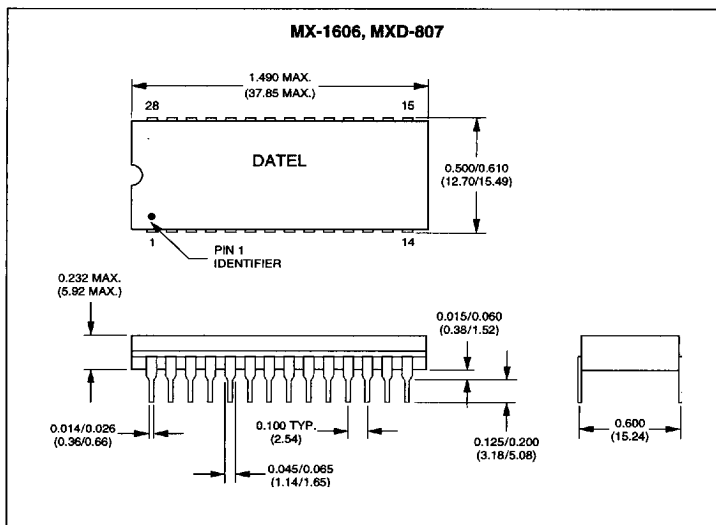
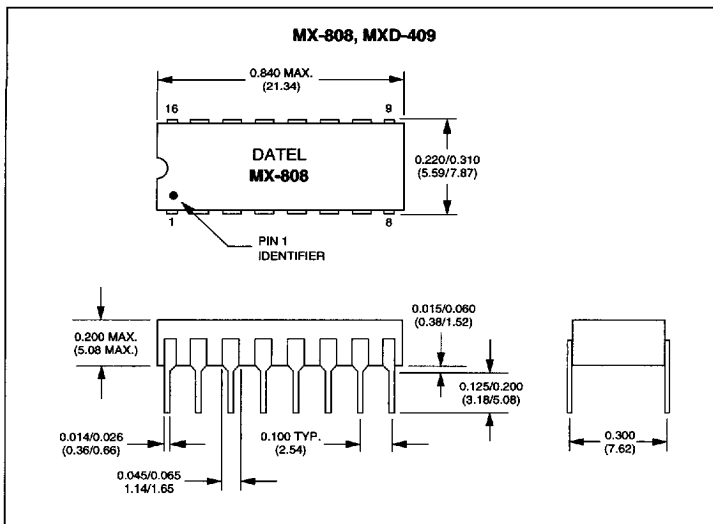


Figure 8. Supply Current vs. Sampling Frequency

# MECHANICAL DIMENSIONS

## INCHES (mm)



## ORDERING INFORMATION

| MODEL   | CHANNELS | OPERATING TEMP. RANGE |
|---------|----------|-----------------------|
| MX-808  | 8 S.E.   | 0 to +70°C            |
| MX-1606 | 16 S.E.  | 0 to +70°C            |
| MXD-409 | 4 Diff.  | 0 to +70°C            |
| MXD-807 | 8 Diff.  | 0 to +70°C            |

2651561 0003625 223