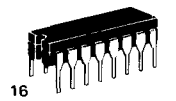
# MC12060 • MC12560
# MC12061 • MC12561

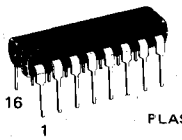
The MC12060/12560 and MC12061/12561 are designed for use with an external crystal to form a crystal controlled oscillator. In addition to the fundamental series mode crystal, two bypass capacitors are required (plus usual power supply pin bypass capacitors). Translators are provided internally for MECL and MTTL outputs.

- Frequency Range = 100 kHz to 2.0 MHz for MC12060/12560
  = 2.0 MHz to 20 MHz for MC12061/12561
- Temperature Range = -55°C to +125°C for MC12560, 61
  = 0°C to +70°C for MC12060, 61
- Single Supply Operation: +5.0 Vdc or -5.2 Vdc
- Three Outputs Available:
  1. Complementary Sine Wave (600 mVp-p typ)
  2. Complementary MECL
  3. Single Ended MTTL



16 1

**L SUFFIX**
CERAMIC PACKAGE
CASE 620

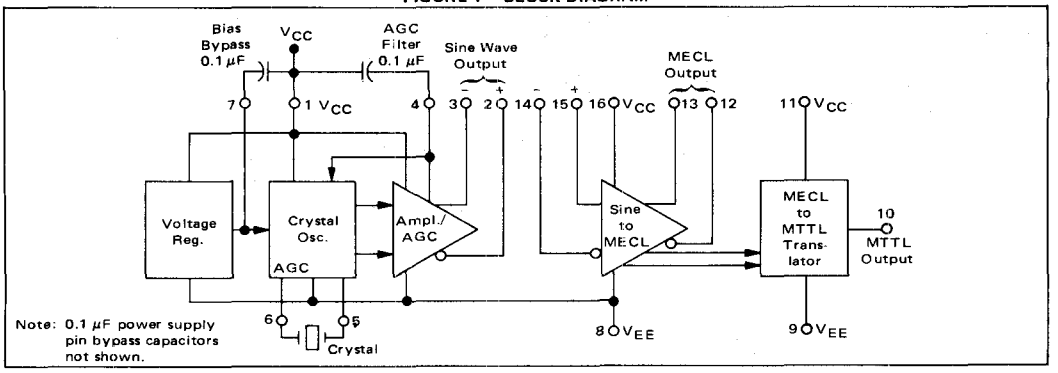


16 1

**P SUFFIX**
PLASTIC PACKAGE
CASE 648

MC12060/MC12061 only.

**FIGURE 1 – BLOCK DIAGRAM**




**TYPICAL CIRCUIT CONFIGURATIONS** Note: 0.1 μF power supply pin bypass capacitors not shown.

**FIGURE 2 – SINE WAVE OUTPUT**

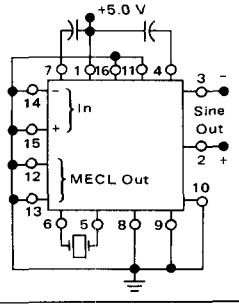



**FIGURE 3 – MTTL OUTPUT**

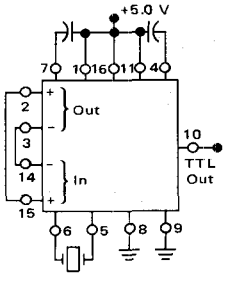



**FIGURE 4 – MECL OUTPUT** (+5.0 V Supply)

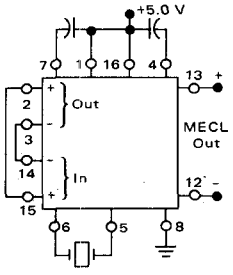
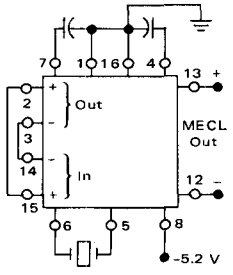



**FIGURE 5 – MECL OUTPUT** (-5.2 V Supply)



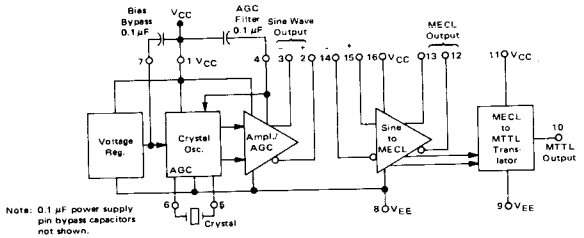

**CRYSTAL REQUIREMENTS**

Note: Start-up stabilization time is a function of crystal series resistance. The lower the resistance, the faster the circuit stabilizes.

| Characteristic | MC12060/12560 | MC12061/12561 |
|---|---|---|
| Mode of Operation | Fundamental Series Resonance | |
| Frequency Range | 100 kHz – 2.0 MHz | 2.0 MHz – 20 MHz |
| Series Resistance, R1 | Minimum at Fundamental | |
| Maximum Effective Resistance, $R_{E(max)}$ | 4 k ohms | 155 ohms |

6

## ELECTRICAL CHARACTERISTICS

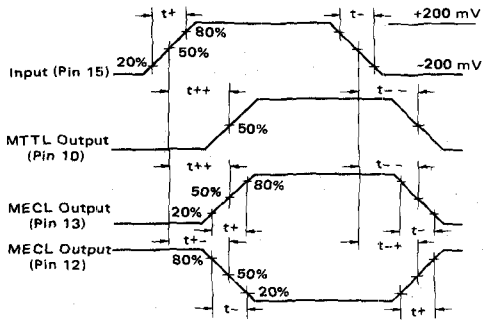


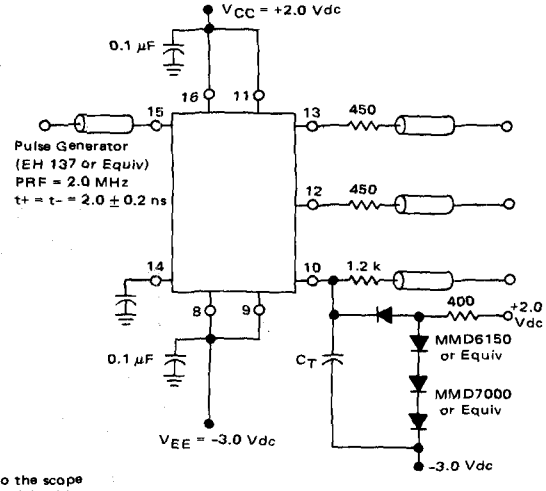

| @ Test Temperature | | TEST VOLTAGE/CURRENT VALUES | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Volts | | | | | | | | mA | | |
| | | $V_{IHmax}$ | $V_{ILmin}$ | $V_{IHAmin}$ | $V_{ILAmax}$ | $V_{IHT}$ | $V_{CCL}$ | $V_{CC}$ | $V_{CCH}$ | $I_{OL}$ | $I_{OH}$ | $I_L$ |
| MC12560, MC12561 | -55°C | 4.07 | 3.18 | 3.72 | 3.49 | 4.0 | 4.5 | 5.0 | 5.5 | 16 | -0.4 | -2.5 |
| | +25°C | 4.19 | 3.21 | 3.90 | 3.52 | 4.0 | 4.5 | 5.0 | 5.5 | 16 | -0.4 | -2.5 |
| | +125°C | 4.37 | 3.25 | 4.03 | 3.60 | 4.0 | 4.5 | 5.0 | 5.5 | 16 | -0.4 | -2.5 |
| MC12060, MC12061 | 0°C | 4.16 | 3.19 | 3.86 | 3.51 | 4.0 | 4.75 | 5.0 | 5.25 | 16 | -0.4 | -2.5 |
| | +25°C | 4.19 | 3.21 | 3.90 | 3.52 | 4.0 | 4.75 | 5.0 | 5.25 | 16 | -0.4 | -2.5 |
| | +75°C | 4.28 | 3.23 | 3.96 | 3.55 | 4.0 | 4.75 | 5.0 | 5.25 | 16 | -0.4 | -2.5 |

| Characteristic | Symbol | Pin Under Test | MC12560, MC12561 -55°C Min | -55°C Max | +25°C Min | +25°C Typ | +25°C Max | +125°C Min | +125°C Max | MC12060, MC12061 0°C Min | 0°C Max | +25°C Min | +25°C Typ | +25°C Max | +75°C Min | +75°C Max | Unit | TEST VOLTAGE/CURRENT APPLIED TO PINS LISTED BELOW $V_{IHmax}$ | $V_{ILmin}$ | $V_{IHAmin}$ | $V_{ILAmax}$ | $V_{IHT}$ | $V_{CCL}$ | $V_{CC}$ | $V_{CCH}$ | $I_{OL}$ | $I_{OH}$ | $I_L$ | Gnd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Power Supply Drain Current | $I_{CC}$ | | | | | | | | | | | | | | | | mAdc | | | | | | | | | | | |
| – MC12060/12560 | | 1 | – | – | 13 | 16 | 19 | – | – | | | 13 | 16 | 19 | – | – | | – | – | – | – | – | – | 1 | – | – | – | – | 8 |
| – MC12061/12561 | | 1 | – | – | 18 | 23 | 28 | – | – | – | – | 18 | 23 | 28 | – | – | | – | – | – | – | – | – | 1 | – | – | – | – | 8 |
| | | 11 | – | – | – | 3.0 | 4.0 | – | – | – | – | – | 3.0 | 4.0 | – | – | | 14 | 15 | – | – | – | – | 11,16 | – | – | – | – | 8,9 |
| | | 16 | – | – | 13 | 16 | 19 | – | – | – | – | 13 | 16 | 19 | – | – | | – | – | – | – | – | – | 16 | – | – | – | – | 8 |
| Input Current | $I_{INH}$ | 14 | – | – | – | – | 250 | – | – | – | – | – | – | 250 | – | – | μAdc | 14 | 15 | – | – | – | – | 16 | – | – | – | – | 8 |
| | | 15 | – | – | – | – | 250 | – | – | – | – | – | – | 250 | – | – | μAdc | 15 | 14 | – | – | – | – | 16 | – | – | – | – | 8 |
| | $I_{INL}$ | 14 | – | – | – | – | 1.0 | – | – | – | – | – | – | 1.0 | – | – | μAdc | 15 | – | – | – | – | – | 16 | – | – | – | – | 8,14 |
| | | 15 | – | – | – | – | 1.0 | – | – | – | – | – | – | 1.0 | – | – | μAdc | 14 | – | – | – | – | – | 16 | – | – | – | – | 8,15 |
| Differential Offset Voltage | ΔV | 4 to 7 | – | – | 40 | – | 325 | – | – | – | – | 40 | – | 325 | – | – | mVdc | – | – | – | – | 5,6 | – | 1 | – | – | – | – | 8 |
| MC12060/12560 | | 2 to 3 | – | – | -220 | 0 | +220 | – | – | – | – | -300 | 0 | +300 | – | – | | – | – | – | – | 4 | – | 4 | – | – | – | – | |
| MC12061/12561 | | 2 to 3 | – | – | -100 | 0 | +100 | – | – | – | – | -200 | 0 | +200 | – | – | | – | – | – | – | 4 | – | 4 | – | – | – | – | |
| Output Voltage Level | $V_{out}$ | 2 | – | – | – | 3.5 | – | – | – | – | – | – | 3.5 | – | – | – | Vdc | – | – | – | – | 4 | – | 1 | – | – | – | – | 8 |
| | | 3 | – | – | – | 3.5 | – | – | – | – | – | – | 3.5 | – | – | – | Vdc | – | – | – | – | 4 | – | 1 | – | – | – | – | 8 |
| Logic "1" Output Voltage | $V_{OH1}$* | 12 | 3.92 | 4.07 | 4.04 | – | 4.19 | 4.17 | 4.37 | 4.00 | 4.16 | 4.04 | – | 4.19 | 4.10 | 4.28 | Vdc | 14 | 15 | – | – | – | – | 16 | – | – | – | 12 | 8 |
| | | 13 | 3.92 | 4.07 | 4.04 | – | 4.19 | 4.17 | 4.37 | 4.00 | 4.16 | 4.04 | – | 4.19 | 4.10 | 4.28 | Vdc | 15 | 14 | – | – | – | – | 16 | – | – | – | 13 | 8 |
| | $V_{OH2}$ | 10 | 2.4 | – | 2.4 | – | – | 2.4 | – | 2.4 | – | 2.4 | – | – | 2.4 | – | Vdc | 15 | 14 | – | – | – | 11,16 | – | – | – | 10 | – | 8,9 |
| Logic "0" Output Voltage | $V_{OL1}$* | 12 | 2.97 | 3.39 | 3.00 | – | 3.44 | 3.04 | 3.50 | 2.98 | 3.43 | 3.00 | – | 3.44 | 3.02 | 3.47 | Vdc | 15 | 14 | – | – | – | – | 16 | – | – | – | 12 | 8 |
| | | 13 | 2.97 | 3.39 | 3.00 | – | 3.44 | 3.04 | 3.50 | 2.98 | 3.43 | 3.00 | – | 3.44 | 3.02 | 3.47 | Vdc | 14 | 15 | – | – | – | – | 16 | – | – | – | 13 | 8 |
| | $V_{OL2}$ | 10 | – | 0.5 | – | – | 0.5 | – | 0.5 | – | 0.5 | – | – | 0.5 | – | 0.5 | Vdc | 14 | 15 | – | – | – | 11,16 | – | – | 10 | – | – | 8,9 |
| | | 10 | – | 0.5 | – | – | 0.5 | – | 0.5 | – | 0.5 | – | – | 0.5 | – | 0.5 | Vdc | 14 | 15 | – | – | – | – | – | 11,16 | 10 | – | – | 8,9 |
| Logic "1" Threshold Voltage | $V_{OHA}$ | 12 | 3.90 | – | 4.02 | – | – | 4.15 | – | 3.98 | – | 4.02 | – | – | 4.08 | – | Vdc | – | – | 14 | 15 | – | – | 16 | – | – | – | 12 | 8 |
| | | 13 | 3.90 | – | 4.02 | – | – | 4.15 | – | 3.98 | – | 4.02 | – | – | 4.08 | – | Vdc | – | – | 15 | 14 | – | – | 16 | – | – | – | 13 | 8 |
| Logic "0" Threshold Voltage | $V_{OLA}$ | 12 | – | 3.41 | – | – | 3.46 | – | 3.52 | – | 3.45 | – | – | 3.46 | – | 3.49 | Vdc | – | – | 15 | 14 | – | – | 16 | – | – | – | 12 | 8 |
| | | 13 | – | 3.41 | – | – | 3.46 | – | 3.52 | – | 3.45 | – | – | 3.46 | – | 3.49 | Vdc | – | – | 14 | 15 | – | – | 16 | – | – | – | 13 | 8 |
| Output Short-Circuit Current | $I_{OS}$ | 10 | 20 | 60 | 20 | – | 60 | 20 | 60 | 20 | 60s | 20 | – | 60 | 20 | 60 | mAdc | 15 | 14 | – | – | – | 11,16 | – | – | – | – | – | 8,9,10 |

*Devices will meet standard MECL logic levels using $V_{EE}$ = -5.2 Vdc and $V_{CC}$ = 0.

FIGURE 6 – AC CHARACTERISTICS – MECL AND MTTL OUTPUTS




All input and output cables to the scope are equal lengths of 50 Ω coaxial cable.

Unused outputs are connected to a 50 Ω ±1% resistor to ground.

$C_T$ = 15 pF = total parasitic capacitance which includes probe, wiring, and load capacitance.

| Characteristic | Symbol | Pin Under Test | MC12560, MC12561 -55°C Min | -55°C Max | +25°C Min | +25°C Typ | +25°C Max | +125°C Min | +125°C Max | MC12060, MC12061 0°C Min | 0°C Max | +25°C Min | +25°C Typ | +25°C Max | +75°C Min | +75°C Max | Unit | TEST VOLTAGES/WAVEFORMS APPLIED TO PINS LISTED BELOW: Pulse In | Pulse Out | +2.0 Vdc | -3.0 Vdc | Gnd |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Propagation Delay | $t_{15+10+}$ | 10 | – | 30 | – | 17 | 25 | – | 30 | – | 22 | – | 17 | 25 | – | 27 | ns | 15 | 10 | 11,16 | 8,9 | 14 |
| | $t_{15-10-}$ | 10 | – | 22 | – | 12 | 18 | – | 22 | – | 19 | – | 12 | 18 | – | 18 | | | 10 | | | |
| | $t_{15+12-}$ | 12 | – | 5.0 | – | 4.3 | 5.5 | – | 6.0 | – | 5.2 | – | 4.3 | 5.5 | – | 5.8 | | | 12 | | | |
| | $t_{15-12+}$ | 12 | – | 4.8 | – | 3.7 | 5.2 | – | 5.5 | – | 5.0 | – | 3.7 | 5.2 | – | 5.2 | | | 12 | | | |
| | $t_{15+13+}$ | 13 | – | 4.6 | – | 4.0 | 5.0 | – | 5.4 | – | 4.8 | – | 4.0 | 5.0 | – | 5.2 | | | 13 | | | |
| | $t_{15-13-}$ | 13 | – | 5.0 | – | 4.0 | 5.0 | – | 5.2 | – | 5.0 | – | 4.0 | 5.0 | – | 5.1 | | | 13 | | | |
| Rise Time | $t_{12+}$ | 12 | – | 3.8 | – | 3.0 | 4.0 | – | 5.0 | – | 4.0 | – | 3.0 | 4.0 | – | 4.4 | ns | 15 | 12 | 11,16 | 8,9 | 14 |
| | $t_{13+}$ | 13 | – | 3.8 | – | 3.0 | 4.0 | – | 5.0 | – | 4.0 | – | 3.0 | 4.0 | – | 4.4 | ns | 15 | 13 | 11,16 | 8,9 | 14 |
| Fall Time | $t_{12-}$ | 12 | – | 3.8 | – | 3.0 | 4.0 | – | 4.5 | – | 4.0 | – | 3.0 | 4.0 | – | 4.0 | ns | 15 | 12 | 11,16 | 8,9 | 14 |
| | $t_{13-}$ | 13 | – | 3.8 | – | 3.0 | 4.0 | – | 4.5 | – | 4.0 | – | 3.0 | 4.0 | – | 4.0 | ns | 15 | 13 | 11,16 | 8,9 | 14 |

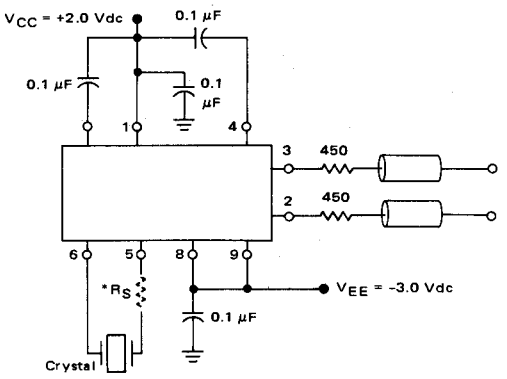
6

FIGURE 7 – AC TEST CIRCUIT – SINE WAVE OUTPUT

Crystal – Reeves Hoffman Series Mode, Series Resistance Minimum at Fundamental
MC12060/12560:
f = 500 kHz
$R_E$ = 1 k Ω
MC12061/12561:
f = 10 MHz
$R_E$ = 5 Ω

*$R_S$ – MC12060/12560 = 3 kΩ
MC12061/12561 = 150 Ω
$R_S$ is inserted only for test purposes. When used with the above specified crystal, it guarantees oscillation with any crystal which has an equivalent series resistance ≤ 4 kΩ for MC12060/12560 and 155 Ω for MC12061/12561.

All output cables to the scope are equal lengths of 50 Ω coaxial cable. All unused cables must be terminated with a 50 Ω ±1% resistor to ground.
450 Ω resistor and the scope termination impedance constitute a 10:1 attenuator probe.




| Characteristic | Pin Under Test | MC12560 MC12561 +25°C Min | MC12560 MC12561 +25°C Typ | MC12060 MC12061 +25°C Min | MC12060 MC12061 +25°C Typ | Unit | TEST VOLTAGE APPLIED TO PINS LISTED BELOW +2.0 Vdc | TEST VOLTAGE APPLIED TO PINS LISTED BELOW -3.0 Vdc |
|---|---|---|---|---|---|---|---|---|
| Sine Wave Amplitude | | | | | | | | |
| MC12060/12560 | 2 | 600 | 675 | 500 | 650 | mVp-p | 1 | 8,9 |
| | 3 | 600 | 675 | 500 | 650 | | | |
| MC12061/12561 | 2 | 700 | 750 | 650 | 750 | | | |
| | 3 | 700 | 750 | 650 | 750 | | | |

## OPERATING CHARACTERISTICS

The MC12060/12560 and MC12061/12561 consist of three basic sections: an oscillator with AGC and two translators (Figure 1). Buffered complementary sine wave outputs are available from the oscillator section. The translators convert these sine wave outputs to levels compatible with MECL and/or MTTL.

Series mode crystals should be used with the oscillator. If it is necessary or desirable to adjust the crystal frequency, a reactive element can be inserted in series with the crystal – an inductor to lower the frequency or a capacitor to raise it. When such an adjustment is necessary, it is recommended that the crystal be specified slightly lower in frequency and a series trimmer capacitor be added to bring the oscillator back on frequency. As the oscillator frequency is changed from the natural resonance of the crystal, more and more dependence is placed on the external reactance, and temperature drift of the trimming components then affects overall oscillator performance.

The MC12060/12560 and MC12061/12561 are designed to operate from a single supply – either +5.0 Vdc or -5.2 Vdc. Although each translator has separate $V_{CC}$ and $V_{EE}$ supply pins, the circuit is NOT designed to operate from both voltage levels at the same time. The separate $V_{EE}$ pin from the MTTL translator helps minimize transient disturbance. If neither translator is being used, all unused pins (9 thru 16) should be connected to $V_{EE}$ (pin 8). With the translators not powered, supply current drain is typically reduced from 35 mA to 16 mA for the MC12060/12560, and from 42 mA to 23 mA for the MC12061/12561.

**Frequency Stability**

Output frequency of different oscillator circuits (of a given device type number) will vary somewhat when used with a given test setup, however the variation should be within approximately ±0.001% from unit to unit.

Frequency variations with temperature (independent of the crystal, which is held at 25°C) are small – about -0.08 ppm/°C for MC12061/12561 operating at 8.0 MHz, and about -0.16 ppm/°C for MC12060/12560 operating at 1.0 MHz (see Figure 8).

**Signal Characteristics**

The sine wave outputs at either pin 2 or pin 3 will typically range from 800 mVp-p (no load) to 500 mVp-p (120 ohm ac load). Approximately 500 mVp-p can be provided across 50 ohms by slightly increasing the dc current in the output buffer by the addition of an external resistor (680 ohms) from pin 2 or 3 to ground, as shown in Figure 9. Frequency drift is typically less than 0.0003% when going from a high-impedance load (1 megohm, 15 pF) to the 50-ohm load of Figure 9. The dc voltage level at pin 2 or 3 is nominally 3.5 Vdc with $V_{CC}$ = +5.0 Vdc.

Harmonic distortion content in the sine wave outputs is crystal as well as circuit dependent. The largest harmonic (third) will usually be at least 15 dB down from the fundamental. The harmonic content is approximately load independent except that the higher harmonic levels (greater than the fifth) are increased when the MECL translator is being driven.

Typically, the MECL outputs (pins 12 and 13) will drive up to five gates, as defined in Figure 10, and the MTTL output (pin 10) will drive up to ten gates, as defined in Figure 11.

**Noise Characteristics**

Noise level evaluation of the sine wave outputs using the circuit of Figure 12, with operation at 1.0 MHz for MC12060/12560 or 9.0 MHz for MC12061/12561, indicates the following characteristics:

1. Noise floor (200 kHz from oscillator center frequency) is approximately -122 dB when referenced to a 1.0 Hz bandwidth. Noise floor is not sensitive to load conditions and/or translator operation.
2. Close-in noise (100 Hz from oscillator center frequency) is approximately -88 dB when referenced to a 1.0 Hz bandwidth.

6

FIGURE 8 – FREQUENCY SHIFT versus TEMPERATURE

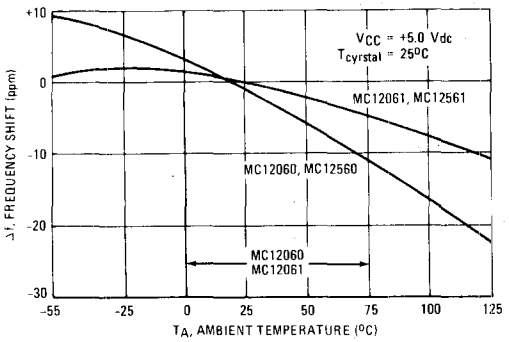



FIGURE 9 – DRIVING LOW-IMPEDANCE LOADS

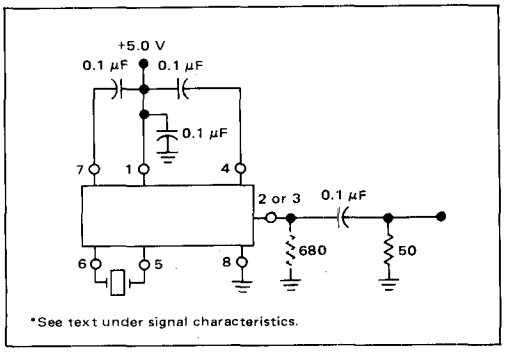



FIGURE 10 – MECL TRANSLATOR LOAD CAPABILITY

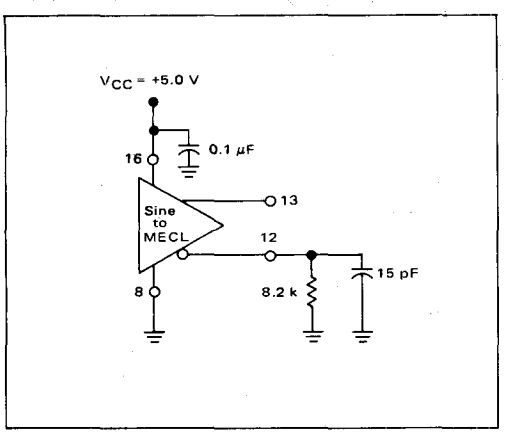



FIGURE 11 – MTTL TRANSLATOR LOAD CAPABILITY

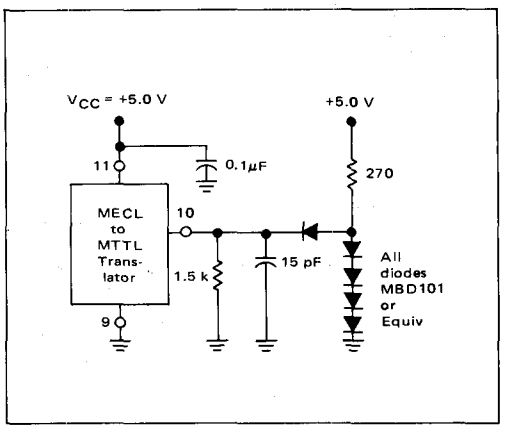
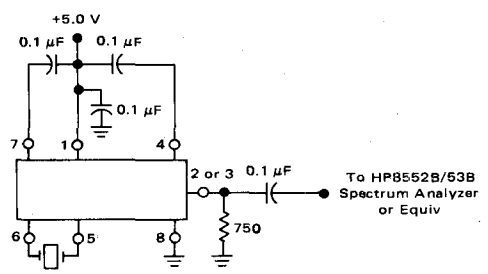


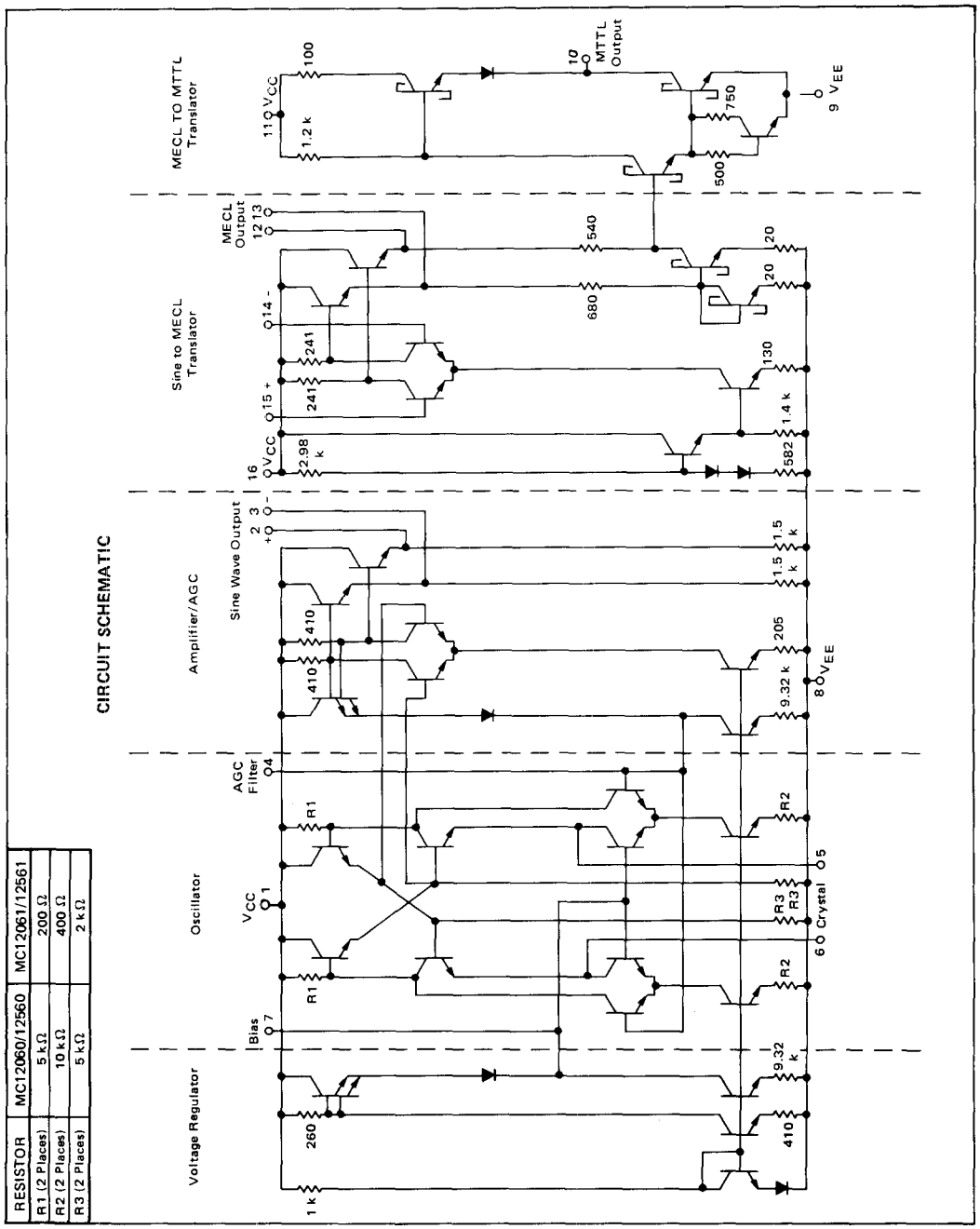

FIGURE 12 – NOISE MEASUREMENT TEST CIRCUIT




ANALYZER SETTING

| Measurement | Sweep | Bandwidth | Video Filter |
|---|---|---|---|
| Noise Floor | 50 kHz/div | 10 kHz | 10 Hz |
| *Close-In Noise* | 20 kHz/div | 10 Hz | 10 Hz |

6




| RESISTOR | MC12060/12560 | MC12061/12561 |
|---|---|---|
| R1 (2 Places) | 5 kΩ | 200 Ω |
| R2 (2 Places) | 10 kΩ | 400 Ω |
| R3 (2 Places) | 5 kΩ | 2 kΩ |