Φ INFRARED SYSTEMS DEVELOPMENT CORPORATION

MCT-1000 Preamplifier For Photoconductive MCT (HgCdTe)

1. Theory Of Operation:

The MCT-1000 Series preamplifiers are current-mode trans-resistance preamplifiers with a second gain stage. The first stage is a typical current-mode op-amp with the detector connected to the inverting input. A low-noise DC voltage is summed into this input node to provide a majority of the required bias current. The non-inverting input is connected to an adjustable DC voltage derived form the Bias voltage. This allows the first stage amplifier to operate in closed loop DC mode with the bias current. The Bias supply is balanced with the select components to allow the first stage op-amp to have a quiescent current of 0 amps, and up to +/- 20 ma for signal current, since the quiescent bias current is summed with the amplifiers input. This allows for adjustment of the Bias voltage without affecting the 0V DC level of the first stage output.

Negative feedback is used to convert the change in bias current in the detector (due to signal) to a voltage. This first stage typically has a voltage gain of 10-15 V/V and a trans-impedance gain of 500 to 1000 Volts per Amp.

The output of the first stage is coupled through a large (100uf) non-polar capacitor to the second stage. This AC coupling capacitor typically provides a 1.5 Hz low frequency roll-on pole to remove any DC drift or ambient background drifts. The AC coupling can be removed for DC coupled operation.

The second stage is a standard type voltage amplifier with an adjustable gain from 5 to 120. The output impedance of the second stage is 50 ohms and need only be matched for very high bandwidth versions of the MCT-1000 (>5 Mhz). The output level is bi-polar with +/- 12V limits when operated at +/-15V. The preamplifier is typically used with the output connected directly to the input of another post-amplifier, A/D card, signal processor, Oscilloscope, or any other type of test equipment without need for impedance matching or special cabling.

The noise performance of the MCT-1000 is excellent and typically less than 1 nv per root hertz (nv/$Hz^{1/2}$). Typical MCT detector noise is 3-10

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nv/Hz$^{1/2}$, allowing the MCT-1000 to provide detector noise limited performance in all cases.

Frequency response is determined by the selected amplifier components, and is typically 1.5 Hz to 150Khz in standard configuration. Other configurations include 1 Mhz and 10Mhz versions. Please refer to the specific test datasheet to determine the actual parameters that your MCT-1000 has been configured for. MCT-1000, MCT-1000DC (DC coupled), MCT-1000HS (High Speed >1 MHz) etc.

2. Output Impedance:

The MCT-1000 output is a low impedance coupled through a current limiting 50 Ohm resistor. The Output is designed to be connected to relatively high impedance devices such as Oscilloscopes, A/D converter inputs. The Output should never be connected to a 50 Ohm Scope or any other 50 Ohm terminated load.

3. General:

3.1. The MCT-1000 was specifically designed to operate with Photoconductive Mercury Cadmium Telluride detectors. The low noise and high gain aspects coupled with a precision constant voltage bias provide an ideal complement to these detectors.

3.2. The MCT-1000 preamplifier provides the MCT detector with all of the interface circuitry required for optimum operation. No external bias or load resistors are required.

The MCT detector is connected to the input BNC connector with an SMA – BNC cable typically supplied with the detector. Positive and Negative 15 Volt DC power supplies with at least 200-milliampere output (100 ma for -15V) are required. The detector bias is internally provided, and the bias voltage (or current) is adjustable from typically 0V to +2.5 Volts. The electrical bandwidth is internally set to 1.5Hz to 150Khz, other bandwidths are available. Adjustable gain provides variable signal amplitude typically from 50 to 1000 times. The Bias Voltage and Gain are affected by the detector impedance, and as all detectors are slightly different in resistance, there will be a slight variation in maximum bias voltage and maximum gain.

3.3. CAUTION:

Carefully read and follow the bias and offset adjustment procedures (2) below prior to initial operation. Failure to follow these instructions may result in detector or circuit damage.

4. Initial Operation Procedure:

4.1. Set Detector at its proper operating temperature by filling the dewar with liquid nitrogen or applying TE cooler power. Wait for detector to come to operating temperature before proceeding.

4.2. Refer to figure 1 for location of connectors and adjustment access areas, and figure 2 and figure 3 for proper circuit connections.

4.3. Connect a BNC "TEE" connector to the preamp input. Connect one end of the BNC "TEE" to a digital voltmeter (+ is center and shell is -), and connect the other end of the BNC "TEE" to the detector cable. Connect the detector cable to the detector SMA connector. See Figure 2.

4.4. With a small screwdriver, turn the BIAS adjustment potentiometer fully Clockwise (CW). Access is made through the access port near the Input BNC.

4.5. Be sure power supply is off and run wires from the power supply to the +15V, -15V and Ground terminals on the preamp.

4.6. Set the voltmeter for 0-3 volt scale and adjust bias potentiometer until the voltage at the input BNC "TEE" is one-half of the optimum bias voltage.

Note: Optimum Bias voltage can be found by using the optimum bias current and detector resistance values from the detector data sheet supplied by the manufacturer.

Bias Voltage = (Bias Current * Detector Resistance)

Example: Bias current from data sheet = 20 ma
Detector resistance at operating temperature = 50 ohms

Bias Voltage = 0.02 * 50 = 1 Volt

4.7. Move digital Voltmeter (+) wire to the Zero Adjust test point (see Figure 3) TP1 and adjust the ZERO potentiometer with a small screwdriver either clockwise or counter-clockwise to bring the voltage at TP1 to 0.0 ± 0.020 volts.

4.8. Move digital voltmeter back the BNC "TEE" connector and adjust bias voltage for optimum bias voltage determined in step 2.6 above.

4.9. The DC voltage at TP1 must be set between +5 volts and –5 volts for proper preamp operation. If the voltage at TP1 is not at 0.0 ± 0.020 volts, there will be interaction between Bias and Zero adjustments. Be sure to repeat the adjustment of Zero and Bias until the bias voltage is correct and the voltage at TP1 is between +5 volts and –5 volts. TP1 set to 0.0 ± 0.020 volts provides maximum preamplifier output swing and prevents clipping of very large input energies.

4.10. The MCT-1000 is now setup for use with your detector and need not be re-adjusted if the detector or its temperature do not change.

5. Gain Adjustment:

5.1. Carefully, with a small screwdriver adjust the GAIN potentiometer through the access port in the preamp case to the desired gain level.

5.2. The GAIN adjustment potentiometer is a 10 turn miniature potentiometer. As you reach the limits of the 10 turn pot, a slight clocking sound can be heard.

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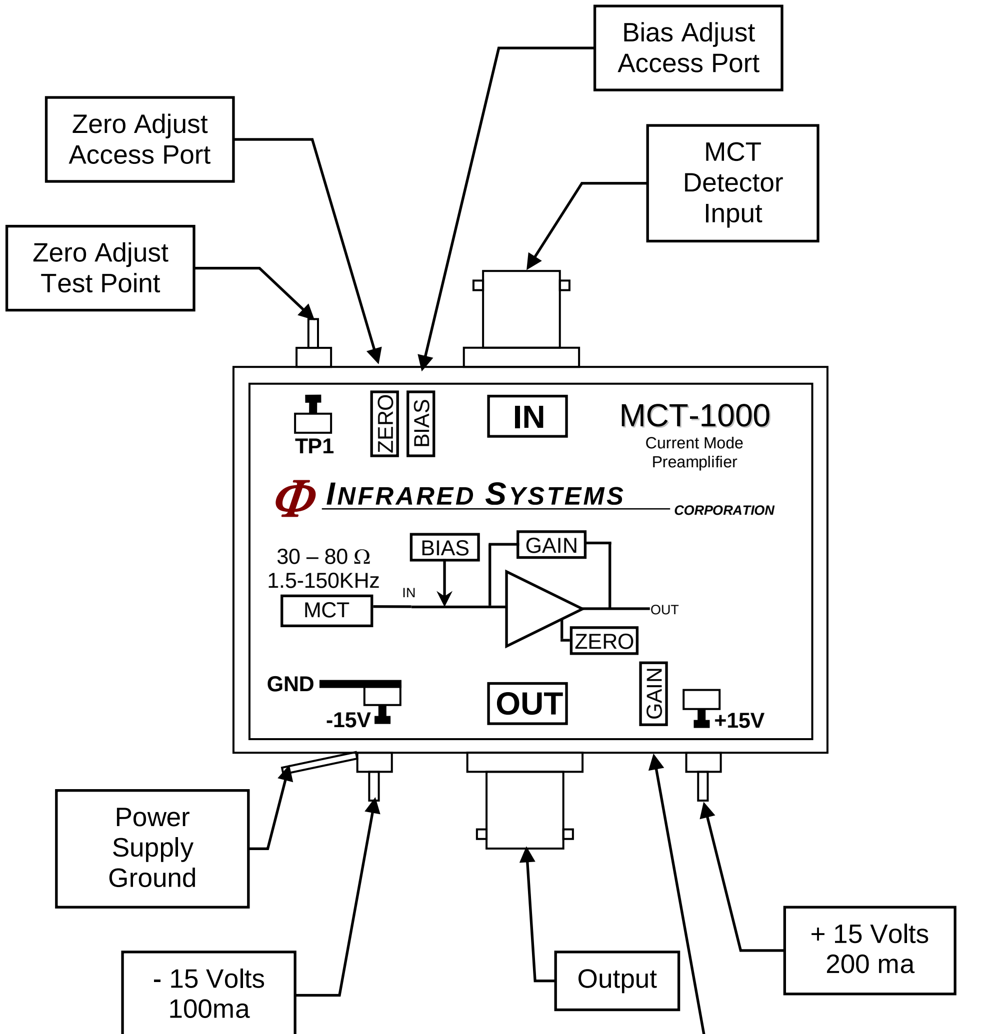

MCT-1000 Preamplifier
Figure 1

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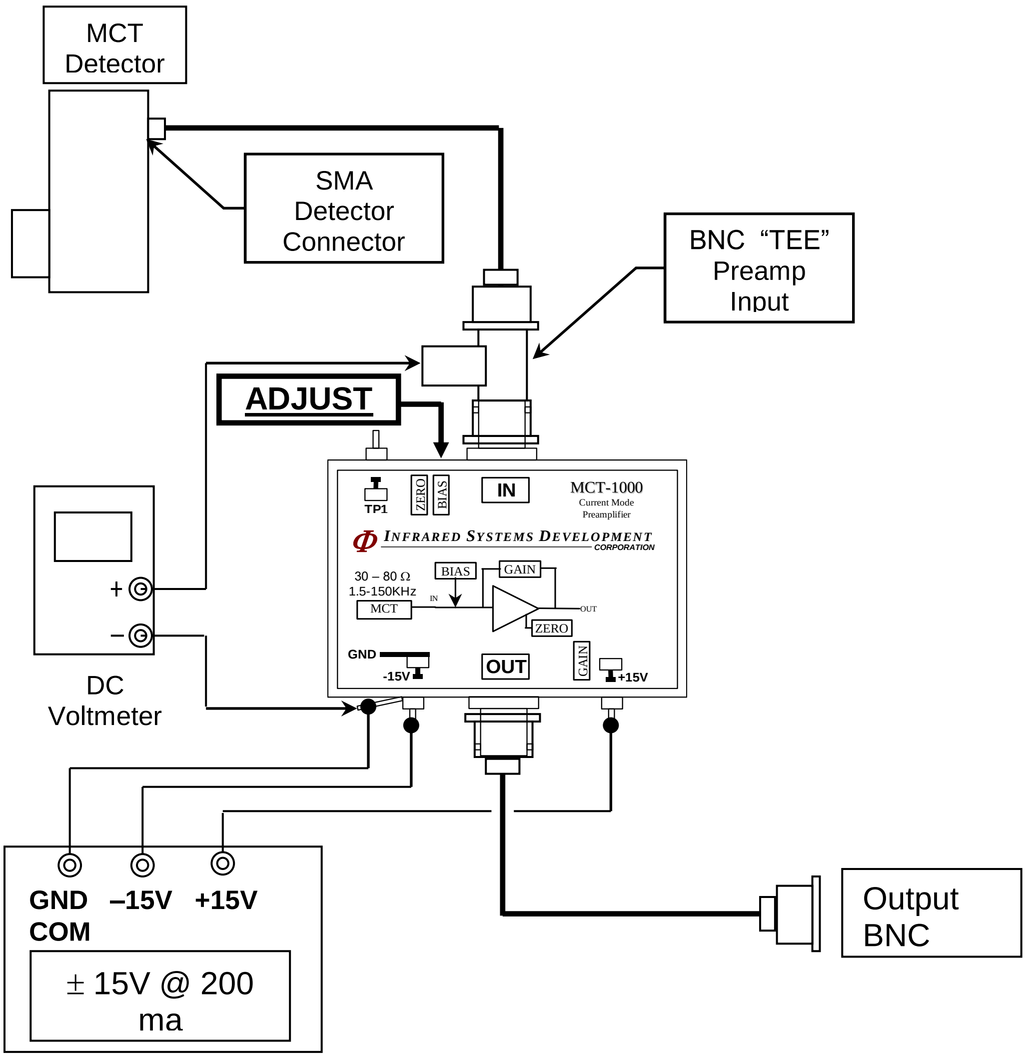

Bias Adjustment
Connection Diagram
Figure 2

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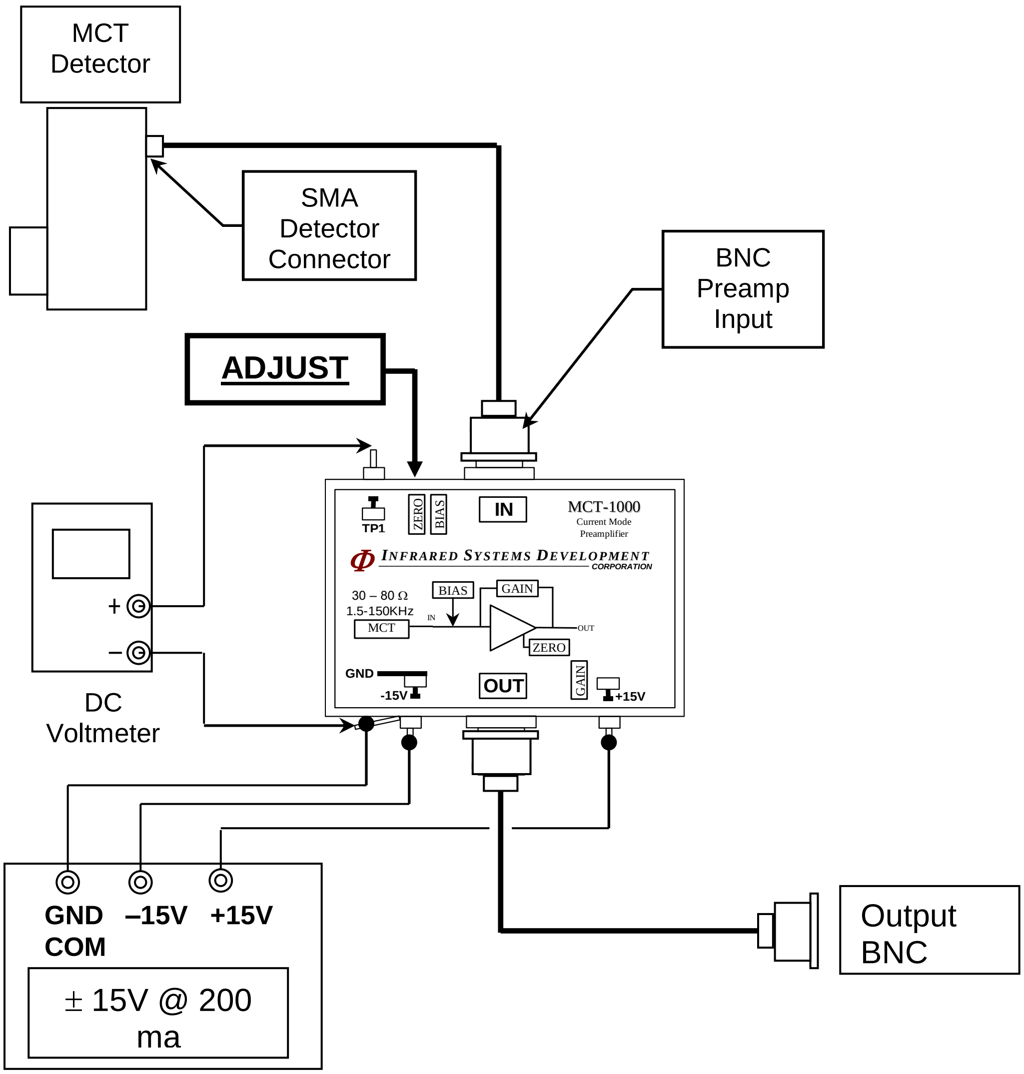

Offset Adjustment
Connection Diagram
Figure 3