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MKS

Instruction Manual

106462-P1
REV B, 9/94

MKS Type 170M-6C Electronics Unit

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for Type 170M-6C
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106462-P1
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MKS Type 170M-6C
Electronics Unit

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SECTION 1
INTRODUCTION

1.1 General (Figure 1-1).

The MKS Baratron® Type 170 High Accuracy Capacitance Manometer Pressure Measurement and Control Systems are designed with a modular concept. For high accuracy pressure monitoring the only required modules are the Sensor Head and Electronic Unit (170M-6C), while for high accuracy Closed Loop Pressure Control the only required modules are the Sensor Head, Electronics Unit (170M-6C), Automatic Pressure Controller and Control Valve. To these basic systems, optional modules can conveniently be added to provide display (analog and/or digital readout) and Data Acquisition (analog strip chart recorder and/or digital printer).

Additional Sensor Heads can be added to the basic system utilizing modular multi-channel manual or automatic Sensor Head selectors to cover up to 10 decades of pressure measurement with the highest realizable system accuracy.

For multi-point/multi-gas automatic pressure and/or flow control, additional Set-Point and valve selector modules can be conveniently added.

1.2 Brief Electrical Description.

The electronics unit is a self-contained signal conditioner with a built-in regulated power supply, 10 kHz oscillator, a high accuracy AC to DC converter to provide a very stable ± 10V DC output which is linear with pressure. An MKS Sensor Head and the 170M-6C Electronics Unit provide the minimum necessary configuration required for a conversion of pressure into a useable stable DC output. Three ranges are provided and are manually selectable or remotely selectable, via rear connections. Required input to the 170M-6C Electronics Unit is 105-130VAC, 60 Hz or 210-260 VAC, 50-60 Hz through a grounded 3-wire cord. Both AC inputs are selectable via taps and are readily accessible.

1.3 Brief Mechanical Description.

The type 170M-6C Electronics Unit is designed to match the other 170M" building block systems." In these systems thumb screws secure the Electronics Unit in either a cabinet or 19" Rack Mount. The Electronics Unit is removed by loosening the thumb screws, disconnecting all cables from the rear, and pulling the electronics unit forward.

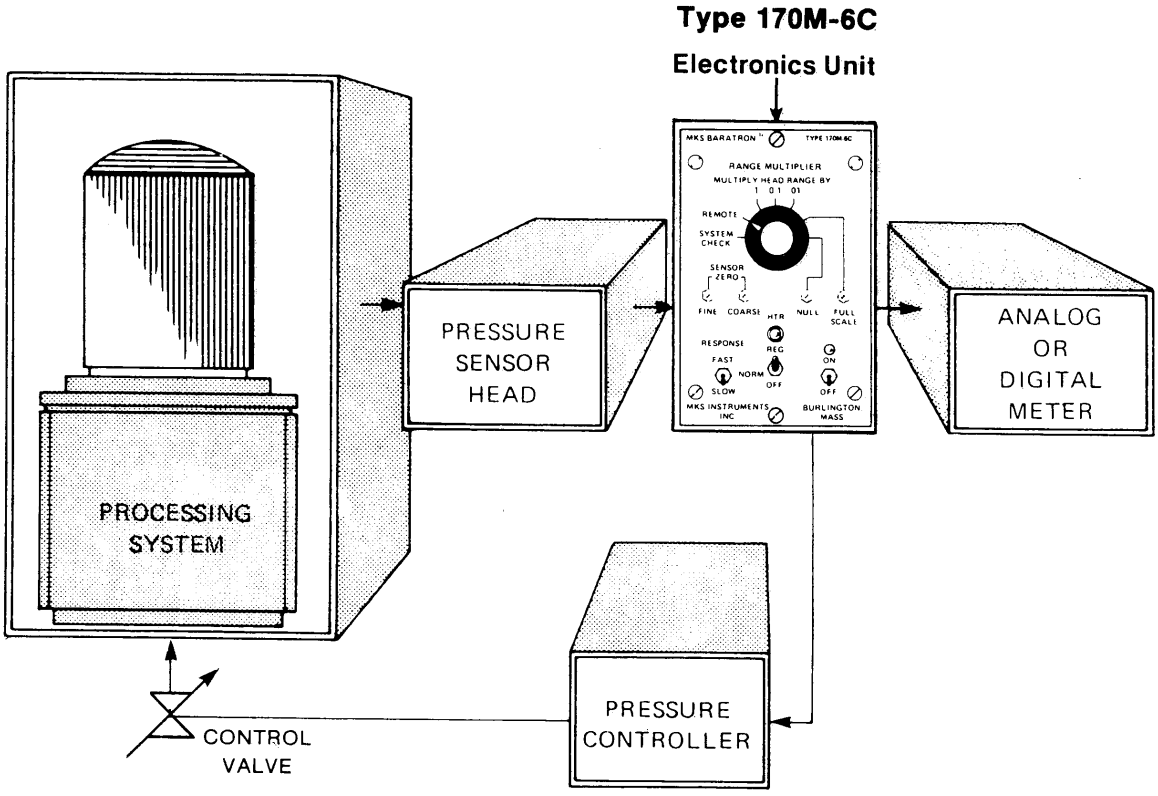


Figure 1-1 Type 170 High Accuracy Baratron® Pressure Measurement And Control System

1.4 Specifications.

Input: 105-130VAC 50/60 Hz
210-260VAC 50/60 Hz

Output: Two: 0-10V DC per range into 10K ohm or greater load for simultaneous inputs to analog and digital readouts if desired Available simultaneously at two output connections.

DC Output Source Impedance:
Less than 1 ohm.

Operating Temperature:
15-40°C

Ranges: X1, X0.1, X0.01 of full range of Sensor Head.

Gain Stability:
25 PPM/° C uncompensated

Resolution:
1 x 10-6 See Table 1-1

Zero Drift:
Less than 0.1 mV/°C

Linearity:
0.005% of reading + 0.001% of full scale.

Output Noise:
Low frequency, less than 70 microvolts all ranges @ 0.4 Hz bandwidth.
High frequency, 4mV peak-to-peak. (1kHz-1 MHz)

Remote Range Selection:
Ground closure or TTL Lo.

Response Time Selection:
Fast: 165 Hz bandwidth . . . . 1 msec
Normal: 4.0 Hz bandwidth . . . . 40 msec
Slow: 0.4 Hz bandwidth . . . . 400 msec

Dimensions:
1A module (See Data Sheet)

"USEABLE" SYSTEM (SENSOR HEAD - 170M-6C) RESOLUTION WITH VARIOUS READOUT UNITS

On Range / With Readout Unit	Analog Meter Type 170M-26B	Digital Readout Type 170M-27D	Digital Readout Type 170M-25C
× 1	2×10^{-4}	1×10^{-4}	1×10^{-5}
× 0.1	2×10^{-5}	1×10^{-5}	1×10^{-5}(*)
× 0.01	2×10^{-5} (*)	1×10^{-5} (*)	1×10^{-5}(*)

*Note: Resolution of signal conditioning system is greater than useable system resolution at present time. Under "ideal" operating conditions, better useable resolution may be attainable.

SECTION 2
OPERATION

2.1 General.

This section provides information covering unpacking, packing, inspection after shipping and general operation. Please read paragraphs on control description and rear panel connectors, before energizing the Electronic Unit.

2.2 Inspection After Receipt

Reasonable care has been taken to pack your Electronics Unit in a manner such that it will reach you in perfect operating condition, however, to be sure that the instrument will function properly check to see that it has not been damaged in shipping, there should be no dents, cracks, or breaks in the case.

2.3 Unpacking

When shipped as a part of a MKS pressure measuring system the type170M-6Cis mounted in a cabinet or a rack frame and is ready to operate once the system is cabled properly. When ordered separately the type170M-6Cis shipped in a cardboard container and is isolated from normal shipping shock by suitable absorbing materials.

2.4 Packing for Return to MKS

PRIOR TO RETURN TO MKS, AN ERA NUMBER (EQUIPMENT RETURN AUTHORIZATION) SHOULD BE OBTAINED FROM MKS CUSTOMER SERVICE DEPARTMENT. THE ERA SHOULD BE CLEARLY VISIBLE ON THE PACKING LABEL AND PACKING SLIP.

If the original shipping container and its shock absorbing materials have been saved the Type170M-6Cmay be easily packed and shipped by any commercial transportation facility or by mail. If original shipping container has been discarded, the instructions below will suffice. Do not return equipment before advising MKS Instruments, Inc.

1. Carefully inspect the Electronics Unit for loose items.
2. Pack in container using the box within a box procedure.

3. Obtain a shipping container which is sufficiently iarge enough to permit one inch of shock absorbing padding to surround the unit. Suitable Padding Materials are:
   - A. Shredded newspaper
   - B. Crumpled newspaper
   - C. Kimbak
   - D. Excelsior, either wood or paper
   - E. Foam rubber
   - F. Rubber Hair

4. Place the Electronics Unit in a plastic bag to prevent padding materials from entering during shipment.

5. Place the container in a larger box surrounding it with at least one inch (top, bottom and sides) of some isolating material.

6. Address the box. Containers of 2 cubic feet or more should have address labels on at least two opposite sides.

7. Be sure to insure the shipment accordingly.

8. The method of shipment depends on the cost involved and urgency of the shipment.

2.5 Installation.

2.5.1 Electronics Unit

The Electronics Unit is designed primarily as a companion unit for type 170 pressure and vacuum systems and normally supplied in either a cabinet or 19" rack mount along with other 170 modules. In the event that the Electronics Unit was supplied separately it may be mounted on a customer's panel using the front panel thumb screws or simply placed on a work stand. The mounting position is not critical and it will operate properly in any plane.

Natural convection cooling is sufficient for proper operation of the Electronics Unit. No special precautions are needed to protect the unit from ordinary mechanical shock and vibration.

Normal operating temperature is 15-40°C and special care should be exercised when installing the unit to assure proper ventilation. This is particularly important when a rack mount is used and the unit may be positioned between other equipment which would cut-off ventilation.

All electrical connections are made via connectors on the rear panel of the Electronics Unit. Connector descriptions are shown in Figure 2-1 while the cable diagram Figure 2-2 shows all proper cables connections between various 170 modules.

2.5.2 Sensor Installation.

Refer to MKS operating and maintenance instructions for 170 series sensor heads.

2.6 Rear Connector Descriptions (See Figure 2-1).

REMOTE (A)

(P2 Figure 2-2) Provides connection to range selection circuits when used with a controller or other external devices to range change. The three ranges (1., .1, .01) along with a 0-10V DC output on each range is available through this connector, range connections are as shown in Table 2-2.

ACCESSORY (B)

(J1 Figure 2-2) Interfaces with Digital Readout Units (DRU), provides 0-10 VDC output, decimal point location for digital readouts, and oscillator power supply outputs.

INPUT (C)

(J3 Figure 2-2) Sensor cable or other sensor conditioning cable is inserted in this connector to provide, excitation, Heater power etc.

DC. OUT (D)

When used with Ground Jack provides 0-10V DC output for 170M-26B analog meters, 170M-41 recorders or other external devices.

AC. OUT (E)

Test point for maintenance/trouble shooting purposes.

GROUND (F)

Test point provides access to Electronics Unit Ground.

OSC (G)

Test point for maintenance/trouble shooting purposes.

FUSE (H)

Line fuse to protect internal circuitry of the Electronics Unit. The "High Side" of the line is fused.

Fuse Values: 3/8 A.S.B. (115VAC)
1/4 A.S.B. (230VAC)

ACCESSORY POWER OUTPUT (I)

(Not labeled) This outlet is controlled by the front panel power switch and provides a voltage identical to the input to the Electronics Unit (115 or 230Vac). This outlet is not fused.

INPUT POWER CORD (J)

(Not labeled) Provides 115 or 230 Vac to the electronics unit. The slide switch on the transformer bracket sets the unit for the proper voltage.

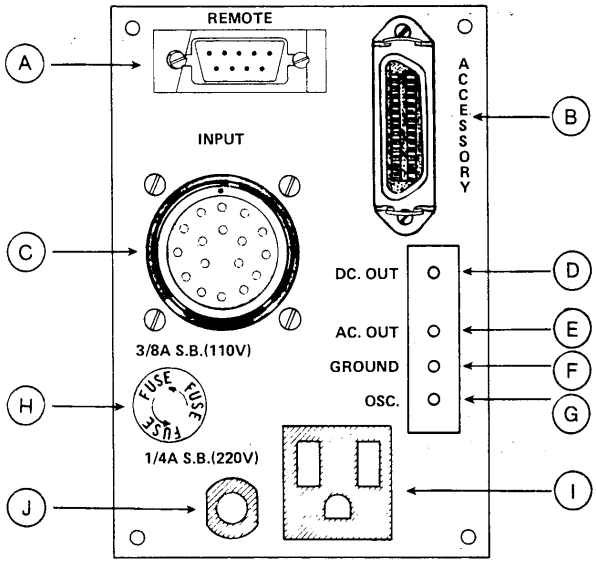


Figure 2-1 Rear Panel Cable Connections

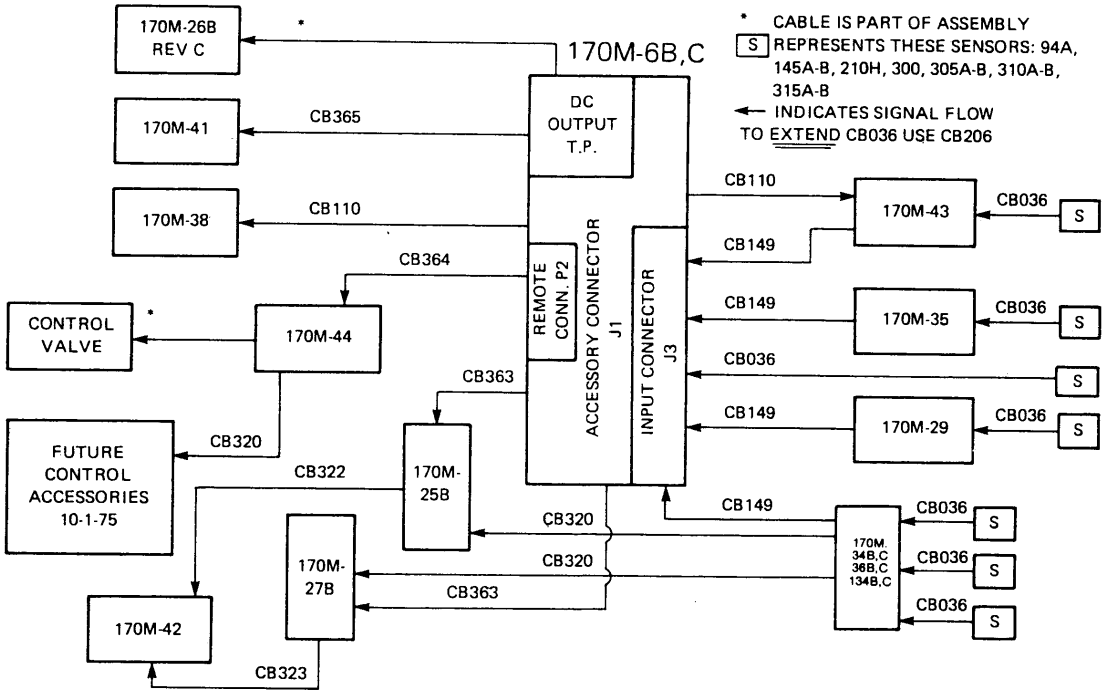


Figure 2-2 Cable Connections, B10 4 117

LINE VOLTAGE SELECTION

TO CHANGE—DISCONNECT THE UNIT FROM ANY POWER SOURCE AND REMOVE THE BOTTOM COVER AND USE A SCREWDRIVER TO SET THE SWITCH TO THE PROPER VOLTAGE.

2.7 Front Panel Controls. (See Figure 2-4)

A description of the front panel controls is given below.

NOTE: Capital Letters Indicate Actual Front Panel Markings.

RANGE MULTIPLIER (A)

This switch controls the measurement mode of the instrument. The remote, 1, 0.1, & .01 positions are active measurement ranges while the System Check, Null and Full Scale are operational check positions.

NULL (B)

When the range switch is placed in the Null position, the input to the 170M-6C is at ground level. This control is then adjusted to produce a zero reading at the DC output. (Signal Conditioner Null).

FULL SCALE (C)

When the Range Multiplier switch is placed in the Full Scale position the input to the 170M-6C is connected to an internal calibration signal. This control is then adjusted to produce a Full Scale (± 10V)at the DC output. (Signal Conditioner Full Scale).

SENSOR ZERO-COARSE (D)

This control is used in conjunction with the Sensor Coarse Zero to provide an approximate zero setting.

SENSOR ZERO-FINE (E)

This control is used in conjunction with the 170M-6CCoarse Zero to provide high resolution in the zero setting.

HEATER (F)

This lamp comes on when power is being applied to the heaters.

REG/OFF (G)

This switch controls power to the heaters. When placed in the reg. position, power is applied to the heaters in the sensor to maintain a pre set temperature. This minimizes zero and span shift due to ambient temperature variation. This switch is a locking type and the **handle must be pulled back** to change positions.

RESPONSE (H)

This switch controls the electrical bandwidth of the instrument. The three positions are:

FAST .....165 Hz . . . . 1 msec
NORMAL 4 Hz . . . . 40 msec
SLOW .....4 Hz . . . . 400 msec

ON/OFF (I)

This switch controls power to the 170M-6C as well as to the accessory outlet on the rear panel.

PILOT LAMP (J)

This lamp indicates that power has been applied to the indicator and that the power supplies are functioning.

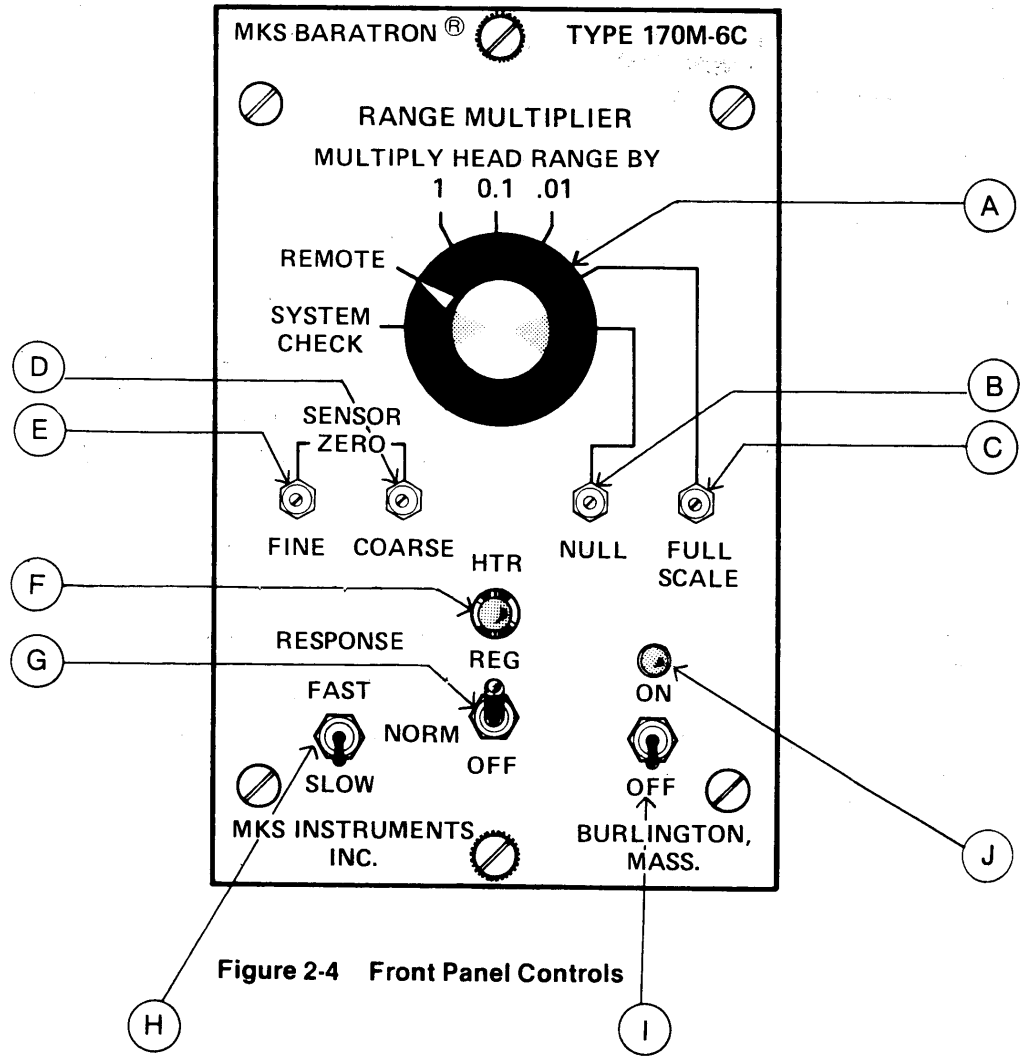


Figure 2-4 Front Panel Controls

2.8 Operation.

The 170M-6C is designed to operate with most MKS Sensors of recent manufacture. (Currently Types 94A & B, 145 A & B, 210, 300 A & B, 305 A & B, 310 A & B and 315 A & B. For simplicity, the descriptions that follow will be based on a Sensor (one of the above), the 170M-6C Electonics Unit and Type 170M-27B-D digital indicator.

2.8.1 Cable Connections.

Cable all 170 components and sensor as shown in figure 2-2, and according to the instructions below:

A. Connect the sensor to the 170M-6C with a CB 036 cable to the Input connector, J3.

B. Connect the digital readout (type 170M-27B-D) to the accessory connector using a CB 363 cable.

C. Plug-in the power cable from the digital readout to the accessory power outlet on the rear of the Electronics Unit.

D. Set the range switch on the digital readout (Type 170M-27B-D) to match the range of the sensor used.

E. With the 170M-27D place the display units switch to the required display range.

F. Plug the power cable from the 170M-6C to any appropriate source of AC power. Use only a three-wire grounded receptacle or an adapter plug to ground the 170M-6C through the power line.

G. Apply power to the entire system by placing the 170M-6C power switch in the ON position.

2.8.2 Sensor Temperature Stabilization.

Non Bakeable sensors such as Types 145 and 310 have built in heaters to minimize the zero and span drift that would be caused by changes in the ambient temperature. Power to these heaters is controlled by the heater switch on the front panel and is indicated by the lamp mounted directly over the switch. This provides a visual indication of current flow in the heaters. Bakeable sensors such as Type 94 and 315 require external sources of heat control (MKS Type 1090 temperature controller) and do not use the built-in heater supply in the 170M-6C. When bakeable sensors are used with the 170M-6C Electronics the heat circuit is inoperative and the heater lamp WILL NOT LIGHT.

A. To properly temperature stabilize a "cold sensor". Turn on the heater switch and allow the heaters a **minimum of 4 hours** to stabilize the sensor. For sensors that have just been received it is recommended that the sensor be on heat overnight. For the best possible accuracy the sensor should always be operated with the heaters on.

NOTE:

Some sensor Types have a proportional type heater control. There is a small delay between the application of power and a visual indication on the heater lamp. The lamp then comes on brightly - goes out and comes back on at a lower intensity. It remains on at the lower intensity. For sensors having a thermostat control, the lamp will cycle on and off with the thermostat.

When a sensor is connected to a 170M-134C or 170M-34B,C the heaters are powered from supplies in those units and the heater switch on the 170M-6C should be turned OFF.

2.8.3 Setting System Zero. (For additional information refer to INSTRUCTION MANUAL for 170 Series sensor heads)

To obtain and adjust zero, an absolute sensor must be pumped down below its maximum resolution; a differential sensor must be cross-ported, or both sides exposed to the same pressure. If a head selector unit is connected in the system the zero controls on the 170M-6C are bypassed, and the multiplex unit zero adjust control is used.

Sometimes when sensors and signal conditioners have been supplied separately it may not be possible to set the system zero with the electronics unit coarse zero. It is then necessary to adjust the coarse zero control on the sensor. First center the indicator coarse zero and then remove the snap plug at the rear of the sensor case. The sensor coarse zero is the control marked "O". Adjust for approximately zero on the meter and then trim with the indicator controls. The control marked "S" is the sensitivity adjustment and this should **NEVER** be adjusted since it requires a known pressure standard to reset it.

A. Switch the range switch to the NULL position to check the zero of the 170M-6C. Adjust the NULL if necessary.

B. Switch the range switch to the desired Range normally x1 for 170M-25B,C Readout and the x.1 for the 170M-27B-D Readout).

C. Adjust the Electronics Unit coarse zero to bring the output as close to zero as practical and then use the fine zero to set it precisely.

2.8.4 Quadrature Control.

Because of improved sensor and indicator phasing the Quadrature control is no longer required, and has been removed from the 170M-6C However, this control **does** appear on the 170M-34B & 170M-36B head selector units. When a 170M-6C is used in conjunction with either of the head selectors the Quadrature contol should be centered to avoid injecting an unnecessary Quadrature signal into the system. To center the control, turn 25 times in CW direction and then CCW 12 times.

2.8.5 System Check.

When the range switch is placed in system check a calibrated signal is sent from the sensor through the sensor cable to the 170M-6C. The value of this signal is recorded on the calibration sheet for each sensor. This signal is useful in checking the operation of the sensor electronics and sensor cable. The sensor is bypassed in this position and therefore the system check is an electronic test only not a calibration check. Calibration can be checked only against an appropriate primary, secondary, or transfer standard.

To reproduce the systems check number, **apply a zero pressure** to the sensor and adjust the system zero. Then switch to the system check position and the system check number will be displayed at the output.

2.8.6 System Resolution/Readouts.

With three ranges of sensitivity on the 170M-6C and the combination of a 4½ or 5½ place digital display it is possible to exceed the practical resolution of the Sensor and display system noise. For general purpose use it is therefore advisable to recognize this limitation. Table 1-1 may be used as a guide for range selection.

2.8.7 Remote Operation.

The three sensitivity ranges, 1, .1, and .01 may be selected remotely. Selection is done through the Remote connector shown in Table 2-1. The DC output voltage is also present at this connector. The range multiplier switch must be placed in the Remote position.

Table 2-1 Remote Range Selection

Range to be Selected	Remote Connector Pin 3	Pin 4
1	Hi	Hi
.1	Lo	Hi
.01	Hi	Lo

Lo = ground to +.8V
Hi = +2.4V to open circuit
Digital ground is on pin 5.

2.8.8 Operating The System.

1. Turn power switch "ON"

2. Allow a minimum of 4 hours for Sensor Heaters to stabilize.

3. Turn range multiplier switch to the NULL position. The output should read zero volts. If not adjust the NULL potentiometer until the output is exactly 0.0000 volts.

4. Turn range multiplier switch to the FULL SCALE position. The output should read +10V ± .01%. If not adjust the F.S. potentiometer until output is exactly 10.0000 volts.

5. Apply zero differential pressure to the Sensor. (Pump absolute sensors down to a pressure below system resolution.)

6. Switch the range multiplier to the System Check position and compare output reading with that shown on the sensor calibration sheet. If reading is not correct refer to Section 4, Maintenance, as a problem is evident. See Section 2.8.5.

7. Set range multiplier to appropriate measurement range (X1, X0.1, X.01).

8. Apply pressure and measure pressure (absolute or differential) directly in Torr or other engineering units on the display.

NOTE: With experience, the frequency which these adjustments need to be made will rapidly be determined. For extremely critical measurements of very low pressures, checking zero and full scale more often increases the accuracy of the measurements being made.

SECTION 3
THEORY OF OPERATION

3.1 General See Figure 3-1.

This section is devoted to a discussion on the theory of operation of the type 170M-6C Electronics Unit and its purpose is to provide the reader with sufficient information to improve his general knowledge of the equipment and to facilitate any maintenance procedures in the event they become necessary. It is to be noted that the maintenance procedures described in Section 4 do not require a knowledge of this section.

A basic 170 system consists of the 170M-6C Electronics Unit, Sensor Cable, and a Sensor. A typical system is shown in Figure 3-1. Basically the 170M-6C consists of a power supply, Oscillator, AC Amplifier, DC Converter, A Demodulator Drive and a range selection circuit and a range multiplier switch. Individual descriptions of each of these functions is below.

3.2 Heater Power Supply See Figure 3-2.

The heater supply consists of bridge rectifiers DB102 and the RC filter R201 and C208 The voltage at no load is approximately 110 volts which will be approximately 85 volts under full heater load (approximately 12 watts). The heater supply is totally above ground so some care must be taken not to ground the heater return. Power is supplied through VR 202 and the heater lamp. This parallel combination provides a visual heater indication when used with the proportional heaters and prevents lamp burn out when used with the thermostat type control.

3.3 ± 13 Volt Supply. See Figure 3-2.

Both power supplies are identical floating 13 volt power supplies. The negative terminal of one is connected to the positive terminal of the other and connected to ground. This produces the required +13v and -13v at the other remaining terminals.

The regulators are the three terminal adjustable type. An adjustment range of approximately IV is obtained from the potentiometers R203, R204. These regulators provide current limit, thermal over-load and safe area protection. The rectifiers D210, D211 protect against voltage reversal.

At the output of each supply there is a jumper bus. This bus doubles as a test point and a means of isolating the power supply when troubleshooting the circuit.

CAUTION: TO AVOID DAMAGE, NEVER OPERATE THE INSTRUMENT WITH ONE POWER SUPPLY DISCONNECTED. BOTH SUPPLIES MUST BE DISCONNECTED AT THE SAME TIME.

3.4 Preamplifier Power Supply.

The RC Filter formed by R227 and C219 provides a +13 volt supply for the sensor electronics.

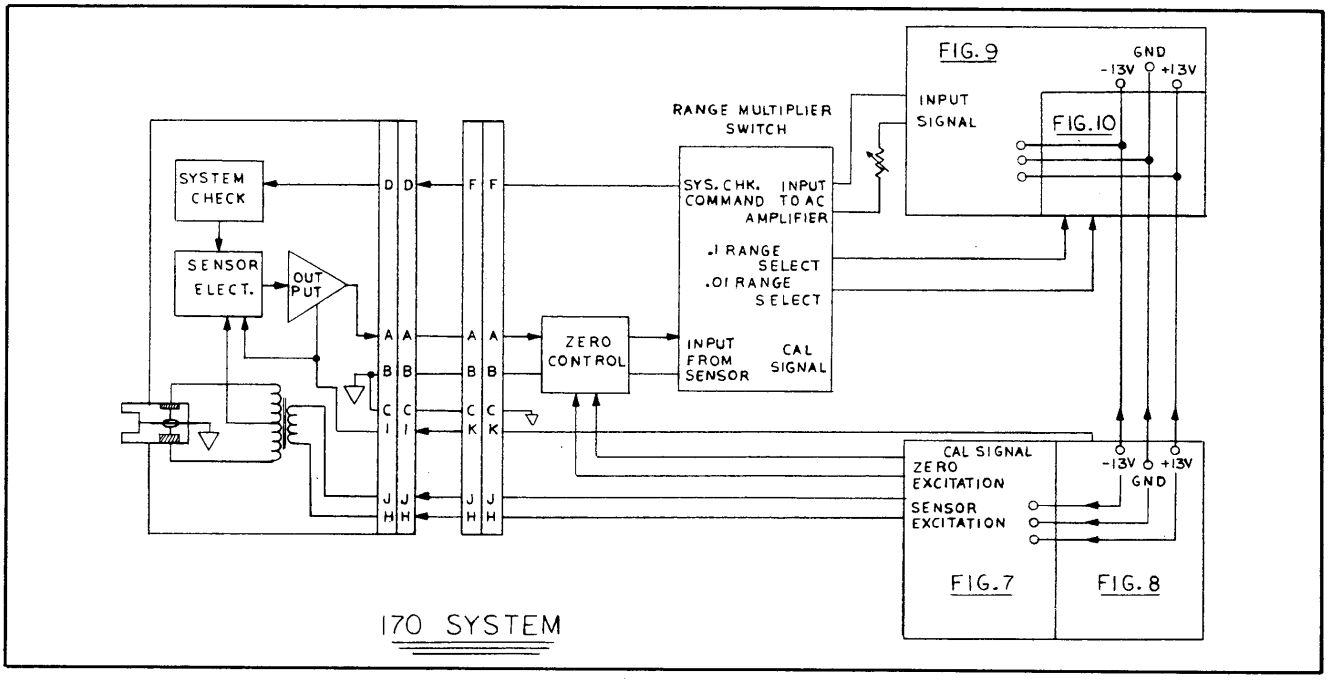


Figure 3-1 170 System Block Diagram, 104216

3.5 Oscillator. See Figure 3-3.

Oscillator is a Wein Bridge type which has a buffered output and amplitude stabilization to insure constant output voltage under all load conditions. The oscillator is formed by amplifier V203 and the bridge network C214, C218, R216, R221 & R222. The frequency is factory adjusted to 10 KHz by adjustment of R222. The output of V203 passes through the buffer amplifier formed by Q201-Q204. This output is fed back to the oscillator input by R217. Diodes D201 and D202 act to shut down the buffer amplifier in the event of a short circuit at the output. Amplitude stabilization is accomplished by rectifying the output and comparing the DC level against the temperature regulated precision reference VR201. This reference voltage is applied to the positive input of the integrating amplifier V205. The negative input of this amplifier is connected to a precision half wave rectifier, V204. The integrator compares the difference between the reference voltage and the rectified output and produces a control signal for Q205. Should the rectified output exceed the reference voltage, Q205 is biased OFF and the gain of the oscillator amplifier is decreased. When the rectified output falls below the reference voltage, Q205 is biased ON and the gain of the oscillator amplifier is increased.

This technique of buffering and amplitude stabilization produces a high purity sine wave capable of driving loads on the order of 100 ohms or less with almost no change in the output. The output is also connected to T201 which provides excitation to the zero controls through windings 5, 6, and 7. Winding 3-4 provides the precision voltage, 1.5V RMS which is the signal that is connected to the FULL SCALE position of the instrument. This voltage is the internal standard which is used to set the gain of the 170M-6C.

3.6 AC Amplifier and AC to DC Converter. See Figure 3-4.

The input signal is applied across P102 pins 1 & 2 and is coupled into the differential input of the first AC amplifier U103. The differential mode is used to eliminate any possible errors of 60Hz signal on measurement grounds. The signal is then amplified by a factor of 3 and then passed on to the range transformer T101. Depending on the range selected the signal is either passed through directly (.01 range), or divided by 10 for the .1 range or divided by 100 for the 1 range. Selection of the proper transfer taps is done by turning ON or OFF FET switches Q102-Q104. The logic that commands these switches is discussed in conjunction with synchronous detector (demodulator) drive controls.

The signal passes from the transformer to the high impedance input of the second AC amplifier U105. U105 amplifies the signal 30 times and couples it through C111 & C112 to the primary of the transformer T102. T102 together with the switching FET's Q106 and Q107 form the synchronous detector. The

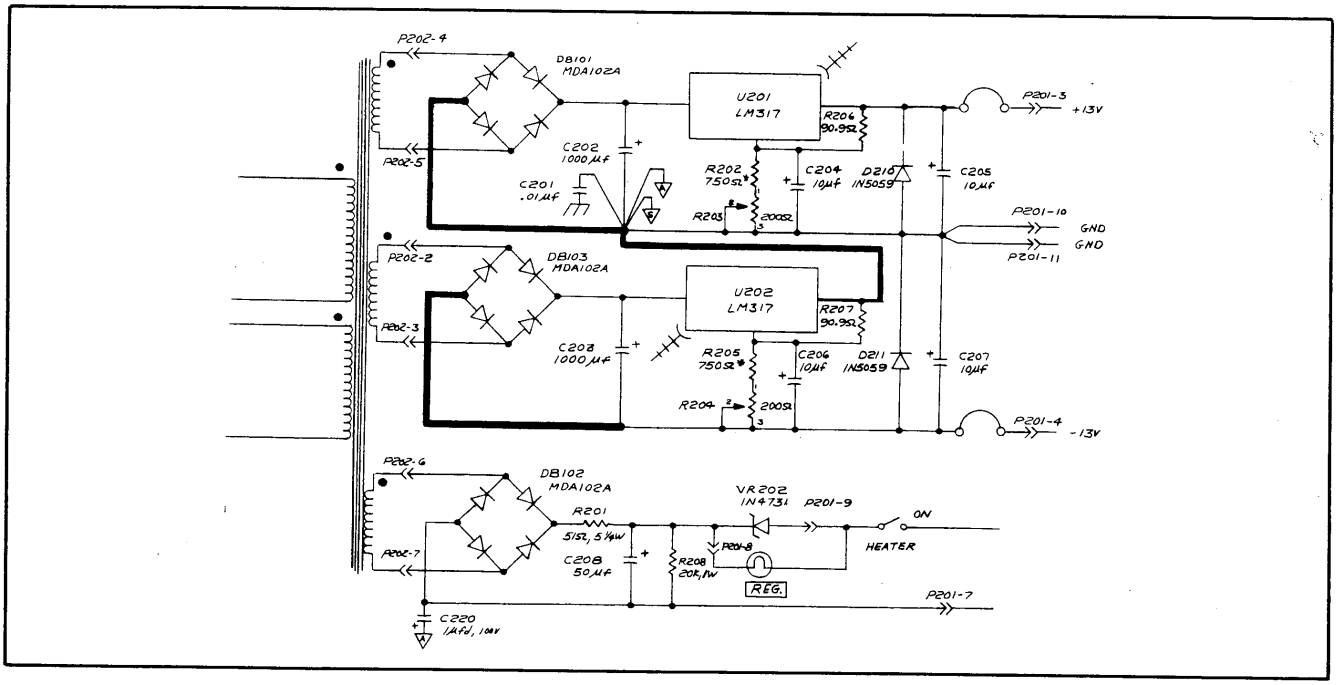


Figure 3-2 Schematic, 170M-6B, Heater,+13V Power Supply B-104212

FET's are driven 180° out of phase by a 25V P-P switching squarewave which is synchronized perfectly to the 10kHz Oscillator. The FET's are turned ON and OFF, first grounding one end of the secondary of T102 and then the other, this causes the center of the transformer to produce a full wave rectified signal. By switching in this manner all 60Hz and all 90° quadrature signals are blocked from the output.

The rectified signal then passes through to the input of the DC integrator U106 which filters and amplifies the wave form to produce a noise free DC output signal. The signal is adjusted to the proper full scale of 10 volts with the course span adjust R151 and is filtered once more by L101 and C129 and then applied to the proper output connectors.

3.7 Demodulator Drive. See Figure 3-5.

This circuit provides a fast switching wave form that is synchronized with the Oscillator to drive the switching FET's in the demodulator, (synchronous detector) and is done by applying the Oscillator input voltage to the comparator U107. When the Oscillator crosses through Zero the comparator switches; one output goes high while the other goes low. These outputs are applied to the high speed "flip flop" that is formed by Q108-Q111. The demodulator drive circuit increases the switching speed and produces a waveform that switches between ± 13 volts. This waveform and its complement are connected to the switching FET's through C113 and C114.

3.8 Range Selection Circuit. See Figure 3-5.

The range selection circuit provides a means to select the proper sensitivity range either by the manual range switch or by the external control connector and to provide decimal point information to the 170 digital indicators. The switching is based on the principle that the 1 range is selected by the absence of a command to the .1 or .01 ranges. The command to select the .1 or .01 range by the range switch is done by applying a ground closure to P102-5 or 6. P102-7 is left in the HI state to "Lockout" any commands from the remote connector. Two nand gates U102C and U102D produce the range commands which are applied to the junctions of U104A and B and U101E & F. U104 produces the commands to the switching FET's, Q102-Q104, while U101D-F selects the proper decimal command to be sent to the accessory connector.

In the **remote position** P102-7 is grounded which defeats the "Lockout" and enables commands from the remote connector to be entered through U101 B and C. The outputs from U101 are passed through the "Lockout" gates U102 A and B to the inputs of U102 C and D. At this point range selection is identical to the process described before.

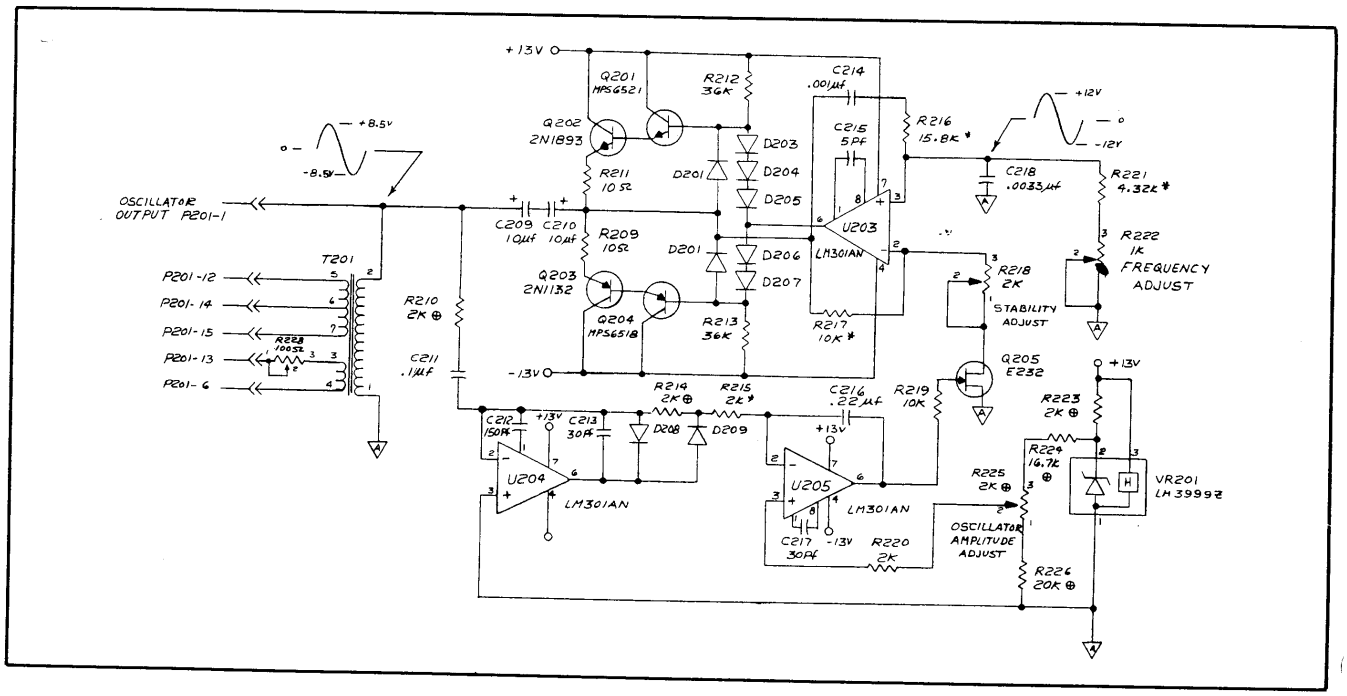


Figure 3-3 Schematic, 170M-6B, Oscillator, B-104213

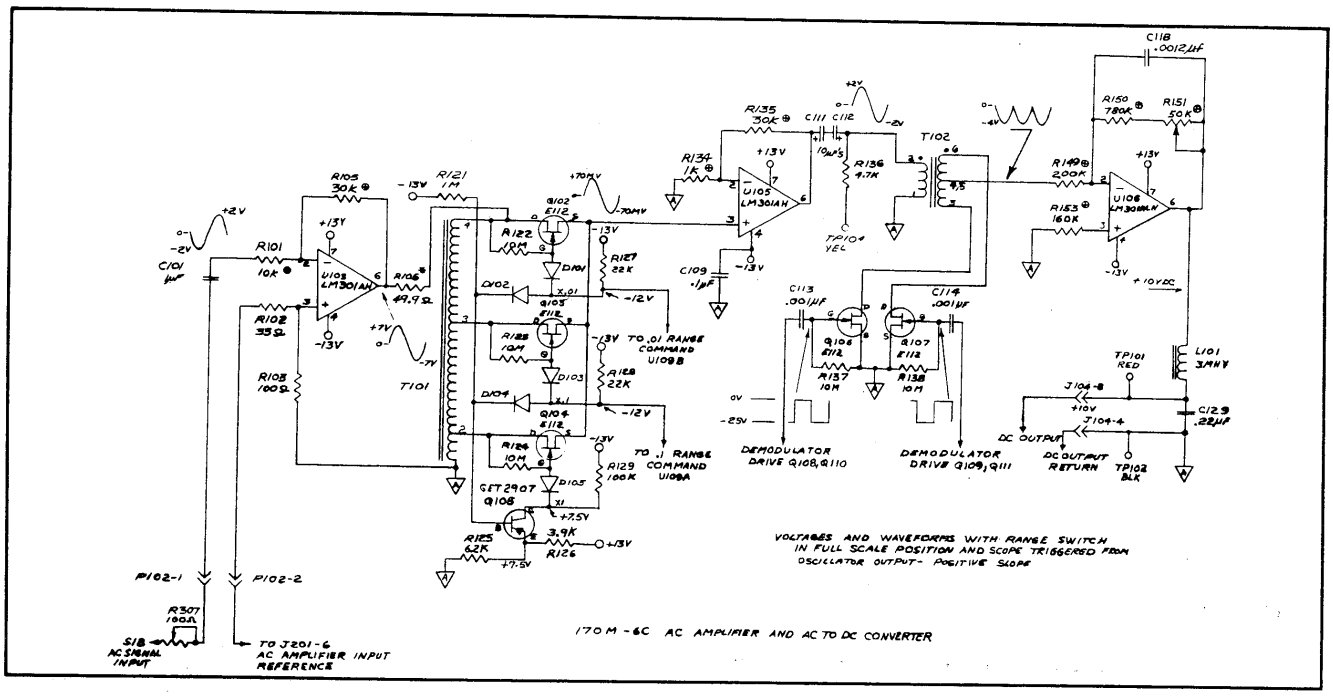


Figure 3-4 Schematic, AC Amplifier, AC to DC Converter, B-104214

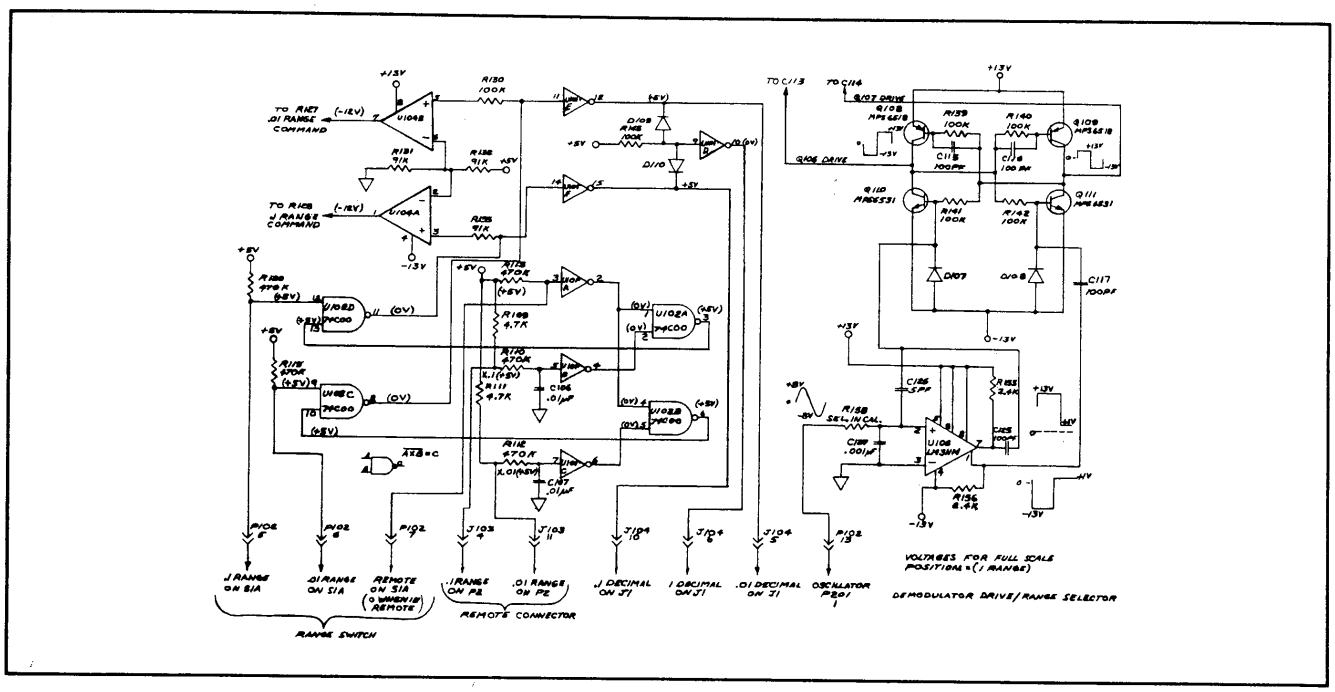


Figure 3-5 Schematic, Demodulator Drive/Range Selector, B-104215

SECTION 4
MAINTENANCE

4.1 General.

MKS Instruments recommends that any instrument that is still covered by the warranty be returned to the factory for repair and recalibration. If it is not possible to return the instrument, contact the MKS Factory for assistance.

While the circuits in the170M-6Care not in themselves extremely complex, replacement of components may require various stages of recalibration.

The theory of operation section (Section 3) describes all circuits plus waveforms and voltages at key points.

The circuits are contained on two circuit boards which are mounted between the upper and lower support rods. To remove a board: Remove the top cover and remove the screws that fasten the upper support rod to the front and rear panels. Then remove the counter sunk screws on the side of the bottom rails, and lift out, the upper rod and the circuit board. By removing the power supply board and laying it flat, the instrument may be operated while all circuits are totally exposed. When viewed from the front, the power supply/oscillator board is on the right and the amplifiers are on the left.

4.2 Trouble Shooting.

Should difficulties be encountered in the use of any 170 system, information in this section should help to isolate the source of the problem. Whenever similar equipment is available the method of substitution is recommended.

If the pressure reading is over ranged, (11V), or otherwise suspect, make the checks listed below.

1. Check to be sure that all vacuum fittings are tight and that the sensor is properly pumped. down. Low range absolute sensors (100 mmhg and below) will be over ranged at atmospheric pressure.

2. Connect another meter, analog or digital, to the output to verify the proper operation of the system's meter.

3. Place the range switch in the system check position to locate the source of the problem, and perform tests in Figure 4-1.

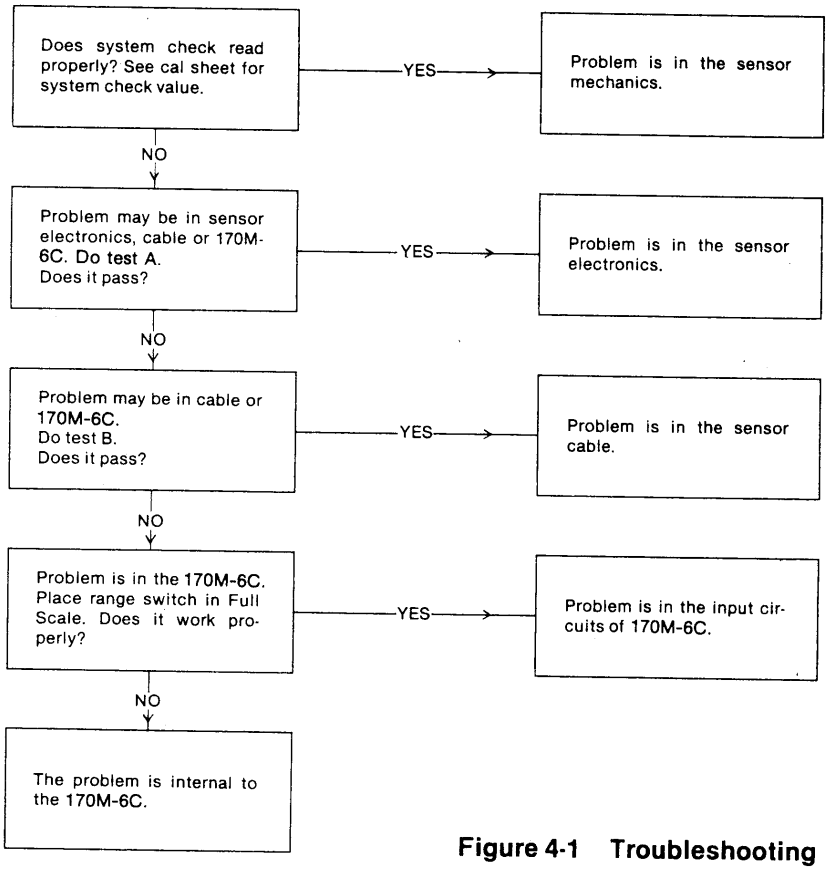


Figure 4-1 Troubleshooting

4.3 Test A, Localizing Malfunction to Cable or Electronics Unit

Equipment required: VOM

1. Disconnect the sensor from the sensor cable.

2. Place the range switch in the system check position.

3. Place the heater switch in the OFF Position.

4. Use the VOM to check the voltages at the sensor end of the cable. See Table 4-1. **Reference the VOM to pin H.**

Table 4-1 Sensor Cable Voltage Checks

Sensor Cable Pin No.	Voltage	Function
I	+ 12 to + 13V	Sensor electronics supply voltage
D	+ 12 to + 13V	System Check command
J	6v RMS	Excitation voltage

5. Connect two resistors to the sensor cable connector as shown in Figure 4-2.

This should produce a negative full scale ± 10% with the range switch in the system check position.

Connect a short circuit across the 1K, resistor place the range switch in the .01 position and adjust the coarse zero control. It should be possible to adjust this control ± 40% of full scale.

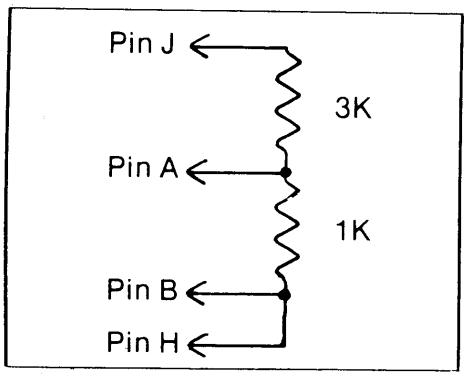


Figure 4-2 Test Resistors

4.4 Test B, Localizing Malfunctions to Electronics Unit

Disconnect the sensor cable from the 170M-6B and check voltages at the input connector. See Table 4-2. (J3) Reference the VOM to pin H.

Table 4-2 Electronics Unit Voltage Checks

Sensor Cable Pin No.	Voltage	Function
K	+ 12 to + 13V	Sensor electronics supply voltage
F	+ 12 to + 13V	System Check command
J	6v RMS	Excitation voltage

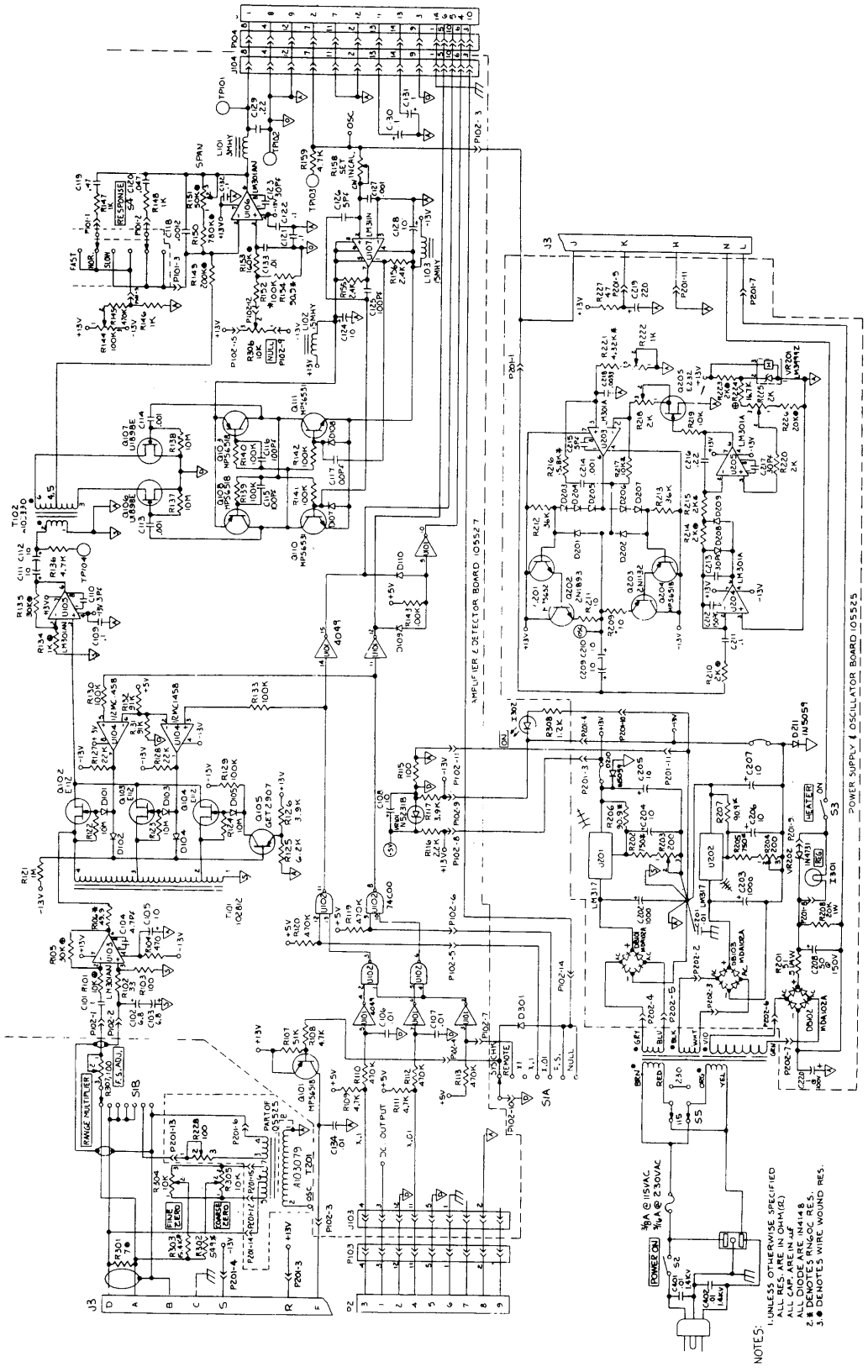
Repeat test A part 5 at the input connector. (J3)

4.5 Recalibration.

Whenever components have been replaced in the 170M-6B it is necessary to perform a calibration check.

A. Adjust the null for a zero reading.

B. Switch to the Full Scale and adjust the Full Scale adjust for + 10V ± .01%.


AMPLIFIER & DETECTOR BOARD 105527
POWER SUPPLY & OSCILLATOR BOARD 105525
NOTES:
1. UNLESS OTHERWISE SPECIFIED ALL RES. ARE IN OHM (Ω) ALL CAPS ARE IN μF ALL DIODES ARE 1N4148.
2. # DENOTES 1%6QC RES.
3. ● DENOTES WIRE WOUND RES.

SECTION 5
170 DIGITAL INTERFACING INFORMATION

INPUTS

Type 11 "TTL/DTL" Inputs: Standard DTL/TTL Circuitry

LO = 0 to +0.8V; 1 unit load = −1.6 MA.

LO input should be less than +0.4V for 0.4V noise margin.

HI = +2.0 to +5.0V; 1 unit load = +40 UA.

HI input should be greater than +2.4V for 0.4V noise margin.

Most MKS inputs are 1 unit load, some are more.

Type 12 "TTL/DTL/5V. CMOS" Inputs

Input Z: Greater than 4K ohms from ≈ +5V.

I MAX with input at ground = 1.6 MA = 1 TTL load.

Inputs usually filtered except where speed is needed; filter T.C. usually 500 µS gives greatly increased immunity to fast noise.

LO = 0 to +1.5V; including short to ground.

LO input should be less than +0.5V for 1V noise margin.

HI = +3.5V to +5V; including open circuit.

HI input should be greater than 4.5V for 1V noise margin.

Acceptable Inputs

1. Standard TTL. The input 4.7K pull-up resistor will pull up open collector, and totem pole outputs, as well as outputs already resistor pulled up.

2. Standard DTL.

3. CMOS **Buffers** such as the CD-4049 and CD-4050 operating from +5V supplies.

4. Switch or Relay contact closure to ground.

5. Connection to ground via transistor or optoisolator, capable of sinking at least 1.6 MA to less than +0.5V (for 1V noise immunity) when "ON", and drawing less than 100 µA of leakage current at 5V when "OFF", even when hot.

Input resistors easily changed to allow inputs from CMOS **non-buffers** (ordinary CMOS) as well as buffers, with power supplies of +5 to +15V; and other logic swings from −25V to +28V, including levels of EIA standard No. RS-232C, and CCITT recommendation V 24.

OUTPUTS:

Type 21 "DTL/TTL": Standard Levels

LO = 0 to 0.4V; unit load = +1.6 MA.

HI = +2.4 to +5.0V; unit load = −40 µA.

HI = +4.5 to +5.0V with 4.7K pull-up resistor to +5V.

All MKS outputs drive at least 2 unit loads, some as many as 10.

Type 22 Contact Closures

Isolated contacts from switches or relays, suitable for driving DTL/TTL/CMOS circuits (with pull-up R's for added noise immunity) as well as lights, etc.

170M-6C Interfacing

Range ID's: LO = range selected; output is from an unloaded 4049AE.

LO = 0 to .4V sinking < 2.6 mA; 5mA typical.

HI = 4.2 to 5.4 sourcing < 400 uA.

These values are measured relative to the digital common.

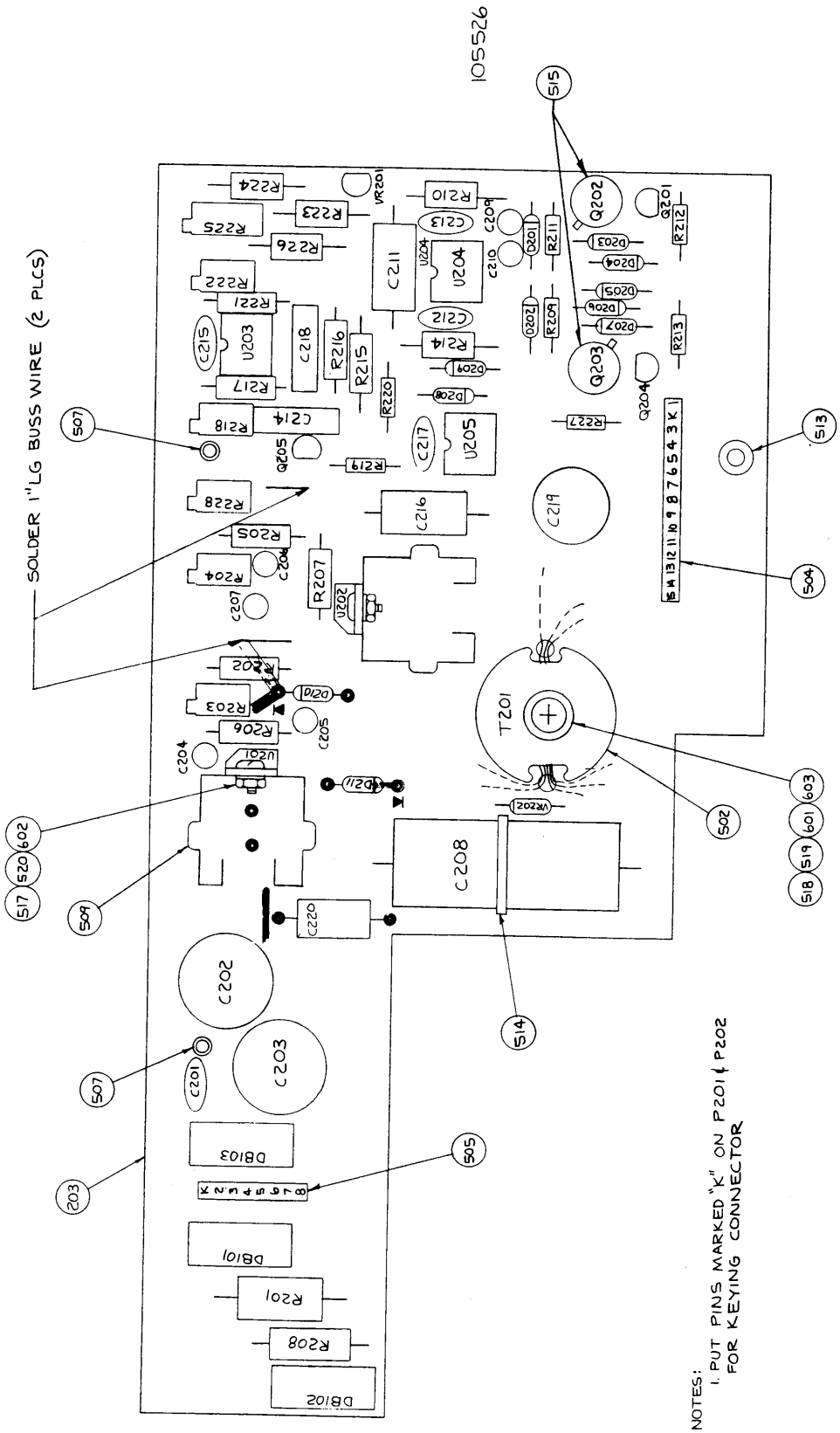
Range Command: LO = Select range.

Inputs to CMOS via 4.7K pull up to +5V and 4.7 m sec filter

LO = 0 to 1.4V at < 1.3 mA.

HI = 3.8 to 6V including open circuit. (I to digital ground less than 100 PA for 1 volt noise immunity.

P.S./OSC. PC LAYOUT



P.S./OSC. PARTS LIST

DISTR TO

REV	REVISION DESCRIPTION	DCR	EO	BY/DATE	PROJ. ENG.
A	REL TO PRODUCTION	#	1049	IS 6-12-77	PA 6/13/77

PL EA-105526

REV	SH	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
REV	SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		A	A	A	A	A															

DRN IS 4-20-77 CHK

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255

170M-6C P/S & OSC. P.C. BD ASS'Y

PROJ ENGR

D105815 NEXT ASSY NO. | MGR JHE 6/14/77 | PL EA-105526 | SHEET 1 OF 6 | REV. A

BRUNING 40-107 37383

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
201	C	EA-105526	REF	P.C. BOARD ASS'Y		
202	D	105784	REF	SCHEMATIC		
203	D	PC-105525	1	P.C. BOARD		
204						
205		064-2050	2	RES. 1/4W, 5% 10Ω R209, 211		
206		064-2067	2	RES. 1/4W, 5% 36K R212, 213		
207		065-2806	1	RES. RN60C 15.8K R216		
208		065-2450	1	RES. RN60C 10K R217		
209		065-3216	1	RES. RN60C 4.32K R221		
210		053-4240	1	POTENTIOMETER-25 TURNS CERMET 1K R222		
211		053-4352	1	POTENTIOMETER-25 TURNS CERMET 2K R218		
212		064-2057	1	RES. 1/4W, 5% 10K R219		
213		065-4125	1	RES. RN60C 2K R215		
214		066-3026	3	RES. 1%, WW 2K R210, 214, 223		
215		064-2076	1	RES. 1/4W, 5% 2K R220		
216		064-2574	1	RES. 1/4W, 5% 47Ω R227		
217		053-2915	1	POTENTIOMETER-25 TURNS WW 2K R225		
218		066-3035	1	RES. 1%, WW 20K R226		
219		065-4344	2	RES. RN60C 90.9Ω R206, 207		
220		065-2449	2	RES. RN60C 750Ω R202, 205		

PL EA-105526

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255 | PL EA-105526 | REV A | SH 2 OF 6

BRUNING 40-107 37383

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
301		053-4239	2	POTENTIOMETER - 25 TURN CERMET 200Ω R203, 204		
302		064-2220	1	RESISTOR 1W, 5% 20K R208		
303		067-2402	1	RESISTOR 5 1/4W 515Ω R201		
304		053-4443	1	POTENTIOMETER- 25 TURN CERMET 100Ω R228		
305		066-4440	1	RES. 16.7K WW R224		
306						
307		007-3291	6	TANTALUM CAPACITOR 10 mfd @ 20V C204-207, 209, 210		
308		005-4122	1	SILVER MICA CAPACITOR .001 mfd C214		
309		005-2456	1	CERAMIC CAPACITOR 5pf C215		
310		005-4123	1	SILVER MICA CAPACITOR .0033 UF C218		
311		006-3211	1	MYLAR FILM CAPACITOR .22 mfd @ 80V C216		
312						
313		005-4097	1	MICA CAPACITOR 150pf C212		
314		006-4294	1	MYLAR FILM CAPACITOR .1 mfd @ 80V C211		
315		005-2369	2	CERAMIC CAPACITOR 30pf C213, C217		
316		007-3283	2	ALUMINUM ELECTROLYTIC CAPACITORS 1000 mf C202, 203		
317		005-3259	1	CERAMIC CAPACITOR .01 mfd @ 500V C201		
318		007-2691	1	ALUMINUM ELECTROLYTIC CAPACITOR 50 mfd @ 150V C208		
319		007-2757	1	ALUMINUM ELECTROLYTIC CAPACITOR 1 mfd @ 100V C220		
320		007-4143	1	ALUMINUM ELECTROLYTIC CAPACITOR 220 mfd @ 25V C219		

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MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255 | PL EA-105526 | REV A | SH 3 OF 6

BRUNING 40-107 37383

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
401						
402						
403		015-2395	2	DIODE IN5059 D210, 211		
404		015-2412	9	SIGNAL DIODE IN4148 D201-D209		
405		015-4348	3	F.W. RECTIFIER PACKS MDA 102A DB101, 102, 103		
406						
407		016-4444	1	VOLTAGE REFERENCE LM399Z VR201		
408		017-3095	1	ZENER DIODE 1N4731 VR202		
409						
410						
411		082-2015	1	NPN TRANSISTOR 2N1893 Q202		
412		082-2026	1	NPN TRANSISTOR MPS 6521 Q201		
413		084-2004	1	PNP TRANSISTOR 2N1132 Q203		
414		084-2028	1	PNP TRANSISTOR MPS 6518 Q204		
415		086-3240	1	N CHANNEL FET E232 Q205		
416						
417						
418		030-3270	3	AMPLIFIER LM301AN U203, 204, 205		
419		033-4341	2	POSITIVE REGULATOR LM317MP U201, 202		
420						

PL EA-105526

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255 | PL EA-105526 | REV A | SH 4 OF 6

BRUNING 40-107 37383

PL EA-105526

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
S01						
S02	A	TA-103079	1	CAL REZERO XFMR T201		
S03						
S04		110-3472	1	15 PIN HEADER P201		
S05		110-3589	1	8 PIN HEADER P202		
S06						
S07		173-2208	2	TERMINAL - PLAIN		
S08						
S09		123-3470	2	HEAT SINKS		
S10						
S11		156-3251	3	Socket 8 PIN DIP XU203-XU205		
S12						
S13		105-3484	1	CAPTIVE STANDOFF		
S14		106-2316	1	STA-STRAP		
S15		181-2752	2	TRANSISTOR PAD, XQ202,203		
S16						
S17		185-3744	2	# 4 INT TOOTH LOCKWASHER		
S18		185-3745	1	# 6 " " "		
S19		185-3741	1	# 6 FLAT WASHER		
S20		146-3753	2	#4-40 HEX NUT		

BRUNING 40-107 37393

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255 | PL EA-105526 | REV A | SH 5 OF 6

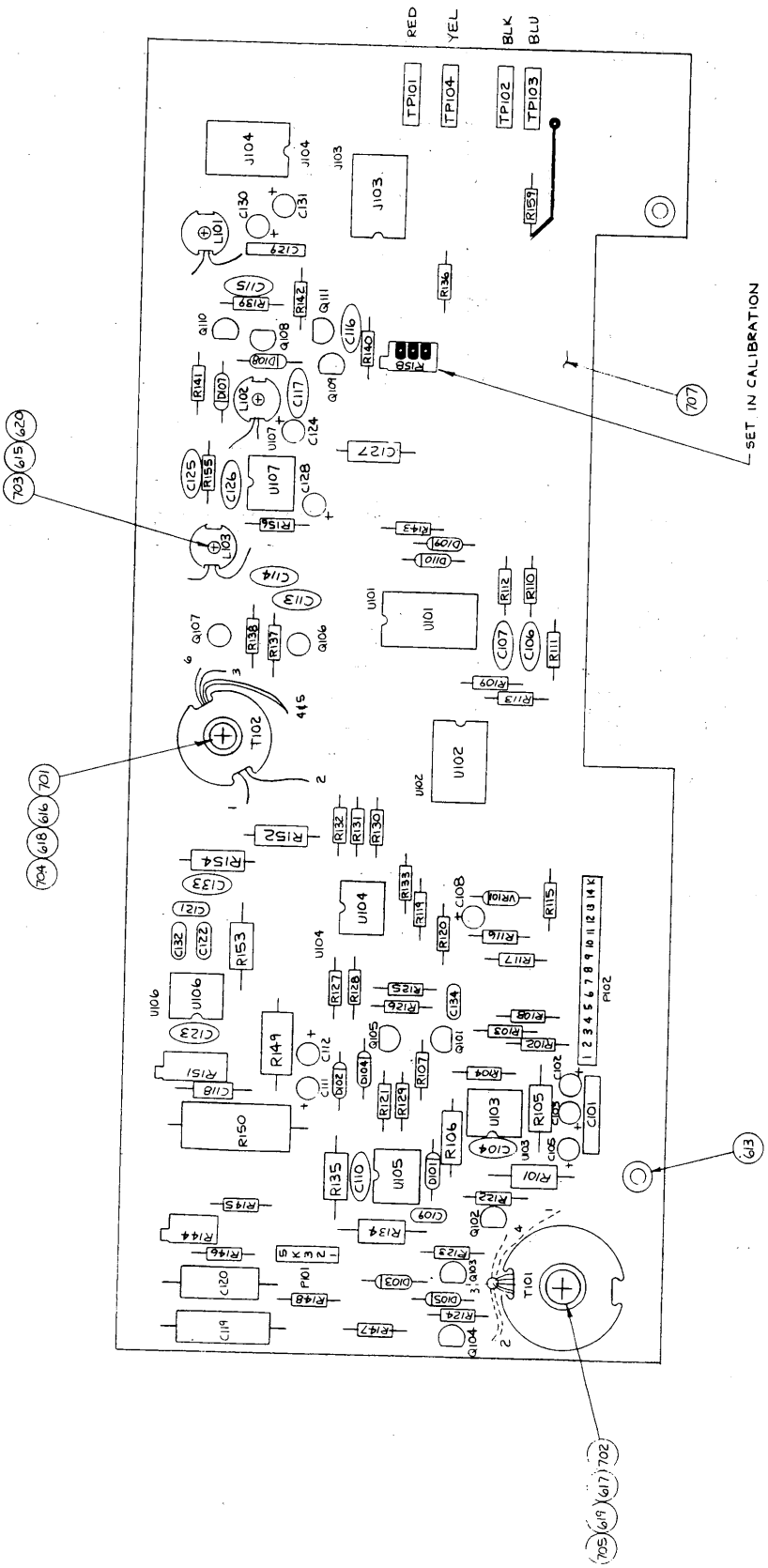
PL EA-105526

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
601		146-3754	1	# 6-32 HEX NUT		
602		160-3687	2	# 4-40 x 1/4 PAN HD SCREW		
603		160-3714	1	# 6-32 x 7/8 PAN HD SCREW		
604						
605						
606		093-2100	2"	#22 GA BUSS WIRE		
607						
608						

BRUNING 40-107 37393

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9255 | PL EA-105526 | REV A | SH 6 OF 6

AMP/DET PC LAYOUT



AMP/DET PARTS LIST

DISTR TO

REV	REVISION DESCRIPTION	DCR	EO	BY/DATE	PROJ. ENG.
A	REL TO PRODUCTION	#	1049	JS 6-12-79	

PL EA-105528

REV	SH 21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
REV	A	A	A	A	A	A														
SH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20

DRW JS 4-20-79
CHK
PROJ ENGR P. Hall 6/12/79
MGR JHE 6/14/79

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9850

170M-6C AMP/DET P.C.BD ASSEMBLY

D105815 NEXT ASSY NO.

PL EA-105528

SHEET 1 OF 7

REV. A

BRUNING 40-107 37393

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
201		066-2911	1	RES. 1% WW 10K R101		
202		064-2573	1	RES. 1/4W, 5% 33Ω R102		
203						
204		064-2713	1	RES. 1/4W, 5% 470Ω R104		
205		066-3036	2	RES. 1% WW 30K R105, R135		
206		065-2953	1	RES. RN60C 49.9Ω R106		
207		064-3086	1	RES. 1/4W, 5% 51K R107		
208		064-2959	1	RES. 1/4W, 5% 1M R121		
209		064-2714	5	RES. 1/4W, 5% 10M R122-124, 137, 138		
210		064-3195	1	RES. 1/4W, 5% 6.2K R125		
211		064-2592	2	RES. 1/4W, 5% 3.9K R117, 126		
212		064-2469	8	RES. 1/4W, 5% 100K R129, 130, 133, 139-143		
213		064-2445	2	RES. 1/4W, 5% 22K R127, 128		
214		064-3117	2	RES. 1/4W, 5% 91K R131, 132		
215		064-4051	6	RES. 1/4W, 5% 470K R110, 112, 119, 113 120, 145		
216		064-2470	5	RES. 1/4W, 5% 4.7K R109, 111, 108, 136, 159		
217		064-2438	2	RES. 1/4W, 5% 100Ω R115, 103		
218		064-2396	1	RES. 1/4W, 5% 2.2K R116		
219		066-3025	1	RES. 1% WW 1K R134		
220		053-4149	1	POTENTIOMETER - 25TURNS CERMET 100K R144		

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9850 PL EA-105528 REV A SH 2 OF 7

PL EA-105528

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
301		064-2428	3	RES. 1/4W, 5% 1K R146-148		
302		053-4060	1	POTENTIOMETER - 25TURNS WW 50K R151		
303		066-4445	1	RES. 1% WW 780K R150		
304		066-4442	1	RES. 1% WW 200K R149		
305		066-4441	1	RES. 1% WW 160K R153		
306		065-4344	1	RES. RN60C 90.9Ω R154		
307		065-2768	1	RESISTOR RN60C 100K R152		
308						
309						
310		053-4240	1	POT 1K 25T R158		
311						
312		064-2599	2	RES. 1/4W, 5% 2.4K R155, 156		
313						
314						
315						
316						
317						
318		005-2753	1	CERAMIC CAPACITOR 1μfd @ 50V C101		
319		007-4029	2	TANTALUM CAPACITOR 6.8μfd @ 35V C102-C103		
320		005-3130	1	CERAMIC CAPACITOR 4.7pf C104		

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9850 PL EA-105528 REV A SH 3 OF 7

PL EA-105528

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
401		007-3291	6	TANTALUM CAPACITOR 10μfd @ 20V C105, 108, 111, 112, 124, 128		
402		005-2336	3	CERAMIC CAPACITOR .01μfd @ 25V C106, 107, 133		
403		005-2908	5	CERAMIC CAPACITOR .1μfd @ 100V C109, 121, 122 132, 134		
404		005-4087	1	CERAMIC CAPACITOR 3pf C110		
405		006-4145	1	POLYCARBONATE FILM .47μfd @ 50V C119		
406		006-2407	1	POLYCARBONATE FILM .047μfd @ 80V C120		
407		006-4310	1	MYLAR FILM .0012μfd @ 200V C118		
408		005-2961	2	CERAMIC CAPACITOR .001μfd C113, 114		
409		005-2848	4	CERAMIC CAPACITOR 100pf C115-117, 125		
410		005-2369	1	CERAMIC CAPACITOR 30pf C123		
411		005-2456	1	CERAMIC CAPACITOR 5pf C126		
412		006-4079	1	MYLAR FILM .001μfd @ 200V C127		
413		005-2523	1	CERAMIC CAPACITOR .22μfd @ 50V C129		
414		007-3298	2	TANTALUM CAPACITOR 1μfd @ 35V C130, 131		
415						
416						
417						
418		015-2412	9	SIGNAL DIODE IN4148 D101-105, 107-110		
419						
420		017-4151	1	ZENER DIODE IN5231B VR101		

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9850 PL EA-105528 REV A SH 4 OF 7

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
501		084-2028	3	PNP TRANSISTOR Q101,108,109 MPS 6518		
502		086-2951	3	N CHANNEL FET Q102-Q104 E112		
503		084-4128	1	NPN TRANSISTOR Q105 GET 2907		
504		086-4162	2	N CHANNEL FET Q106-Q107 U1038E		
505		082-2952	2	NPN TRANSISTOR Q110, Q111 MPS 6531		
506						
507						
508		030-3270	3	AMPLIFIER U103,105,106 ICLM301AN-PA		
509						
510		030-4273	1	AMPLIFIER MC1458 U104		
511		036-9011	1	QUAD NAND GATES MM74C00N U102		
512		036-9006	1	HEX INVERTER CD4049AE U101		
513		031-3265	1	COMPARATOR LM311N U107		
514						
515						
516	A	TA-102812	1	RANGE XFMR T101		
517	A	TA-103330	1	DEMODULATOR XFMR T102		
518						
519	A	TA-102797	1	3MHY FILTER CHOKE L101		
520	A	TA-102798	2	15MHY FILTER CHOKE L102-L103		

PL EA-105528

BRUNING 40-107 37383

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9595

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LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
601		110-3473	1	5 PIN HEADER P101		
602		110-3472	1	15 PIN HEADER P102		
603		156-2475	3	SOCKET 14PIN DIP XU102, XU103, XU104		
604		156-2788	1	SOCKET 16 PIN DIP XU101		
605		156-3251	5	SOCKET 8 PIN DIP XU103-107		
606						
607						
608		128-3482	1	TEST JACK YELLOW TP104		
609		128-3483	1	TEST JACK BLUE TP103		
610		128-3481	1	TEST JACK BLACK TP102		
611		128 3480	1	TEST JACK RED TP101		
612						
613		105-3484	2	CAPTIVE STANDOFF		
614						
615		185-3893	3	#0 INT TOOTH LOCK WASHER		
616		185-3744	1	#4 " " " "		
617		185-3745	1	#6 " " " "		
618		185-3740	1	#4 FLAT WASHER		
619		185-3741	1	#6 " "		
620		146-3882	3	#0-80 HEX NUT		

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MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9595

PL EA-105528 REV A SH 6 OF 7

LINE ITEM NO.	DWG. CODE	IDENTIFICATION NUMBER	QTY	ITEM NAME & DESCRIPTION	MFR CODE IDENT	NOTE NO.
701		146-3753	1	# 4-40 HEX NUT		
702		146-3754	1	# 6-32 " "		
703		160-3891	3	# 0-80 x 7/16 PAN HEADSCREW		
704		160-3703	1	# 4-40 x 5/8 " " "		
705		160-3714	1	# 6-32 x 7/8 " " "		
706						
707	D	PC-105527	1	P.C. BOARD		
708	D	105784	REF	SCHEMATIC		
709	D	EA-105528	REF	P.C. BOARD ASS'Y		
710						
711						
712						
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BRUNING 40-107 37383

MKS INSTRUMENTS, INC. BURLINGTON, MASS. 01803 - 617-272-9595

PL EA-105528 REV A SH 7 OF 7

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