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INSTRUCTION MANUAL

170 SERIES

170M-27D

MKS Instruments
22 Third Avenue
Burlington, MA 01803
617-272-9255

MKS INSTRUMENTS, INC.

WARRANTY

MKS Instruments, Inc. (MKS) warrants that all equipment manufactured by **MKS** shall be free from defects in materials and workmanship for a period of one year from date of shipment. For the period commencing with the date of shipment of the equipment and ending one year later, **MKS** will, at its option, either repair or replace any part which is defective in materials or workmanship without charge to the purchaser. The foregoing shall constitute the sole remedy of the purchaser for any breach by **MKS** of this warranty.

The purchaser, before returning any equipment covered by this warranty, which is asserted to be defective by the purchaser, shall make specific written arrangements with respect to the responsibility for shipping the equipment and handling and other incidental charges, with the **MKS** sales representative or distributor from which the equipment was purchased, or in the case of a direct purchase, from **MKS** home office in Burlington, Massachusetts, USA.

The warranty does not apply to any equipment which has not been used in accordance with the specifications recommended by **MKS** for the proper and normal use of the equipment. **MKS** shall not be liable under any circumstances for consequential or incidental damages in connection with, or arising out of the sale, performance or use of, the equipment covered by this warranty.

THIS WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES BY **MKS,** EXPRESSED OR IMPLIED, INCLUDING WARRANTIES OF MERCHANTABILITY, WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE AND WARRANTIES AGAINST INFRINGEMENT OF ANY PATENT.

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SPECIFICATIONS

MECHANICAL

PACKAGE: Cabinet style or rack mount.
DIMENSIONS: 2A Module.
WEIGHT: 6 Lbs.

ENVIRONMENTAL

MAX. OPERATING TEMPERATURE: 50° C (122° F).

INTERFACE

All input/output and power connections are available on the rear panel.

ELECTRICAL

POWER: 115/230 VAC, 50/60 Hz, 7 Watts.
RESOLUTION: 1Mv.
INPUT IMPEDANCE: 100K.
TEMPERATURE COEFFICIENT: ±0.0015%R ±0.001%F.S./° C.
ACCURACY: 8hrs/25 C ±0.01%R ±0.01%F.S.
READING RATE: 2/sec & 30/sec by grounding pin 4 on the BCD connector.
DISPLAY: .55 inch, 7 segment, planar, gas discharge, numerals with + and − indicators.
ANALOG OUTPUTS: 0–10VDC available on the Accessory Connector and a scaled analog voltage which tracks the display is available on the BCD Connector. Each can drive a 10K ohms or greater load.
BCD OUTPUTS: Parallel Line BCD with polarity, decimal and over-range information. These outputs can drive 2 TTL loads.

CONVERSION FACTORS FOR SCALING

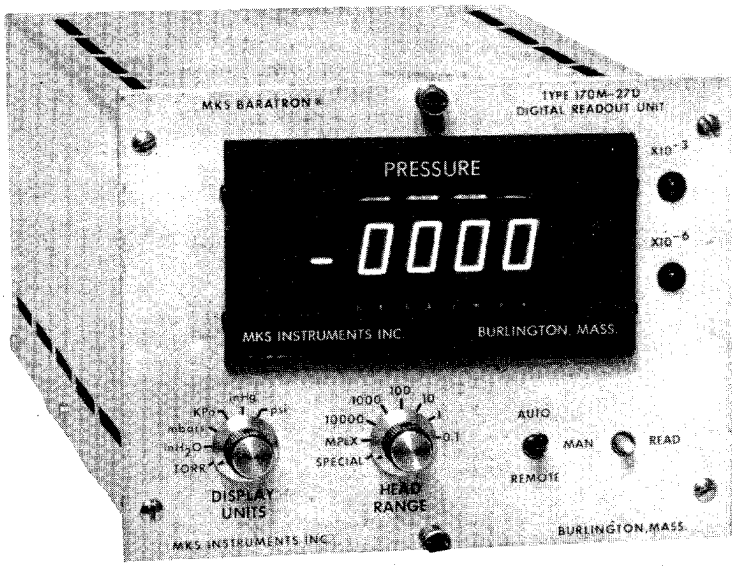
1 Torr* =	39.37×10^{-3}	in Hg (0° C)
	133.32×10^{-3}	kPa
	0.5353	in H_2O (4° C)
	1.3332	mbars
	19.337×10^{-3}	psi

THE 170M-27D READS DIRECTLY IN TORR. THE REMAINING RANGES ARE SCALED IN REFERENCE TO TORR. THEREFORE, ALL INPUTS TO THE 170M-27D MUST BE IN TORR.

SECTION 1

GENERAL DESCRIPTION

The 170M-27D is a rack/cabinet mountable 4½ place digital readout which accepts the analog output from the 170M-6B electronics unit. This unit retains all of the features of the 27C unit such as complete BCD outputs, remote reading control and complete interface with all 170 series multiplex units. In addition the 27D unit has a front panel display switch which allows the operator to select one of the following scale factors for the digital display. Torr, in H_2O, mbars, kPa, in Hg and psi. The 27D also has an analog output voltage, available at the BCD connector, which tracks the digital display.



SECTION 2

INSTALLATION & OPERATION

The 170M-27D is packaged in a type 170 2A width module. This module can be mounted in a rack mount adapter or a cabinet. Connection to the 170M-6B is made with a CB363 cable. This cable connects to the ACESSORY connector on the rear of the 170M-6B and to the ELECTRONICS connector on the rear of the 170M-27D. Connection to a multiplex unit is made with a CB320 cable. This cable connects to the DVM connector on the rear of the multiplex unit and to the MULTIPLEX connector on the rear of the 170M-27D. Connection to the BCD outputs is made with the 50 pin PC connector that is supplied with each unit. The BCD outputs are:

PIN NO.	
1	— Digital Ground
2	— 8
3	— Good Data
4	— 30/sec
5	— Blanking
6	— N.C.
7	— 2000
8	— 10,000
9	— Over-Range
10	— −4P
11	— −3P
12	— −2P
13	— +4P
14	— +3P
15	— +2P
16	— CH 2 ID
17	— CH 1 ID
18	— Data Ready
19	— CH 3 ID
20	— Remote Read
21	— N.C.
22	— N.C.
23	— N.C.
24	— N.C.
25	— Digital Ground

PIN NO.	
A	— Digital Ground
B	— 4
C	— 1
D	— 2
E	— 10
F	— 80
H	— 20
J	— 40
K	— 800
L	— 100
M	— 200
N	— 400
P	— 8000
R	— 1000
S	— 4000
T	— Digits Test
U	— Polarity
V	— +1P
W	— 0P
X	— −1P
Y	— −5P
Z	— Analog Return
AA	— Analog DC Voltage
BB	— N.C.
CC	— Digital Ground

CONNECT NO LINES TO PINS MARKED N.C.

DECIMAL POINT

The decimal information that is present at the rear connector is labeled as powers of ten. EXAMPLE: The decimal point for 1000.0 is +3P while conversely the decimal for .001 is −3P. Unlike the rest of the output data which is positive true logic, the presence of a decimal point is indicated by a low signal. (0 to +.4V negative true logic.)

GOOD DATA

This line is high when the 170M-6B Range Selector is in either the Remote, X1, X.1 or X.01 position and the 170M-27D Head Range Selector is in either the 10K, 1K, 100, 10, 1 or .1 position. This identifies a valid pressure measuring mode, as defined by MKS.

30/SEC

Grounding this line causes the conversion rate of the meter to change from 2/sec to 30/sec.

BLANKING

When +5V is applied to this line, all the digits in the display are blanked.

CHANNEL ID

The three channel ID lines are intended to interface into a computer to identify the proper channel when the 170M-27D is used with a multiplex unit. A table of the logic levels for each channel is given below:

	CH 1	CH 2	CH 3
Channel 1 ID	0	1	1
Channel 2 ID	1	0	1
Channel 3 ID	0	0	0

MARKED 5/13/81
P. Ashby

DATA READY

This line goes high to indicate the completion of a conversion cycle and remains high until the beginning of the next conversion cycle. Output data should be taken when this line is in the high state.

REMOTE READ

This line can be used to remotely control the conversion rate of the unit. The Control Mode switch is placed in the Remote position and this line is held low (0 to +.4V) to prevent an unwanted conversion. To initiate a conversion cycle, pulse this line. Pulse width should be from 50μsec MIN to 2Msec MAX.

DIGITS TEST

Grounding this line lights all readout segments for test purposes.

BCD OUTPUT SPECIFICATIONS

Two types of outputs are used on the 170M-27D. The outputs from the panel meter are DTL/TTL while the outputs from the interface electronics (decimal data, channel ID & data ready command) are CMOS. Both types will drive 2 DTL/TTL unit loads with a unit load defined as:

LO = 0 to +0.4V unit load = +1.6Ma
HI = +2.4 to +5.0V unit load = −40μa

The CMOS output specifications are:

LO = 0 to +0.4V sinking 2.6Ma; 5Ma typical
HI = 4.2 to 5.4V sourcing −400μa

The DTL/TTL output specifications are:

LO = 0 to +0.5V sinking 10Ma
HI = 2.4 to +5.5V, source resistance = 6K ohms

FIG. A

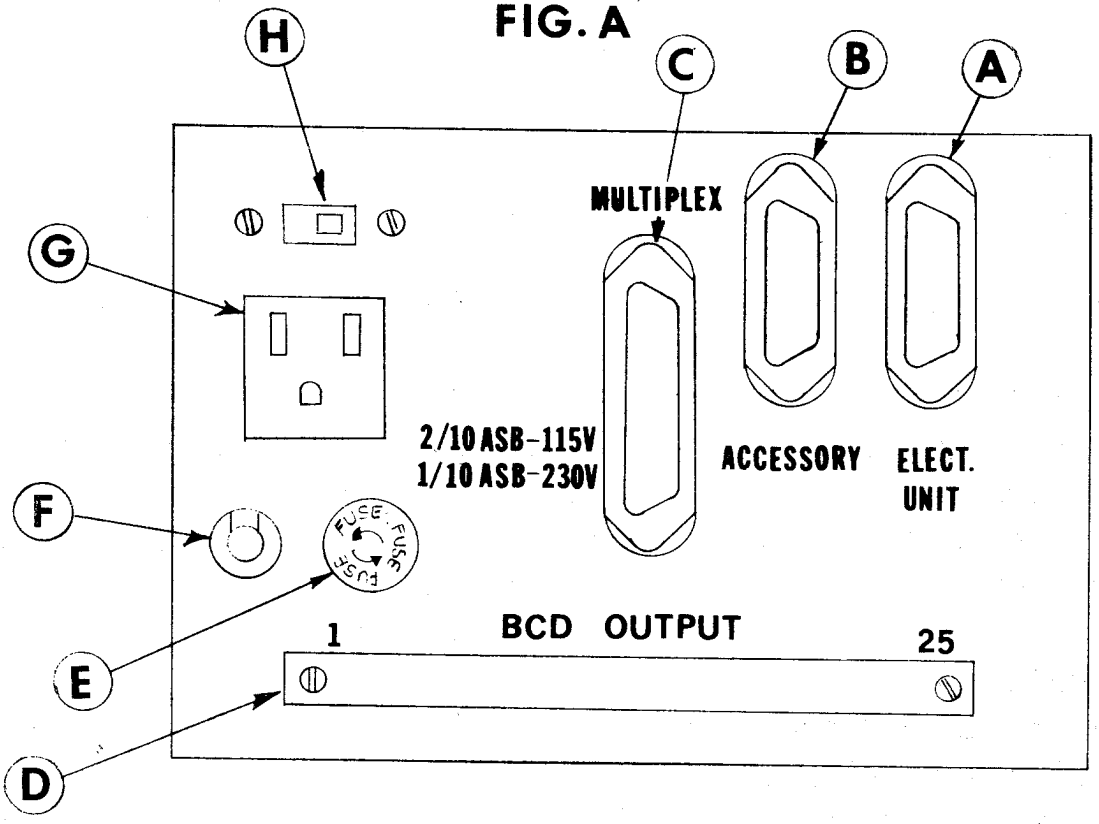
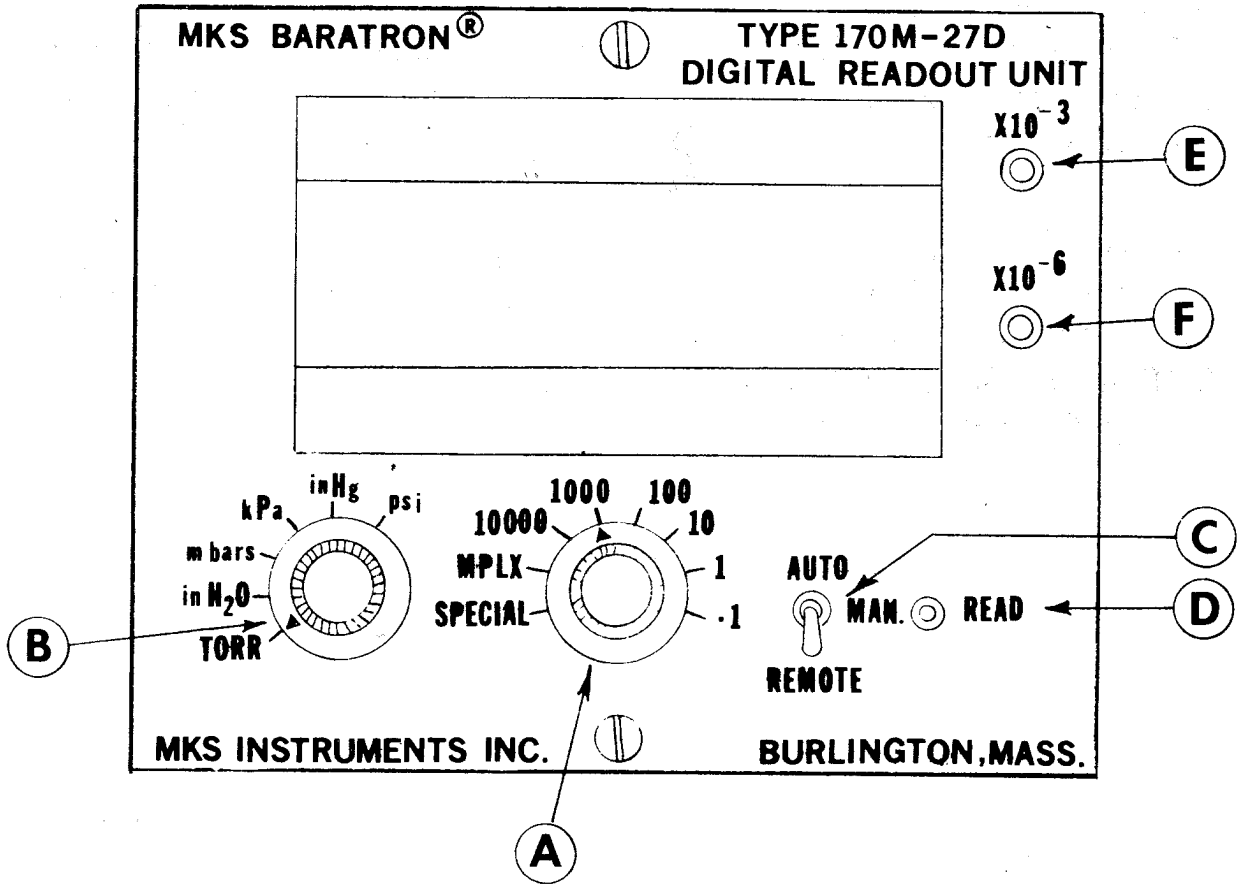

H
C
B
A
MULTIPLEX
G
2/10 ASB-115V
1/10 ASB-230V
ACCESSORY
ELECT. UNIT
F
FUSE
FUSE
E
1
BCD OUTPUT
25
D

FIG. B


MKS BARATRON®
TYPE 170M-27D
DIGITAL READOUT UNIT
X10⁻³
E
X10⁻⁶
F
kPa
inHg
psi
m bars
in H₂O
TORR
B
1000
100
10000
10
MPLX
1
SPECIAL
.1
AUTO
MAN.
READ
C
D
REMOTE
A
MKS INSTRUMENTS INC.
BURLINGTON, MASS.

REAR PANEL CONTROLS & CONNECTIONS

SEE FIG. A

ELECTRONICS UNIT (A)

The electronics unit (170M-6B) is interfaced to the Digital Readout Unit through this connector. This connection provides the DC analog signal and the range multiplier information that is necessary for the proper display.

ACCESSORY (B)

This connector is identical in every connection to the above connector (A). This connector provides access to the output information for the electronics unit when a readout unit is in use, allowing the user to drive several output type units together from the output of the electronics unit.

MULTIPLEX (C)

This connector provides access into the logic circuits of the meter. When the Head Range Selector is in the multiplex position the multiplex unit controls the placement of the head range, channel ID and sample commands through this connector.

BCD OUTPUT (D)

This connector provides access to all of the BCD output information such as the display reading, decimal point, channel ID, remote trigger, analog DC output, etc.

FUSE

Line fuse to protect internal circuitry of the readout unit. The "High Side" of the line is fused. Fuse values:
2/10 A Slo Blo @ 115VAC
1/10 A Slo Blo @ 230VAC

INPUT POWER CORD (F)

This three wire power cord provides the 115 or 230VAC power input to the unit.

ACCESSORY POWER OUTPUT (G)

This connector provides power to other modules. It is wired in parallel with the input power cord and is controlled by the electronics unit when the cord is connected to that unit. The connector is NOT FUSED and assumes the potential of the unit to which it is connected.

LINE VOLTAGE SWITCH (H)

Used to select the proper input voltage. A screwdriver is used to switch it to the correct voltage. Selected voltage level is displayed in the slot.

FRONT PANEL CONTROLS

SEE FIG. B

HEAD RANGE SELECTOR (A)

When switched to the range of the transducer in use, this switch combines the head range and the multiplier level of the electronics unit to properly position the decimal point.

The switch is set in the MULTIPLEX position when used with a multiplex unit and to the SPECIAL position when a special range has been provided.

DISPLAY UNITS SELECTOR (B)

This switch is used to select the units in which the pressure is displayed.

SAMPLE MODE CONTROL (C)

This toggle switch selects the way in which the command to read a signal is generated.

1. AUTO — In this position the unit is free running from the internal pulse generator. Sample rate is 2/sec.

2. MANUAL In this position the unit is commanded to sample by depressing the button marked READ.

3. REMOTE In this position the unit is commanded to sample by external sources through the BCD connector (Pin 20) or the multiplex connector (Pin 20). In this position the input of the sampling circuit is left open. This point must be held lo or the meter will free run. This is done in multiplex units supplied by MKS.

MANUAL READ SWITCH (D)

When the SAMPLE MODE CONTROL is set in the MANUAL mode, the command to start a reading is done by depressing the MANUAL READ SWITCH.

$X10^{-3}$ LAMP (E)

Since it is not possible to display the decimal point to the left of the MSD, a full scale reading of +.10000 (10 MM range, Units display Torr, 6B on X.01 range) is displayed as +100.00 and the $X10^{-3}$ lamp is illuminated.

$X10^{-6}$ LAMP (F)

When it becomes necessary to display a full scale reading of +.13332 $X10^{-3}$ (.1 MM range, Units display kPa, 6B on X,01 range) is displayed as +133.32 and the $X10^{-6}$ lamp is illuminated.

OPERATION

1. Connect the 170-27D into the system as outlined on page 2-1.
2. Connect the power cord into the rear of the 170M-6B.
3. Place the Units Display switch to the desired unit.
4. Place the Head Range Selector to the range of the sensor that is being used.
5. Place the Scan Mode Control in Auto.
6. When the power to the 170M-6B is turned on the 170M-27D will automatically read at a rate of 2 conversions per second.

7. Should the system contain a 170 series multiplex unit then place the Head Range Selector into the MULTIPLEX position.

SPECIAL RANGE POSITION

In the event that the six display ranges supplied with the meter are not sufficient, it is possible to add another through the SPECIAL position on the Head Range switch. To do this it is necessary to cut a PC jumper and install a pot and 2 resistors, and a jumper wire to select the required decimal point. See figure C for the location of these components.

The value of the resistors R48, R50 and the potentiometer R49 is calculated in the following manner:

1. The full scale output from the 170M-6B into the meter is +10V.
2. The full scale input of the meter is +2V.
3. The total resistance of the divider should be approx. 100K.
4. The proper divider is:

$$\text{Full Scale Desired}^* = \frac{+10\text{V (R50)}}{\text{R50} + \text{R48}}$$

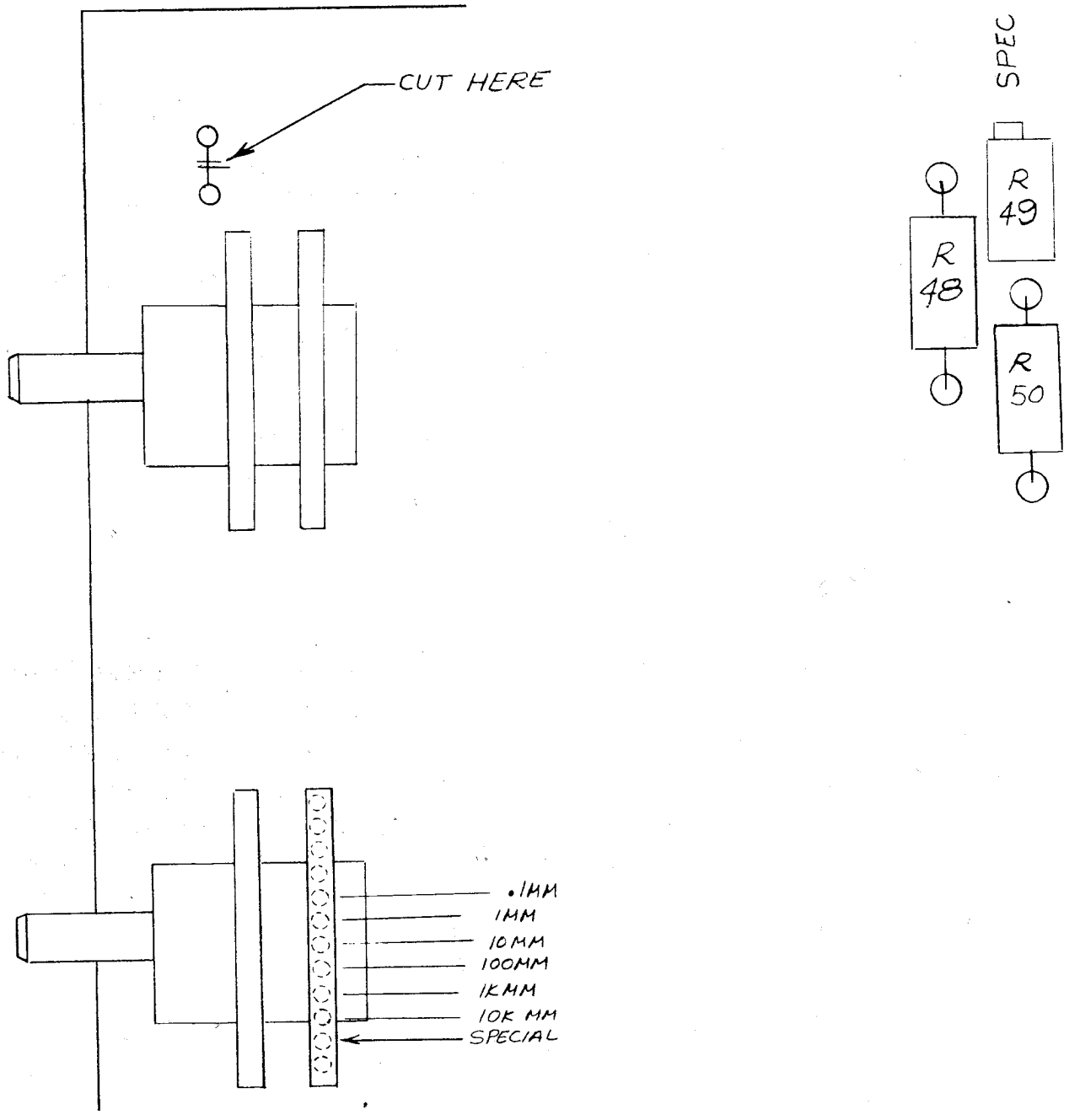
*Less than 2V.

5. The potentiometer R49 is added to adjust for the ±1% tolerances of the resistors. This potentiometer should be able to provide at least ±2% of full scale adjustment. Recommend Bourns 3299 or equivalent. When the value of the potentiometer is chosen, take one half of its value and subtract that amount from R48 and R50. This should center the adjustment range. Select the nearest standard value of RN60C style resistors for R48 and R50.

REMOTE CONTROL

Should it be necessary to remotely command the meter to read, place the SCAN MODE CONTROL in REMOTE and control via the BCD connector. (See Remote Read, page 2-7.)

FIGURE C



To select a decimal point for the SPECIAL position — connect a jumper from the SPECIAL position on the switch to the desired head range on the switch. Place the Display Units switch in the TORR Position.

NOTE: 10K position on the 170M-27D yields no decimal point on the display.

CHECKING DISPLAY UNITS FULL SCALE

The full scale value of each display unit can be checked by placing the 170M-6B in the F.S. position and comparing each display with the table below:

DISPLAY UNIT	FULL SCALE
Torr	10000
in H_2O	5353
mbars	13332
kPa	13332
in Hg	3937
psi	19337

Adjustments for each range are located on the front left hand side of the unit.

SECTION 3

THEORY OF OPERATION

Refer to figure D.

INPUT SIGNAL

The 0 to +10V DC signal is received at the rear electronics connector (Fig. A, item A) and is applied to the input voltage divider, optional special range divider and the input comparator circuit. A section of the display units switch selects the proper tap on the divider and applies this voltage to a section of the head range switch. This switch section selects either the voltage from the standard divider or the optional special range divider and applies it to the digital panel meter.

INPUT COMPARATOR/OVER RANGE CIRCUIT

This circuit is used to sample the level of the input voltage and generate a command to over-range the digital panel meter when the input voltage is in the 10.5 to 11.5V range. This is done to prevent erroneous readings due to a saturated output signal from the 170M-6B.

DECIMAL POINT SELECTION

The placement of the decimal point is determined by the position of the 170M-6B multiplier range switch, the head range switch and the units display switch. This is done by creating a BCD number for each switch position and then adding these numbers together. These numbers are indicated on the schematic as logic code numbers and are processed in the following manner:

1. The 170M-6B range ID's are connected to the digital interface circuits which generate a BCD number for each position of the 170M-6B range switch. For Example: the X1 range generates a logic code of 2L which is placed into the B input of the first adder.
2. The display unit switch is connected to a digital interface circuit which generates a BCD number for each position of the switch. For Example: the Torr range generates a code of 2L which is placed into the A input of the first adder.

3. The sum of the A&B inputs, 4L, is then placed into the B input of the second adder.
4. The head range selector, or the multiplex unit when in use, is connected to a digital interface circuit which generates a BCD number for each position of the switch. For Example: the 1000 range generates a code of 4L which is placed into the A inputs of the second adder.
5. The sum of the A&B inputs, 8L, is then applied to the storage unit. This storage unit updates upon command of the data ready delay circuit.
6. This places the decimal code into the input of a BCD to decimal decoder where one of 10 lines is activated to correspond to the BCD input. In this example the $\overline{8}$ line goes low.
7. This information goes to a buffer stage for transmission to the BCD connector and to the decimal lamp driver circuit which interfaces with the decimal lamps in the meter. The $\overline{8}$ is connected to decimal lamp 3 which generates a reading of 000.0. This agrees with our example of a 170M-6B range at X1, a head range of 1000 and the display units in Torr.

DATA READY DELAY

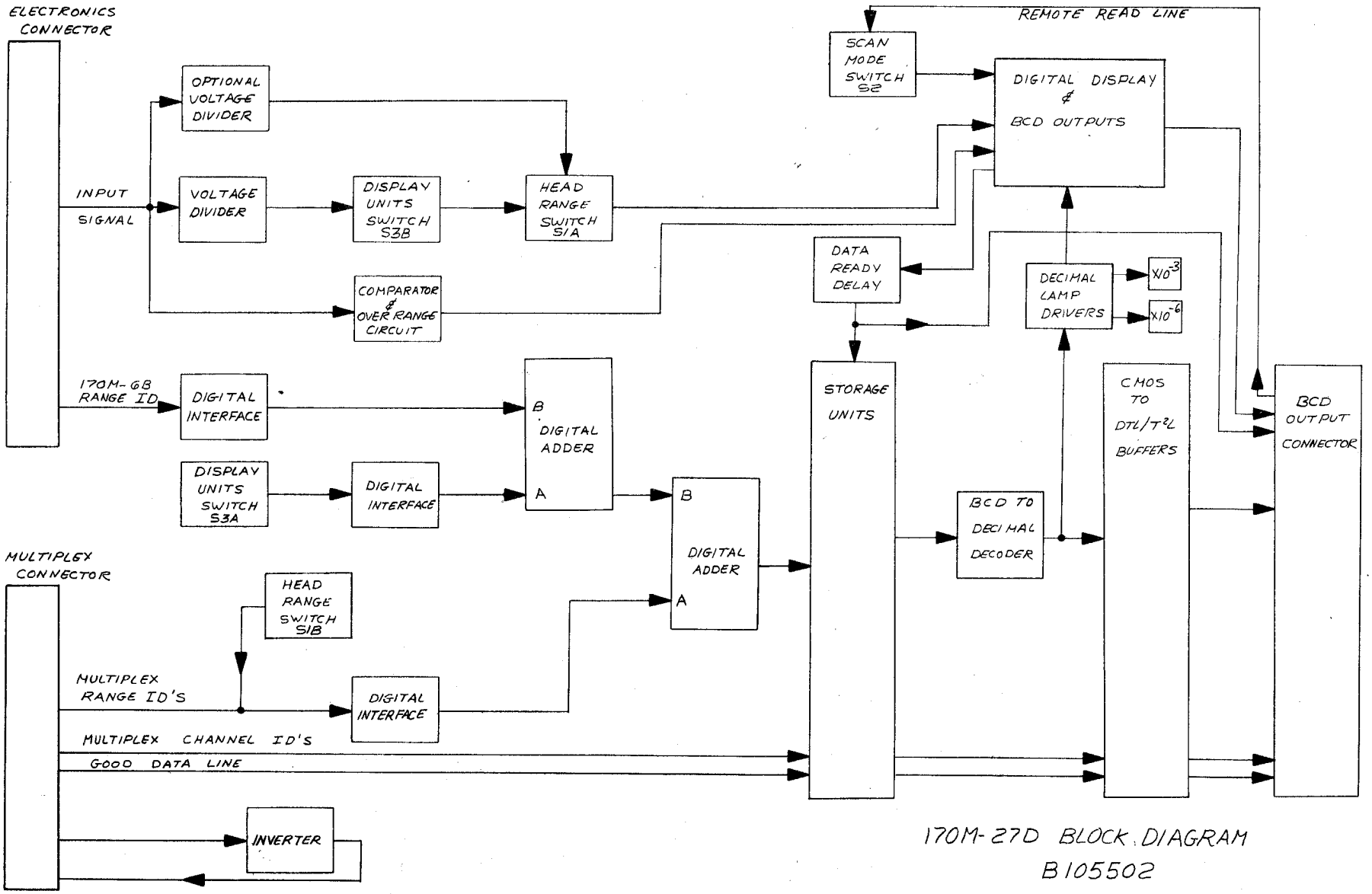
This circuit accepts the data ready command from the meter, delays it, and then sends that signal to the BCD output connector and to the storage units as a clock pulse. The delay is created to allow time for the logic from the meter (BCD outputs) and the logic from the decimal selection circuits to reach their proper logic levels.

DECIMAL LAMP DRIVERS

This circuit interfaces the low voltage logic levels to the higher voltage of the gas discharge display. It also provides logic circuits to drive the $X10^{-3}$ and $X10^{-6}$ lamps when the decimal selected requires it. (See section 2, page 7.)

INVERTER

This digital inverter is intended for the user. For Example: A positive going pulse is required for remote read control of the meter. Should the user have a negative pulse it can be wired to the inverter input while the inverter output is connected to the remote read line to provide the required pulse polarity.



170M-27D BLOCK DIAGRAM
B105502

SECTION 4

MAINTENANCE

GENERAL

MKS Instruments recommends that any instrument that is still covered by the Warranty be returned to the factory for repair and recalibration. First contact the MKS factory for assistance. (Customer Service Section)

FAULT ISOLATION

GENERAL

Should a problem occur with the 170M-27D when it is connected into a system it is best to localize the problem by disconnecting the unit and the electronics unit from the system.

1. An incorrect voltage reading on the meter may be traced to the input voltage divider, faulty panel meter or an incorrect signal from the electronics unit.

2. A reading of 18888 usually indicates a faulty +5V logic power supply inside the panel meter.

3. A problem with the placement of the decimal point may be due to a failure of the internal logic circuits or from an improper range ID from the electronics unit or multiplex when in use.

4. Failure of the decimal point to move when the head range switch is moved may be due to a bad storage unit or failure of the data ready delay circuit or no data ready command from the meter.

5. No decimal points on any range may be caused by the incorrect signal on the good data line. (See good data, page 2-2.)

6. Failure to interface properly with a printer or computer may be caused by no data ready command at the rear connector, too heavy a load on the BCD outputs or faulty logic in the 170M-27D or the panel meter. (See BCD output specifications, page 2-3.)

TROUBLE SHOOTING

GENERAL

For proper trouble shooting the 170M-27D must be connected to the 170M-6B since it supplies power to the comparator/over range circuit.

Use the block diagram and the preceding section on isolation to try and determine the area in which the problem most likely lies.

The following procedures provide a means of checking certain key operations of the 170M-27D. In the event that the proper result is not obtained it then is necessary to trouble shoot the circuit to find the fault.

1. Connect the ground lead of a voltmeter to pin 1 on the BCD connector. Measure the +5V logic supply on the PC board. It should be +4.25 to +5.75V.

2. To check out the voltage divider proceed as follows:

   A. Place the 170M-6B into the F.S. position. Connect a digital voltmeter to the DC output of the 6B. The DC output must be 10V ± 1% (9.900 to 10.100). Adjust F.S. pot if necessary.

   B. Connect the voltmeter to the arm of S3 and reference the ground to the BCD connector pin Z. You should measure the following voltages for each position of the switch:

Torr	=	+0.990 to +1.010V
in H_2O	=	+0.5298 to +0.5406
mbars	=	+1.3196 to +1.3463
kPa	=	+1.3196 to +1.3463
in Hg	=	+0.3897 to +0.3976
psi	=	+1.9142 to +1.9529

C. Should this be correct then repeat the measurement at the arm of S1A. This checks the voltage up to the panel meter.

3. To check for the proper operation of the data ready command proceed as follows:

A. Apply a +10V input as in step 3.

B. Connect an oscilloscope to pin 18 on the BCD connector. Reference to pin 1.

C. Place the scan mode control in Auto.

D. The scope should indicate a pulse that falls from approx. +5V to ground, 6 Msec wide and occurring about 2 times to 3 times per second.

4. To check for the proper operation of the decimal logic proceed as follows:

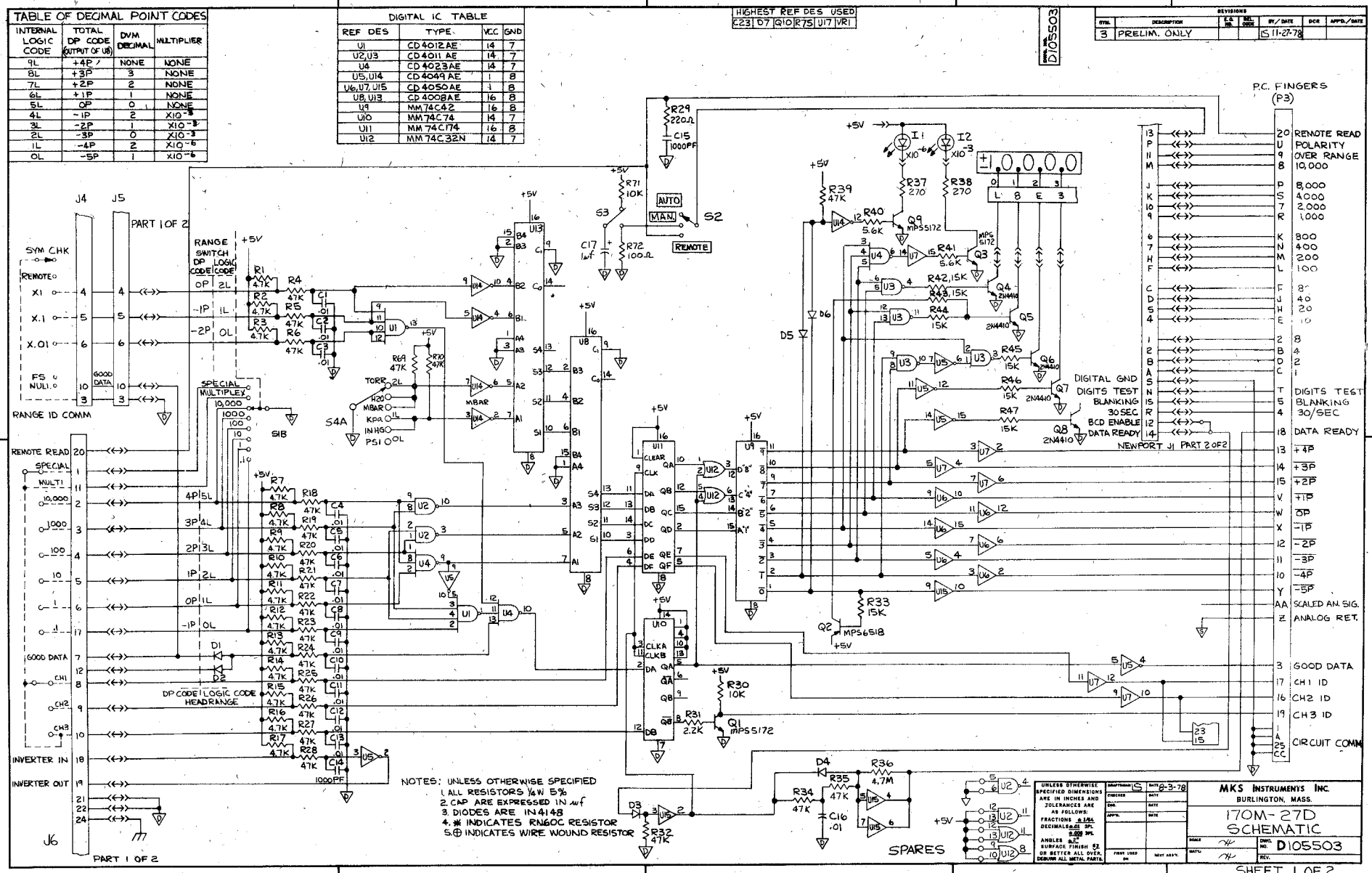
A. Disconnect the 170M-6B and connect a jumper wire from pin 4 to pin 3 on the electronic unit connector. This simulates the X1 range ID from the electronics unit.

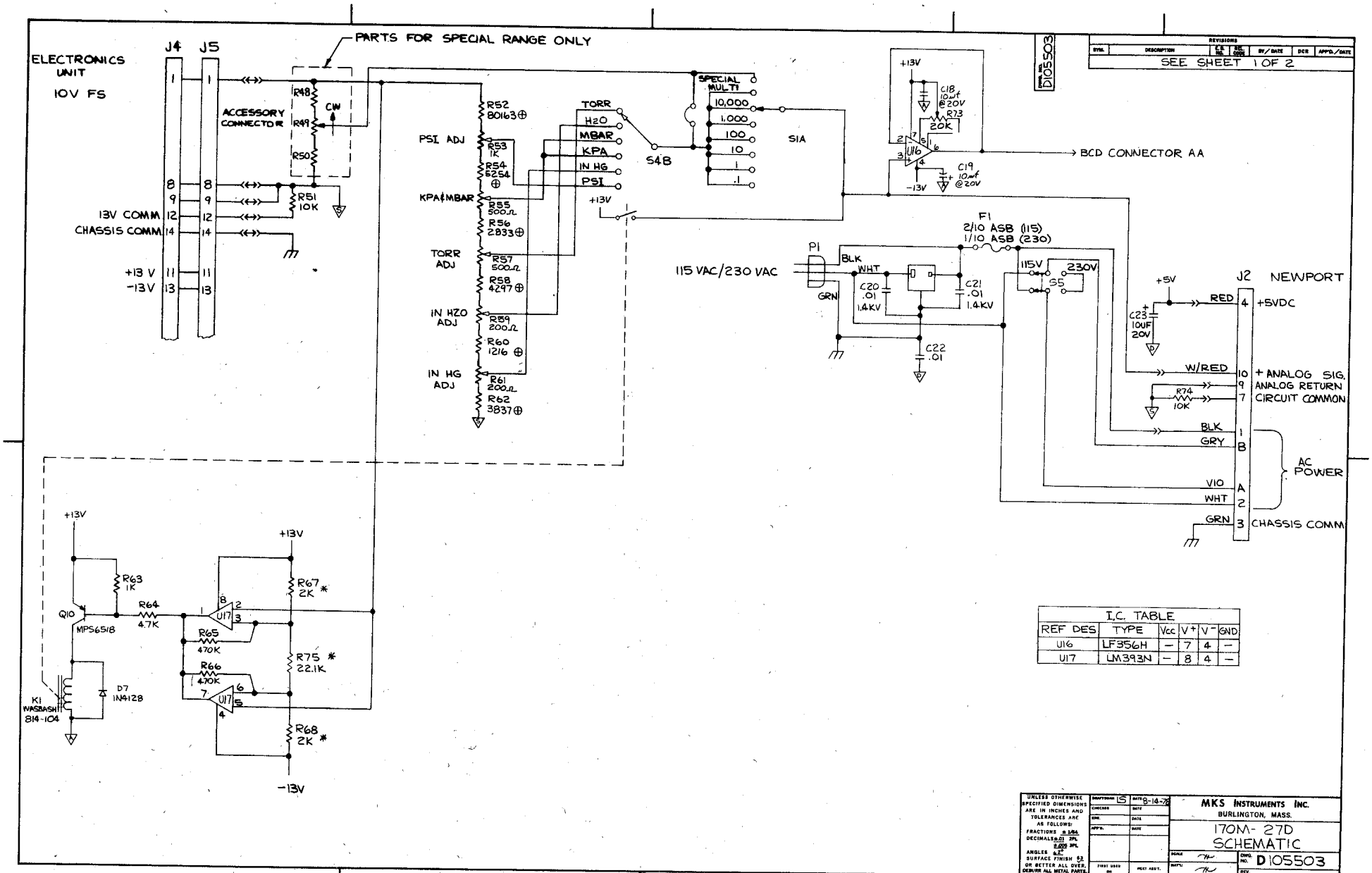
B. Place the head range switch in the 1000 position.

C. Place the display unit switch in the Torr position.

D. This commands the unit to display decimal point 3 to indicate a full scale of +1000.0 when a +10V signal is applied.

5. On problems concerning the comparator/over range circuit check the ± power input from the signal conditioner. Should be ±13V ± 1%.


TABLE OF DECIMAL POINT CODES
INTERNAL LOGIC CODE | TOTAL DP CODE (OUTPUT OF U8) | DVM DECIMAL | MULTIPLIER
9L | +4P | NONE | NONE
8L | +3P | 3 | NONE
7L | +2P | 2 | NONE
6L | +1P | 1 | NONE
5L | 0P | 0 | NONE
4L | -1P | 2 | X10-3
3L | -2P | 1 | X10-3
2L | -3P | 0 | X10-3
1L | -4P | 2 | X10-6
0L | -5P | 1 | X10-6
DIGITAL IC TABLE
REF DES | TYPE | VCC | GND
U1 | CD4012AE | 14 | 7
U2,U3 | CD4011AE | 14 | 7
U4 | CD4023AE | 14 | 7
U5,U14 | CD4049AE | 1 | 8
U6,U7,U15 | CD4050AE | 1 | 8
U8,U13 | CD4008AE | 16 | 8
U9 | MM74C42 | 16 | 8
U10 | MM74C74 | 14 | 7
U11 | MM74C174 | 16 | 8
U12 | MM74C32N | 14 | 7
HIGHEST REF DES USED
C23 D7 Q10 R75 U17 VR1
D105503
REVISIONS
SYM. | DESCRIPTION | E.A. NO. | ENG. ORDER | BY/DATE | DCR | APPD./DATE
3 | PRELIM. ONLY | | | IS 11-27-78 | |
P.C. FINGERS (P3)
PART 1 OF 2
PART 2 OF 2
NEWPORT J1
RANGE ID COMM
SPECIAL MULTIPLEY
DP CODE | LOGIC CODE HEADRANGE
SPARES
NOTES: UNLESS OTHERWISE SPECIFIED
1. ALL RESISTORS ¼W 5%
2. CAP ARE EXPRESSED IN mf
3. DIODES ARE IN4148
4. * INDICATES RN60C RESISTOR
5. ⊕ INDICATES WIRE WOUND RESISTOR
MKS INSTRUMENTS INC.
BURLINGTON, MASS.
170M-27D
SCHEMATIC
DWG NO. D105503
REV.
SHEET 1 OF 2
4-4



I.C. TABLE					
REF DES	TYPE	Vcc	V+	V-	GND
U16	LF356H	—	7	4	—
U17	LM393N	—	8	4	—

DWG NO. D105503

REVISIONS						
SYM	DESCRIPTION	E.C. NO.	REL. DATE	BY / DATE	DCR	APPD. / DATE

SEE SHEET 1 OF 2

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES AND TOLERANCES ARE AS FOLLOWS: FRACTIONS ± 1/64, DECIMALS .01 3PL ± .005 2PL, ANGLES ± 2°, SURFACE FINISH 63 OR BETTER ALL OVER. DEBURR ALL METAL PARTS.

DRAFTSMAN IS DATE 8-14-78
CHECKED DATE
ENG. DATE
APP'D. DATE
FIRST USED ON NEXT ASSY.

MKS INSTRUMENTS INC.
BURLINGTON, MASS.

170M-27D
SCHEMATIC

SCALE NONE DWG. NO. D105503
DRAFT. REV.

SHEET 2 OF 2

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