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MKS

Instruction Manual

114633-P1
REV A, 4/92

MKS Type 290C Charge Rate® Ion Gauge Controller

SIX SHATTUCK ROAD, ANDOVER, MASSACHUSETTS 01810 (508) 975-2350 (800) 227-8766 FAX (508) 975-0093

MKS INSTRUMENTS, INC.

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for Type 290C
Equipment

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MKS Type 290C Charge Rate® Ion Gauge Controller

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Section 1 GENERAL DESCRIPTION

The Type 290 Charge-Rate B/A Ion Gauge Controller is a compact, stable, general purpose, hot filament digital ion gauge. It is intended for use in vacuum systems operating at pressures from 10^{-3} Torr to 10^{-9} Torr.

The Type 290 features both analog and digital design techniques which are patented. As a result of these unique ideas, the instrument becomes auto-ranging and adjustment free. Operation is easy and straightforward.

The Charge-Rate technique converts ion current from the B/A gauge tube into voltage pulses whose frequency is proportional to pressure and inversely proportional to emission current. A microprocessor based frequency counter measures the rate of these pulses and displays this information as pressure. The instrument is protected against common forms of abuse such as overpressure and short circuits. Emission current is automatically reduced at higher pressures to maintain accuracy.

As a standard feature, two fail safe alarm set points are included. Relay contacts representing the output of these two set points will be found on the rear panel connector (J202).

Optional features to the basic 290 are offered alone or in combination, such as two tube select, and front panel sensitivity adjust.

A 37 pin type D connector is located on the rear panel. It carries BCD data associated with the display as well as various input and output control functions. Detailed information regarding the use of this connector can be found in the appendix.

Section 2 INSTALLATION AND OPERATION

Installation

THE 290 MUST BE MOUNTED IN SUCH A MANNER AS TO PROVIDE ADEQUATE AIR CIRCULATION ABOUT THE UNIT.

The 290 can be mounted in a panel cutout or a 19" rack when supplied with the RM-6 Rack Mount option. *Figure A* shows the cables necessary to connect between the 290 and other instruments.

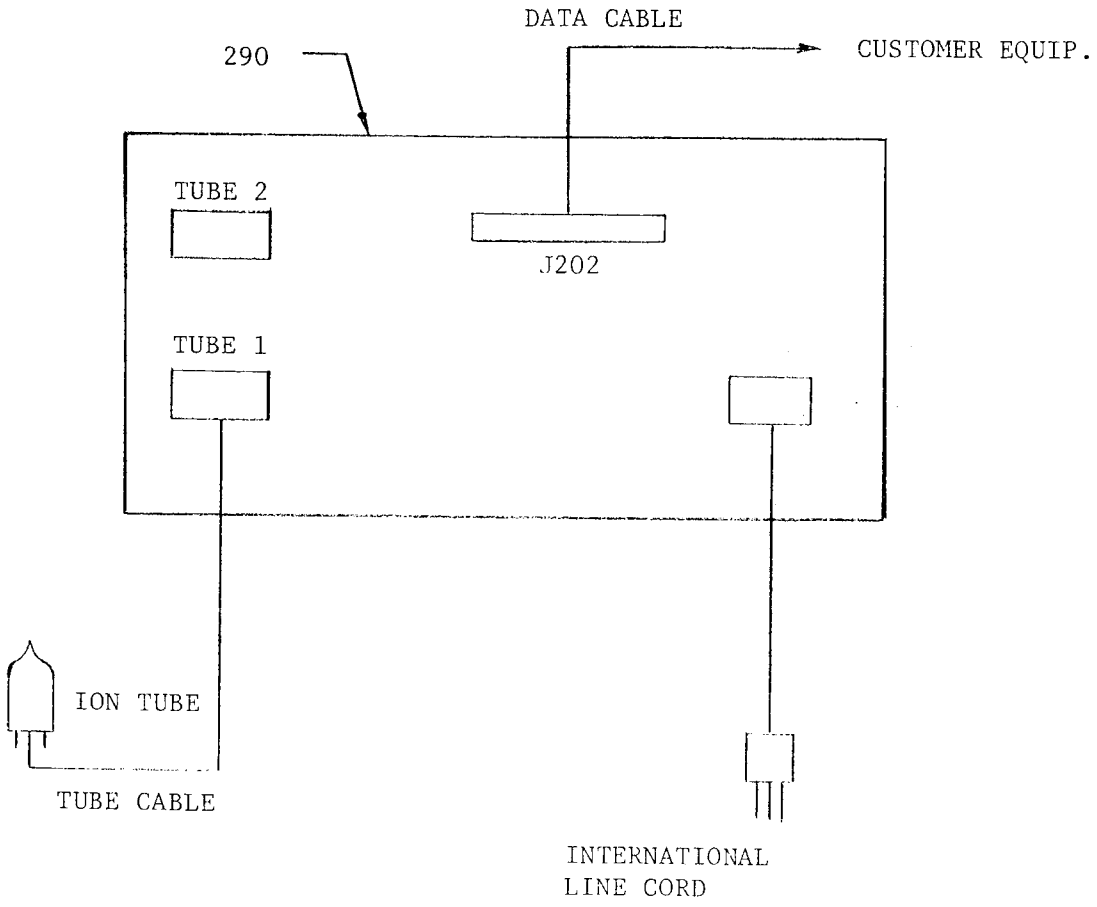
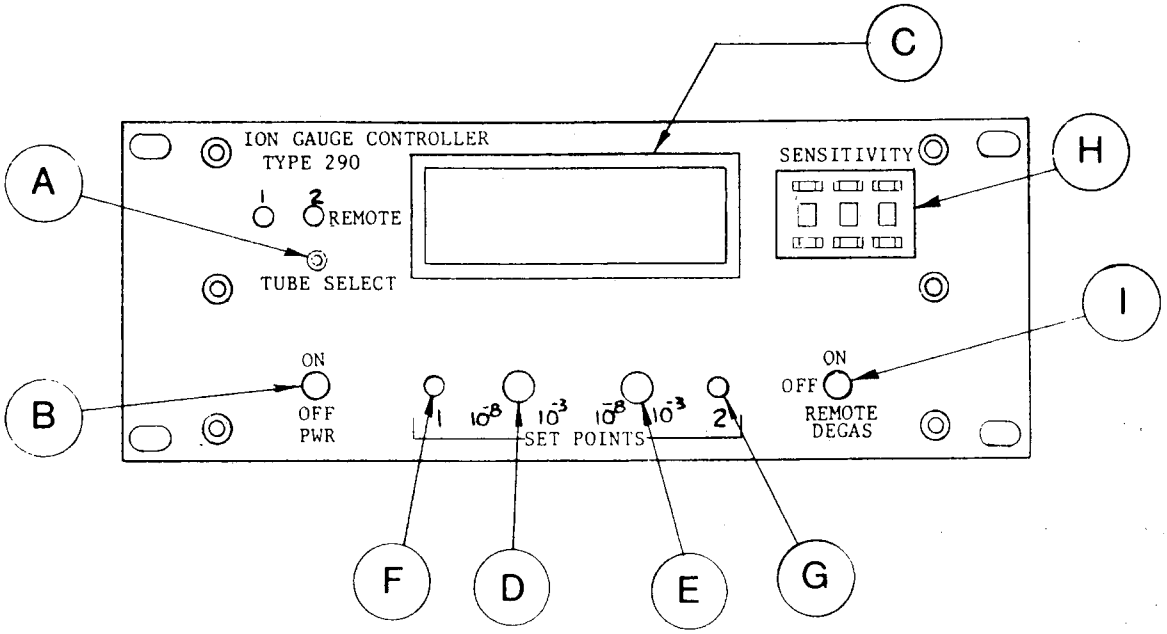
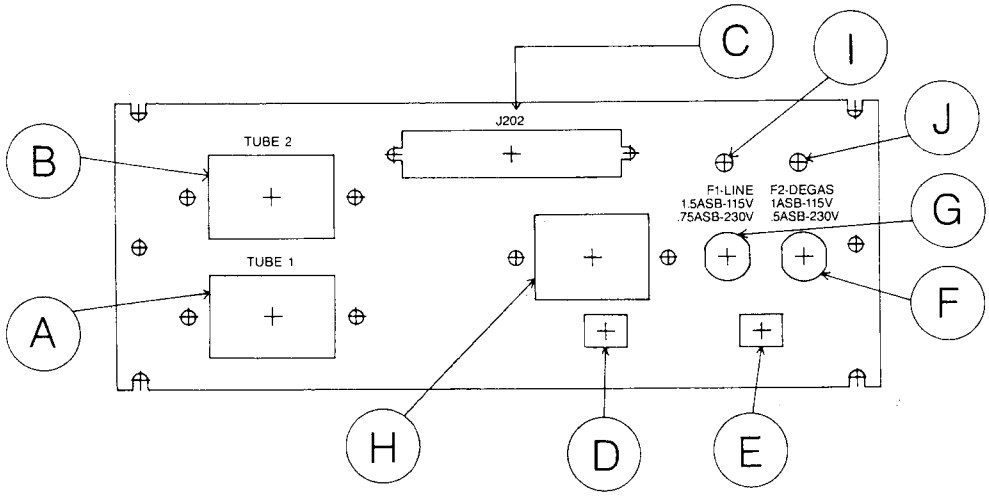


FIGURE A

FRONT PANEL
FIGURE B



REAR PANEL
FIGURE C



FRONT PANEL CONTROLS (See Figure B)

Tube Select (A) – Optional

When in position one, tube (1) is selected; in position two, tube (2) is selected.

For remote operation the following is required at pin 37 of the rear panel data connector J202. An open condition will select tube (1), while a true low will select tube (2).

NOTE: Whenever tube selection is going to be changed, filament power should be removed first. This can be done by turning off the front panel power switch or by bringing R/S low. After the new selection is made, return line power, or let R/S go open.

Power Switch (B)

Turns AC line power on or off.

Digital Display (C)

Displays complete pressure reading in Torr.

Set Point Controls (D, E)

Through-the-panel slot adjustable controls, to set alarm limits. Pressure readings on digital display above the set point cause an alarm condition.

CAUTION: With two tube option, setpoint relays are connected to the gauge tube being displayed and will change to other tube when tube-select switch is changed.

Alarm Visual Indicator (F,G)

These are bicolor indicators. Pressure readings below set point are indicated by a green visual, while pressures above the set point show a red visual.

Sensitivity (H)

This is a digital potentiometer which ultimately sets Ion Tube Emission current. The range of sensitivities can be set from 5 $Torr^{-1}$ to 50 $Torr^{-1}$. A reading of 050 on this control would correspond to 5 $Torr^{-1}$, while a reading at 500 would give a sensitivity of 50 $Torr^{-1}$. A setting of 100 (or 10 per Torr) is normal.

Degas (I)

This switch controls DEGAS power, "ON", "OFF", local or remote. For remote operation, a true low is required at pin 35 of J202 at the rear panel data connector.

NOTE: When in DEGAS mode, the sign display of exponent will flash alternate H's.

REAR PANEL CONTROLS (See Figure C)

Tube Connector (A), (B, Optional)

The tube connectors are 8 pin, Jones type of adequate contact capacity.

Data Connector (C) J202

This is a 37 pin miniature type D connector. A list of pinouts will be found in Appendix regarding its use.

Power Line Select Switch (D)

This switch selects 115 or 230 VAC operation.

Degas Line Select Switch (E)

This switch selects 115 or 230 VAC operation.

Power Line Fuse (F)

Fuse to protect against internal overloads.

Degas Line Fuse (G)

Fuse to protect against internal overloads.

AC Receptacle – Line Filter (H)

The AC line receptacle is an integral part of an RFI filter. An international three wire cord is used.

20 ma Adjustment (I)

Allows adjustment for the 20 ma output.

4 ma Adjustment (J)

Allows adjustment for the 4 ma output.

OPERATION

1. Connect the appropriate end of the ion tube cable to the rear panel tube connector of the 290. Connect the other end to the ion tube in use.

2. With front panel power switch off, connect the line cord to rear panel receptacle. Set the line voltage switch to the right position.

3. Adjust set point controls to desired positions, set DEGAS switch to off.

4. If your unit has the options/features of "tube select" and "sensitivity" adjust, set these controls to proper position. Consult the topic "Front Panel Controls" for a refresher as to their function.

5. The 290 may be turned on now to read pressure, provided the pressure being seen by the ion tube is below the mid-three range. The 290 is designed to shut down at pressures above the mid-three range. For this reason, should the unit go into shutdown, it must be reset by turning off the power momentarily or toggling the remote start line (R/S). Keep the preceding in mind when using the DEGAS function.

6. Certain remote control functions are possible within the 290. They are as follows:

   Remote DEGAS
   Remote Tube select (optional)
   Remote Start stop (R/S)

   If it is desirable to use any of these functions as well as other features such as BCD display data, analog output, etc., consult Appendix for rear panel data connector pinouts.

7. DEGAS NOTE: DEGAS with collector lead removed from gauge tube after installing a new tube or pumping down after a tube has been exposed to atmosphere for some time. Remember to shut-off DEGAS, turn off controller and reconnect the collector lead when finished.

Section 3 THEORY OF OPERATION

ANALOG CIRCUITS (Refer to Schematic 107408)

Section A

These circuits are concerned with the DEGAS function. A filament status level from U106-C into U111-A will determine if DEGAS will be allowed. In normal operation U106-C output is high, going low with filament shut down. This change in level will eventually shut Q118 off, stopping DEGAS.

Section B

This section contains the HV, anode power supply. In series with this supply is a current limiter circuit comprised of Q114, Q115. R155 sets the trip current. CR120 and C128 form a half wave DC supply. Current out of this supply will be limited to about 60 ma.

Section C

This section controls the gauge tube filament power. SCR U107 receives turnon commands via U108 and Q113. U109 allows the firing of U107 to be in sync with the line voltage. Q112 will turn on via R152 and shut down the filament drive, should excessive current flow occur in the output filament lines.

Section D

This circuitry makes up a current-to-frequency converter of wide dynamic range. The output freqency (F) is $F\Big|_{S=K} = f\left(\frac{I^+}{I^-}\right)$ I^+ is the gauge tube ion current and I^- is the emission current. Because the circuits compensate for variations in emission current, the expression $P=\frac{I^+}{I^-S}$ is satisfied.

Ion current through R124 charges C110 towards a threshhold level determined by J305 drain voltage, C111 waits with a charge determined by tube emission current. Upon reaching threshhold, switching action is such that U105-C output turns on Q110, which shuts Q109 off, and Q106 on. C110 looks directly into C111 now. C111 injects opposite charge into C110. This action stops when the voltage on C110 falls below threshhold; a new cycle will now take place and be ongoing.

Section E, F

These circuits provide the following needs:

a) Filament DC bias
b) Filament shut down (overpressure)
c) A voltage bus proportional to emission current
d) SCR (U107) drive signal and drive modification (Q111)

Filament DC bias is derived via VR103, VR104 (15 volt zeners) through Q116 base emitter junction (Q116 normally on). Summing up the voltage rises from the 5 volt rail will place VR103 cathode at approximately 35 volts. The circuit is complete back to the 180 volt supply through the dynamic anode to filament resistance.

Gauge tube emission current flows through VR103, Q116 collector and R136. A DC voltage proportional to emission current appears across R136, it is buffered by U106B to form a control bus which eventually supplies the charge injection capacitor C111. The bus also controls the non-inverting input of U106A. U109 supplies a 60Hz square wave to the integrating network of R138 and C119. A 60Hz triangular wave then appears at U106A inverting input. The amplitude of this wave and the DC level on the inverting input control the firing angle of U107. Note that U107 is optically coupled by U108. Note also that higher values of emission current tend to increase the firing angle of U107 and thus turn filament power down.

Q111, C116 and R132 provide drive modification to SCR U107. At higher pressures as seen by the gauge tube, starting about the mid-four range, chopping action by Q111 starts to lower the square wave output amplitude of U109. The firing angle of U107 is increased further turning down filament power and emission current. In the mid-three range emission current will be so low that VR103 will not sustain itself on. Q117 will now turn on via R163. U106 plus input will go high bringing U106C output low, shutting off

the illuminating current supply to U108 diode. The gauge tube filament will now be shut down, and U106C will be locked up. The controller will no longer operate unless the pressure is lowered and the instrument is reset. Reset will take place when the 290 is shut down from the line momentarily. Should Q112, Section C turn on due to excessive filament current, U106C will again be driven to lock up and the filament will shut down.

Section G These circuits are optional. They are quite straightforward and merely provide the two tube selection function. U110B is a comparator whose output powers relay driver Q119

Section H This section is the power supply. The secondary of T2 along with CR101, CR106, and C101 make up the unregulated supply. Three terminal regulator U101 sets up a 5 volt rail to power both analog and digital circuits of the 290. Q101 is a current booster to supply the Seven Segment displays. Its collector is supplied with full 120Hz ripple through diodes CR102 and CR105. This connection allows a somewhat reduced duty cycle and average current to the displays.

Section I A voltage doubler made up of C103, CR108, CR107, and C104 provides the input voltage for darlington E.F. regulator Q102, Q103, and VR101. This well-filtered rail is used for analog output circuits located on the digital PWB.

Section J Section J contains two independent set point channels: Relay outputs are located on the digital PWB.

Typical operation of a channel follows. An analog input voltage proportional to pressure is applied to voltage comparator U102A. If this potential is higher than a reference level from R109, U102A will switch to a high state. U103A Q output will then switch high upon arrival of the next clock pulse, Q will naturally switch low. U112B output will go low bringing on the red alarm LED. U112C output will open, de-energizing the channel output relay. If J115-9 is held low, this alarm condition will be latched into U103A by the combination of U104A,B. To delatch the channel, J115-9 must be allowed to switch high and U102A input must fall below the reference level from R109. R107 provides hysteresis for greater noise immunity.

DIGITAL CIRCUITS (Refer to Schematic 114190)

Section A The dual, 4-stage, binary counters U3A and U3B comprise a divide by 256 of the frequency output SIG. via the analog board. U8A, C, and D select the divide by 256 or 1 via the microcontroller U16. D36, R10 and C4 together stretch the frequency output SIG. to make the width of the frequency output compatible with U16. Pins 9 and 10 use C8 to select the divide by 256 or 1 via the microcontroller.

Section B Section B contains the microcontroller U16. This 8 bit microcontroller has 256 x 8 RAM, (3) 16 bit timer counters, and 8K x 8 ROM on board. RN4 is an external 4.7K pullup for port zero. U11 is a buffer which increases the drive capability from the microcontroller U16. U1 is a watchdog timer which resets the microcontroller on powerup or if the 5 volt supply falls below 4.5 volts. C1, C2, and a crystal at 11.059 MHz, comprise the system clock for the microcontroller U16. JP1 and JP2 are for factory testing only.

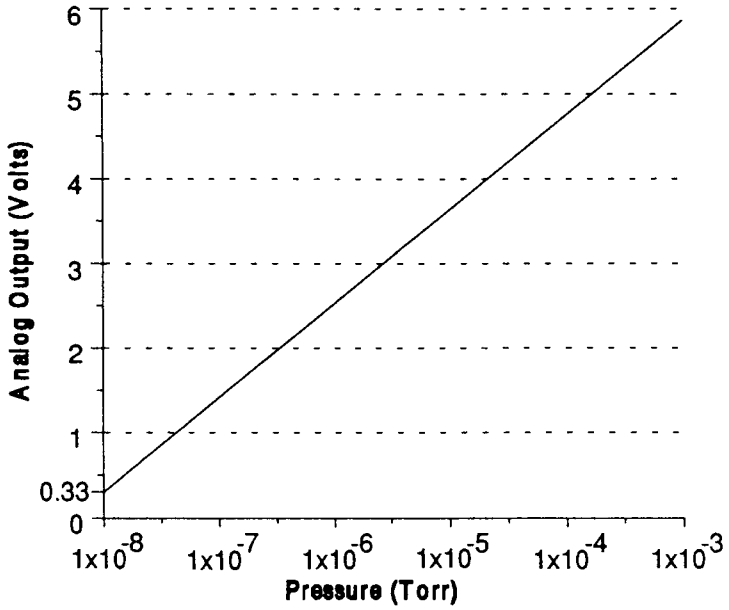
Section C Relays K1 and K2 are the setpoint channel relay outputs.

Section D U6, U7, and U10 are BCD to seven segment decoder/drivers, with open collector outputs, which take the BCD information from the microcontroller (U16) and convert it to a seven segment display which is visible on the front panel. RN1, RN2, and RN3 are current limiting resistor package network systems which limit the current to the seven segment LEDs located on the display board.

Section E U2, U4, and U5 are customer accessible, inverting, open collector outputs which provide the pressure reading in BCD format. U2A, pin 2 outputs a strobe pulse approximately 8 microseconds in width. At the end of this pulse, the BCD output data is well established.

Section F U15 is a 12 bit, serial input, voltage output, D to A converter which works with operational amplifier U12 to provide a customer accessible analog output. The output of U12B is an analog voltage which rises 1 volt per decade of pressure (see Figure D below). U12A comprises the analog setpoint voltage and gives it to the analog board. U5E buffers the frequency output SIG from the analog board and gives a signal of operation called *status*. If the pulse portion of SIG is missing, U5D goes high and provides a signal to the microcontroller (U16). This, in turn, blanks the display and drives the analog output (via U15 and U12) to greater than or equal to 6.5 volts.

FIGURE D



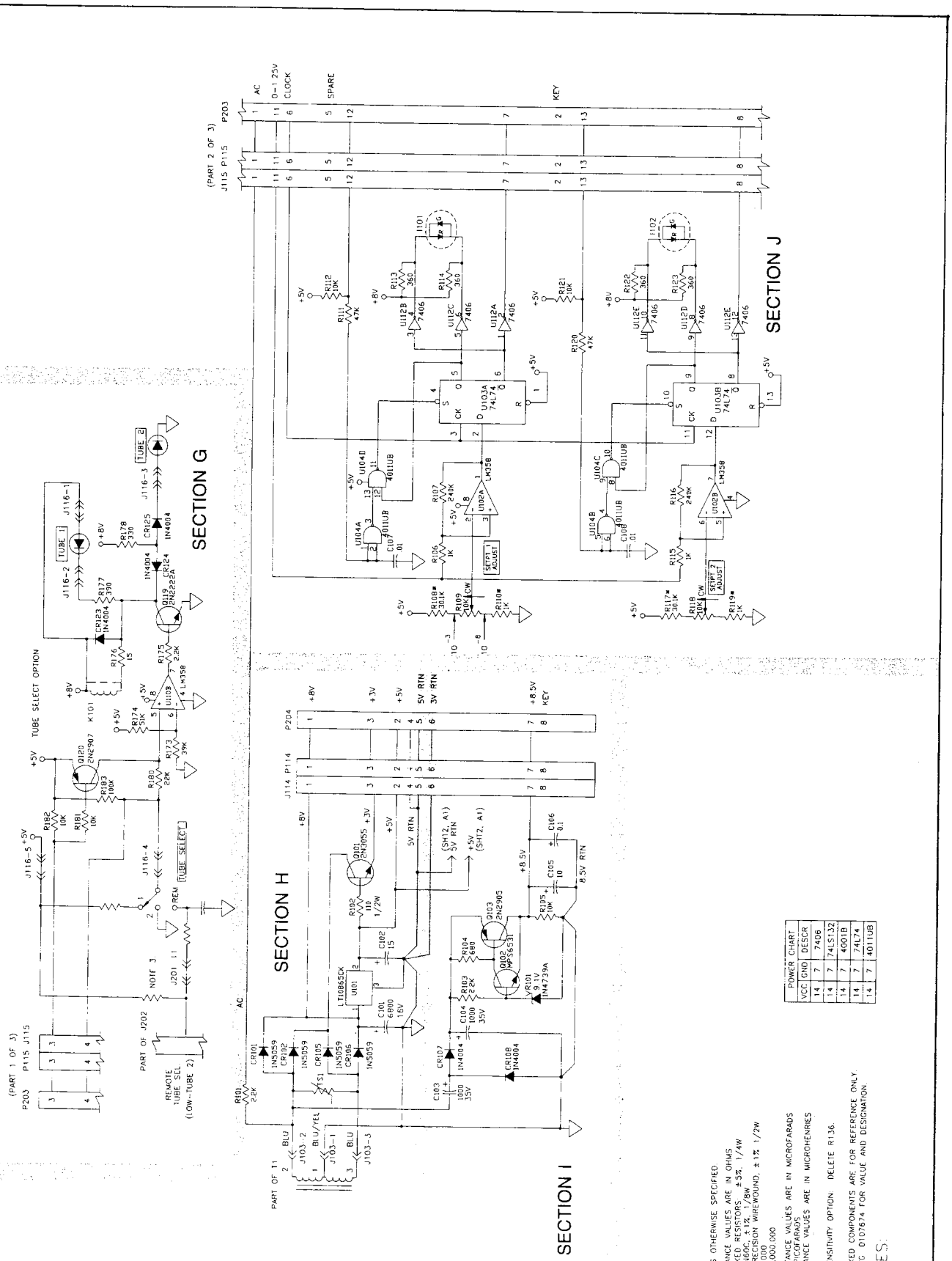
Section G U17 is a 9 volt DC regulator which powers the analog portion of the digital board. U12C, U12D, and Q2 convert the analog output to a customer accessible 4 to 20 milliamp output. R24 is the 4 milliamp adjustment pot. R25 is the 20 milliamp adjustment. Both R24 and R25 are accessible via the rear panel.

Section H Section H shows which decoupling capacitors correspond to which chip.

DISPLAY CIRCUITS (Refer to Schematic 107674)

Section A All the devices U301-U307 with the exception of U303 are LED 7 segment bar displays. U303 is a separate LED decimal point. The pictorial view of the total display points out the position of each device.

Section B These circuits, located on the display card, are part of other circuits located on the analog board (107408, Section G) and help control and set up the two tube select feature.

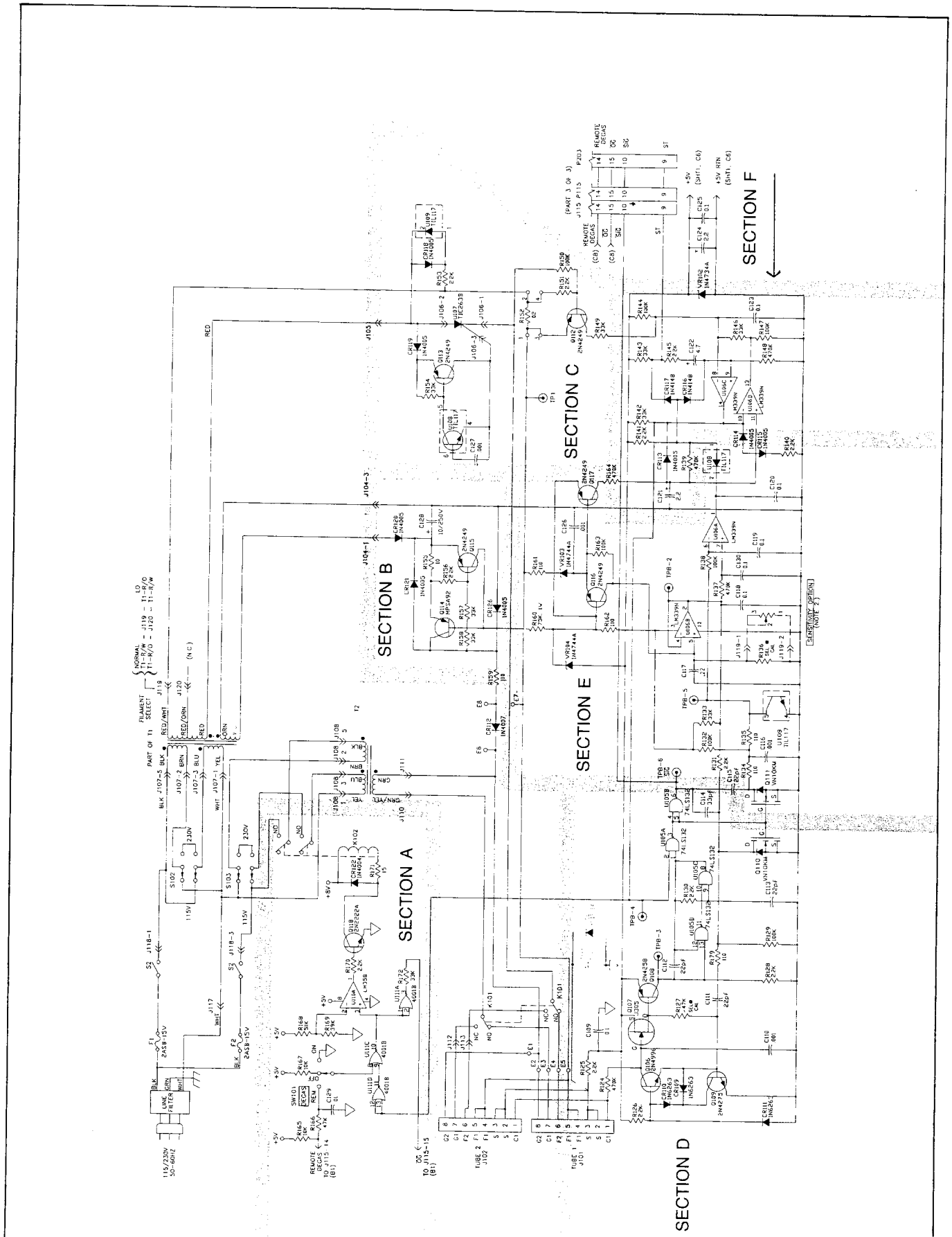


POWER CHART		
VCC	GND	DESCR
14	7	7406
14	7	74LS132
14	7	4001B
14	7	74L74
14	7	4011UB

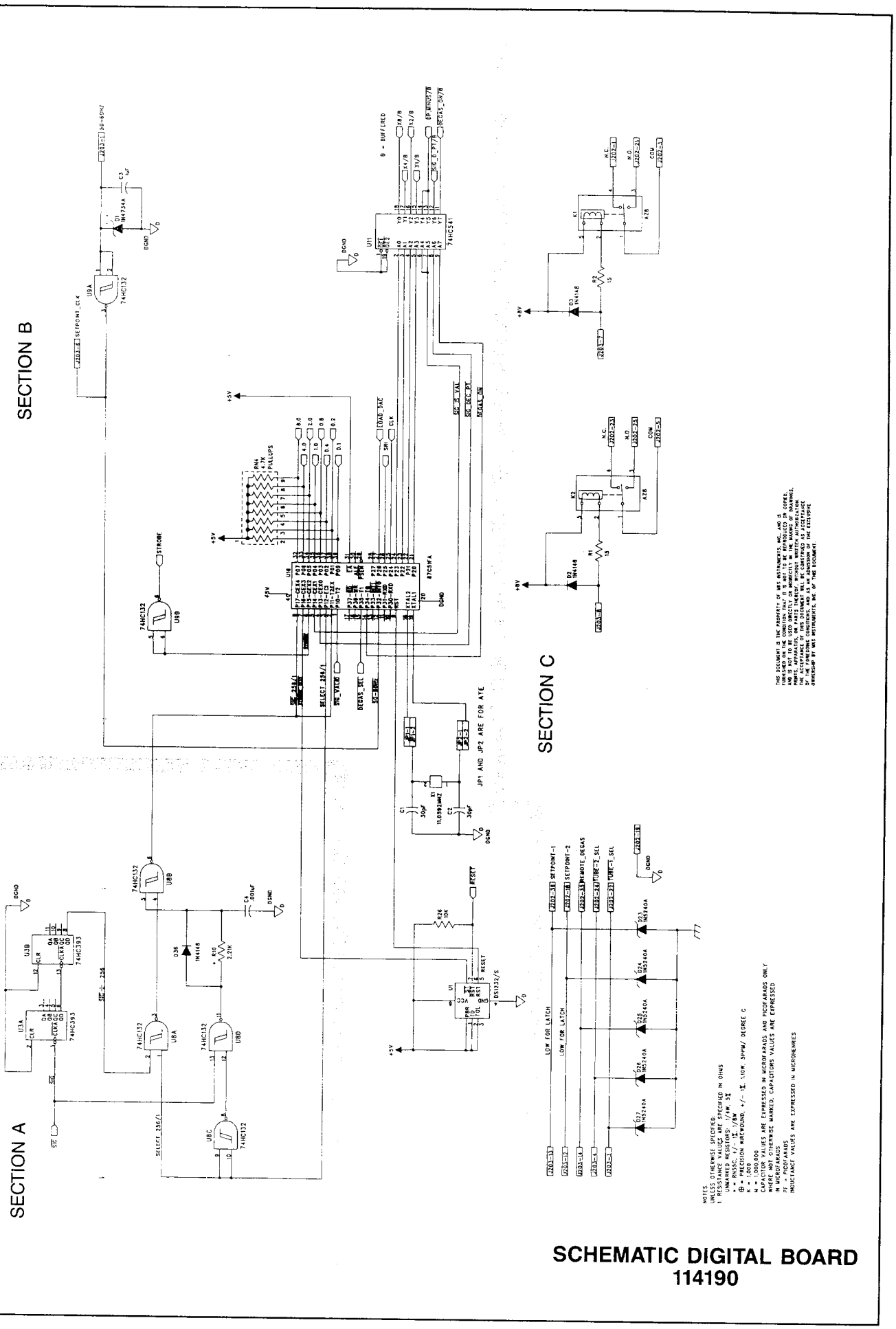
NOTES:

1. UNLESS OTHERWISE SPECIFIED
   RESISTANCE VALUES ARE IN OHMS
   UNMARKED RESISTORS, ±5%, 1/4W
   • = RN60C, ±1%, 1/8W
   Φ = PRECISION WIREWOUND, ±1% 1/2W
   K = 1,000
   M = 1,000,000
   CAPACITANCE VALUES ARE IN MICROFARADS
   PF = PICOFARADS
   INDUCTANCE VALUES ARE IN MICROHENRIES
2. FOR SENSITIVITY OPTION DELETE R136.
3. UNMARKED COMPONENTS ARE FOR REFERENCE ONLY.
   SEE DWG 0107674 FOR VALUE AND DESIGNATION.

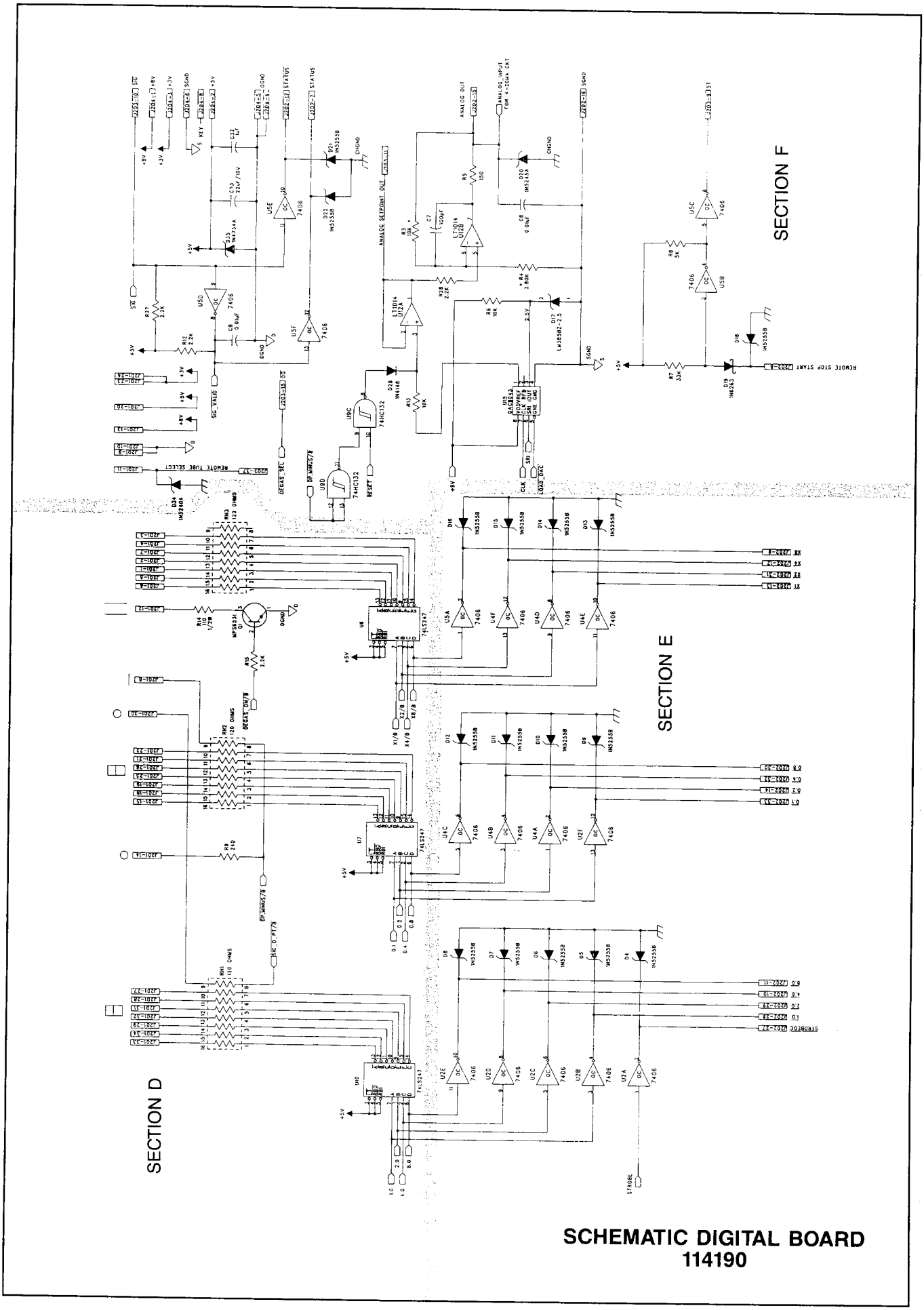
SCHEMATIC ANALOG BOARD
113003-A



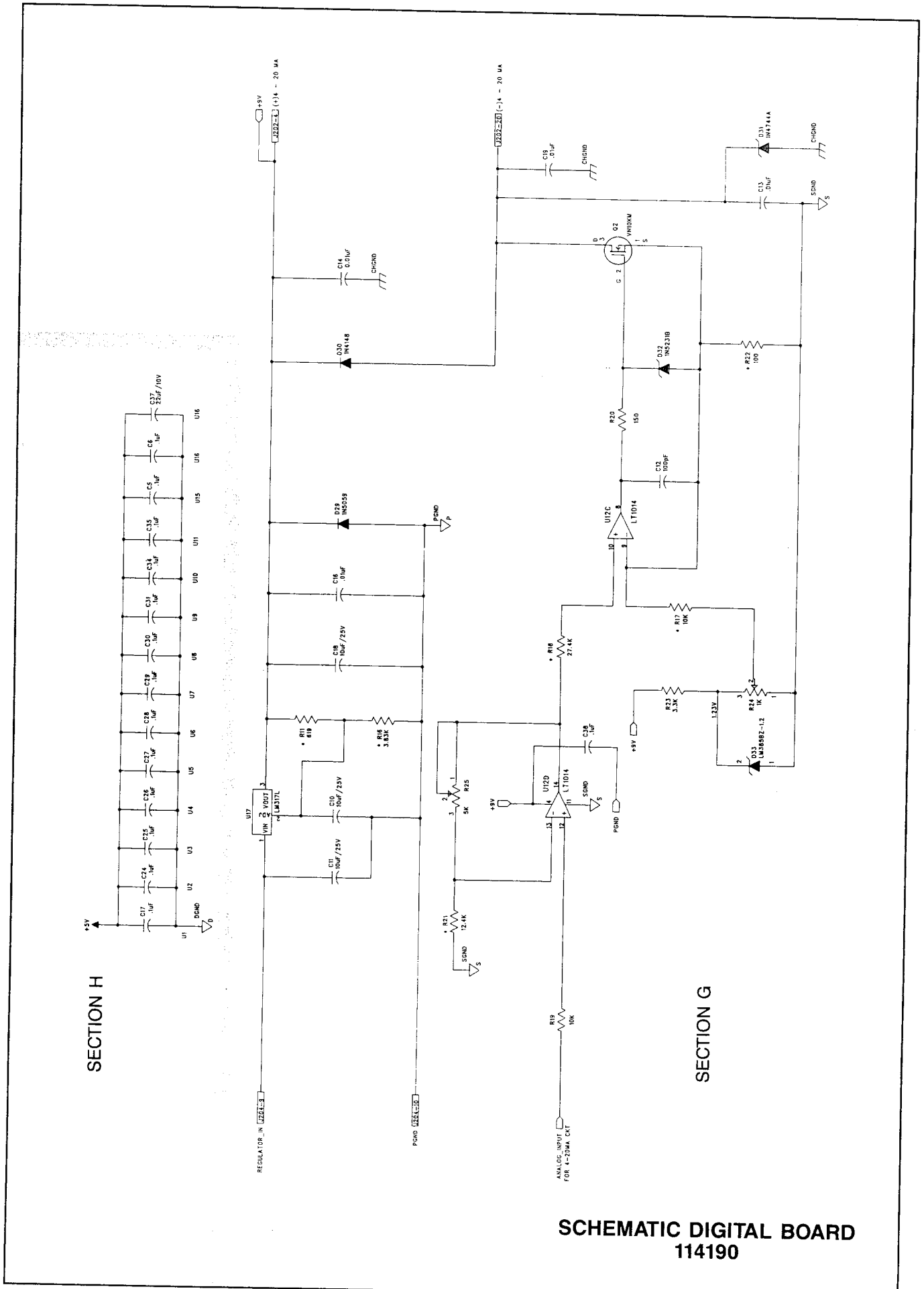
SCHEMATIC ANALOG BOARD
113003-A



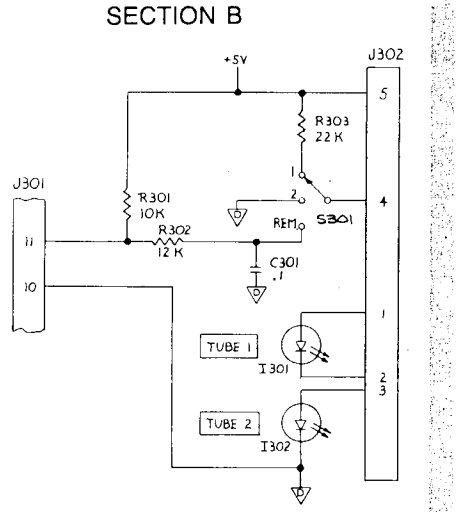
SCHEMATIC DIGITAL BOARD
114190

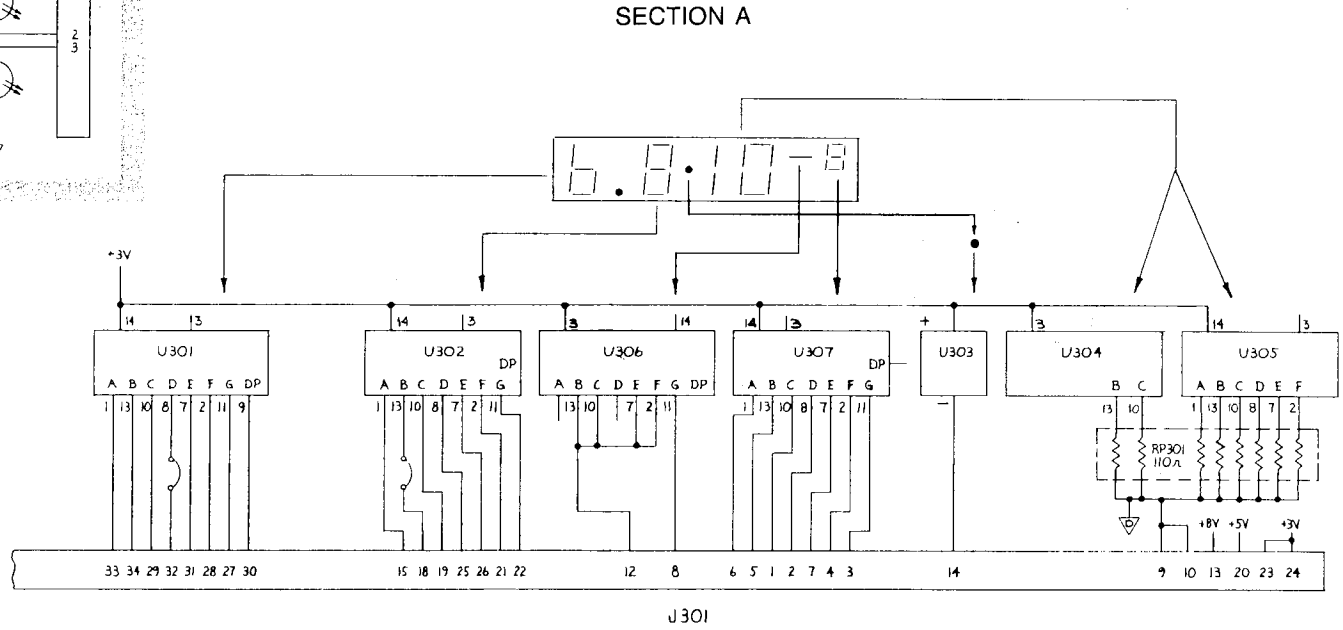


SCHEMATIC DIGITAL BOARD
114190


SECTION H
SECTION G
SCHEMATIC DIGITAL BOARD
114190
+5V
DGND
PGND
SGND
CHGND
+9V
REGULATOR_IN
ANALOG_INPUT
FOR 4-20MA CKT

SCHEMATIC DISPLAY BOARD
107674





Section 4 MAINTENANCE AND TROUBLESHOOTING

General

Should any difficulties be encountered in the use of your instrument, it is recommended that you contact any authorized MKS Sales Office or Home Office for repair instructions.

> IF IT IS NECESSARY TO RETURN THE INSTRUMENT TO MKS FOR REPAIR, PLEASE CONTACT MKS' CUSTOMER SERVICE COORDINATOR AT MKS' HOME OFFICE FOR AN ERA NO. (EQUIPMENT RETURN AUTHORIZATION NUMBER), TO EXPEDITE HANDLING AND ASSURE PROPER SERVICING OF YOUR INSTRUMENT.

Troubleshooting

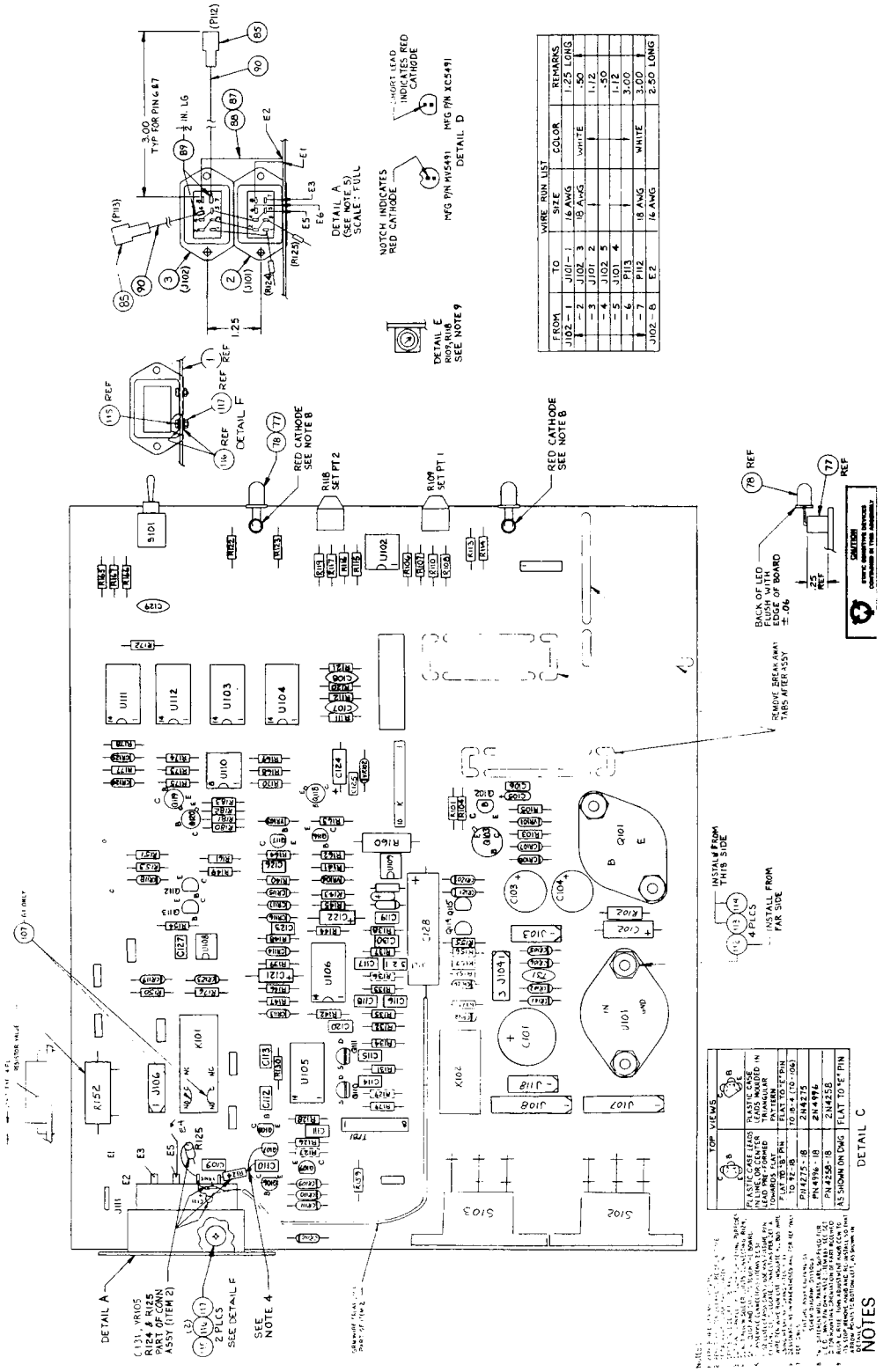
Should difficulties be encountered in the use of any 290 system, information in this section should help to isolate the source of the problem. Whenever similar equipment is available, this method of substitution is recommended.

Localizing Malfunction

Problem	Probable Cause
Flickering Filament.	• Faulty or dirty "Gauge Tube" • Internal problems associated with filament control circuits. Defective Q116, U106, U108, U109.
Filament lights, but will not stay on.	• Sensitivity control (R136 out of range or defective). • Vessel pressure too high (above 10^{-3}). • Poor connections or poor gauge tube cable. • Check Q112 collector to see if it is on. If it is, the filament lines are being loaded excessively. • Check output anode power supply. Q114 collector should be 180 to 200 volts DC. • Internal problems associated with filament control circuits. Defective Q116, U106, U108, U109.
Filament brightness does not decrease with higher pressures. (Above mid-six range).	• Problem is most likely in the front end. Consult theory or operation "Analog Circuits". Defective Q111, C116, R134, R135.

No DEGAS indication.	• Faulty Q1, U11, or U16.
Display reading zero, zero x 10^{-8}.	• Collector lead from gauge tube is open.
Analog output out of spec.	• Faulty D17, U15, or U12.

Section 5 PARTS LISTS



ANALOG BOARD ASSY.
113005

PC ASSEMBLY, ANALOG CIRCUIT

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
PC Board, Analog Circuit	D113004-P1	1	1	1
Connector Assy	B106519-G1	2	1	1
Connector, Reworked	B106532-P1	3		1
Schematic	D113003	4	REF	REF
		5		
I.C., LT10865CK U101	033-0293	6	1	1
I.C., LM358 U102, U110	030-4328	7	2	2
I.C., 74LS74 U103	037-5040	8	1	1
I.C., CD4011UBE U104	036-9035	9	1	1
I.C., 74LS132 U105	036-4468	10	1	1
I.C., LM339N U106	031-4469	11	1	1
I.C., TIL117 U108, V109	032-4467	12	2	2
I.C., CD4001BE U111	036-9029	13	1	1
I.C., SN7406 U112	036-4472	14	1	1
		15		
		16		
Resistor, 2.2K, 5%, 1/4W, CC R101, R103, R126, R128, R130, R131, R140, R141, R145, R151 R153, R156, R170, R175	064-2396	17	14	14

PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Resistor, 110Ω, 5%, 1/2W, CC R102	064-2504	18	1	1
Resistor, 680Ω, 5%, 1/4W, CC R104	064-2587	19	1	1
Resistor, 10K, 5%, 1/4W, CC R105, R112, R121, R165, R167 R181, R182	064-2057	20	7	7
Resistor, 1K, 5%, 1/4W, CC R106, R115	064-2428	21	2	2
Resistor, 240K, 5%, 1/4W, CC R107, R116	064-2835	22	2	2
Resistor, 30.1K, 1%, 1/8W, RN55C R108, R117	065-4254	23	2	2
Resistor, 1K, 1% 1/8W, RN55C R110, R119	065-4249	24	2	2
Resistor, 47K, 5%, 1/4W, CC R111, R120, R166	064-2051	25	3	3
Resistor, 360Ω, 5%, 1/4W, CC R113, R114, R122, R123	064-3103	26	4	4
Resistor, 470K, 5%, 1/4W, CC R137, R139, R148, R164	064-4051	27	4	4
Resistor, TBD, 5%, 1/4W, CC R127, R136	Select @ CAL	28	2	2
Resistor, 100K, 5%, 1/4W, CC R129, R132, R138, R144, R147, R150, R163, R183	064-2469	29	8	8
Resistor, 33K, 5%, 1/4W, CC R133, R142, R143, R146, R149, R154, R157, R158, R172	064-2446	30	9	9
Resistor, 10Ω, 5%, 1/4W, CC R155	064-2050	31	1	1

ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Resistor, 110Ω, 5%, 1/4W, CC R134, R135, R159, R161, R162, R179	064-3099	32	6	6
Resistor, 75K, 5%, 1/4W, CC R160	064-4483	33	1	1
Resistor, 51K, 5%, 1/4W, CC R168, R174	064-3086	34	2	2
Resistor, 39K, 5%, 1/4W, CC R169, R173	064-2441	35	2	2
Resistor, 15Ω, 5%, 1/4W, CC R171, R176	064-2568	36	2	2
Resistor, 390Ω, 5%, 1/4W, CC R177	064-3104	37	1	1
Resistor, 330Ω, 5%, 1/4W, CC R178	064-2586	38	1	1
Resistor, 22K, 5%, 1/4W, CC R180	064-2445	39	1	1
Pot, 10K, 1 Turn R109, R118	053-4928	40	2	2
Resistor, 4 Terminal .02Ω, 5%, 2W R152	067-0297	41	1	1
		42		
		43		
Cap., 6,800μF, 16V, Alum. Elect C101	007-5894	44	1	1
Cap., 15μF, 25V, Alum. Elect C102	007-2297	45	1	1
Cap., 1000μF, 35V, Alum. Elect. C103, C104	007-0200	46	2	2

PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Cap., 10μF, 20V, Tant C105	007-2962	47	1	1
Cap., .1μF, 50V, CER. C106, C109, C118, C123, C119, C120, C125, C130	005-4458	48	8	8
Cap., .01μF, 500V, CER. C107, C108, C129	005-3259	49	3	3
Cap., .001μF. 200V. CER. C110, C116, C126, C127	005-4459	50	4	4
Cap., 22PF, CER. C111, C112, C113, C115	005-4461	51	4	4
Cap., 33PF, CER. C114	005-4460	52	1	1
Cap., 2.2μF, 20V, Tant C121, C124	007-4457	53	2	2
Cap., 10μF, 250V, Alum. Elect. C128	007-4326	54	1	1
Cap., 4.7μF, 10V Tant C122	007-5559	55	1	1
Cap., .22μF, 50V CER. C117	005-4998	56	1	1
		57		
		58		
Diode, 1N5059 CR101, CR102, CR105, CR106	015-2395	59	4	4
Diode, 1N4004 CR107, CR108, CR122, CR123, CR124, CR125	015-4323	60	6	6

ANALOG BOARD PARTS LIST
113005

PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Diode, 1N6263 CR109, CR110, CR111	015-4463	61	3	3
Diode, 1N4007 CR112	015-3096	62	1	1
Diode, 1N4005, CR113, CR114, CR115, CR118, CR119, CR120, CR121, CR126	015-4462	63	8	8
Diode, 1N4148 CR116, CR117	015-2412	64	2	2
Diode, Zener, 1N4739A VR101	017-3186	65	1	1
Diode, Zener, 1N4734A VR102	017-4466	66	1	1
Diode, Zener, 1N4744A VR103, VR104	017-4464	67	2	2
Trans. Suppressor, Varistor, V33ZAI TS1	017-5133	68	1	1
		69		
		70		
Transistor, 2N3055 Q101	083-2624	71	1	1
Transistor, MPS6531 Q102	082-2952	72	1	1
Transistor, 2N2905A Q103	084-4395	73	1	1
Transistor, 2N4996 Q106	083-4476	74	1	1

PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Transistor, J305 Q107	086-4475	75	1	1
Transistor, 2N4258 Q108	084-4477	76	1	1
Transistor, 2N4275 Q109	082-4478	77	1	1
Transistor, VN10KM Q110, Q111	086-9059	78	2	2
Transistor, 2N4249 Q112, Q113, Q115, Q116, Q117	082-4481	79	5	5
Transistor, 2N2222A Q118, Q119	082-4261	80	2	2
Transistor, MPSA92 Q114	084-4480	81	1	1
Transistor, 2N2907 Q120	084-4128	82	1	1
		83		
		84		
		85		
Relay, DPDT, 6V K101	057-0304	86	-	1
Relay, DPDT, 6V K102	057-4926	87	1	1
LED, Dual-Color, Red/Green I101, I102	044-4512	88	2	2
Spacer, LED XI101, XI102	074-2724	89	2	2

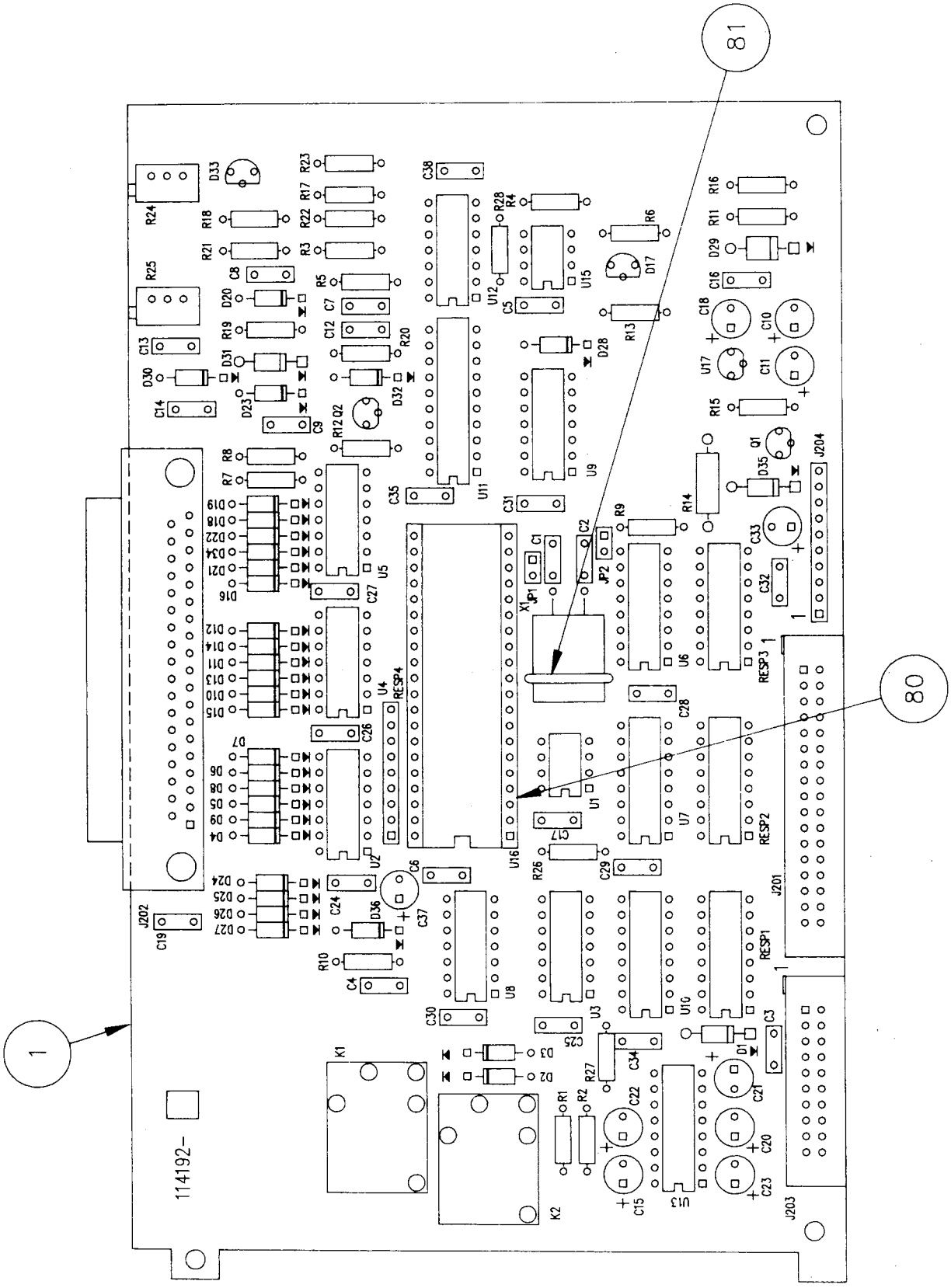
PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
		90		
Conn., S.I.P., 5 pin (FFMMM) J107, J108	110-6042	91	2	2
Conn., S.I.P., 3 pin (FFM) J104	110-6040	92	1	1
Conn., S.I.P., 3 pin (FMM) J103, J106, J118	110-6054	93	3	3
Conn., 10 pin Header J114	110-6706	94	1	1
Conn., 8 pin Header TPB-1	110-3589	95	1	1
Conn., 5 pin Header J116	110-3473	96	1	1
Conn., 20 Pos Male Ribbon CBl Mate (3M #3592-6002) J115	110-8320	97	1	1
Conn., 3 pin Header J121	110-3474	98	1	1
Conn., PC Mount, Male Spadelug J105, J110, J111, J112, J113, J117, J119, J120	174-3446	99	8	8
Conn., Female Quick-Disconnect P112, P113	174-6556	100	2	2
Tubing, Heatshrink, .19 I.D.	169-3597	101	6.5 In.	3.0 In.
Tubing, Teflon #22	170-2038	102	1.0 In.	1.0 In.
Tubing, Heatshrink, .12 I.D.	169-2279	103	- In.	1.0 In.

PC ASSEMBLY, ANALOG CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY -G1	QTY -G2
Wire, Bus, #16 AWG	093-4559	104	3.75 In.	-
Wire, #18 AWG, 1 Conductor, Stranded, Wht	093-4439	105	9.25 In.	-
Insulator Pad XQ103	181-2752	106	1	1
Wire, Bus. #18 AWG	093-3881	107	1.0 In.	-
		108		
		109		
Switch, Rht Angle PC MT Slide Line Select S102, S103	072-5077	110	2	2
Switch Rt. Angle P.C. Mt Toggle S101	072-4296	111	1	1
Screw, 6-32 x .38 Lg. Phil Pan Hd.	160-3710	112	4	4
Washer, #6 Int. Tooth Lock	185-3750	113	4	4
Hex Nut, 6-32 Small Pattern	146-3754	114	4	4
Screw, 4-40 x .25 Lg. Phil Pan Hd	160-3687	115	2	2
Washer, #4 Int. Tooth Lock	185-3749	116	2	2
Hex Nut, 4-40 Small Pattern	146-3753	117	2	2
		118		
		119		
		120		

ANALOG BOARD PARTS LIST
113005



SCHEMATIC DIGITAL BOARD
114192

PC ASSEMBLY, DIGITAL CIRCUIT

DESCRIPTION	PART NO.	ITEM	QTY
PC Board, Digital Circuit	114191-P1	1	1
Schematic	114190	2	Ref
		3	
		4	
		5	
I.C. Watch Dog Timer, DS1232 U1	038-9141	6	1
I.C. Hex Inv Open Collector, 7406N U2, U4, U5	036-4472	7	3
I.C. Dual 4-Bit Binary Counter, 74HC393N U3	037-9229	8	1
I.C. BCD-Seven-Segment, 74LS247N U6, U7, U10	037-4873	9	3
I.C. Quad 2 Input NAND ST, 74HC132N U8, U9	036-9108	10	2
I.C. Octal Buffer-Line Driver 74HC541N U11	036-9134	11	1
I.C. Quad Op-AMP, LT1014CN U12	030-5768	12	1
I.C. 12 Bit D/A Converter Max 543BCPA U15	039-9157	13	1
I.C. Single Chip 8-Bit Micro-controller w/8K Bytes EPROM, P87C52EBPN U16	114461-P1	14	1
I.C. 3 Terminal Adj, LM317L U17	033-0189	15	1

PC ASSEMBLY, DIGITAL CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY
		16	
		17	
		18	
Resistor, 15Ω, 5%, 1/4W CF R1, R2	064-2568	20	2
Resistor, 10K, 1%, 1/8W MF RN55C R3	065-4234	21	1
Resistor, 2.80K, 1%, 1/8W MF RN55C R4	065-5304	22	1
Resistor, 150Ω, 5%, 1/4W CF R5, R20	064-2582	23	2
Resistor, 10K, 5%, 1/4W CF R6, R13, R17, R19, R26	064-2057	24	5
Resistor, 33K, 5%. 1/4W CF R7	064-2446	25	1
Resistor, 5K, 5%, 1/4W CF R8	064-2444	26	1
Resistor, 240Ω, 5%, 1/4W CF R9	064-3102	27	1
Resistor, 2.21K 1%, 1/8W MF RN55C R10	065-4233	28	1
Resistor, 619Ω, 1%, 1/8W MF RN55C R11	065-5246	29	1
Resistor, 2.2K, 5%, 1/4W CF R12, R15, R27, R28	064-2396	30	4
Resistor, 110Ω, 5%, 1/2W CF R14	064-2504	31	1

PC ASSEMBLY, DIGITAL CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY
Resistor, 3.83K, 1%, 1/8W MF RN55C R16	065-5315	32	1
Resistor, 27.4K, 1%, 1/8W MF RN55C R18	065-5385	33	1
Resistor, 12.4K, 1%, 1/8W MF RN55C R21	065-5355	34	1
Resistor, 100Ω, 1%, 1/8W MF RN55C R22	065-4253	35	1
Resistor, 3.3K, 5%, 1/4W CF R23	064-4254	36	1
Resistor, 1K Pot, E-Adj 25T R24	053-4240	37	1
Resistor, 5K Pot, E-Adj 25T R25	053-4299	38	1
Resistor, 120Ω, Thick Film, 8 Isolated Resistors RN1, RN2, RN3	069-0006	39	3
Resistor, 4.7K, Thick Film 8 Resistors with one Common RN4	069-5965	40	1
		41	
		42	
		43	
Capacitor, 30pF, 10%, 1KV, Cer. C1, C2	005-2369	44	2
Capacitor, 0.1μF 10%, 100V, Cer. C3,C5,C6,C17,C24, C25,C26,C27,C28,C29,C30,C31, C32,C34,C35,C38	005-2908	45	16

PC ASSEMBLY, DIGITAL CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY
Capacitor, .001μF, 10%, 200V Cer. C4	005-4459	46	1
Capacitor, 100pF, 10%,200V, Cer. C7, C12	005-4488	47	2
Capacitor, .01uF, 10%, 200V, Cer. C8, C9, C13, C14, C16, C19	005-4447	48	6
Capacitor, 10μF, 25V, Tant C10, C11, C18	007-5665	49	3
Capacitor, 22μF, 10V, Tant C33, C37	007-5891	50	2
		51	
		52	
		53	
Zener Diode, 1N4734A D1, D35	017-4466	54	2
Diode, 1N4148 D2, D3, D28, D30, D36	015-2412	55	5
Zener Diode, 1N5255B D4-D16, D18, D21-22	017-0295	56	16
Diode, LM385BZ-2.5 D17	016-5624	57	1
Diode, 1N6263 D19	015-4463	58	1
Zener Diode, 1N5245A D20	017-0321	59	1
Zener Diode, 1N5240A D23-D27, D34	017-0322	60	6
Diode, 1N5059 D29	015-2395	61	1

DIGITAL BOARD PARTS LIST
114192

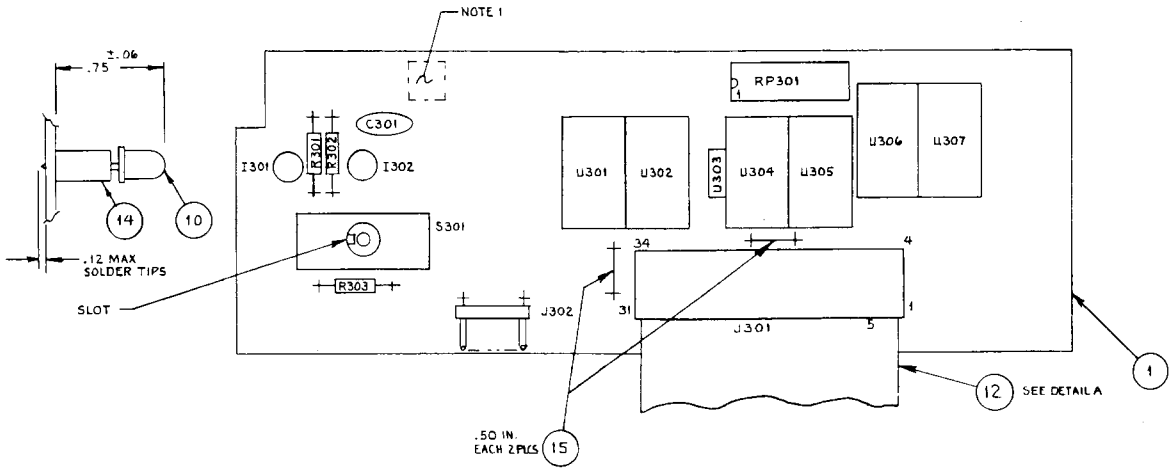
PC ASSEMBLY, DIGITAL CIRCUIT
(Continued)

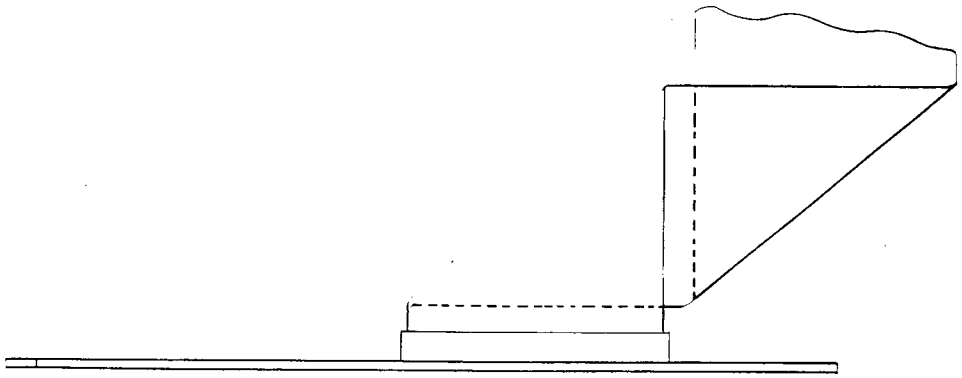
DESCRIPTION	PART NO.	ITEM	QTY
Zener Diode, 1N4744A D31	017-4464	62	1
Zener Diode, 1N5231B D32	017-4151	63	1
Diode, LM385BZ-1.2 D33	016-4379	64	1
		65	
		66	
		67	
Transistor, MPS6531 Q1	082-2952	68	1
Transistor, VN10KM Q2	086-9059	69	1
		70	
		71	
		72	
Relay, SPDT, 6V,AZ8 K1, K2	057-0294	73	2
Shorting Jumper JP1, JP2	113-7229	74	2
Connector, 34 Pos. Male Ribbon, CBL Mate J201	110-7061	75	1
Connector, 37 Pos Female "D", Rht Angle J202	110-8319	76	

PC ASSEMBLY, DIGITAL CIRCUIT
(Continued)

DESCRIPTION	PART NO.	ITEM	QTY
Header, 10 Pin Male J204	110-6706	77	1
Connector, 20 Pos. Male Ribbon, CBL Mate J203	110-8320	78	1
Header, 2 Pin Male J1, J2	110-8017	79	2
Socket, 40 Pin, Dual Row	156-3282	80	
Bus Wire, #22 Awg	093-2100	81	1 In.
		82	
		83	
Crystal, 11.0592 MHz	011-5855	84	

DIGITAL BOARD PARTS LIST
114192





DETAIL A
TOP VIEW

2. INTENSITY CODES FOR ITEM 6 (QTY 4) MUST BE SAME LETTER; INTENSITY CODES FOR ITEM 8 (QTY 2) MUST BE SAME LETTER; HOWEVER CODES MAY DIFFER BY TWO LETTERS BETWEEN GROUPS.

1. MARK FINISHED ASSY PER MKS A106716.

1.0 IN	1.0 IN	15	093-2100	BUS WIRE, 22AWG	
2	–	14	074-2724	SPACER, LED	XI301, XI302
1	–	13	072-4917	SWITCH, TOGGLE	S301
1	1	12	B113046-G1	RIBBON CABLE ASSEMBLY, 34 PIN	J301
1	–	11	110-6421	CONN, 5 PIN, RIGHT ANGLE	J302
2	–	10	044-4500	LED YELLOW	I301, I302
1	1	9	069-4485	RES NETWORK 110Ω	RP301
2	2	8	043-4489	DISPLAY	U306, U307
1	1	7	044-4491	LED INDICATOR RED	U303
4	4	6	043-5533	DISPLAY 7611R	U301, U302, U304, U305
1	–	4	069-2041	RES 12K 1/4W 5%	R302
1	–	3	069-2057	RES 10K 1/4W 5%	R301
1	–	2	005-4458	CAP .1μF 50V CER	C301
1	1	1	C112998-P1	P.C. BOARD, DISPLAY	
G2	G1	ITEM	PART NO	DESCRIPTION	REMARKS
	QTY	LIST OF MATERIALS			

DISPLAY BOARD ASSY. & PARTS LIST
112999

Section 6 APPENDIX

290 Rear Connector Information (J202)

FUNCTION	PIN
Analog Output	15
Analog Ground	16
Status ($\overline{ON}$)	17
Status (ON)	7
Digital Ground	19
Strobe	27
R/S	8
Remote Tube Select	37
Remote DEGAS	35
Setpoint Relay 1 latch	18
Setpoint Relay 2 latch	36
Tube 1 Select	22
Tube 2 Select	24

FUNCTION	PIN
+4 ma - 20 ma	4
−4 ma - 20 ma	20

Display BCD Data

MSD	1		28
	2		29
	4		10
	8		11
LSD	1		33
	2		14
	4		32
	8		30
Exponent	1		13
	2		31
	4		12
	8		9
Setpoint Relay contacts	1	Wiper	3
		NO*	21
		NC*	1
Setpoint Relay contacts	2	Wiper	5
		NO*	25
		NC*	23
Not Used			2
			4
			6
			20
			26
			34

***NOTE:** 290 is operating and not in an alarm condition. (Pressure below the alarm point)

ELECTRIC CHARACTERISTICS OF INPUT OUTPUT FUNCTIONS

Analog Output

Slope is 1 volt per decade. Within any decade the slope is a straight line. The resolution within any decade is 11 millivots or 1.1% relative to 1 volt, 10^{-8} Torr is approximately .33 Volts, 10^{-3} Torr is approximately 5.33 Volts. Output impedance is 2K ohms at DC. The output will be >6 Volts, if the 290 shuts down because of overpressure or a fault situation.

4 ma - 20 ma Output

Slope is 3 ma per decade. Within any decade the slope is a straight line. The resolution within any decade is .033 ma or 1.1% relative to 3 ma. 10^{-8} Torr is approximately 5 ma, 10^{-3} Torr is approximately 20 ma. The output will be greater than 23 ma, if the 290 shuts down because of overpressure or a fault situation. The maximum compliance voltage that the 4 ma to 20 ma output can deliver is 6.5 Volts. Thus the sampling resistor, selected by the user must be ≤ 250 Ohms.

Status

The $\overline{ON}$ is low when the filament is on with a positive-going pulse whose frequency is proportional to pressure. The pulse width is approximately 0.2 micro seconds. When filament shutdown occurs, this output then goes to a logic high. Pull-up resistor required. On status (Pin 7) is high when the filament is on. Pull-up resistor required.

Strobe

This is a negative-going pulse in time coincidence with the enabling and reading of internal Display. Pulse width is approximately 8 micro sec. Delay time is approximately 90 ns. Pulled up required.

R/S

Remote start stop. This input is used to turn the tube filament on and off. An open condition at this input turns filament on while a true low shuts filament down. No pull up required.

Remote Tube Select

When Front Panel Tube Select switch is in Remote position, the following is required. An open condition will select tube one while a true low will select tube two. *NOTE: No pull up is required.*

Also, filament power on the active tube should be removed before making the change. This can be done by turning off the front panel power switch or by bringing R/S low. After the other tube is selected, return line power or let R/S open. No pull up required.

Remote DEGAS

When front panel switch is in the remote position, a true low at this input will turn on DEGAS. This input is otherwise left open. No pull up required.

Setpoint Relay Latch

When a true low is applied to these inputs, any alarm condition will be put in a latched condition. Reset, after the alarm condition is over, is accomplished by returning these inputs to an open condition. No pull up required.

Display BCD Data

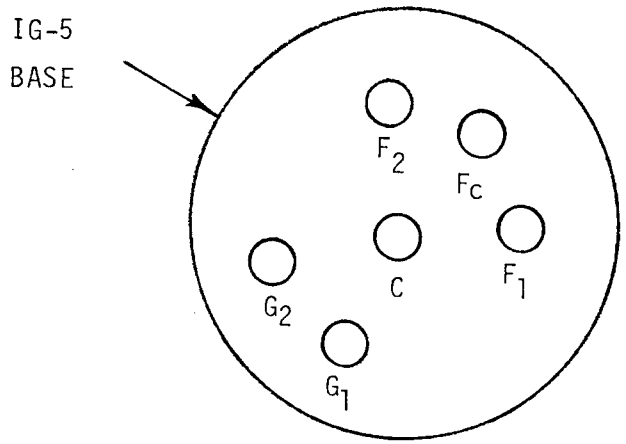
All these outputs show a true low when selected. Pull ups are required.

NOTE: All output requiring pull ups are derived from the following specifications.

1. *Low Level Output Current ≤ 30 ma*
2. *Low Level Output Voltage ≤ .4 V @ ≤ 16 ma, .7V @ ≤ 30 ma.*
3. *High Level Output Voltage < 25 V*
4. *High Level Leakage Current ≤ .25 ma @ ≤ 21 V.*

The SN7406 IC's used for outputs requiring pull-ups are clamped with a 28V, ±5% Zener Diode 1N5255B.

Instructions for connecting "Nude Gauge Cable" to Nude Tube Base.



Nude Tube Base

F_2 = Filament two

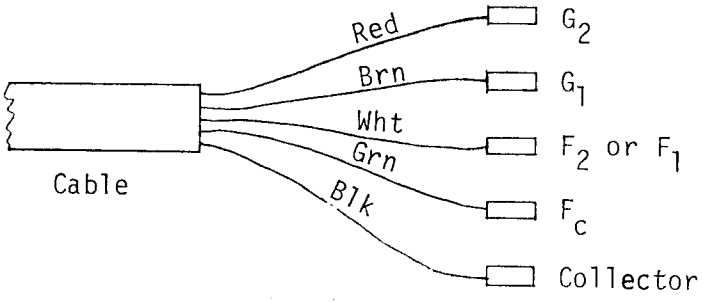
F_c = Filament common

F_1 = Filament one

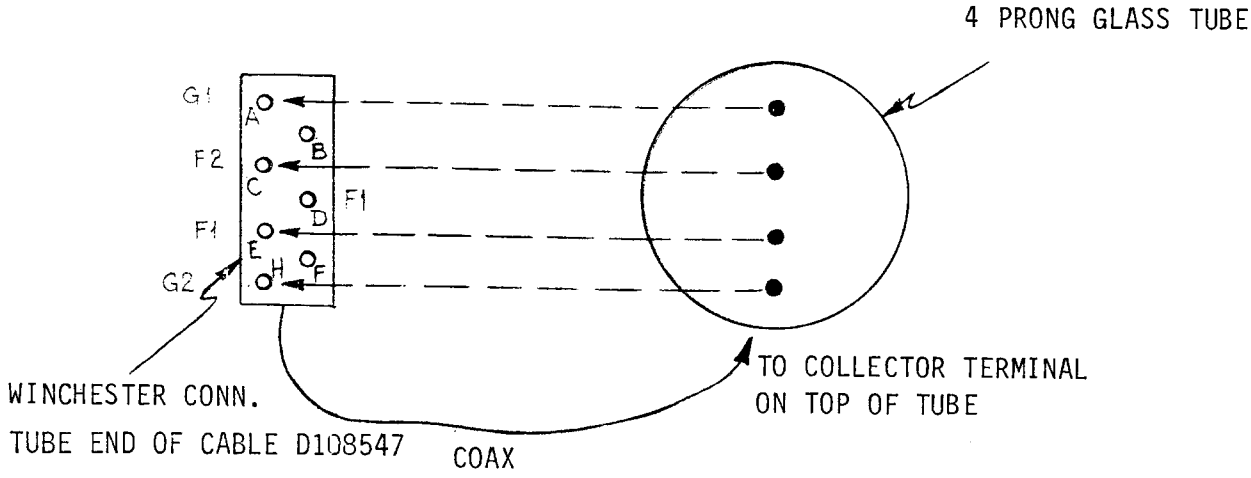
G_1 = Grid

G_2 = Grid

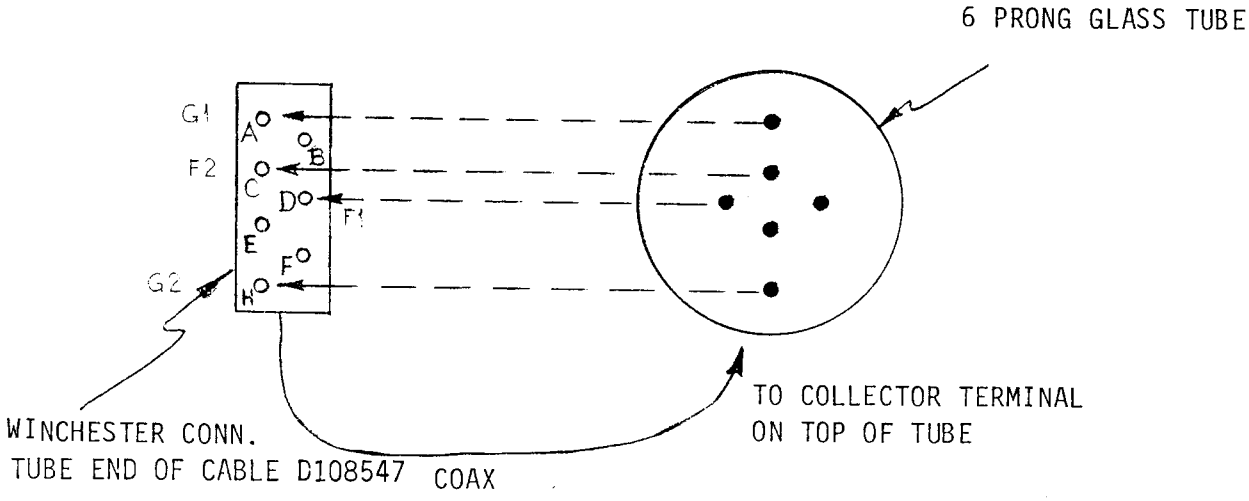
C = Collector



Nude Cable Base End



NOTE: TUBE MAY BE ROTATED AND CONNECTED 180° FROM PICTURE AND STILL FUNCTION.



NOTE: TUBE MAY BE ROTATED AND CONNECTED 180° FROM PICTURE TO USE OTHER FILAMENT.

SPECIFICATIONS

Mechanical	Package:	Cabinet style or rack mount 9½ x 3½ x 9 inches
	Weight:	10 lbs
Environmental	Temperature Range:	15° to 40°C
Electrical	Range:	10^{-9} to 10^{-3} Torr (Auto-ranging)
	Repeatability:	+3% ±1 LSD
	Accuracy:	15% ± 1 LSD
	Display Format:	X.X • 10^{-x} Torr
	Minimum Reading:	0.1 • 10^{-8} Torr
	Display Update Time:	0.8 seconds
	Low Pressure Visual Indicator Rate:	5 per second per 10^{-8} Torr (500 MHz per Torr)
	Gauge Sensitivity:	10 Torr $^{-1}$ (for MKS IG-XX, RG75 or NRC 563, gauge tube)
	Option - 02	Front panel sensitivity adjustment Range of adjustability 5.0 - 50.0 Torr $^{-1}$
	Option - 03	Two Tube select via front panel switch
	Set Points	2 relays. Contact capacity resistive load, 2A @ 300 VAC or 2A @ 28 VDC. Contact material - Silver, gold plated. Set point range is 10^{-8} to 10^{-3} Torr in decade steps.
	Analog Output	Increasing with pressure one volt per decade 10^{-8} Torr is approximately 0.33 Volts, 10^{-3} Torr is approximatley 5.33 Volts Output impedance at DC 2K ohms
	4 ma - 20 ma Output:	Increasing with pressure 3 ma per decade. 10^{-8} Torr is approximatley 5 ma, 10^{-3} Torr is aproximately 20 ma. Compliance voltage $\leq$ 6.5 Volts. Sampling resistor $\leq$ 250 ohms.
	Emission Current:	8 ma below 10^{-6}, decreasing to less than 0.5 ma at 10^{-3} Torr
	Protection:	Overpressure, above 10^{-3} Torr Filament circuit shorts, anode shorts
	DEGAS:	60 watts, I^2R
	Line Voltage:	115, 230 VAC ± 10% 50-60 Hz.
	Power Consumption:	50 watts nominal, 110 watts in DEGAS
	Line Fuse (F1):	1.5 ABS @ 115 VAC, .075 ABS @ 230 VAC.
	Degas Fuse (F2):	1 ABS @ 115 VAC, .05 ABS @ 230 VAC.

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