ADDENDUM TO VLA TECHNICAL REPORTS NO. 10 AND 11

CRYOGENICS CONTROL AND PUMP REGULATOR TEST SET

S. LYMPANY

DECEMBER 1977

(Issued November 1978)

The cryogenics control section of the test set provides loads and neon indicators for the pump valve, refrigerator, and heater circuits, calibration provision for the temperature sensors and a variable current source for adjusting and checking the vacuum meter.

The pump regulator section provides ±15V, a simulated pump load, a monitor for pump voltage, a heater, and remote pump shut-down capabilities.

PRINCIPLES OF OPERATION

A. Cryogenics Control System

The pump, valve, refrigerator, and heater are connected to a 1K/20W load with a neon indicator across the load.

The "TEMP" control switches either a short or a 100Ω resistor across the sensor lines. The lines are shorted in the "0 DEGREES" position and the temperature indicator can be calibrated. In the "CAL" position a 100Ω resistor is placed across the lines which should result in a full scale reading on the temperature indicator. (300°K or 30°K depending upon which scale is selected.)

A variable current source is provided to check the operation of the vacuum meter. It is a simple variable load on the +15 supply.

B. Pump Regulator

The remote pump shutdown switch requires +5V for the pump voltage to be disabled which is provided by a 1N4734 zener from the +15V supply.

The pump voltage supplied by the regulator is applied to a 6Ω resistor which acts as a pump load. The voltage across the load can be monitored on the test set using the front panel jacks labeled "V MONITOR".

The heater is simulated by a 6Ω load. (Two 12Ω resistors in parallel.) This heater is attached to a mounting block which the LX5600 is clamped to during the testing of a pump regulator.

CRYOGENICS CONTROL SYSTEM TEST PROCEDURE

1) Make sure connector ZVP3 is disconnected and apply DC power to the panel.

2) With the temperature range switch at 0-30°K, switch "TEMP" switch to "0 DEGREES" and adjust R8 for zero on the temperature meter.

3) Switch to the 0-300°K range and put the "TEMP" switch in "CAL". Check for full scale reading.

4) Refer to the Temperature vs Output Voltage graph and find the voltage corresponding to the desired pump/valve cutout temperature. Monitor the voltage at Pin 2 of IC_2 and adjust R16 to the voltage found on the graph.

5) Turn the test set "VACUUM METER" switch on and adjust the test set front panel pot to see that the vacuum meter will track through its full range.

6) Connect AC power plug ZVP3. Apply AC and DC power to the panel.

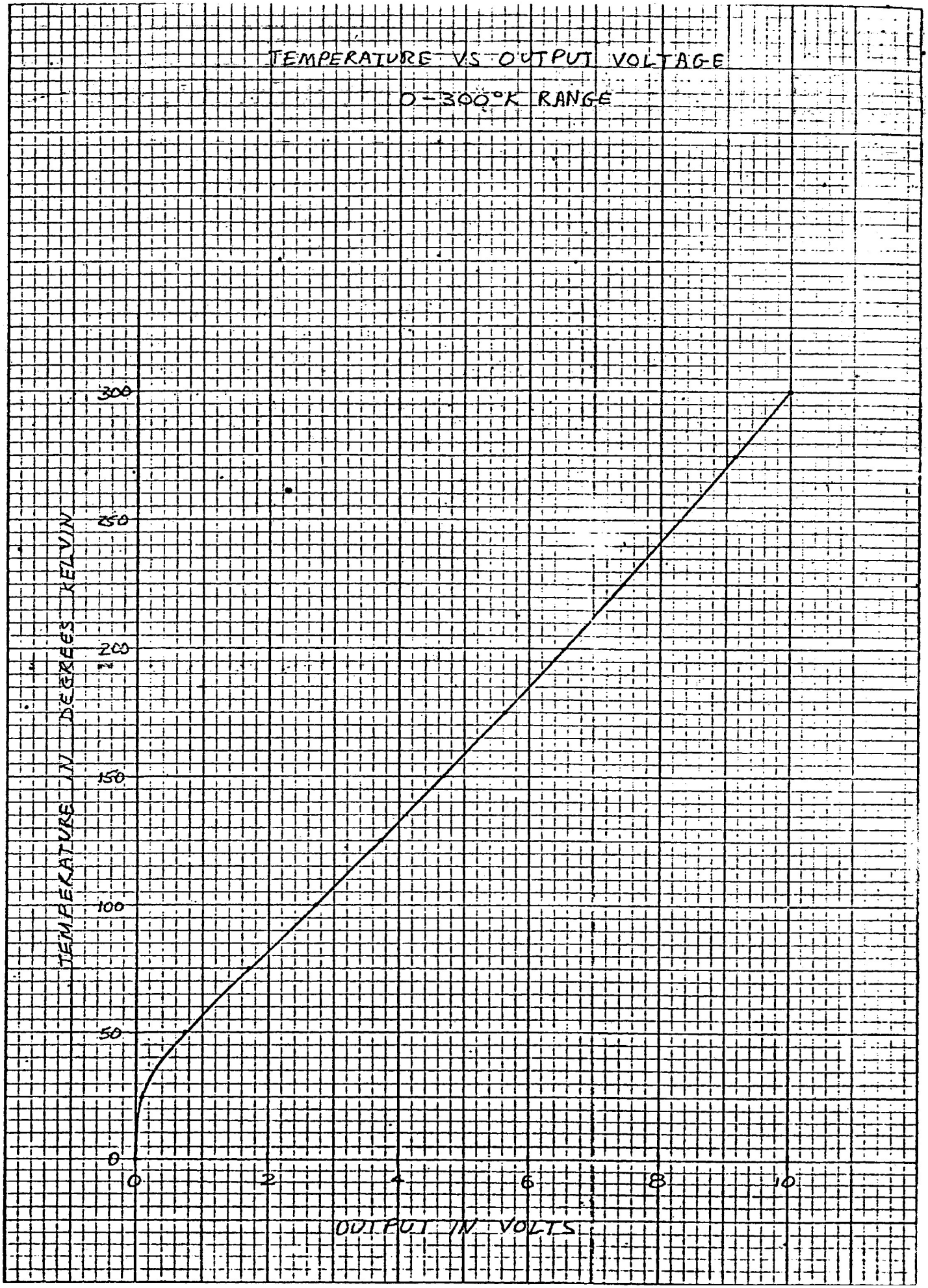
7) Check the following conditions:
   a) The valve opens in the auto position approximately two minutes after the pump comes on.
   b) After this time the valve can be opened or closed manually with the valve switch.
   c) The pump and valve are both shut down in auto when the "TEMP" switch on the test set is switched to "0 DEGREES".
   d) The valve will open ONLY when the pump is on and the "TEMP" switch is in the "CAL" position.
   e) The heater is on only when the refrigerator is off and the "TEMP" switch is in the "0 DEGREES" position
   f) The heater timer functions properly.

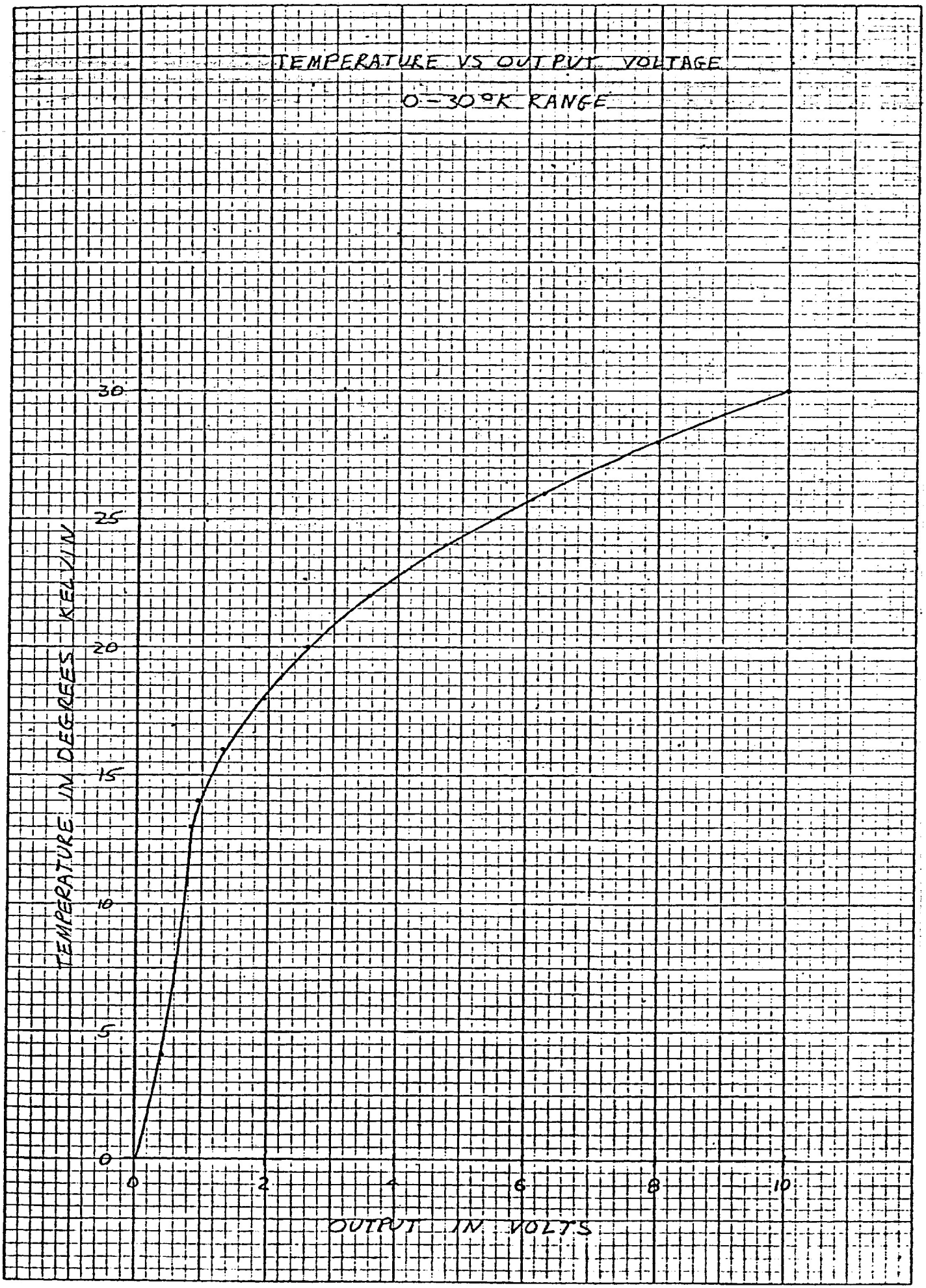
TEST SHEET

TEST CONDITIONS: Panel is connected to rack and both AC and DC power are applied. Switches are as follows: Temperature range 0-300, RFF off, pump off, valve closed. Vacuum gauge switch in OPERATE. Measurements taken after calibration. All voltages are with respect to ground.

TEST POINT	ALLOWABLE RANGE	MEASURED VALUE	FUNCTION
E25	0-1.11 depending on cold stage temp. (3)		V+ for P+ thermometer
E24	0.00 +.0015		V+ for P+ thermometer
E19	Cold stage temp ±5%		0-300°K monitor
E20 E24 & E25 shorted	0.000 ±.001		Thermometer Zero
E20 E24 & E25 open	13.5V ±1		Thermometer output 0-300°K
IC_2-2	Pump/Valve cutout (1)		Pump/Valve cutout set point
E16	-1.5 - -3.5		Helium supply pressure gauge V^-
E17	-1.5 - -3.5		Helium return pressure gauge V^-
E12	Supply Pressure 30 ±5%		Helium supply pressure gauge V_o
E14	Return Pressure 30 ±5%		Helium return pressure gauge V_o
E8	Supply Pressure 100 ±5%		Helium supply pressure monitor
E10	Return Pressure 100 ±5%		Helium return pressure monitor
E9 S5 at Short	0.00 ±.01		Vacuum gauge amplifier zero
E9 S5 at Operate	0-10V depending on vacuum (2)		Vacuum gauge amplifier zero
E1	Dewar Pressure ±5% (2)		Dewar vacuum monitor

1. Voltage obtained from voltage to temperature chart.
2. Voltage obtained from voltage to vacuum chart.
3. See Rosemount data sheet for value of R_T at a given temperature.


TEMPERATURE VS OUTPUT VOLTAGE
0-300°K RANGE
TEMPERATURE IN DEGREES KELVIN
300
250
200
150
100
50
0
0
2
4
6
8
10
OUTPUT IN VOLTS


TEMPERATURE VS OUTPUT VOLTAGE
0-30°K RANGE
TEMPERATURE IN DEGREES KELVIN
0
5
10
15
20
25
30
0
2
4
6
8
10
OUTPUT IN VOLTS

PUMP REGULATOR TEST PROCEDURES

1) Connect the supply connector ONLY. Connect an LX5600 into the socket and clamp it into the mounting block.

2) Pump switch in "LOAD".

3) Monitor PUMP V and adjust R18 full CCW and full CW. Record the minimum (<5.7V) and maximum (>7.7V) voltages.

4) Turn pump switch to "OFF" and attach the pump connector. See that the pump voltage goes to 0.0V. Remove pump connector.

5) Monitor I HTR and check that -13V < I HTR < -11V.

6) Monitor T MON and check that 13V < T MON < 15V.

7) Turn pump switch to "LOAD" and heater "OFF". Plug in the pump connector.

8) Attach a thermometer sensor to the heater mounting block close to the LX5600.

9) Monitor SUPPLY V. Adjust R18 to read 6.00V.

10) Monitor SUPPLY V and put pump switch in the "SHORT" position. Measure voltage as < 1.5V.

11) Monitor T MON and set R3 to temperature shown on thermometer, e.g. 2.5V ≡ 25°C.

12) Monitor I HTR and turn heater "ON". Within 3 minutes the voltage should drop to approximately 0 volts.

13) Monitor T MON. Should be 4.5 - 5.5V.

14) Monitor SUPPLY V. Adjust R18 to minimum voltage.

PARAMP PUMP REGULATOR

TEST DATA SHEET

S/N _____ DATE TESTED _____ TESTED BY _____

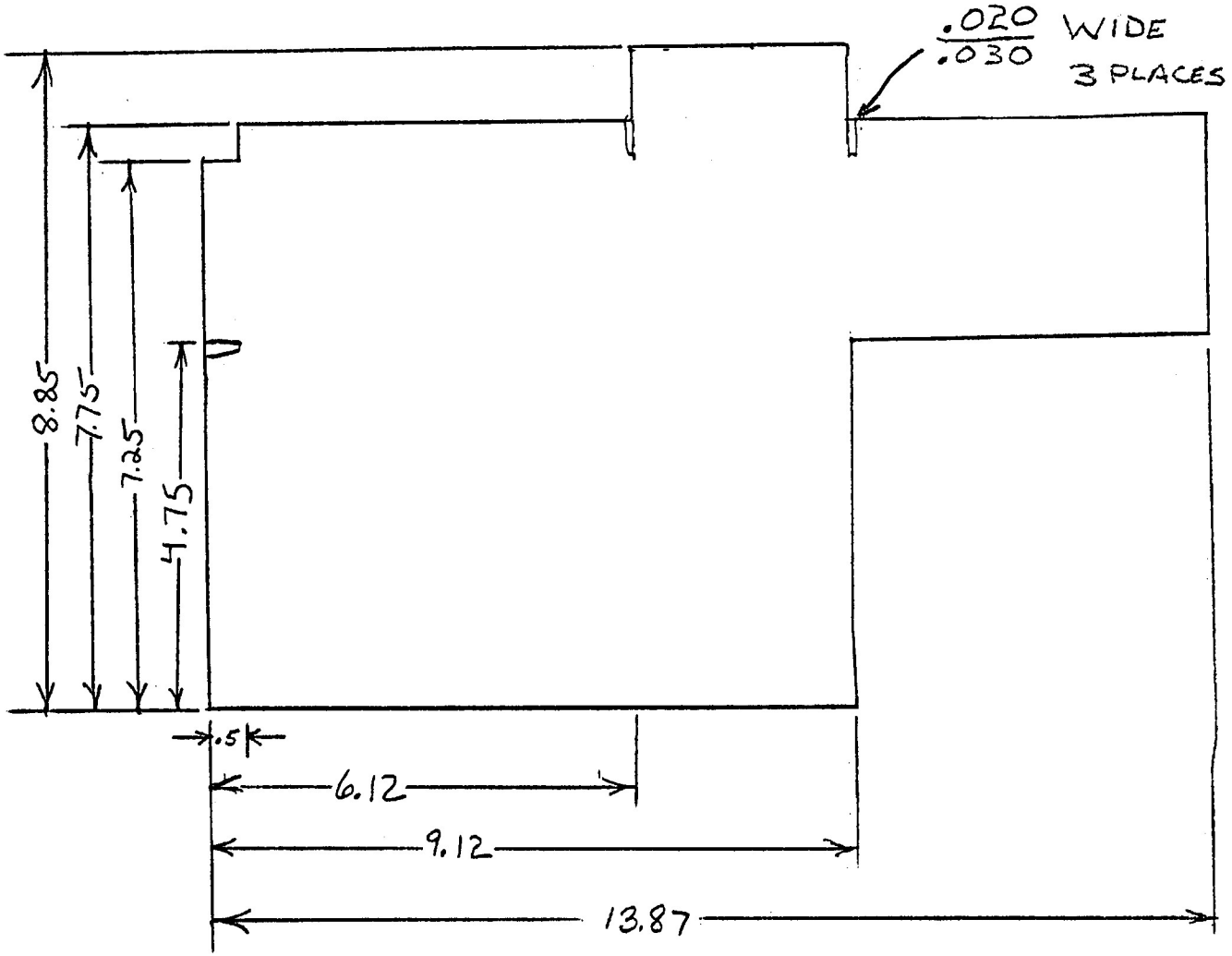
SUPPLY CONNECTOR ONLY Turn Pump Switch "On"

MONITOR	ADJUST	MEASURE	NOTES
Pump V.	Pump Voltage Adjust	Min _____V MAX _____V (<5.7V) (>7.7V)	
Pump V	Pump Switch "Off"	_____ (0.0 Volts)	PUMP CONNECTOR PLUGGED IN
I HTR	N/A	_____ (-11 to -13 Volts)	
T MON	N/A	_____ (13-15 Volts)	

Turn pump switch "on", heater load switch "off" and plug in pump connector.

MONITOR	ADJUST	MEASURE	NOTES
Supply V	Pump Voltage Adjust	6.00	6 ohm load
Supply V	N/A	_____ (1.5V)	Shorted load.
T MON	Temp Cal	_____°C	Set to temperature shown on thermometer 2.5V = 25°C
I HTR	N/A	_____ (√) OK	Turn heater load switch "on". Monitor must drop to approximately zero within 3 minutes.
T MON	N/A	_____ (4.5-5.5V)	
Supply V	Pump Voltage Adjust	N/A	Turn to min. voltage

MATERIAL: CANE METAL
.020" THICKNESS



BILL OF MATERIAL

NATIONAL RADIO ASTRONOMY OBSERVATORY

[ ] ELECTRICAL [XX] MECHANICAL BOM # _____ REV _____ DATE _____ PAGE 1 OF 1

MODULE # _____ NAME Cryo and Pump Reg. Test Set DWG # _____ SUB ASMB _____ DWG # _____

SCHEMATIC DWG # _____ LOCATION _____ QUA/SYSTEM _____ PREPARED BY _____ APPROVED _____

ITEM #	REF DESIG	MANUFACTURER	MFG PART #	DESCRIPTION	TOTAL QUA	
1		Bud	AC-401	Chassis	1	
2		NRAO		Temp. sensor mtg. bracket	1	
3		NRAO		Pump load mounting bracket	1	
4				3/4" round #4 threaded spacer	2	
5				6-32 x 1/4" binder head s.s. screw	7	
6				4-40 x 1/4" binder head s.s. screw	12	
7				6-32 x 2-1/4" binder head s.s. screw	4	
8				#6 flat washer	10	
9				#4 flat washer	2	
10				#6 nut	11	
		H.H. Smith	2170	Grommet	6	
		H.H. Smith	823	Strain relief clamp	1	

BILL OF MATERIAL

NATIONAL RADIO ASTRONOMY OBSERVATORY

[XX] ELECTRICAL [ ] MECHANICAL BOM # _____ REV _____ DATE _____ PAGE 1 OF 2

MODULE # _____ NAME Cryo and Pump Reg. Test Set DWG # _____ SUB ASMB _____ DWG # _____

SCHEMATIC DWG # _____ LOCATION _____ QUA/SYSTEM _____ PREPARED BY _____ APPROVED _____

ITEM #	REF DESIG	MANUFACTURER	MFG PART #	DESCRIPTION	TOTAL QUA	
1		Power-One	HA15-0.5	-15V supply	1	
2		Power-One	C15-3	+15V supply	1	
3		JBT	JMT-123	Switch	3	
4		JBT	JMT-232	Switch	1	
5		JBT	ST 12 A	Switch	1	
6		E. F. Johnson	105-0802-001	Tip Jack	1	
7		E. F. Johnson	105-0803-001	Tip Jack	1	
8		Bournes	3500S-2-501	500Ω, 10 turn pot	1	
9		Littlefuse	Series 970	AC neon panel indicator	5	
10		Hewlett Packard	5082-4655	Red LED	1	
11		H.H. Smith	1410-6	Solder lug	1	
12		Littlefuse	342	Fuseholder	1	
13		H. H. Smith	866	Terminal strip	2	
14				360Ω 1/4W 5%	1	
15				10K 1/4W 5%	1	

BILL OF MATERIAL

NATIONAL RADIO ASTRONOMY OBSERVATORY

[XX] ELECTRICAL [ ] MECHANICAL BOM # _____ REV _____ DATE _____ PAGE 2 OF 2

ITEM #	REF DESIG	MANUFACTURER	MFG PART #	DESCRIPTION	TOTAL QUA	
16				100Ω RN60 1%	1	
17				53.6K RN60 1%	1	
18				1N4734 Zener	1	
19				Power cord	1	
20				AC plug	1	
21		Air Products	#36800	3 pin receptacle	1	
22		Air Products	#36720	19 pin receptacle	1	
23		Cinch	DE-9P	Connector	1	
24		Cinch	DE-9S	Connector	1	
25				Octal connector	1	
26		Amphenol		Valve connector	1	

POWER-ONE, Inc.
531 DAWSON DRIVE
CAMARILLO, CALIF. 93010
(805) 484-2806

APPLICATION DATA INCLUDING:
1. Schematic
2. Parts List
3. Specifications
4. Outline & Mounting Dwg.
5. General User Information

MODEL
HA5-1.2/OVP
HA15-0.5.

SPECIFICATIONS

AC Input: 105-125 VAC, 47-440 Hz (Derate unit 15% at 50 Hz operation)

DC Output:

Model	Voltage	Current (Amps)	OVP
HA5	5	1.2	6.2 ±.4V
HA15	-9 to 15	.5	NA

Line Regulation: ±.05% for a 10V input change

Load Regulation: ±.05% for a 50% load change

Output Ripple: 1.5 mV Pk-Pk, 0.4 mV RMS

Transient Response: 30μ sec for 50% load change

Overload & Short Circuit Protection: Automatic current limit/foldback

Reverse Voltage Protection: Reverse protection on output

Stability: ±0.05% for 24 hours after warmup

Input Fusing: See Table

Temperature Coefficient: 0.01%/°C maximum, 0.002%/°C typical

Cooling: Units are full rated to 50°C in free air, must be derated or fan cooled when mounted in confined area

Temperature Rating: 0-50°C - 100%
60°C - 60%
71°C - 40%

Efficiency: @ 115 VAC, full load on output
5V & 6V - 40%
12V & 15V - 50%

Note: In systems where the AC voltage is controlled, operate at 103-110 VAC for greatest efficiency

Construction: All aluminum chassis

Weight: 1 lb.

Vibration: Per Mil-Std-810B, Method 514, Procedure I, Curve AB (to 50 Hz)

Shock: Per Mil-Std-810B, Method 516, Procedure V

2 YEAR GUARANTEE

POWER-ONE will repair or replace any power supply of its manufacture that does not perform to published specifications as a result of defective materials or workmanship for a period of 2 years from date of original purchase. No other obligations or liabilities are implied or expressed. Returns must be freight prepaid.

TROUBLESHOOTING GUIDE

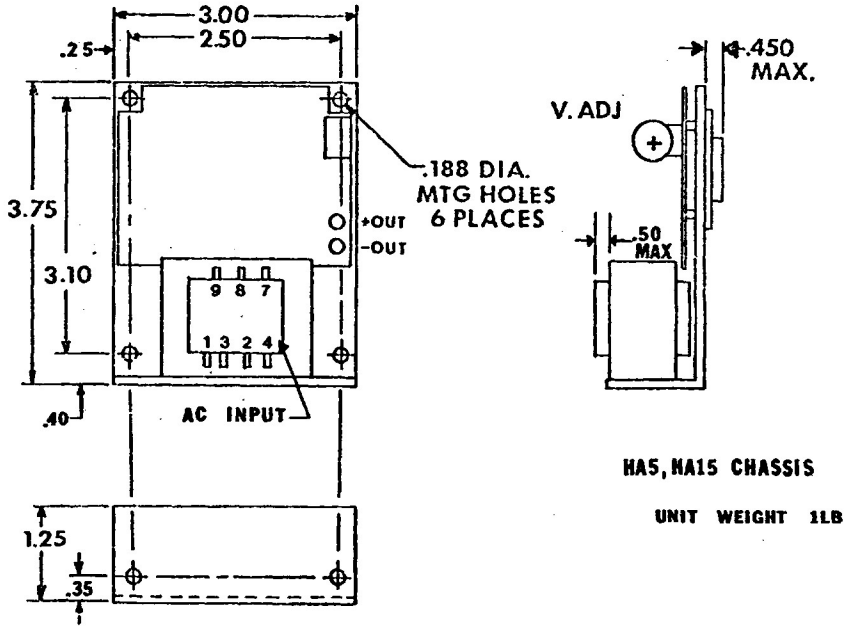
Refer to voltage test points shown on schematic for ease of failure determination

MODEL HA5, HA15

SYMPTOM	POSSIBLE PROBLEM
Unit Overheating	1. Output overloaded 2. Inadequate ventilation 3. Improper transformer primary connection 4. High input AC voltage
Low Output Voltage With High Ripple	1. Output overloaded 2. U1 faulty 3. CR1, CR2 or CR3 open 4. C1, C2 or C3 leaky 5. Q1 open 6. R13 open
High Output Voltage and Ripple, Poor Regulation	1. Q1 or Q2 shorted 2. U1 faulty 3. R14 open 4. R10 shorted
High Input Current, Blows Fuses	1. Improper input voltage or frequency 2. C1 or C2 shorted 3. CR1, CR2 or CR3 shorted

AC CONNECTION & FUSE TABLE

For Use At	Primary Fuse At	Connect	Apply Power To
115	.25A	1-3,2-4	1 & 4
230	.125A	2-3	1 & 4



HA5, HA15 CHASSIS

UNIT WEIGHT 1LB

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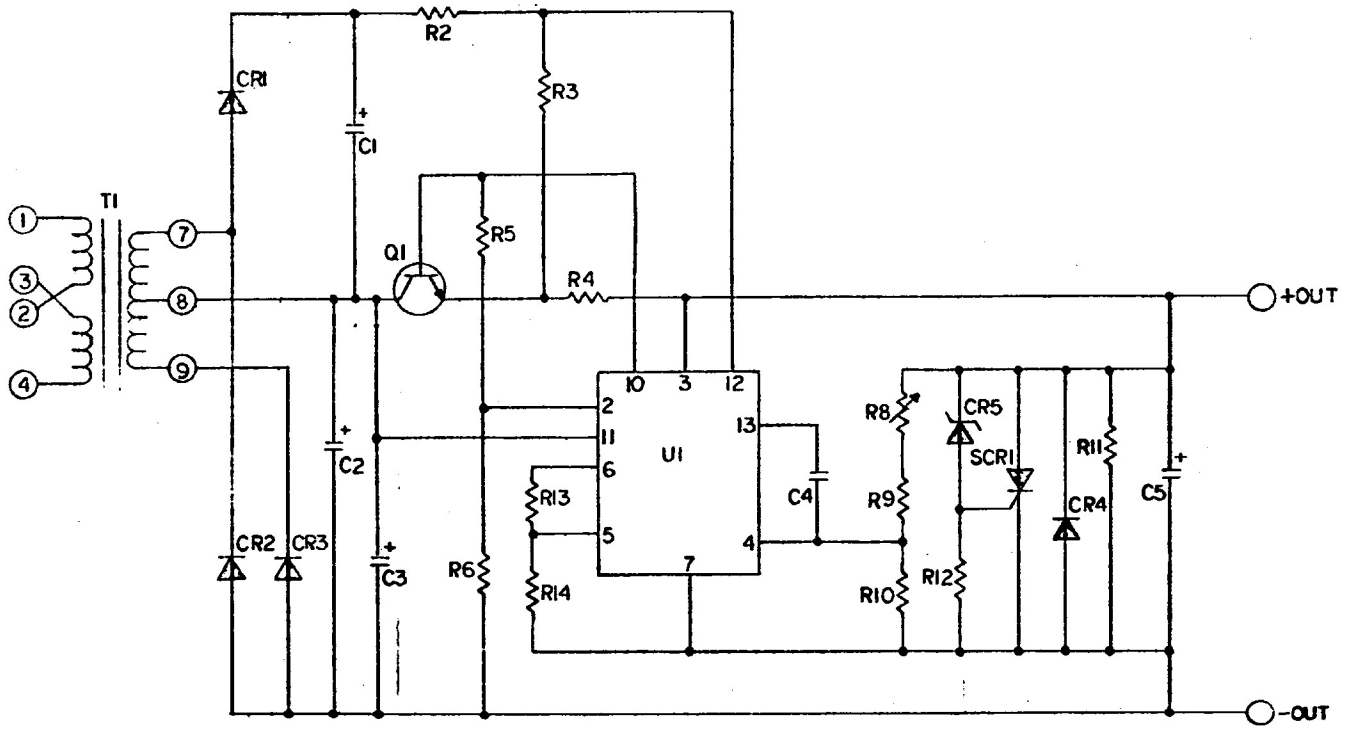
REF DES	HA15-.5	HA5-1.2 OVP	DESCRIPTION
C1,5	100/35	220/16	CAPACITOR ELECT.
C2,3	330/35	1000/16	CAPACITOR, ELECT.
C4	.001/100	.001 100	CAPACITOR, MYLAR
CR1,2,3,4	AEIC	AEIC	DIODE 1A 200V
CR5	——	IN752	DIODE ZENER
SCR1	——	S0303LS3	SCR 3A
Q1	12500-4	12500-4	TRANSISTOR, NPN
R11	1K	220Ω	RESISTOR ½W 5% CF
R12	——	47Ω	
R2	2.2K	47Ω	
R5	220Ω	220Ω	
R3	——	——	
R4	1Ω	——	
R6	4.7K	1.6K	
R10	1.6K	3.3K	
R9	300Ω	6.8Ω	½W 5% CF
R13	47Ω CF	750Ω MF	CF OR MF
R14	——	1.18K	¼W 2% MF
R4	——	.39Ω	RESISTOR 2W BWH
R8	1.5K	1.5K	POTENTIOMETER, 2W, WW
U1	µA723	µA723	IC VOLTAGE REGULATOR
T1	12573	12569	TRANSFORMER
CHASSIS	12567	12567	CHASSIS
P.C.B	12574	12574	P.C. BOARD



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APPLICATION DATA INCLUDING:

1. Schematic
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3. Specification
4. Outline & Mounting Drawing
5. General User Information

MODEL

C5-6
C15-3
C24-2.4

SPECIFICATIONS:

AC Input: 105-125 VAC, 47-470 HZ (derate unit 15% at 50 HZ operation)

RATING CHART

MODEL	VOLTAGE	CURRENT(Amps)
C5-6	5 6	6 6
C15-3	12 15	3.4 3.0
C24-2.4	18 20 24	2.6 2.6 2.4

Line Regulation: ±.01% for a 10V input change
Load Regulation: ±.02% for a 50% load change
Output Ripple: 1.5 mV PK-PK, 0.4 mV RMS
Transient Response: 30 u seconds for 50% load change
Overload & Short Circuit Protection: Automatic current limit (adjustable on C5-6)
Reverse Voltage Protection: Reverse protection diode across output and on pass transistors
Remote Sensing: Provided, connection for local sense not required
Stability: ±0.05% for 24 hours after warm up
Input Fusing: Recommended, fuse at 1 A
Temperature Coefficient: 0.01%/°C maximum
0.002%/°C typical
Cooling: Units are full rated to 50°C in free air, must be derated or fan cooled when mounted in confined area
Temperature Rating:
0 - 50°C - 100%
60°C - 60%
71°C - 40%
Efficiency: @ 115 VAC, full load on output
5V & 6V-50%
12V & 15V-65%
20V & 24V-70%
Note: In systems where the AC voltage is controlled, operate at 108-110 VAC for greatest efficiency
Construction: All aluminum chassis
Weight: 4 lbs.
Vibration: Per Mil-Std-810B, method 514, procedure I, curve AB (to 50 HZ)
Shock: Per Mil-Std-810B, method 516, procedure V.

TROUBLESHOOTING GUIDE

Refer to voltage test points shown on schematic for ease of failure determination

MODEL C5

SYMPTOM	POSSIBLE PROBLEM
Unit Overheating	1. Output Overloaded 2. Inadequate Ventilation 3. Improper Transformer Primary Connection 4. High Input AC Voltage
Low Output Voltage With High Ripple	1. Output Overload 2. U1 Faulty 3. CR1-5 or 6 Open 4. C1 or C2 Leaky 5. Q1 or Q2 Open 6. R13 Open
High Output Voltage And Ripple, Poor Regulation	1. Q1 or Q2 Shorted 2. U1 Faulty 3. CR7 Shorted 4. R12 Open
High Input Current Blows Fuses	1. Improper Input Voltage or Frequency 2. C1 or C2 Shorted 3. CR1-5 or 6 Shorted

MODEL C15, C24

SYMPTOM	POSSIBLE PROBLEM
Unit Overheating	1. Output Overload 2. Inadequate Ventilation 3. Improper Transformer Primary Connection 4. High Input AC Voltage
Low Output Voltage With High Ripple	1. Output Overload 2. U1 Faulty 3. CR1, 2 or 3 Open 4. C1 or C2 Leaky 5. Q1 or Q2 Open 6. R13 Open
High Output Voltage and Ripple, Poor Regulation	1. Q1 or Q 2 Shorted 2. U1 Faulty 3. CR4 Shorted 4. R12 Open
High Input Current, Blow Fuses	1. Improper Input Voltage or Frequency 2. C1 or C2 Shorted 3. CR1, 2 or 3 Shorted

2 YEAR GUARANTEE

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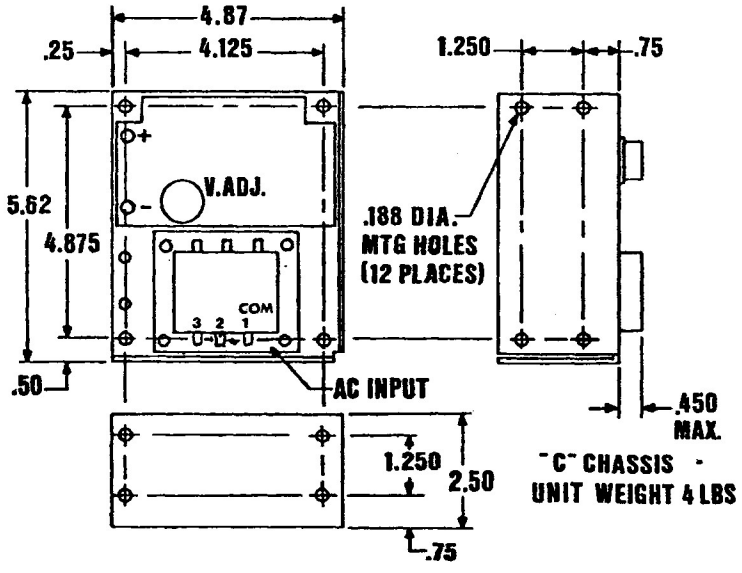

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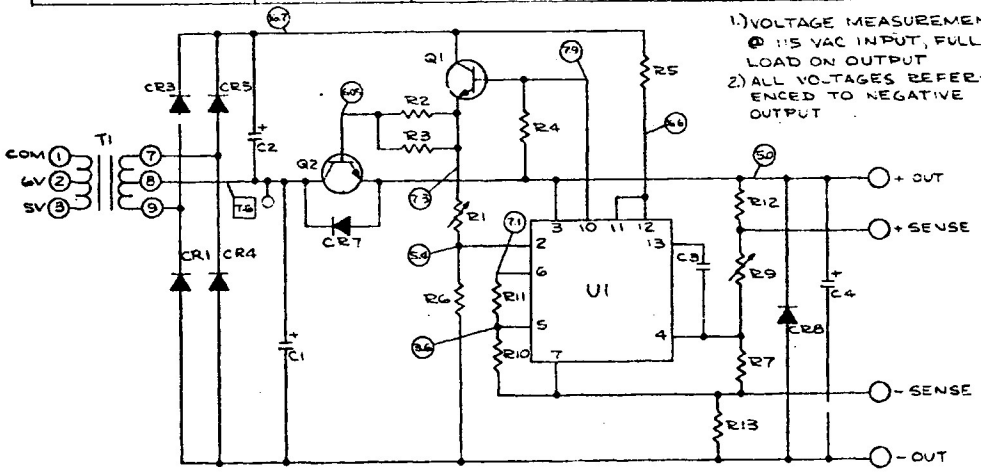
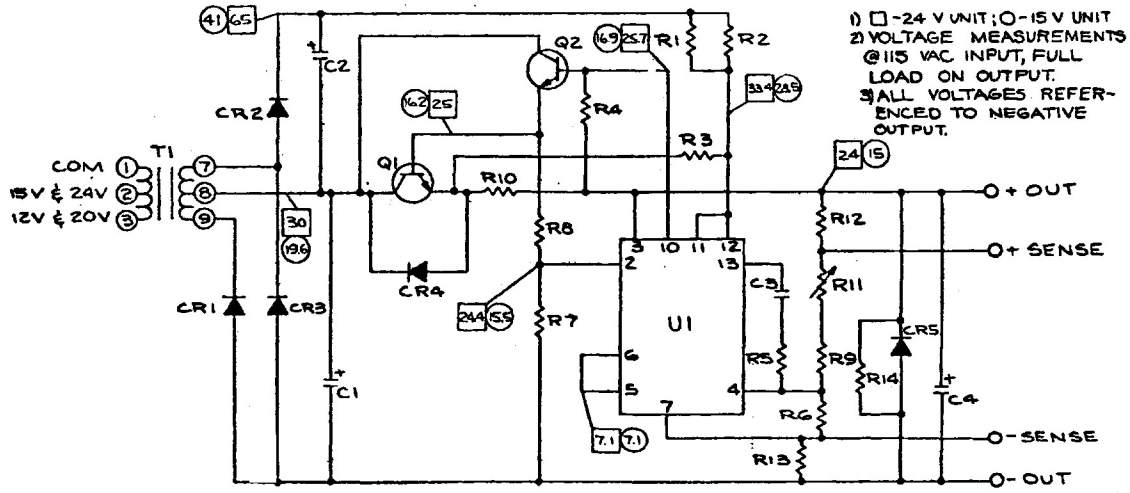
REF DES	CS-6.0		DESCRIPTION
C1	16000/5		CAPACITOR, ELECTROLYTIC
C2,4	1500/6		ELECTROLYTIC
C3	.001/.03		CAPACITOR, MICA
CR3-5,7	AE1C		RECTIFIER, 1A, 200V
CR8	AE3B		RECTIFIER, 3A, 200V
CR1,6	MR750		RECTIFIER, 6A, 50V
R2,3,5-2,13,	6.8Ω		RESISTOR, 1/2W, 5%, C.F.
R2,6,10,11	2.2K		2W, 5%, C.F.
R7	.6K		RESISTOR, 1/2W, 5% W.W.
R1,9	1.5K		POTENTIOMETER, 2W, WW
Q1	12500-5		TRANSISTOR, POWER
Q2	12505-2		TRANSISTOR, POWER
U1	MA723		I.C. VOLTAGE REGULATOR
T1	11033		POWER TRANSFORMER
P.C.B.	11030		PRINTED CIRCUIT BOARD
CHASSIS	11031		ALUM., ALODINE COATED



REF DES	C15-3.0	C24-2.4		DESCRIPTION
C1	7500/35	5700/60		CAPACITOR, ELECTROLYTIC
C2	100/35	47/50		
C4	330/35	330/35		CAPACITOR, ELECTROLYTIC
C3	.001/100	.001/100		CAPACITOR, FILM
CR1,3	AE3B	AE3B		RECTIFIER, 3A, 100V
CR2,4,5	AE1C	AE1C		RECTIFIER, 1A, 200V
R1	2.2K	10K		RESISTOR, 1/2W, 5%, C.F.
R2		10K		
R3	4.7K	4.7K		
R4	750Ω	2.2K		
R7	4.7K	4.7K		
R8	330Ω	240Ω		
R12,13,5	6.8Ω	6.8Ω		
R14	750Ω	2.2K		RESISTOR, 1/2W, 5%, C.F.
R6	1.6K	750Ω		RESISTOR, 1/4W, 2%, M.F.
R9	750Ω	1K		RESISTOR, 1/4W, 2%, M.F.
R10	.12Ω	.22Ω		RESISTOR, 2W, WW, 10%
R11	1.5K	1.5K		POTENTIOMETER, 2W, WW
Q1	12505-2	12505-2		TRANSISTOR, POWER
Q2	2N2219A	2N2219A		TRANSISTOR, SIGNAL
U1	MA723	MA723		I.C. VOLTAGE REGULATOR
T1	13193	13282		POWER TRANSFORMER
P.C.B.	11040	11040		PRINTED CIRCUIT BOARD
CHASSIS	11031	11031		ALUM., ALODINE COATED