

C3A, 3B	68 UF	60 VDC
C6, 8, 9	22 UF	25 VDC
C7	150 UF	15 VDC
C10	S. I. T. = 0.01 UF	100 VDC
C11A, 11B, 11C	220 UF	10 VDC
C14-16, 25, 26, 28	1 UF	100 VDC
C17, 35, 36	0.022 UF	100 VDC
C20-22	0.001 UF	100 VDC
C23, 37	0.0047 UF	100 VDC
C24, 27	0.5 UF	100 VDC
C29	1 UF	35 VDC
C30, 31, 32	0.001 UF	100 VDC
C34	4.7 UF	10 VDC
CR4, 7-14, 16	EM79466H 1N939B	
CR15		
J1	PT1H-16-8P	
L1	1964	
Q5, 6	EM78324H	
Q7	2N2905	
Q8	EM74709H	
Q9	EM79816H	
Q10	2N2878	
Q11	EM14166	
SR1	19640	

R8, 10	30 Ω	1%	3 W
R9, 11	2 K	1%	3 W
R12	S. I. T. = 64.9 Ω		1/8 W
R13	S. I. T. = 619 Ω		1/8 W
R14	1.25 K	1%	3 W
R15	1.50 K	1%	3 W
R16, 29	51.1 Ω		1/8 W
R17	2.61 K		1/8 W
R18	(POT.) 500 Ω		
R19	7.5 K		1/8 W
R20	68 Ω	5%	1/2 W
R21	3.9 K	5%	1/2 W
R22	S. I. T. = 22 Ω	5%	1/4 W
R23	5.62 K		1/8 W
R24	681 Ω		1/8 W
R26	S. I. T. = 60 Ω	BALCO	
R27	0.5 Ω	1%	3 W
R28	60 Ω	1%	3 W
R30	300 Ω	1%	1 W
R31	27 Ω	5%	1/4 W
R32	S. I. T. = 7.5 K		1/8 W
T1	39639		

- NOTES:
1. THE LAST REFERENCE DESIGNATIONS USED ARE: C37, CR16, L2, Q11, R32, SR1, T1, J1.
 2. R25 IS A SET IN TEST RESISTOR, IF USED IT WILL BE IN PARALLEL WITH EITHER R6 OR R7.
 3. REFERENCE DESIGNATIONS OMITTED OR NOT USED ARE: C1, C2, C12, C18, C19, CR5, CR6.

Figure 2-2. 5 Volt Measuring Voltage Supply Schematic Diagram

IBM

Ed. Smith, Jr.
Saturn Instrument Unit

Technical Manual

MSFC No. III-5-510-8

IBM No. 65-966-0019H

5 Volt Measuring Voltage Supply

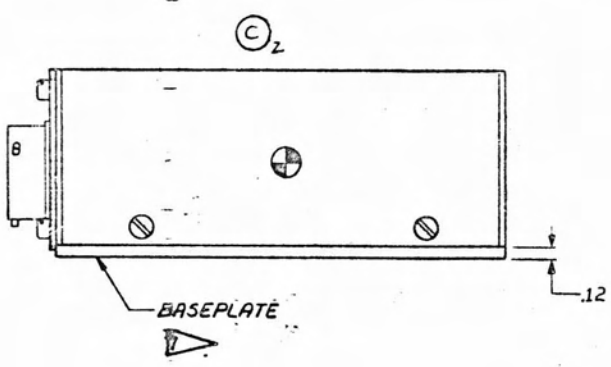


20964
REV D

REVISIONS					
CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED
	66032GM	-	REVISED AND RELEASED	1/8/65	J.H.M.
	6605-PV	A	REDRAWN & INCREASE EFF.	1/16/65	J.H.M.
	66016-EY	B	(1) CHANGED NOTE 1	1/24/65	P.R.M.
	66016-PM	C	(5) SEE ENGRS NOTICE	2/22/65	R.R.M.
	66191EN	D	CLASS I, ECP 1411E, MB18-2 SEE EN (1)	11-7-67	MOTTER

NOTES:

- ① FINISH WITH TWO COATS OF VITAVAR "THERMOKOTE" ALUMINUM NO. 625 PER IBM DWGS 40237478 AND 40237479 EXCEPT BASEPLATE WHICH SHALL BE FINISHED PER MIL-C-5541.
- ② PIN CONNECTIONS:
 - A - 28 VDC
 - B + 28 VDC
 - C, D E - 5 VDC
 - F, G, H + 5 VDC
- ③ 3.0 LB. CALC.
- ④ HEAT DISSIPATION: 12 WATTS.



QTY REQD	SYM BOL	NOMENCLATURE OR DESCRIPTION	PART OR IDENTIFYING NO.	SPECIFICATION	MATERIAL OR NOTES	CODE IDENT NO	ITEM NO	
LIST OF MATERIAL OR PARTS LIST								
<input type="checkbox"/> ONLY THE ITEM(S) LISTED ON THIS DRAWING AND IDENTIFIED BY VENDOR NAME(S), ADDRESS(ES), AND PART NUMBER(S) HAVE BEEN TESTED AND APPROVED BY IBM FOR USE IN (). A SUBSTITUTE ITEM SHALL NOT BE USED WITHOUT PRIOR TESTING AND APPROVAL BY IBM.		IDENT. OF SY I. V. VENDOR ITEM SEE SPEC OR SOURCE CONT DWG R-REF QTY ALL DIMENSIONS AND TOLERANCES APPLY TO FINISHED PART UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCE ON 2 PLACE DEC 3 PLACE DEC ANGLES .03 .010		CONTR NO NAS 8-4000 PREPARATION <i>C. Holcomb</i> DSGN CHK <i>P.P. Manned 11/21/65</i> DRAWING CHECK <i>J.P. Manned 11/21/65</i> DESIGN APPROVAL <i>Holcomb 11/21/65</i>		INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION ARMONK, NEW YORK 10504		TITLE OUTLINE DRAWING MASTER MEASURING VOLTAGE SUPPLY
<input type="checkbox"/> COMMERCIAL PRODUCT MUST BE EQUAL TO AND COMPLETELY INTERCHANGEABLE WITH (SEE SOURCE OF SUPPLY)		MATL HARD CASE D'PTH SVCF TREAT		SIZE CODE IDENT NO. DRAWING NO. D 20234 40220964		SCALE NONE WT VOTE 3 SHEET 1 OF 1		
CIFICATION ER AND TYPE NOTE ITEM NO APPLIES TO		CHECK BLOCK <input checked="" type="checkbox"/> IF APPLICABLE						

NOTICE

The enclosed pages comprise Change No. 1 to the following technical manual:

5 Volt Measuring Voltage Supply

IBM No. 65-966-0019H

Before inserting these change pages, your manual title page must reflect the following date:

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MSFC No. III-5-510-8

IBM No. 65-966-0019H

TECHNICAL MANUAL

5 VOLT MEASURING VOLTAGE SUPPLY

Prepared under Contract

NAS 8-14000

by

International Business Machines Corporation

Federal Systems Division

Huntsville, Alabama

1 October 1965

Changed 1 June 1972

LIST OF EFFECTIVE PAGES

NOTE: The portion of the text affected by the changes is indicated by a vertical line in the outer margins of the page.

Page	Issue
*Title	1 June 1972
*A	1 June 1972
B thru C	Original
*i	1 June 1972
ii Blank	Original
*1	1 June 1972
2 thru 5	Original
6 Blank	Original
7 thru 9	Original
10 Blank	Original
11 thru 13	Original
14 Blank	Original
15 thru 17	Original
18 Blank	Original

*The asterisk indicates pages changed, added, or deleted by the current change.

Original	Change 1				
1 Oct 65	1 June 72				

RELATED DOCUMENTS

The following documents have been published under NASA contract as source and reference information on the IU, its subsystems, and components. A more detailed listing of technical manuals, handbooks, reports, etc. is located in Technical Manual IBM No. 66-966-0006.

It is recommended that you review the following listing for other documents you may require or documents already in your possession. For documents in your possession, compare the date(s) on your document with the date(s) in this listing. If an incompatibility exists, direct inquiries to the following address; however, this listing is current only to the date shown on the bottom of these pages.

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Title	Number		Published Date	Changed Date
	IBM	MSFC		
GENERAL				
Apollo-Saturn Emergency Detection System Description (AS-200 Series Vehicles)	66-966-0010	III-5-509-6	1 Jun 1966	1 May 1967
Apollo-Saturn Emergency Detection System Description (AS-500 Series Vehicles)	66-966-0022	III-5-509-7	1 Aug 1966	1 Jul 1967
Astrionics System Handbook	None	None	1 Aug 1965	15 Aug 1967
Component Handling Equipment, Description and Operating Instructions	66-966-0005	III-5-510-10	1 Feb 1966	1 Nov 1966
EDS Q-Ball Sensor Assembly (50Z12580)	66-966-0027	III-5-510-22	1 Dec 1966	
IU System Description and Component Data	66-966-0006	III-5-509-4	1 Jun 1966	1 Dec 1966
Structure Repair Manual	65-966-0011H	III-5-510-1	1 Jun 1967	
System Test Reference Manual Volume I: Control System Volume II: Guidance System Volume III: ST-124M-3 Inertial Stabilizer System	66-966-0004	III-5-509-3	1 Jul 1967 1 Mar 1967 1 Mar 1966	1 Aug 1967 1 Aug 1967
Umbilical Sat IB	67-966-0004	MSFC-MAN-009	1 Apr 1967	
Umbilical Sat V	67-966-0005	MSFC-MAN-010	1 Apr 1967	

RELATED DOCUMENTS (CONT)

Title	Number		Published Date	Changed Date
	IBM	MSFC		
ELECTRICAL SUBSYSTEM				
5 Volt Measuring Voltage Supply	65-966-0019H	III-5-510-8	1 Oct 1965	1 Nov 1966
56 Volt Power Supply (S-IU-202 thru 212/501 thru 515)	65-966-0018H	III-5-510-7	1 Oct 1965	
Auxiliary Power Distributors *	65-966-0013H	III-5-510-2	1 Oct 1965	
Battery	66-966-0024	III-5-510-20	1 Jun 1967	
Control Distributor *	65-966-0016H	III-5-510-5	1 Oct 1965	
Emergency Detection System Distributor *	65-966-0015H	III-5-510-4	1 Oct 1965	
Measuring Distributors *	65-966-0017H	III-5-510-6	1 Oct 1965	
Power Distributor *	65-966-0014H	III-5-510-3	1 Oct 1965	
Switch Selector, Model II	66-966-0001	III-5-510-9	1 Feb 1966	1 Mar 1967
ENVIRONMENTAL CONTROL SUBSYSTEM				
Environmental Control System Description	66-966-0009	III-5-509-5	1 Nov 1966	1 Jun 1967
GUIDANCE AND CONTROL SUBSYSTEM				
Control Accelerometer	66-966-0012	III-5-510-12	1 Mar 1966	1 Oct 1966
Control-EDS Rate Gyro Package	66-966-0013	III-5-510-13	1 Mar 1966	
Control Signal Processor	66-966-0014	III-5-510-14	15 Nov 1966	
Flight Control Computer (S-IU-203)	66-966-0015	III-5-510-15	15 Mar 1966	
Flight Control Computer (200 Series Vehicles)	66-966-0021	III-5-510-19	1 May 1967	
Flight Control Computer (500 Series Vehicles)	66-966-0025	III-5-510-21	1 May 1967	
Navigation, Guidance, and Control System Description	66-966-0003	III-5-509-2	1 Nov 1966	
MEASURING AND TELEMETRY SUBSYSTEM				
Measuring Rack and Measuring Rack Selector (S-IU-204 thru 212/501 thru 515)	66-966-0017	III-5-510-6	1 Oct 1966	
Measuring and Telemetry System Description **	67-966-0008	III-5-509-9	15 Apr 1967	

RELATED DOCUMENTS (CONT)

Title	Number		Published Date	Changed Date
	IBM	MSFC		
RADIO FREQUENCY SUBSYSTEM				
C-Band Radar Transponder Set SST-135C (S-IU-203)	66-966-0008	III-5-510-11	31 Jul 1964	1 Mar 1966
C-Band Radar Transponder Set (S-IU-204/501 and Subsequent)	66-966-0020	III-5-510-18	1 Jan 1967	
CCS Power Amplifier	67-966-0002	III-5-510-23	1 Mar 1967	
CCS Transponder	67-966-0003	III-5-510-24	1 Jul 1967	
Command Decoder (S-IU-204 thru 212/501 thru 515)	66-966-0019	III-5-510-17	1 Mar 1967	
Command Receiver	Not Avail	Not Avail	(Not rel)	
Command System Description	67-966-0007	III-5-509-8	1 Jun 1967	
<p>* These manuals are at the S-IU-201 level. No plans exist to update their contents to later vehicle configurations.</p> <p>** Replaces Instrumentation System Description, 65-966-0021</p>				

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SECTION I

INTRODUCTION AND DESCRIPTION

1-1 INTRODUCTION

The 5 Volt Measuring Voltage Supply, shown in Figure 1-1, is a dc-to-dc converter. It is the voltage source which supplies the excitation and calibration voltage requirements to the IU instrumentation system. The voltage supply accepts unregulated 28 Vdc from the IU primary batteries and converts it to a highly regulated 5 Vdc.

The 5 Vdc is distributed through the measuring distributors to the IU potentiometer transducers, S-IB and S-IVB potentiometer transducers, all measuring racks, the TM calibrator, both FM telemeters, and both analog multiplexers. The 5 Vdc applied to the transducers is used as an excitation voltage, whereas the 5 Vdc applied to the telemetry components serves as a calibration reference voltage.

1-2 DESCRIPTION

The 5 Volt Measuring Voltage Supply consists of five main assemblies (see Figure 1-2). The main assemblies are: the base assembly, the connector assembly, and three terminal board assemblies. The connector assembly and terminal board assemblies (Figures 1-3 through 1-6) are mounted on the base assembly. The base assembly also provides a mounting surface for several of the component parts.

Connector J1 facilitates all electrical connections to the 5 Volt Measuring Voltage Supply.

Assembly of the voltage supply requires two steps of encapsulation. The first step involves conformal coating the components mounted on the connector assembly and terminal board assemblies with Epocast 202. After assembly and test all recesses and remaining space are filled with Eccosil 4640, except that Sylgard 182 will be used on S-IU-206 and subsequent units and S-IU-512 through S-IU-515 inclusive.

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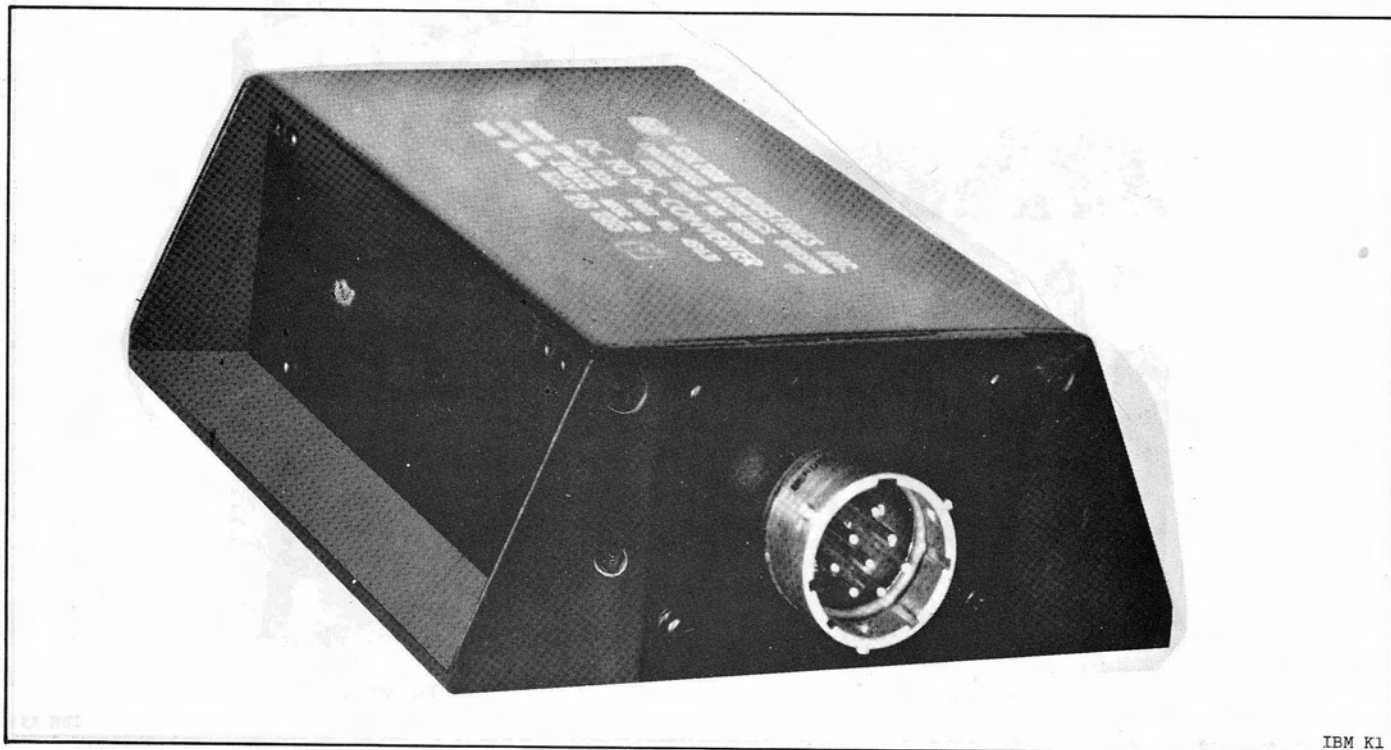
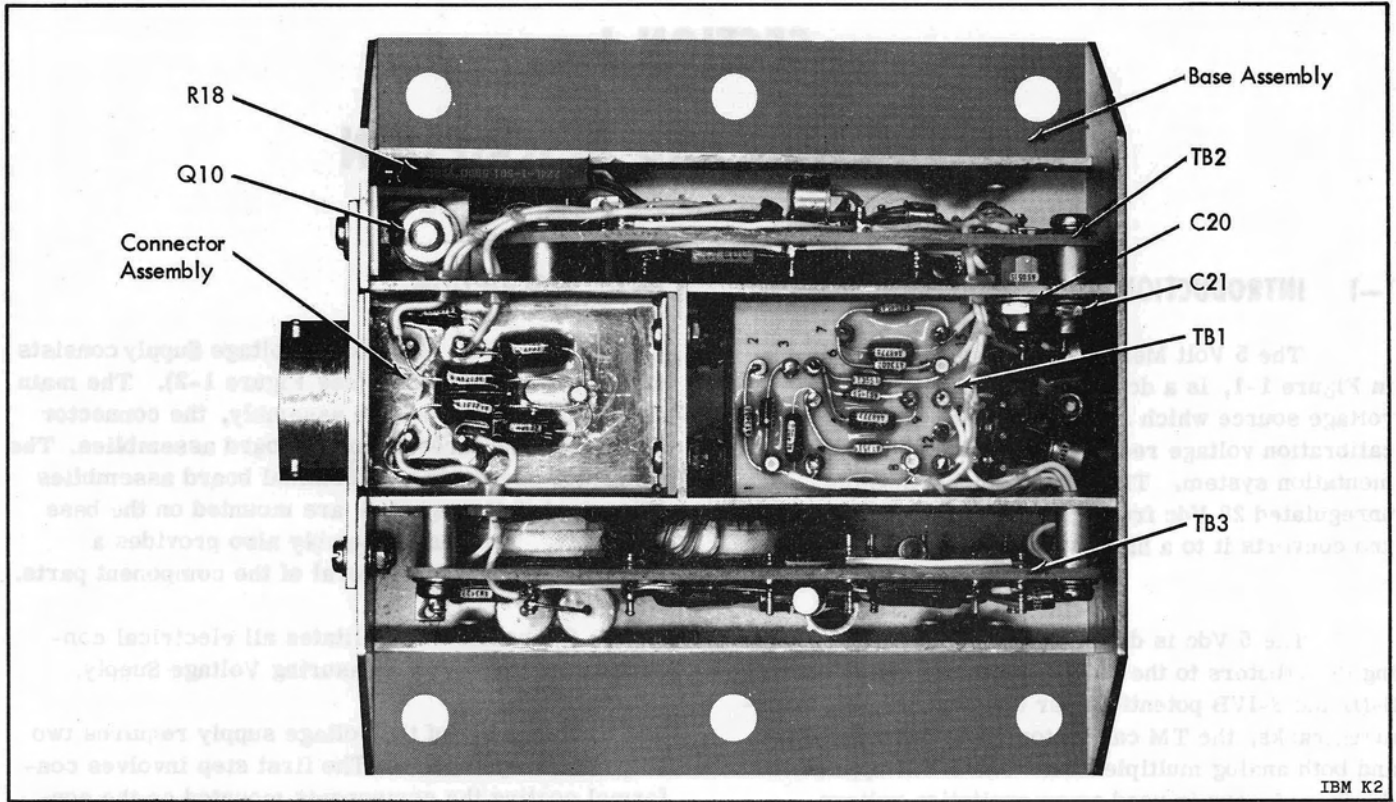
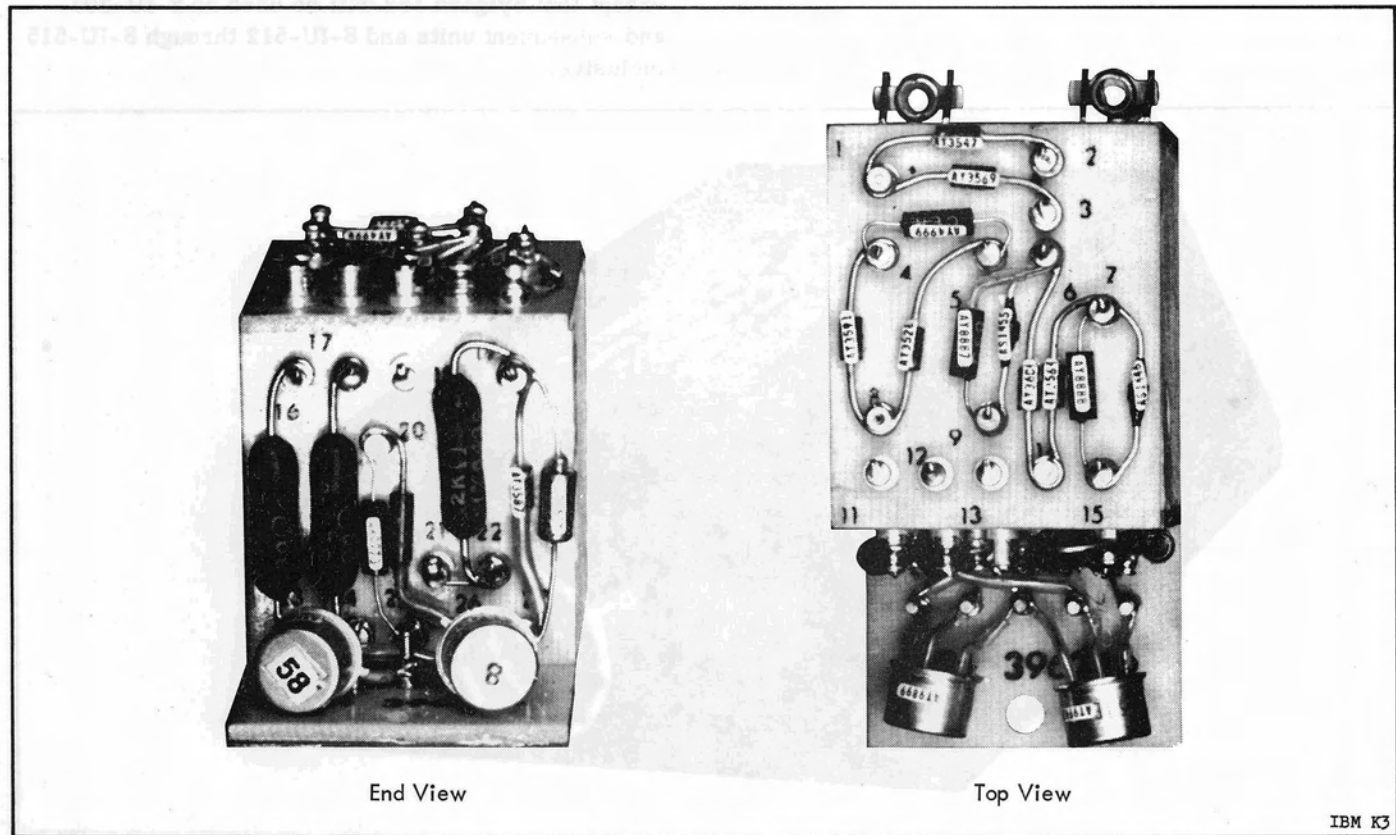


Figure 1-1. 5 Volt Measuring Voltage Supply (Three-Quarter View)



IBM K2

Figure 1-2. 5 Volt Measuring Voltage Supply with Cover Removed - Top View



IBM K3

Figure 1-3. Component Assembly Terminal Board TB1

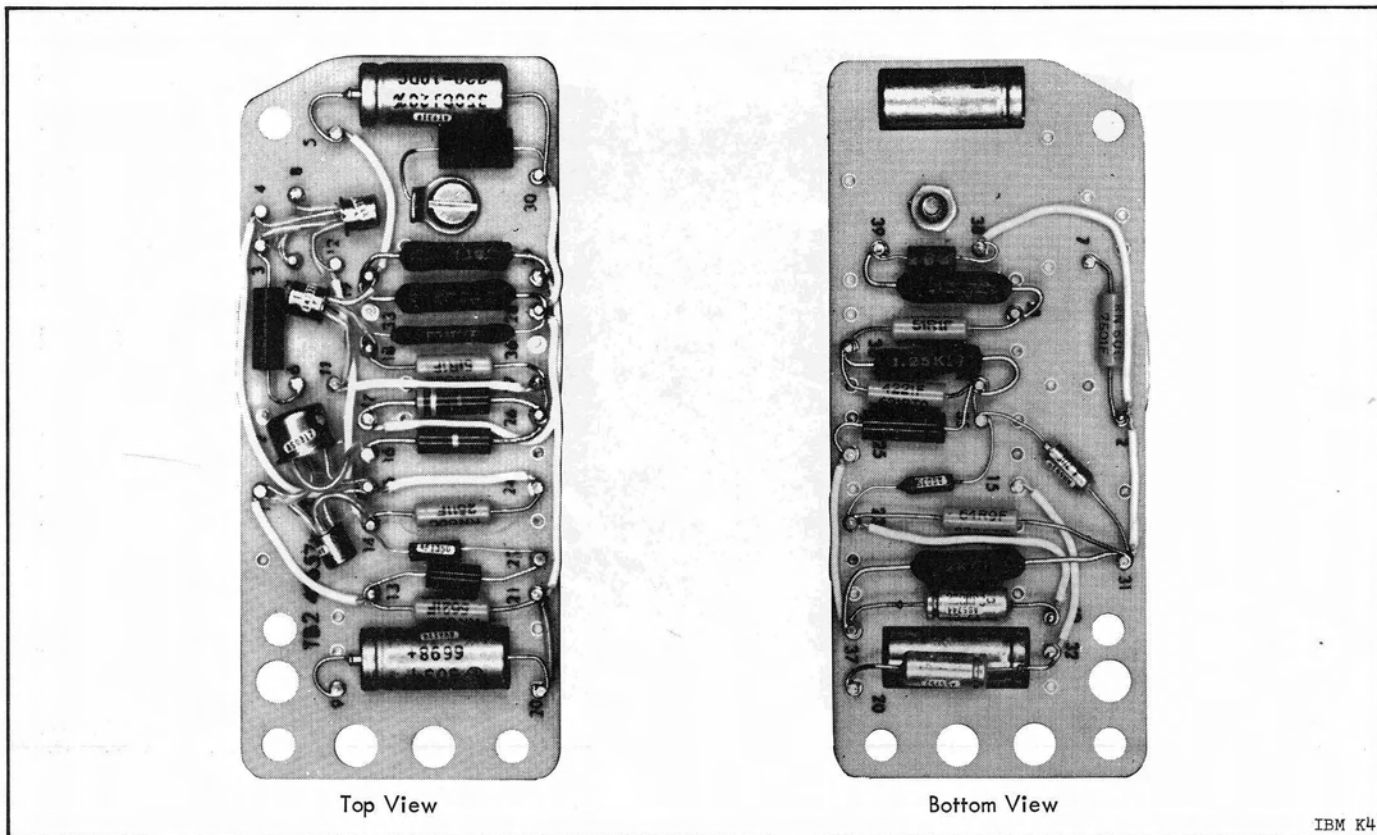


Figure 1-4. Component Assembly Terminal Board TB2

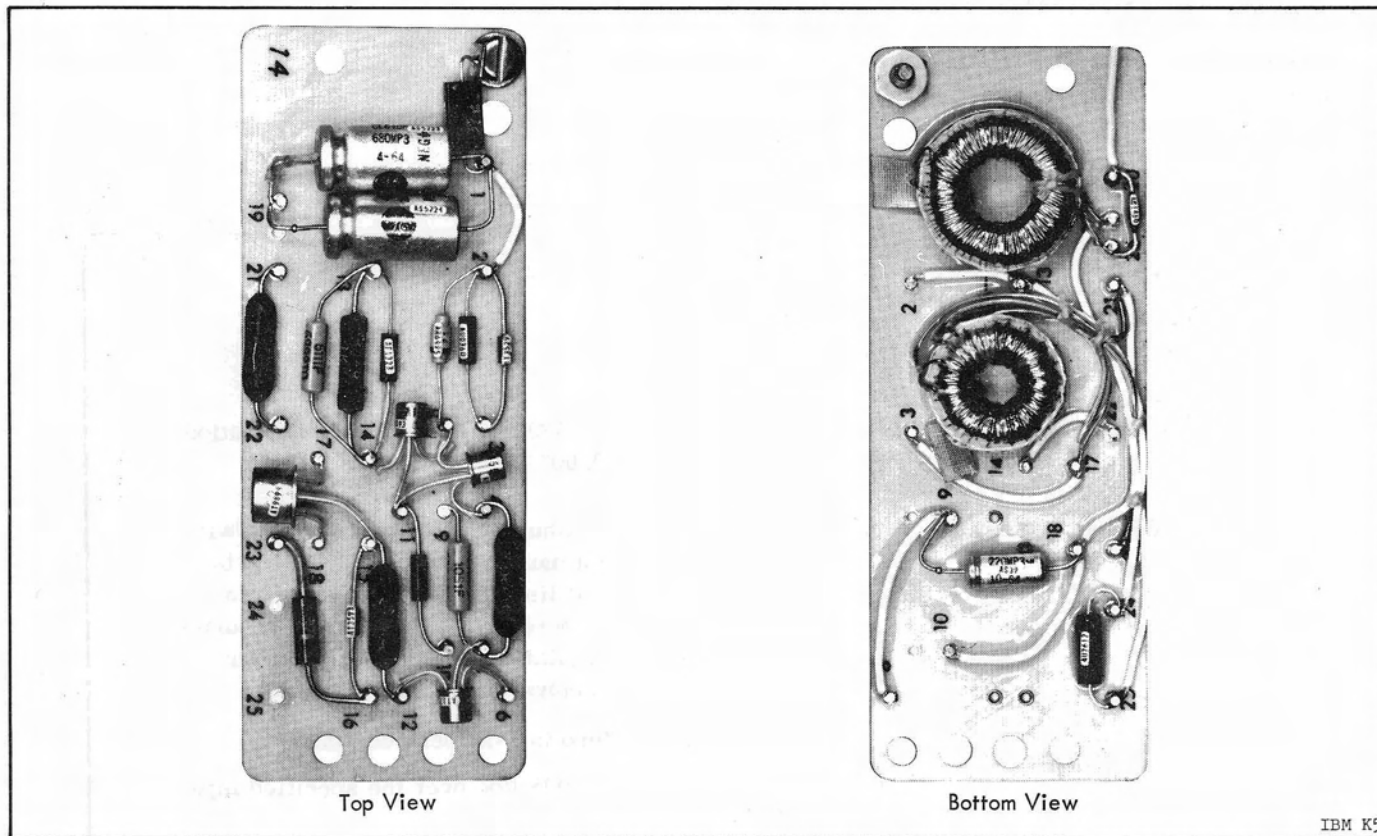


Figure 1-5. Component Assembly Terminal Board TB3

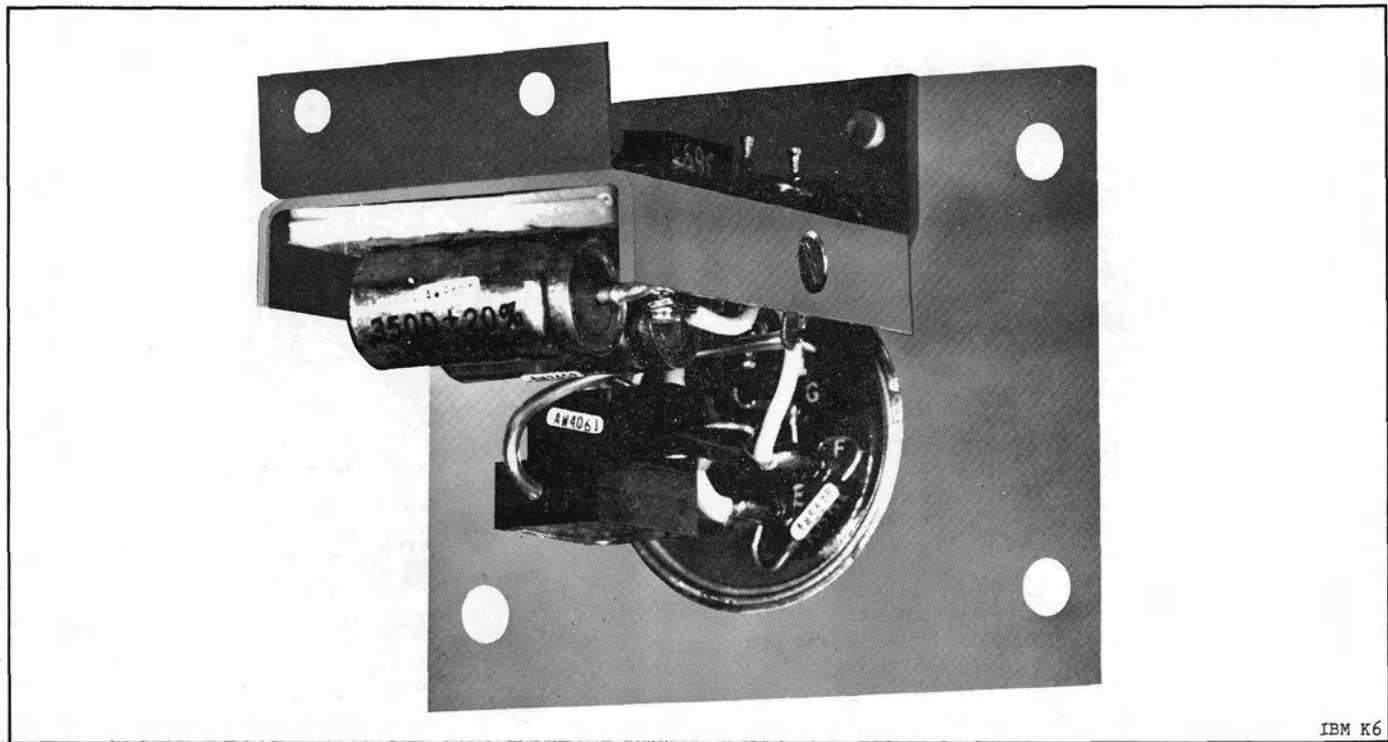


Figure 1-6. Connector Assembly Including Filter Assembly

1-3 ELECTRICAL CHARACTERISTICS

The electrical characteristics of the 5 Volt Measuring Voltage Supply are specified in Table 1-1.

Table 1-1. Electrical Characteristics

Input Voltage	24 to 32 Vdc
Output Voltage	
Zero to 1-ampere load	5.000 ± 0.005 Vdc
Adjustability	
1-ampere load	± 0.050 Vdc. Adjustable resolution 0.002 Vdc or less.
Short Circuit Protection	Continuous output short circuit will not damage the unit. The unit is self limiting to a maximum of 3 amperes input current and resumes regulation within 1 second after removal of the short circuit.
Output Load	Zero to 1-ampere continuous
Steady State Output Voltage Regulation	± 0.005 Vdc over the specified input voltage range

Table 1-1. Electrical Characteristics (Cont)

Dynamic Output Voltage Regulation	± 0.005 Vdc for step changes over the specified voltage input range. Output voltage will not vary more than ± 0.10 Vdc and will recover within 100 microseconds to ± 0.005 Vdc following application of a 1-ampere maximum step load change with a 5-microsecond risetime. AC current reflected back into the source will not exceed 100 ma peak-to-peak.
Output Ripple	
Zero to 1-ampere load	*0.005 V peak-to-peak maximum
Input Voltage Transients	± 50 volts for 20 microseconds superimposed on the input line will not cause output voltage variations of more than ± 5 millivolts.
Efficiency	43 percent at 1-ampere load
Warmup Time	None required
Operating Temperature	0°C to 50°C (32°F to 122°F)
Pin Functions	
A	28Vdc Return
B	28 Vdc
C, D, E,	5 Vdc Return
F, G, H	5 Vdc
Electrical Insulation	
All pins to housing	** 10 Megohms maximum
Pins A, B to C, D, E, F, G, H	** 10 Megohms maximum
* Measured at connector J1 with Tektronix 555 Oscilloscope equipped with a Type L preamplifier.	
** Measured at a 50 Vdc megger test potential.	

1-4 DIMENSIONS AND WEIGHT

The 5 Volt Measuring Voltage Supply has the following dimensions and weight:

- Height : 2 inches maximum
- Width
 - Base: 4-7/8 inches maximum
 - Top : 3-9/32 inches maximum
- Length : 4-13/16 inches maximum
- Weight : 2.5 pounds maximum

SECTION II

PRINCIPLES OF OPERATION

2-1 GENERAL PRINCIPLES OF OPERATION

The 5 Volt Measuring Voltage Supply consists of the following major circuits:

- Input filter-regulator circuit
- DC-to-DC converter circuit
- Output regulator-filter circuit

Figure 2-1 is a block diagram of the 5 Volt Measuring Voltage Supply. Unregulated 28 Vdc is applied to the input filter-regulator circuit. In this circuit the 28 Vdc source voltage is filtered and line variations are removed. The output of the regulator is compared to a constant reference voltage and the resulting error voltage is applied to an amplifier which varies the duty cycle of a transistor switch. The output of the transistor switch is a square wave whose period is a function of the error voltage detected in the comparator. A filter circuit follows the switch to provide an average value of the output. The output of the regulator circuit is applied to the oscillator portion of the dc-to-dc converter. The square wave oscillator output voltage is reduced in the stepdown transformer and is rectified and filtered prior to being applied to the output regulator. Output regulation is accomplished by varying conduction through the series regulator control element. The conduction of this transistor is controlled by the magnitude of the error voltage sensed by the comparator.

An overload protection circuit is provided to limit the series regulator current to a safe level in the event of an overload at the output.

2-2 DETAILED PRINCIPLES OF OPERATION

The following is a more detailed description of the 5 Volt Measuring Voltage Supply (see Figure 2-2).

2-3 INPUT FILTER

Unregulated 24 to 32 Vdc input power is applied across pins A and B of connector J1. Low-frequency filtering is provided by capacitors C14, C15, and C16. Capacitors C17 and C36 provide filtering of RF interference. Capacitor C3 and filter choke L1 filter out any line variations which may be present at the input and also prevents ac current spikes from being reflected back on the 28 Vdc line. Diode CR16 provides reverse polarity protection in case the voltage at the input is reversed; if pin B of connector J1 is negative with respect to pin A of J1, diode CR16 becomes reversed biased and will not conduct current. During normal operation CR16 is forward biased and provides a current path to the input filter-regulator circuit.

2-4 INPUT REGULATOR

To be supplied at a later date

2-5 OSCILLATOR

The output of the input filter-regulator circuit is applied to the oscillator portion of the dc-to-dc converter. The voltage is applied to the collectors of transistors Q5 and Q6 through pin 3 of transformer T1. The emitters of Q5 and Q6 are tied to the input return.

In order for the oscillator to operate, it is necessary to provide base drive for Q5 and Q6. Resistor R9 provides the initial base drive for the transistors. The same voltage which is applied to the collectors of Q5 and Q6 is applied across R9 and the base circuits of Q5 and Q6. As soon as current flows through R9 the oscillator will begin to operate. Once the oscillator has started and voltages are induced in the transformer, CR4 offers a low impedance path to ground and base current will no longer flow through R9. Diode CR4 also serves to block any current flow from ground to the oscillator input voltage.

Assume Q5 conducts first causing its collector voltage to drop. This effectively connects the output of the input regulator across pins 3 and 4 of T1. The

resulting flow of current in this winding results in a field being induced in all windings of T1. At pin 9 of T1 the induced voltage is positive, providing Q5 with increased base drive. At pin 11 of T1 the induced voltage is negative, biasing Q6 off. Current flow between pins 3 and 4 will continue to increase until the voltage induced between pins 18 and 19 is sufficient to allow switching current to flow in saturable reactor SR1.

SR1 operates on a steep hysteresis curve and requires only a small amount of current flow (in either direction) to switch from an unsaturated to a saturated state. When sufficient current flows, SR1 switches from a high impedance unsaturated state to a low impedance saturated state. In the saturated state, SR1 offers a low impedance path from the base of Q5 to the base of Q6. When SR1 switches, the potential at pin 19 of T1 is applied as reverse bias to the base of Q5, and the potential at pin 18 is applied as forward bias to the base of Q6. Q5 is immediately cutoff and the field induced in T1 begins to collapse. The ac path to ground for SR1 switching current is through capacitor C29.

As the field collapses, voltages of the opposite polarity are induced in T1 with the following results:

- SR1 is returned to its unsaturated state
- Pin 9 of T1 is driven negative biasing Q5 off
- Pin 11 of T1 is driven positive, biasing Q6 on

When Q6 conducts current will flow between pins 2 and 3 of T1. Current flow will continue to increase until the voltage induced between pins 18 and 19 is sufficient to allow switching current to flow in SR1. When SR1 saturates in the opposite direction, the potential at pin 18 of T1 is applied as reverse bias to the base of Q6, causing Q6 to be immediately cutoff. This completes one cycle of the oscillator. The oscillator continues to switch in the manner described above at a 4 kc rate.

Resistor R31 and capacitor C37 are used to filter the high-frequency switching spikes that appear at the output of the oscillator.

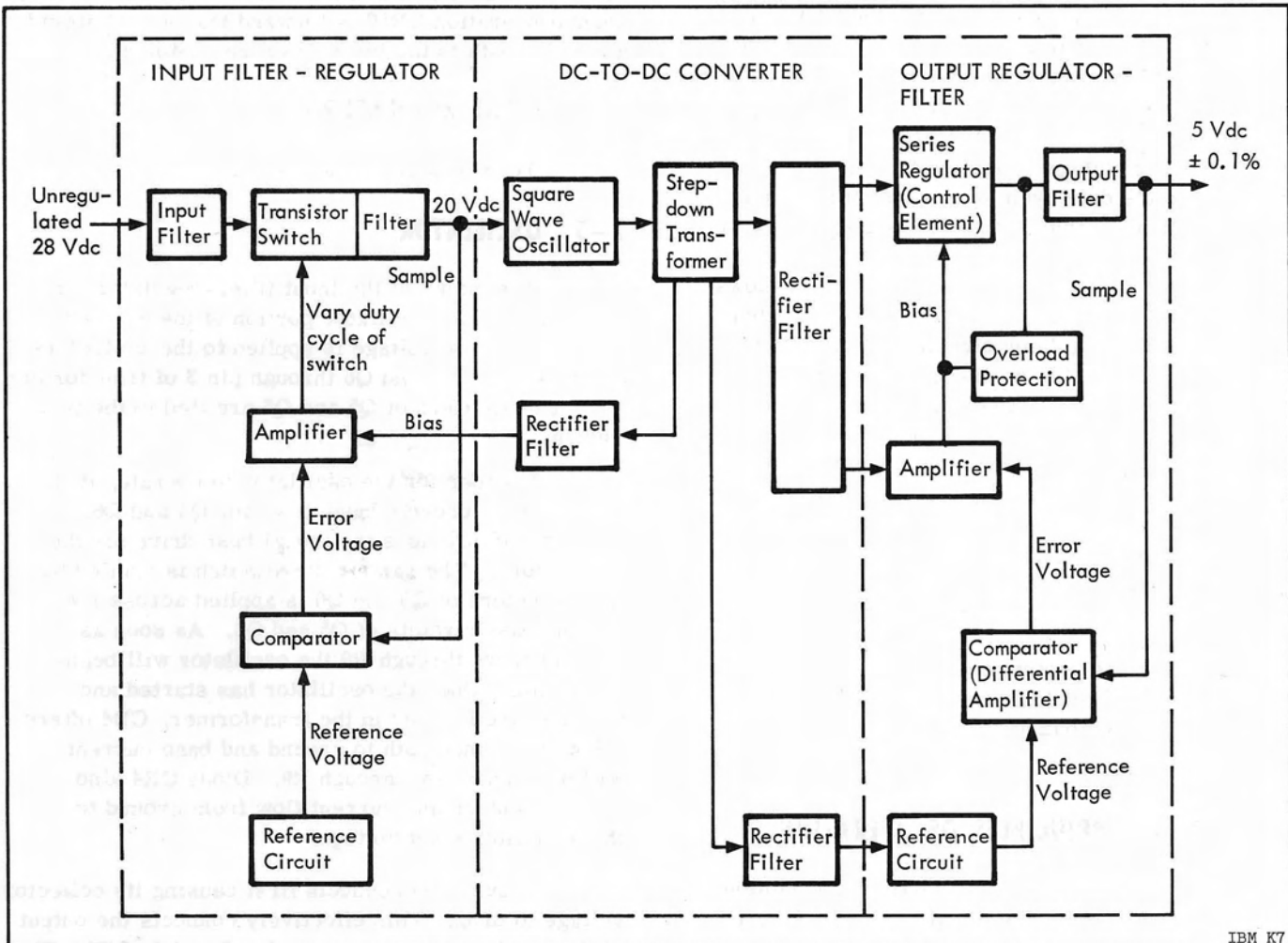
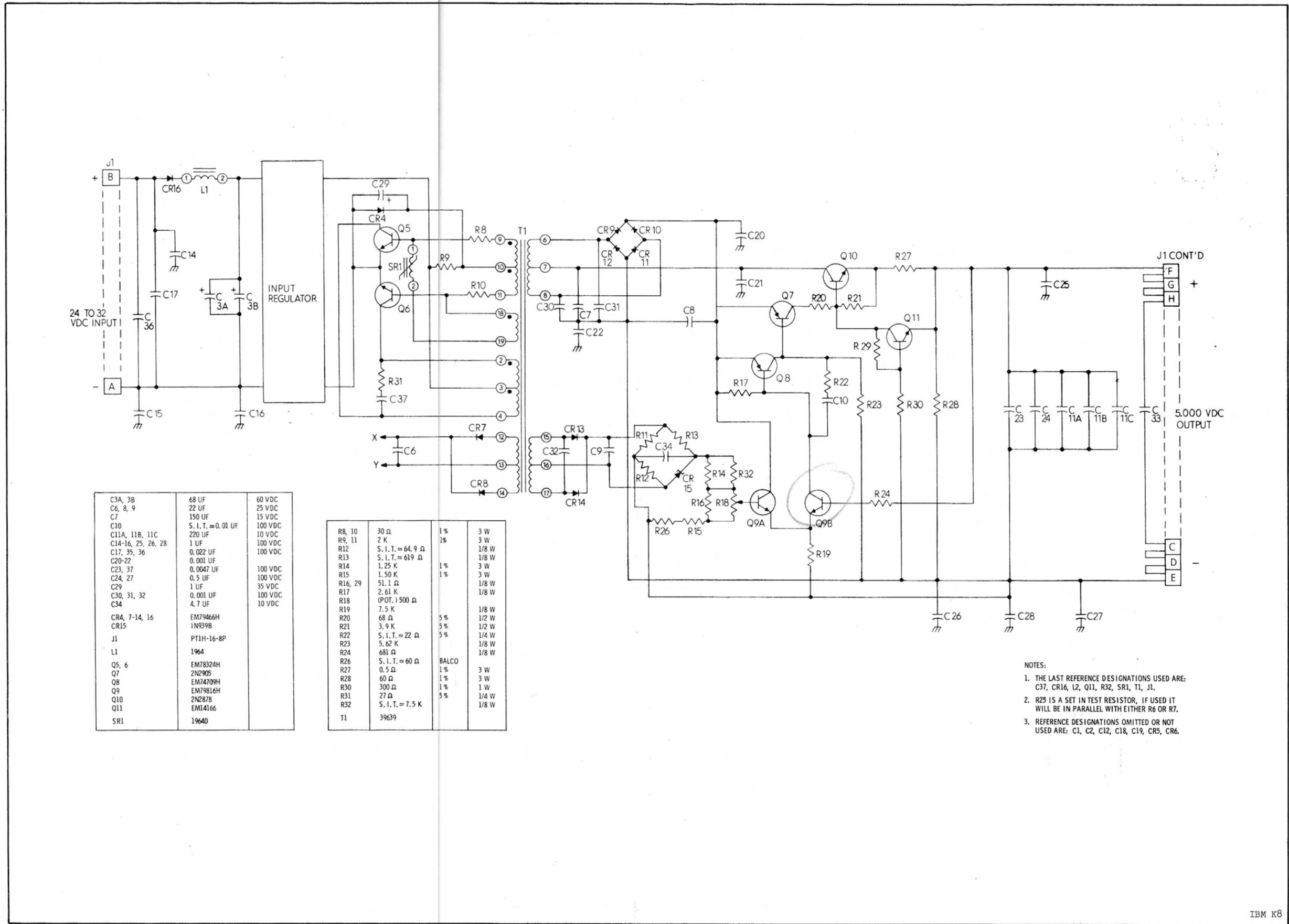


Figure 2-1. 5 Volt Measuring Voltage Supply Block Diagram



C3A, 3B	68 UF	60 VDC
C6, 8, 9	22 UF	25 VDC
C7	150 UF	15 VDC
C10	S. I. T. = 0.01 UF	100 VDC
C11A, 11B, 11C	220 UF	10 VDC
C14-16, 25, 26, 28	1 UF	100 VDC
C17, 35, 36	0.022 UF	100 VDC
C20-22	0.001 UF	100 VDC
C23, 37	0.0047 UF	100 VDC
C24, 27	0.5 UF	100 VDC
C29	1 UF	35 VDC
C30, 31, 32	0.001 UF	100 VDC
C34	4.7 UF	10 VDC
CR4, 7-14, 16	EM79466H	
CR15	1N939B	
J1	PT1H-16-8P	
L1	1964	
Q5, 6	EM78324H	
Q7	2N2905	
Q8	EM74709H	
Q9	EM79816H	
Q10	2N2878	
Q11	EM14166	
SR1	19640	

R8, 10	30 Ω	1%	3 W
R9, 11	2 K	1%	3 W
R12	S. I. T. = 64.9 Ω		1/8 W
R13	S. I. T. = 619 Ω		1/8 W
R14	1.25 K	1%	3 W
R15	1.50 K	1%	3 W
R16, 29	51.1 Ω		1/8 W
R17	2.61 K		1/8 W
R18	(POT.) 1500 Ω		
R19	7.5 K		1/8 W
R20	68 Ω	5%	1/2 W
R21	3.9 K	5%	1/2 W
R22	S. I. T. = 22 Ω	5%	1/4 W
R23	5.62 K		1/8 W
R24	681 Ω		1/8 W
R26	S. I. T. = 60 Ω	BALCO	
R27	0.5 Ω	1%	3 W
R28	60 Ω	1%	3 W
R30	300 Ω	1%	1 W
R31	27 Ω	5%	1/4 W
R32	S. I. T. = 7.5 K		1/8 W
T1	39639		

- NOTES:
1. THE LAST REFERENCE DESIGNATIONS USED ARE: C37, CR16, L2, Q11, R32, SR1, T1, J1.
 2. R25 IS A SET IN TEST RESISTOR, IF USED IT WILL BE IN PARALLEL WITH EITHER R6 OR R7.
 3. REFERENCE DESIGNATIONS OMITTED OR NOT USED ARE: C1, C2, C12, C18, C19, CR5, CR6.

Figure 2-2. 5 Volt Measuring Voltage Supply Schematic Diagram

2-6 RECTIFIER — FILTERS

There are three separate rectifier-filter circuits in the dc-to-dc converter section of the 5 Volt Measuring Voltage Supply. All three are transformer coupled to the output of the oscillator circuit and provide the output and bias voltages for the voltage supply. A minimum of filtering is required in these circuits because of the near perfect square wave output of the oscillator.

Preregulator Bias Supply

The rectifier (CR7 and CR8) at pins 12, 13, and 14 of T1 produces the dc bias voltage required by the input regulator circuit. The voltage coupled across transformer T1 is full wave rectified and referenced to the incoming 28 Vdc line. Capacitor C6 provides sufficient filtering for this voltage.

Output Regulator Reference Supply

The object of the circuit located at pins 15, 16, and 17 of T1 is to develop a reference voltage on the base of transistor Q9A. The voltage used to drive this reference circuit is supplied by the transformer coupled voltage appearing at pins 15, 16, and 17 of T1. This voltage is full wave rectified by diodes CR13 and CR14 and is filtered by capacitor C9.

In order to maintain a constant voltage at the base of Q9A, a constant voltage must be maintained across the voltage divider network consisting of resistors R14, R15, R16, R18, R26, and R32. The resistance bridge consisting of resistors R11, R12, R13, and Zener diode CR15 is used to develop and maintain this required voltage.

The constant voltage required by the voltage divider network is developed in the following manner. The voltage rectified at the transformer is applied across the resistance bridge from the junction of R11 and R13 to the junction of R12 and CR15. When this voltage is applied, Zener diode CR15 conducts establishing a set voltage at the top of the voltage divider network. R13 establishes the bias for CR15 and sets the current level in CR15. The impedance ratio between R13 and CR15 is approximately 10:1 ($R13 = 619$ ohms, $CR15 \cong 65$ ohms).

Concurrent with this action, the other leg of the bridge (R11 and R12) must divide the applied voltage so that a voltage differential exists across the voltage divider network. Two factors determine how

the voltage is developed across R11 and R12. The first factor is the impedance ratio between R11 and R12 is approximately 30:1 ($R11 = 2K$, $R12 \cong 64.9$ ohms). This results in a very small portion of the voltage applied across R11 and R12 being dropped across R12. The second factor is the impedance ratio between the two legs of the bridge is approximately 3:1 ($R11 + R12 \cong 2.06K$, $R13 + CR15 \cong 0.67K$). As a result more current will flow through CR15 than R12. The combination of these factors, (noting that the impedance of R12 and CR15 are approximately equal) results in a much smaller portion of the applied voltage being dropped across R12 than across CR15. Thus a voltage differential is established across the voltage divider network.

In order to maintain a constant voltage at the base of Q9A, the voltage developed across the bridge must be independent of line variations. This is accomplished by critical selection of the bridge components. R12 is a "set-in-test" resistor selected, at the time of factory test, to match the impedance of CR15 when CR15 is at its breakdown potential. When an increase in voltage is applied across the bridge, the voltage developed across CR15 increases slightly due to increased current flow. Keep in mind that the increase in voltage across CR15 is not proportional to the current flow through CR15. Therefore the increase in voltage applied to the bridge is dropped almost completely across R13. In the other leg of the bridge the impedance ratio (30:1) results in the increased voltage being dropped almost completely across R11. Because of the manner in which R12 was selected, the portion of the voltage dropped across R12 will be approximately equal to the increased voltage dropped across CR15. By algebraically adding the voltage drops across R12 and CR15, (or R11 and R13) it can be seen that there is no change in the potential across the voltage divider.

Once the voltage across the bridge is established and maintained at a constant level it is the function of the voltage divider network to establish the required voltage level at the base of Q9A. Temperature compensating resistor R26 maintains a constant voltage across the voltage divider network by varying its resistance with any change in temperature. R15 sets the low side of the adjustment circuit (R16 and R18) to the desired level. R18 is a 500 ohm, 22-turn potentiometer which provides the ± 50 -millivolt adjustment capability of the supply. R18 is shunted by R16 (51.1 ohms) to lower the resistance of the adjustment circuit and thereby increase the resolution of adjustment.

The output of the supply is adjusted to 5.000 Vdc when the correct value of "set-in-test" resistor R32 is selected (during factory test) and placed in parallel with R14, thereby establishing the proper operating point of Q9A.

Capacitor C34 in the bridge circuit provides, filtering for the oscillator frequency which may be present at the output of the rectifier.

Main Power and Output Regulator Bias Supply

The bridge rectifier at pins 6, 7, and 8 of T1 provides output and bias voltage to the output series regulator. The circuit operates in the following manner (see Figure 2-3 for a simplified schematic).

When pin 6 is negative with respect to pins 7 and 8, diodes CR10 and CR12 are forward biased and will conduct. When conduction occurs point "A" is clamped to the potential at pin 6 and point "B" is clamped to the potential at pin 8. The induced voltage between pins 6 and 7 is now directly across Rx, and the induced voltage between pins 6 and 8 is now directly across Ry, and current flows in both load circuits.

When pin 8 becomes negative with respect to pins 6 and 7, diodes CR9 and CR11 are forward biased and will conduct current. Point "A" is now clamped to the potential at pin 8 and point "B" is clamped to the potential at pin 6. It can therefore be seen that point "B" is always clamped to the high side of T1, and point "A" to the low side of T1. This results in a constant dc voltage being maintained across Rx and Ry.

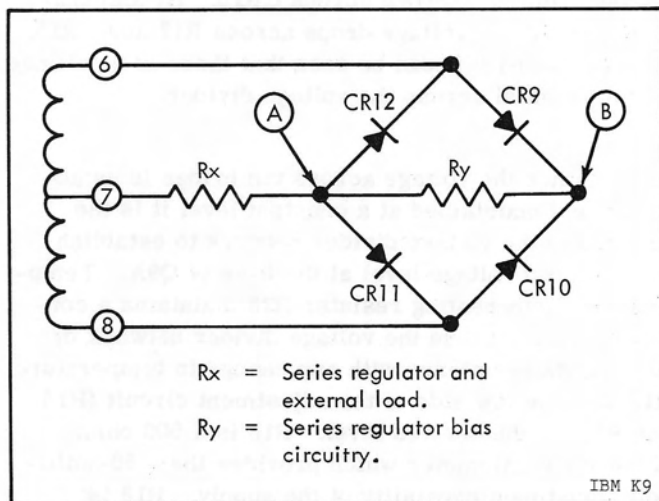


Figure 2-3. Simplified Schematic of Main Power and Output Regulator Bias Supply

Filtering is provided for both RF interference and low frequencies (see Figure 2-2). Capacitors C7 and C8 filter low-frequency variations, while capacitors C20, C21, C22, C30, and C31 attenuate RF interference.

2-7 OUTPUT REGULATOR

The output of the 5 Volt Measuring Voltage Supply is series regulated by transistor Q10. Basically, the output regulator works as follows (see Figure 2-2). The supply output voltage is fed back to the base of Q9B (through R24) and is compared to the reference voltage present at transistor Q9A. Transistors Q9A and Q9B form a differential amplifier. Any difference voltage between the sample and the reference voltage is amplified by the differential amplifier and further amplified by dc amplifiers Q7 and Q8. The output of dc amplifier Q7 is used to control the base drive of series regulator Q10.

As an example of the regulation action, assume the output voltage decreases due to an increase in load. The decrease in output voltage appears at the differential amplifier causing Q9B to conduct less. As current flow through Q9B decreases, its collector voltage increases. This increase in voltage is applied to the base of Q8, resulting in Q8 being biased off. As current flow through Q8 decreases, the voltage drop across resistor R23 decreases. This decrease in voltage is applied to the base of Q7, resulting in Q7 being biased on. Increased current flow through Q7 results in an increased voltage drop across R29 and R30. The base of Q10 senses the increase in voltage and Q10 is biased on. As current flow through Q10 increases, the voltage drop across Q10 decreases resulting in the output of the regulator increasing to its original level.

Because of the high gain developed across Q7 and Q8, high-frequency oscillations may appear in the regulator. To prevent these oscillations an RC network consisting of R22 and C10 is utilized to reduce the high-frequency gain across the dc amplifiers. Resistor R21 provides increased current stabilization for transistor Q10.

Incorporated into the output regulator circuit is a short-protection circuit. This circuit consists of bias resistors R29 and R30, transistor Q11, and current sampling resistor R27. If the output of the supply exceeds a set level, the current flow through R27 forward biases Q11 allowing it to conduct. The conduction

of Q11 overrides the regulation control of Q7 resulting in Q10 being biased toward the off state. The more output current that is drawn, the more Q10 will be biased off.

Resistor R28 is a load resistor placed across the output of the voltage supply to improve voltage stability.

2-8 OUTPUT FILTER

RF interference at the output of the 5 Volt Measuring Voltage Supply is attenuated through capacitors C23 through C28, and C35. Capacitors C11A, C11B, and C11C provide low-frequency filtering.

SECTION III

PREPARATION FOR USE AND SHIPMENT

3-1 PREPARATION FOR USE

The packaged 5 Volt Measuring Voltage Supply shall be opened in the following manner:

- a. Slit tape on outer carton.
- b. Cut barrier bag immediately below seal.
- c. Slit tape on inner carton.
- d. Check humidity indicator (see following paragraph)
- e. Lift out top cushioning pad.
- f. Remove component.
- g. Remove dust cover from connector. (Bendix Part No. 10-70506-18)
- h. Visually inspect power supply for physical damage and corrosion.
- i. Replace dust cover on connector.

The humidity indicator has three blue indicators graduated to indicate thirty, forty, and seventy percent humidity. These indicators will turn pink when their respective percent of humidity has been reached. A visual inspection for corrosion should always be made immediately after unpacking a power supply. If the seventy percent indicator is pink, it is recommended the voltage supply be returned to the laboratory for inspection and testing.

3-2 PREPARATION FOR SHIPMENT

3-3 PACKAGING

The 5 Volt Measuring Voltage Supply shall be packaged in accordance with Method IIb or Method III of Military Specification MIL-P-116 and marked in accordance with Military Standard MIL-STD-129. Determination of whether to use Method IIb or Method III is dependent upon the degree of protection required. Method III is to be used if the power supply is to be shipped between plants at the Huntsville facility and there will be no storage required. Method IIb is to be used in all other cases. Refer to Figure 3-1 for packaging instructions.

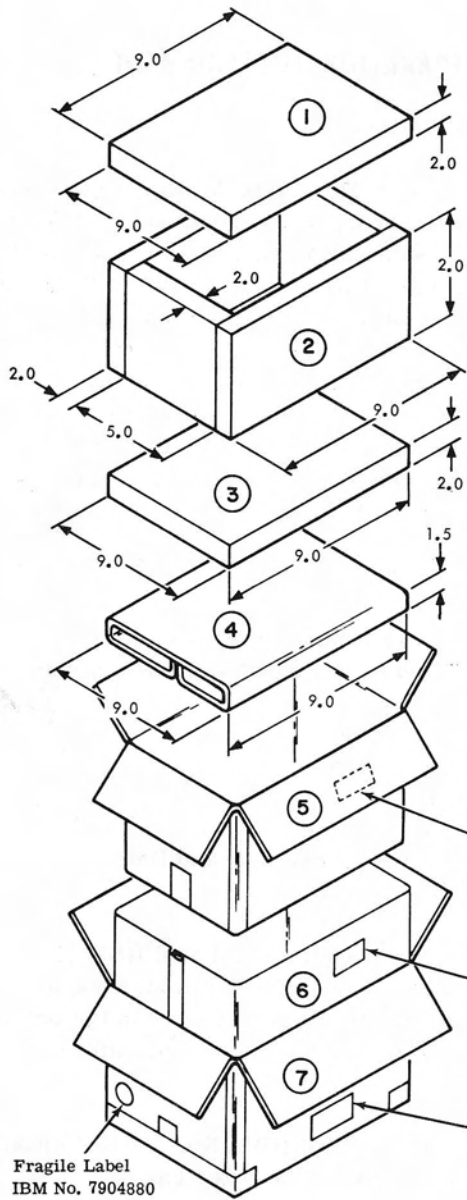
3-4 MARKING

Markings containing the following information shall be applied on the inner and outer cartons.

MSFC Number
Item Description
Quantity
Contract Number
Level of Preservation and Date
Serial Number

A Method IIb Process Label (IBM No. 7904879) shall be applied to the top of the water-vaporproof barrier bag after it has been placed in the outer carton. Make certain the packaging date is recorded on this label.

A Fragile Label (IBM No. 7904880) shall be applied to both ends of the outer carton.



- ④ Desiccant Pad
Material: 275 lb test "B" flute corrugated fiberboard.
- ⑤ Carton
Per PPP-B-636
Type 1, Class 1
Style: RSC
Material: 275 lb test "A" flute
IBM Stock No. 7904770
Inside Dimensions
Length: 9.0 inches
Width: 9.0 inches
Depth: 7.50 inches
- ⑥ Water-vaporproof Barrier Bag
Material: Mil-B-131G, Class 1
Style: Bag
Dimensions 20.0 x 22.0 inches
- ⑦ Carton
Per PPP-B-636
Type 1, Class 1
Style: RSC
Material: 275 lb test "A" flute
IBM Stock No. 7904770
Inside Dimensions
Length: 9.75 inches
Width: 9.75 inches
Depth: 9.25 inches

MSFC Number
Item Description
Quantity
Contract Number
Level of Preservation and Date
Serial Number

Method Iib Process Label
IBM No. 7904879

MSFC Number
Item Description
Quantity
Contract Number
Level of Preservation and Date
Serial Number

Method Iib: Use items 1 thru 7.
Method III: Use items 1 thru 5. Do not include the desiccant or the humidity indicator.

Items 1, 2, and 3 to be fabricated from polyurethane foam cushioning 4 lb/ft³ density.

Power Supply will be surrounded by cushioning provided by items 1, 2, and 3.

Place two, 8-unit bags of desiccant inside of the pad, item 4.

Inner carton, item 5, to be closed with pressure sensitive tape and corners are to be blunted so as not to damage barrier bag, item 6.

After inner carton has been inserted in barrier bag, place humidity indicator on top of inner carton. When barrier bag is sealed, the humidity indicator will be between inner carton and barrier bag. The barrier bag originally is heat sealed, however, when packaging a defective voltage supply, waterproof tape may be used.

After barrier bag has been inserted in outer carton, apply a Method Iib process label on top of the barrier bag. Record the packaging date on the label.

Outer carton, item 7, to be closed with 3-inch Kraft Tape.

Figure 3-1. Packaging Methods Iib and III for the 5 Volt Measuring Voltage Supply

SECTION IV

PREVENTIVE MAINTENANCE AND REPAIR

4-1 PREVENTIVE MAINTENANCE (Not Applicable)

4-2 REPAIR

All repairs on the 5 Volt Measuring Voltage Supply will be accomplished by component replacement. If failure analysis determines repair is possible, the component should be returned to the manufacturer for repair.

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