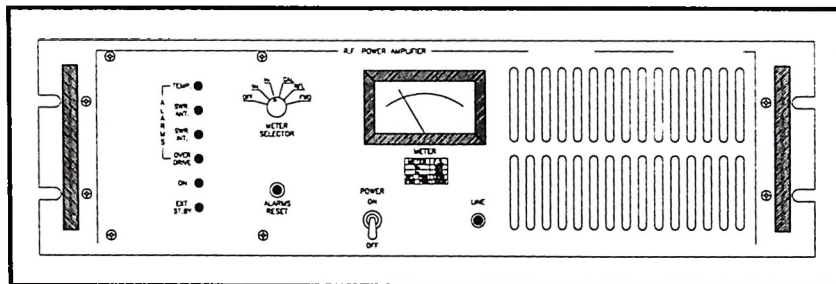


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# FM-500SC



## TECHNICAL AND MAINTENANCE MANUAL

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**PRELIMINARY INSTRUCTIONS AND WARRANTY INFORMATION**

Please observe safety precautions when handling this unit. This equipment contains dangerous currents and high voltages.

This manual is written as a general guide for those having previous knowledge and experience with this kind of equipment. It is not intended to contain a complete statement of all safety warnings which should be observed by personnel in using this or other electronic equipment.

Armstrong Transmitter Corporation does not assume responsibility for injury or damage resulting from improper procedures or practices by untrained/unqualified personnel in the handling of this unit. Please observe all local codes and fire protection standards in the operations of this unit.

**CAUTION:** Always disconnect power before opening covers or removing any part of this unit. Use appropriate grounding procedures to short out capacitors and high voltage points before servicing.

Any damage to the equipment must be reported to the carrier in writing on the shipment receipt.

Any discrepancy or damage discovered subsequent to delivery should be reported to Armstrong Transmitter Corp. within five (5) days from its receipt.

Armstrong Transmitter Corp. warrants this equipment against manufacturing defects for one year after purchase date.

Armstrong is not liable for any damage resulting in connection with the product or its use thereof.

Your warranty does not cover the following:

- 1) Freight charges to and from factory - Ship all equipment for repair prepaid and insured to the factory
- 2) Any unauthorized repair/modification
- 3) Incidental/consequential damages as a result of any defect
- 4) Nominal non-incidental defects
- 5) Re-shipment costs or insurance of the unit or replacement units/parts
- 6) Final tubes and transistors in the final stage of amps are covered by the manufacturer of such devices and NOT Armstrong Transmitter.

To claim your rights under this warranty:

- a. Contact the dealer or distributor where you purchased the unit. Describe the problem and ask if he has an easy solution. Dealers and Distributors are supplied with all the information about problems that may occur and usually they can repair the unit quicker than the manufacturer. Very often installing errors are discovered by dealers.
- b. If your dealer cannot help you, contact the technical staff at Armstrong and explain the problem. If it is decided to return the unit to the factory, Armstrong will issue you a regular authorization with all the necessary instructions to send back the goods.
- c. When you receive the authorization, you can return the unit. Pack it carefully for the shipment, preferably using the original packing and seal the package perfectly. The customer always assumes the risks of loss. Armstrong is NOT responsible for loss or damage of equipment in transit to factory. We suggest you to insure the goods for total value. Shipment must be C.I.F. (PREPAID) to factory.

**DO NOT RETURN UNITS WITHOUT OUR AUTHORIZATION AS THEY WILL BE REFUSED.**

Be sure to enclose a written technical report of all the problems found and a copy of your original invoice establishing the start date of the warranty. Replacement and warranty parts may be ordered from us directly. Be sure to include the equipment model and serial number as well as a part description and part number.

Armstrong Transmitter Corporation reserves the right to modify the design and specifications of the equipment in this manual without prior notice.

## WARNING!

The currents and voltages in this equipment are dangerous!  
Always observe proper safety rules and regulation!

This manual is intended as a general guide for trained and qualified personnel who are aware of the dangers inherent in handling potentially hazardous electrical and electronic circuits. It is not intended to contain a complete statement of all safety precautions which should be observed by personnel in using this or other electronic equipment.

The installation, operation, maintenance and service of this equipment involves risks both to personnel and equipment, and must be performed only by qualified personnel exercising due care.

ARMSTRONG TRANSMITTER CORPORATION is not responsible for injury or damage resulting from improper procedures or from the use of improperly trained or inexperienced personnel performing such tasks.

During installation and operation of this equipment, local building codes and fire protection standards must be observed.

## WARNING!

Always disconnect power before opening covers, doors, enclosures, gates, panels or shields.  
Always use grounding sticks and short out high voltage points before servicing. Never make internal adjustments, perform maintenance or service when alone or tired.

Do not remove, short-circuit or tamper with interlock switches on access covers, doors, enclosures, gates, panels or shields. Keep away from live circuits. Know your equipment and don't take chances.

## WARNING!

Disconnect power and discharge caps before servicing

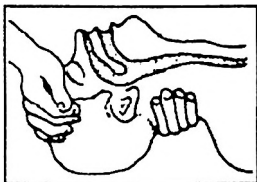


## Treatment of electrical Shock

1) If victim is not responsive follow the A-B-C's of basic life support.  
PLACE VICTIM FLAT ON HIS BACK ON A HARD SURFACE

### A AIRWAY

IF UNCONSCIOUS,  
OPEN AIRWAY



LIFT UP NECK,  
PUSH FOREHEAD BACK,  
CLEAR OUT MOUTH IF NECESSARY,  
OBSERVE FOR BREATHING

### B BREATHING

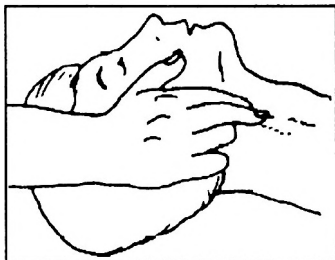
IF NOT BREATHING,  
BEGIN ARTIFICIAL  
BREATHING.



TILT HEAD,  
PINCH NOSTRILS,  
MAKE AIRTIGHT SEAL,  
4 QUICK FULL BREATHS.  
REMEMBER MOUTH TO MOUTH  
RESUSCITATION MUST BE  
COMMENCED AS SOON AS  
POSSIBLE.

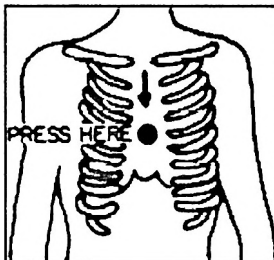
### C CIRCULATION

CHECK CAROTID PULSE



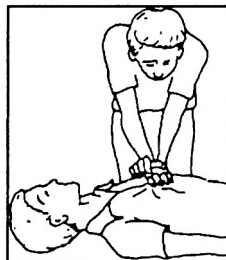
IF PULSE ABSENT,  
BEGIN ARTIFICIAL  
CIRCULATION

DEPRESS STERNUM 1 1/2" TO 2"



APPROX. 80 SEC. : ONE RESCUER, 15 COMPRESSIONS,  
2 QUICK BREATHS.

APPROX. 60 SEC. : TWO RESCUERS, 5 COMPRESSIONS,  
1 BREATH



NOTE: DO NOT INTERRUPT RHYTHM OF COMPRESSIONS  
WHEN SECOND PERSON IS GIVING BREATH.

**Call for medical assistance as soon as possible.**

2) If victim is responsive:

- a. Keep them warm.
- b. Keep them as quiet as possible.
- c. Loosen their clothing (a reclining position is recommended).

# FIRST-AID

Personnel engaged in the installation, operation, maintenance or servicing of this equipment are urged to become familiar with first-aid theory and practices. The following information is not intended to be a complete first-aid procedure. It is brief and is only to be used as a reference. It is the duty of all personnel using the equipment to be prepared to give adequate Emergency First Aid and thereby prevent avoidable loss of life.

## Treatment of electrical burns

- 1) Extensive burned and broken skin.
  - a. Cover area with clean sheet or cloth.  
(Clean available cloth article).
  - b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply any salve or ointment.
  - c. Treat victim for shock as required.
  - d. Arrange transportation to a hospital as quickly as possible
  - e. If arms or legs are affected keep them elevated.

## NOTE

If medical help will not be available within an hour and the victim is conscious and not vomiting, give him a weak solution of salt and soda: 1 level teaspoonful of salt and 1/2 level teaspoonful of baking soda to each quart of water (neither hot or cold).

Allow victim to sip slowly about 4 ounces (half a glass) over a period of 15 minutes.

Discontinue fluid if vomiting occurs (Do not give alcohol).

- 2) Less severe burns - (1st & 2nd degree)
  - a. Apply cool (not ice cold) compresses using the cleansed available cloth article.
  - b. Do not break blisters, remove tissue, remove adhered particles of clothing, or apply salve or ointment.
  - c. Apply clean, dry dressing if necessary.
  - d. Treat victim for shock as required.
  - e. Arrange transportation to a hospital as quickly as possible.
  - f. If arms or legs are affected, keep them elevated.

## SECTION 1

# GENERAL DESCRIPTION

### 1.1 EXTERNAL DESCRIPTION

The FM -500SC is housed in a 3U nineteen-inch rack. Each single module is wired with connectors allowing easy servicing and replacement. On the front panel, the alarm indicators are placed on the left. The main switch and the meter for the principal parameters are in a central position.

On the rear panel, the RF INPUT and RF OUTPUT connectors are located, together with the telemetry connector, the RF output test connector (directional coupler), the main socket, the fuses, and an auxiliary main line output for exciters of a different design and make.

### 1.2 ELECTRICAL DESCRIPTION

FM-500SC is a MOSFET power amplifier working on the 87.5-108 MHz band with an output power in excess of 500W and a drive level of about 16W. This amplifier uses two RF modules able to deliver more than 300W each, with one high efficiency switching power supply.

A built in low-pass filter suppresses the harmonic content below the FCC and CCIR requirements. A system protects the amplifier against thermal problems, excessive input drive power and excessive SWR inside the amplifier or along the feeder. This system provides an automatic reset to initial conditions when the overload condition clears up.

### 1.3 METERS AND INDICATORS

The principal parameters of the amplifier are read by the analog multimeter (9 Fig.1) and selected by the rotary switch (8 Fig.1) on the front panel. On the front panel are two different sections of LED indicators.

In the first section there are four red overload LEDs (Temp., SWR. Ant., SWR. Int., Over Drive), one green LED to signal the On/Off status and one yellow LED for an External Stand By. In the second section there are two green LEDs to signal each single RF power amplifier module fuse status.

### 1.4 AUTOMATIC GAIN CONTROL

This amplifier is a high gain power amplifier. Without preamplifiers it provides an output power of 500W with a drive of only 8W. A power limiter stabilizes the output power against input drive fluctuations.

## 1.5 PROTECTION CIRCUITS

The protection circuits set the amplifier in stand-by in case of a fault condition. After 10 seconds, the protection reactivates the amplifier if the fault has disappeared. If not, this process is repeated 4 times and then the amplifier stays disabled for 90 seconds. After 90 seconds, if the trouble persists, the protection performs four more cycles and then disables the amplifier indefinitely. If, during these cycles the anomaly disappears and the amplifier works regularly for more than 90 seconds, the counting system is reset and the original conditions established (NOTE: The intervals described are indicative).

The protection circuits monitor for excessive SWR, over-temperature and overdrive. The circuits indicate the problem with warning lights and disable the pilot exciter.

## 1.6 RF AMPLIFIERS

The amplifier employs two broadband modules with 50 Ohm input/output impedance. The output power of each module is 300W with 4-5W of drive.

## 1.7 DEVICE SPECIFICATIONS

Refer to Table A for electrical specifications, and to Table B for dimensional and environmental specifications.

TABLE A  
**TECHNICAL SPECIFICATIONS**

AC Supply	100-130 V, 50-60Hz 198-250 V, 50-60 Hz
Cooling	Forced Ventilation
Frequency Range	from 87.5 to 108 MHz
Power Output	500 W
RF Drive Power	approximately 8W for P out=500W
RF Input Connector	Standard "N" type connector
RF Input Impedance	50 Ohm
RF Output Connector	Standard "N" type connector
RF Output Impedance	50 Ohm
Spurious & Harmonic Suppression	meets or exceeds all FCC and CCIR requirements

TABLE B  
**DIMENSIONAL AND ENVIRONMENTAL SPECIFICATIONS**

Cabinet Dimension	129.0 mm (5.07") H 445.0 mm (17.52") W 504.0 mm (19.84") D
Panel Size	483.0 mm (19") W 132.5 mm (5.22") H
Operating Temperature	-10°C to 50°C
Humidity	95% Max, Non Condensing
Weight	30Kg (66 lbs)

## SECTION 2

# ELECTRICAL DESCRIPTION

This section describes the overall working theory of FM-500SC. The amplifier description is subdivided into subassemblies that will be discussed in detail below. The block diagram is illustrated in Fig.3.

### 2.1 POWER SUPPLY

The power supply is housed in the left side of the amplifier as shown in Photo 1. The Switching Power Supply is mounted on a heatsink that allows cooling through forced ventilation. Housed inside the FM-500SC are two transformers. All transformers have a selectable input for voltages between 110 and 240 Volts.

The first has one output, 61-0-61 Volts, for the Switching Power Supply. The second has three outputs: A 18-0-18 Volt, B 0-15 Volt, C 0-15 V. The output A drives the Alarms Card and the Soft Start Card. The outputs B and C supply the Control Section of the Switching Power Supply.

Inside the Alarms Card, a rectifying and stabilization circuit provides the +15 and -15 Volt needed by the electronics. The 50Volt switchers regulate the RF output power using voltage detected by a directional coupler mounted on the low-pass filter output.

### 2.2 RF POWER AMPLIFIER

The RF power amplifier section is composed of the two power modules coupled with a Wilkinson Splitter and Combiner realized with "Strip Line Technology." The four RF modules, splitter card and combiner cards are housed in the top side of the equipment. All of the RF section is mounted on a heatsink that allows cooling through forced ventilation. Every module delivers 300W with 4-6W of drive and is supplied by a switching power supply.

The quiescent parameters of each module are:

$$V_{DC}=50V \quad V_{gs}=3.5V \quad I_{dq}=200mA$$

The active device employed is a MOSFET (BLF278).

### 2.3 WILKINSON SPLITTER AND COMBINER

The Wilkinson Splitter and Combiner are realized with "Strip-Line Technology." The Splitter Card is used to split the driving power of each RF power amplifier module. The Combiner Card is used to combine the output power of each RF Power Amplifier module.

These two circuits insure equal phases on the input and output power of each RF Power Amplifier module. A power resistor placed on each circuit is used to absorb any unbalanced power in case of a fault.

## 2.4 BIAS CARD

This card controls, and if necessary, corrects the polarization current of each single MOSFET of the RF section.

## 2.5 ALARMS CARD

This card is housed on the front panel, at left, as showed in Photo 1. On this board, the electronics detect any system anomaly such as excessive SWR, internal or antenna; over-temperature, etc. This module will also, whenever possible, reset the system to its original conditions after a fault is cleared.

## 2.6 TELEMETRY TERMINALS

The telemetry connector (11 Fig.2) is placed on the rear panel in the right side as shown in Fig.2. This connector provides the essential parameters of the amplifier for remote measurement and control purposes.

SIGNAL	PIN N°	VOLTAGE LEVEL
OFF	1	N.C.
Power Amplifier Current	2	2.0V for 20A
Reflected Power	4	1.4V for 100W
Inhibit Tx	5	12V
Internal SWR	6	15V when fault
Operate	8	15V
Power Amplifier Voltage	14	2.0V for 50V
Calibration	15	2.0V for f.s.
Forward Power	16	1.6V for 1000W
Temperature	17	15V when fault
Antenna SWR	18	15V when fault
Over Drive	19	15V when fault
Stand By	20	15V
Ground	3,7,21	0V

The other pins are not used.

## 2.7 SOFT START

The soft start is mounted on a board placed on the left side of the amplifier in the position shown in Photo 1. This circuit eliminates the current spikes generated by the transformer when it is powered up.

## 2.8 LOW-PASS FILTER

This filter is housed in the right side of the equipment as shown in Photo 1. The low-pass filter and RF sections are mounted on a heatsink that allows cooling through forced ventilation. This low-pass filter reduces the harmonic suppression below 80 dB.



## FRONT PANEL VIEW DESCRIPTION (FIG. 1)

1	EXT. ST. BY	LED indicating an External Stand-By
2	ON	AC ON Power indicator
3	ALARMS RESET	Press to reset the alarm status
4	ON/OFF POWER	On/Off Power Switch
5	LINE	AC Line Indicator
6	AIR GRID	Air Grid for forced ventilation
7	ALARMS	LED indicating the FM-500SC's alarms status
8	METER SELECTOR	Selector to monitor operating parameters: OFF            Not Used PA V          FM-500SC Voltage PA I          FM-500SC Current CAL          Calibration RFL          Reflected Power FWD          Forward Power
10	METER	Analog meter used to monitor the operating parameters of the amplifier

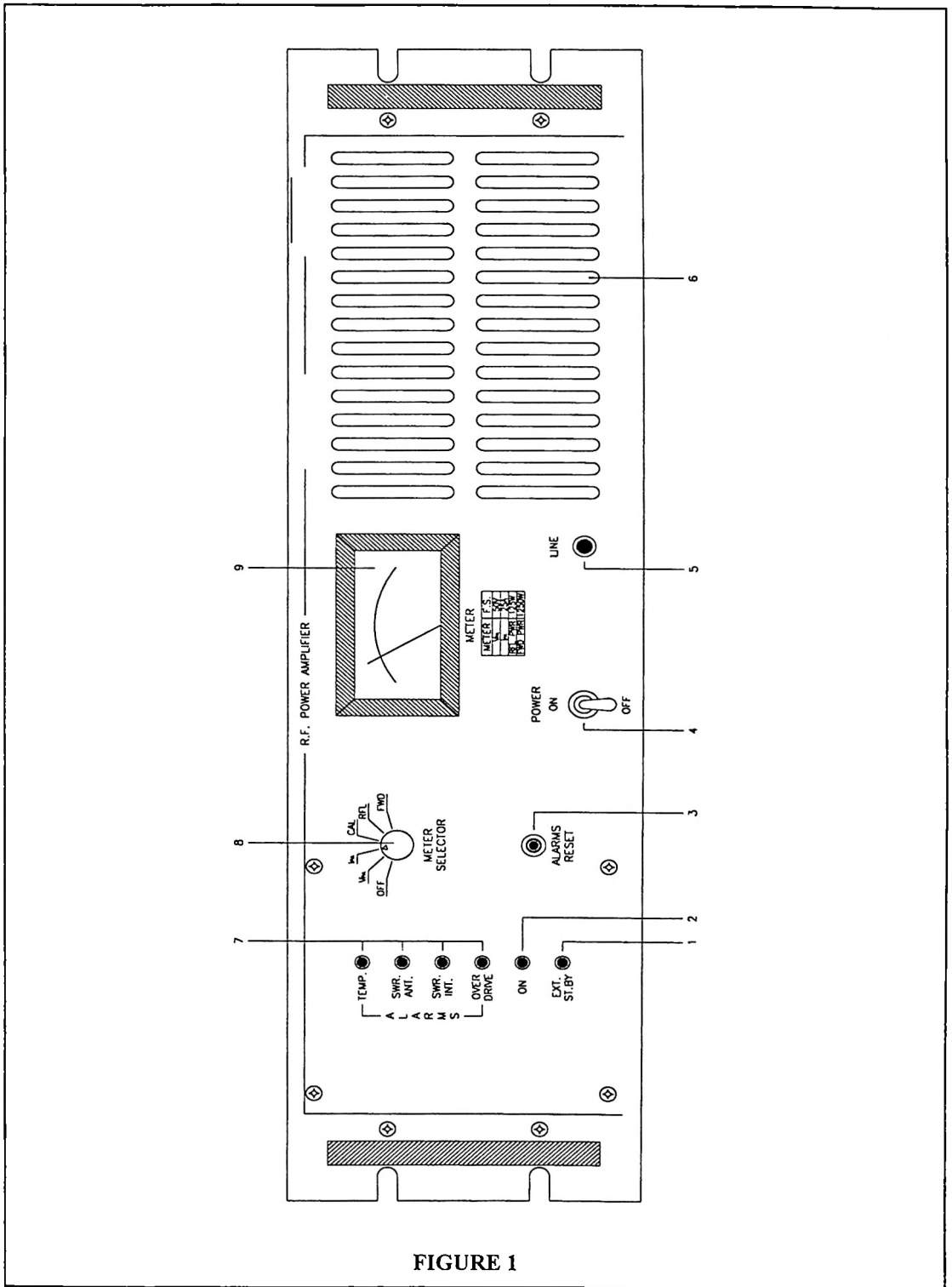


FIGURE 1

## REAR PANEL VIEW DESCRIPTION (FIG. 2)

1	FAN	Fan for Forced Ventilation						
2	FAN	Fan for Forced Ventilation						
3	AUX. OUT. AC LINE FUSE	Auxiliary Output AC Line Fuse						
4	AC LINE FUSE	AC Line Protection Fuse						
5	MODULE RF FUSE	Protection Fuse for Module RF						
6	MAIN VOLTAGE SOCKET	Main Voltage Socket						
7	VOLTAGE CHANGER	Main Voltage Changer & Service Voltage Changer: <table><thead><tr><th><u>Voltage</u></th><th><u>Jumper</u></th></tr></thead><tbody><tr><td>110 Vac</td><td>1-2 / 3-4</td></tr><tr><td>220 Vac</td><td>2-3</td></tr></tbody></table>	<u>Voltage</u>	<u>Jumper</u>	110 Vac	1-2 / 3-4	220 Vac	2-3
<u>Voltage</u>	<u>Jumper</u>							
110 Vac	1-2 / 3-4							
220 Vac	2-3							
8	RF OUTPUT	Output RF connector ("N" type)						
9	RF TEST -60dB	-60dB with respect to the Output Level						
10	AUX. OUT. AC LINE	Auxiliary Output AC Line						
11	TELEMETRY CONNECTOR	Connector for remote measurement of operating parameters						
12	ALARMS/INTERLOCK	BNC connector which permits the exciter to be put in stand-by (by grounding the center contact) in case of amplifier overload						
13	RF INPUT	Input RF connector ("N" type)						

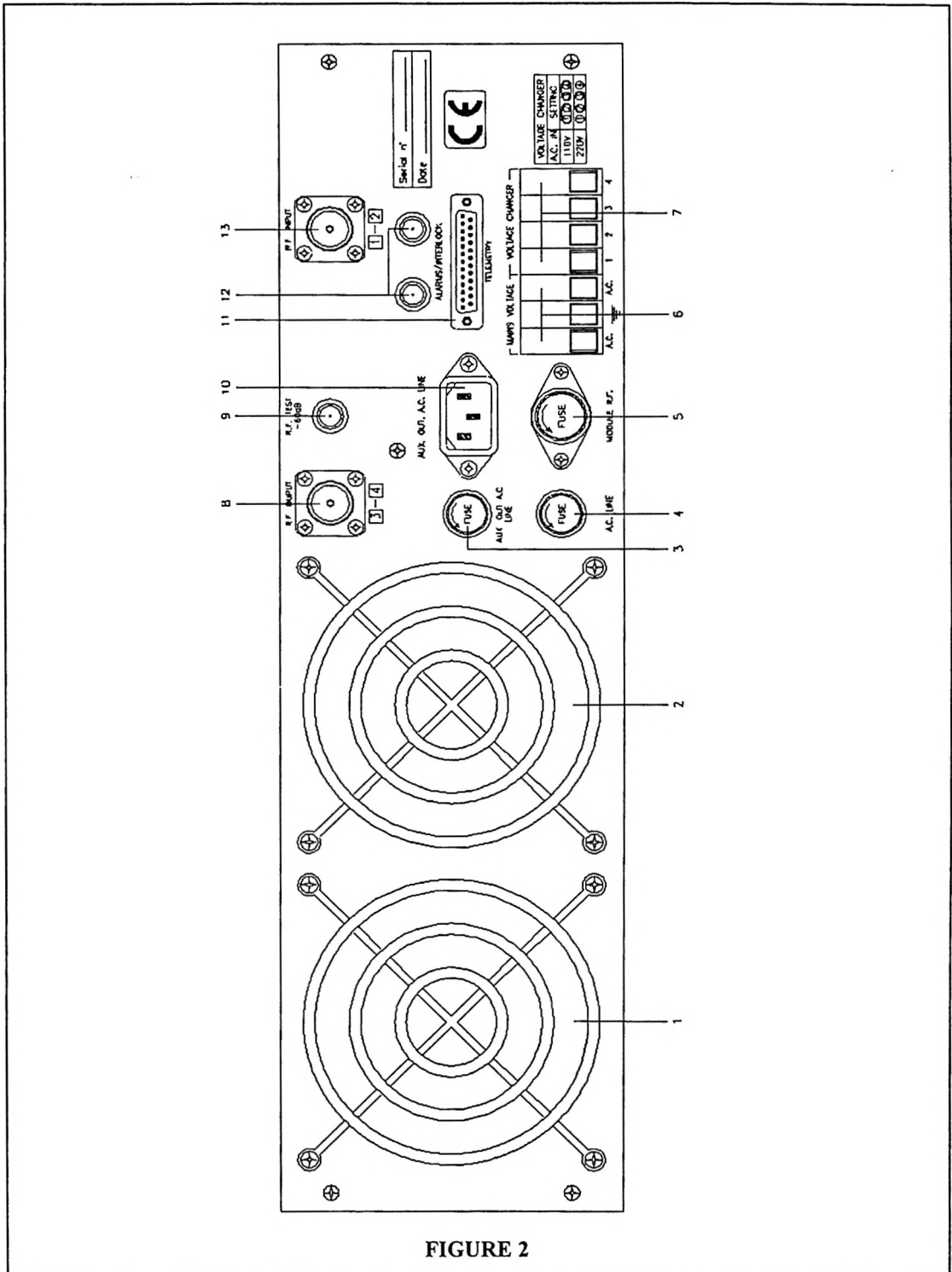
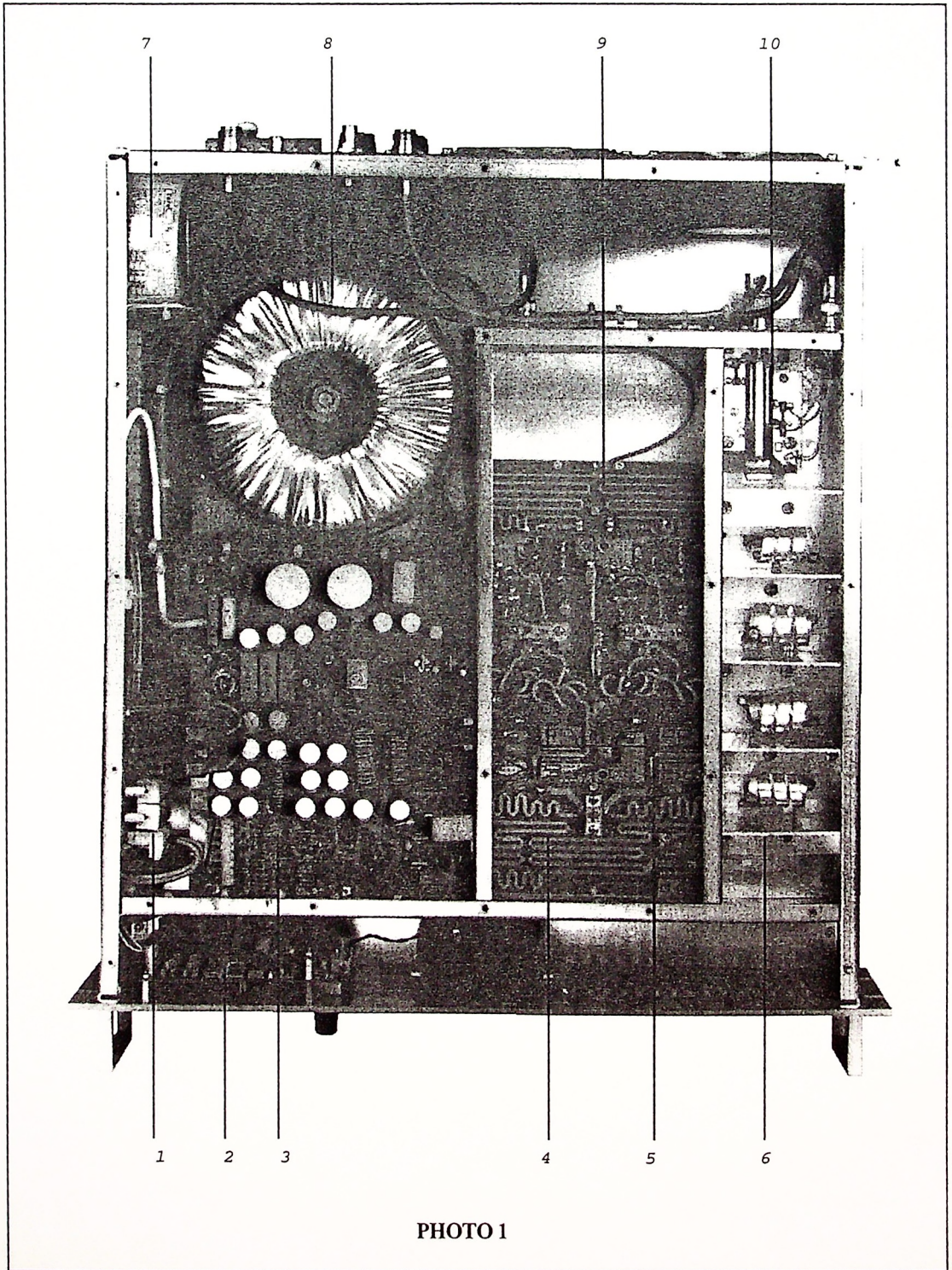


FIGURE 2

## TOP VIEW DESCRIPTION (PHOTO 1)

- |    |       |                                 |
|----|-------|---------------------------------|
| 1  | ..... | Soft Start Card                 |
| 2  | ..... | Alarms Card                     |
| 3  | ..... | Switching Power Supply          |
| 4  | ..... | Wilkinson "2-Way" Power Coupler |
| 5  | ..... | RF Modules                      |
| 6  | ..... | Low-Pass Filter                 |
| 7  | ..... | Service Transformer             |
| 8  | ..... | Main Transformer                |
| 9  | ..... | Wilkinson "2-Way" Power Divider |
| 10 | ..... | Directional Coupler             |



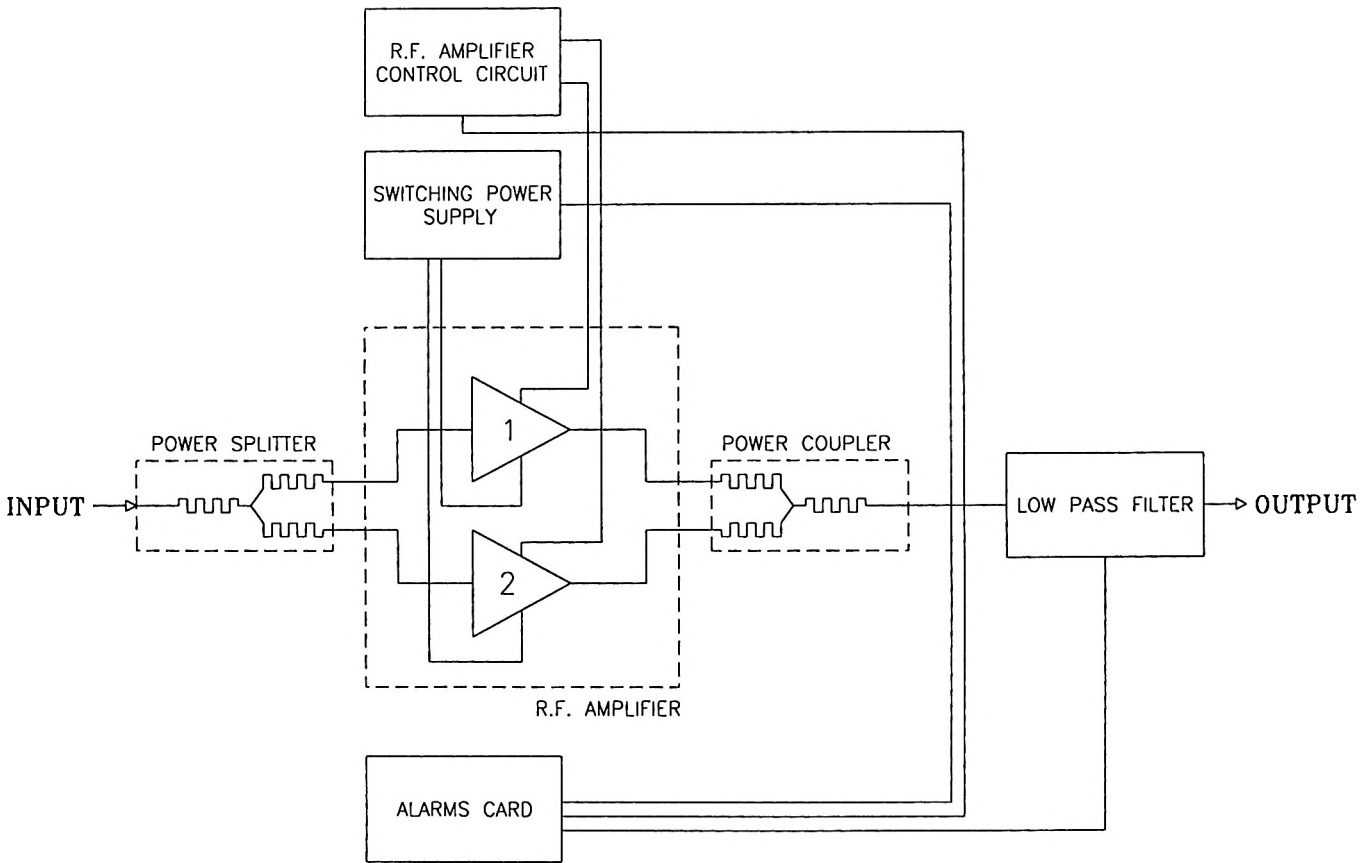
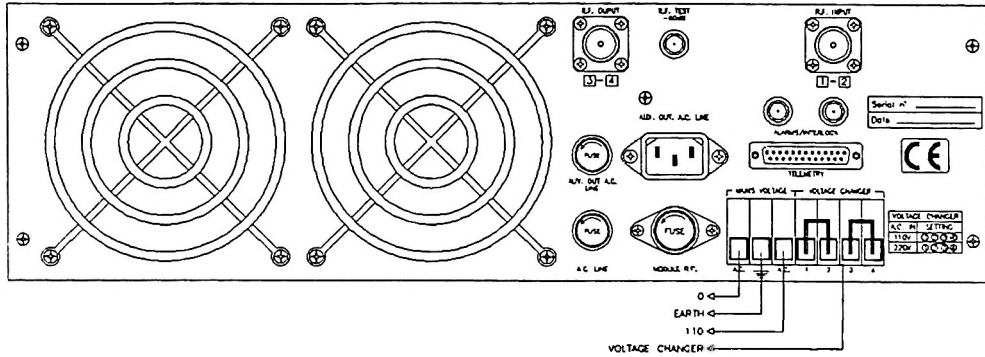


FIGURE 3

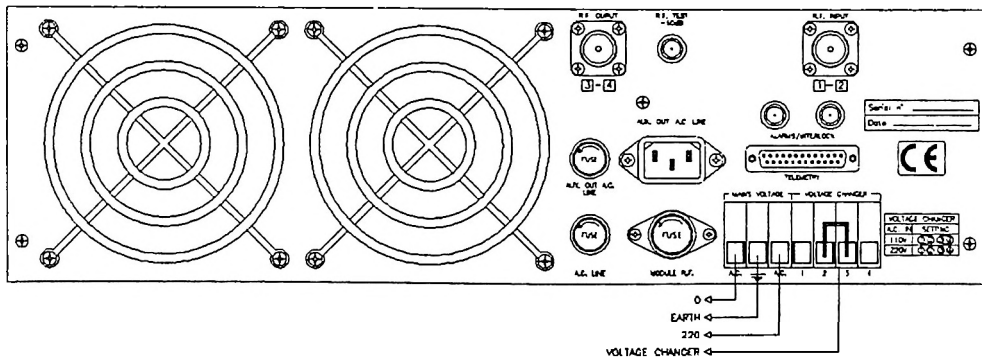
TABLE C  
**RECOMMENDED TEST EQUIPMENT**

INSTRUMENT	MODEL	SPECIFICATIONS
Oil Dielectric Loads	Bird Mod. 8251	Power Rating 1000W continuous Impedance 50 Ohms nominal
Truline RF Power Analyst	Bird Mod. 4391	Power Range 100mW to 10KW Freq. Range 0.45 to 2300MHz
Plug-In-Elements	Bird Mod. 100B	Power Rating 100W Freq. Range 50 to 125MHz
Plug-In-Elements	Bird Mod. 1000B	Power Rating 1000W Freq. Range 50 to 125MHz
Spectrum Analyzer	H.P. Mod. 8591E	9KHz-1.8GHz
Network Analyzer	H.P. Mod. 8753A	300KHz-3.0GHz
S-Parameter Test Set	H.P. Mod. 85046A	300KHz-3.0GHz
Digital Multimeter	Fluke Mod. 73	
Electronic Load Resistor	ARMSTRONG	Min. Work Voltage: 50Vdc Min. Work Current: 20A





100VAC - 130VAC



198VAC - 250VAC

VOLTAGE SETTINGS

**TABLE D**  
**PROTECTION FUSE TABLE**

MAIN VOLTAGE 198-250V

REFERENCE	CURRENT	SIZE	TYPE
AUX OUT A CLINE	6A	6.3x32	FAST
RF Module	25A	10x38	FAST
A CLINE	10A	6.3x32	NORMAL

MAIN VOLTAGE 100-130V

REFERENCE	CURRENT	SIZE	TYPE
AUX. OUT A CLINE	6A	6.3x32	FAST
RF Module	25A	10x38	FAST
A CLINE	16A	6.3x32	NORMAL

## SECTION 3

# INSTALLATION OPERATIONS

### 3.1 INTRODUCTION

This chapter contains necessary information for the preliminary checks and installation of the FM-500SC.

### 3.2 UNPACKING

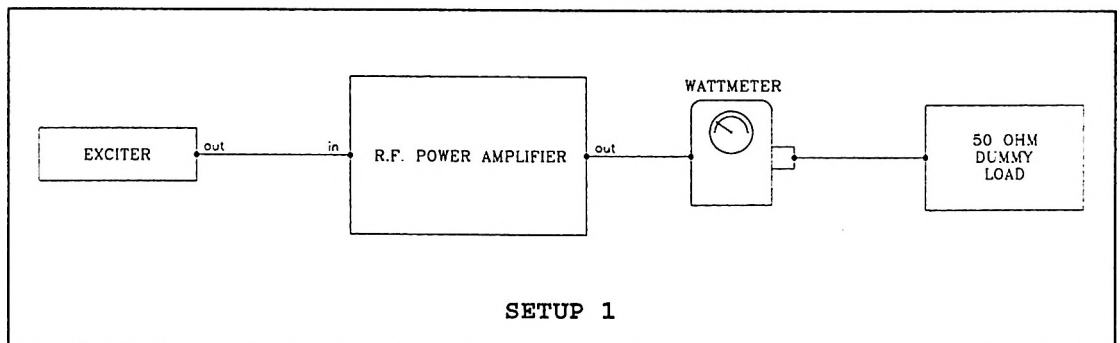
Unpack the amplifier and, before any other operation, check that the amplifier is not damaged and that all controls on the front and rear panel are in good condition.

### 3.3 INSTALLATION

- 1) On the rear panel check the setting of the main voltage selector for the proper value. Connect the main cable by screwing in the three headers (2 Fig.2).

NOTE For 110V supply, use a cable with at least 25Amp capacity. For 220V supply, use a cable of at least 16 Amp capacity.

- 2) Leave the main switch in the off position (4 Fig.1).
- 3) Check the AC line fuse for the proper value (5 Fig.2) 16A for 220V supply or 25A for 110V supply.



- 4) See SETUP 1. Connect a dummy load with a 500W power rating at 50 Ohm to the RF output connector (8 Fig.2) with a through wattmeter.
- 5) Switch on the main switch and check that the proper LED is on.

- 6) Select with the meter selector (8 Fig. 1) the power amplifier supply voltage ( $V_{pa}$ ) and check the value of 50Vdc power supply. Select the current "PA I" and check the value (approx. 800mA). In the same way, check that FWD and RFL powers are zero.
- 7) Connect to the RF input connector (13 Fig. 2) to an exciter able to deliver a power of between 0 and 30W.
- 8) Connect the Alarms interlock connector (12 Fig. 2) to the appropriate connector of the exciter.
- 9) Switch on the exciter with the output power set to the minimum value. Tune the exciter to operating frequency and wait for the PLL to lock. Then gradually raise the output power of the exciter. Verify the increase in the output power. Simultaneously monitor the current of PA I. They should increase proportionally. Continue this operation until a 500W output value is obtained. At this point, the working parameters are:  
 $V_1 = V_2 = V_{pa} = \text{about } 50V$   
 $I_{pa} = \text{about } 18A \text{ (typ.)}$
- 10) Check the reading of the internal wattmeter with that of the external one (a discrepancy of about 10% is tolerable).
- 11) With the amplifier at full power, push and hold the reset switch, and check that output power, PA V and PA I go to zero. The output power of the exciter goes to zero, too. Release the switch and all the previous parameters will go back to their original values.
- 12) Increase the drive power until the Over Drive LED lights. At this point, the overload condition should disable the amplifier and exciter for about 10 sec., after which the amplifier will try to restart. If the drive power setting has not changed, another overload condition will occur. Otherwise, the amplifier will restart normally. In the case of another lock condition, the protection circuit will make 4 attempts at a restart. Should this fail, the amplifier will wait for longer periods and make 4 more attempts. Should this not be successful, the amplifier will remain disabled indefinitely.

## SECTION 4

# MAINTENANCE

This section provides general maintenance information and electrical adjustment procedures for the FM-500SC Amplifier.

### 4.1 SAFETY CONSIDERATIONS

WARNING! WARNING! WARNING! WARNING! WARNING! WARNING! WARNING!

When the amplifier is operated with the top cover removed, hazardous voltages are accessible on the AC line voltage selector. Heavy currents are accessible on the exposed terminals of the power supply filter capacitor and power transistors mounted on the RF amplifier heatsink assembly. Use the insulated tuning tool provided for any adjustment. Do not touch any component within the amplifier when power is applied. Ensure all primary power is disconnected from the amplifier before attempting equipment maintenance.

### LEVEL I MAINTENANCE

#### 4.2 ORDINARY MAINTENANCE

The only regular maintenance needed by FM-500SC is the periodic replacement of the blowers, the cleaning of dust filters, and any dust removal inside the amplifier. The time between overhauling of the blowers depends upon several environmental factors including: temperature, humidity, dust pollution, etc. Blowers should be checked every 6 months and replaced if noisy. They should be replaced after 18-24 months of service.

### SECOND LEVEL MAINTENANCE

#### 4.3 CARDS SUBSTITUTION

This section contains useful information for card replacement.

WARNING! TO RE-INSTALL THE CARDS, EXECUTE OPERATION SEQUENCE IN THE OPPOSITE ORDER OF REMOVAL.

#### 4.4 POWER SUPPLY REPLACEMENT

- 1) Open the top cover.
- 2) Take note of the cable position inside the terminal boards J1, J2, J3, J4, J5, J6.

- 3) Disconnect the external terminal boards by loosening the screws of the connectors mounted on the board.
- 4) Remove the nine screws that attach the power supply to the heatsink.
- 5) Carefully remove the power supply

#### **4.5 RF POWER AMPLIFIER MODULE REPLACEMENT**

- 1) Open the top cover.
- 2) Take note of the wiring.
- 3) Disconnect all cables (Supply, Gain Control, Input RF and Output RF).
- 4) Remove the five screws that attach the RF power amplifier module to the heatsink.
- 5) Carefully remove the RF power amplifier module.

#### **4.6 WILKINSON SPLITTER CARD**

- 1) Open the top cover.
- 2) Unsolder the wire that connects the input of the splitter to the RF input connector of RF section.
- 3) Unsolder the two wires that connect the four outputs of the splitter to the inputs of RF power amplifier modules.
- 4) Remove the screw that fixes the card to the heatsink.
- 5) Carefully extract the card.

#### **4.7 WILKINSON COMBINER CARD**

- 1) Open the top cover.
- 2) Unsolder the wire that connects the output of the combiner to the low-pass filter.
- 3) Unsolder the two wires that connect the four inputs of the combiner to the outputs of RF power amplifier modules.
- 4) Take note of the wiring of the directional coupler.
- 5) Unsolder the three wires of the directional coupler.
- 6) Remove the screws that fix the four power resistors to the heatsink.
- 7) Remove the screws that fix the combiner card to the heatsink.
- 8) Carefully extract the card.

#### **4.8 DIRECTIONAL COUPLER CARD REPLACEMENT**

- 1) Open the top cover.
- 2) Take note of the wiring.
- 3) Unsolder the wires of the directional coupler.
- 4) Unsolder the wire connecting the directional coupler card to RF output connector.
- 5) Unsolder the wire connecting the directional coupler card to low-pass filter output.
- 6) Remove the four screws that fix the directional coupler card to the hex standoffs and remove the board.

#### 4.9 SOFT START REPLACEMENT

- 1) Open the top cover.
- 2) Disconnect Soft-Start connectors M1 and M2.
- 3) Disconnect the fastener placed on pin 6 and on relay K1.
- 4) Remove the four securing screws and remove the board.

#### 4.10 ALARM CARD REPLACEMENT

- 1) Open the top cover.
- 2) Remove the meter selector knob by loosening the screw inside the knob.
- 3) Remove the screws of the meter selector switch and Alarms Reset push-button.
- 4) Disconnect the CN1 and CN3 alarm card connectors.
- 5) Disconnect the CN2 telemetry card connector.
- 6) Remove the screws securing the board to the front panel.
- 7) Carefully extract the card.

#### 4.11 BIAS CARD REPLACEMENT

- 1) Open the top cover.
- 2) Take note of the wiring.
- 3) Disconnect all bias card connectors.
- 4) Remove the screw that holds the bias control card.
- 5) Carefully extract the card.

## SECTION 5

### INTERNAL ADJUSTMENTS

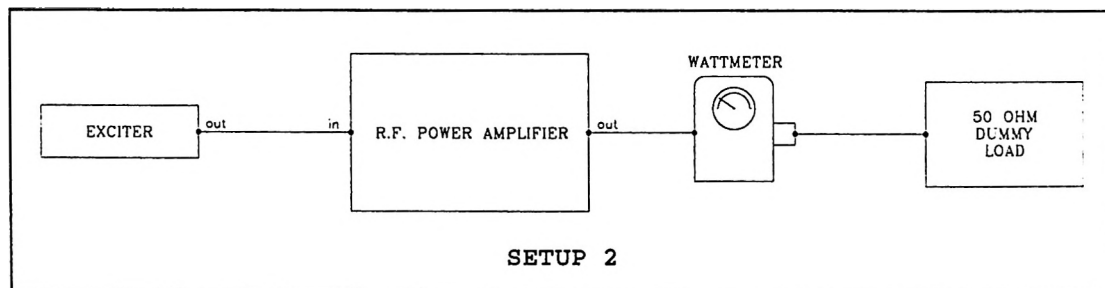
#### 5.1 POWER SUPPLY ADJUSTMENT

After changing the power supply module and joining all the connectors, make the following tests and adjustments:

- 1) Disconnect the cable from the Switching Power Supply to the RF section.
- 2) Connect a dummy load (50 Ohm, P>500W) to the amplifier output.
- 3) Switch on the amplifier.
- 4) Check the 50V output of the new power supply using an analog meter and selecting the appropriate reading with the meter selector switch. Confirm the output voltage with a digital multimeter connected to pins 1-2 and 3-4 of the J3 power supply connector. If needed, adjust the value with R79.
- 5) Verify that the test point TP2 has a voltage of 1.6V. If this value is different, adjust R71 to obtain the correct voltage.

#### 5.2 RF POWER AMPLIFIER ADJUSTMENT

After you have changed the module and you have reconnected all cables, perform the following operations:



- 1) See SETUP 2. Connect a dummy load to the RF output connector (8 Fig.2) with a through watt meter in series.
- 2) Connect the RF input connector (13 Fig.2) to an exciter with a power of between 10 and 30W.
- 3) Connect the Alarms/Interlock (12 Fig.2) to the appropriate connector on the exciter.
- 4) Set the output power of the exciter to its minimum value.
- 5) Switch on the FM-500SC and the exciter and wait for the PLL to lock.
- 6) Slowly increase the drive checking that the output power rises progressively, with an increase of PA I current.

**NOTE:** with  $P_{out}=500W$  we have  $4.5W < P_{in} < 6W$  and  $15A < I_{pa} < 18A$



Some dissimilarities in the currents drawn are related to the gains of the MOSFET devices (BLF 278) and must be compensated with the trimmers R15 placed on each RF power amplifier board. The trimmer to be adjusted will be the one related to the RF module that has a higher current consumption. This one must be adjusted turning it counterclockwise to obtain the same current consumption in each RF module. Differences of less than 800mA between the four modules are acceptable.

### 5.3 WILKINSON SPLITTER CARD ADJUSTMENT

No adjustments are required on this module.

*Be very careful to correctly reconnect the splitter card, since incorrect connections will destroy the RF power modules.*

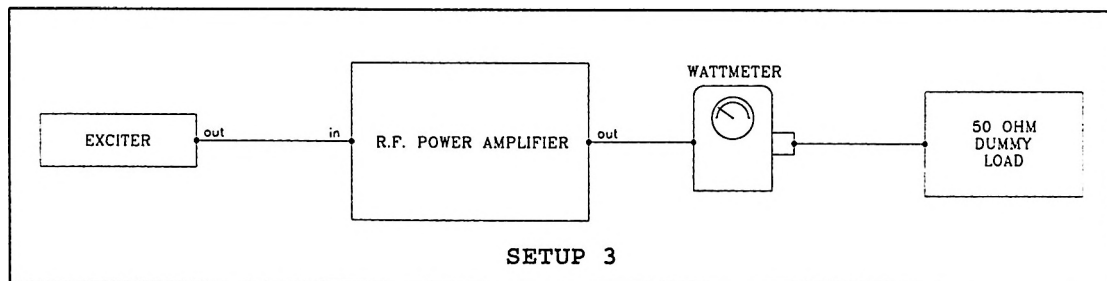
### 5.4 WILKINSON COMBINER CARD ADJUSTMENT

No adjustments are required on this module.

*Be very careful to correctly reconnect the splitter card, since incorrect connections will destroy the RF power modules.*

### 5.5 AGC CONTROL ADJUSTMENT

After you have changed the directional coupler card or the low-pass filter, perform the following operations.



- 1) See SETUP 3. Connect a dummy load to the RF Output Connector (8 Fig.2) with a through wattmeter in series.
- 2) Connect an exciter able to deliver a power of between 0 and 30W to the RF Input connector (13 Fig.2).
- 3) Connect the Alarms/Interlock connect (12 Fig.2) to the appropriate connector on the exciter.
- 4) Turn the AGC Control trimmer TR1 completely counterclockwise.
- 5) Set the output power of the exciter to its minimum value.
- 6) Switch on the amplifier FM- 500SC and the exciter and wait for the PLL to lock.
- 7) Slowly increase the drive power to obtain 500W of output power.
- 8) Adjust the AGC Control trimmer TR1 until you obtain a slight output power drop in the FM-500SC amplifier.

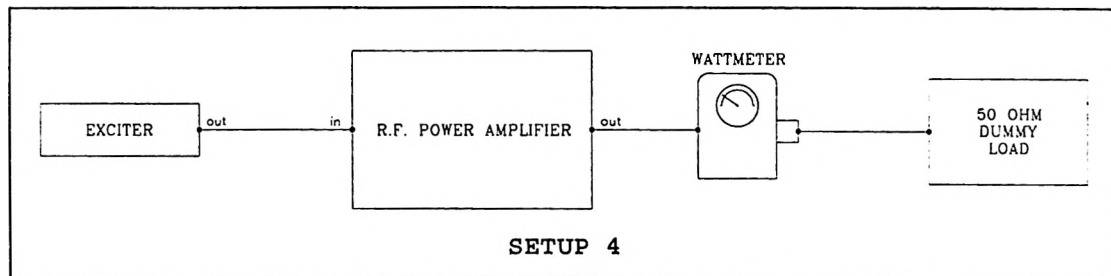
This power drop indicates that the power limit system is activated.

- 9) Now increase the drive until V PA decreases and the lock condition of the amplifier results due to the Over-Drive Protection. This protection is adjustable by means of trimpot R26 on the Alarms Card. This protection must activate when PA V voltage is at about 48VDC.
- 10) Verify that the readings on the internal wattmeter (9 Fig. 1) for an output power of 500W and the external wattmeter coincide (If not, adjust R11 on the Alarms Card).

### 5.6 ALARMS CARD ADJUSTMENT

NOTE: Make sure that this replacement is really necessary.

- 1) After changing the board, connect the amplifier as shown in the SETUP 4 schematic.

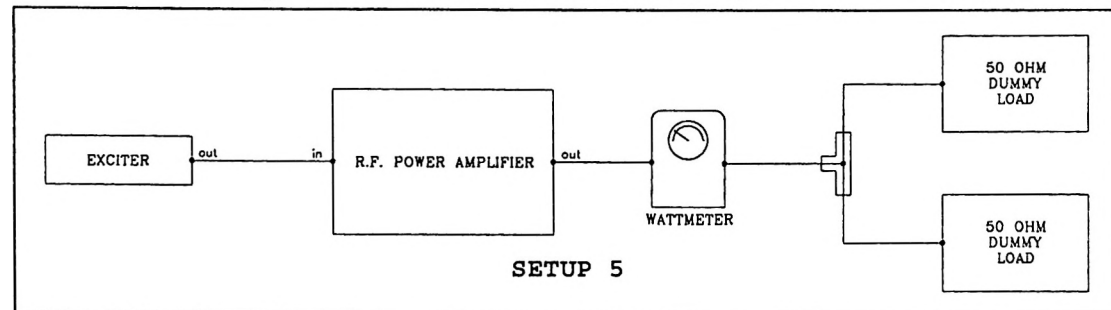


- 2) Switch on FM-500SC.
- 3) Place the meter selector on PA V.
- 4) Adjust trimpot R14 to obtain an FSD reading of 50V (check that the output voltage of the power supply is really 50V).
- 5) Switch on the exciter and wait for PLL lock.
- 6) Increase the output power to a level of 500W.
- 7) Adjust the FWD reading with trimpot R11.
- 8) Adjust the Over Drive trip point as indicated in step 9 of "AGC Control" adjustment.

NOTE: If the low pass filter and directional coupler card has not been changed, don't move "AGC Control" trimmer TR1.

### 9) INTERNAL SWR CALIBRATION (SWR INT.)

- 9A) Reduce the drive power to the minimum value. Switch off the amplifier and the exciter.
- 9B) Connect two paralleled dummy loads to the RF output connector of the amplifier as in schematic SETUP 5.
- 9C) Switch on the amplifier and the exciter and wait for the PLL to lock.

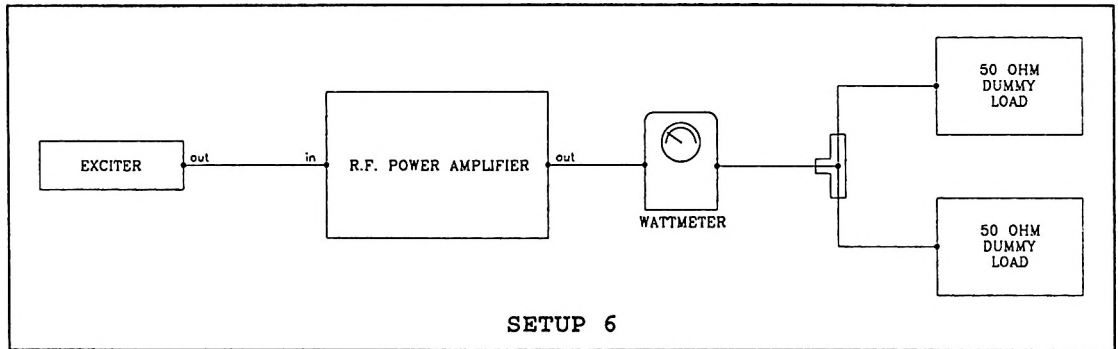


- 9D) Select RFL with the meter selector, and set the external wattmeter for reflected power reading.
- 9E) Increase the output power to obtain a reading of 50W RFL on the external wattmeter. Now adjust trimpot R40 on the alarms card until the SWR-INT protection is activated.
- 9F) With a voltmeter, measure the voltage on the central pin of R40 or U2A pin 2 or U1D pin 13. Multiply this value by 2 and adjust R40 to obtain this new value.

NOTE: This setting may vary with the working frequency. It's preferable to make this adjustment at the operating frequency.

10) ANTENNA SWR CALIBRATION (SWR ANT.)

- 10A) Reduce the drive power to the minimum value. Switch off the amplifier and the exciter.
- 10B) Connect two paralleled dummy loads to the RF Output connector of the amplifier as in schematic SETUP 6.
- 10C) Switch on the amplifier and the exciter and wait for the PLL to lock.



- 10D) Select RFL with the meter selector, and set the external wattmeter for reflected power reading.
- 10E) Increase the output power to obtain a reading of 100W RFL on the external wattmeter. Now adjust trimpot R13 on the Alarms Card to obtain the same reading on the FM-500SC meter.
- 10F) Increase the power, until you read 50W of reflected power. Adjust R56 on the Alarms Card (remove the metallic shield that covers the alarm cards) until the SWR ANTENNA protection is activated.

NOTE: This setting may vary with the working frequency. It's preferable to make this adjustment at the operating frequency.

11) OVER-TEMPERATURE ALARM CHECK (TEMP.)

- 11A) Check the over-temperature protection by short circuiting the terminals of the temperature sensor placed on the RF Section heat sink (or on the power supply heat sink). The appropriate LED will light, and the amplifier will stop.
- 12) EXTERNAL STAND BY CHECK (EXT.ST.BY)
- 12A) Check the EXT.ST.BY protection by short circuiting Pin 20 of the Telemetry Connector, and verify that the EXT.ST.BY LED lights and the amplifier will stop.
- 12B) Short circuiting Pin 8 of the Telemetry Connector will regularly restart.

## 5.7 DIRECTIONAL COUPLER CARD ADJUSTMENT

The Directional Coupler Card doesn't need any adjustment. It may be necessary to execute the following checks after replacing the card:

- 1) Verify the "AGC Control."
- 2) Verify Antenna SWR Calibration.
- 3) Verify FWD PWR reading.
- 4) Verify RFL PWR reading.

## 5.8 SOFT-START CARD ADJUSTMENT

No adjustments are needed after this board has been changed.

*NOTE: Pay attention to the correct insertion of the connectors.*

## 5.9 BIAS CARD ADJUSTMENT

No adjustments are required inside the Bias Card because it's a factory adjusted device.

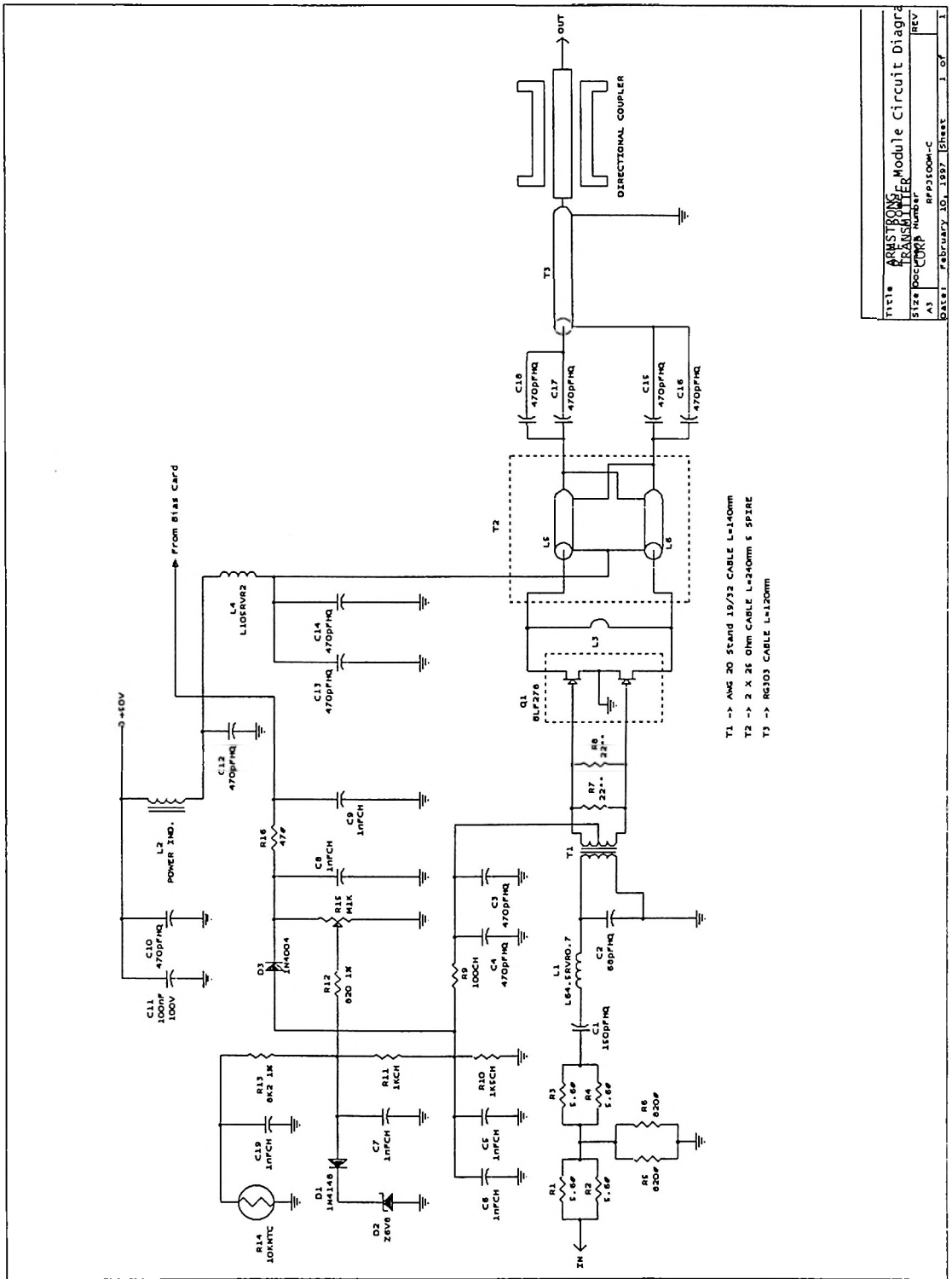
## APPENDIX A

### **CIRCUIT DIAGRAMS, LAYOUTS AND BILLS OF MATERIAL**

This section contains circuit diagrams, layouts and bills of material of the modules which composing the equipment. For more information about each module see as reference Section 2.

## RF POWER AMPLIFIER MODULE

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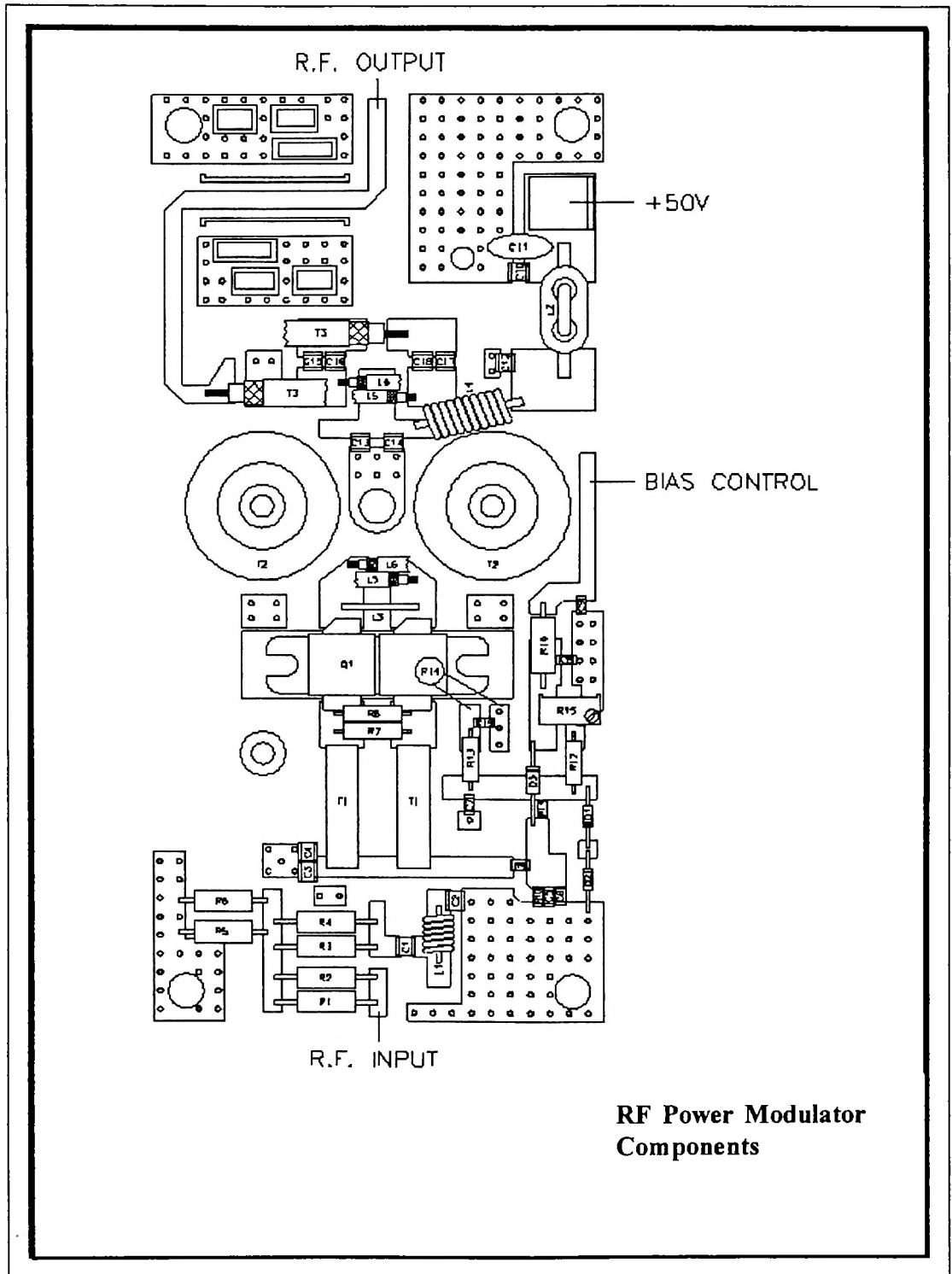


Title		ARMSTRONG Transmitter Module Circuit Diagram	
Size		A3	
Date		February 10, 1957	
REV	Number	APP	1 of 1

RF Module Amplifier Bill of Materials Page 1

Item	Quantity	Reference	Part	Description	Part Order Code
1	4	R1,R2,R3,R4	5.6#	RESISTOR 2W	RSC002JH05,6
2	2	R7,R8	22**	RESISTOR 1W 5%	RSC001JH0022
3	1	R16	47#	RESISTOR 2W	RSC002JH0047
4	1	R9	100CH	CHIP RESISTOR	RCC1/4JH0100
5	1	R12	820 1%	RESISTOR 1/4W 1%	RSM1/4FH0820
6	2	R5,R6	820#	RESISTOR 2W	RSC002JH0820
7	1	R11	1KCH	CHIP RESISTOR	RCC1/4JH0001
8	1	R10	1K5CH	CHIP RESISTOR	RCC1/4JH01,5
9	1	R13	8K2 1%	RESISTOR 1/4W 1%	RSM1/4FK08,2
10	1	R14	10KNTC	NTC	RNTCPAKK0010
11	1	R15	M1K	TRIMMER MULTIGIRI	RVTMULAK0001
12	1	C2	68pFHQ	HIGHT Q CAPACITOR	CHQ680AJ500
13	1	C1	150pFHQ	HIGHT Q CAPACITOR	CHQ151AJ500
14	10	C3,C4,C10, C12,C13,C14, C15,C16,C17, C18	470pFHQ	HIGHT Q CAPACITOR	CHQ471AJ500
15	6	C5,C6,C7, C8,C9,C19	1nFCH	CERAMIC CHIP CAP.	CCC102AJ500
16	1	C11	100nF	CERAMIC CAPACITOR	KM104BK600P
17	1	L2	POWER IND.	RF BINOC. CHOCKE	
18	1	L1	L64.5RVR0.7	6 SP DIA 4.5 R.S. 0.7mm	BFS070064.5
19	1	L4	L105RVR2	10 SP DIA 5 F 2mm	BFS20001005
20	1	L3	BU6012RVR2	BOB U L60MM D12 F.A. 2mm	
21	1	T1	4:1	TRASF. RF. CAVO 25 OHM	CAV7612/78
22	1	T3	RG303	COAX CABLE RG303	AVRG303V
23	2	L5,L6	RG316-25	COAX CABLE RG316 25 Ohm	AVRG31625
24	1	D1	1N4148	SILICON DIODE	DIS1N4148
25	1	D3	1N4004	SILICON DIODE 400V	DIS1N4004
26	1	D2	Z6V8	ZENER DIODE 6.8V 0.4W	DIZ6V80W4
27	1	Q1	BLF278	VHF PUSH-PULL POWER MOS	TRNBLF278

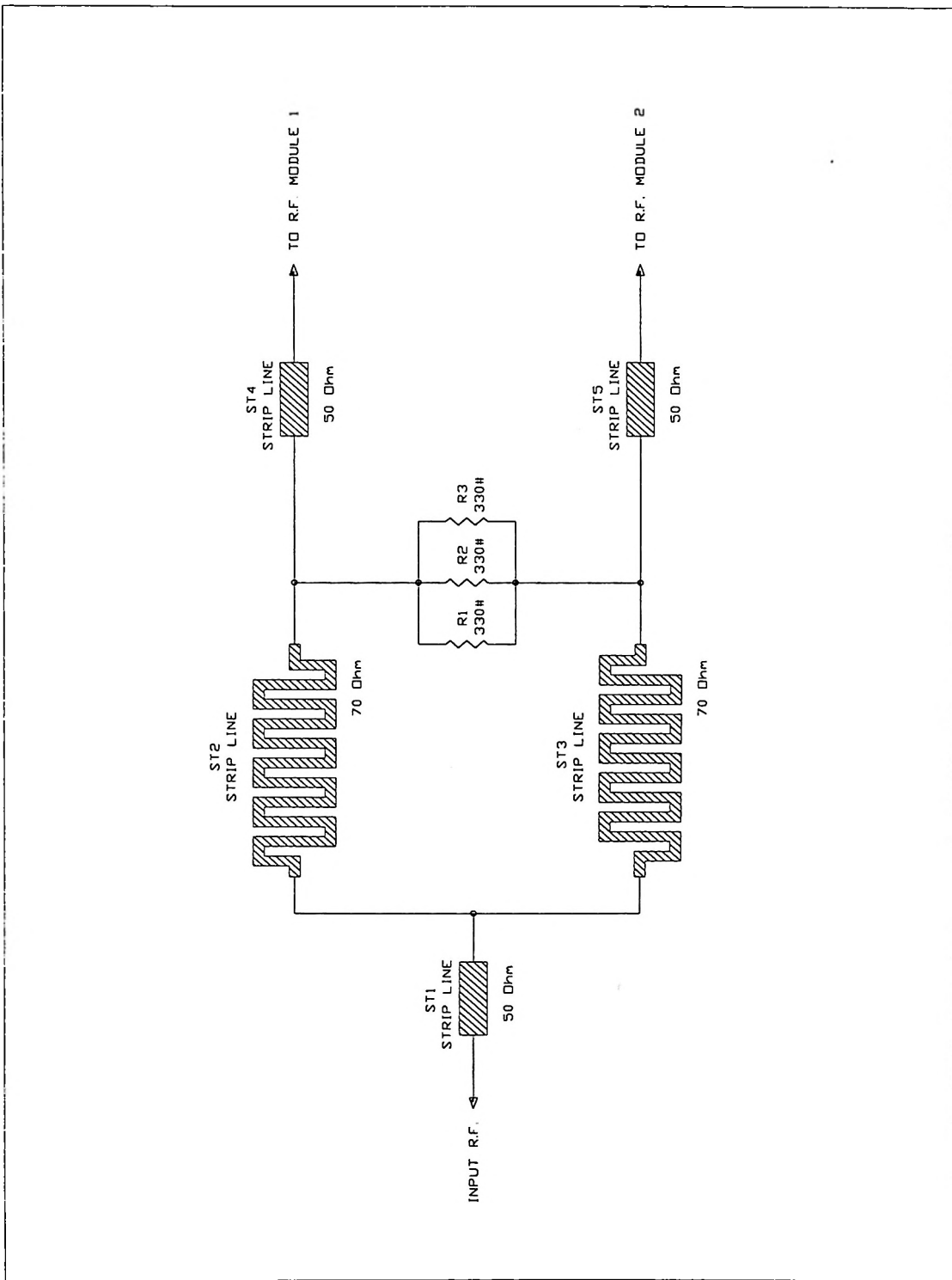




**RF Power Modulator  
Components**

## WILKINSON "2-WAY" SPLITTER CARD

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Splitter Card

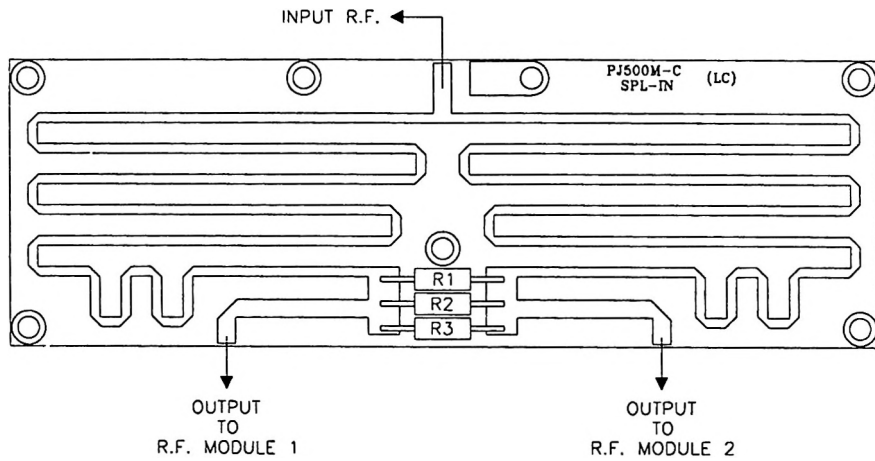
Bill of Materials

Page 1

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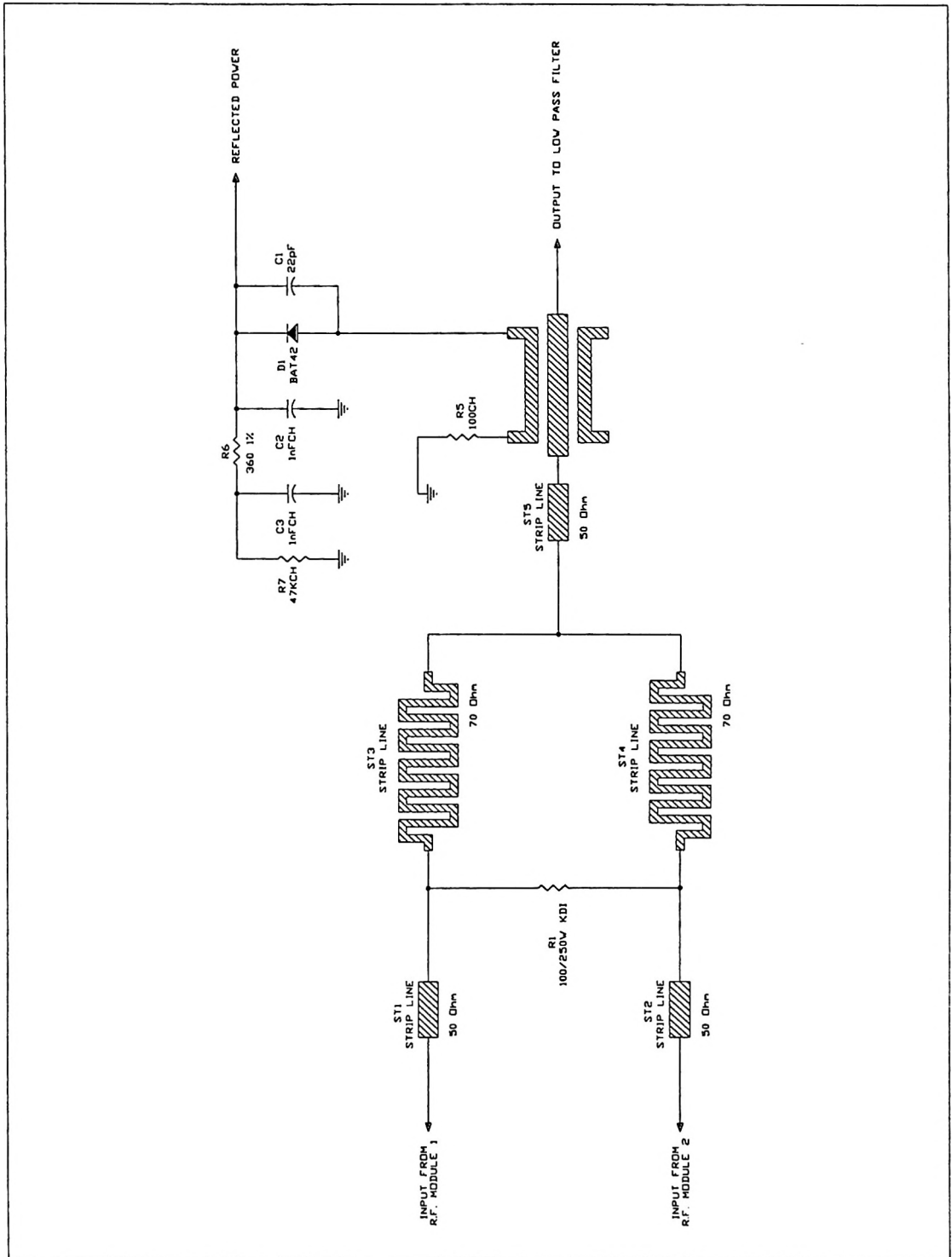
Item	Quantity	Reference	Part	Description	Part Order Code
1	3	R1,R2,R3	330#	RESISTOR 2W	RSC002JH0330
2	5	ST1,ST2,	STRIP LINE	STRIP LINE	
		ST3,ST4,ST5			

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## WILKINSON "2-WAY" COMBINER CARD

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2	Bill of Materials	Page 44
3	Layout	Page 45



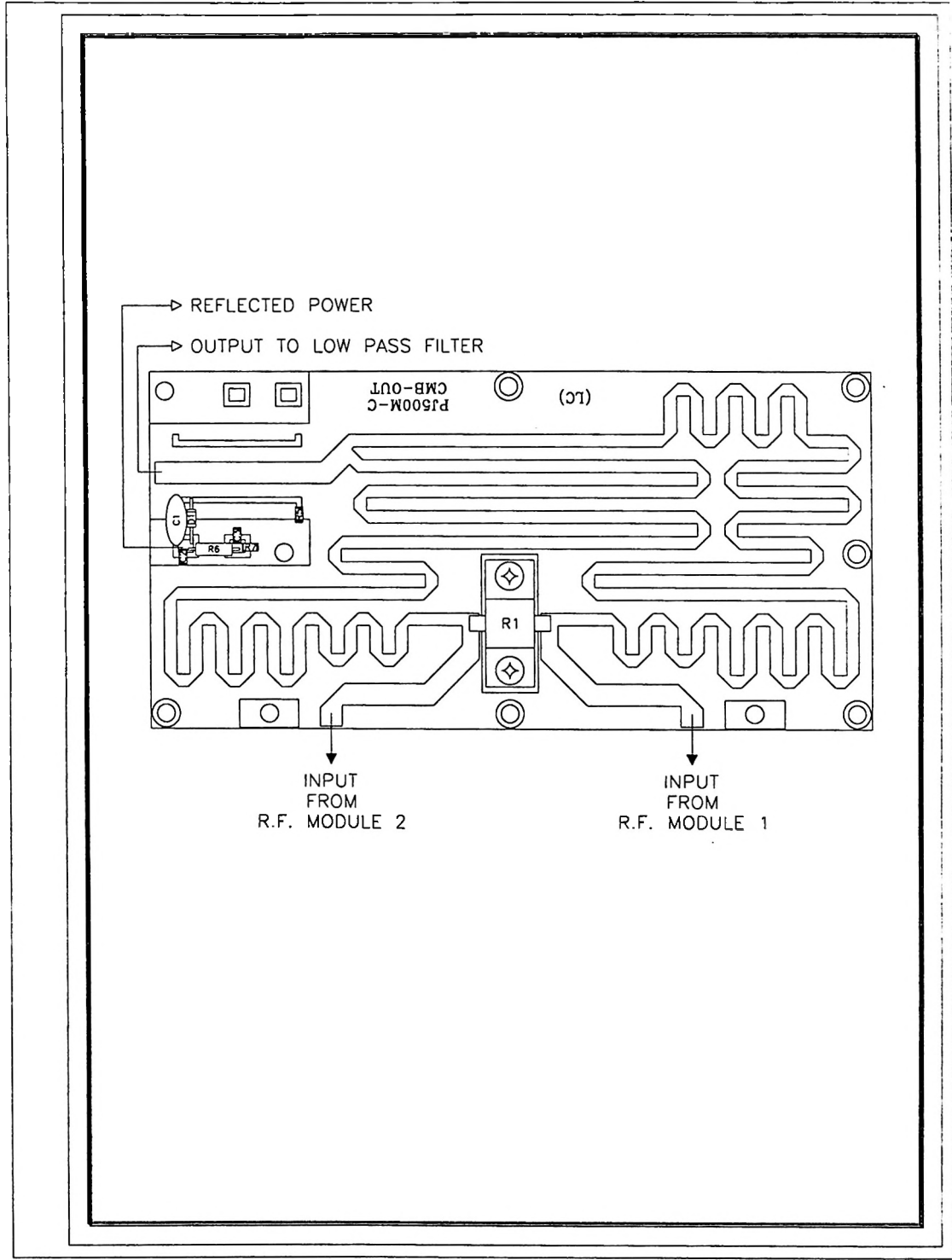
## Combiner Card

## Bill of Materials

Page 1

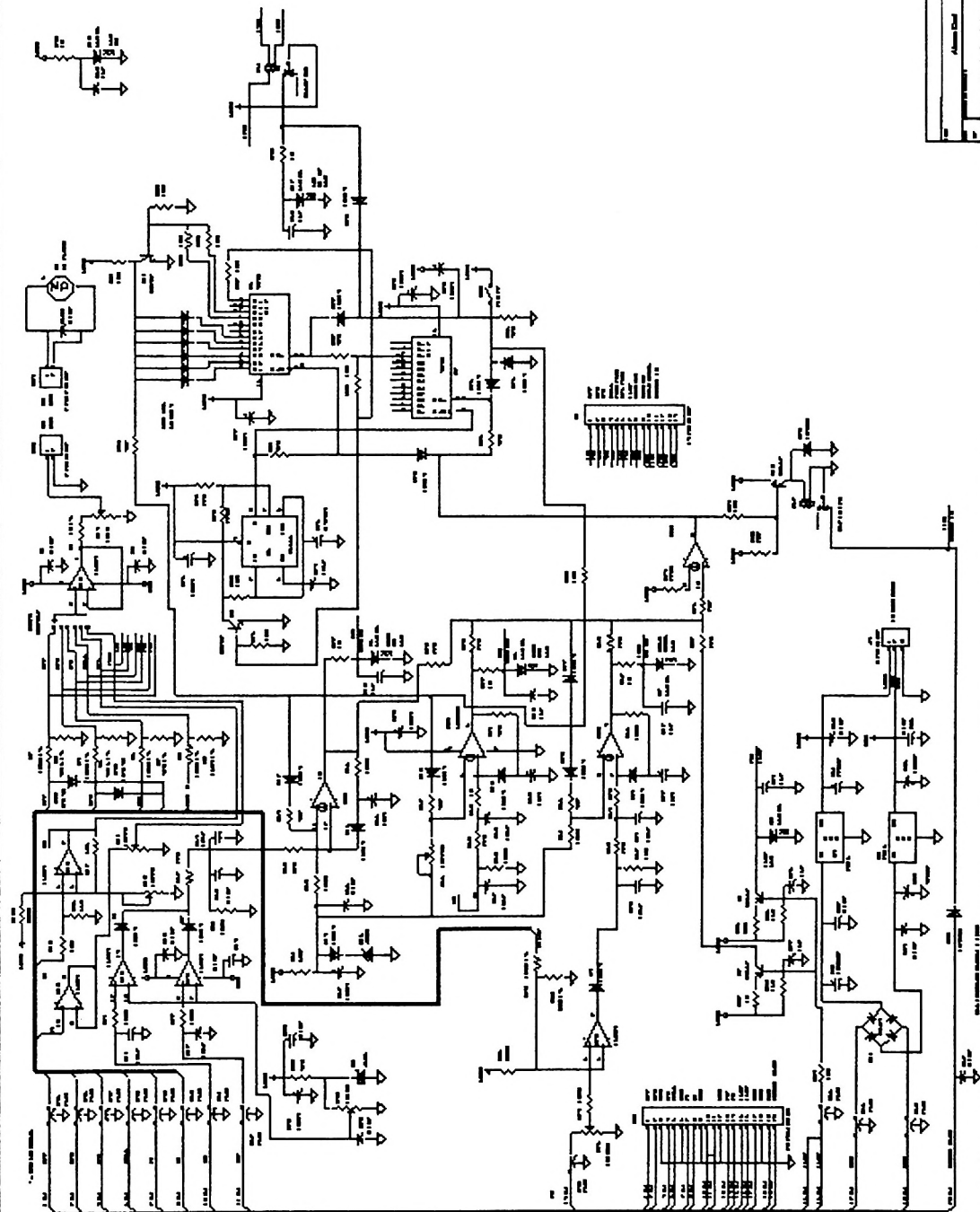
Item	Quantity	Reference	Part	Description	Part Order Code
1	1	R5	100CH	CHIP RESISTOR	RCC1/4JH0100
2	1	R1	100/250W	RESISTENZA KDI 250W	RDT250H0100
3	1	R6	360 1%	RESISTOR 1/4W 5%	RSM1/4FH0360
4	1	R7	47KCH	CHIP RESISTOR	RCC1/4JK0047
5	1	C1	22pF	CERAMIC CAP. NP0	CKM220BJ600C
6	2	C2,C3	1nFCH	CERAMIC CHIP CAP.	CCC102AJ500
7	1	D1	BAT42	HOT CARRIER DIODE	DHCBAT42
8	6	ST1,ST2, ST3,ST4, ST5,ST12	STRIP LINE	STRIP LINE	





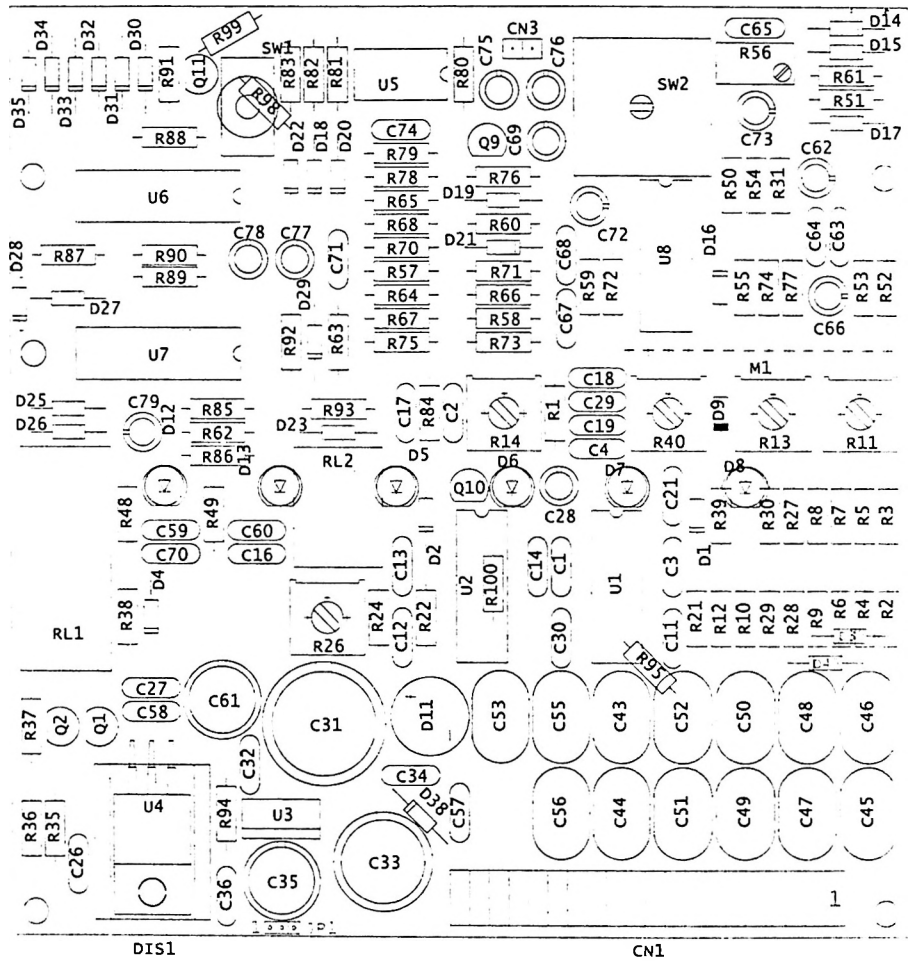
## ALARMS CARD

1	Circuit Diagram	Page 47
2	Bill of Materials	Page 48
3	Layout	Page 50



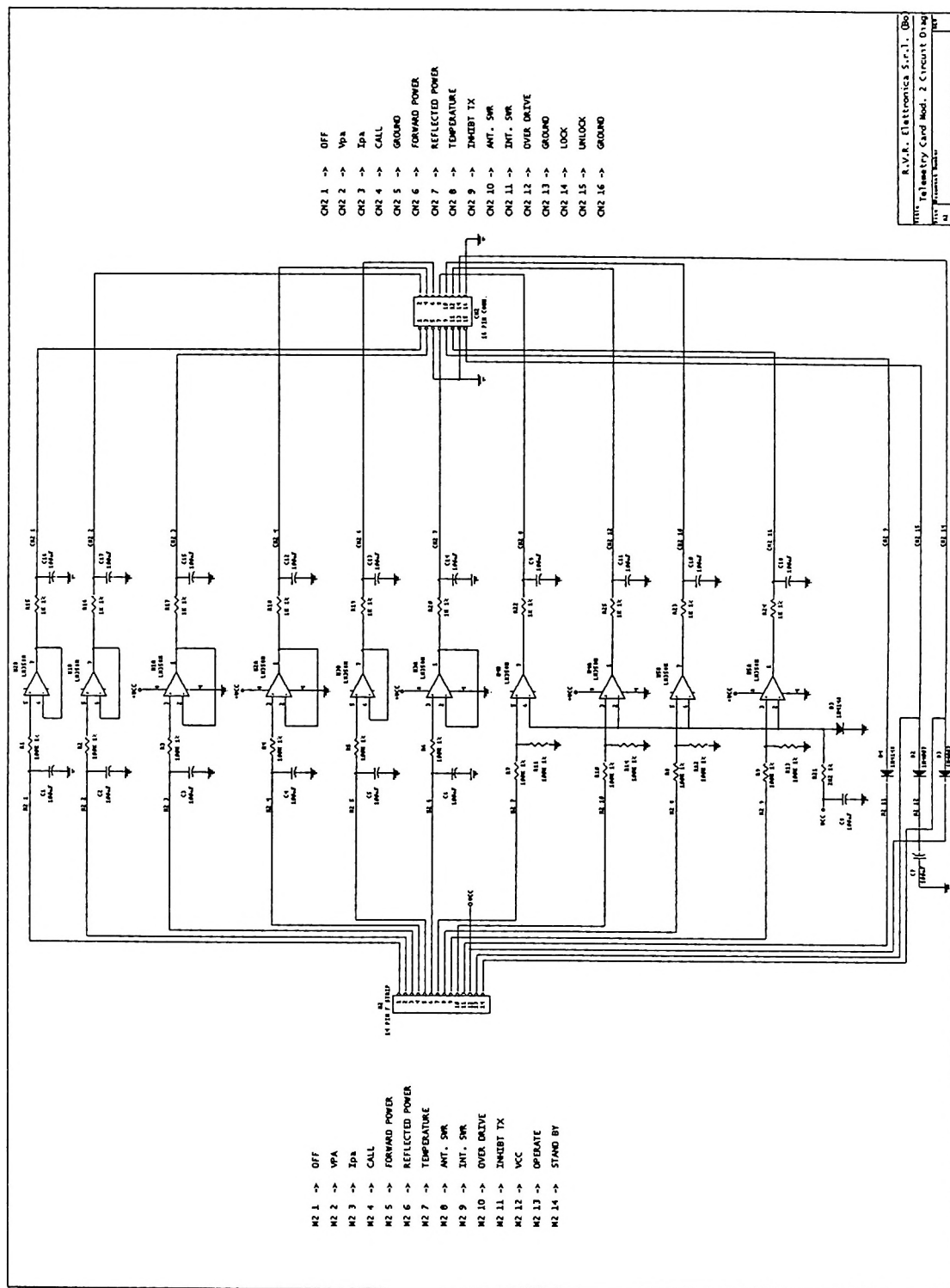
Alarms Card		Bill of Materials			Page 1
Item	Quantity	Reference	Part	Description	Part Order Code
1	1	R35	330	RESISTOR 1/4W 5%	RSC1/4JH0330
2	1	R39	470	RESISTOR 1/4W 5%	RSC1/4JH0470
3	1	R51	680*	RESISTOR 1/2W 5%	RSC1/2JH0680
4	1	R1	1K 1%	RESISTOR 1/4W 1%	RSM1/4FK0001
5	7	R37,R48, R49,R60, R67,R72,R77	1K	RESISTOR 1/4W 5%	RSC1/4JK0001
6	2	R75,R93	2K2	RESISTOR 1/4W 5%	RSC1/4JK02,2
7	1	R30	3K3 1%	RESISTOR 1/4W 1%	RSM1/4FK03,3
8	2	R3,R5	4K16 1%	RESISTOR 1/4W 1%	RSM1/4FK4,16
9	4	R54,R57, 4K7 R65,R99		RESISTOR 1/4W 5%	RSC1/4JK04,7
10	1	R12	5K6	RESISTOR 1/4W 5%	RSC1/4JK05,6
11	13	R10,R62, 10K R76,R80,R82, R83,R84,R88, R89,R90,R91, R94,R98		RESISTOR 1/4W 5%	RSC1/4JK0010
12	2	R36,R38	15K	RESISTOR 1/4W 5%	RSC1/4JK0015
13	1	R8	15K4 1%	RESISTOR 1/4W 1%	RSC1/4FK15,4
14	8	R52,R59, 22K R63,R68, R70,R73, R78,R92		RESISTOR 1/4W 5%	RSC1/4JK0022
15	1	R7	47K 1%	RESISTOR 1/4W 1%	RSM1/4FK0047
16	5	R71,R81, 47K R85,R86,R87		RESISTOR 1/4W 5%	RSC1/4JK0047
17	1	R95	56K	RESISTOR 1/4W 5%	RSC1/4JK0056
18	2	R53,R64	82K	RESISTOR 1/4W 5%	RSC1/4JK0082
19	5	R2,R4,R6, R9,R29	100K 1%	RESISTOR 1/4W 1%	RSM1/4FH0100
20	9	R21,R22, R24,R31,R50, R55,R58,R61, R66	100K	RESISTOR 1/4W 5%	RSC1/4JK0100
21	2	R74,R79	220K	RESISTOR 1/4W 5%	RSC1/4JK0220
22	2	R96,R100	330K	RESISTOR 1/4W 5%	RSC1/4JK0330
23	1	R14	TC1K	TRIM. REG. VERT. CERMET	RVTCERVK0001
24	1	R40	TC10K	TRIM. REG. VERT. CERMET	RVTCERVK0010
25	2	R11,R13	TC22K	TRIM. REG. VERT. CERMET	RVTCERVK0022
26	1	R26	TC100K	TRIM. REG. VERT. CERMET	RVTCERVK0100
27	1	R56	TM220K	TRIM. MULT. REG. VERT.	RVTMULVK0220
28	8	C17,C18, 1nF C19,C21,C26, C27,C59,C60		CERAMICCAPACITOR	CKM102BK600P
29	8	C11,C12, 10nF C64,C67,C68, C70,C71,C74		CERAMICCAPACITOR	CKM103BK600P
30	14	C1,C3,C13, C14,C29,C30, C32,C34,C36, C57,C58A,C58, C63,C65	0.1µF	CERAMICCAPACITOR	CKM104BK600P

Item	Quantity	Reference	Part	Description	Part Order Code
31	1	C75	0.47 $\mu$ FT	TANTALIUM CAPACITOR	CET474AM350
32	3	C66,C69,C72	1 $\mu$ FT	TANTALIUM CAPACITOR	CET105AM350
33	7	C28,C62, 10 $\mu$ FT C73,C76,C77, C78,C79		TANTALIUM CAPACITOR	CET106AM350
34	1	C35	100 $\mu$ F	ELECTROLYTIC CAPACITOR	CEA107BM350
35	1	C61	220 $\mu$ F	ELECTROLYTIC CAPACITOR	CEA227BM350
36	1	C33	470 $\mu$ F	ELECTROLYTIC CAPACITOR	CEA477BM350
37	1	C31	1000 $\mu$ F	ELECTROLYTIC CAPACITOR	CEA108SCM350
38	1	M1	ST 250UA	STRUMENTO 250 $\mu$ A	SMABM42RQ251
39	1	CN3	2 PIN STRIP	STRIP M P 2.54 2 PIN	CNTSTRIPMCS
40	1	JP1	3 PIN STRIP	STRIP M P 2.54 3 PIN	CNTSTRIPMCS
41	1	M1	14P STRIP	STRIP M P 2.54 14 PIN	CNTSTRIPMCS
42	1	CN4	2P F STRIP	STRIP F P 2.54 2 PIN	CNTSTRIPFCS
43	1	CN1	20P CN.CS.	CON.STRIP 20P.M. CSP.	CNTSRMCS20PO
44	12	C43,C45, C46,C47,C48, C49,C50,C51, C52,C53,C55, C56	FEMI	FILTRO EMIMURATA	FEAY5S223500
45	1	RL2	RLY 1V 12V	RELAY 1 VIA 12V	RLD112
46	1	RL1	RELAYS/R	RELAY SET/RESET 12V	RLDMZP-R2
47	1	SW1	P1V2P	PULSANTE 1 VIA 2 POS	PLS1V11M03CS
48	1	SW2	SW2V6P	COM. 2 VIE 6 POS FEME	COMR2V6PCS
49	2	D39,D40	1N4148	SILICON DIODE	DIS1N4148
50	22	D1,D2,D4, D14,D16,D17, D18,D19,D20, D21,D22,D25, D26,D27,D28, D29,D30,D31, D32,D33,D34, D35	1N914	SILICON DIODE	DIS1N914
51	1	D23	1N4001	SILICON DIODE 50V	DIS1N4001
52	1	D38	1N4003	SILICON DIODE 200V	DIS1N4003
53	1	D11	WL04	DIODE BRIDGE 1.5A	PNRWL04
54	5	D5,D6,D7, D8,D12	LED-R5	RED LED DIODE	LEDRO05
55	1	D13	LED-G5	GREEN LED DIODE	LEDVE05
56	1	D15	Z3V9	ZENER DIODE 3.9V 0.4W	DIZ3V90W4
57	1	D9	Z5V6	ZENER DIODE 5.6V 0.4W	DIZ5V60W4
58	1	U4	7815	POS. STABILIZER 1A	CIL7815P
59	1	U3	7915	NEG. STABILIZER 1A	CIL7915P
60	2	Q9,Q11	BC237	NPN TRANSISTOR	TRNBC237
61	3	Q1,Q2,Q10	BC557	PNP TRANSISTOR	TRNBC557
62	2	U1,U2	TL084	QUAD OP. AMP.	CILTL084
63	1	U5	NE555	TIMER	CIL555
64	2	U6,U7	4040	CMOS DIVIDER	CID4040
65	1	U8	LM3900	NORTON QUAD AMP.	CILLM3900



## TELEMETRY CARD

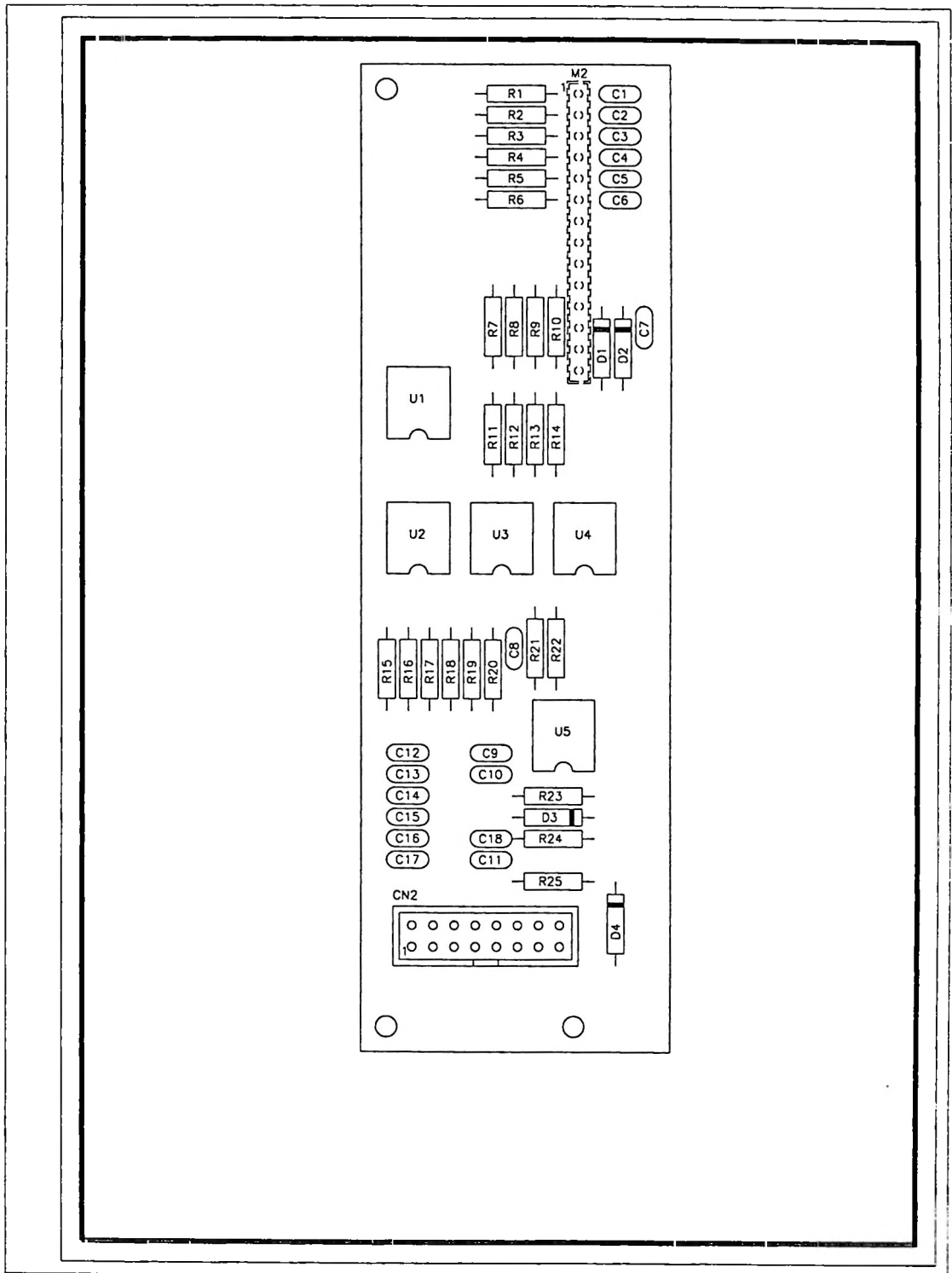
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R.V.R. Electronics S.r.l. (Bo)  
 Telemetry Card Mod. 2 Circuit Diagram  
 Rev. 1.00  
 1982

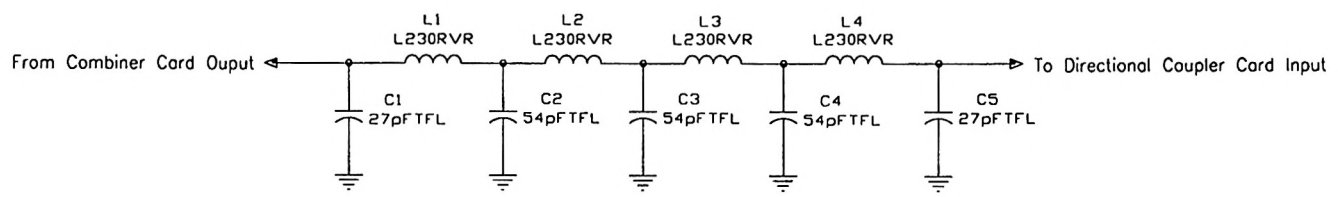


Item	Quantity	Reference	Part	Description	Part Order Code
1	10	R15,R16, R17,R18, R19,R20, R22,R23, R24,R25	1K	RESISTOR 1/4W 5%	RSC1/4JK0001
2	1	R21	2K2	RESISTOR 1/4W 5%	RSC1/4JK02,2
3	10	R1,R2,R3, R4,R5,R6, R7,R8,R9, R10	100K 1%	RESISTOR 1/4W 1%	RSM1/4FH0100
4	4	R11,R12 R13,R14	150K 1%	RESISTOR 1/4W 5%	RSM1/4JK0150
5	18	C1,C2,C3, C4,C5,C6, C7,C8,C9, C10,C11, C12,C13, C14,C15, C16,C17, C18	100nF	CERAMIC CAPACITOR	CKM104BK600P
6	1	M2	14P F STRIP	STRIP F P 2.54 14 PIN	CNTSTRIPFCS
7	1	CN2	16P CONN.	CONN. M 2*8 P 2.54	CNTMCSFC16P
8	2	D3,D4	1N4148	SILICON DIODE	DIS1N4148
9	2	D2,D3	1N4007	SILICON DIODE 1000V	DIS1N4007
10	5	U1,U2,U3, U4,U5	LM358N	DOUBLE OP. AMP.	CILLM358N



## LOW-PASS FILTER

- |   |                   |         |
|---|-------------------|---------|
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Low-Pass Filter

Bill of Materials

Page 1

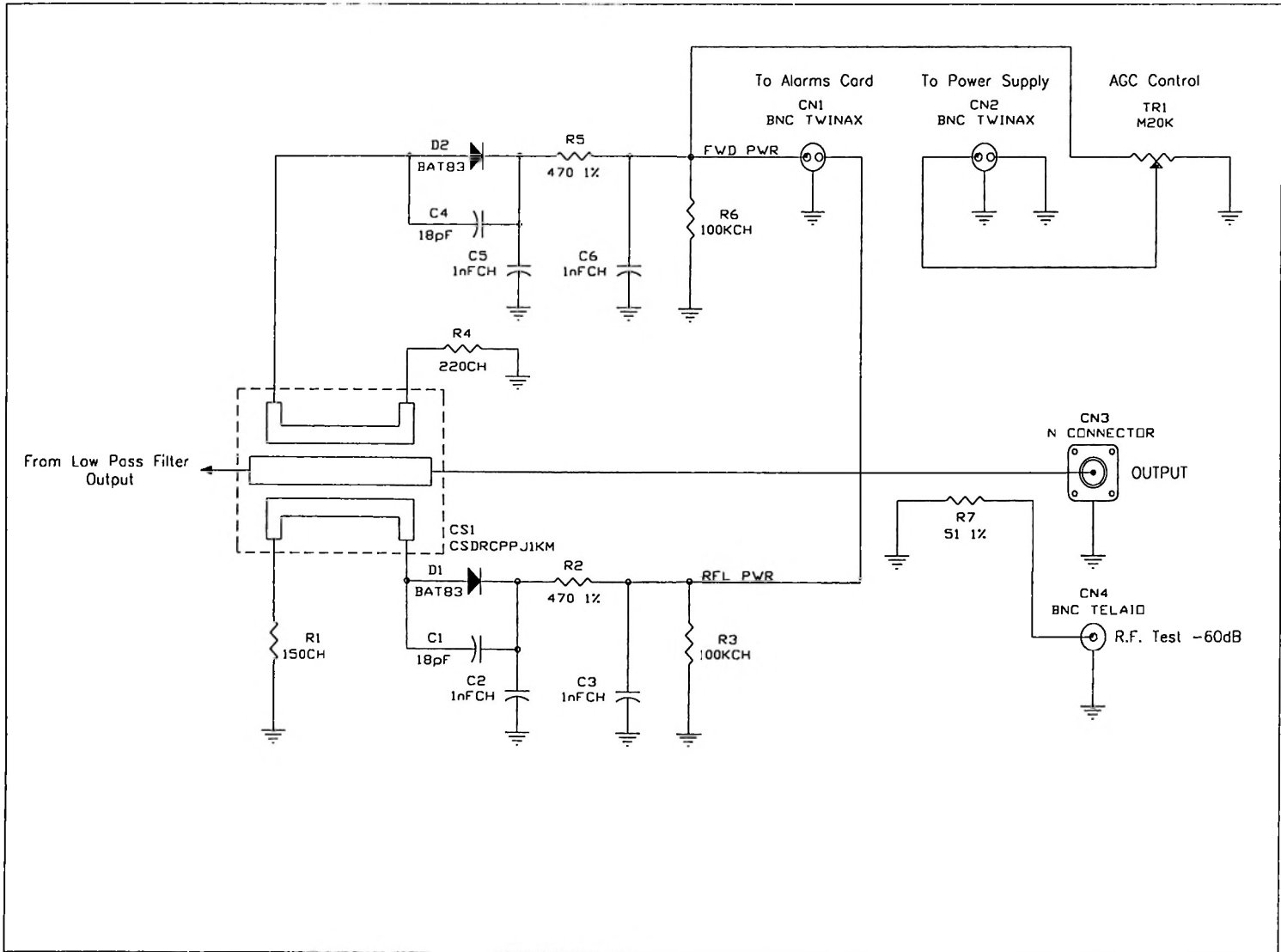
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Item	Quantity	Reference	Part	Description	Part Order Code
1	2	C1,C5	27pFTFL	COND. BAND. RAME TEFLON	BRT270RVR
2	3	C2,C3,C4	54pFTFL	COND. BAND. RAME TEFLON	BRT540RVR
3	4	L1,L2,L3,L4	L230RVR	2 SP DIA 30 BAND. RAME	BR5000230

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## DIRECTIONAL COUPLER CARD

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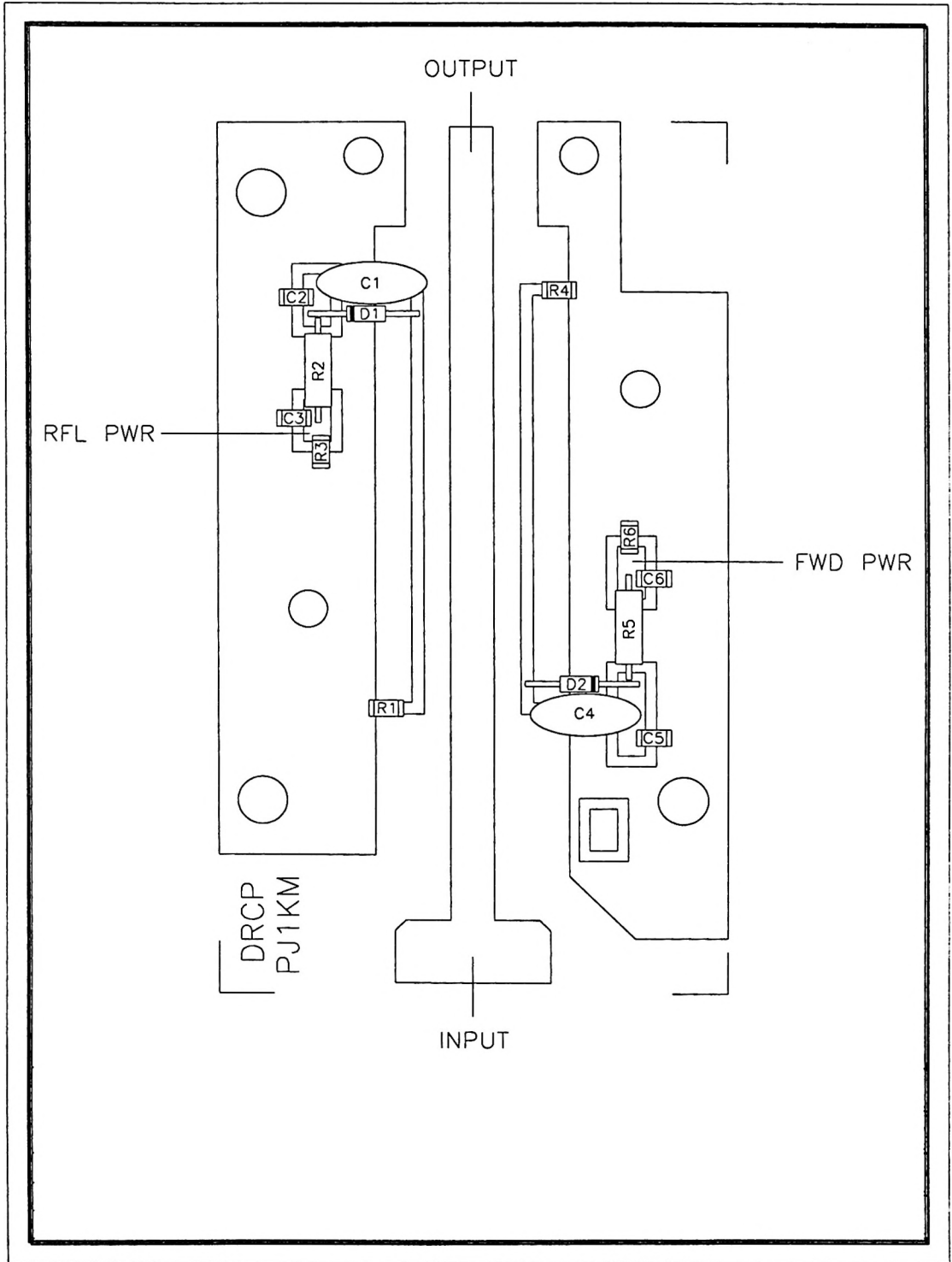


## Directional Coupler Card Bill of Materials

Page 1

Item	Quantity	Reference	Part	Description	Part Order Code
1	1	R7	51 1%	RESISTOR 1/4W 1%	RSM1/4FH0051
2	1	R1	150CH	CHIP RESISTOR	RCC1/4JH0150
3	1	R4	220CH	CHIP RESISTOR	RCC1/4JH0220
4	2	R2,R5	470 1%	RESISTOR 1/4W 1%	RSM1/4FH0470
5	2	R3,R6	100KCH	CHIP RESISTOR	RCC1/4JK0100
6	1	TR1	M20K	TRIMMER MULTIGIRI	RVTMULAK0020
7	2	C1,C4	18pF	CERAMIC CAP. NP0	CKM180BJ600C
8	4	C2,C3,C5,C6	1nFCH	CERAMIC CHIP CAP.	CCC102AJ500
9	1	CN4	BNC TELAIO	CONN. BNC A TELAIO	CNTBNCFPV
10	2	CN1,CN2	BNCTWINAX	CONN. BNC PER CAVO TWIN	CNTBNCTWINAX
11	1	CN3	NCONNECTOR	CONN. N A TELAIO	CNTNFPFL
12	2	D1,D2	BAT83	HOT CARRIER DIODE	DHCBAT83
13	1	CS1	CSDRCPJ1KM	CSDIR. COUPLER PJ1KM	CSDRCPJ1KM





## SWITCHING POWER SUPPLY

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## Switching Power Supply Bill of Materials

Item	Quantity	Reference	Part
1	1	CFP	1μF/250V
2	10	CF7,C12,C23,C26,C27, C39,C46,C49,C52,C57	0.1μF
3	1	C1	0.1μF
4	3	C2,C14,C19	MKP1nF/600
5	1	C3	1μF/25
6	4	C4,C5,C6,C20	EKE1000μF/63
7	1	C7	1KpF
8	1	C8	6n8
9	17	C9,C33,C34,C35,C36,C37, C40,C41,C42,C43,C44, C47,C48,C53,C54,C55,C56	100pF
10	3	C10,C50,C51	0.33μF
11	1	C11	0.22μF
12	1	C13	4n7UF
13	1	C15	EKE470μF/100
14	2	C16,C17	EYS4700μF/100
15	1	C18	47μF/16
16	1	C21	470μF/40
17	2	C22,C25	100μF/25
18	1	C24	470/40
19	1	C28	0.1μFCER
20	1	C29	470μF
21	1	C30	10KpF
22	2	C31,C32	47μF
23	2	C38,C45	0.47μF
24	1	C58	1μF/35
25	2	R35,C60	N.C.
26	2	D1,D2	11DQ04
27	1	D3	27V/1W
28	3	D4,D5,D30	40EPS08
29	2	D6,D7	20V/1W*
30	1	D8	30V/1W
31	4	D9,D10,D11,D26	1N4004
32	2	D12,D13	WL02
33	3	D14,D15,D16	LEDV
34	1	D17	HFA50PA60C
35	1	D18	LM336-5V
36	10	D19,D20,D21,D22,D23, D24,D25,D27,D28,D29	1N4148
37	7	F1,F2,F3,F4,F5,F6,F7	BL02
38	2	IS1,IS2	4N26
39	1	JP4	KRA6
40	2	JP5,JP9	STRIP
41	1	JP6	KRA8
42	2	JP8,JP10	KRA4
43	2	L1,L2	84μH
44	2	L3,L4	BFN0720
45	1	L5	BFN0610
46	1	Q1	BC237
47	3	Q2,Q5,Q8	IRFD120
48	2	Q3,Q4	IRFP250

Switching Power Supply Bill of Materials

Item	Quantity	Reference	Part
49	1	Q6	IRFD9120
50	1	Q7	50RIA20
51	1	RV1	V120ZA6
52	2	R1,R9	5K62
53	1	R2	390R
54	1	R3	2K47
55	2	R4,R5	14R7
56	2	R6,R29	3R3
57	4	R7,R22,R32,R41	237R
58	2	R8,R85	820R
59	1	R10	4K02
60	3	R11,R74,R84	1K0
61	1	R12	22K
62	2	R13,R80	2K0
63	2	R14,R17	100R
64	3	R15,R20,R21	10R/4W
65	1	R16	6K81
66	1	R18	909R
67	4	R19,R52,R62,R75	1K
68	1	R23	80R2
69	2	R24,R28	4R99
70	3	R25,R26,R27	2K2
71	2	R30,R42	2K61
72	1	R31	2K55
73	1	R33	87W-2K
74	1	R34	27K4
75	1	R36	2K74
76	1	R37	1K37
77	5	R38, R51, R64, R67, R68	100K0
78	1	R39	150K0
79	1	R40	2K7
80	1	R43	715R
81	1	R44	10K/1W
82	1	R45	22K/1W
83	8	R46, R47, R48, R49, R57, R58, R59, R60	10K0
84	4	R50, R53, R61, R65	49K9
85	2	R54, R63	4K7
86	1	R55	300R
87	1	R56	511R
88	2	R66, R70	549R
89	1	R69	1K21
90	1	R71	87W/5K
91	1	R72	2K21
92	1	R73	87W/10K
93	3	R76, R82, R83	1M
94	1	R77	87W-10K
95	1	R78	47K5
96	1	R79	87W-500R
97	1	R81	2K49
98	1	TP1	TPCLK
99	5	TP2, TP3, TP4, TP5, TP6, TP7, TP	

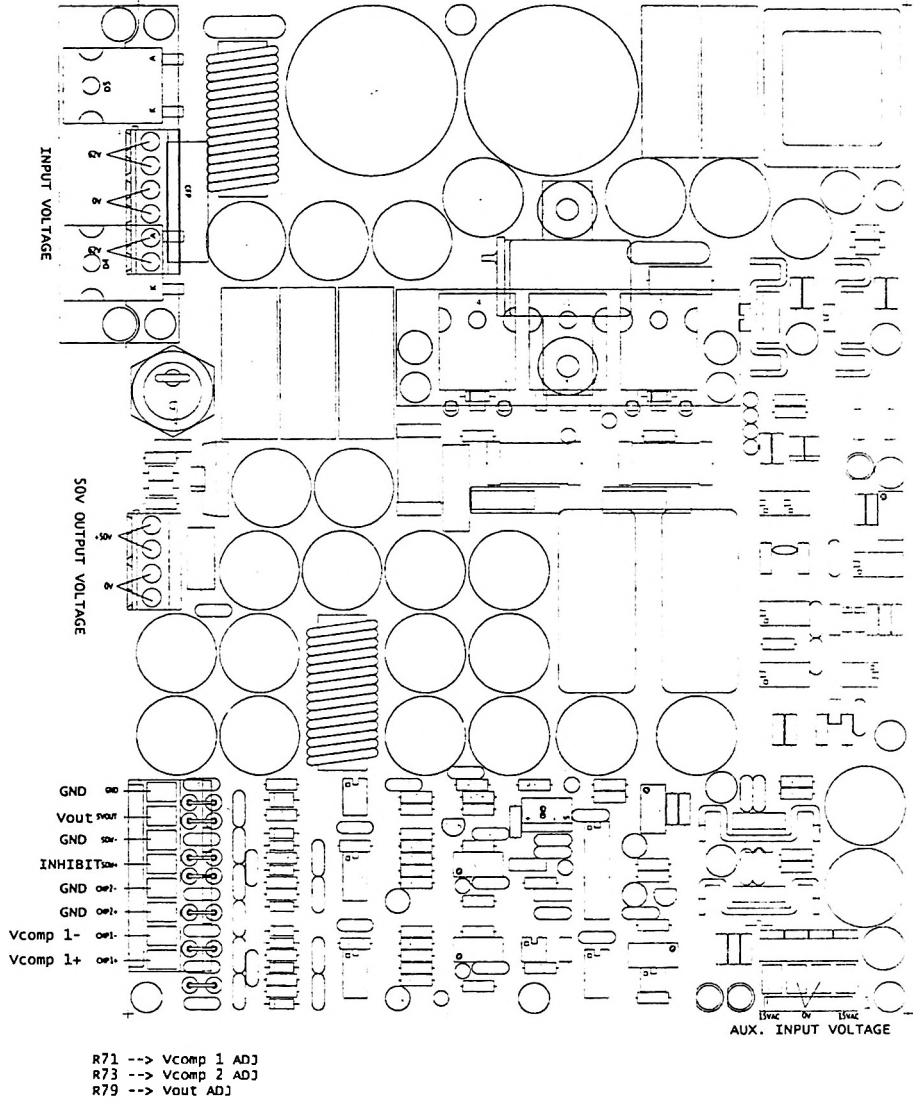
Switching Power Supply

Bill of Materials

Page 3

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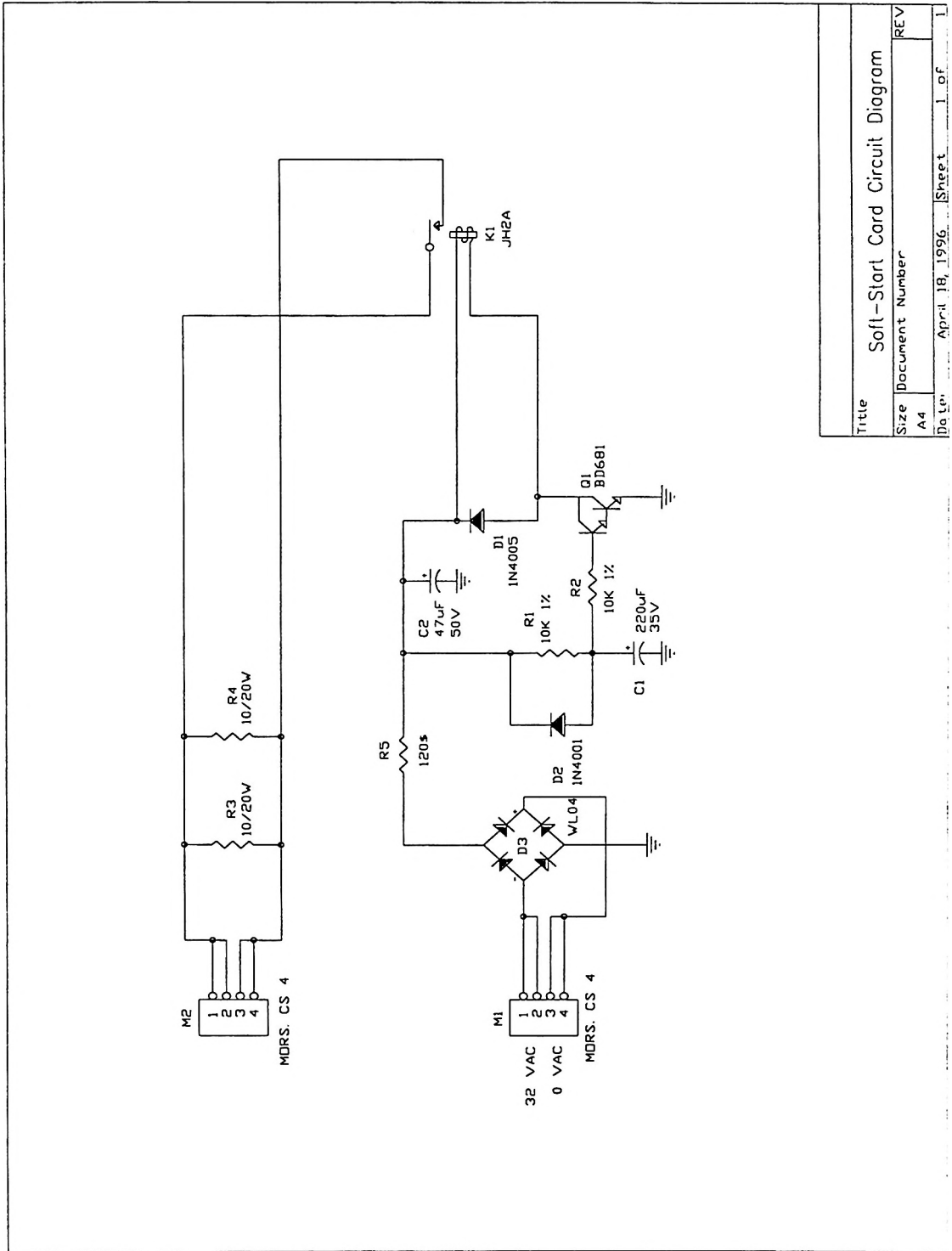
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100	1	T1	15V
101	1	U1	HCPL2611
102	1	U2	UC3823
103	3	U3,U4,U8	LM317
104	1	U5	TC427
105	3	U6,U11,U12	LM358
106	1	U7	LM393
107	1	U9	HTP50
108	1	U10	LM337



## SOFT START CARD

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3	Layout	Page 71





Title Soft-Start Card Circuit Diagram

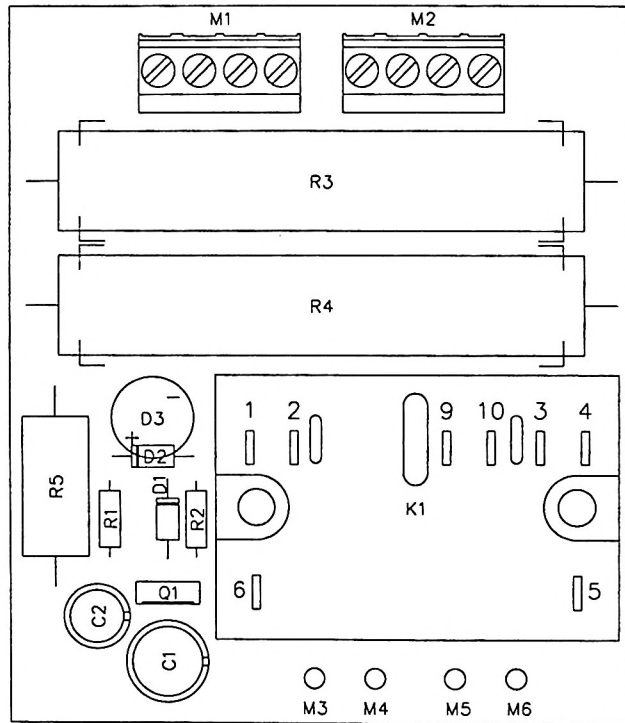
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Soft-Start Card

Bill of Materials

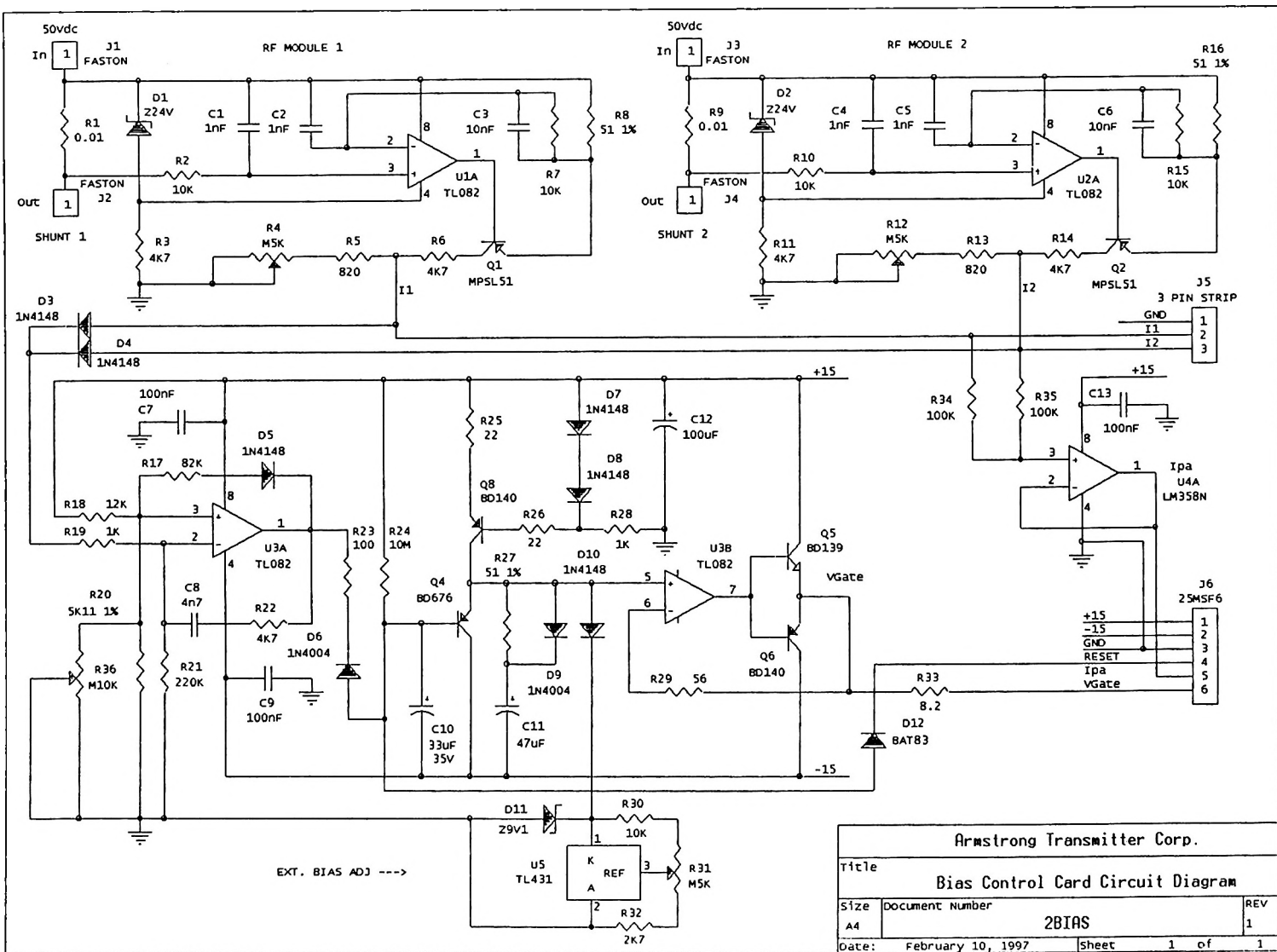
Page 1

Item	Quantity	Reference	Part	Description	Part Order Code
1	2	R3,R4	10/20W	RESISTOR 20W 10%	RAF020KH0010
2	1	R5	120\$	RESISTOR 5W	RSC005JH0120
3	2	R1,R2	10K 1%	RESISTOR 1/4W 1%	RSM1/4FK0010
4	1	C2	47μF	ELECTROLYTIC CAPACITOR	CEA476BM630
5	1	C1	220μF	ELECTROLYTIC CAPACITOR	CEA227BM350
6	2	M1,M2	MORS. CS 4	MORSETTIERA CS 4 CONT.	MORSKB04PPO
7	1	K1	JH2A	RELAY MATHSUSH. 2CA1CC	RLDJH2AB24
8	1	D2	1N4001	SILICON DIODE 50V	DIS1N4001
9	1	D1	1N4005	SILICON DIODE 600V	DIS1N4005
10	1	D3	WL04	DIODE BRIDGE 1.5A	PNRWL04
11	1	Q1	BD681	NPNDARLINGTON	TRNBD681

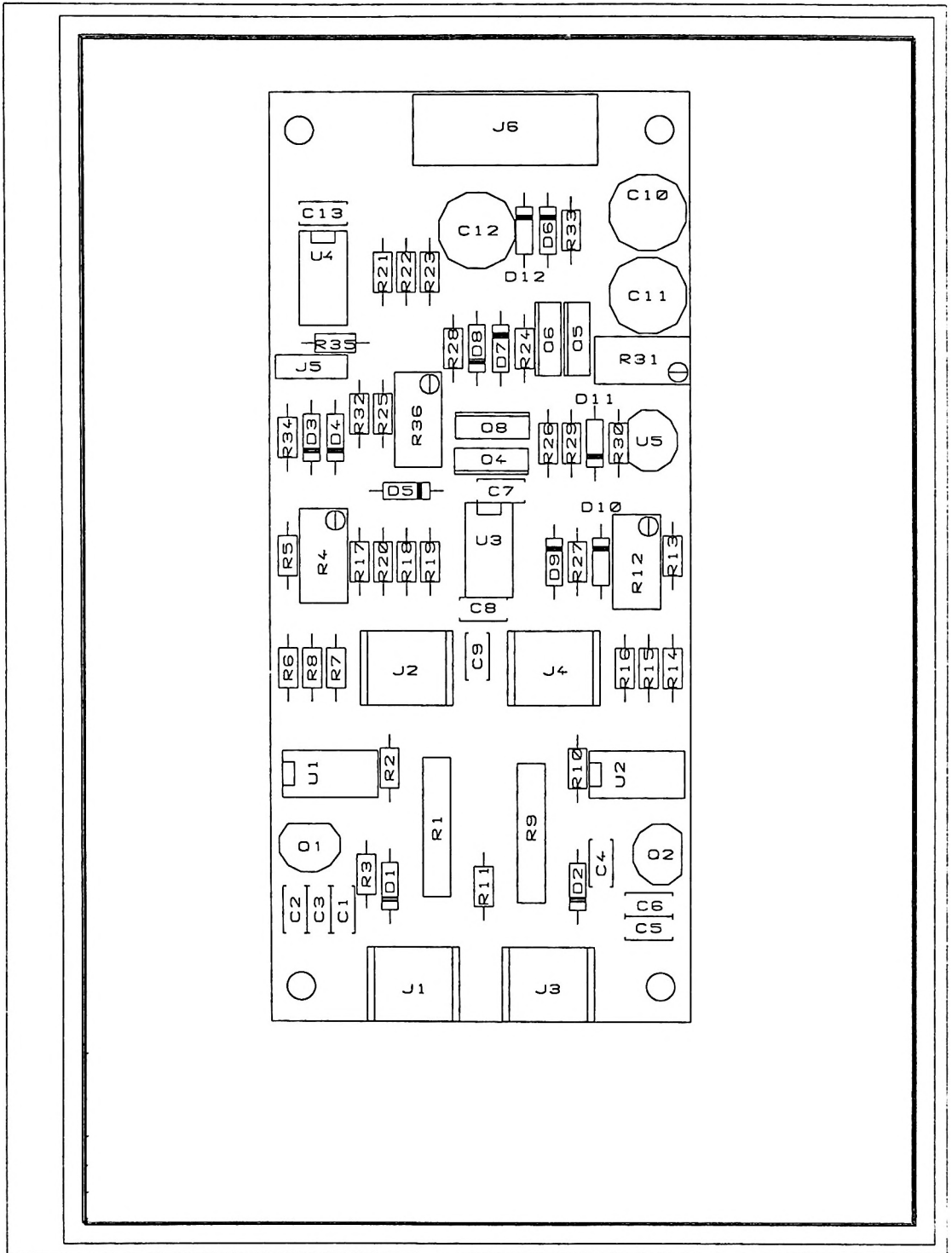


## BIAS CONTROL CARD

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Bias Control Card		Bill of Materials			Page 1
Item	Quantity	Reference	Part	Description	Part Order Code
1	2	R1,R9	0.01	RESISTOR 1/4W 5%	RSC1/4JH0,01
2	1	R33	8.2	RESISTOR 1/4W 5%	RSC1/4JH08,2
3	2	R25,R26	22	RESISTOR 1/4W 5%	RSC1/4JH0022
4	3	R8,R16,R27	51 1%	RESISTOR 1/4W 1%	RSM1/4FH0051
5	1	R29	56	RESISTOR 1/4W 5%	RSC1/4JH0056
6	1	R23	100	RESISTOR 1/4W 5%	RSC1/4JH0100
7	2	R5,R13	820	RESISTOR 1/4W 5%	RSC1/4JH0820
8	2	R19,R28	1K	RESISTOR 1/4W 5%	RSC1/4JK0001
9	1	R32	2K7	RESISTOR 1/4W 5%	RSC1/4JK02,7
10	5	R3,R6,R11, R14,R22	4K7	RESISTOR 1/4W 5%	RSC1/4JK04,7
11	1	R20	5K11 1%	RESISTOR 1/4W 1%	RSM1/4FK5,11
12	5	R2,R7,R10, R15,R30	10K	RESISTOR 1/4W 5%	RSC1/4JK0010
13	1	R18	12K	RESISTOR 1/4W 5%	RSC1/4JK0012
14	2	R34,R35	100K	RESISTOR 1/4W 5%	RSC1/4JK0100
15	1	R17	82K	RESISTOR 1/4W 5%	RSC1/4JK0082
16	1	R21	220K	RESISTOR 1/4W 5%	RSC1/4JK0220
17	1	R24	10M	RESISTOR 1/4W 5%	RSC1/4JM0010
18	3	R4,R12,R31	M5K	TRIMMER MULTIGIRI	RVTMULAK0005
19	1	R36	M10K	TRIMMER MULTIGIRI	RVTMULAK0010
20	4	C1,C2,C4,C5	1nF	CERAMIC CAPACITOR	CKM102BK600P
21	1	C8	4n7	CERAMIC CAPACITOR	CKM472BK600P
22	2	C3,C6	10nF	CERAMIC CAPACITOR	CKM103BK600P
23	3	C7,C9,C13	100nF	CERAMIC CAPACITOR	CKM104BK600P
24	1	C10	33µF	ELECTROLYTIC CAP.	CEA336BM350
25	1	C11	47µF	ELECTROLYTIC CAP.	CEA476BM630
26	1	C12	100µF	ELECTROLYTIC CAP.	CEA107BM350
27	1	J5	3P STRIP	STRIP M P 2.54 3 PIN	CNTSTRIPMCS
28	1	J6	25MSF6	MINIMODUL CON. 2.5MM 6P	CNT25MSF6
29	4	J1,J2,J3,J4	FASTON	CON. FASTON M C.S.	CNTFSTMCSGR
30	6	D3,D4,D5, D7,D8,D10	1N4148	SILICON DIODE	DIS1N4148
31	1	D12	BAT83	HOT CARRIER DIODE	DHCBAT83
32	2	D6,D9	1N4004	SILICON DIODE 400V	DIS1N4004
33	1	D11	Z9V1	ZENER DIODE 9.1V 0.4W	DIZ9V10W4
34	2	D1,D2	Z24V	ZENER DIODE 24V 0.4W	DIZ24V0W4
35	1	U5	TL431	VOLT. PRECISION REF.	CILTL431
36	2	Q1,Q2	MPSL51	PNP H. VOLT. AMP. TRAN.	TRNMPSL51
37	1	Q5	BD139	NPN TRANSISTOR	TRNBD139
38	2	Q6,Q8	BD140	PNP TRANSISTOR	TRNBD140
39	1	Q4	BD676	PNP DARLINGTON	TRNBD676
40	1	U4	LM358N	DOUBLE OP. AMP.	CILLM358N
41	3	U1,U2,U3	TL082	DOUBLE OP. AMP.	CILTL082



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**ARMSTRONG TRANSMITTER CORPORATION  
4835 NORTH STREET  
MARCELLUS, NY 13108**

**TEL: 315-673-1269      FAX: 315-673-9972**  
**ARMSTRONG TRANSMITTER CORPORATION**