Unit 6

UHF 625W Amplifier

1. 625W amplifier:

1.1. Introduction:

This module amplifies the RF power that comes from the 3dB hibrid splitter to the 625W level.

1.2. +32Vdc 25 A switched power supply:

Its function is to supply the 160W amplifier and also the protection circuits that compose the module.

The input voltage is about 50Vdc, obtained from a 36Vac three-phase rectifyng supply.

1.3. Protections and Monitoring:

For these functions, we have:

VSWR Circuit: it protects the amplifier module transistors, when the output VWSR is superior to 4%. This circuit acts in the output transistors bias gate.

Temperature Circuit: it acts in the output transistors bias gate when the heat sink temperature is above 56°C.

Forward RF power limiting circuit: it acts in the output transistor bias gates when the RF output power exceeds the pre-fixed value, this way limiting the maximum power.

1.4. Supply fuses:

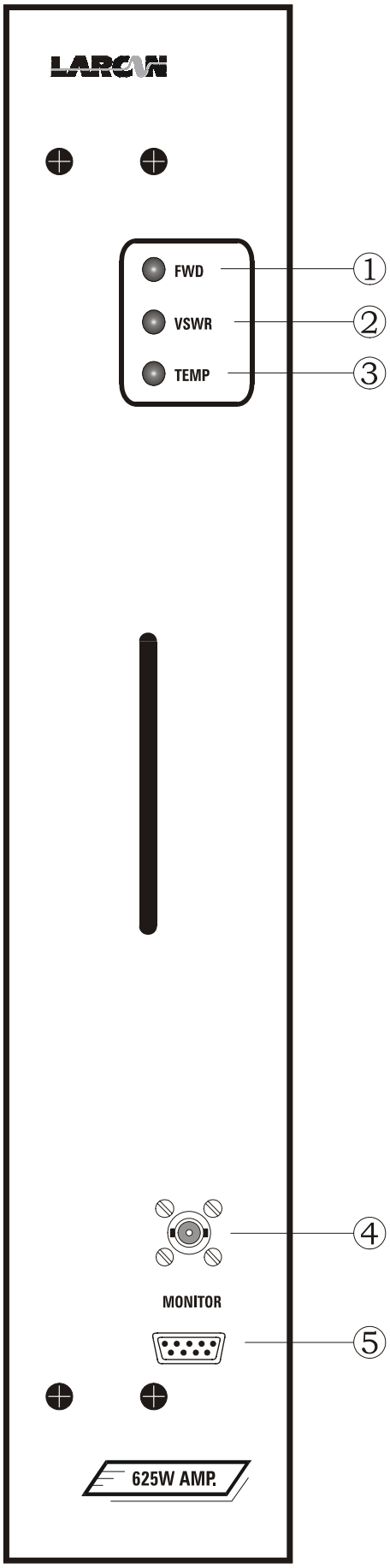
In this circuit there are four 15 A fuses, one for each 160W amplifiers.

1.5. Amplifier stages:

Four amplifier modules with 160W each are used in parallel. Each 160W amplifier module has four LDMOS transistors MRF373A in parallel. Its gain is about 20 dB in class AB.

2. Frontal and back panel:

2.1. Frontal panel:



Each element in the panel has the following function:

1. FWD: when the red led lights, it indicates power than less 3dB in relation to the nominal; when less than one lights, it indicates nominal power.

2. VSWR: When the led lights, it indicates an exceeding VSWR.

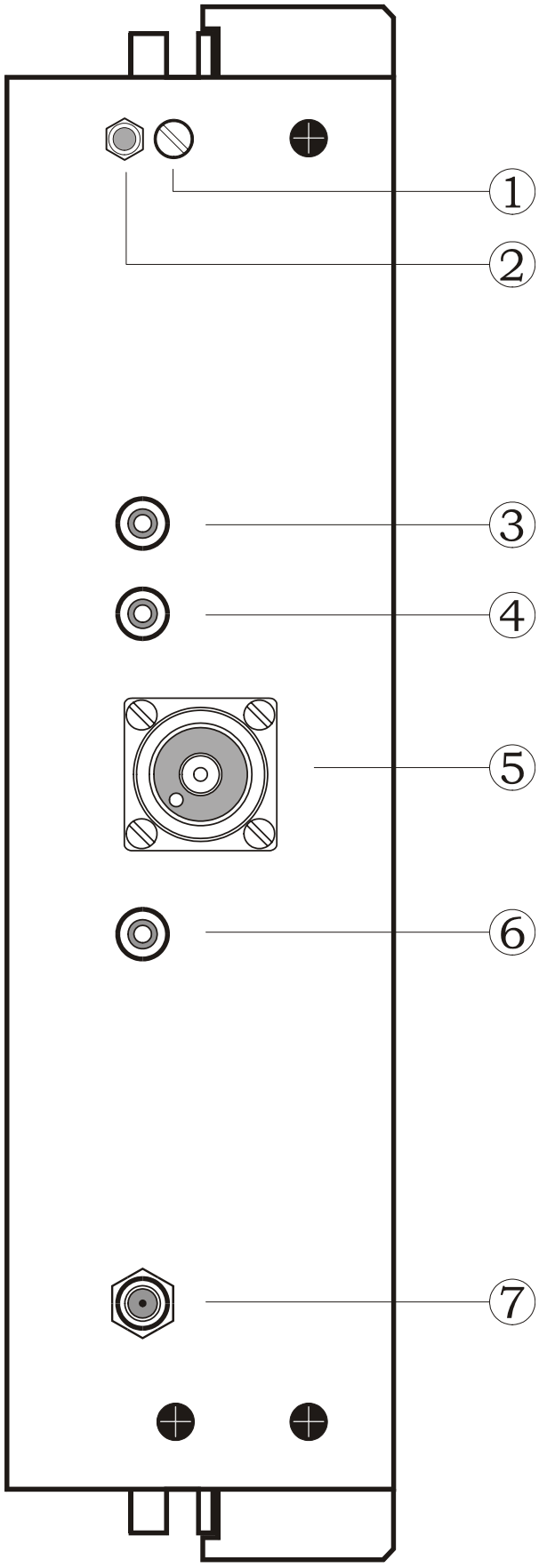
3. TEMPERATURE: When the led lights, it indicates an over temperature.

4. MONITOR: Connector (BCN) is used to monitoring the RF output signal in the spectrun analizer.

5. DB9 Monitoring: it allows monitoring the following functions:

Pin 1: Ground
Pin 2: IC2 – current power supply 2
Pin 3: VC2 – voltage power supply 2
Pin 4: VSWR measurement
Pin 5: DV (+12V)
Pin 6: IC1 – current power supply 1
Pin 7: VC1 – voltage power supply 1
Pin 8: Forward RF power measurement
Pin 9: Temperature measurement

2.2. Back panel:



Each element in the panel has the following function:

1. FIXING SCREW: A screw-nut is attached to it, to tie the module to the rack, where the screw-nut starts the power shut off (2).

2. POWER SHUT: Off inter lock that acts on power supply shutting off power.

3. RED PLUG: +46Vdc power supply input to power A.

4. RED PLUG: +46Vdc power supply input to power B.

5. RF OUT: RF signal output.

6. BLACK PLUG: Ground.

7 RF IN: RF signal input.

3. +32V 25A switched power supply:

3.1. Function:

There are two +32V 25 A switched power supplies, each one supply two 160W amplifier modules.

3.2. Technical Characteristics:

Input voltage: _____ +46Vdc with 18 A
Output voltage: _____ +32Vdc to 25 A
Module Current: _____ 11.5 A with black video + Audio Carrier

3.3. Technical description:

The integrated circuit IC1 operates as PWM (Pulse Width modulator).

In the IC1 pins 11 and 12 , we have the IC supply voltage that comes from zener D1. The power supply Soft Start is performed by capacitor C9 1μF with resistor R9 10K, acting in IC1 pin 4. The power supply oscillation is determined by capacitor C14 and by resistor R12. In pin 9 and 10 from integrated circuit TL494 we have pulses that will activate the current drivers Q1 and Q2.

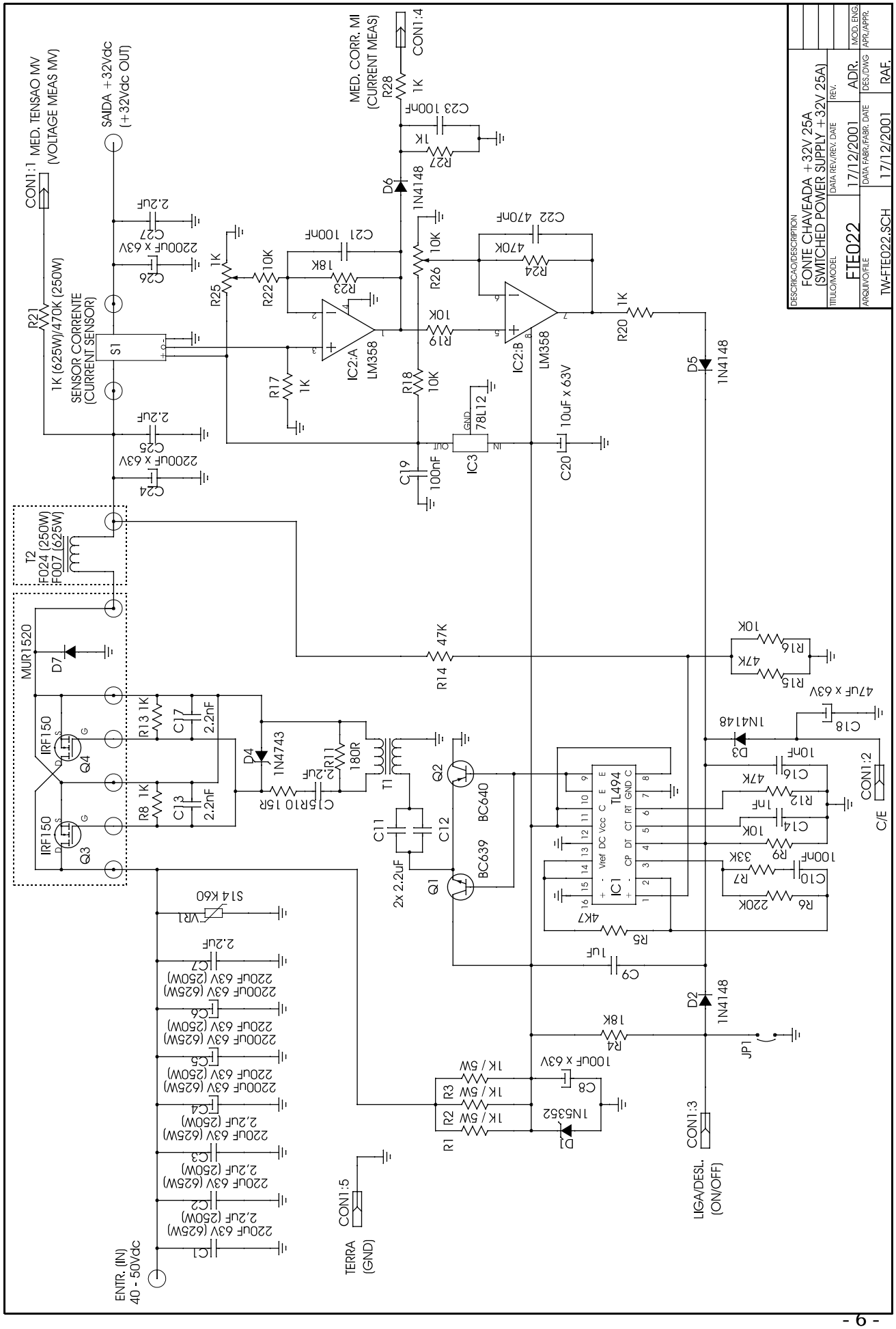
This pulses are transferred to transformer T1 that will activate, through its secondary, the FET's Q3 and Q4. D7 is a fast diode used in switching to avoid reverse voltages in the FET's. T2 function is to isolate switched power supply from the continuing voltage and also, with capacitors C24, C25, C26 and C27 form the filter LC. S1 is a current sample sensor. R25 adjusts the current to be measured in connector CN1:4.

The over current protection is performed by R26, acting in IC2B pin 6. The voltage at IC2B pin 7, feeds the IC1 control pin 4, reducing the output voltage.

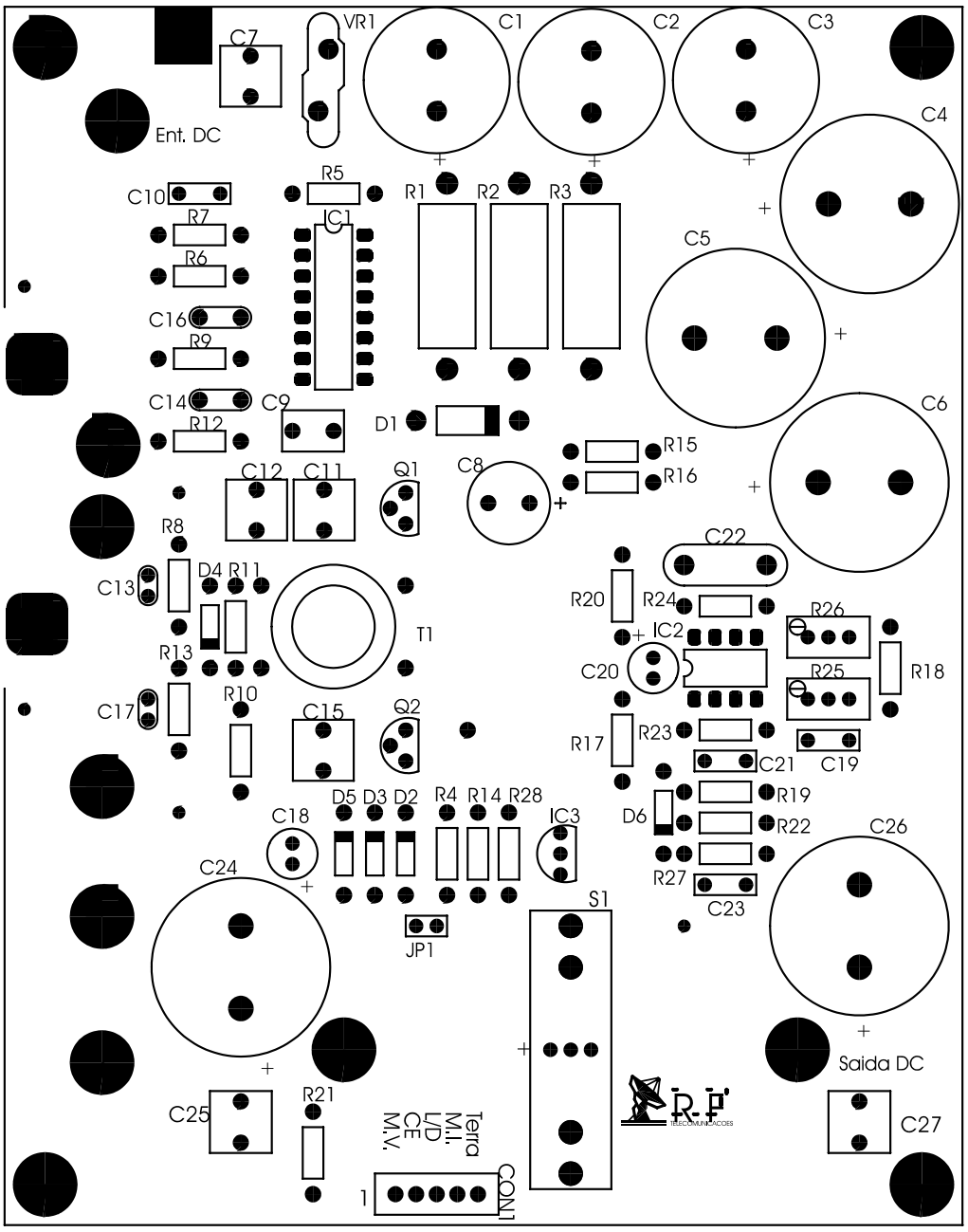
The voltage divider formed by R14 and R15//R16 determines the power supply output voltage. This voltage sample acts in pin 1 from integrated circuit TL494. Any voltage variation in the output is compensated in pin 1 that acts in the pulse width present on pins 9 and 10. The resistors R6 and R7 and capacitor C10 act in the power supply voltage feed back.

The capacitors C1 to C3 and C4 to C6 form an input filter CA after the rectification, and C1 to C3 form the output filter.

3.4. Circuit Diagram FTE022:



3.5. Layout FTE022:



3.6. Parts list FTE022:

Quant.	Description	Position	Code
1	INTEGRATED CIRCUIT LM 358	IC2	60052
1	INTEGRATED CIRCUIT TL 494 CN	IC1	60074
1	INTEGRATED CIRCUIT LM 78 L12 ACZ	IC3	60141
1	VARISTOR S14K60	VR1	71037
1	CAPAC. ELCO RADIAL 100µF 63V	C8	74018
1	CAPAC. ELCO RADIAL 10µF 63V	C20	74023
5	CAPAC. ELCO RADIAL 2200µF 63V	C4,C5,C6,C24,C26	74025
3	CAPAC. ELCO RADIAL 220µF 63V HFC	C1,C2,C3	74037
1	CAPAC. ELCO RADIAL 47µF 63V	C18	74045
1	CAPAC. POLIESTER METAL. 470ηF	C22	75015
5	CAPAC. POLIESTER METAL. 100ηF	C10,C19,C21,C23,C28	75019
1	CAPAC. POLIESTER METAL. 1µF	C9	75021
6	CAPAC. POLIESTER METAL. 2,2 µF	C7,C11,C12,C15,C25,C27	79512
1	CAPAC. MUTLILAYER 1ηF	C14	76044
1	CAPAC. MUTLILAYER 10ηF	C16	76046
2	CAPAC. PLATE 2 K 2	C13,C17	79512
4	DIODE 1N 4148	D2,D3,D5,D6	82011
1	DIODE 1N 4743 A 13V	D4	82021
1	DIODE 1N 5352 15V	D1	82074
1	TRIMPOT 10 K	R26	90027
1	TRIMPOT 1 K	R25	90028
1	SHOCK	T1	95076
1	RESISTOR 1/8W 15 Ohms	R10	100009
1	RESISTOR 1/8W 180 Ohms	R11	100020
7	RESISTOR 1/8W 1 K	R8,R13,R17,R20,R21,R27,R28	100028
1	RESISTOR 1/8W 4 K 7	R5	100037
5	RESISTOR 1/8W 10 K	R9,R16,R18,R19,R22	100041
2	RESISTOR 1/8W 18 K	R4,R23	100044
1	RESISTOR 1/8W 33 K	R7	100047
3	RESISTOR 1/8W 47 K	R12,R15,R14	100048
1	RESISTOR 1/8W 220 K	R6	100056
1	RESISTOR 1/8W 470 K	R24	100058
3	RESISTOR AXIAL WIRE 5W 1 K	R1,R2,R3	105016
1	TRANSISTOR BC 639	Q1	120007
1	TRANSISTOR BC 640	Q2	120008
1	CONNECTOR BURDY MMP-5S1	COM1	800818
1	CURRENT SENSOR	S1	IMPSEN001
1	PCB +32V 25 A SWITCHED POWER S	PCI1	PCIFTE022

4. Amplifier protection:

4.1. Function:

This module function is to protect the final amplifier modules against excessive VSWR, temperature and excessive RF power.

4.2. Technical Description:

Directional Coupling detectors in the amplifier module output gives information about the Forward RF Power and VSWR.

The voltage proportional to the Forward RF Power supplies IC5A buffer amplifier integrated circuit. This amplifier output supplies two comparing circuits, IC5B and IC2A. The integrated circuit IC5B acts as a power limiting be that, if the forward RF power exceeds the pre-fixed value by trimpot R31, transistor Q1 is conducted by diode D3 and resistor R39, removing the bias from the final amplifier gates. The integrated circuit IC2A compares the forward RF power to a –3dB adjusted value by R10, lightning the forward green Led in the panel. The integrated circuit IC2B is an inverter amplifier, be that, when the forward RF power drops below to –3dB, its output reaches +12V lightning the forward red Led in the panel.

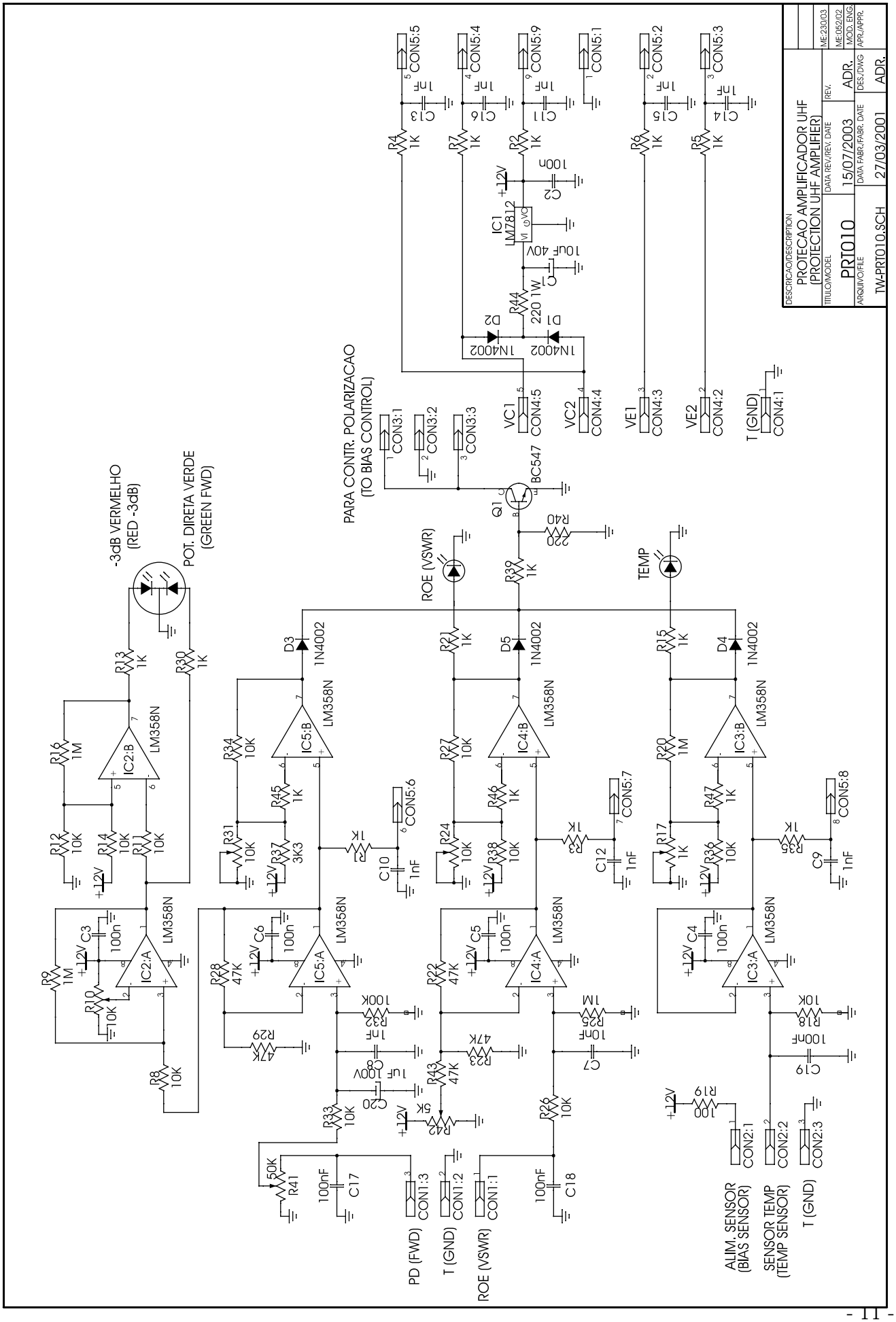
VSWR proportional voltage supplies IC4A buffer amplifier integrated circuit. IC4A output supplies IC4B comparing input, and also the monitoring in the panel by resistor R1.

If the RF signal exceeds the pre-fixed value by R24, the VSWR Led lights in the panel and transistor Q1 conducts through diode D5 and resistor R39, removing the bias from the output amplifier transistor gates.

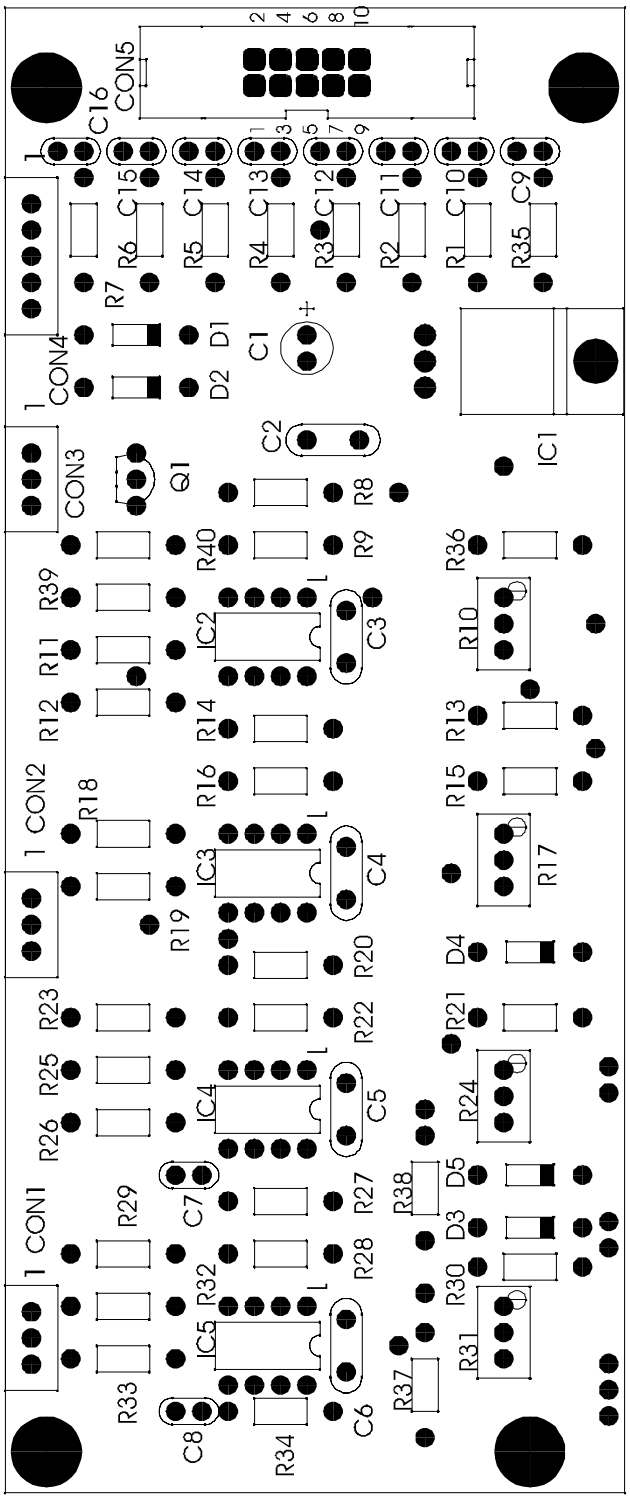
A temperature sensor protects the temperature. It provides a proportional voltage to the 10mV/°C monitored temperature, be that, for 50°C we have 500mV. Through IC3A buffer amplifier, this voltage is compared to a pre-determined value by trimpot R17 and also sent to the frontal panel. IC3B integrated circuit lights “temperature” Led in the panel and by transistor Q1, diode D4 and resistor R39, is removed the bias from the final amplifier transistors.

Diodes D1 and D2 and the fixed voltage regulator IC1, are responsible for generating the +12V voltage that supplies several IC’s from the protection circuit.

4.3. Circuit Diagram PRT010:



4.4. Layout PRT010:



4.5. Parts list PRT010:

Quant.	Description	Position	Code
4	INTEGRATE CIRCUIT LM 358	IC2,IC3,IC4,IC5	60052
1	CAPAC. ELCO RADIAL 10µF 50V	C1	74024
5	CAPAC. POLYESTER METAL. 100ηF	C2,C3,C4,C5,C6	75016
8	CAPAC. MULTILAYER. 1ηF	C7,C8,C9,C10,C11,C12,C13,C14, C19,C16	76044
5	DIODE 1N 4002	D1,D2,D3,D4,D5	82001
2	DIODE LED 3 mm (RED)	DL1	82017
1	DIODE LED 3 mm (THREE COLOR)	DL2	82093
3	TRIMPOT 10 K	R10,R24,R31	90027
1	TRIMPOT 1 K	R17	90028
1	RESISTOR 1/8W 100 Ohms	R19	100017
1	RESISTOR 1/8W 220 Ohms	R40	100021
13	RESISTOR 1/8W 1 K	R1,R2,R3,R4,R5,R6,R7,R13,R16, R21,R30,R35,R39	100028
1	RESISTOR 1/8W 3 K 3	R37	100035
11	RESISTOR 1/8W 10 K	R8,R11,R12,R14,R18,R26,R27, R33,R34,R36,R38	100041
4	RESISTOR 1/8W 47 K	R22,R23,R28,R29	100048
1	RESISTOR 1/8W 100 K	R32	100051
4	RESISTOR 1/8W 1 M	R9,R16,R20,R25	100059
1	TRANSISTOR BC 547 A	Q1	120003
1	FIXED VOLTAGE REGULATOR 7812	IC1	126019
1	MALE CONECTOR MULTIP. 3 PINS	COM1,COM2,COM3	800817
1	CONNECTOR BURDY	COM4	800818
1	MALE CON. FLAT-CABLE ANG. 10 P.	COM5	801814
1	PCB 250W UHF PROTECTION	PCI1	PCIPRT010

5. Supply fuses:

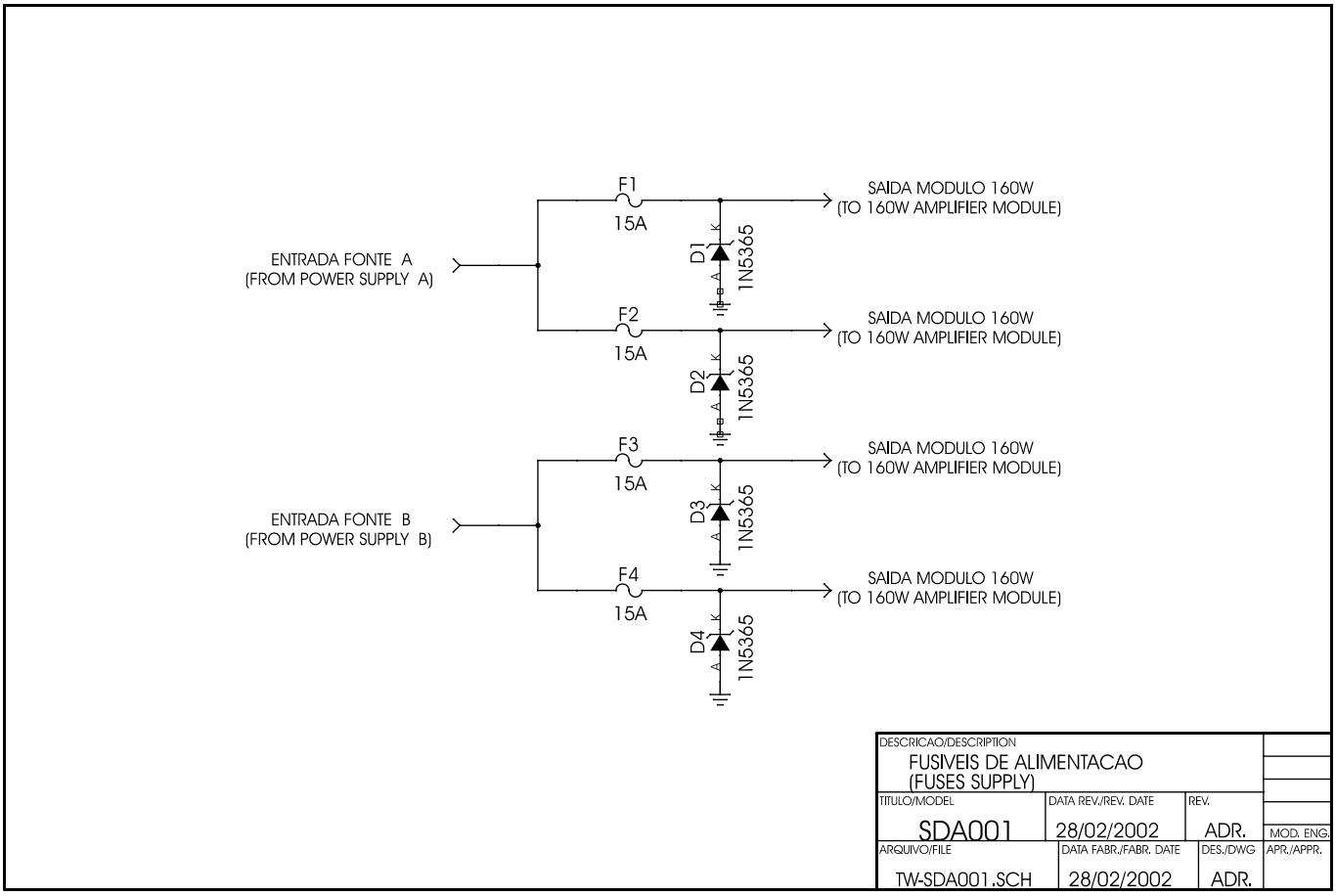
5.1. Function:

This circuit protects the both power supplies against short circuit zener diodes D1 to D4, perform the over voltage protection.

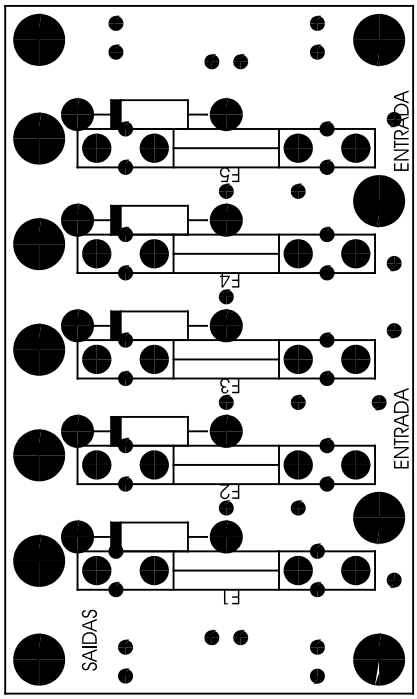
5.2. Technical Description:

The +32Vdc voltage of each internal power supplies the power amplifier modules by 4 fuses of 15 A each, F1 and F2 for power supply A and F3 and F4 for power supply B.

5.3. Circuit diagram SDA001:



5.4. Layout SDA001:



5.5. Parts list SDA001:

Quant.	Description	Position	Code
5	DIODE ZENER 1N 5365		82116
1	FUSE 5 AMP		86005
4	FUSE 15 AMP		86041
1	PCB 625W UHF AMPLIFIER OUTPUT	PCI1	PCISDA001

6. 625W final amplifier:

6.1. Function:

Its function is to amplify the power that comes from splitter 1:8 to a 160W output level.

6.2. Technical characteristics:

Output power: _____ 160W Peak Sync
Gain: _____ 20 dB
Activating temperature: _____ 56°C

6.3. Technical Description:

The UHF 160W amplifier is formed by the combination of two 80W amplifiers.

At the input and output there are two 3 dB hibrid couplers with the rejection loads R1 and R14.

The signal splitted by the 3 dB coupler input feeds the two 80W amplifiers through C1 and C2.

At the input of each 50W amplifier there is a balun L1 and L2 that splittes the signal again for two transistor Q1, Q2 and Q3, Q4 respectively.

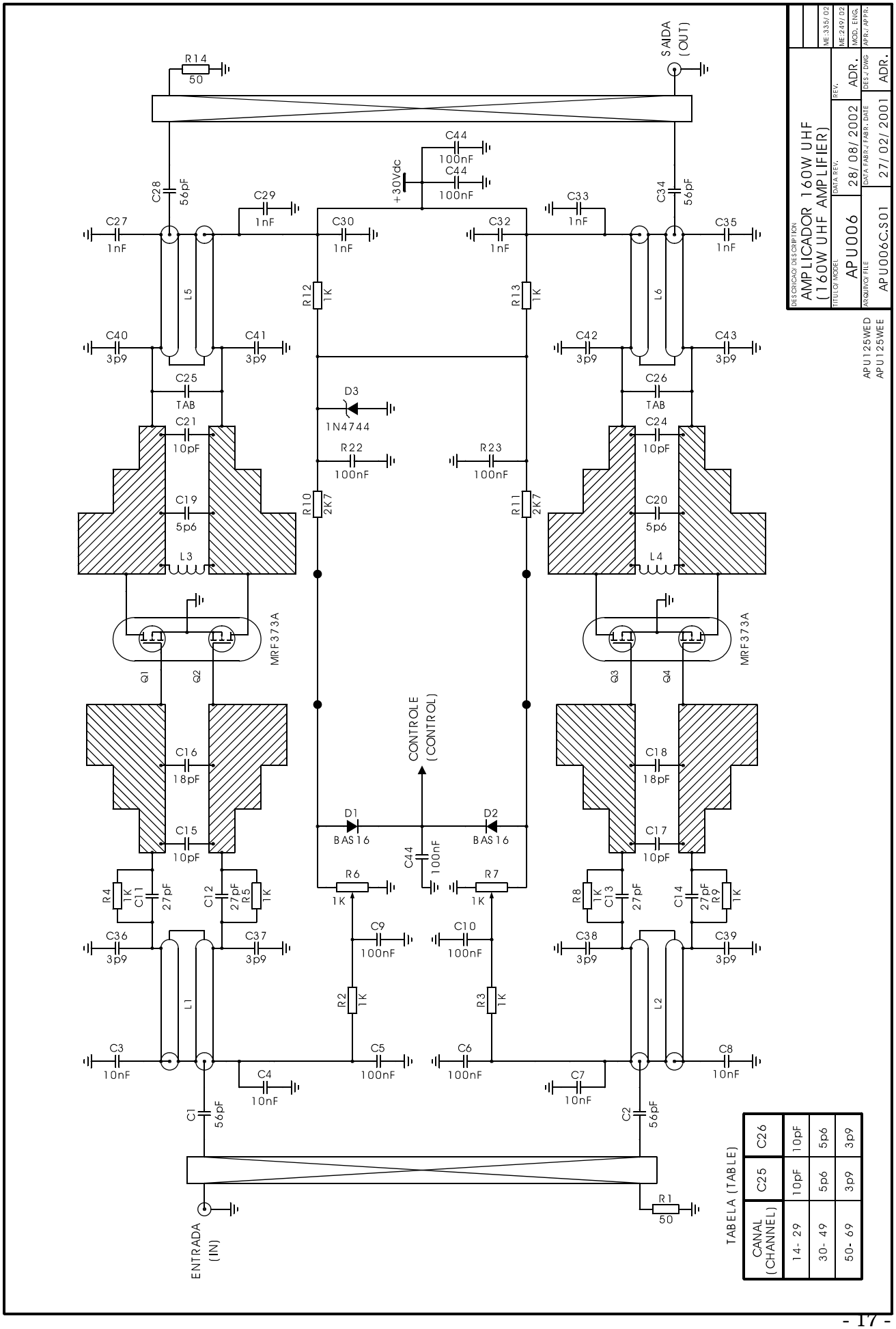
The amplified signals through the baluns L5 and L6 are combined in the final 3 dB coupler with the coupling capacitors C28 and C34.

The bias circuit is formed by resistores R12, R13 and zener diode D3 that generates a +15Vdc.

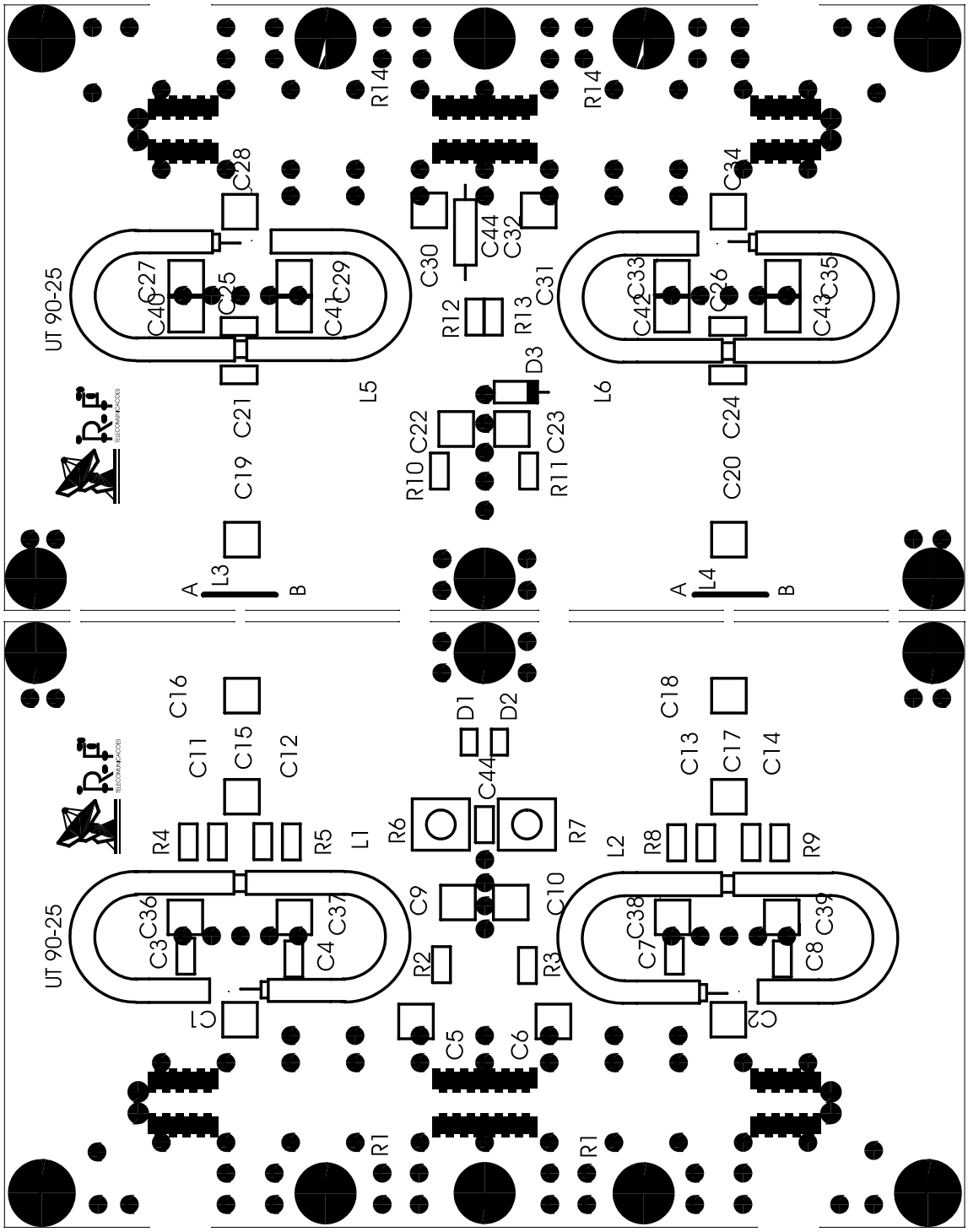
Through trimpot's R6 and R7 the bias voltage for the transistor's gate are adjusted.

The diode D1 and D2 allow a protection, for the amplifier, reducing the bias voltage and the gain of the amplifier.

6.4. Circuit Diagram APU006:



6.5. Layout APU006:



6.6. Parts list APU006:

Quant.	Description	Position	Code
1	CAPAC. ELCO. RADIAL 220µF 63V HFC	C31	74037
1	DIODES 1N 4733 A 5V1	D3	82018
1	DIODES 1N 4735 A 6V2	D4	82022
4	CAPAC. MONOL. 27ρF	C11,C12,C13,C14	IMPC00088
6	CAPAC. MONOL. 10ρF	C15,C17,C21,C24,C25,C26	IMPC00092
2	CAPAC. MONOL. 5ρ6	C19,C20	IMPC00093
2	CAPAC. MONOL. 22ρF	C16,C18	IMPC00091
4	CAPAC. MONOL. 56ρF	C1,C2,C28,C34	IMPC00101
30 Cm	CABLE COAXIAL UT 90-25	L1,L2,L5,L6	IMPCX0008
2	RESISTOR RF CBT-20-5 50 Ohms	R1,R14	IMPR00011
4	TRANSISTOR LDMOS MRF 373 A	Q1,Q2,Q3,Q4	IMPT00131
8	CAPACITOR SMD 1206 10ηF	C3,C4,C7,C8,C27,C29,C33,C35	ISMCAP103
8	CAPACITOR SMD 1206 100ηF	C5,C6,C9,C10	ISMCAP104
2	DIODE SMD BAS16	D1,D2	ISMDIOS16
10	RESISTOR SMD 1206 1K	R2,R3,R4,R5,R8,R9,R10,R11, R12,R13	ISMRES102
2	TRIMPOT SMD 1K	R6,R7	ISMTRP102
1	PCB 160W UHF AMPLIFIER LDMOS	PCI1	PCIAPU006

7. 625W UHF amplifier: