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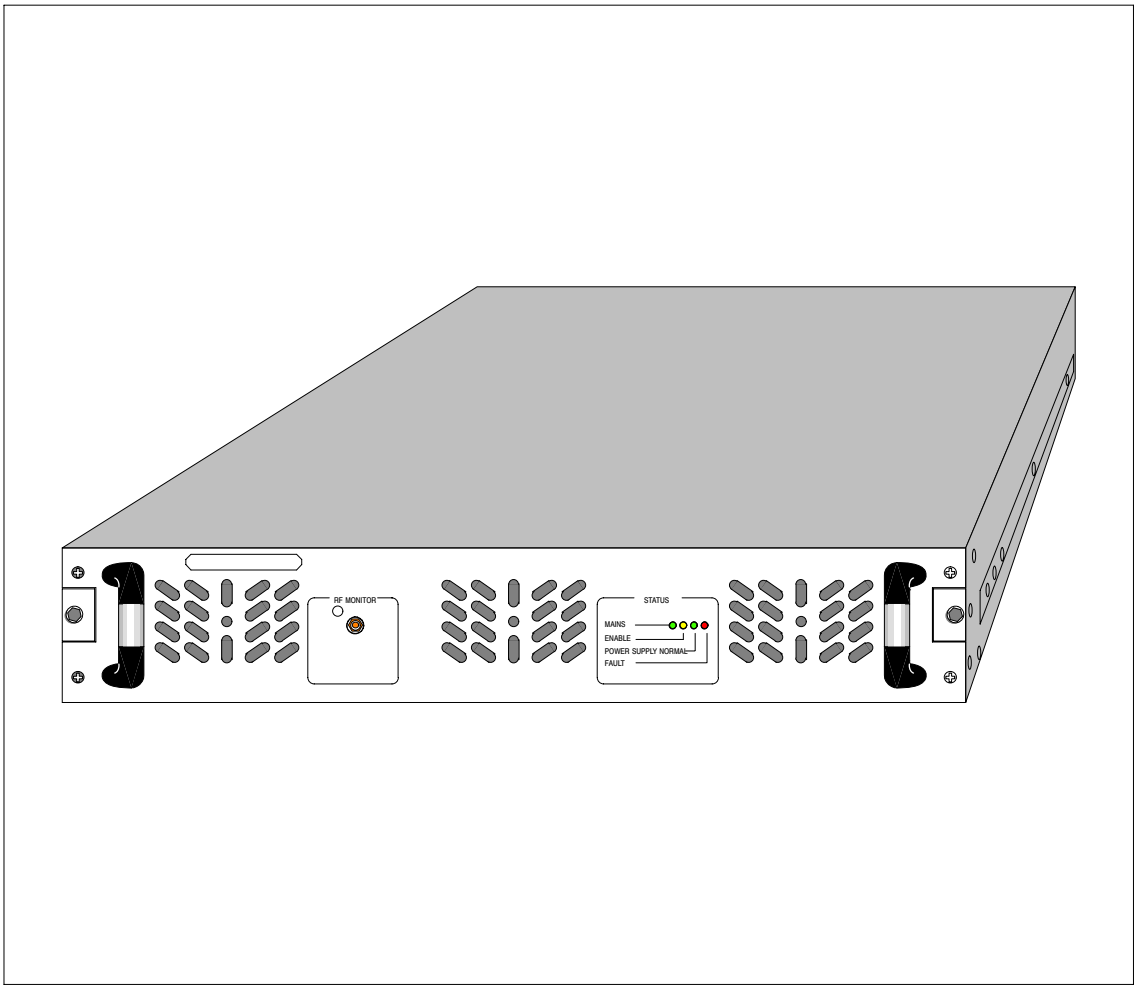

W1-235L BI LDMOS AMPLIFIER
p/n. 5110123502

technical manual

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W1-235L BI FULL LDMOS LIQUID COOLED SS H.P.A.

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CHAPTER 1:
GENERAL INFORMATION

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CHAPTER 1: GENERAL INFORMATION

1.1 MANUAL APPLICABILITY

This technical manual provides information relevant the following unit:

- W1-235L BI Full LDMOS Water Cooled Solid State HPA . . . . . p/n 5110123502.

For the sake of simplicity, in the following, the amplifier will be referred to as W1-235L.

1.2 GENERAL INFORMATION

W1-235L RF Amplifier unit (see general layout on fig. Fig. 1.1) is manufactured using high reliability, solid state components. It is able to work in the frequency range from 55 to 88MHz an delivers an output power of 3000Wp.s..

The cooling system of the W1-235L module is a cold plate which carries out the indirect thermic exchange between the electronic devices and a suitable cooling liquid. This system is more efficient than the air-cooled ones concerning with the dissipation of high thermic powers generated by several heat sources uniformly distributed. Gain of the module can be adjusted without need of module extraction.

W1-235L amplifier final stages work in AB class to reach a good compromise between introduced distortion and dissipated power with low current consumption.

W1-235L module is self-protected from overdrive of the RF input power, from incidental reflected power, from overvoltage of the amplifier power supply voltages and from driver and final stage abnormal absorption. The protections are performed through the module control logic section, which consists of a master CPU *(CPU Module Board)* and an interface board *(Module Field Interface).* The data acquired by the module control logic section are also transferred to the equipment control logic (G042) via RS485 and consequently the module status and functioning can be monitored on G042 control logic monitor (see figure Fig. 1.5).

Refer to fig. Fig. 1.2 and fig. Fig. 1.4 for simplified block diagrams of the W1-235L RF Amplifier.

The W1-235L RF Amplifier is composed of a Full LDMOS Amplifer section, a power supply section, a control logic section and a liquid cooling section.

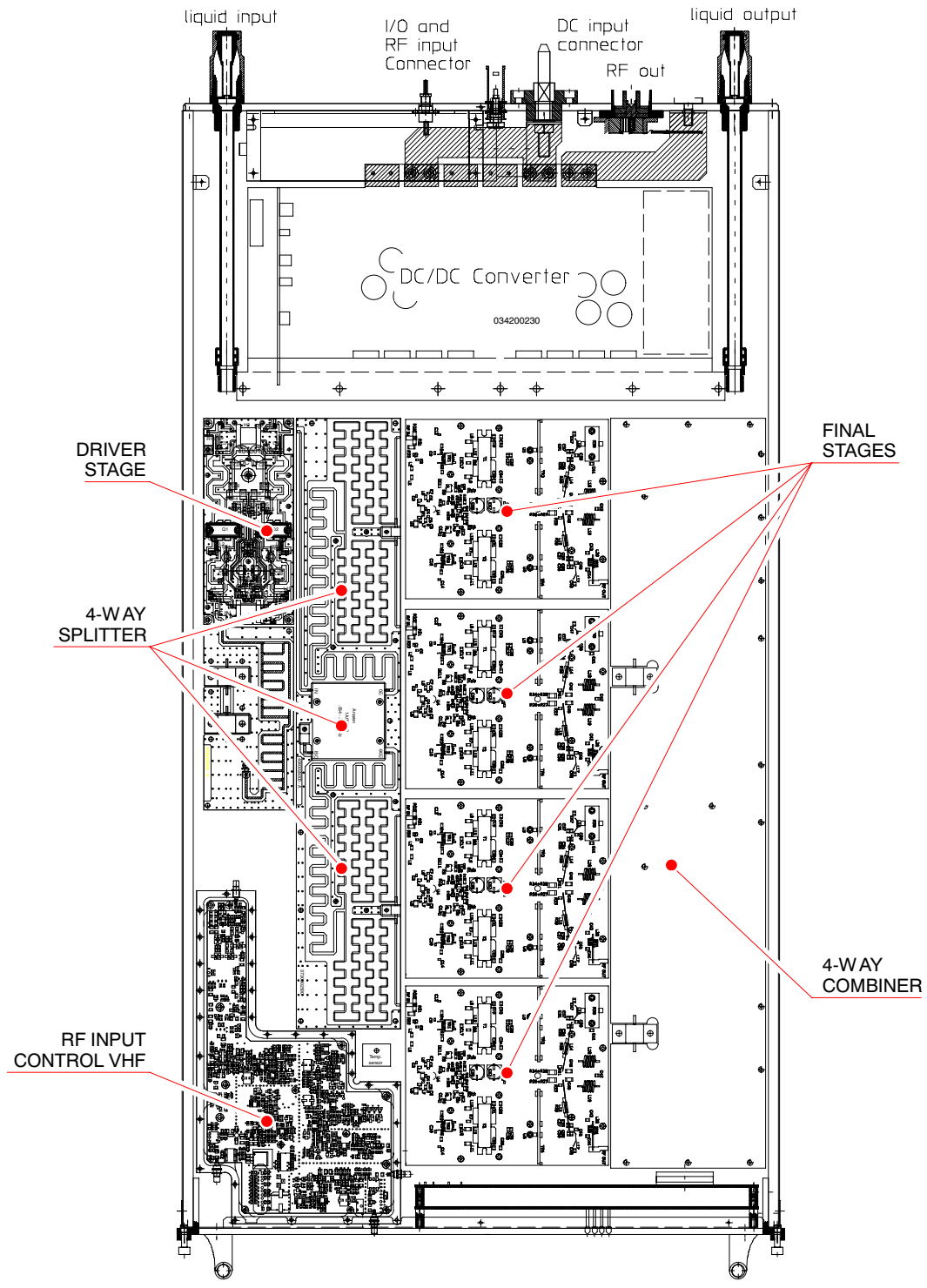

Fig. 1.1 - W1-235L General layout

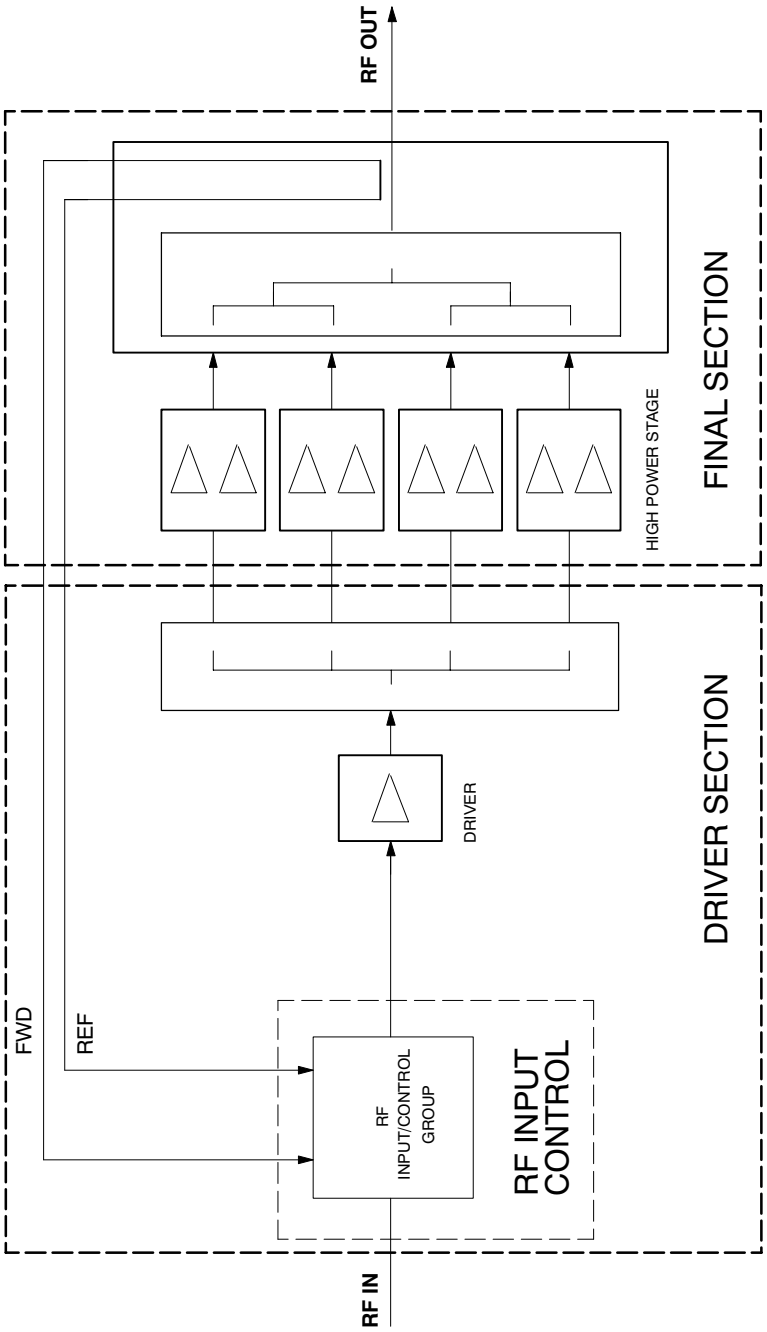

Fig. 1.2 - W1-235L/ Block Diagram

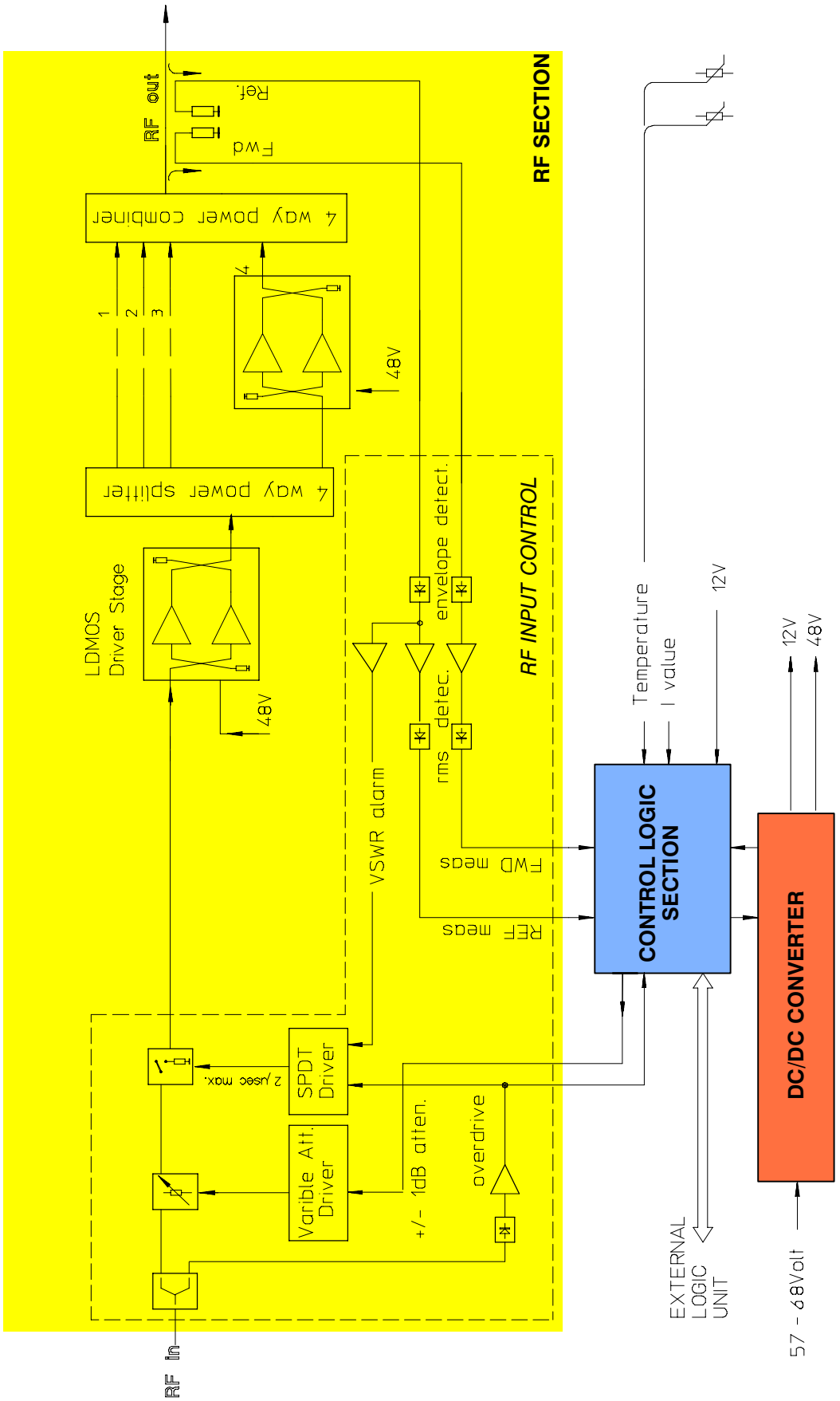

Fig. 1.3 - W1-235L RF Amplifier section/ Block Diagram

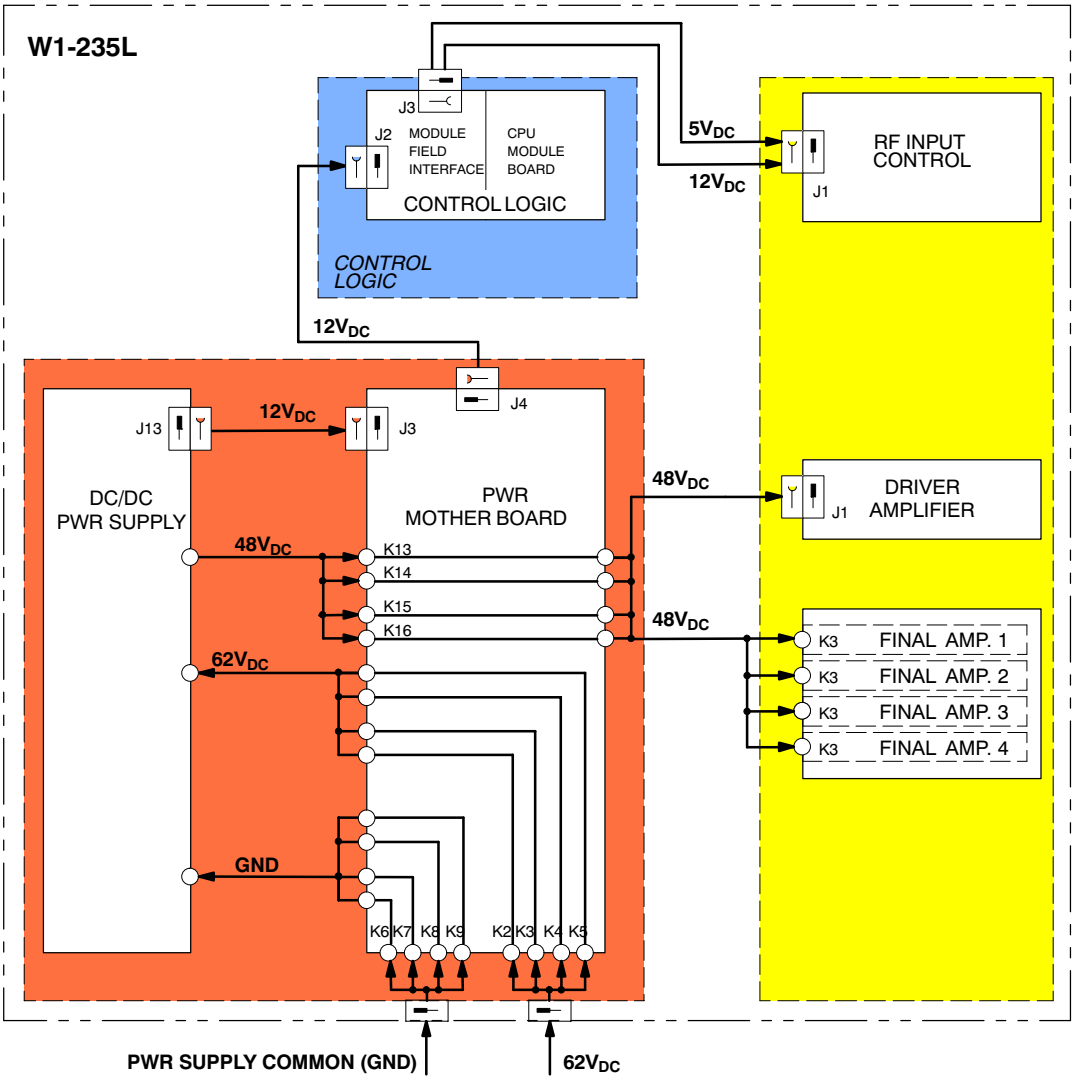

Fig. 1.4 - Module Power Supply section/ Block Diagram

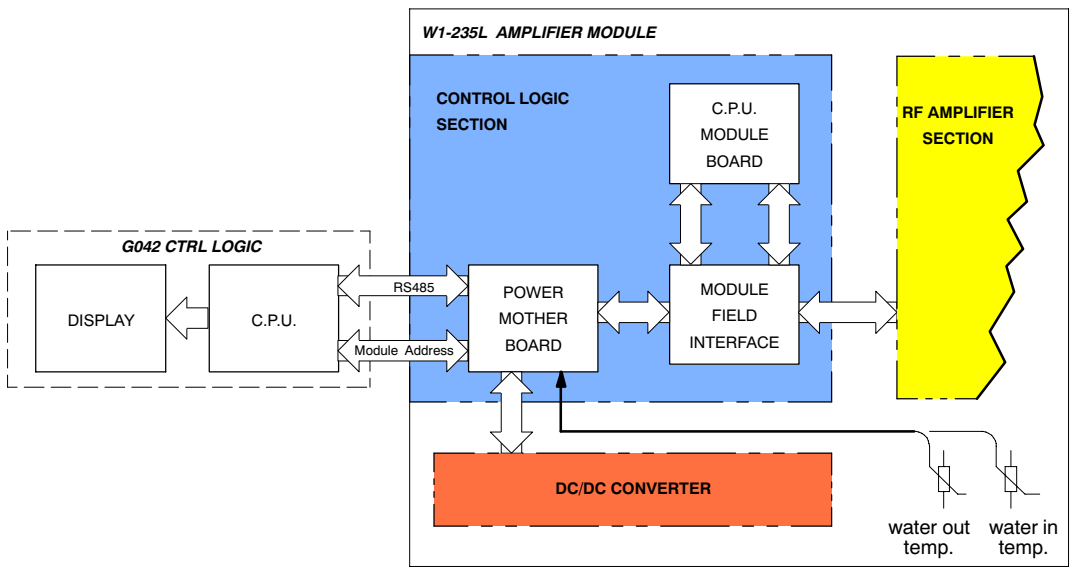

Fig. 1.5 - Control Logic section / Block Diagram

1.3 TECHNICAL SPECIFICATIONS

RF CHARACTERISTICS	
Frequency range	55 to 88MHz
Output Power	3000Wp.s.
Input Power	30Wp.s.
Power Gain	50±2dB
Input/output Impedance	50Ω
Input Return Loss	<-18dB
Power Consumption	4900W
Cooling	Cold-plate (liquid cooling)
Operating Temperature	0°C to +45°C
I/O CONNECTORS	
RF Input (*on rear panel*)	
RF ouput (*on rear panel*)	7/16” snap-on
Power Supply Input (*on rear panel*) **+V_{DC}** **GND**	 ● Slide-in plug (male) ● on dowels
I/O Signal *(on rear panel)*	22 pin ”D” female
Insert module	microswitch with limit stop
RF Monitor *(on front panel)*	”SMB” male

MECHANICAL	
Frame	19”-2HE
Dimensions (wxhxd) (mm):	423x68x800
Weight (kg):	25

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CHAPTER 2:
OPERATING INSTRUCTIONS

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CHAPTER 2: OPERATING INSTRUCTIONS

2.1 INTRODUCTION

The present chapter describes all the controls and indicators available to the operating personnel and the settings concerning the control logic section of W1-235L.

Note that the W1-235L is not provided with turn-on control since the ON/OFF condition is determined by the equipment housing it. Therefore refer to the equipment technical manual which the W1-235L is part of, for the operating instruction related to turn-on and off.

All the information about the RF Amplifier state of functioning are sent via RS485 serial line to G042 Control Logic (see G042 Control Logic technical manual). The same information is available on the RS232 9 pin connector, which is attainable by opening the front panel.

2.2 CONTROLS AND INDICATORS

All the indicators are easily available to the operator. The following Tab. 2.1 refers to fig. Fig. 2.1 in which the front and rear panels of the W1-235L are shown.

In this table the left-column numbers are the call-outs of all controls, indicators, connectors, meters, displays, etc. mounted on the W1-235L. Furthermore, a brief description is given for each function.

In order to adjust the Gain of the HPA, the relevant controls can be made available by unscrewing the W1-235L front panel. Fig. Fig. 2.2 shows the front view of the W1-235L with the front panel removed while Tab. 2.2 refers to this figure.

In this table the left-column numbers are the call-outs of all controls available by removing the front panel of the W1-235L. A brief description is given for each control.

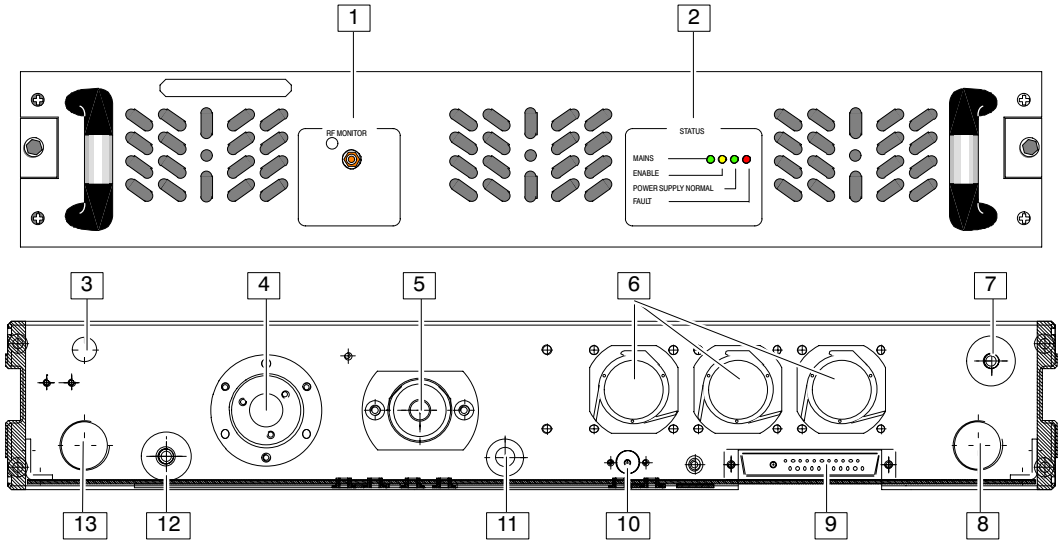

Fig. 2.1 - W1-235L / Front and rear panels

Tab. 2.1 - W1-235L Amplifier Front and Rear Panels (ref. Fig. 2.1)

NO.	LABEL	FUNCTION
1	RF MONITOR	SMB connector (male), it allows monitoring the RF output signal of the HPA. Trimmer; allows adjusting the total gain of the HPA (-2dB to +2dB).
2	MAINS	Green led; it lights up when the Mains is supplied to the DC/DC Power Supply.
	ENABLE	Yellow led; when lit, it indicates that the enable signal for the DC/DC power supply has been sent by the Master CPU Logic. In this condition the DC/DC Power Supply is enable properly.
	POWER SUPPLY NORMAL	Green led; when lit, it indicates that the DC/DC converter works regularly (No P.S. fault).
	FAULT	Red led; when lit, it indicates that the RF amplification chain has been interrupted because of a unit fault.
3		Microswitch; it is used to communicate the correct insertion of the HPA to the logic section of the HPA itself.
4		7/16” Snap on connector; it is the RF output.
5		Slide in plug (male); it is the power supply (+DC) input.
6		Exhaust cooling air outlets.
7		Dowel for the positioning of the module in the mainframe and for the grounding of the unit.
8		Quick hydraulic connector. It is the input of the water pipe inside the HPA.
9		22 pin D connector (male); it is used for exchanging I/O signals with G042 and addressing HPAs (for the akcowledgement on G042). Pin-out assignment of the connector is listed on table 2.3.
10		OSP connector; it is the RF input.
11		Multilamellar plug. It feeds the current to the capacitance of the HPA module internal power supply, when it is inserted in the transmitter rack in order to control the transient conditions.
12		Dowel for the positioning of the module into the mainframe.
13		Quick hydraulic connector. It is the output of the water pipe inside the HPA.

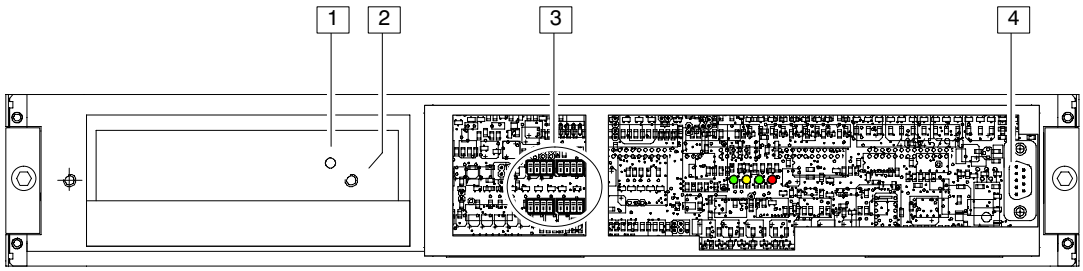

Fig. 2.2 - W1-235L/ Front view of the internal panel

Tab. 2.2 - W1-235L Amplifier front view (without Front Panel) (ref. Fig. 2.2)

NO.	DESCRIPTION	FUNCTION
1	Trimmer	It allows adjusting the total gain of the HPA.
2	RF MONITOR	SMB connector (male), it allows monitoring the RF output signal of the HPA.
3	Dip-Switches	Four dip-switches allow setting the HPA according to the required use (analog/digital signal; VHF/UHF). For further details refer to para. 2.4.1
4	9 pin D connector	RS232 serial line. It allows to monitor directly the HPA status, without passing through RS485 serial line.

2.3 W1-235L INTERFACING TOWARD G042 CONTROL LOGIC UNIT

The pin-out assignment of I/O signals connector (type ”D” 22 pins), is listed on Tab. 2.3. The interfacing between W1-235L module and G042 Control Logic unit, is performed through *Power Mother Board (p/n. 405025911)* and *Module Field Interface (p/n. 405461810)* board. The connector is available on the rear panel of the HPA.

Tab. 2.3 - Pin-out assignment of 22 pins ”D” connector for I/O signals

PIN	FUNCTION	PIN	FUNCTION
1-2	GND	13-14	+24V AUX.
3	+24V AUX.	15	RX1C (RS485)
4	EXT ON/OFF	16	INTERLOCK MODULE (+63V presence)
5	TX1C (RS485)	17	*NOT USED*
6	GND	18	ADDRESS 3
7	ADDRESS 4	19	ADDRESS 1
8	ADDRESS 2	20	ADDRESS 0
9	ADDRESS 5	21	SWITCH BREAK
10-11	*NOT USED*	22	*NOT USED*
12	GND		

2.4 W1-235L CONTROL LOGIC SECTION SETTINGS

The boards of W1-235L control logic section (location on Fig. 2.3) are factory set, and do not require any other setting. In case a board of the logic section have to be replaced it is advisable to check the correct settings of jumpers and dip-switches. The following paragraphs give the information about the correct settings of the logic boards of the W1-235L.

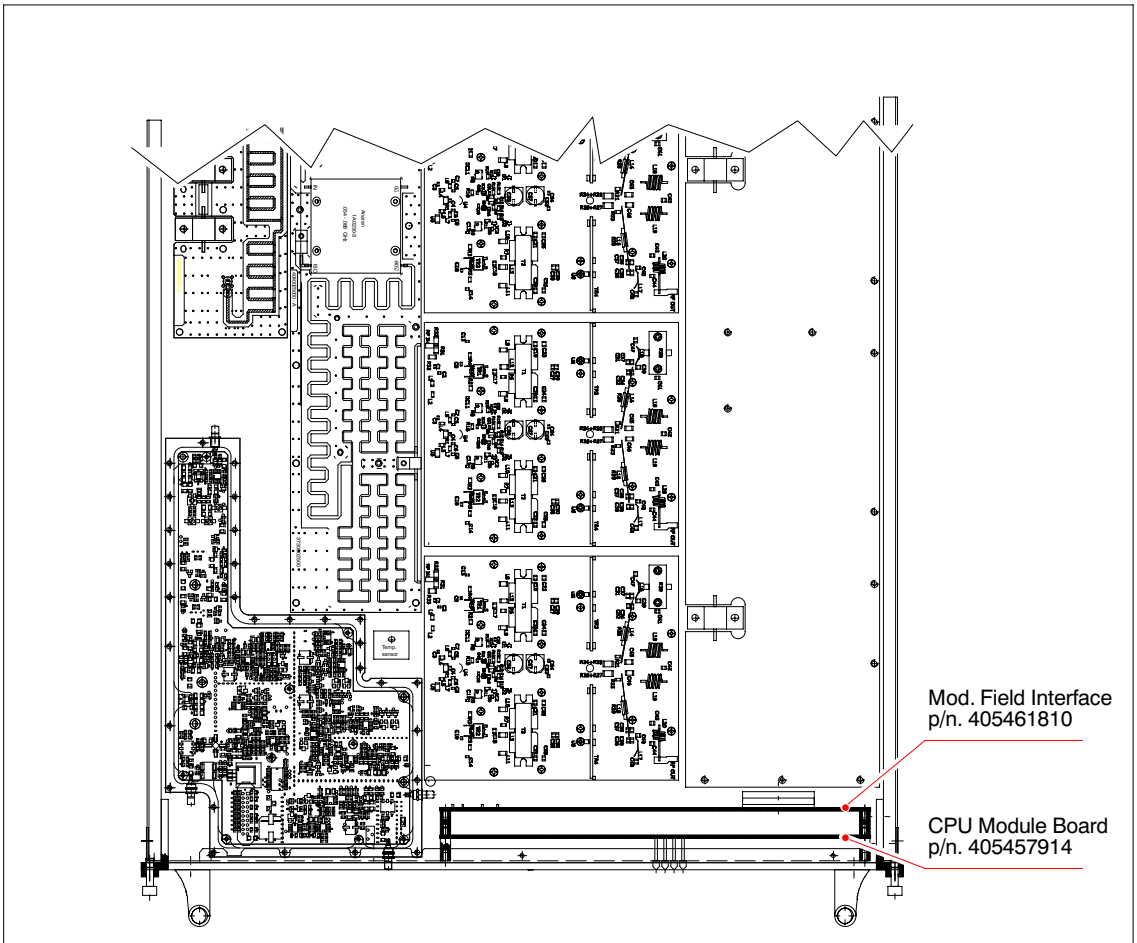

Fig. 2.3 - W1-235L/ Ctrl Logic section location

2.4.1 CPU Module Board (p/n. 405457914)

DIP-SWITCHES
The dip-switches location and relevant settings are shown on Fig. 2.4.

JUMPERS
The jumpers location and relevant settings are shown on Fig. 2.4.

2.4.2 Module Field Interface (p/n. 405461810)

DIP-SWITCHES
No dip-switches is present on this board.

JUMPERS
Only U1 jumper is present on the board; location and relevant setting is shown on Fig. 2.4.

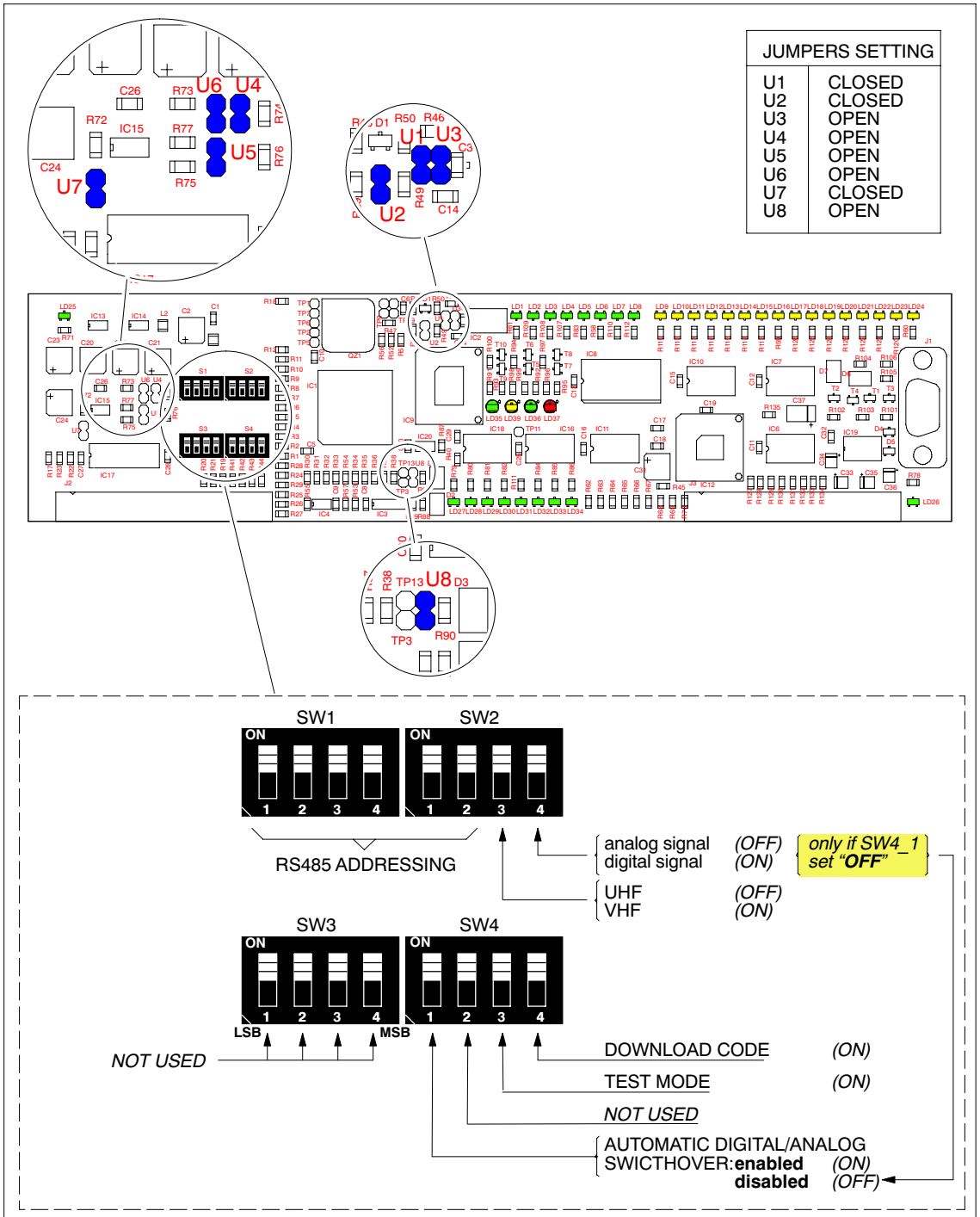

Fig. 2.4 - CPU Module Board set-up

2.4.3 LEDs description

The functioning state of the W1-235L module is shown by leds placed on the module control logic boards as indicated on Fig. 2.5 (*CPU Module Board p/n. 405457914*) and Fig. 2.6 (*Module Field Interface p/n. 405461810*).

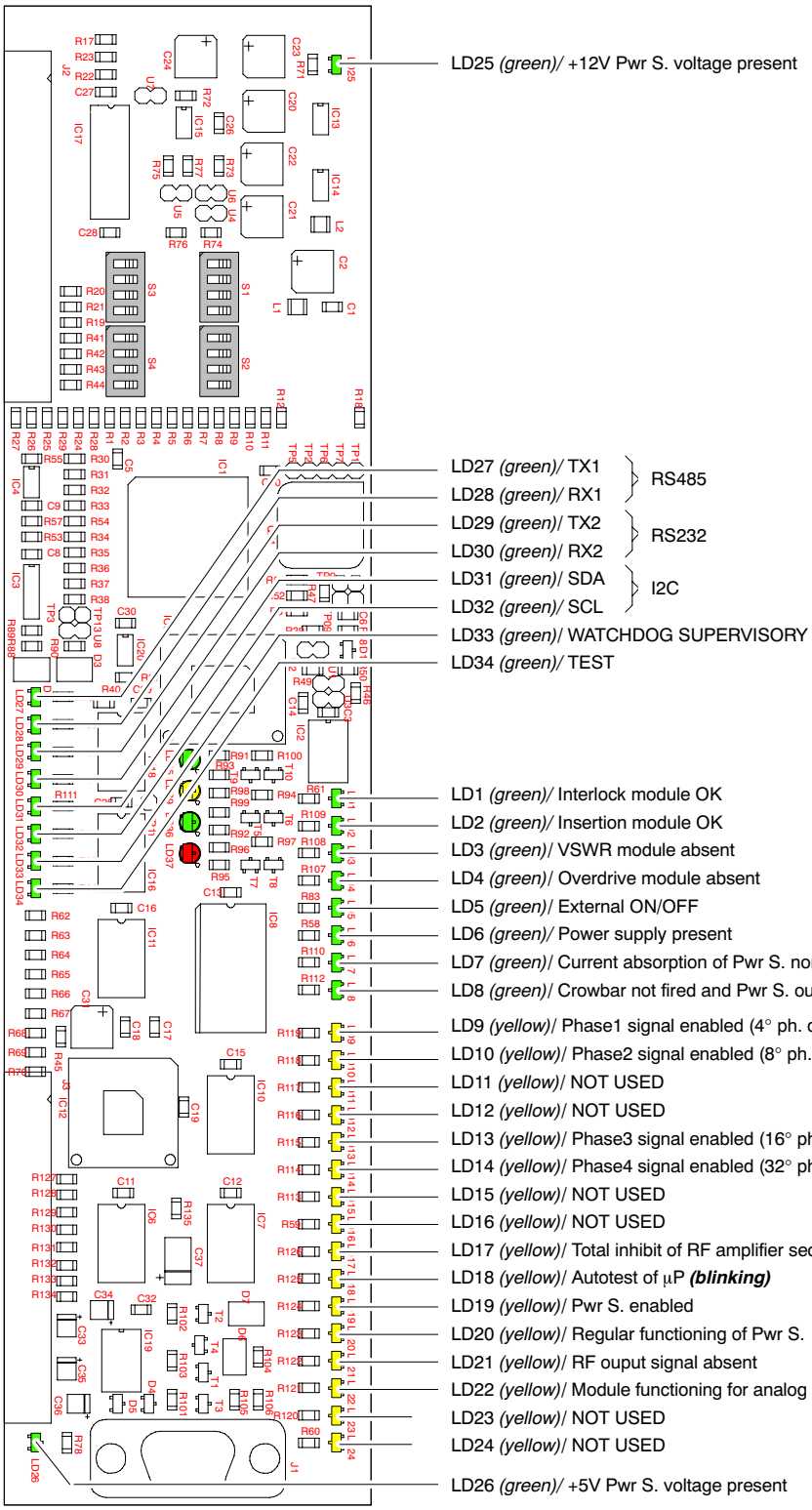

Fig. 2.5 - CPU Module Board (p/n. 405457914) leds

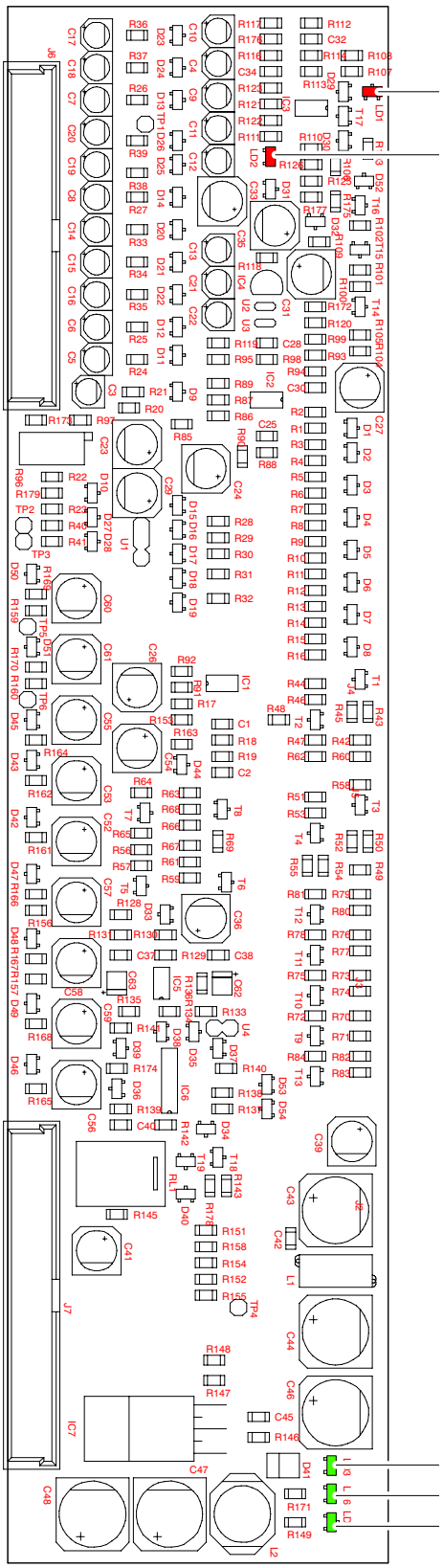

Fig. 2.6 - Module Field Interface (p/n. 405461810) leds

2.5 MEANING OF *ANA_IN/OUT* AND *DIG_IN/OUT* SIGNALS

In order to make the comprehension of the circuit diagrams easier, the following paragraph gives information on the meaning of *ANA_IN/OUT* and *DIG_IN/OUT* signals used on circuits diagrams of the *Control Logic Section* of the HPA. Tab. 2.4 lists he meaning of *ANA_IN/OUT* signals (*analogic signals*); Tab. 2.5 lists the meaning of *DIG_IN/OUT* signals (*digital signals*). For both tables are also given the references to the signals on G042 display.

Tab. 2.4 - Meaning of *ANA_IN/OUT* signals

ANALOG INPUTS	REF. ON G042	MEANING
ANA_IN1	Fnl1	*Current absorption of Final stage 1*
ANA_IN2	Fnl2	*Current absorption of Final stage 2*
ANA_IN3	Drv	*Current absorption of Driver stage*
ANA_IN4	NOT USED	
ANA_IN5	Water_Temp_In	*Input Liquid Temperature*
ANA_IN6	Fnl3	*Current absorption of Final stage 3*
ANA_IN7	Fnl4	*Current absorption of Final stage 4*
ANA_IN8	NOT USED	
ANA_IN9	PDrv	*Current absorption of Pre-Driver stage*
ANA_IN10	Water_Temp_Out	*Output Liquid Temperature*
ANA_IN11	Fnl5	*NOT USED*
ANA_IN12	Fnl6	*NOT USED*
ANA_IN13	Fnl7	*NOT USED*
ANA_IN14	Fnl8	*NOT USED*
ANA_IN15	Pwr_Out	*Output Power meas.*
ANA_IN16	Pwr_In	*Input Power meas.*
ANA_IN17	NOT USED	
ANA_IN18	Pwr_Refl	*Reflected Power meas.*
ANA_IN19	NOT USED	
ANA_IN20	NOT USED	
ANA_IN21	VAmp	*Power Supply voltage of Final stages meas.*
ANA_IN22	NOT USED	
ANA_IN23	VSer	*Power Supply Service voltage meas.*
ANA. OUTPUTS	**REF. ON G042**	**MEANING**
PWM1	Gain_Adj	*Soft start*
PWM2	APL_Adj	*NOT USED*

Tab. 2.5 - Meaning of *DIG_IN/OUT* signals		
DIGITAL INPUTS	**REF. ON G042**	**MEANING**
DIG_IN1	Module Interlock	*Interlock presence*
DIG_IN2	Inserted Module	*HPA correctly inserted*
DIG_IN3	Vswr	*Absence of Vswr*
DIG_IN4	Overdrive_Mod	*Absence of overdrive*
DIG_IN5	Ext_On/Off	*External On/Off presence*
DIG_IN6	Ps_Fault	*Failure of DC/DC Converter*
DIG_IN7	Ps_Idmax	*Maximum current absorption of DC/DC Converter*
DIG_IN8	Ps_Crow	*DC/DC Converter crowbar fired*
DIGITAL OUTPUTS	**REF. ON G042**	**MEANING**
DIG_OUT1	NOT USED	
DIG_OUT2	NOT USED	
DIG_OUT3	NOT USED	
DIG_OUT4	NOT USED	
DIG_OUT5	NOT USED	
DIG_OUT6	NOT USED	
DIG_OUT7	NOT USED	
DIG_OUT8	NOT USED	
DIG_OUT9	Total Inhibit	*Total Inhibit signal generated by Module Field Interf.*
DIG_OUT10	Test	
DIG_OUT11	Enable	*'Enable' signal for DC/DC Converter*
DIG_OUT12	Panel_Ps_Normal	*Indication of 'POWER SUPPLY NORMAL' on unit front panel*
DIG_OUT13	Panel_Prf_Faullt	*Indication of 'FAULT' (absence of RF output) on unit front panel*
DIG_OUT14	Module_Analog	*Indication of functioning mode: DVB, DTV or Video amplifiers*

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CHAPTER 3:
FUNCTIONAL DESCRIPTION

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CHAPTER 3: FUNCTIONAL DESCRIPTION

3.1 INTRODUCTION

The present chapter contains a detailed functional analysis of the W1-235L Amplifier module. The chapter is arranged in paragraphs as follows:
3.2 - Description of the RF Amplifier section
3.3 - Description of the Control Logic section
3.4 - Description of the Power Supply section
3.5 - Description of the Liquid Cooling section

RF Amplifier section, in turn, consist of the following subassemblies (see Fig. 3.1):
- RF Input Control section
- RF Driver section
- RF Final section

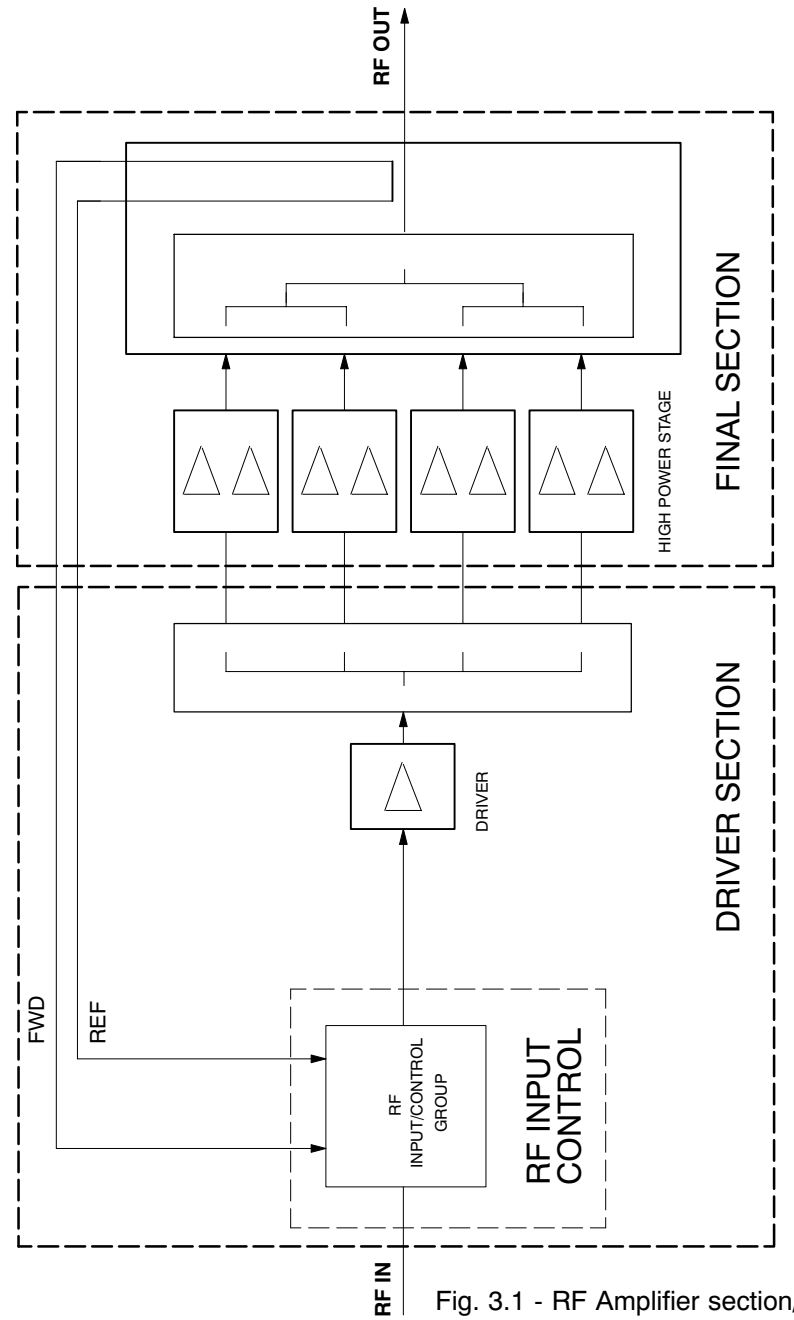

Fig. 3.1 - RF Amplifier section/ Block Diagram

3.2 DESCRIPTION OF THE RF AMPLIFIER SECTION

The RF Amplifier section mainly consists of the RF Input/Control board, located at the input of the whole amplifier chain, and of the RF Amplifier Stages (PreDriver, Driver and Final section) which consists of RF amplifiers combined in order to get the necessary output power.

3.2.1 RF Input Control section (ref. dwg. no. 405625013ED)

The functional description of this assembly is referred to figure Fig. 3.2 simplified block diagram.

An integrated splitter splits (in two) the RF input signal: the former signal is routed to the RF Driver Section (via an RF Attenuator), the latter signal is processed and sent to the *Control Logic Section*, in order to perform the control of the RF output power.

For this purpose an envelope detector detects the input signal and through a suitable circuit (SPDT Driver) drives an RF switch which routes the RF signal on a dummy load if an overdriving occurs. The same signal is also sent to the *Control Logic Section* for processing. After the envelope detetctor an *rms* detector detects the signal and sends the information to the *Control Logic Section* for displaying the input power of the RF signal.

The *Control Logic Section* processes the data from *RF Input Control* board and sends a signal which drives the variable attenuator in order to perform the reduction of the output power; the variable attenuator can be also adjusted by a trimmer (accessible to the operator by removing the front panel of HPA).

A directional coupler at the output of HPA, picks up two RF signals proportional to *FWD* and *REF* power and sends them to *RF Input Control* board:

- *FWD* signal is split in two: the first signal is available to the operator on front panel of HPA for monitoring, the other one is first envelope and then rms/peak detected (according to module analog/digital signal). This last signal is sent to the *Control Logic Section.*
- *REF* signal is envelope detected and used to trigger the SPDT Driver in case of VSWR. An *rms/peak* detector follows which sends VSWR information to the *Control Logic Section* for processing.

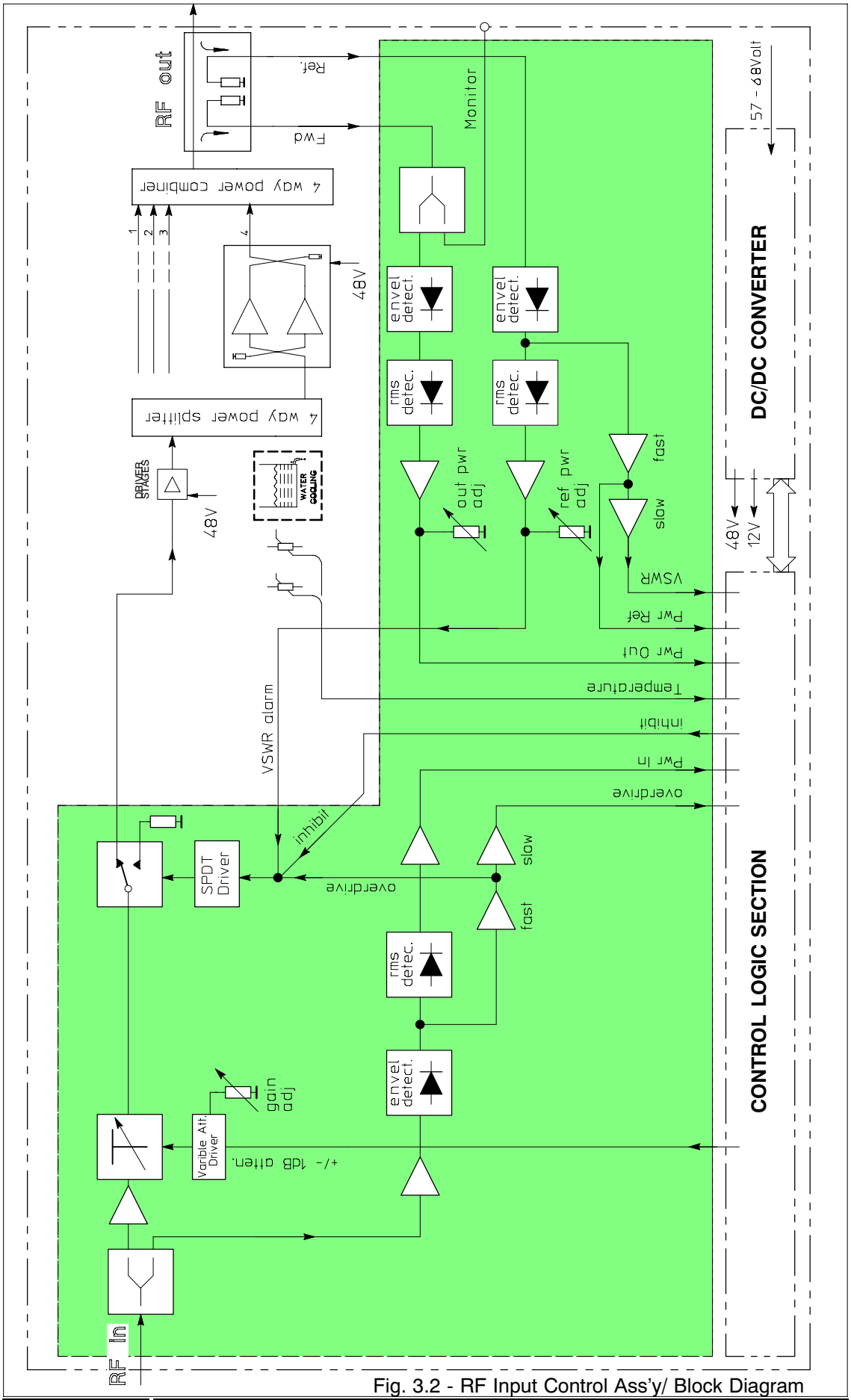

Fig. 3.2 - RF Input Control Ass'y/ Block Diagram

3.2.2 RF Driver section

The RF output signal from RF Input/Control is applied to the RF Driver Section (fig. Fig. 3.3) composed of:

- Driver stage;
- 4-W ay Splitter

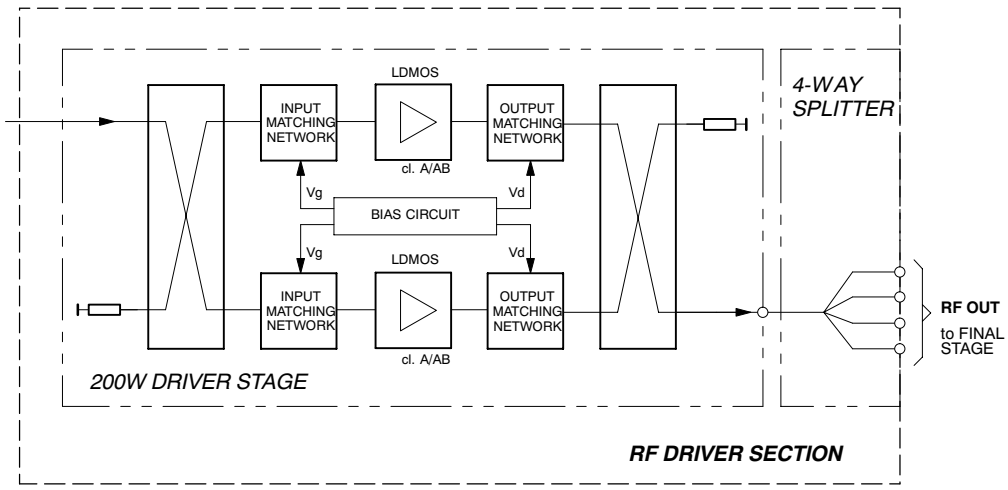

Fig. 3.3 - RF Driver section/ Block Diagram

200W DRIVER STAGE *(Medium Power Stage p/n. 4040011011)*
The gain of the stage is 30dB±1dB; the working condition is very close to class A.

4-W AY SPLITTERS
The driver stage output is split into four signals and sent to the final stages. The splitting function is performed by a hybrid splitter and two 2-way Wilkinson splitters carried out with microstrip. The 4-Way Splitter has a characteristic impedance of 50Ω.

3.2.3 RF Final section

The RF output signals from the RF Driver section are applied to the RF Final amplifier stages (see fig. Fig. 3.4) composed of:

- Final Power Amplifiers (q.ty 4)
- 4-W ay Combiner and Coupler

FINAL POWER AMPLIFIERS *(1kW BI RF Amplifier BI p/n. 1594000003)*
The final stage is made up of four amplifier stages, each of them is referred as "Fnl1 to Fnl4" on G042 Control Logic display; they are made to work in class AB. The power supply voltage is $48V_{DC,}$ suitable biasing circuits deliver the gate and drain voltages. The current absorption, detected by an integrated shunt resistor mounted on *PCB*, via *Module Field Interface* board is monitored by *CPU Module Board*.

The gain of the stage is 23dB.

4-W AY COMBINER and COUPLER
A 4-Way Combiner carries out the sum of the Final stage output signals. The combining function is performed with the air suspended stripline technique, with characteristic impedance of 50Ω. The assembly also includes a directional coupler which picks up the forward and reflected power and sends the relevant detected signals to the *RF Input/Control* board by means of 50Ω coaxial cables.

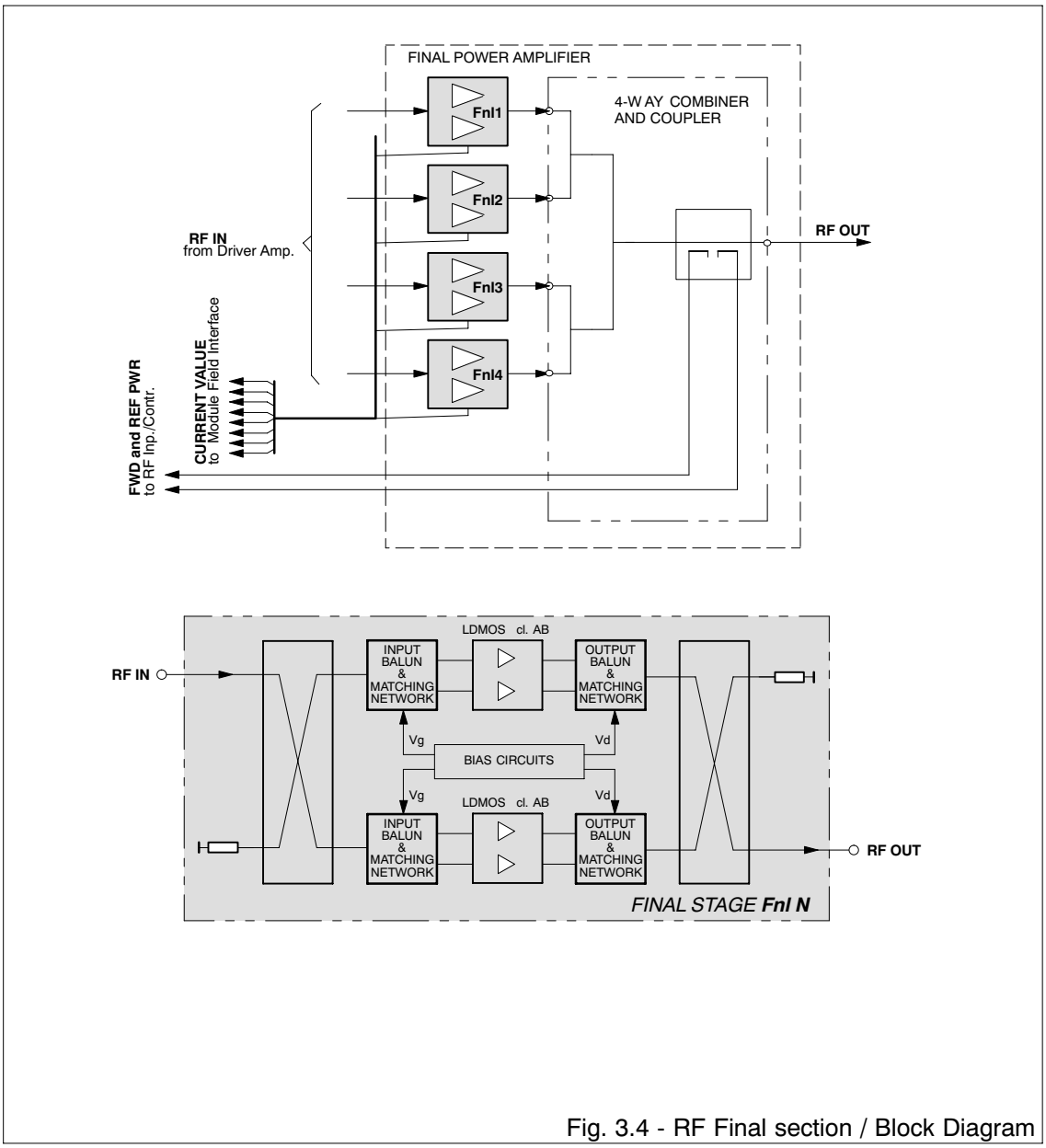

Fig. 3.4 - RF Final section / Block Diagram

3.3 DESCRIPTION OF THE CONTROL LOGIC SECTION

The *Control Logic Section* (block diagram on fig. Fig. 3.5) receives and manages all information provided by the RF section and by *DC/DC Converter*.

The HPA control functions are carried out by the *CPU Module Board* equipped whit a H8-3003 family μP, and by a *Module Field Interface* board performing the interfacing of the analog measurements from *RF Amplifier section*. A *Power Mother Board* interfaces DC/DC Converter and allows the communication with G042 Control Logic.

In order to protect the module from serious damages, *CPU Module Board* has been designed to control directly W1-235L functioning and, at the same time, to transfer information to the equipment supervisory control logic (G042), which is enabled to carry out only few, but extremely important, controls on the module itself. Measures and alarms can be displayed on G042 Control Logic display by recalling the relevant menus (see G042 Control Logic technical manual).

RS485 is the serial line which carries all the information between W1-235L Control Logic and G042 Control Logic. It allows connecting up to 32 modules, that is proper of a multidrop link. Each W1-235L module is identified by a 6 bit address.

The over voltage protection circuit (on *Module Field Interface*) has been designed to control the $48V_{DC}$ output voltages: when they exceed 10% of the nominal values this circuit sends an inhibit signal to *RF Input Control* board which cuts-off the RF input signal.

The *Control Logic Section* circuits are supplied by the $12V_{DC}$ voltages coming from *Power Mother Board* which is fed by the *DC/DC Converter*.

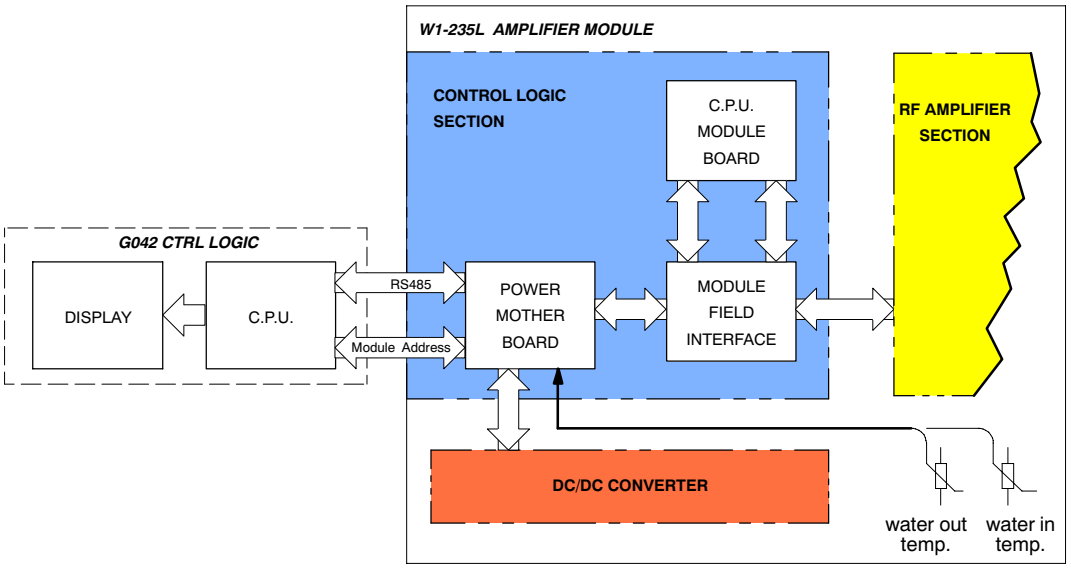

Fig. 3.5 - Control Logic section / Block Diagram

3.3.1 Control of the RF Amplifier

When just one of the fault conditions, listed in Tab. 3.1, occurs, the RF signal amplification has to be interrupted by the *CPU Module Board*. This board sends telecontrols towards *RF Amplifier Section*, and, at the same time, it transfers the relevant alarm signal to the G042 Control Logic, through the RS485 serial line.

Tab. 3.1 - Faulty conditions of the RF amplifier section

FAULT	DETECTION	CONTROL OPERATION
FIRED CROWBAR	By *Module Field Interface* (over voltage protection circuit/IC3), when the output voltage level ($48V_{DC}$) is 10% over the nominal value.	*CPU Module Board* receives the alarm signal from *Module Field Interface* and the *Module Field Interface*, drives the SPDT driver of the *RF Input Control* (see fig. 3.2). *CPU Module Board* also informs G042 about the fault presence. The Over Voltage Protection carries out a secondary protection function, but it is faster than the power supply one (see table 3.2) so it operates before the crowbar is actually fired.
	By *DC/DC Converter*, when they are > 10%.	*DC/DC Converter* makes the crowbar fire and also sends an alarm signal to G042 Control Logic via *Power Mother Board, Module Field Interface* and *CPU Module board.* *DC/DC Converter* manages the primary protection function, but the Over Voltage Protection is faster than the power supply one (see table 3.1).
OVERDRIVE	By *RF Input Control*, when RF output power is 2dB over the nominal value (overdrive threshold fixed by R176 *analog signal*/R178 *digital signal*).	*CPU Module Board* receives the overdrive signal via *Module Field Interface*. Then *Module Field Interface* drives the SPDT driver of *RF Input Control* (see fig. 3.2). *CPU Module Board* also informs G042 about the fault presence.
VSWR	By *RF Input Control*, when the reflected output power reaches -10dB in respect to the nominal output power..	*CPU Module Board* receives the overdrive signal via *Module Field Interface*. Then *Module Field Interface* drives the SPDT driver of *RF Input Control* (see fig. 3.2). *CPU Module Board* also informs G042 about the fault presence.
DRIVER AND FINAL STAGE ABNORMAL CURRENT ABSORPTION	By *CPU Module Board* when the current absorption of driver and/or final stages is > +25% or <-25%, (values referred to the average of the driver and final current absorptions).	*CPU Module Board* receives the abnormal current absorption signal via *Module Field Interface* and communicates to G042 the fault presence.

3.3.2 RF input power, RF forward power and reflected power measures

The *RF Input Control* board includes the detector and measurement circuits for monitoring RF input power, RF forward output power and reflected output power values. These measurements, collected by *Module Field Interface*, are processed by *CPU Module Board* and then routed to G042 Control Logic, which displays these values.

3.3.3 Control of the *DC/DC Converter*

The fault conditions concerning *DC/DC Converter* functioning are listed on Tab. 3.2 shown below.

Tab. 3.2 - Faulty conditions of the *DC/DC Converter*

FAULT	DETECTION	CONTROL OPERATION
FIRED CROWBAR	By *DC/DC Converter*, when the output voltage levels ($48V_{DC}$) are 10% over the nominal values.	*DC/DC Converter* makes the crowbar fire and also sends an alarm signal to G042 Control Logic via *Power Mother Board, Module Field Interface* and *CPU Module board.* *DC/DC Converter* manages the primary protection function, but the Over Voltage Protection is faster than the power supply one (see table 3.1).
	By *Module Field Interface* (over voltage protection circuit/IC3), when the output voltage levels ($48V_{DC}$) are 10% over the nominal values	*CPU Module Board* receives the alarm signal from *Module Field Interface* and sends a Total Inhibit signal, through the *Module Field Interface*, to the SPDT driver of the *RF Input Control* (see fig. 3.2). *CPU Module Board* also informs G042 about the fault presence. The Over Voltage Protection carries out a secondary protection function, but it is faster than the power supply one (see table 3.2) so it operates before the crowbar is actually fired.
FOLDBACK PRESENCE	By *DC/DC Converter*, when the maximum value of the delivered current is > +10% referred to the nominal value.	The *DC/DC Converter* reduces 48V output voltages and, at the same time, sends an alarm signal to G042 Control Logic via *Power Mother Board*.

3.3.4 Control of the liquid temperature

The temperature control is carried out by means of two temperature detector circuits monitoring inlet and outlet liquid temperature. The overtemperature fault occurs when *CPU Module Board* detects an inlet/outlet liquid temperature greater than 70°C. The temperature telesignal passes through *Power Mother Board* and *Module Field Interface,* is processed by *CPU Module Board* which cuts the *enable* signal to DC/DC Converter through *Module Field Interface*. When the cold plate temperature decreases below 65°C approx., *CPU Module Board* enables again the RF amplification.

3.4 DESCRIPTION OF THE LIQUID COOLING SECTION

The cooling system used for the W1-235L module consists of a cold plate which carries out the indirect thermic exchange between the electronic devices and the single phase liquid. This system allows to dissipate the high thermal power, concentrated close to the driver and the final power stage transistors.

The cold plate consists of an aluminium plate inside which the conducts, bringing the fluid towards a set of fins placed under the heat sources, are created. The set of fins makes the contact surface between the solid devices and the liquid extremely wide and increases the turbulence of the flow so that elevate thermic power can be easily dissipate with small liquid thermal heads between the inlet and the outlet of the fluid circuit. The cold plate with heat-sinks manufactured with this technique, is the architecture that fits better in case of several thermic sources not uniformly distributed.

The cooling fluid is brought to and kept at the working pressure by means of a pump. If two or more W1-235L amplifier modules are present, the pump outlet fluid is sent to a branch conduct designed to split equally the fluid flow rate among the different module cold plates. The liquid removes the heat produced by the electronic devices of the module and is conveyed to the return branch conduct.

The cooling liquid must be a water-glycol mixture. Further details on the way to use the coolants are given in the transmitter 'Operator's Manual' in the appendix relevant to the cooling system.

3.5 DESCRIPTION OF THE POWER SUPPLY SECTION

A DC/DC Converter (5kW) (block diagram on fig. Fig. 3.6) feeds the different sections of HPA through *Power Mother Board*. The external 62V_{DC} voltage supply enters *Power Mother Board* and is routed to DC/DC Converter which delivers three output voltage levels:

- +48V_{DC} feeds *Driver* and *Final Power Amplifiers* (through *Power Mother Board*);
- +12.5V_{DC} feeds *Control Logic Section*. This last, in turn, delivers +12V_{dc} and +5V_{DC} to *RF Input Control* board.

The 12.5V_{DC} output voltage is always present even if a fault or a foldback or a crowbar insertion occur. The control of the power supply status and functioning is carried out by the *Control Logic Section* of HPA. The technical characteristics of DC/DC Converter are listed here below.

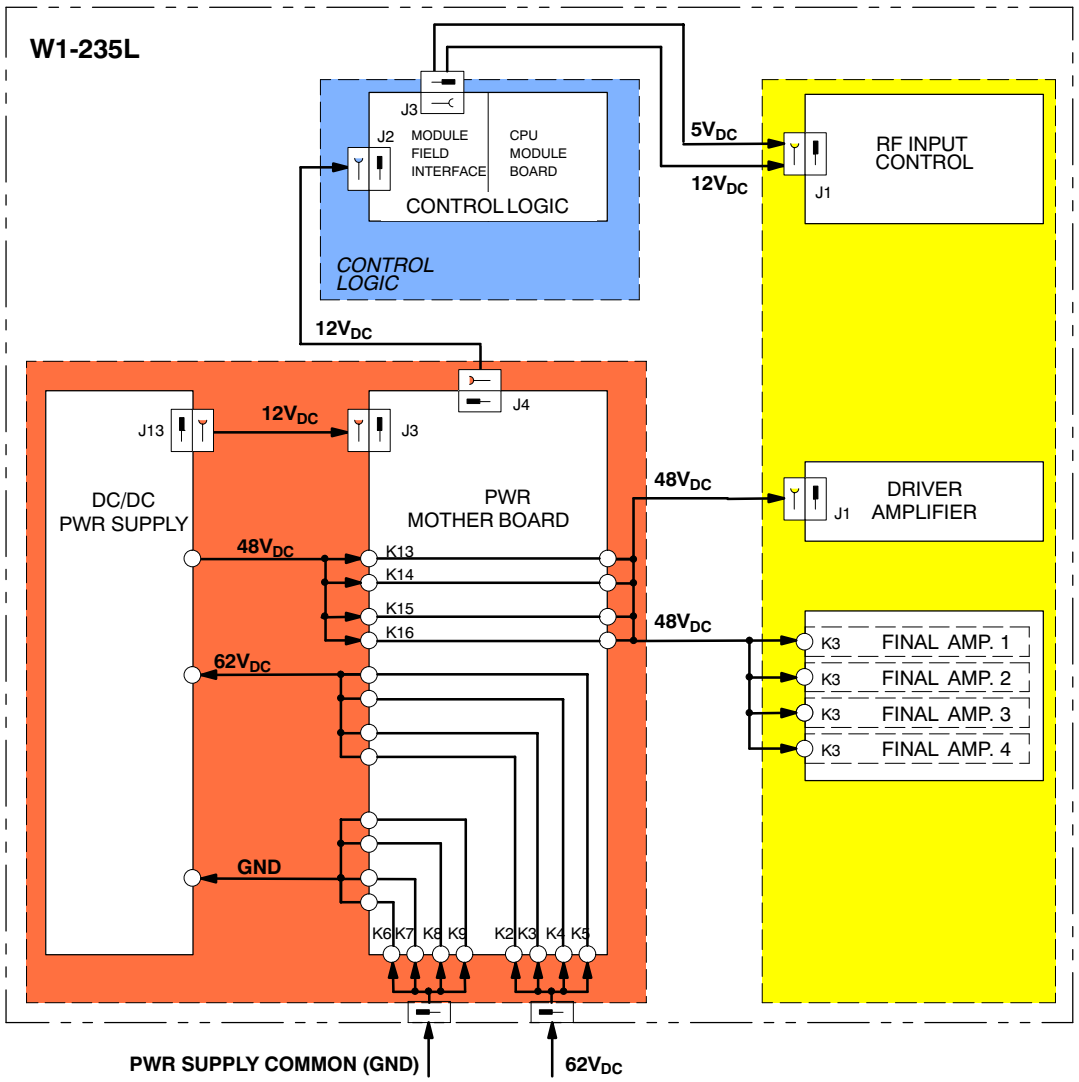

Fig. 3.6 - Module Power Supply section/ Block Diagram

DC/DC CONVERTER *Technical Characteristics*

INPUT

Input voltage range	57 to 68V
Input voltage typical	$62V_{DC}$
Residual ripple (50 to 1000Hz)	4% (rms) max
Maximum power absorption	5.15kW
Efficiency	97%

OUTPUTS

Output nominal voltage levels	$48V_{DC}$ $12.5V_{DC}$
Maximum current	100A with $48V_{DC}$ 2A with $12.5V_{DC}$
Static stability (V_{in} variations ±20%)	±80mV with $27V_{DC}$ ± 30mV with $12.5V_{DC}$
Dynamic stability (variations of load current absrpt. 40 to 70%)	±250mV with $32V_{DC}$ ±150mV with $12.5V_{DC}$
Recovery time	≤0.3 msec

PROTECTIONS

Maximum output current threshold	+10% (referred to the nominal current) with foldback=50% and automatic reset
Maximum output voltage threshold	+10% (referred to the max. voltage) with over voltage protection crowbar (manual reset) for $48V_{DC}$ outputs

TELESIGNALS ON I/O CONNECTOR *(TTL logic 0-5V)*

Not regular functioning	= high level
Foldback presence	= high level
Fired crowbar	= high level

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CHAPTER 4:
MAINTENANCE

CHAPTER 4: MAINTENANCE

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CHAPTER 4: MAINTENANCE

4.1 INTRODUCTION

4.1.1 Introduction to Maintenance

The purpose of this section is to assist the maintenance personnel in keeping the RF Amplifier Unit at best operational status. Maintenance can be subdivided into the following actions:

- PREVENTIVE MAINTENANCE,
- CORRECTIVE MAINTENANCE.

Preventive maintenance refers to maintenance procedures which have to be carried out periodically so as to prevent malfunctions. Corrective maintenance includes a series of tables representing a troubleshooting guide used to locate the most likely area where a malfunction has occurred or reference to the unit manuals.

4.1.2 Types and Levels of Maintenance

The type and level of maintenance to be carried out on HPA depends on the adopted maintenance policy, and depends entirely on the operational requirements and level of experience of the maintenance personnel. In general, there are three maintenance levels that can be carried out:

1st Level (*On site*), including the following tasks:

- switch-on and switch-off procedures, also for emergency situations;
- activation and/or deactivation of operative and semi- operative functions, which can be performed on the relative control panel;
- replacement of fuses and monitor lamps located both on panels and switches;
- preventive maintenance on both mechanical and electrical/electronic parts. The maintenance tools and instruments will be simple to use (e.g. spanners, screwdrivers, multimeters etc.);
- corrective maintenance which includes the replacement of units or sub-assemblies. These do not require complicated procedures or adjustments and are coherent with the capabilities of the maintenance personnel.

2nd Level (*On Site*), including the following tasks:

- all first level maintenance tasks**;**
- all corrective maintenance operations which require the use of instruments which are not part of the equipment (e.g. oscilloscope, counters, function generators, ect.);
- all on-site alignments from a single module up to the whole system;
- troubleshooting procedures;
- corrective maintenance which includes the replacement of faulty modules;
- corrective maintenance of mechanical parts;
- setting of semi-operative variables (setting-up optimization) depending on the operational environment and requirements;
- evaluation of the performance of the Equipment and of the System.

3rd Level (*Laboratory*)

This is the highest maintenance level that can be performed and includes procedures which allow the personnel to isolate and replace faulty components. This level also includes adjustment procedures for the repaired modules, as well as the calibration of the instruments used by the maintenance personnel on site.
The way this maintenance is carried out depends on the available technical resources and logistic infrastructure. The technical personnel working at this level should have specific knowledge of the laboratory instruments and tools, and should be skilled in carrying out repairs to a high quality standard.

4.1.3 Maintenance Tools

Maintenance tools include Commercial, Standard and Special Tools used for the 1st and 2nd levels of Maintenance. Commercial Tools include the tools normally used for the maintenance activities (screwdrivers, pliers,soldering irons, etc.) and are normally available on the local market. Standards Tools include those materials considered as standard for maintenance activities (coax cables of standard length, coax adapters, etc.) and are available on the local market and/or from the manufacturer of the unit. Special Tools include tools prepared by the manufacturer for maintenance requirements and are available only from the manufacturer of the unit for which they are designed.

4.1.4 Test Instruments

The Test Instruments required on-site in order to carry out the maintenance activities are listed in paragraph 4.4 ”Maintenance Procedures”. Please note that all the listed Test Instruments are of commercial type and may be substituted by equivalents available on the local market.

4.2 PREVENTIVE MAINTENANCE

This paragraph deals with the suggested preventive maintenance operations to guarantee continued performance of the RF Amplifier Unit.

All unit parts shall be examined to check for dust or dirt, overheating, loose screws and foreign bodies. Dust, for example, may cause current discharges or leakages.

1) *Frames*
Frames, through which the ventilation air flows, need to be internally cleaned from dust. Cleaning can be carried out using a vacuum cleaner for the accessible parts or a clean, dry cloth or bristle brush.

2) *Printed Circuit Boards (PCB)*
PCBs shall not be removed unless dust is noted on their surface. In this case, the PCBs shall be removed one at a time. Use only moderately compressed air or a soft bristle brush to remove the dust. Clean the lance contacts of the connectors on the PCB using a bristle brush soaked in pure alcohol.

3) *Power Supply Modules and Converters*
Removal of the dust accumulated on the housing and components is normally sufficient to clean power supply modules. To clean the PCBs extract them from the Module, then carefully clean the connector pins using a bristle brush soaked in pure alcohol.

4) *Indicator Lamps*
Lamps must be well inserted in their socket. Remove any trace of corrosion, oxidation or dirt by the use of a cloth soaked in carbon tetrachloride.

5) *Fuses*
Fuse tips are subject to oxidation and must be periodically removed from their holders to check for any presence of oxidation. The oxidation or dust increases the resistance of the electrical circuit. Fuse tips shall be cleaned using a cloth soaked in carbon tetrachloride.

NOTE

FUSES SHALL BE REMOVED ONE AT A TIME IN ORDER TO AVOID INSERTING THEM INTO A WRONG HOLDER. THE VALUE PRINTED ON THE FUSES SHALL CORRESPOND TO THAT PRINTED ON THEIR RELEVANT HOLDERS.

6) *Connections Cables*
Connection cables shall be periodically examined to ensure that breaks in the external insulating coating are not present to cause possible short-circuits. Cover the parts showing deterioration of the insulating coating. Coaxial cables shall be carefully examined since they can be easily damaged by crushing or sharp bends. Connectors shall be checked to ascertain that corrosion is not present on their metallic contacts. Cables showing damages must be protected and eventually replaced.

7) *Terminal Boards*
Terminal boards shall be examined to ascertain that there are no traces of dirt, loose wires or excess solder on the terminals, which could cause undue contacts with the adjacent terminals. Fixing screws or mounting brackets shall be tightened. Terminal boards shall be cleaned using a dry cloth or bristle brush.

8) *Resistors*
Resistors shall be checked for evidence of cracks, discoloration or ”cooking”. Discoloration indicates that the resistor is subject to overload which could be caused by an incorrect operation of the circuit. Examine resistor leads for dust, dirt or loose connections.

9) *Transformers and Coils*
Examine transformers and coil leads for any trace of dust, dirt or humidity. Check that they are secured in their seats; tighten fixing screws and mounting brackets. Housings, terminals and insulators supporting transformers and coils should be free from foreign objects. Use a dry cloth or, if necessary, moisten the cloth with a suitable solvent. Should the wiring be corroded, tag each wire, disconnect and clean the contact surface using emery paper with a fine grain and then clean the surfaces using a clean cloth. Reconnect the wires.

10) *Potentiometers and Variable Resistors*
Potentiometers and variable resistors, with the exception of those with special features and mounting, shall be examined to ascertain that there is not mechanical backlash. If necessary, disassemble the knob mounted on the axis and tighten the locking screw. The knob must be reassembled in its original position. The housing, if any, must be cleaned from dust by using a bristle brush or compressed air. Ascertain that there are no traces of overheating which indicates an irregular operation of the circuit on which the potentiometer or the variable resistor is inserted. Look for the cause of overheating and eliminate it as soon as possible.

11) *Mechanical Inspection*
According to the environmental conditions, periodically check and lubricate the following mechanical parts:
- hinges of front doors;
- hinges of rear doors.

4.3 CORRECTIVE MAINTENANCE

Causes which give rise to a corrective maintenance action can derive from:

- Out of tolerance conditions of standard levels, waveforms and timings, detected during preventive maintenance;
- Failure conditions shown either by indicator lamps, displays, LEDs located on PCB (if any), TTY diagnostic print outs.
- Failure conditions detected by operative personnel.

Restoring the unit to operation in a short time also depends on the availability of spare parts and components.

4.3.1 Corrective Maintenance Concepts

1) The corrective maintenance involves the location and isolation of the failure at site level. One or more failed replaceable parts may correspond to each failed function. These parts are classified as follows:
   - repairable PCB's and assemblies;
   - single components not included in the above repairable items.
2) Once the failed part has been isolated, it shall be replaced with a serviceable one from the available spare parts. The replaceable parts of the "single components" type (i.e. fans, pushbuttons, transformers, relays, etc.) once replaced shall be discarded. The repairable items shall be sent to the third maintenance level (laboratory) where they shall be repaired by using Test Stations, repair procedures and personnel suitable for this Level of maintenance. In the same area, calibration and repair of the instruments and tools, both for site and laboratory maintenance will be accomplished.

4.3.2 Troubleshooting

A malfunction can be identified in different ways: as a result of a preventive maintenance operation; during the operative program running. Troubleshooting Guide of Tab. 4.1 delivers the following informations: fault, probable cause, corrective actions.

Tab. 4.1 - Troubleshooting

STEP	FAULT	PROBABLE CAUSE	CORRECTIVE ACTIONS
1	Power supply missing •*MAINS* led . . . . . OFF •*ENABLE* led . . . . . OFF •*PWR S NORMAL* led OFF •*FAULT* led . . . . . OFF	▪ Failure on the switch of the MAINS BREAKER GROUP (accessible on rack rear side);	Check presence of 62V_{DC} at switch input or check the connection between switch and HPA
		▪ Failure on the RECTIFIER DIODES ASS'Y (accessible on rack rear side);	Check presence of 62V_{DC} on RECTIFIER DIODES ASS'Y or check the connection to the switch
2	RF Power missing at the RF output. •*MAINS* led . . . . . ON •*ENABLE* led . . . . . OFF •*PWR S NORMAL* led OFF •*FAULT* led . . . . . OFF	▪ Failure of internal DC/DC Converter	Apply procedure on para. 4.4.5 or replace the RF Amplifier Unit.
3	RF output power ≤3dB in respect to the nominal value. •*MAINS* led . . . . . ON •*ENABLE* led . . . . . ON •*PWR S NORMAL* led ON •*FAULT* led . . . . . ON	▪ Failure on the antenna system or on the 4-way Combiner of HPA. Some time a problem on the interconnections RF cable or connectors, can occur.	Utilizing a Dummy Load and a Power Meter, verify the HPA output power. If the alarm is not present any more, the troubleshooting will be applied at the equipment level (Antenna system or RF interconnections).
		▪ Failure on the RF amplifier stages, internally to the HPA. Sometime no RF power is present on the input of the HPA.	Apply procedure number 2 (Refer to para. 4.4.2).If the fault is on the RF Amp. circuit, it is advisable to replace the RF Amplifier Unit.

4.4 MAINTENANCE PROCEDURES

The maintenance procedures can be utilized for periodic performances checks or after a substitution of failed component or board. These procedures can be utilized one at a time or in sequence, depending from the needs. The procedures are divided in paragraphs as follows:

4.4.1 How to use the extender frame for HPA
4.4.2 Functional checks on W1-235L
4.4.3 . Functional checks on *DRIVER* stage
4.4.4 Functional checks on *FINAL* stage
4.4.5 Functional checks on *DC/DC CONVERTER*

A layout of the amplifier is shown in Fig. 4.1 where the components location is pointed out.

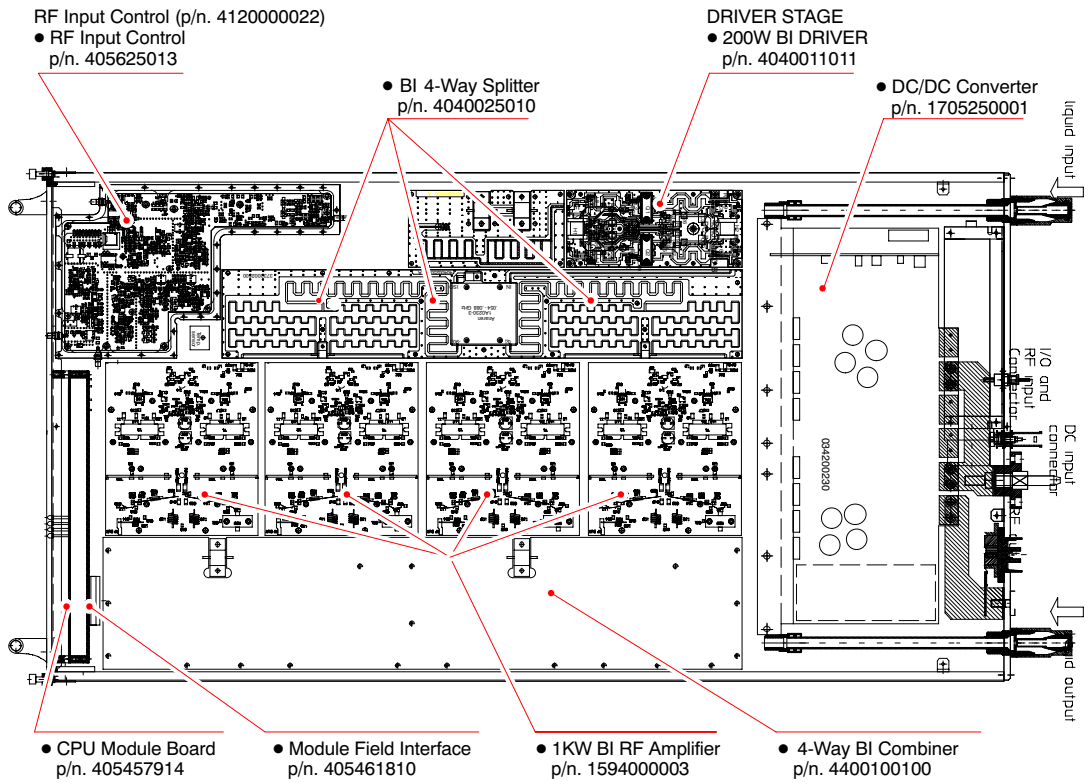
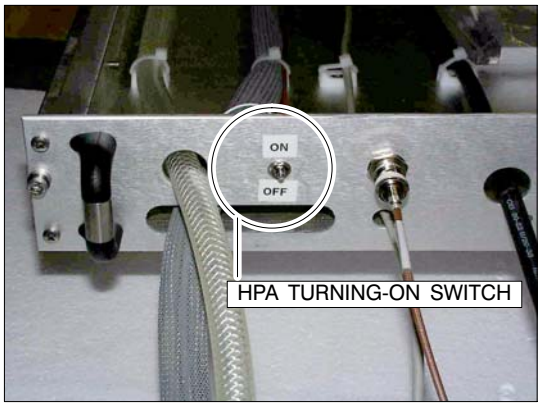


Fig. 4.1 - W1-235L general layout

4.4.1 How to use the extender frame for HPA

In order to service the HPA, it is necessary to use the extender frame delivered with the transmitter. The extender frame must be inserted in the transmitter rack, in place of the HPA to be serviced. Once the extender has been inserted in the rack, lay the HPA down on a table of suitable height, now lock the movable panel of the extender to the rear panel of the HPA. Follow the directions given on the picture here below to correctly and safely operate.



Clamps with relevant screws and washers, delivered with the extender frame.

Fit the clamps delivered with the extender frame, on the rear part of HPA and on both sides. Use the suitable screws and the relevant washer.

Lock the clamps to the movable panel of the extender frame.

4.4.2 Functional checks on W1-235L

For the functional check of the HPA, the following procedure can be performed through the control logic unit of the transmitter and using a digital multimeter. In order to carry out these procedures it is necessary to extract the HPA to be tested from the rack, and to insert the suitable extender frame (delivered with the transmitter) in the rack *(see previous page and Fig. 4.2*)

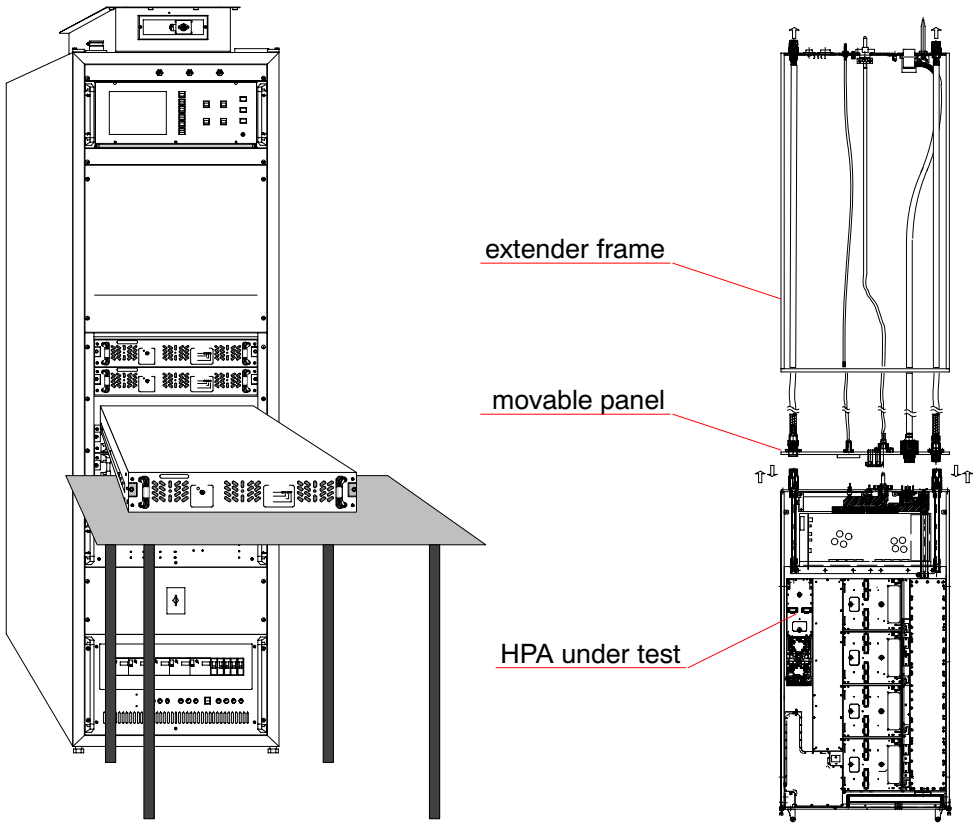


Fig. 4.2 - HPA extender frame for service

CHECKING SUPPLY VOLTAGES

1 Check the presence of the service supply voltages of the control section on the relevant boards. These voltages can be checked by the lighting of green leds; the correspondence between leds and voltages and their location on the boards are shown on Fig. 4.3 below.

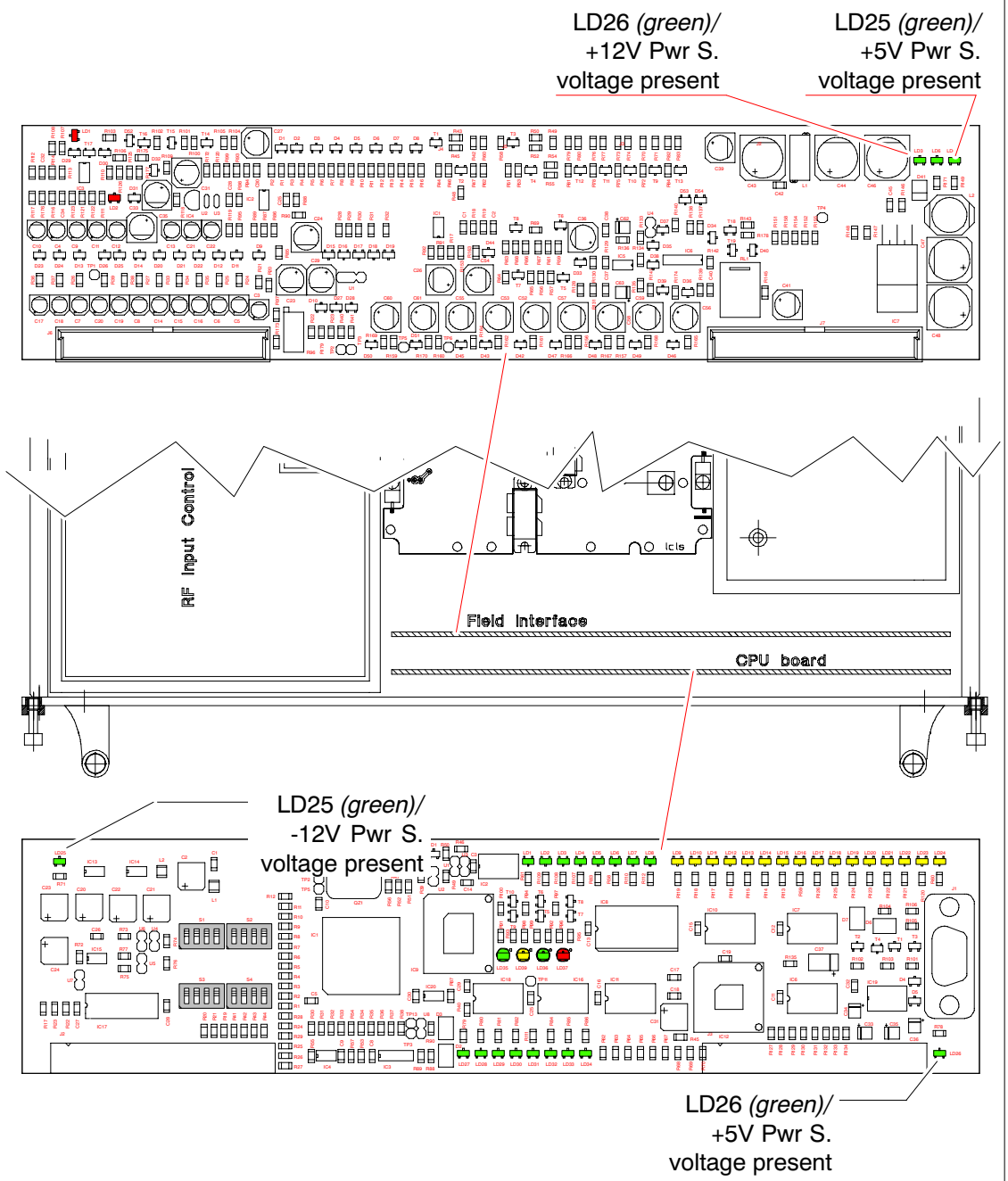


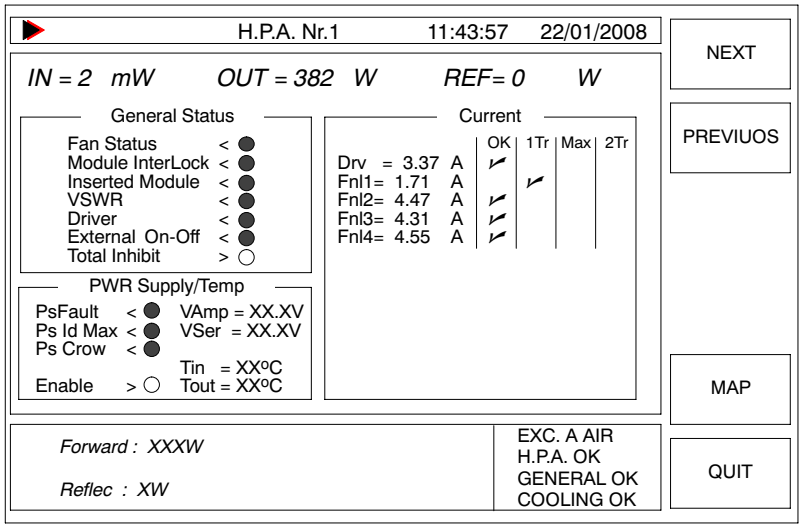
Fig. 4.3 - W1-235L/checking supply voltages

FINDING THE RF STAGE IN FAILURE CONDITIONS

2 Execute the sequence here below on G042 keyboard (starting from *main menu*):

F1 (HPA) → F5 (MAP) → select number of HPA under test, by the arrows (NEXT, DOWN) → F1 (SHOW NrX) → F3 (DETAIL)

G042 displays the following mask: in the '*CURRENT*' box the current absorptions of the different stages are listed. The meaning of the marks is explained on Tab. 4.2.



NOTE
numerical values indicated, are only by way of example

Tab. 4.2 - Fault finding

FAILURE CONDITIONS ON G042 DISPLAY ("*Current*" box)	PROBABLE CAUSE	ACTION
Drv = XX.X (OK 1Tr ✓ Max 2Tr)	One transistor of Driver stage in fault condition	Carry out the checking of paragraph 4.4.3
Drv = XX.X (OK 1Tr Max ✓ 2Tr)	Anomalous current absorption (too high) of both transistors of Driver stage	
Drv = XX.X (OK 1Tr Max 2Tr ✓)	Two transistors of Driver stage in fault condition	
FnlX = XX.X (OK 1Tr ✓ Max 2Tr)	One transistor of Final stage X in fault condition	Carry out the checking of paragraph 4.4.4
FnlX = XX.X (OK 1Tr Max ✓ 2Tr)	Anomalous current absorption (too high) of both transistors of Final stage X	
FnlX = XX.X (OK 1Tr Max 2Tr ✓)	Two transistors of Final stage X in fault condition	
Very different current absorption between a final stage and the other ones.	Fault in FnlXA(B) stage	Carry out the checking of paragraph 4.4.4

4.4.3 Functional checks on *DRIVER* stage
(200W BI DRIVER p/n. 4040011011)

Remove the top cover of the HPA in order to access the *DRIVER* stage; location of the pallet is shown on Fig. 4.4. Remove the electric shield to access the components. The functional checks on the pallet can be carried out by following the indication given in Tab. 4.3.

Tab. 4.3 - Functional checks on *DRIVER* stage

checking	measure point / component	measurements	regulation
Q1 biasing (quiescent curr.)	current absorption displayed by G042		rotate R7 completely anti-clockwise (minimum of the current I_0); adjust R7 in order to read on G042 display I_0 + 1500mA
Q2 biasing (quiescent curr.)	current absorption displayed by G042		adjust R21 in order to read on G042 display I_0 + 3000mA (I_0 + 1500mA + 1500mA)

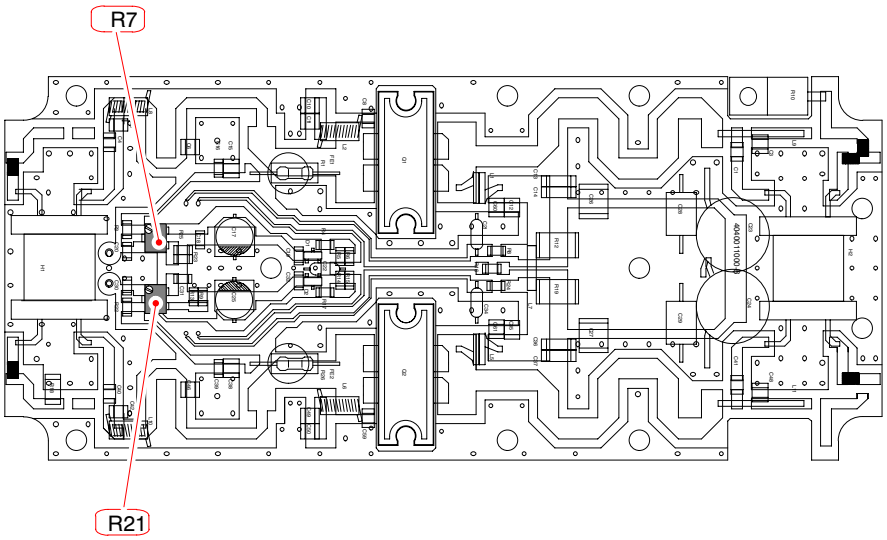


Fig. 4.4 - DRIVER stage (200W BI DRIVER p/n. 4040011011) layout

4.4.4 Functional checks on *FINAL* stage

(1KW BI RF Amplifier p/n. 1594000003)

Remove the top cover of the HPA in order to access the *FINAL* stage; location of the pallet is shown on Fig. 4.1. Remove the electric shield to access the components. The functional checks on the pallet can be carried out by following the indication given in Tab. 4.4.

Tab. 4.4 - Functional checks on *FINAL* stage

checking	measure point / component	measurements	regulation
T1 biasing (quiescent curr.)	current absorption displayed by G042		rotate R8 and R9 completely anticlockwise (minimum of the current I_0); adjust R8 in order to read on ammeter I_0 + 1400mA
T2 biasing (quiescent curr.)	current absorption displayed by G042		adjust R9 in order to read on ammeter I_0 +2800mA (I_0 + 1400mA + 1400mA)

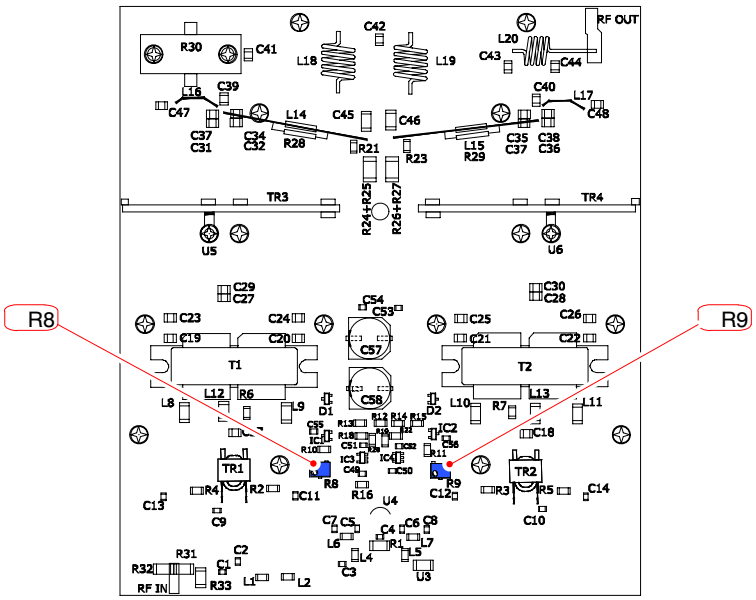


Fig. 4.5 - FINAL stage (1KW BI RF Amplifier p/n. 1594000003) layout

4.4.5 Functional checks on *DC/DC CONVERTER*
(p/n. 1705250001)

The *DC/DC CONVERTER* is accessible once the top cover of the HPA has been removed; itslocation is shown on Fig. 4.1. The functional checks on the *DC/DC CONVERTER* can be carried out by referring to the voltages power supply of Fig. 4.6 and to pin-out assignment of J13 connector listed on Tab. 4.5.

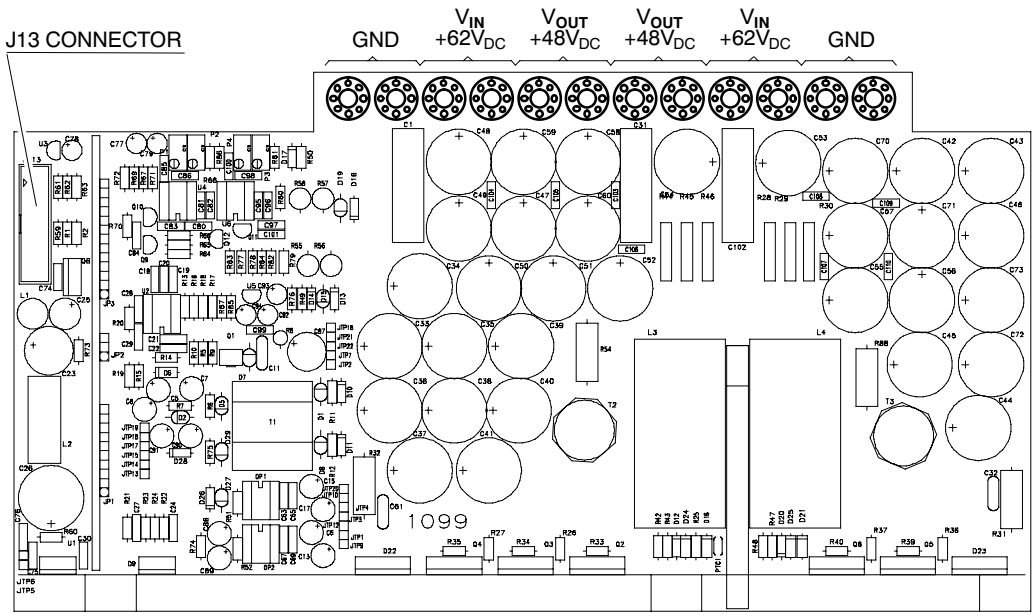


Fig. 4.6 - DC/DC Converter (p/n. 1705250001) layout

Tab. 4.5 - Pin-out assignment of 20 pin ”multipin” connector for I/O signals (J13)

PIN	FUNCTION	
1	+24V_{DC} AUX. (*input*)	
2	+24V_{DC} AUX. (*input*)	
3	FOLDBACK SIGNAL OUTPUT	(*alarm= high level, 5V_{DC}*)
4	CROWBAR SIGNAL OUTPUT	(*alarm= high level, 5V_{DC}*)
5	MONITOR +48V_{DC}	
6	OUTPUT POWER VOLTAGE PRESENCE	(*regular= low level, 0V_{DC}*)
7-8	NOT USED	
9	MONITOR +48V_{DC}	
10	INPUT OF CONTROL SIGNAL ***(NOT USED)***	*(regulation of output dc voltage)*
11	OUTPUT CURRENT MONITOR	
12	ENABLE SIGNAL	
13-14	GND	
15-16	+12V_{DC} OUTPUT	
17-18	GND	
19-20	CROWBAR SIGNAL OUTPUTS	*(for external switch breaker)*