MPS 24-120

MULTICHASSIS SWITCHING POWER SUPPLY FOR MAGNETRON WITH E-MAGNET FROM 15 TO 100 kW

MPS 24 (15 KW MAG.)
MPS 48 (30 KW)
MPS 72 (50 KW)
MPS 96 (75 KW)
MPS 120 (100KW)

TECHNICAL NOTE

(issue September 2019)

mks
Alter® Products

(Cover Rear)

CE Declaration of Conformity
Dichiarazione di Conformità CE

Manufacturer's Name: MKS Instruments Italy s.r.l
Nome del Costruttore:

Manufacturer's Address: Via P. e M. Curie, 8 - 42122 Reggio Emilia - Italy
Indirizzo del Costruttore:

Declare that the magnetron power supply system:
Dichiara che il Prodotto:

product name:	SM181x (power supply unit) and AC 571 (filament control unit)
nome del prodotto	*SM181x (alimentatore elettrico) e AC 571 (unità di controllo)*
models:	SM1818T.xxx - SM1818U.xxx - SM1813T.xxx - SM1813U.xxx
modello	AC 571T.xxx - AC 571U.xxx

The product described above is in conformity with the provision of the following European Directives:
Il prodotto sopra descritto è in conformità con le seguenti Direttive Europee:

2014/35/UE	Harmonization of the laws of the member States relating to electrical equipment designed for use within certain voltage limits *Riavvicinamento delle legislazioni degli Stati membri relative al materiale elettrico destinato ad essere adoperato entro taluni limiti di tensione*
2014/30/UE	Harmonization of the laws of the member States relating to electromagnetic compatibility *Riavvicinamento delle legislazioni degli Stati membri relative alla compatibilità elettromagnetica*

Conformity to the Directives is assured through the application of the following standards:
La conformità alle Direttve è assicurata tramite l'applicazione dei seguenti standards:

Reference number *Numero di riferim*	Edition *Edizione*	Description *Descrizione*
EN 61010-1	2013-10	Safety requirements for electrical equipment for measurement, control and laboratory use *Prescrizioni di sicurezza per apparecchi elettrici di misura, controllo e per uso in laboratorio*
EN 61000-6-4	2007-11	Electromagnetic compatibility - Generic emission standard, industrial environment *Compatibilità elettromagnetica - Norma generica sull'emissione, ambiente industriale*
EN 61000-6-2	2006-10	Electromagnetic compatibility - Generic immunity standard, industrial environment *Compatibilità elettromagnetica - Norma generica sull'immunità, ambiente industriale*

Reggio Emilia, September 2019.

Marco Garuti

General Manager

Policy about Reduction on Hazardous Substances (RoHS) and Waste Electrical and Electronic Equipment (WEEE)

Law Reference

- Directive 2012/19/EU of European Parliament (WEEE)
- Decreto Legislativo D.L. n. 49 – 14/03/2014 (WEEE)

- Directive 2011/65/EU of European Parliament (RoHS)
- Decreto Legislativo D.L. n. 27 – 4/03/2014 (RoHS)

Risk Assessment on RoHS

The Multichassis Power Supply System (MPS) is RoHS compliant.

Important information to User about disposal, recycling, reuse of this electronic equipment at the end of its useful life (WEEE Directive).

According to Directive 2012/19/EU this equipment is not included on the list of categories/products covered by the Directive (as a matter of fact it does not perform a function alone, must be included into a larger process equipment and it's for stationary use).
Nevertheless we invite the User to respect the following Directive rules:

- this WEEE is not a municipal waste and should be collected separately according to rules of your country
- the symbol  means that this WEEE cannot be disposal in the same place and in the same way like municipal waste
- this WEEE may present risk for environment as well as for person in case of disposal in unauthorized place, due to content of hazardous substances
- for disposal of this WEEE in unauthorized area the User may be charged with a fine or prosecuted by law.

Rev.	Revision note	Date	File
0	*First emission for MPS group from 24 to 96 kW*	*March 2012*	*MPSxx_r0eng*
1	*Update logo, Control AC571, software*	*July 2015*	*MPSxx_r1eng*
2	*Added Conn #4 Auxiliary Line (SM181x) & Comp. Lists*	*August 2015*	*MPSxx_r2eng*
3	*Cancelled version 0. Version 1 (bus) is the standard. Software relesae update for introduction of new CPU*	*March 2016*	*MPSxx_r3eng*
4	*Update norms. Added fuse spec for filament (pg 5). Revised alarm table*	*April 2017*	*MPSxx_r4eng*
5	*Added New version "Bus Link Extended" SM1818 (v.2). New software with extended commands and user interface*	*September 2019*	*MPSxx_r5eng*
6	*Updated MPS120 description on table pag. 4*	*April 2024*	*MPSxx_r6eng*

Contents

General information

These equipments satisfy the European Standard EN 61010-1

With reference to EN 61010-1 standard, note:
these power supplies must be installed and serviced only by qualified personnel.
These power supplies must only be used by persons acquainted with the regulations covering the application.

Note about EMC regulation:
The equipments described in this manual have been classified
as industrial, scientific and medical (ISM) radio-frequency equipments and the related standard for the emission is EN55011 (=CEI110-6) (title: Limits and methods of measurement of radio disturbance characteristics of ISM equipment.)

With reference to the EN55011 standard, these equipments are included into Group 2 (Microwave generators, Thyristor command equipment, Welding equipment, Induction heating equipment or machine, Microwave industrial oven, etc.), Class A (industrial environment): for this reason these equipments shall not be used in the residential, commercial and light-industrial environment.

The SM181x and AC 571, when properly installed, comply with the limits of radio disturbance characteristic of a Group2, Class A equipment as stated by EN55011.

WARNINGS

Both SM181x and AC571 are powered by AC main line and the SM181x has high voltage output (close 17 kV): read carefully this manual before using. Be sure that the equipments are correctly connected as described below. Failure to comply with the instructions enclosed in this manual may involve considerable risks for the staff responsible for checking and using the equipments, as well as the risk of general malfunctions of the equipments themselves.

Handling warnings

Both units have two handles, on the front panel, to help unpacking and handling operations: never use the handles to lift the equipment but support the weight with an appropriate base underneath the equipment!

The handles will not withstand the off-center weight of the equipment (SM181x=55 kg/121 lbs, AC 571= 16 kg/ 36 lbs)

General description

The MPS system is able to supply the power necessary to drive large power magnetron with electromagnet, from 15 kW up to 75, and includes the following:
- no. 1 AC571 filament & electromagnet Control Unit
- up to 5 pcs SM181x Power Units, depending from max power of the magnetron

MPS Configuration Table

MPS type	Output Power	Magnetron type/Power	Power Module type & no.
MPS 24	23 kW	CWM-15S /15 kW@2450 MHz	1 x SM 1813
MPS 48	46 kW	CWM-30S /30 kW@2450 MHz	2 x SM 181x
MPS 48	46 kW	CWM-30L /30 kW@915 MHz	2 x SM 1818
MPS 72	70 kW	CWM-75L /50 kW@915 MHz	3 x SM 1818
MPS 96	92 kW	CWM-75L /75 kW@915 MHz	4 x SM 1818
MPS 120*	120 kW	75kW with "redundancy set-up"	5 xSM 1818

The control and the power units have to be assembled stacked, in a closed cabinet, and wired according our specification: they swap signals throught a bus system, on the rear of the units, with a specific cable supplied with them.
Note*: It is possible a configuration called "Redundancy", which means to have one power module SM181x in excess compared to the true power required: the added inverter has two goals:
1- reduce the average power of each SM181x in normal operation, with benefit on service life (increased MTBF)
2- in case one of inverter goes OFF line permanently (i.e. for a failure not resettable), it supports automatically the request of full power operation of the system.

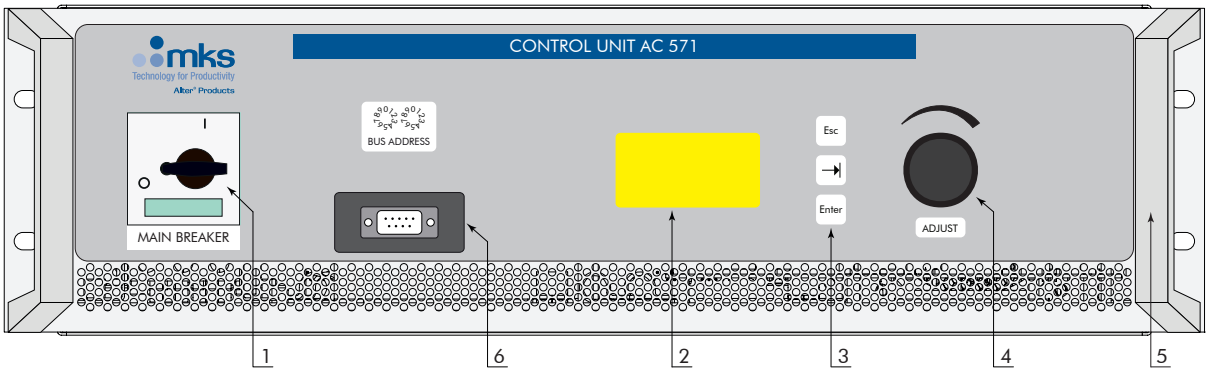
Any MPS may be controlled:
a) manually via the front panel keys on the AC571
b) remotely via a PLC with 0-10V analog signal
c) with the bus provided on the Control unit (for version 1)

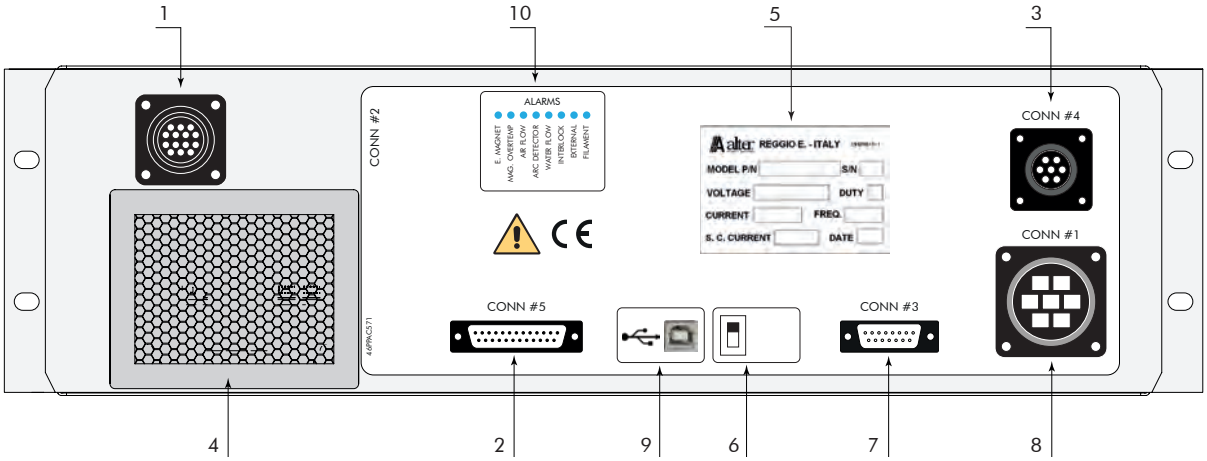
AC571 Description and Specifications
(common to all versions)

The AC571 is built in a self-ventilated 19" wide rack, 3HE high, with a front panel including (see drawing):
- a main switch [1];
- a backlit LCD display , [2]
- 3 push-buttons for parameters settings [3]
  «escape»
  «scroll down»
  «enter»;
- a rotating knob to adjust the chosen value [4];
- pull off handles [5].
- the connector with the fieldbus interface [6]

The rear panel of the AC571 includes the following:
- a 7 pins socket for the main supply (CONN. #1) [8]
- a 14 pins socket for the signals from the remote microwave head (CONN. #2) [1]
- a 15 pins "D" type socket to control the power units (bus link) (CONN: #3) [7]
- a 7 pins socket to power the remote microwave head (CONN. #4) [3]
- a 25 pins «D» type socket for the external control signals (CONN. #5) [2]
- a USB male type socket (slave USB) to upload new software version or connect to a PC USB port [9]
- the filter mesh of the outlet cooling air, which also reduces EMI noise [4]
- the equipment label [5]
- a 2 position switch DISPLAY-CPU [6]. The swicth allows selecting to which one of the two boards is connected the USB port. In normal operation (Run) let the switch set in CPU position. See chapter "Software upgrade" for further info.
- a 8 red alarm LED indicator [10] warning for a specific alarm state of the following inputs:
  - Electromagnet
  - Magnetron Overtemperature
  - Air Flow
  - Arc Detector
  - Water Flow
  - Interlock
  - External
  - Filament

FRONT PANEL of AC571





REAR PANEL of AC 571

AC571 Specifications

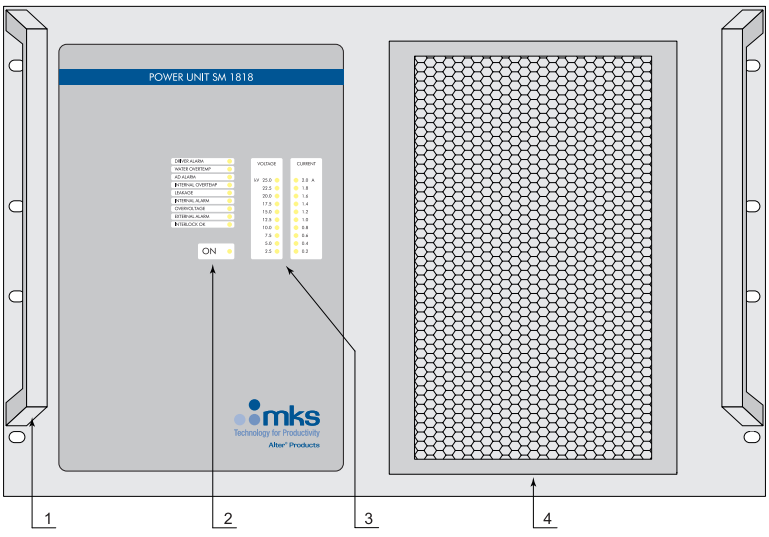
	AC571T	AC571U
Main supply (50/60 Hz):	3x400 V	3x480 V
Minimum main voltage:	360 V	435 V
Maximum main voltage:	440 V	525 V
Transient overvoltage:	overvoltage cat. II according IEC 664	
Intake current @ 400 V:	6 A rms	5 A rms
Current controlled output to filament trafo:	5 A rms	5 A rms
Stability of filament output:	within 1% for input fluctuations within +/- 10%	
Controlled output to electromagnet:	50 V, 5 A	50 V, 5 A
Stability of electromagnet output:	within 1% for input fluctuations within +/- 10%	
Electromagnet type (preferred)	WR975EMC-2	
Filament control:	with preset curve stored in the CPU	
Filament preheating:	automatic at power-on, typical 3 minutes	
Filament Transformer type (Preferred)	FIL500 - FIL1500 - FIL1500/400 - FIL1600 (Alter)	
Filament protecting fuse (internal, on board M268)	10 A 500V, T (delayed) 6.3 x 32 mm	
Enable microwave command	24 Vdc (range 12 ÷ 24Vdc) optoinsulated	
Reference signal to adjust power	0-10 Vdc optoinsulated, Z=100 kΩ	
Load of the Alarm contacts: Working mode of Alarm contact	max 24V - 0,5A (CONN #5, pin 7-9) Unit in Power OFF: **contact open** Unit in Power ON, no alarms: **contact closed** Unit in Power ON, alarm status: **contact open**	
Management of alarm event	Open of Alarm contact (CONN #5, pin 7-9) Showing of alarm type on display Emission of a 4 bit code of the alarm number (CONN #5, pin 10-11-12-13) (see relevant Alarm Table)	
Load of Ready Output signal Working mode of Ready signal	max 24 V - 50 mA Unit in Power OFF: **OFF** Unit in Power ON, no alarms filament ready (heating completed): **ON** Unit in Power ON, alarm status: **OFF**	

The function “Fast Recovery Alarm”, also called “Re-Try”, allows to detect some transient alarms and restart automatically the inverters as fast as possible (typically within 1 second).
The user must provide a proper cooling flow: the cooling air enters into the AC571 through the front panel and exits through the rear panel. The intake air flow is approx 100 m^3/h and care should be taken to avoid mixing output air with inlet air.

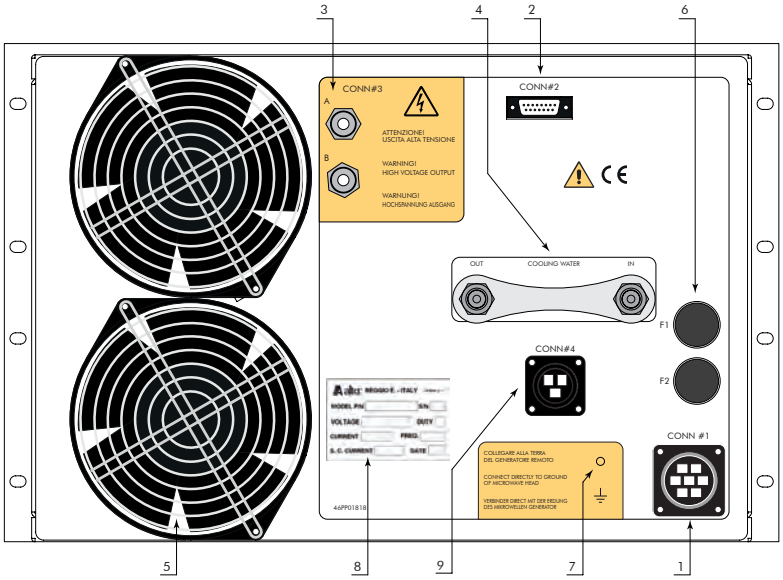
SM181x Description and Specifications

The Power Units are offered in two models that differ for the output characteristics (see the table on next page):
- the SM1813 delivering up to 2 A x 13 kV
- the SM1818 delivering up to 1.25 A x 18.5 kV

The Power unit is built in a self-ventilated 19” wide rack, 7 HE high, with a front panel including (see next drawing):
- pull off handles [1];
- two analog LED bars, one showing Anodic Voltage (10 LED, range 0-25 kV, each indicates 2,5 kV), the second showing the Anodic Current (12 LED range 0- 2.000 mA, each indicates 200 mA) [3].
- a status LED bar, giving visual aid to user for the main system status, including the type of alarm. See next paragraph “Alarm Led explanation” [2].
- intake air mesh [4].



The rear panel (see next drawing) includes the following:
- a 7 pins socket for the main supply (CONN. #1) [1]
- a 15 pins “D” type socket for the bus-link to the AC571 (CONN. #2) [2]
- a 1pin socket for the high voltage in/out (CONN. #A)[3]
- a 1pin socket for the high voltage in/out (CONN. #B)[3]
- the water inlet and outlet fittings [4]
- the fans [5]
- the fuses holders (F1, F2) [6]
- thr “hearth”screw [7]
- the equipment label [8]
- a 4 pin socket for auxilliary supply (CONN. #4) [9]
- a 10 position rotary switch for PSU address set [10]



-

Environmental conditions

Use:	Indoor use only
Altitude:	up to 2,000 m (~6,000 ft)
Temperature:	5°C to 40°C (41°F÷104°F)
Relat. Humidity:	80% for temperature up 31°C (88°F), decreasing linearly to 50% RH at 40°C (104°F)
Pollution degree:	2, complies with the norm IEC664 (non conductive dust)

Fuse specifications

The power unit have two fuses on the rear panel that protect the connection going to the head.

SM1818 Fuse F1 and F2 specs:

- Size, type: 10x32 mm, ceramic cartridge
- Speed action: quick (F)
- Rated current: 5 A
- Rated voltage: 500 V minimum

For instructions about fuse replacement please refer to related paragraph on next page.

SM181x Power Module Specifications:				
	SM 1813T	SM 1818T	SM 1813U	SM 1818U
Main supply (50/60 Hz):	3x400 V	3x400 V	3x480 V	3x480 V
Minimum main voltage:	360 V	360 V	435 V	435 V
Maximum main voltage:	440 V	440 V	525 V	525 V
Transient overvoltage:	cat . II/IEC664	cat . II/IEC664	cat . II/IEC664	cat . II/IEC664
Intake current on power section lines:	40 A_{rms} @ 3x400V	40 A_{rms} @ 3x400V	36 A_{rms} @ 3x480V	36 A_{rms} @ 3x480V
Intake current on auxiliary lines:	0,6 A_{rms} @ 2x400V	0,6 A_{rms} @ 2x400V	0,5 A_{rms} @ 2x480V	0,5 A_{rms} @ 2x480V
Anodic Output Current (max):	2.000 mA	1.250 mA	2.000 mA	1.250 mA
Anodic Output Voltage (max):	13 kV_{dc}	18,5 kV_{dc}	13 kV_{dc}	18,5 kV_{dc}
Current ripple (max):	≈ 5%			
Dimensions (19" rack style x 7 HE)	mm 311 (h) x 500 (d) x 482 (panel width, 19")			
Cooling requirements: solution 80%water + + 20% glycol	**Water low rate: 2 liters/minute, max 35°C, min 12°C; pressure >2 bar, <5bar** Water quality: clean, particle < 20um, electrical resistance > 20 kOhm-cm, hardness below 6 °dH (=10.7 °f=107 ppm). **Use a solution with 20% of glycol**.			
Fittings for water piping	BSPP 1/4" F			

Equipment maintenance

Cleaning

Cleaning of the air filter: verify once a month. In case you need to remove dust then proceed as follows:
- remove main line from the unit
- remove the cover
- use clean, oil free, pressurized air from inside to outside for short time: do not exceed or you may damage the fan
- install the cover and then power-on again.

Fuse replacement

To replace the fuses on the rear panel proceed as follow:
- switch-off power with the device provided to remove main line from the equipment (breaker/contactor/etc);
- unplug power connectors #1 and #4
- unscrew the fuseholder cap;
- replace the fuse with a new one with the same electrical characteristics;
- also inspect the fuseholder: if it's oxidised or it has burn marks then replace it;
- install the fuseholder cap and screw tight.
- plug again connector #1 and #4
- fuse values are given in "Fuse Specs" par. in this page

Equipment installation

The MPSxx cannot operate on a bench: it must be installed into a proper cabinet such as a commercial 19" standard enclosure.
The equipment is intended for industrial use only, not for laboratory use, and the user must respect the wiring norms and prescriptions as described into next paragraph ("Wiring instructions").

The equipment must not operate cantilevered, it must be safely fixed inside a cabinet by means of screws on the front panel and supported by means of a proper frame on the bottom for, at least, 3/4 of the total depth.
Usually two "L" shaped supports on each side of the equipment, having a dimension of mm 10(h) x 30(l) x 1.5 (thick) are suitable for this purpose.

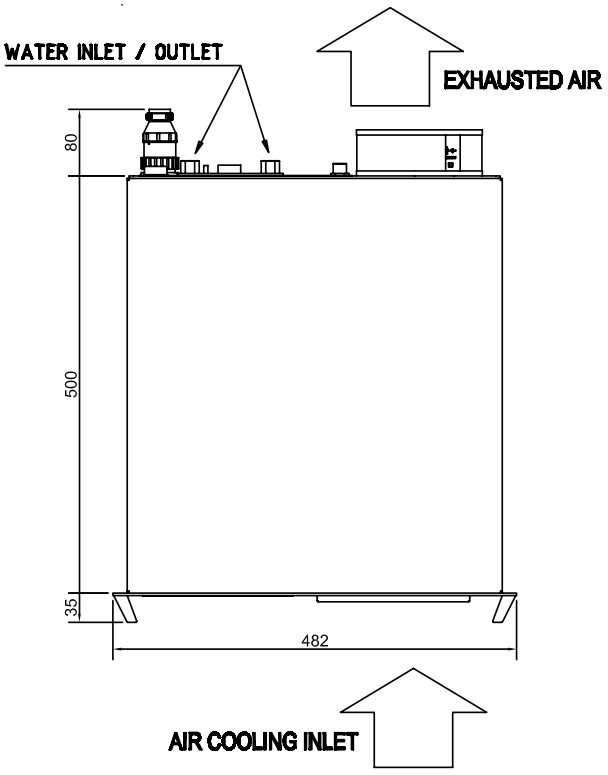
The rear side of the equipment must be protected by a fixed panel which can be removed only by means of tools or by a door with security micro-switch: when the door is opened the micro-switch must shut-off the main line.

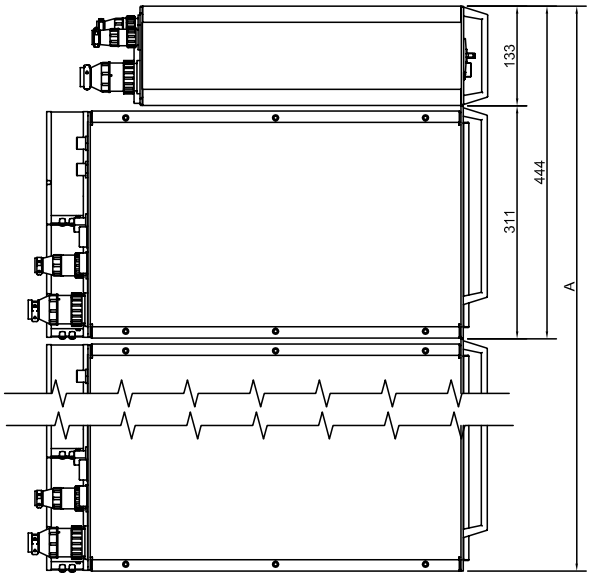
This safety precautions must be taken to avoid operation on rear fuses or on connectors while the unit is still powered.

Special attention must be taken on designing the cooling air flow whenever several units are stacked in the same cabinet.
Note that each SM181x has its own fans which supplies approx 700 m^3/h: the outlet of the exhaust air is on the back of the equipment.

When designing the cabinet for the MPS we recommend to adopt the followings design criteria:
- use a standard 19" wide enclosure with a depth of 800 mm (32");
- allow free intake of the cooling air from the front of the cabinet and exhaust air from the back;
- in case of ambient air with high degree of dust and moisture, install a proper air conditioner;
- provide a separation between the air intake duct and the air outlet, in order to avoid air-recycling.

MPS Physical data & cooling						
MPS type	**Output Power**	**Module type & no.**	**Total Height** (marked "A") on drawing	**Total Weight**	**Total air flow (max 35°C)**	**Total water flow at temp. max 35°C min12°C** (not condensing!)
MPS 24	23 kW	1 x AC571 +1 x SM 181x	mm 444	71 kg (156 lbs)	800 m³/h	2 lt/minute
MPS 48	46 kW	1 x AC571 + 2 x SM 1818	mm 755	126 kg (280 lbs)	1500 m³/h	4 lt/minute
MPS 48	46 kW	1 x AC571 + 2 x SM 181x	mm 755	126 kg (280 lbs)	1500 m³/h	4 lt/minute
MPS 72	70 kW	1 x AC571 + 3 x SM 1818	mm 1066	181 kg (400 lbs)	2200 m³/h	6 lt/minute
MPS 96	92 kW	1 x AC571 + 4 x SM 1818	mm 1377	236 kg (520 lbs)	2900 m³/h	8 lt/minute
MPS 120	114 kW	1 x AC571 + 5 x SM 1818	mm 1688	291 kg (640 lbs)	3600 m³/h	10 lt/minute





Handling instructions

The total weight is indicated on the table: each module is heavy, always lift from the bottom and use an adequate rugged support to avoid personal injury and damages to the equipment itself.
In case of shipping, use the original package or a wooden case with a proper filler: movement of the equipment inside the package must be avoided.

Warning: use handles only for helping during installation. **Never use handles to lift the rack: the handles will not withstand the off-center weight of the rack!**
To lift always lean the rack over a proper supporting base.

Wiring instructions

The MPSxx must be installed and serviced only by qualified personnel acquainted with the regulations covering the application. For safety operations the following rules must be adopted:

I) the equipment must be grounded through connector #1 using pin 4 (see the wiring diagram at pages 21, 22);

II) connect the ground screw on the panel rear (indicated by "ground" symbol) directly to the remote microwave generator head by a separate yellow/green wire gauge 2.5 mm²;

III) **SM181xT:** The main supply, 3x400V (480V for model U) must be provided through connector #1: connect phases according to schematic at page 21. A 10 mm² wire must be used with this connector.
Use CONN. #4 to provide 2x400V (480V for model U) line for auxiliary voltage of the unit: this line may remain live in case of power OFF of the unit, so that the control circuits

inside remain powered.
Connect phases according to schematic at page 21. Up to 2.5 mm² wire can be used with this connector.

AC571T: the main supply, 3x400V (480V for model U) must be provided through connector #1: connect phases according to schematic at page 22. From 1.5 up to 2.5 mm² wire can be used with this connector.

IV) Connect the AC571 to SM181x by means of the 15 pins "D" type socket, marked CONN #3 (AC571) and CONN #2 (SM181x), using the proper cable supplied.

V) The magnetron head unit must be connected to the AC571 control unit by:
- CONN #2 (signals): up to 1 mm² wire can be used with this connector. Use cable with insulation 300V/500V. Refer to wiring diagram at page 23;
- CONN #4 (power): up to 1.5 mm² wire can be used with this connector. Use cable with insulation 450V/750V. Refer to wiring diagram at page 23.

VI) The **high voltage output** from the last SM181x power unit has to be connected to the magnetron's cathode by CONN #3. This voltage is near **20 kV**. SM181x high voltage in/out are connected together in parallel by high voltage cable assemblies. CONN #3 A is linked to CONN #3B of the next power supply.
Use a proper insulated cable with working voltage >25 kVdc and minimum gauge of 0.25 mm²; protect the wire with sheathing (armoured if possible).
ALTER can supply the HV cable with length on request.

VII) On the AC571 the "D" type female CONN #5 has 25 pins and brings the I/O signals to the equipment. We suggest shielded ribbon cable for this purpose.
Refer to wiring diagram at page 24

VIII) the user must provide an external cut-off device, to protect the MPSxx from short-circuit and thermal runaway conditions; this external protection device must also allow the main line to be isolated for maintenance operations.

a) the external circuit breaker must be a 3-pole breaker and must comply with EN61010-1 specifications;
b) the external circuit breaker must be in close proximity to the equipment and within easy reach of the operator;

IX) External circuit breakers must be provided also for each SM181x and AC571; they must be marked as the disconnecting device for the SM181x and the AC571.

X) CONN #1 and #4 must never be used as a switch-off device for SM181x. Switch off both external breaker on CONN#1 and CONN#4 before unplugging the power connectors.

XI) Connector #1 must never be used as a switch-off device for AC571.

Failure to comply with these instructions may involve considerable risks for the staff responsible for checking and using the equipment, as well as the risk of general malfunctions of the equipment itself.

Equipment operation

Power-up procedure

Before powering-up the equipment you must be sure:
1) to have cooling water open (!)*
2) to have properly connected the equipment (look at the paragraph "Wiring instructions" in case of any doubt)
3) set the AC571 front panel breaker in "ON" position, marked with "1" **
4) have the SM181x addresses given by the rotary switch position set to addresses from 1 up.
Same addresses not allowed.
5) power the SM181x using the devices provided for switching main line and auxiliary line **

***Note for cooling water circuit**: **do not hold water flowing for period over 30 minutes when the system is powered off to avoid water condensing inside the equipment.**

****** Note: Once set OFF the line, wait at least five seconds before setting it ON again.**

At power on the unit enters into "POWER-ON" state for few seconds to perform some internal checks and then goes immediately into "STAND-BY" and remains in this state until the "hibernate" command is switched OFF.

It's also possible to permanently disable the "hibernate" command: in this case the system performs the filament heating immediately after the "POWER-ON" state, if no alarm conditions are present.

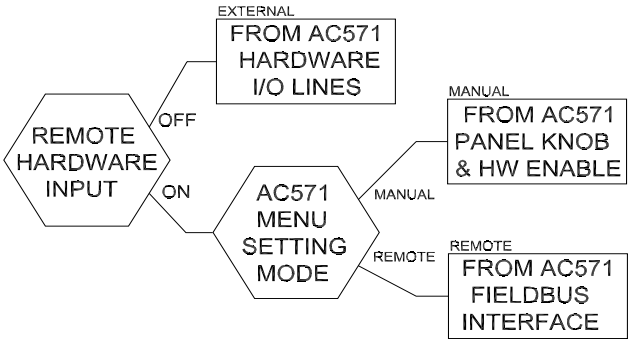
At the end of the heating cycle, the unit enters the "READY" mode: the power supply may now power the magnetron to generate microwaves, when it receives the enable command.

Any type of alarm will force the unit to exit the "READY" state and to enter the "ALARM" state.

In absence of any alarm the power supply may be left in the "Ready" state continuously (but after 30 minutes stop water cooling recirculating to avoid condensing inside, on the heatsink): when it receives the enable command (ON) it enters into "RF-ON" state and generates output power, when the enable command is removed (OFF) the unit comes back to the "READY" state.

MPS System Control

The control of the MPS system is achieved through the AC571. The AC571 can work in three ways: Manual, External or Remote. In Manual control the AC571 buttons, knob and display are used. In External Control the hardware interface is used, and a customer PLC or the cabinet door switches and knob are used. In Remote Control the fieldbus data communication is used to enable/disable MW generation and to set the MW level, but an hardware Enable input is also needed in AND logic for safety reason.The logic of the AC571 control is picted in the following graph:



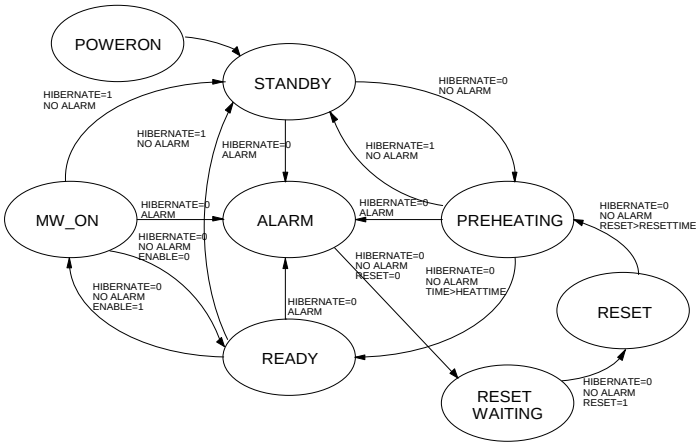
The REMOTE hardware input selects the external control if OFF or not wired. When it is ON, the AC571 menu page named INFO 3 (position 1.2) allows to select between MANUAL and REMOTE control.

Working modes

The working capability of the MPSxx depends from its "working status": it has several states, each with a different meaning and functionality. These states are:

POWER-ON: it goes in this state at power-on, when the main breaker is set to 1: the CPU performs some internal controls, display the factory's logotype and, after few seconds, the unit enters the Stand-by mode.

STAND-BY: this is a waiting state, the unit is powered but not yet ready to generate microwaves as the magnetron filament is not powered. In this state all of the working parameters can be set from Operator Panel; the unit enters in Stand-By from the previous Power-On state or from a Reset state. The unit exits from Stand-by and goes to Preheating only if there are no alarms present, and the "Hibernate" is OFF.



PREHEATING: this is a temporary state, controlled by an internal timer, which allows the filament to be heated. Entrance in this state is done by an external command or automatically after the end of the Power-On state. When the timer has elapsed the unit goes into the Ready state.

READY: the unit waits for the external enable command to generate power to the magnetron. The magnetron filament has been heated.
The unit may remain in this state as long as needed: it automatically exits should any alarm be generated or when the "hibernate" command is set. When the ENABLE command is set the unit enters into the "MW-ON" state.

MW-ON: when this appears on the LCD screen the unit is generating microwave emission at the preset power level. The unit exits from this state if:
- the enabling command is set OFF. It will now enter the Ready state.
- any ALARM signal is generated. It goes into the Alarm state.
- Hibernate signal is set ON.

ALARM: in this state the output power and the filament is immediately shut-off. The alarm type is indicated on the display. The unit exits the Alarm mode and enters the Reset Waiting state only when the alarm cause is removed by a "RESET" signal (CONN#5) pulse.

RESET WAITING: the unit enters in this state when the alarm cause is cancelled and the enable command is still present (ON). The unit exits from this condition and enters in Reset state, only when the enable command is switched OFF.

RESET: this is a temporary state, driven by a two seconds timer. When the timer is elapsed the Reset state ends and the system automatically enters the Stand-By status.

Description of the external commands.

HIBERNATE: has value ON/OFF.
- If ON the magnetron's filament is not powered and the system goes into the Stand-by state.
- If OFF the filament is heated and when the related timer has elapsed, the unit enters the Ready state. The heating timer value can be preset from the front panel.
- If a user does not wish to use the Hibernate function, it may remain disconnected and the system will treat it as in OFF condition.

POWER ENABLE: has value ON/OFF.
The effectiveness of this signal will depend on the state of the HIBERNATE signal in this way:

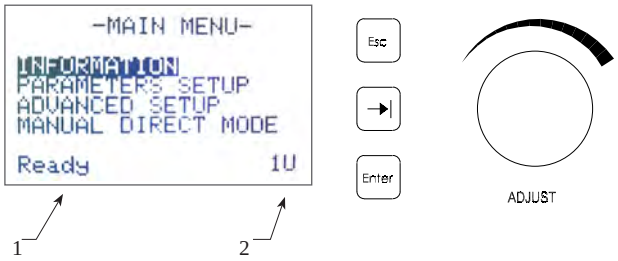
a) ENABLE OFF and HIBERNATE OFF the unit performs filament preheating and goes in Ready state but does not generate output power;
b) ENABLE OFF and HIBERNATE ON the unit is in the Stand-by state but does not gene rate output power;
c) ENABLE ON and HIBERNATE OFF the unit awaits the end of preheating sequence and then starts to generate output power provided that the power set signal is > 0%.

d) ENABLE ON and HIBERNATE ON the unit is the Stand-by state but does not generate any output power.

POWER SET: this is an analog input signal and sets the level of output power.
When the power set value is greater than 0 the unit generates power proportional to signal value:
the signal is a 0-10V or 0-100% when the mode is "manual" and the power set is given by the panel knob.

Operator interface on AC571 Control unit

The control unit AC571 offers the possibility to verify the working condition and the main working parameters of the magnetron, using the display and the push-buttons located on its front panel.
The operator may control the power output but, per design, cannot "Enable" the microwave output using the commands on the Operator Interface: it is always requested to provide an external hardware command.



The default display looks like the previous image, the numbers mean:

1) Status indicator; can be one of the following:

Standby - Head warm up or reset wating
Ready - MW ON - Alarm "xxx"

2) SM18x units working (quantity)

The AC571 has three control modes:

- **Manual**: via the operator interface. See the next description of all the functionalities that can be available through the operator commands on the panel;
- **External**: via PLC commands, digital and analog. This is the control mode that must be selected when it is requested to drive the GS500 generator through "Local Control" described at previous page or PLC "Remote Control". See also the Generator schematic at next pages.
- **Bus**: via the installed type of fieldbus interface. (implemented only on request). See relevant manual for interface type and managment.

Software upgrading

The software stored on the AC571 can be upgraded to a newer version through the USB type B port provided on the rear panel of the unit, connecting to a PC where the new software is loaded.
The AC571 has two separate controllers (CPU Boards)
- one handling the physical I/O, installed on the rear panel, called M566 "CPU"
- one handling the User interface and display, installed on the front panel, called M516 "DISPLAY"
they are connected internally through a bus and swaps data continuously.
The software of the two CPUs is, of course, different: as there is one single USB port that communicates with one CPU only, on the rear panel of the unit is provided a switch with the indication of the CPU board engaged with the port "CPU" or " DISPLAY".
For uploading a new software version you have to select which CPU needs the upgrade: move the switch accordingly.
Important remark 1: during normal operation, the switch must be returned to the position "CPU" or the system will not be able to run. Hence the position "DISPLAY" must be used only temporarly when is needed to upload a new software on the "M516 Display CPU board".

Important remark 2: at power-on, even if a program is already stored, the microprocessor enters a "BOOT-LOADER" status, lasting 2 seconds, during which it is possible to overwrite, through the USB port, the stored code. If no new code is loaded within 2 seconds, the previously stored one is run.
The USB port emulates a serial (RS232) COMx port, and in the PC a special software driver must be present or it will be automatically downloaded.
When the PC USB port is connected to the AC571, the PC senses a new device, and allocates a new COM port number to the usb connection. The user must find out the COM port number, as the uploading will be done on that serial port.
To upload a new program through the bootloader, simply connect the AC571 USB port to the PC USB port, select the CPU to be upgraded follwing the following instructions.

Warning: The unit does not start until the new program is stored, but be sure that enable signal is not active when upgrading.

The firmware to be uploaded into the AC571 controller is released as a .zip archive named "*program_name.zip*".
Unpacking the .zip archive you generate:
- a directory named "*program_name*" containing the micro code to be loaded,
- an executable program named "*SendApplicationProgram.bat*"
- the loader "*sRecLoad.exe*".

Once unpacked the .zip program
- enter in the folder "*program_name*",
- switch-on the AC571
- run **whithin 2 seconds** the program "*SendApplicationProgram.bat*"
(which launches ***sRecLoad.exe*** application)

During the bootloader wait time, an alarm state is engaged and the unit do not perform any command: if no code is sent, then the previous code is executed, and it is not possible to change it without switching the unit off.

Software menu description

Page name: MAIN VIEW

It's the default view at POWER ON. It is shown, at the centre of the display, one of the possible measurements performed by the unit. At the left lower corner is displayed the machine status and, at opposite corner, the number of working power unit (in the example no. 1)
The buttons ENTER and TAB are not active.
Pressing button ESC you exit MAIN VIEW and go to MAIN MENU.
The upper line informs on the software version number (v2.03)

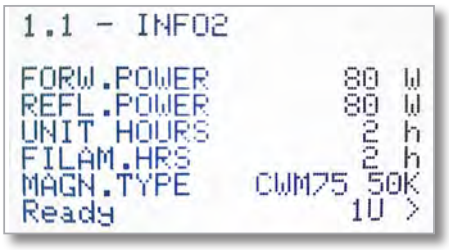
Page name: MAIN MENU (position 0.0)

This page give you access to 4 sub-menus: press TAB to move selection, then press ENTER to select the sub-menu you've highlighted, press ESC to go back to MAIN VIEW.
Sub-menus:

- INFORMATION	go to page 1.0 INFO1
- PARAMETERS SETUP	go to page 2.0 PARAM.SETUP
- ADVANCED SETUP	go to page 3.0 ADV. SETUP
- MANUAL DIRECT MODE	go to page 4.0 DIRECT MODE

Page name: INFO 1 (position 1.0)

It's a read only page. Use TAB to go to next page 1.1.
There are 9 pages of information, from 1.0 to 1.8.
Press button ESC to exit INFO1 and go to MAIN MENU.
This page displays the followings:
Setpoint Reference (%),
Anodic Voltage (V) and Current (mA).
Electromagnet Coil Current (mA),
Filament Current (A).

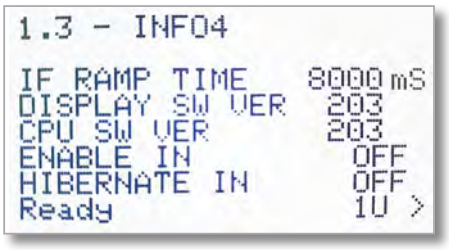


Page name: INFO 2 (position 1.1)

It's a read only page. Use TAB to go to next page 1.2.
Pressing button ESC you exit INFO2 and go to MAIN MENU.
This page displays the followings: level of Forward Power (W) if sensed, Reflected Power(W) if sensed, Filament On Time (hours), Magnetron Type (set in position 3.131).

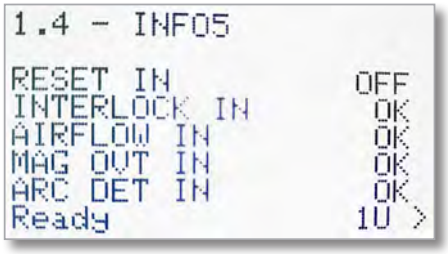
Page name: INFO 3 (position 1.2)

It's a read only page. Use TAB to go to next page 1.3.
Pressing button ESC you exit INFO3 and go to MAIN MENU.
This page displays the followings: Last Occured Alarm, Control Mode (External - panel commands or PLC; Manual - AC571 front panel commands; Fieldbus), Preheating Time (set in position 3.12), Reference Ramp (set in position 3.12), Maximun Delta Anodic Voltage (set in page 3.12).



Page name: INFO 4 (position 1.3)

It's a read only page. Use TAB to go to next page 1.4.
Pressing button ESC you exit INFO3 and go to MAIN MENU.
This page displays the followings: Filament Current Ramp Time (set in position 3.12), Display Software Version, CPU Software Version, Enable Input Value, Hibernate Input Value.

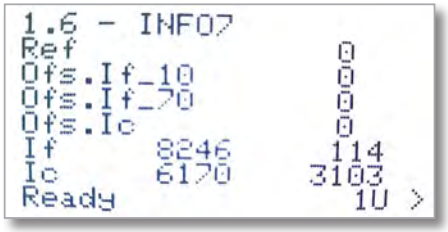


Page name: INFO 5 (position 1.4)

It's a read only page. Use TAB to go to next page 1.5.
Pressing button ESC you exit INFO5 and go to MAIN MENU.
This page displays the followings: Reset Input Value, Interlock Input Value, Airflow Alarm Input Value, Magnetron Overtemperature Alarm Input Value, Arc Detector Alarm Input Value.

Page name: INFO 6 (position 1.5)

It's a read only page. Use TAB to go to next page 1.6.
Pressing button ESC you exit INFO6 and go to MAIN MENU.
This page displays the following input values: E-magnet Water Alarm, Magnetron Water Alarm, Power Supply Units Water Alarm, External Isolator Water Alarm, Head Interlock Alarm.
The status of these input signals is OK or ALARM.



Page name: INFO 7 (position 1.6)

It's a readwrite page. Use TAB to go to next page 1.7.
Pressing button ESC you exit INFO7 and go to MAIN MENU.
This page displays the following input values:
Reference value, Offset Value for Filament Current @10%, Offset Value for Filament Current @70%, Offset Value for E-magnet Current, Filament Current, E-magnet Current.

You can edit the values: press ENTER to jumo on Ofs.If_10, and change it using the encoder knob; the range is from 0 to 20000.
10000 is for no change, or 100%; 8000 is for 80%, 12000 is for 1,2%.
Move to next value to edit using ENTER key.

Page name: INFO 8 (position 1.7)

It's a read only page. Use TAB to go to next page 1.0.
Pressing button ESC you exit INFO8 and go to MAIN MENU.
This page displays for each Power Supply, listed from 1 to 5, the presence (ON/--) the status (E for Enabled, FZ for Frozen), any possible alarm present from that PSU.

Page name: PARAM. SETUP (position 2 page 1)

This page is a read/write one. You can set:
- The type of parameter shown in the Main Menu:
VOLTAGE/CURRENT/POWER/REFERENCE/POWER%/
FWD PWR/REV PWR/FIL CURR/EMAG CURR
- the AC571 control mode (can be set to MANUAL or FIELDBUS if AC571 REMOTE hardware input is true, EXTERNAL otherwise).
- the amount of power units installed in the system.
- the maximun reflected power alarm threshold.
- the Guarding Time (only for Fieldbus control).

Use TAB to move to the next page. Use the panel knob to set the desired value. Press ENTER to save the selection.
Pressing ESC you exit PARAM. SETUP and go to the MAIN MENU.

Page name: PARAMETER SETUP (position 2 page 2)

This page can be reached using TAB buttons from previous page 1.
In this page it is possible to set the parameters associated to the RETRY function. (see Retry feature explanation)
- RESTART DELAY: time between the alarm event and the Reset pulse. Default is 50 msec, but the entire generator has its own ramp up time that is not shorter than 200 msec
- RESET TIME: length of the Reset pulse: Default is 50 msec
- NUM RETRY: specify the number of RETRIES before issuing an alarm and stop. If you set this number = 0 the RETRY function is not enabled. If you set, i.e., the NUM RETRY=3 the controller allows 3 attempt to RETRY if these fall within the maximum time specified at next parameter.
- RET CLEAR TIME: specifies the time slot within which the alarm counter is incremented by the alarm event. At the end of the time slot the counter is zeroed. I.e. if this is set to 10 seconds, the NUM-RETRY is set =3 and you get the fourth alarm event over the time slot, the alarm counter is set to zero and this is recorded as the first alarm.
- FREEZE RETRY: the number of failed retries done on a PSU before the controller set that PSU in the FROZEN state. This allows the process to continue, even in the case a PSU fails, excluding it and working with the other PSUs.

Page name: ADVANCED SETUP (position 3.0)

It's a warning page. Press ENTER to go next page 3.1, the ADVANCED SETUP MENU.
Pressing ESC you exit ADV. SETUP and go to MAIN MENU.

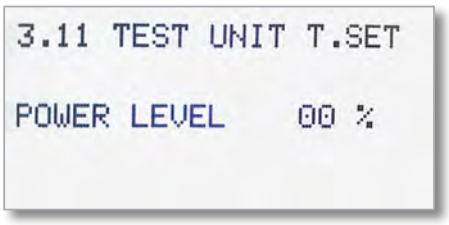
Page name: ADVANCED SETUP 1/2 Menu (position 3.1)

In this page you have the possibility to change the following advanced parameters of the unit:
- Buildable Magnetron Table (see position 3.11 e 3.111 for further information)
- Advanced Parameters set
- Magnetron type Selection (see position 3.12)
- Unit Hours Count Reset (possible only with password #1);
- Filament On Hours Reset (possible only with password #1)

Pressing button ESC you exit ADV. SETUP and go to MAIN MENU.
Press ENTER to go inside the selected sub-menu, or TAB to enter the next Advanced Setup menu.

Page name: ADVANCED SETUP 2/2 Menu (position 3.1)

In this page you can:
- Do a complete Unit Reset to the default values (possible only with password #2).
- Set the Alarm Delay values (position 3.16)
- View the diagnostic page.



Page name: TEST UNIT TABLE SET (position 3.11)

The unit gives the possibility to set a custom set of tables for the working parameters of the magnetron. In position 3.131 you can select the magnetron working tables from a bunch of existing magnetrons or the custom one.
Move the panel knob to select one of the 11 tables (from 0% to 100% in 10% steps of power level) to modify and then press ENTER.
The page of the selected table will appear.
Pressing button ESC you exit and return to ADV. SETUP MENU.

Page name: MAGNETRON PARAMETER SET (position 3.111)

On this page, you are entering the table values for the first step (0%) of the 11 power levels of the TEST UNIT. You can set:
- Anodic Voltage;
- Anodic Current;
- Coil Current;
- Filament Current.

Move between the four parameters, chenge the values with the panel knob, then store them pressing ENTER. This will return to 3.11 menu.
Select the next power level to edit, in the same way.
Edit all the 11 levels and you are done.

Page name: ADVANCED PARAMETERS SET (position 3.12)

In this page it is possible to modify the following parameters:
- Preheating Time, in seconds
- Reference Ramp: the rising time (from 0% to 100%) of the setpoint signal and so the step response of the unit.
- Filament Current Ramp: the rising time of the filament current at every filament switching on.
- Maximun Delta Anodic Voltage (software alarm): the delta, that is the difference between the upper and the lower threshold for the anodic voltage. Zero value means that the software alarm is bypassed, while the hardware alarms (overvoltage and leakage) are still working.
- Anodic Voltage Offset (hardware alarm): with this value it is possible to set an offset for the overvoltage threshold (hardware cicuit).

Press TAB to select one of the parameters, than move the panel knob to change the value and finally press ENTER to save.
Pressing ESC you exit and go to position 3.1.

Page name: MAGNETRON SELECT (position 3.13)

It's a warning page. Press ENTER to go to next page 3.131, the MAGNETRON SELECTION
Pressing ESC you exit MAGNETRON SELECT and go to POSITION 3.1.

Page name: MAGNETRON SETUP (position 3.131)

Move the panel knob to select the desired magnetron. Every magnetron has a set of tables ready to use (you can see the maximum values below the selected magnetron).
The "TEST UNIT" magnetron, if selected, uploads the custom tables filled at position 3.111.
Press ENTER to select the magnetron. Pressing ESC or ENTER you exit MAGN. SETUP and go to position 3.1.

Page name: RACK HOURS COUNTER RESET (position 3.14)

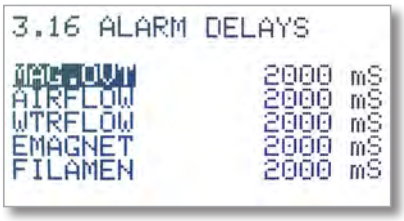
Enter the password #1 * to reset unit powered hours counter, then press ENTER: the hours counter of the unit will be zeroed.
Pressing ESC you exit RACK HOURS COUNT RESET and go to position 3.1.

Page name: FILAMENT HOURS COUNTER RESET (position 3.14)

Enter the password #1 * to reset filament on hours counter, Then press ENTER: the hours counter of filament will be zeroed.
Pressing ESC you exit FILAMENT HOURS COUNTER RESET and go to position 3.1

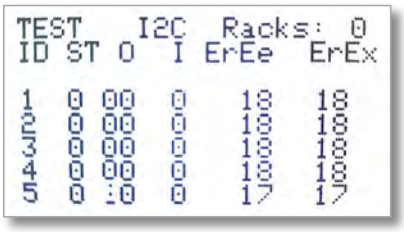
Page name: EEPROM DATA RESET (position 3.15)

Enter the password #2 * to completely reset the EEPROM of the AC571 controller.
Pressing ESC you exit EEPROM DATA RESET and go to position 3.1.



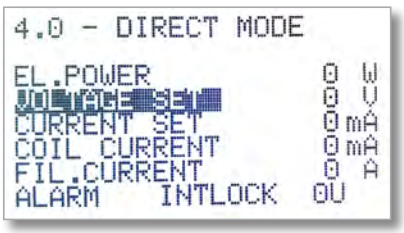
Page name: ALARM DELAYS (position 3.16)

This page allows to edit the values of the time delays before an alarm is issued.
Select the parameter to change with TAB, change using the knob, store using the ENTER key.
Pressing ESC you exit ALARM DELAYS and go to position 3.1.



Page name: TEST I²C (position 3.17)

This is a diagnostic page to test the I²C communication between the AC571 controller and the various PSU.
Pressing ESC you exit TEST I²C and go to position 3.1.



Page name: DIRECT MANUAL MODE (position 4.0)

WARNING: once entered in this page the tables are bypassed. It is possible to set the magnetron working parameters manually. The first row shows the actual output electric power. The unit is driven by the following values:
- Anodic Voltage
- Anodic Current;
- Electromagnet Coil Current;
- Filament Current.

Press ENTER to send the parameters to the unit.
Pressing ESC you exit DIRECT MODE and go to MAIN MENU.

* Contact manufacturer to have passwords.

Unit Freeze Function

From SW version 2.00, and only for power supplies provided with control board M350, a special “Freeze” function has been added.
The system is made by many power supplies, that work in parallel. When an alarm is issued from a power supply SM181x the AC571 controller tries to perform first some alarm reset, if the parameter RETRY_NUMBER is greater than zero.

If the reset funtion is able to restart the faulty unit, the process will go on, otherwise, after FREEZE_RETRY_NUMBER reset pulses the faulty unit is forced into the “Freeze” mode: it is removed from the active units list, and the process will go on using only the remaining good ones. The setpoint of the remaining units is raised, if possible, to compensate the lack of current due to the frozen one, and the process is continued at the same power level.

The duration of the reset pulse (ALARM_RESET_TIME) and the delay before a new ramp after the reset (IA_RESTART_DELAY) are system parameters that can be tuned according to the process need.
The redundant number of power supplies allows to take advantage of the freeze feature, specially where very long processes are achieved, and a stop after an alarm would cause an expensive waste of product.
The freeze function will be active, after the first action, for the remaining power supplies, so that a not-recoverable fault will at the end stop every power supply, ending in an alarm condition.

The number of possible reset pulses before freezing is decremented at each reset, but is reloaded to the FREEZE_RETRY_NUMBER after a time that is set by the RETRY_CLEAR_TIME parameter.

Software release history for versions < 2.00

Display/CPU (M516)		Backpanel/CPU (M566)	
Rel. no.	Comment	Rel. no.	Comment
1.02	Corrected bug on screenshot of filament current and magnet current	1.02	Corrected bug on preheating time parameter.
1.03	Different handling and recording of magnetron test table.	1.03	Corrected bug on direct mode operation and its link with preheating state.
1.10	Adoption of new microprocessor with larger memory capability. Minor bug correction.	1.10	Adoption of new microprocessor with larger memory capability. Minor bug correction.
1.14	30kW magnetron table minor correction	1.14	Forward/Reflected power linearization added
1.15	75kW filament current table changed	1.15	Max Power handling over 65000W
1.16	I^2C communication speed reduced	1.16	15kW Fwd/Refl linearization added
1.17	Some magnetron definition changed	1.17	
1.18	Some magnetron definition changed	1.18	
1.19	50kW magnetron #4 name corrected	1.19	
1.20	40kW magnetron table added	1.20	40kW Fwd/Refl power linearization added
1.21	40kW magnetron table for 480V main line voltage added.	1.21	

Software release history for versions from 2.00 up

Display/CPU (M516)		Backpanel/CPU (M566)	
Rel. no.	Comment	Rel. no.	Comment
2.00	Added Freeze function on power supply units; magnetron table definition number raised to 16	2.00	
2.02	30kW magnetron table correction	2.02	Electro-magnet alarm fix
2.03	Text display fix for values bigger than 65000.	2.03	Interlock signal from magnetron head does not cause alarm, only disable. Magnetron filament and electromagnet current are not zeroed, thus avoiding long preheating time delay.
2.11	Automatic detection of active units	2.11	
2.14	Filtered CPU to display communication	2.14	Filtered CPU to display communication
2.16	Magnetron Degassing procedure added	2.14	Magnetron Degassing procedure added

Remote Control by Fieldbus

PROCESS I/O DATA ACCESS

When the system is driven by the customer fieldbus Master device, it is seen as a Slave. The complete information exchange is performed over two arrays of 32 + 32 data words that are continuously refreshed by the fieldbus, one in Read and the other in Write.
Those data are named Process Data, and they may freely changed during the process. Another set of data are the System Parameter data, that can be set but are not written/read continuously, as they are constant values inside the process. It is possible to change the System Parameters only when the unit status is standby, and this can be done using the AC571 display/keys or through the fieldbus.
Usually the customer PLC is continuously refreshing the Write data, and polling the Read data, so that a complete control over the system values is achieved.
A parameter named **guarding time** is used to ensure a safe interaction between the PLC and the system controller AC571: if the data exchange over the fieldbus is stopped for more than the guarding time, then the system will enter an alarm status, switching off the microwave generation. A complete list of the process I/O data is provided on the next pages.

Process Read Data Table

word	Name	Meaning	Value
1	WARNING_CODE	4bit code of the alarm near to come	TABLE 1
	ALARM_CODE	4bit code of the current alarm	TABLE 1
2	USER_BIT	User input lines status	TABLE 2
	AC571_STATUS	AC571 internal STATUS	TABLE 3
3	RACKS_DETECTED	Number of present and switched on racks	0 - 5
	HEAD_ALARMS	Head alarm lines status	TABLE 4
4	MAG_TYPE	type of magnetron selected	TABLE 5
	SW_VERSION	Software Version of AC571	number
5	FROZEN_UNITS	Units that have been set to FREEZE	TABLE 6
	ACTIVE_UNITS	Units that are present and running	TABLE 6
6	ANODE_CURRENT	Value of actual Anode Current, in mA	0 - 5000
7	ANODE_VOLTAGE	Value of actual Anode Voltage, in Volt	0 - 20000
8	FILAMENT_CURRENT	Value of actual Filament Current, in A	0 - 120
9	COIL_CURRENT	Value of actual E-Magnet Current, in mA	0 - 5000
10	FILAMENT_HOURS	Value of Filament heated hours	0 - 65535
11	POWER_ON_HOURS	Value of Unit powered hours	0 - 65535
12	FORWARD_POWER	Value of Forward Power, in Watt/10	0 - 7500
13	REFLECTED_POWER	Value of Reflected Power, in Watt/10	0 - 3750
14	USER_REFERENCE	Value of % power output set by User	0 - 100
15	EXT_ALARM1	Code of alarm from Unit1	TABLE 7
	EXT_ALARM2	Code of alarm from Unit2	TABLE 7
16	EXT_ALARM3	Code of alarm from Unit3	TABLE 7
	EXT_ALARM4	Code of alarm from Unit4	TABLE 7
17	E XT_ALARM5	Code of alarm from Unit5	TABLE 7
	PWR_UNIT_ ALARM_ CODE	Alarm code of the faulty unit	TABLE 7
18			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30			
31	PARAM_READ_ID	Parameter Number	1 - 32
32	PARAM_READ_VALUE	Parameter Value	0 - 65535

SYSTEM PARAMETER DATA ACCESS

The interface between the external fieldbus Master and the system is always a fixed array of data, regardless the fieldbus type.
To let the user to access the sytem parameter values, the following protocol is performed.

Last 2 locations of Process Read Data and 3 locations of Process Write Data are dedicated to the protocol.

Write sequence.
The data to be written is stored on PARAM_WRITE_VALUE, the address of the parameter is stored inside PARAM_WRITE_ID, the command WRITE is stored into PARAM_WRITE_CMD.
The command is interpreted by the AC571, and the VALUE data is written in the address ID, as required.
The PARAM_READ_ID will be written with the address, while the PARAM_READ_VALUE with the new value stored.

Read sequence.
The address of the parameter is stored inside PARAM_WRITE_ ID, the command READ is stored into PARAM_WRITE_CMD.
The command is interpreted, and the VALUE data in the address ID is read, then the PARAM_READ_ID will be written with that address, while the PARAM_READ_VALUE with the value that is stored.

This mechanism is flexible, as allows to add new parameters in future program updates. Different data tables are present in the Process Parameters area: it is up to the CPU to allow read/write inside the correct address intervals.
Examples of Process Parameter are: magnetron type, preheating time, alarm detection delays, restart retry number, as well as magnetron parameters tables.
A complete list of the system parameters is provided on the next tables.

Process Write Data Table

word	Name	Meaning	Value
1	REMOTE_CTRL_WORD	Command Control from Fieldbus	TABLE 8
2	REMOTE_REFERENCE	Power Level Issued from Fieldbus	0 - 10000
3	IF_OFS10	Filament Current live offset tuning @10% 0=no tune, 10000±x=±x tune	0 - 20000
4	IF_OFS70	Filament Current live offset tuning @70% 0=no tune, 10000±x=±x tune	0 - 20000
5	IC_OFS	Coil current live tuning 0=no tune, 10000±x=±x tune	0 - 20000
6			
7			
8			
9			
10			
...			
19			
20			
21			
22			
23			
24			
25			
26			
27			
28			
29			
30	PARAM_WRITE_CMD	Parameter Command (0=no action 1=Read 2=Write	0 -2
31	PARAM_WRITE_ID	Parameter Number	1 - 32
32	PARAM_WRITE_VALUE	Parameter Value	0 - 65535

Table 1

Code	Warning /Alarm	Meaning
0	NO_ALARM	
1	MAG.OVT	Thermal switch on Magnetron opened: Mag temp. higher than 50°C
2	AIRFLOW	Air flow from Blower to Magnetron is OFF or Low
3	WTRFLOW	Water Flow through Magnetron is OFF or too low.
4	INTLOCK	Interlock chain opened
5	EMAGNET	Electromagnet control board alarm from AC571
6	FILAMENT	Filament control board alarm from AC571
7	DRIVER	Driver alarm from SM1818 PSU: usually related to hardware failure or PSU switch-off
8	WATER T	Power supply Heat Sink water temperature too high.
9	R AIR T	Power Supply Air flow internal temperature too high or missing, due to blocked fan or air inlet reduced
10	FIELDBUS	The Fieldbus communication has been interrupted. (Only in Remote control)
11	COM	RS232 Communication Alarm. This issue is internal on the AC571 controller.
12	UNDCURR	Expected power level not possible with present and running power units: excluded or frozen units
13	VOLTAGE	Under/Overvoltage Alarm detected. Open High Voltage cabling to magnetron, poor filament heating.
14	ARC	Arc Detector alarm sensed on the microwave Head or inside the Circulator section.
15	LEAKAGE	Magnetron Voltage too low, due to current leak to ground or even short circuit on high voltage.

Table 2

0	0	0	Remote	Reset	Hibernate	Enable	Interlock

Table 3

Code	Status	Meaning
0	POWERON	Unit has been switched on, but still no control.
1	STANDBY	Unit is in filament Hibernate, coil is ON
2	PREHEATING	Filament is being heated, but not ready yet
3	READY	Filament is preheated, microwaves are not on.
4	MWON	Microwaves are ON
5	ALARM	Microwaves are OFF due to alarm
6	RESETWAIT	Reset waiting status
7	RESETINPRO-GRESS	Reset active
8	DIRECTMODE	Unit is directly driven by Manual commands from the Controller panel

Table 4

Code	Status	Meaning
0	POWERON	Unit has been switched on, but still no control.
1	STANDBY	Unit is in filament Hibernate, coil is ON

Table 5

n.	name	MW max Power	Fil. Transform. ratio
0	TEST UNIT	75kW	27.89
1	CWM75L 5K	5kW	31.00
2	CTL75 15K	10kW	25.63
3	CWM15S 15K	15kW	34.00
4	CTL75 50K	50kW	25.63
5	CWM75 30K	30kW	27.89
6	CWM75L 30K	30kW	31.00
7	NLM915 30K	30kW	31.00
8	CWM75 50K	50kW	27.89
9	CTL75 75K	75kW	27.89
10	CTL75a 75K	75kW	25.63
11	CTL75b 75K	75kW	23.20
12			

Table 6

bit7	bit6	bit5	bit4	bit3	bit2	bit1	bit0
0	0	0	PSU#5	PSU#4	PSU#3	PSU#2	PSU#1

Table 7

0	0	R_AIR_T	WATER_T	INTLOCK	VOLTAGE	LEAKAGE	DRIVER	Meaning
0	0	0	0	0	0	0	0	No alarm from SM1818
0	0	0	0	0	0	0	1	Driver Alarm
0	0	0	0	0	0	1	0	Alarm Leakage detected
0	0	0	0	0	1	0	0	Alarm Overvoltage detected
0	0	0	0	1	0	0	0	Alarm Interlock
0	0	0	1	0	0	0	0	Water cooling insufficient
0	0	1	0	0	0	0	0	Internal Air temperature too high

Table 8

0	0	0	0	0	0	0	0	0	0	0	0	reserved	BusReset	BusHibernate	BusEnable

System Parameters Table					
Addr	Name	Meaning	Range	Default	unit
0					
1					
2					
3	INSTALLED_UNITS	Number of Power Supply Units present in the system	0 - 5	1	n
4	MAGNETRON_TYPE	Type of Magnetron selected.	0 - 15	8	n
5					
6	PREHEATING_TIME	Filament Preheating Time	0 - 500	120	S
7	REF_RAMP_TIME	Reference Ramp Time: (2)	0 - 650	80	S*0,1
8	GUARDING_TIME	Fieldbus guarding time	0 - 60	0	S
9	FREEZE_RETRY_NUMBER	Number of Retries before Freeze	0 - 200	0	n
10	IF_CURRENT_RAMP	Filament Current Ramp Up Time: (2)	0 - 99	80	S*0,1
11	MAX_REV_POWER	Max Reflected Power:	0 – 50000	10000	W
12	OFFSET_HI_V	High Voltage Setpoint Offset:	0 -5000	1000	V
13	MAX_DELTAV	Max High Voltage Difference	0 - 5000	1200	V
14					
15	IA_RESTART_DELAY	Restart Delay Time: time before a current restart	0 - 5000	50	mS
16	ALARM_RESET_TIME	Alarm Reset Time (mS): duration of the reset pulse time	0 - 5000	50	mS
17	RETRY_NUMBER	Maximum Number of Retries for the System	0 - 10	0	mS
18	RETRY_CLEAR_TIME	Time to Clear Retry Sequence: time to have a new complete retry sequence	10 - 100	10	S
19					
20					
21					
22					
23					
24	MAG_OVT_DELAY	Magnetron overtemp Alarm Delay (2)	0 - 100	20	S*0,1
25	AIR_FLOW_DELAY	Air Flow Alarm Delay (2)	0 - 100	20	S*0,1
26	WATER_FLOW_DELAY	Water Flow Alarm Delay (2)	0 - 100	20	S*0,1
27	EMAGNET_DELAY	E-Magnet Alarm Delay (2)	0 - 100	20	S*0,1
28	FILAMENT_DELAY	Filament Alarm Delay (2)	0 - 100	20	S*0,1
29	Ia_RAMP_TIME	Ramp time after Retries: (2)	0 - 100	5	S
30					
31					

(2) The display shows the time in mS adding 00 after the value; the encoder action changes the 1/10 second value only

Node addressing on Ethernet-type fieldbus interface

The AC571 ethernet-type fieldbus interface must be associated to a unique IP address.
There are 2 ways to set the device IP address:

1) Hardware Setting, using the 2 rotary Dip Switches on the front panel of the unit: the left switch sets the tens, the right sets the units.
A value xx from 1 to 99 can be set, and shall be the least-significant part of the address.
The standard, hardware-set IP address is then: 192.168.0.xx

Default values for the other parameters:
Subnet Mask = 255.255.255.0
Default Gateway = 0.0.0.0
Primary DNS = 0.0.0.0
Secondary DNS = 0.0.0.0

Note: The Module ID 00 is reserved for addressing with HICP and not to be allowed as “Hardware addressing”. Any switches setting different from 00 wins over the software addressing command. The Address is sensed only at the power-on of the system, and does not change until it is switched off if you move the rotary switches.

2) Using HICP, setting to position 0 both rotary-switches.
To set the parameters via HICP a software Tool is available: Anybus IP Config. Using this tool, you can display the list of all the devices attached to the bus. For each device, you can set the following parameters:

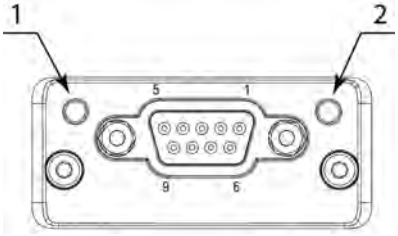
IP address – xxx.yyy.zzz.www
Subnet Mask – aaa.bbb.ccc.ddd
DHCP - off/on

The values xxx yyy and zzz must be the same within the network, www must be set different on different systems.
The master device must have the IP address compatible with the addresses inside the Anybus module: the first three fields must be the same, while the final number www must be different.
It is not allowed to have automatic addressing on the master, and DHCP must be set to off inside the Anybus module.
The address will be stored inside the module, and does not change at power-off.

Example of the Profibus interface

The two rotating switches must be used to set the physical address of the unit inside the network: the left switch sets the tens, the right one the units (range: 0-99)
The connector may differ according to bus type: here is depicted the standard used on the Profibus DP interface, that may be more complex than other.
I.e. the Modbus/TCP interface uses a standard RJ45 socket and using a common network cable "Cat. V" you don't need to care about pin-out.
Close to the socket of the interface, there are two LED indicators (see next drawing) that may be either red or green, flashing or steady:
- pos. 1: Operation Mode Led
- pos. 2: Status Led

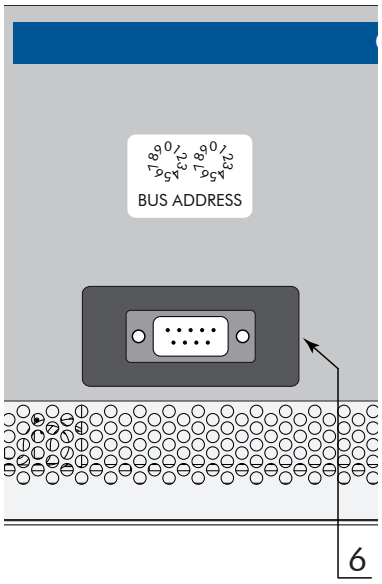
informing of the status of the comunication as follow:



Operation Led	Indication	Comments
Off	Not online / No power	-
Green	On-line, data exchange	-
Flashing Green	On-line, clear	-
Flashing Red (1 flash)	Parametrization error	See 3.7 "Parametrization Data Handling"***
Flashing Red (2 flashes)	PROFIBUS Configuration error	See 3.8 "Configuration Data Handling"***

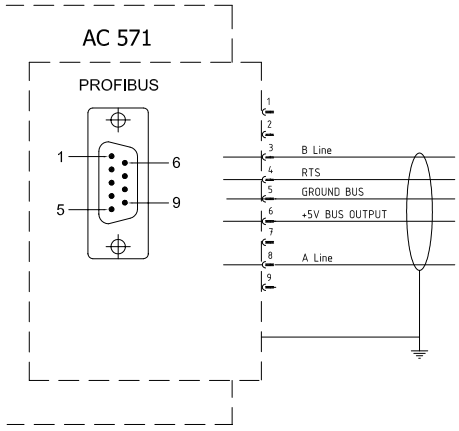
Status Led	Indication	Comments
Off	No power or not initialized	Anybus state = "SETUP" or NW_INIT"
Green	Initialized	Anybus module has left the NW_INIT state
Flashing Green	Initialized, diagnostic event(s) present	Extended diagnostic bit is set
Red	Exception error	Anybus state = "EXCEPTION"

The bus used is based on an interface device named "AnyBus CompactCom" (*) manufactured by HMS Industrial Network AB (**).
To configure your Profibus Master device with the Anybus interface, installed on the AC571 unit, it is necessary:
- to add the description of the Anybus interface contained on the relevant official file GSD (General Station Description file) distributed and available on the Anybus web site



Detailed view of the fieldbus interface on front panel

Fieldbus interface (Profibus DP)



- define in your Configuration Module the map of the interchange frame with 4 Double Word in Output and 4 Double Word in input. With such configurations the device is accessible through the Master Profibus.
More specific and detailed information about the protocol can be found on the Application Note of the specific bus: ask ALTER for the most updated version.

For general information consult http://www.anybus.com. For related technical information search for product type Anybus-CompactCom.
A specific document on the PROFIBUS protocol is 0318-ABCC_DP-V1_2_00_SCM-1200-053.pdf

Note:

* AnyBus logo, HMS logo, AnyBus CompactCom name are register trademark of HMS Industrial Networks AB
** HMS Industrial Networks AB, Stationsgatan 37, 302 45 Halmstad Sweden
*** *see document 0318-ABCC_DP-V1_2_00_SCM-1200-053.pdf (from www.anybus.com)*

Alarm Troubleshooting

The generator is able to prevent catastrophic events using a large set of alarms. They are divided into two sets: one is the software alarm set, managed by the AC571 Control Unit, and the other is the hardware set of alarm, managed independently by each of the SM181x Power Supply Units. The followings paragraphs explain the main cause of alarms and some simple corrective action to do.

Software Alarms

The term means a set of alarms generated internally by the AC571 Control Unit. The level of external signals are monitored and compared with presetted values, for example the working curve of the specific magnetron installed. If the values are not within the upper or lower limit an alarm occurs and the unit goes in alarm status (microwave Enable is set OFF, filament heating is set OFF).

In order to reset the alarm status, when the alarm condition has gone, the reset signal has to be hold down for 2 seconds.
Every alarm is displayed with a short name and a binary code, that is generated for the external PLC interface and represents that specific alarm. The following table depicts all the software alarms, with a description and a possible action to do.

bit #3 (MSB)	bit #2	bit #1	bit #0 (LSB)	Description [Short Name]	Cause/Solution
0	0	0	0	No Alarm	
0	0	0	1	Magnetron Over Temperature: the thermoswitch on the tube has detected a temperature over its threshold. [ALARM MAG. OVT]	a) Check water flow rate and incoming water temperature b) Check magnetron thermoswitch: contact closed = OK, open = alarm
0	0	1	0	Air Flow: the quantity of air flowing through the magnetron is not enough. [ALARM AIRFLOW}	a) Check for restrictions to the air flow b) Check if the magnetron blower safety switch is ON. c) Check for phase-reversal on the 3-phase blower cables
0	0	1	1	Water Flow: the quantity of water flowing through the system is not enough. [ALARM WTRFLOW]	a) Check if water is flowing at the output of the system b) Check the 4 flow meters on the water cooled devices: 1) E-magnet 2) Magnetron 3) Power supplies 4) Dummy load
0	1	0	0	Interlock: the interlock chain is open [ALARM INTERLOCK]	a) Check cabinet doors: those with safety switches must be closed. b) Check also the two external safety loops.
0	1	0	1	Magnetron Coil: alarm coming from the electromagnet of the tube. [ALARM EMAGNET]	a) Remove main line. Disconnect CONN #4 from the rear of AC571. Check with a multimeteer the resistance between pin 6 and 7 of CONN #4. It must be between 9 and 12 OHM.
0	1	1	0	Filament: alarm coming from filament of the tube [ALARM FILAM]	a) Remove main line. Disconnect CONN #4 from the rear of AC571. Check with a multimeteer the continuity of the loop between pin 1 and 2 of CONN #4.

(Sofware Alarm Table - Cont.d)

bit #3 (MSB)	bit #2	bit #1	bit #0 (LSB)	Description [Short Name]	Cause/Solution
0	1	1	1	Driver circuitry of IGBT gone to alarm mode for self-protection. [DRIVER ALARM]	a) An IGBT driver is damaged, or a power IGBT module is damaged: required replacement of entire power stage. b) Temporary overcurrent on the primary stage of power transformer: the driver self-protected itself and IGBTs. Usually a restart solves.
1	0	0	0	Water temperature threshold reached (measured on coldplate of power stage) [WATER TEMP]	The alarm threshold is set to 60°C and has 3-4°C hysteresis. Check water temperature and flow rate.
1	0	0	1	Temperature of incoming air exceed threshold (measured by PTC near power transformer) [RACK AIR TEMP]	Air flow is insufficient: check rear fans Temperature of incoming air is too high (>35°C): reduce air temeperature, remove obstruction of air flow
1	0	1	0	Error on data flow [FILEDBUS ALARM]	This alarm is active only when the “control” parameter is set to “Remote”. Bus cable disconnected or damaged: reconnect or replace cable. Failure of fieldbus board interface: replace the interface.
1	0	1	1	Communication: the internal CPU board and Display board cannot communicate [ALARM COM]	This alarm may happen after a software upload. Switch OFF the AC571, then switch ON again.
1	1	0	0	Undervalue: the total amount of requested anodic current from the generator exceeds the sum of the current for each active inverters [ALARM UNDCURRENT]	a) One of the inverter is out of service: reduce power setting b) The anodic current value set on the control curve exceeds the max available current: verify the type of magnetron set inside the software (screen “1.1 - Info2”) c) Check if the power section of the PSU is ON d) Check the Power Units status
1	1	0	1	Moding: the working voltage of the magnetron is too high or too low than the voltage set-point. The parameter “MAX DELTA V” in screen 3.12 - “ADVANCED SETUP” set the upper and the lower limit [ALARM OVRVOLT]	a) Check if the correct magnetron has been selected - screen 1.1 - “INFO2”. b) If you are driving the magnetron in “Direct Mode” (Screen 4.0), you might have entered a wrong anodic voltage value or c) the electromagnet current is too high: reduce it.
1	1	1	0	Arc detector: an arc has been detected in the waveguide [ALARM ARC]	a) Check inside the waveguide: no arc traces should be present.
1	1	1	1	Current leakage [LEAKAGE]	a) There is an unexpected current “leak” to ground detcted on the HV side: check cables and connectors b) Magnetron is leaking inside: part of anodic current is discharged to ground. Change magnetron if restart do not solve.

Hardware Alarms

Inside each Power Unit is implemented a fast diagnostic control that monitors critical signals. This section is purely “hardware” so that a fast response is obtained.
Each SM181x unit monitors its own signals and generates its own hardware alarm.

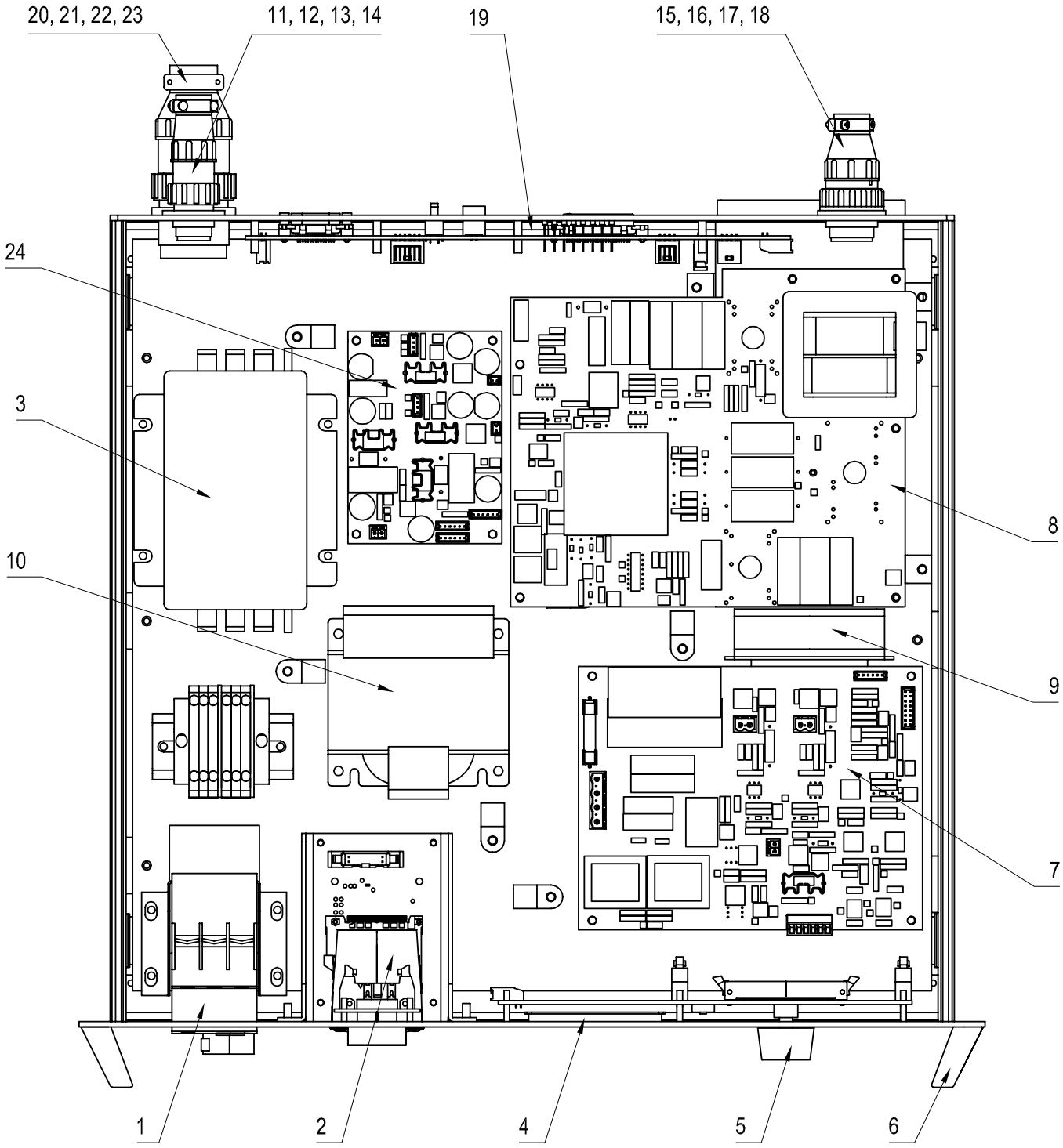
When an alarm occurs, a common alarm line is set on the communication bus and all the power units go in alarm status, if the retry feature is not selected. In order to reset the alarm status, when the alarm condition has gone, the reset signal has to be hold down for 2 seconds. Check the led bar

indicator on the specific unit to see which kind of hardware alarm occurred. When an alarm occurs, if you remove the Enabling signal immediately once you read the alarm mode, then the system enters the Reset procedure and you lost the information about the alarm type.
This may happen also if the RETRY function is enabled.
The following table depicts all the hardware alarms, with a description and a possible action to do.

Hardware Alarm Table (Power Unit Alarm)

LED Name	Description	Cause/Solution
DRIVER ALARM	Driver Alarm: it occurs when the IGBT driver modules detect a fault	a) Possible lack of one of the 3 input phase, even temporarly. Remove enabling signal and turn Reset ON and OFF again. b) Possible damage of the internal driver: if the problem persists the inverter needs to be repaired.
WATER OVERTEMP	Water Overtemperature: the temperature of the heatsink of the power stage is too high.	a) Check at the OUTPUT of the heatsink if the water is flowing. b) Check the temperature of the water at the input of the heatsink. c) If you have flow switches in series with the water circuit, check if the water is flowing in the right way.
AD ALARM	not implemented	
INTERNAL OVERTEMP	Internal Overtemperature: the air flowing through the inverter is too hot or the quantity of air is not enough.	a) The air temperature at the input grid, while inverters are running, must be below 40°C b) Be sure there are no obstructions in the air flow. c) Check that the internal fans are running.
LEAKAGE	Leakage: the anodic voltage is lower than expected.	a) Check the calibration table (“MAGN. SET TABLE” on screen 3.1 – “ADVANCED SETUP” the VOLTAGE SETPOINT parameter and the COIL CURRENT parameter. b) Check the parameter OFFSET V on screen 3.12 – “ADVANCED SETUP”. A good starting point of how to set the OFFSET V and the VOLTAGE SETPOINT in the calibration table is to set the OFFSET V parameter to 0 V and the VOLTAGE SETPOINT in the calibration table equal to the anodic voltage. At 0% step the VOLTAGE SETPOINT and the COIL CURRENT must be equal to the value set at 10%.
INTERNAL ALARM	Not implemented.	
OVERVOLTAGE	Overvoltage: The anodic voltage has exceeded the maximum allowable voltage specified by the controller.	a) Check the filament current on the information screen 1.0 – “INFO1”. If the filament current is too low an overvoltage event may occur. b) Check if the proper magnetron has been selected on screen 1.1 “INFO2”. c) Check the continuity of the connection of the High voltage cable from inverters to Magnetron. d) Check parameters stored in screen 3.12 –“ADVANCED SETUP” and set them as described in the “Leakage Alarm”. e) Increase the reference ramp time parameter (REF RAMP) on screen 3.12 –“ ADVANCED SETUP”. f) Check the preheating time on screen 1.2 – “INFO3”, it should be set longer than 60 seconds.
EXTERNAL ALARM	External Alarm: this alarm signal is common to all power units connected. When an hardware alarm occurs it is set on.	Check on inverter front panel which alarm is on, reset it and restart.
INTERLOCK OK	Interlock led is off and inverter can not be turned on: interlock chain is open.	a) Check every door of the cabinet. The doors with safety switch must be closed. b) Check also the two external safety loops.

COMPONENT LAYOUT AC571
(view from top with cover removed)



Component list AC571 (See drawing pag.16)

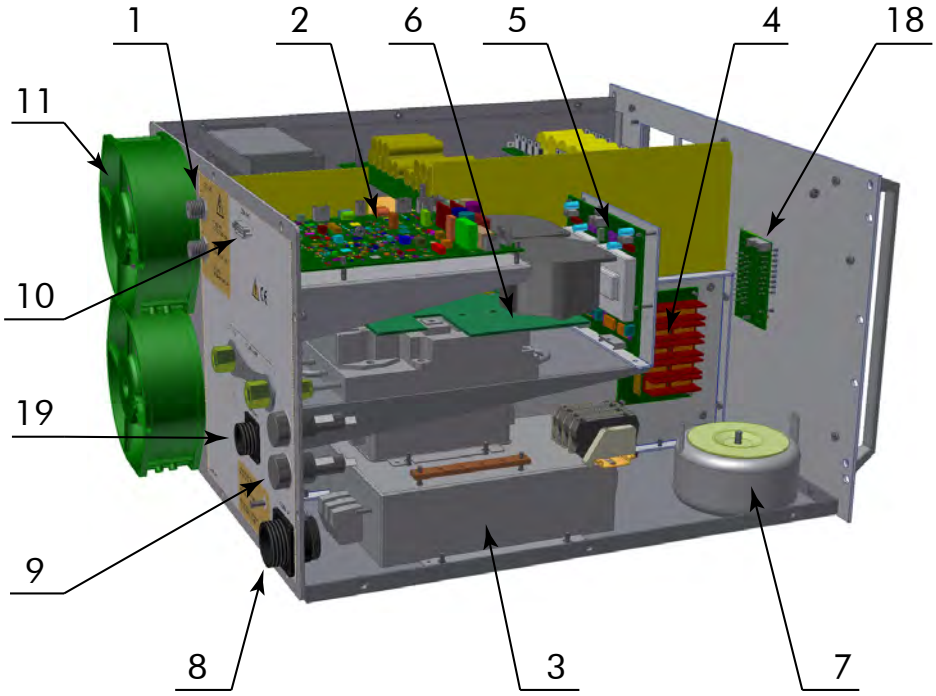
Pos.	Q.ty	Description	P/N	Note
1	1	Main switch	IA3RV1421/1KA10	
2	1	Socket Board M366 for Anybus CC Interface Board	80 0000 366 PLAB6213 Modbus/TCP PLAB6201 Profibus DPV1.2 PLAB6214 EtherNet/IP PLAB6215 Profinet PLAB6218 CanOpen	Note **
3	1	Main filter	FL6FCD10	
4	1	CPU board M516 (Display/CPU)	800000516	
5	1	Digital potentiometer	RSHRPG/AD3259R	
6	2	Handles	AR3636010	
7	1	Filament control board M268	800000268	
8	1	Electromagnet control board M367	800000367	
9	1	Fan, dim. 80x80x25 mm	VE8412NGH	
10	1	Transformer 130VA	42TV570A	
11	1	7 pins Socket, AMP/CPC	MOCPC07/2113981	Conn.#4
12	1	7 pins Plug, AMP/CPC (*)	MOCPC07/2114001(*)	
13	5	Female pin, size lll	MOCPCX/1630881	
14	5	Male pin, size lll	MOCPCX/1630861	
15	1	14 pin Socket. AMP/CPC	MOCPC14/1826411	Conn.#2
16	1	14 pin Plug. AMP/CPC	MOCPC14/1826491 (*)	
17	14	Male pin, size lll	MOCPCX/1630861	
18	14	Female pin, size lll	MOCPCX/1630881	
19	1	Interface board M566 (Backpanel/CPU)	800000566	
20	1	7 pins Socket, AMP/CPC	MOCPC07/2061371	Conn.#1
21	1	7 pins Plug, AMP/CPC (*)	MOCPC07/2061361	
22	4	Female pin, size lll	MOCPCX/0667402	
23	4	Male pin, size lll	MOCPCX/0662614	
24	1	Auxiliary P. S. board M319	800000319	

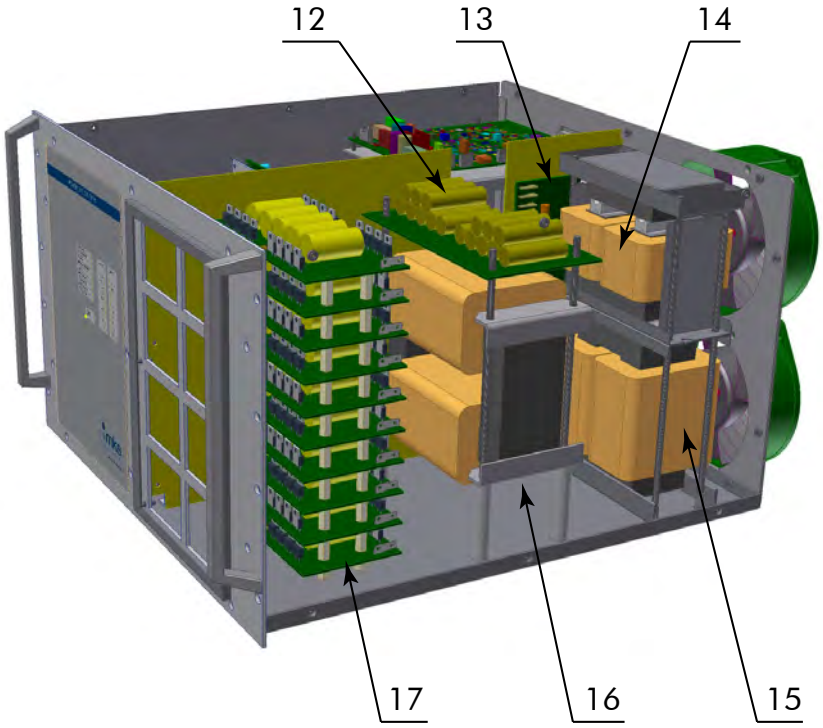
Note: Components marked with (*) are included in the connector set p/n 44SETMPS96 to be ordered separately

Note**: The hardware for the Bus is included, but the protocol to use the bus is up to the customer.
Users having the need to implement the bus funciotnality, may request the new firmware with the payment of a fee.
All the different type of fieldbus share the same data interface to the unit (see Fieldbus data I/O section).

SM18xx COMPONENT LAYOUT

(Sides Views without cover & side wall)



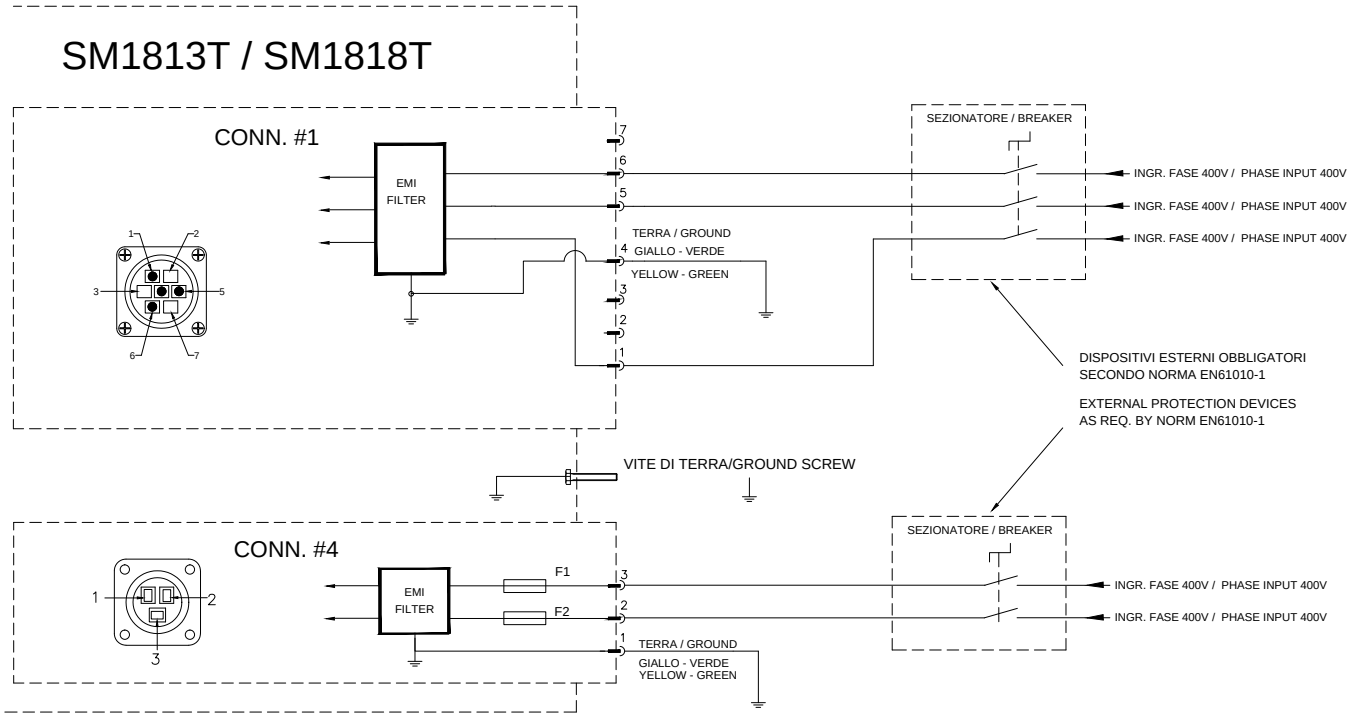


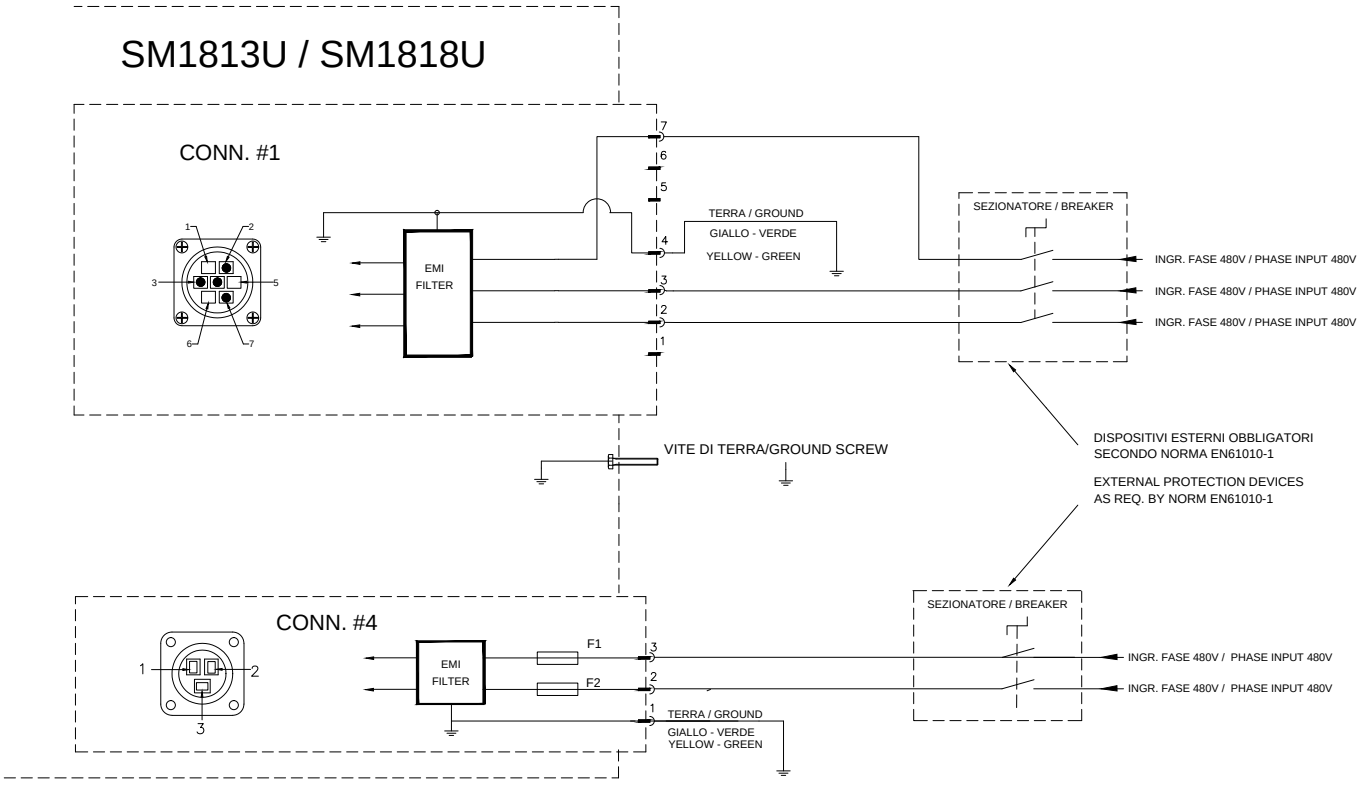
SM18xx Component list (See drawing pag.18)

Pos.	Q.ty	Description	P/N	Note
1	1	H. V. Socket, GES	MOHB31	Conn.#3
	1	H. V. Plug, GES (*)	MOHS31	
2	1	Control board M350 (full replacement M300)	80 0000 350/2x	
3	1	Main filter	FL50FCD10	
4	1	Board for Measuring Ia, M302	80 0000 302	
5	1	Driver board M311	80 0000 311	
6	1	IGBT board M301	80 0000 301	
7	1	Transformer for low and aux voltage	42ATT230/010	
8	1	7 pins Socket, AMP/CPC	MOCPC07/2061371	Conn.#1
	1	7 pins Plug, AMP/CPC (*)	MOCPC07/2061361	
	4	Female pin, size XII (*)	MOCPCX/1939902	
	4	Male pin, size XII	MOCPCX/1939914	
9	2	Fuseholder for fuse10X38 mm	FUP1891	
	2	Fuse 10X38 mm, 6A	FU10X38/6A	
10	1	Connector 15 pin, “D” type	MODFL15M	Conn.#2
11	2	Fan, diam. 150x55 mm	VE7450ES/	
	2	Grid	VELZ241/	
12	1	L. V. Snubber capacitors board M307	80 0000 307	SM181xT
	1	L. V. Snubber capacitors board M307/A	80 0000 307/A	SM181xU
13	1	Board for measuring Va M305	80 0000 305	
14	1	L. V. inductor	42FI1816TB/BTR	SM1818T
	1	L. V. inductor	42FI1816UA/BTR	SM1818U
15	1	H. V. inductor	42FI1816A	
16	1	H. V. transformer	42FT1816TF	SM1818T
			42FT1816UC	SM1818U
17	1	H. V. board pack bridge M306	80 0000 306	Ass.y
18	1	LED meter and status board M 303	80 0000 303	
19	1	3 pins Socket AMP/CPC	MOCPC03/2060362	Conn. #4
	4	Male pin, size XII	MOCPCX/0662614	
	1	3 pins Plug, AMP/CPC (*)	MOCPC03/2060372	
	4	Female pin, size XII (*)	MOCPCX/0667402	

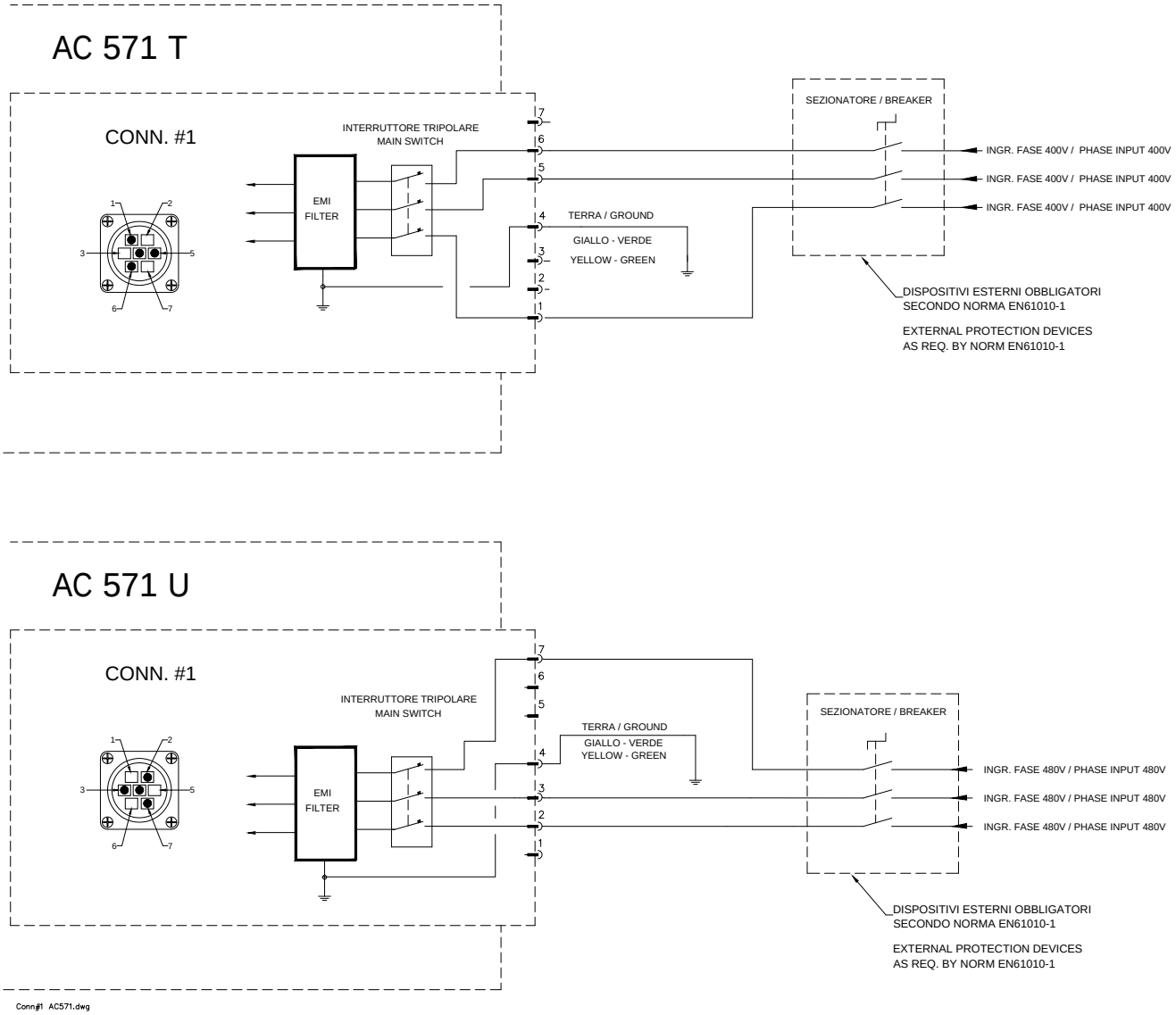
Note: Components marked with (*) are included in the connector set p/n 44SETMPS96 to be ordered separately.

Pin out CONN. #1 and CONN. #4 SM1813-1818

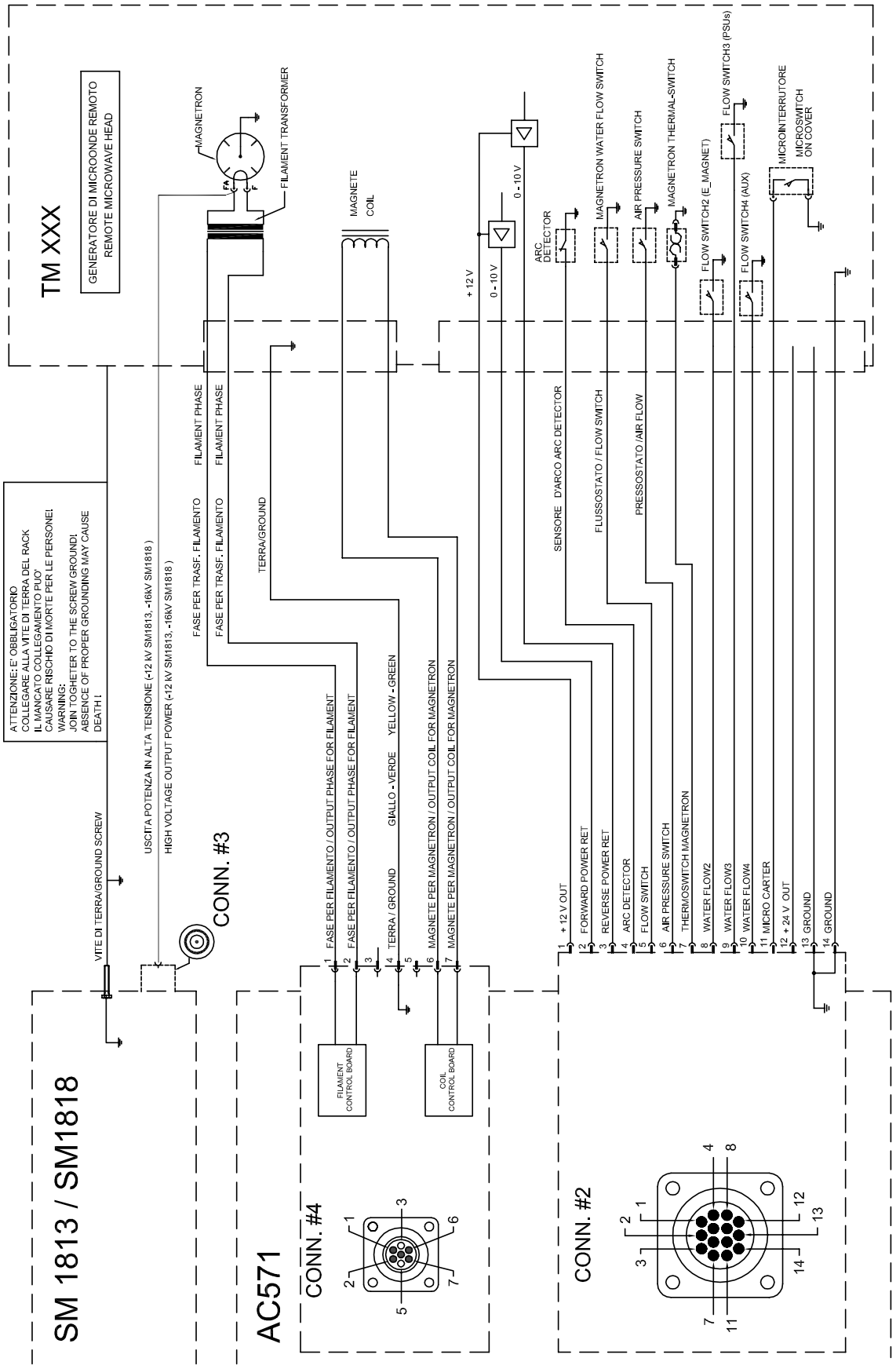




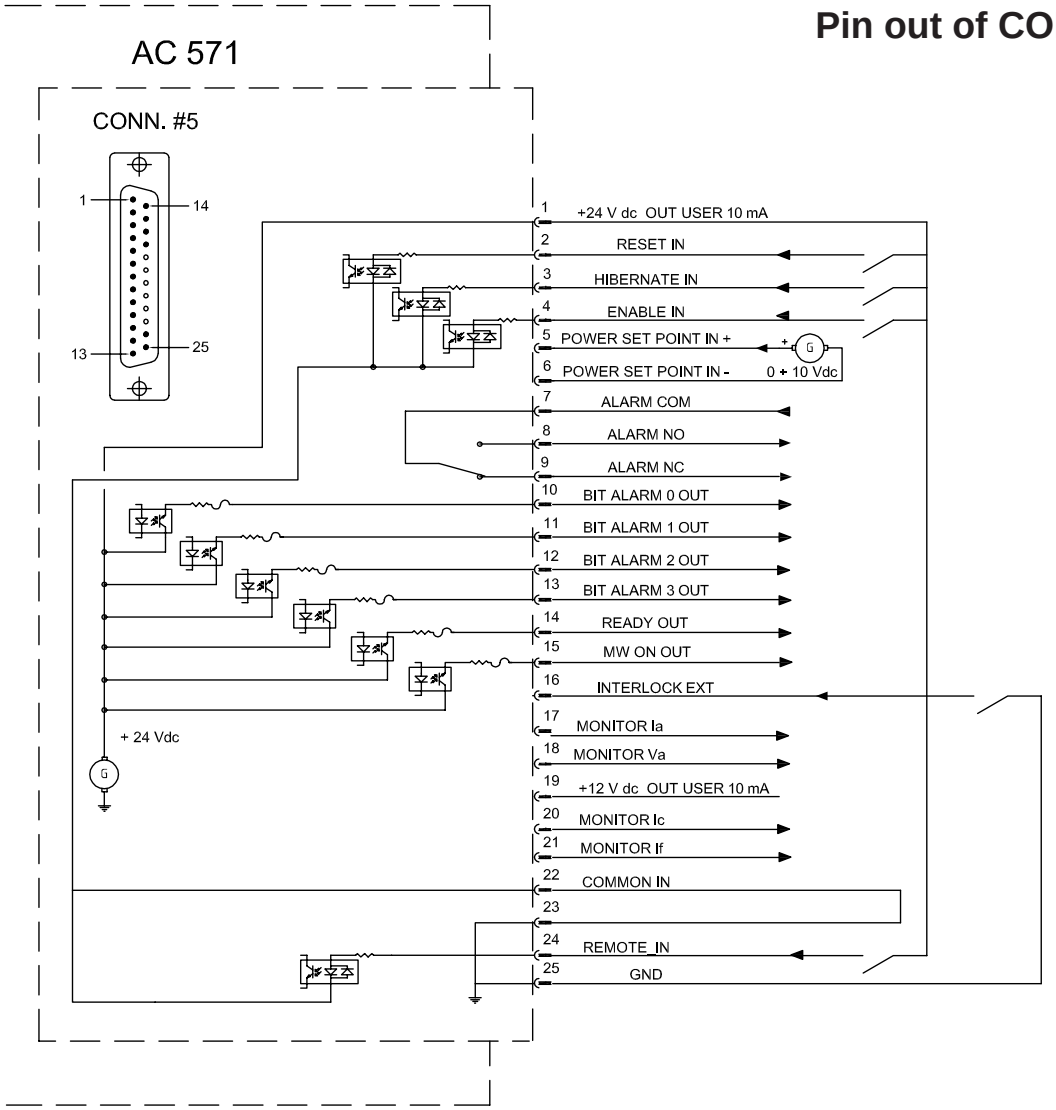
Pin out CONN. #1 for AC 571



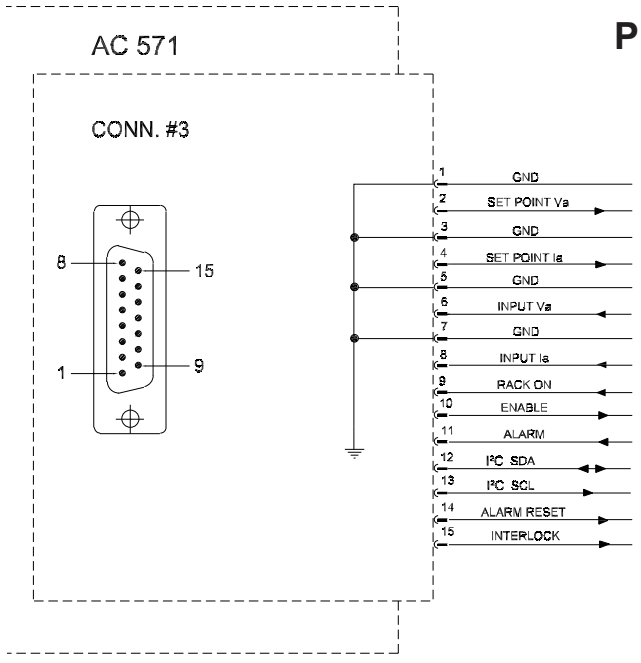
Pin out of AC571 - CONN. # 2, 4 and SM181x - CONN. #3 (H.V.) to a generic MW Head



Pin out of CONN. #5 (AC571)



Pin out of CONN. #3 “Bus Link”(AC571)



How to order

Power supplies: **MPSxxy.cccjb**, where:

xx: **24 - 48 -72 -96 -120** (input power, kW)

y: **T** = 3 x 400
U = 3 x 480

ccc: the code used for a customized unit;

j (version code): **51** = version with Bus interface e aux voltage (STANDARD)

b (interface bus code): MTCP= Modbus/TCP
PROF= Profibus

I.e: MPS 96T.MKS1MTCP = standard version, with ModBus/TCP interface, input 400V

Please specify at time of order the value of the reference signal required: **0-10 V** (standard)

Connector/plug set: p/n **44SETMPSxx**

Cable set with plugs: p/n **44 1384 2yy**
Includes high voltage cable (from last unit to head), main line cables, head cables, signals cable and plugs on psu side. Standard lenght is 5 mt; other lengths available on request

yy: 40 for MPS24T
39 for MPS48T
38 for MPS72T
37 for MPS96T
36 for MPS120T

35 for MPS24U
34 for MPS48U
33 for MPS72U
32 for MPS96U

Mks reserves the right to improve or modify this products, at any time, without any obligation to notify any person or entity of such changes.
No part of this publication may be reproduced without the express written consent of MKS Instruments.

Technical Assistance:

MKS Instruments Italy
42122 Reggio Emilia - ITALY
Tel: ++39 0522 553 820; Web: www.mks.com