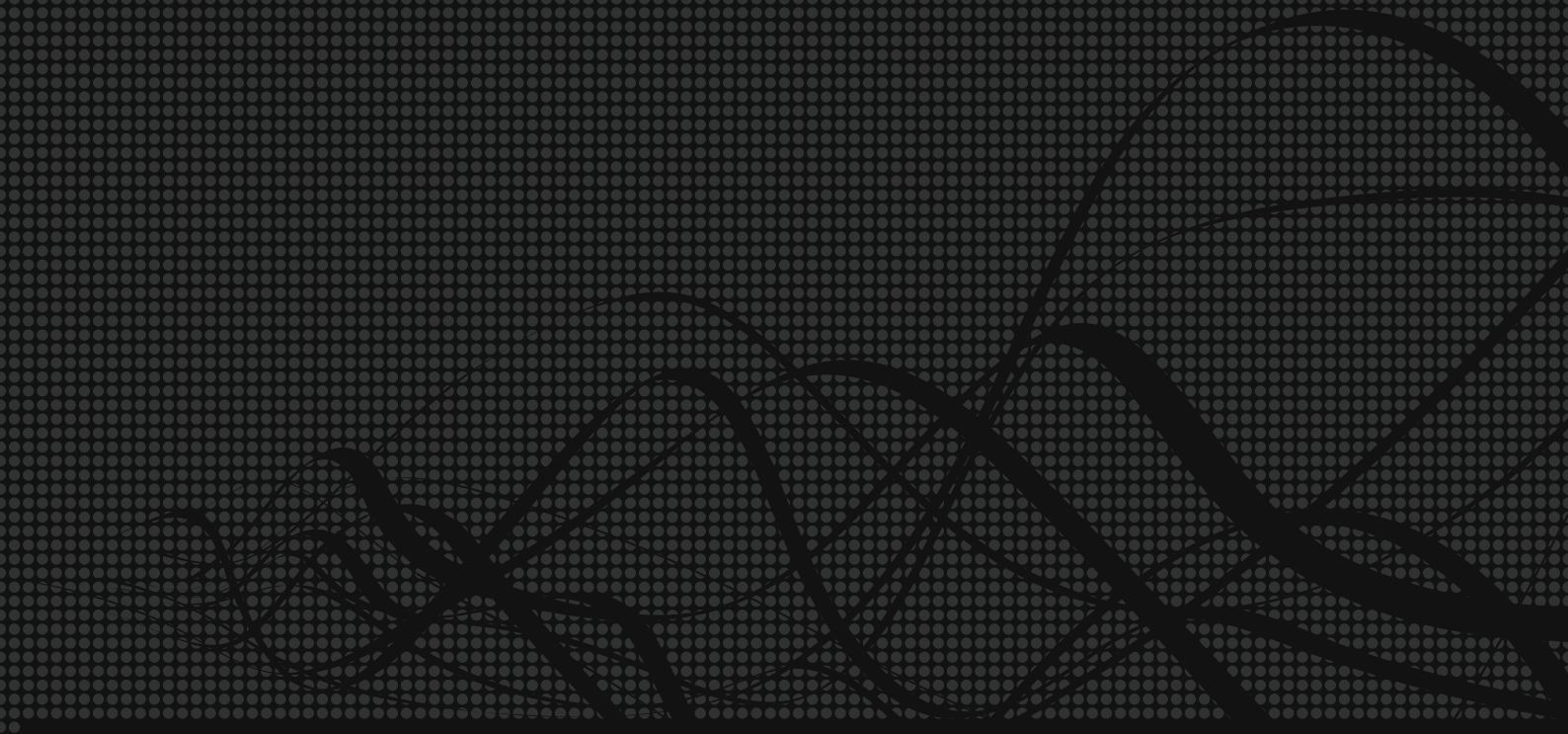
Guida Tecnica:
Regolatore Digitale DER1

Technical Guide:
DER1 Digital Regulator



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Астана (7172)727-132
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Барнаул (3852)73-04-60
Белгород (4722)40-23-64
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Ростов-на-Дону (863)308-18-15
Рязань (4912)46-61-64
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INTRODUCTION

This manual contains information on the operation and use of the DER1 digital regulator.

In order to avoid damage to persons and/or property, only qualified personnel, having full knowledge and understanding of the information contained in this manual, should perform the procedures described herein; when power to the unit is on, the voltage present may be lethal for the operator.

All connections must be made with the power off.
The plastic protections on connectors J1 and J2 must not be removed for any reason whatsoever.

MAIN CHARACTERISTICS

1. Architecture of the system

The DER1 is a voltage regulator for synchronous alternators, designed for stand alone working and calibration; to maximize performances, the regulator should be intended as part of a system made up of at least three components: the DER1 (control unit), a communications module (DI1, for example) and a supervision unit, as illustrated in figure 12 or 13.
The connectors for connection to and from the power generator and communications module are located on the DER1 regulator.
The supervision unit can be made up of a personal computer, another “synoptic” device or both; it does not have the function of controlling the system in real time, but allows programming and visualisation of all operational parameters of the DER1.
If it is equipped with an RS485 or RS232 serial interface, the DI1 communications module is necessary for its connection.

1.1 Regulator

Since the regulator is designed to control many different types of generators, it must be appropriately configured to obtain the best performance; most of the settings are stored in a non-volatile integrated memory (EEPROM). The first time the regulator is turned on, a default configuration will be present, which satisfies the most widely requested characteristics and is suitable to facilitate installation: the trimmers are active and the inputs for the external potentiometer and the 60 Hz jumper are enabled, therefore the basic calibrations can be performed without the use of additional equipment.
Two versions of the DER 1 and DER 1/A regulators are available; the first one is optimised for Mecc Alte Series 3 to 38 alternators, while the second is optimised for Mecc Alte series 40, 43 and 46 alternators; the two versions differ primarily in the default parameters.
NOTE: the parameter that defines the output voltage (with the VOLT trimmer disabled) is set on 0 (so that the adjustment takes place on the minimum voltage).

1.2 Communications module

The DI1 communications module (which is provided for connection to the COM connector of the DER1) is equipped with a RS232 port and a RS485 port, through which it is possible to set the parameters (for both configuration and operation) and “monitor” operation of the generator.

2. Technical Characteristics

- Digital controlled regulator, based on DSP
- On-board machine installation
- Suitable for all Mecc Alte self-regulated alternators
- Power connections through 20 poles Fast-On connector (see fig.2)
- Protection of power winding with 5A fast acting fuse
- Signal connections (Pext, 60Hz Jumper, APO) through 10 poles mini Fast-On separate connector
- Environmental temperature: -25°C ÷ +70°C
- Voltage supply: 40Vac÷270Vac [(2)](from auxiliary winding, output voltage or PMG)
- Maximum continuous output current: 4Adc
- Frequency range: 12Hz÷72Hz
- Three phase or single phase sensing in all connections (Y-Δ-YY-ΔΔ)
- Single phase or three phase sensing automatic recognition
- Average value of voltage regulation
- Voltage regulation range (sensing) from 75Vac to 300Vac
- Precision of voltage regulation: ± 1% from no-load to nominal load in static condition, with any power factor and for frequency variations ranging from -5% to +20% of the nominal value.
- Precision of voltage regulation: ± 0,5% in stabilized conditions (load, temperature).
- Transient voltage drop and overvoltage within ± 15%
- Voltage recovery time within ± 3% of the value set, in less than 300 msec.
- Programmable Soft start
- Parameters: VOLT, STAB, AMP and Hz settable by trimmers (default), 50/60Hz settable by a "jumper" (default), all parameters programmable via software
- 0÷2,5Vdc or -10÷+10Vdc external voltage for analogical remote control of output voltage
- Remote control of output voltage through external potentiometer (from 25Kohm to 100Kohm)
- Underspeed protection with adjustable threshold and slope
- Overvoltage and undervoltage alarms
- Excitation overcurrent protection with delayed intervention
- Management of temporary short circuits (start up of asynchronous motors)
- Open collector output (not insulated) signalling some allarm intervention with programmable activation and delay intervention
- Allarm conditions storage (type of alarm, number of events, duration of the last event, total time)
- Memorization of the regulator operation time
- RS232 and RS485 serial communications interface (with optional DI1 module)
- Compatibile with DSR_term communication software (for parameter setting or working and alarm conditions reading)

WARNING : Operation of the DER1 is not specified below 12 Hz.

3. Inputs and Outputs: technical specifications

TABLE 1 : CONNECTOR CN1				
Terminal[1]	**Name**	**Function**	**Specification**	**Notes**
1	Exc-	Excitation	Continuous Rating: 4Adc Transitory Rating:12Adc at peak	
2	Aux/Exc+			
3	Aux/Exc+	Power	40÷270 Vac, Frequency: 12÷72Hz [2]	(1)
4	UFG	Sensing Range 2	Range 2: 150÷300 Vac Burden: <1VA	U channel
5	UFG			
6	UHG	Sensing Range 1	Range 1: 75÷150 Vac Burden: <1VA	
7	UHG			
8	UHB	Jumper Range1		Short for sensing 75÷150 Vac
9	UFB			
10	UFB		Board reference	Star point (12 YY or 6 Y leads generators) is hard connected to AVR power supply input [1]
11	UFB			
12	UFB			
13	-		Not present	
14	VFG	Sensing	Range 1: 75÷150 Vac Burden: <1VA	V channel, to be connected in parallel to U channel in case of single phase sensing
15	VHG	Sensing Range 1		
16	VHB		Scala 2: 150÷300 Vac Burden: <1VA	
17	VFB	Range 2		
18	-		Not present	
19	WFG	Sensing	Range 1: 75÷150 Vac Burden: <1VA	W channel, unused (with shorted inputs) in case of single phase sensing
20	WHG	Sensing Range 1		
21	WHB		Range 2: 150÷300 Vac Burden: <1VA	
22	WFB	Range 2		

TABLE 2 : CONNECTOR CN3				
Terminal	**Name**	**Funcion**	**Specifications**	**Notes**
23	Common	Active protections output	Type: Non-insulated open collector Current: 100mA Voltage: 30V Max length: 30m [3]	Both activating alarm and delay time are programmable
24	A.P.O.			
25	Common	Jumper 50/60Hz	Type: Not insulated Max length: 3m	Selection of underspeed protection threshold [4]
26	50/60Hz			
27	0EXT	Jumper for remote voltage control 0÷2,5Vdc	Type: Not insulated Max length: 3m	Short for 0÷2,5Vdc input or potentiometer
28	JP1			
29	0EXT	Input for remote voltage	Type: Not insulated Max length: 30m [3]	Regulation: ±10 % [5]
30	PEXT	Input for remote voltage control 0÷2,5Vdc or Pext	Input: 0÷2,5Vdc o Potentiometer 100K	Burden: 0÷1mA (sink)
31	JP2	Pext Jumper	Type: Not insulated Max length: 3m	Short for 0÷2,5Vdc input or potentiometer
32	±10V	control ±10 Vdc	Input: ±10Vdc	Burden: ±1mA (source/sink)

Note 1) The terminals are connected to each other on the board: 2 with 3, 4 with 5, 6 with 7, 9 with 10, 11 and 12.
Note 2) Minimum power voltage 40 Vac at 15 Hz, 100 V at 50 Hz, 115 V at 60 Hz
Note 3) With external EMI filter (3m without EMI filter)
Note 4) 50·(100%-αHz%) or 60·(100%-αHz%) where αHz% is the position relative to the Hz trimmer or the percen tage value of parameter P[21]
Note 5) Value not to be exceeded. The effective range depends on parameter P[16]

TABELLA 3: TRIMMERS		
Name	**Function**	**Notes**
VOLT	Voltage Calibration	From 75Vac to 150Vac or from 150Vac to 300Vac, see paragraph “Setting the voltage”
STAB	Calibration of dynamic response	Adjustment of proportional gain, see paragraph on “Stability”.
Hz	Calibration of underspeed protection intervention threshold	Variation up to -20% with respect to the nominal speed value set in parameter 50/60.
AMP	Calibration of excitation overcurrent protection	See paragraph “Calibration of excitation overcurrent protection”

4. Block diagram

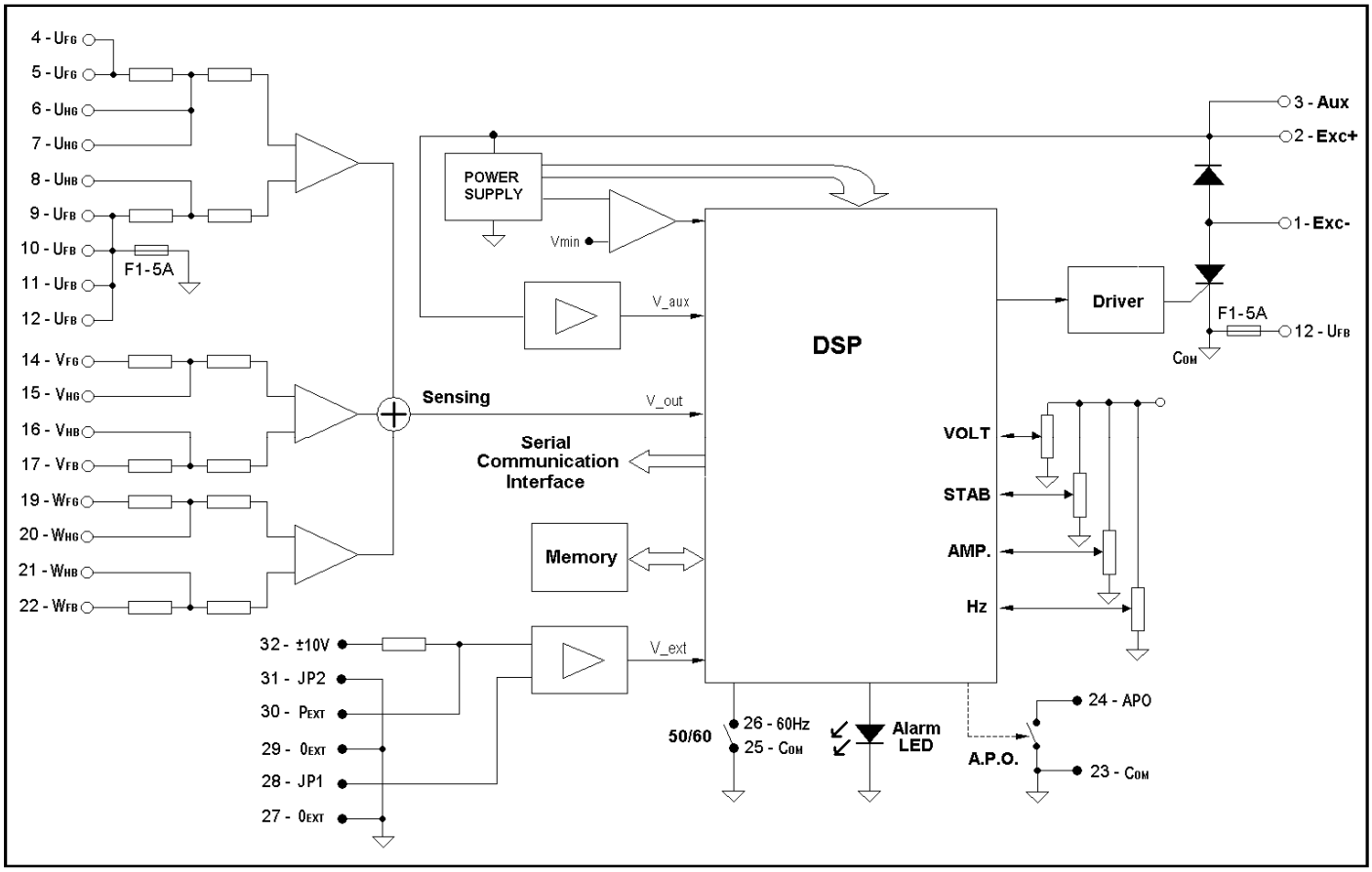
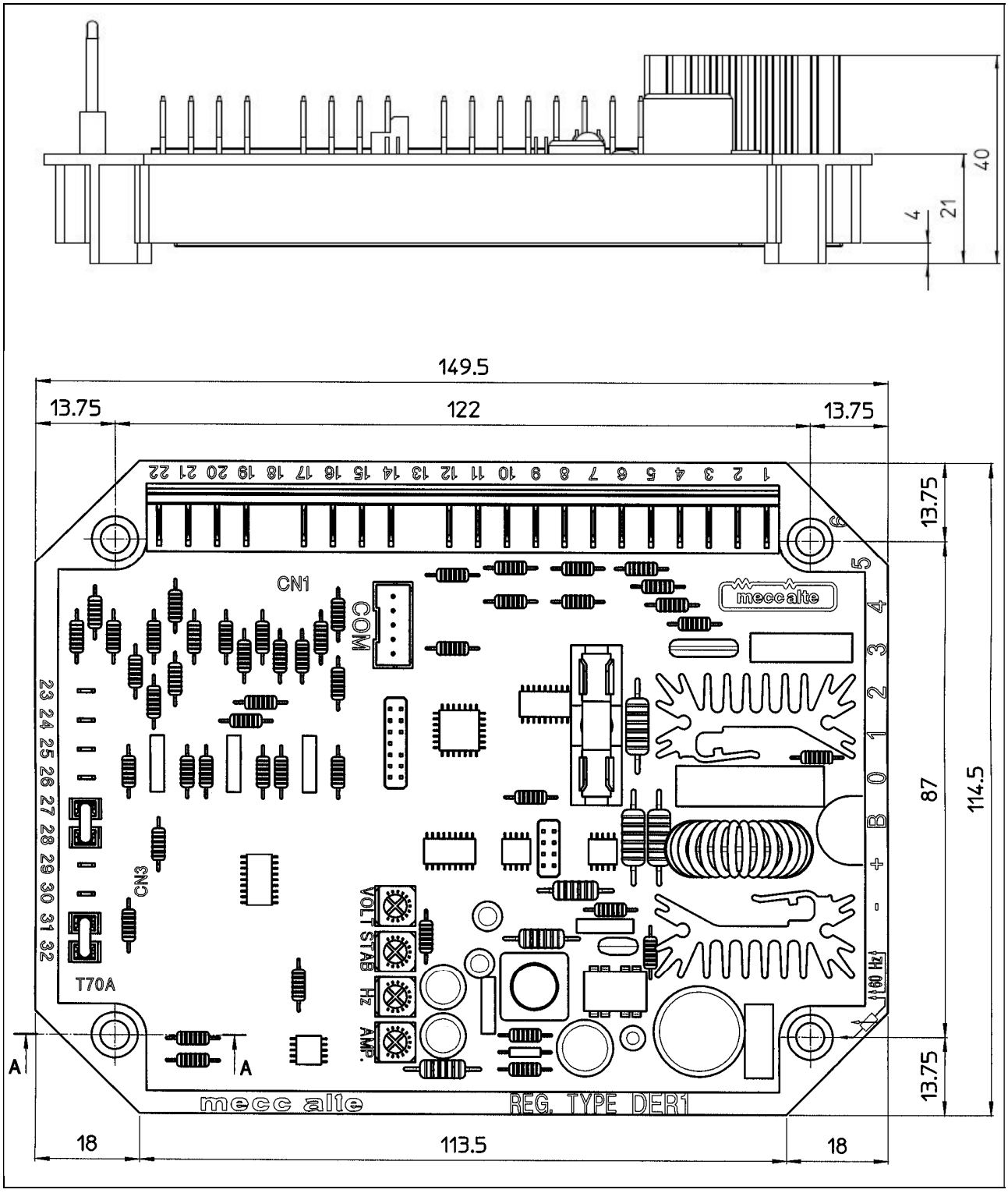


Fig 1

INSTALLATION

Upon receipt of the digital regulator, perform a visual inspection to ensure that no damage has been sustained during transportation and movement of the equipment. In the event of damage, advise the shipper, the insurance company, the seller or Mecc Alte immediately. If the regulator is not installed immediately, store it in its original packaging in a dust and humidity-free environment.
The regulator is normally installed in the generator terminal box. It is fixed with two M4x25 screws and must be installed in a location where the temperature does not exceed the environmental conditions foreseen. Refer to the attached drawings for dimensions and displacement.

1. Overall dimensions drawings



dimensions in mm

Fig 2

2. Connections

The digital regulator connections depend on the application and excitation system.
Figure 1 shows the functional aspect of the connection points to the regulator

An error in connection may have deadly consequences for the unit.
Carefully check to make sure that all connections are precise and in accordance with the attached drawings, before turning on the power.

3. Terminals

Figures 1 and 2 show the connection terminals; the connections must be made using cables having a minimum diameter:

- **1,5 mm²** for power cables on terminals from 1 to 22
- **0,5 mm²** for signal cables on terminals from 23 to 32

4. DER1 connections

The DER1 regulator has 3 differential inputs, with 2 selectable scales for each of them (see fig. 1):

- scale "H" for voltages between 75V and 150V
- scale "F" for voltages between 150V and 300V

4.1 Connections based on main alternator voltage

Based on the machine connections, and the desired voltage(1) you can use the three phase or single phase sensing used in one range or the other. Table 4 summarises the connections for the most common voltages.

TABLE 4: ALTERNATOR VOLTAGE AND SENSING CONNECTION

Connection	Phase-to-Phase Voltage [V]	Sensing - Phase	Range	Drawing	Notes
Series star	380-400-415-440-460-480-500 (from 260 to 500)	Single phase on half phase	H	SCC0160	
		Three phase on half phase	H	SCC0158	
		Single phase on full phase	F	N.A.	
		Three phase on full phase	F	N.A.	
	530-550-575-600-690-760-800-920-960(from 520 to 1000)	Single phase on half phase	F	SCC0161	
		Three phase on half phase	F	SCC0159	
	1200 (from 1100 to 2000)	Single phase on half phase	F	SCC0202	2 channels in series
Parallel star	190-200-208-220-230-240-250 (from 130 to 250)	Single phase	H	SCC0160	
		Three phase	H	SCC0158	
	380-400-415-440-460-480-500 (from 260 to 500)	Single phase	F	SCC0161	
		Three phase	F	SCC0159	
Series delta	220-230-240-254-265-277-290 (from 150 to 300)	Single phase on half phase	H	SCC0160	
		Three phase on half phase	H	SCC0158	
	305-320-330-440-460-530-555 (from 300 to 600)	Single phase on half phase	F	SCC0161	
		Three phase on half phase	F	SCC0159	
	220-230-240-254-265-277-290 (from 150 to 300)	Single phase on full phase	F	N.A.	
		Three phase on full phase	F	N.A.	
Parallel delta	110-115-120-127-133-138-145 (from 75 to 150)	Single phase	H	SCC0160	
		Three phase	H	SCC0158	
	152-160-165-220-230-265-277 (from 150 to 300)	Single phase	F	SCC0161	
		Three phase	F	SCC0159	
Zig-Zag(2)	330-346-360-380-400-415-430 (from 260 to 500)	Single phase on full phase	F	N.A.	
		Three phase on full phase	F	SCC0203	2 channels in series
Single phase parallel	220-230-240-254-265-277-290 (from 150 to 300)	Single phase - Partial	H	SCC0160	
		Single phase - Complete	F	N.A.	
	305-320-330-440-460-530-555 (from 300 to 600)	Single phase - Partial	F	SCC0161	
		Single phase - Complete	F	N.A.	2 channels in series

(1) Compatibly with the rated characteristics of the alternator
(2) Sensing only on full phase

4.2 DER1 connections for typical applications

Drawings SCC158, SCC159, SCC160, SCC161 show DER1 regulator connections for typical applications.

In case of sensing 75V-150V, for example, for ECO/ECP28 – ECO/ECP38 Series alternators with 12 terminals with half-phase reference (and also ECO40-1S, ECO40-2S, ECO401L and ECO40-2L), the typical drawing for three-phase connection is SCC 158, while for single phase it is SCC 160.

In case of sensing 150V-300V, for example, for ECO43 and ECO46 Series alternators with 12 terminals with half-phase reference (and also for ECO40-3S, ECO40-1.5L and ECO40-VL), the typical drawing for three-phase connection is SCC 159, while for single phase it is SCC 161.

5. Setting up the regulator

Selection of the sensing scale takes place directly according to the connection on the power terminal board; additional settings can be made with 4 trimmers (VOLT, STAB, AMP and Hz) and 3 jumpers (50/60Hz, JP1 and JP2); the output voltage can also be set with an external analogical signal; additional settings, including the previous ones but excluding jumpers JP1 and JP2, can be made by modifying the 23 parameters stored in a non volatile integrated memory.

5.1 Alternator voltage signals

Terminals 4-22 of connector CN1 are used for voltage sensing.

5.2 Calibrating sensing

A supplementary calibration may be necessary to compensate any existing tolerances on analogical voltage acquisition channels; in this case follow the procedure illustrated below.

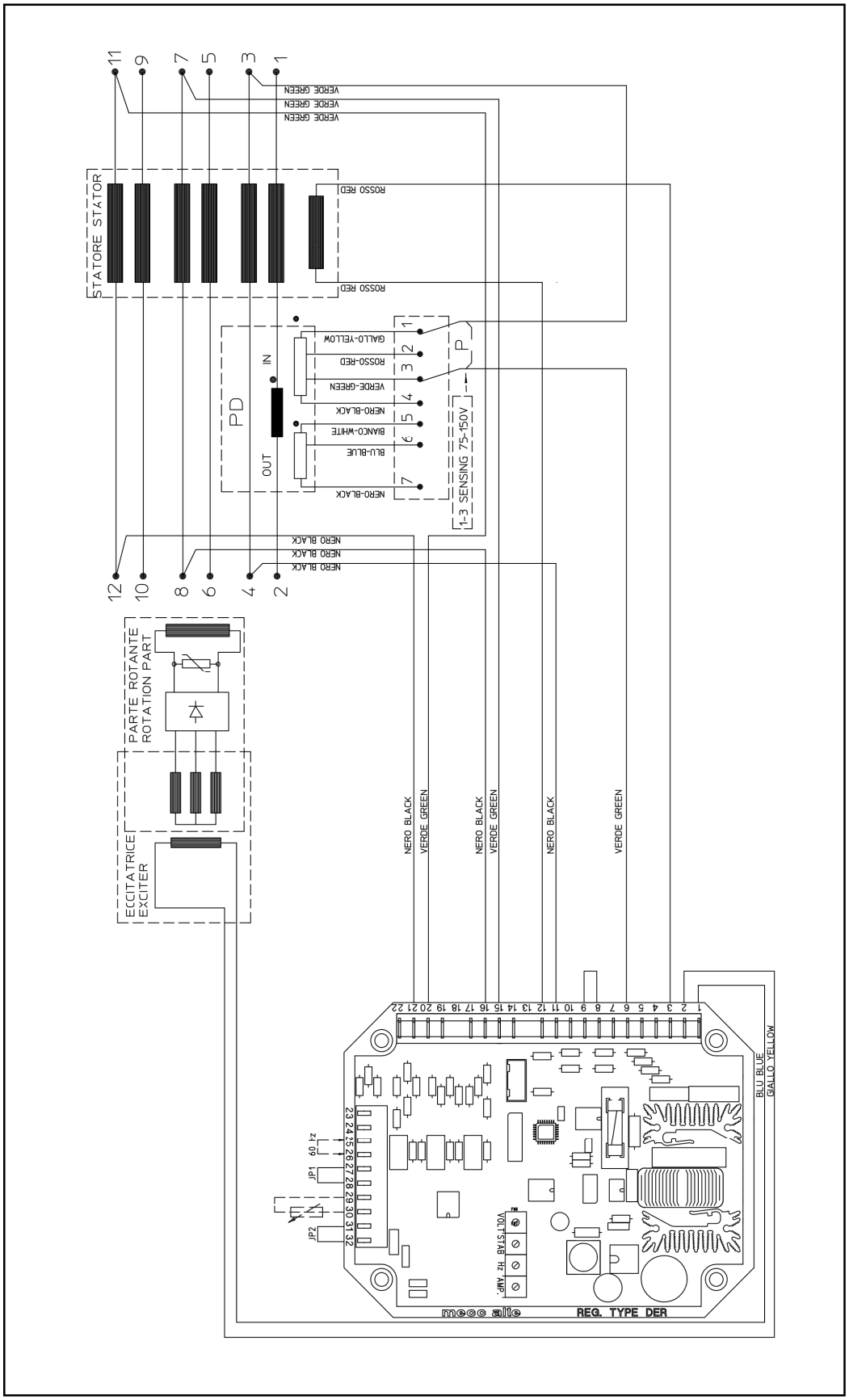
1. Write **16384** on parameter P[19]
2. Disable VOLT trimmer (from the **Configuration** Menu)
3. Disable Vext (from the **Configuration** Menu)
4. The parameter present in parameter P[5](if three phase sensing) or p[6] (if single phase sensing)has to be calibrated. Calibration should be adjust in order to obtain 225V from the generator output when the sensing is cabled to U_{FB} (9-10-11-12) and U_{FG} (6-7), or to 125.5V if connected U_{FB} (9-10-11-12) and U_{HG} (6-7).Please note that a paramenter increment will result in a voltage reduction of the system. It is recommended to measure the voltage output with an instrument capable to catch the average value of the voltage.
5. This procedure is necessary to calibrate the voltage sensing of the regulator. The voltage indicated in location L[36] of the status (It is possible to read it with the DSR terminal software), should match the value read by the voltage measurement instrument used to calibrate the board on point 4. If a mismatch is noticed, please proceed in adjusting the P[7] value in order to clear the offset between the indicated and measured values.
6. Enable the VOLT trimmer again, if it is desired to have it active (from the **Configuration** menu).
7. Enable Vext (from the **Configuration** Menu) if you want to be active.

6. 50/60 Signal

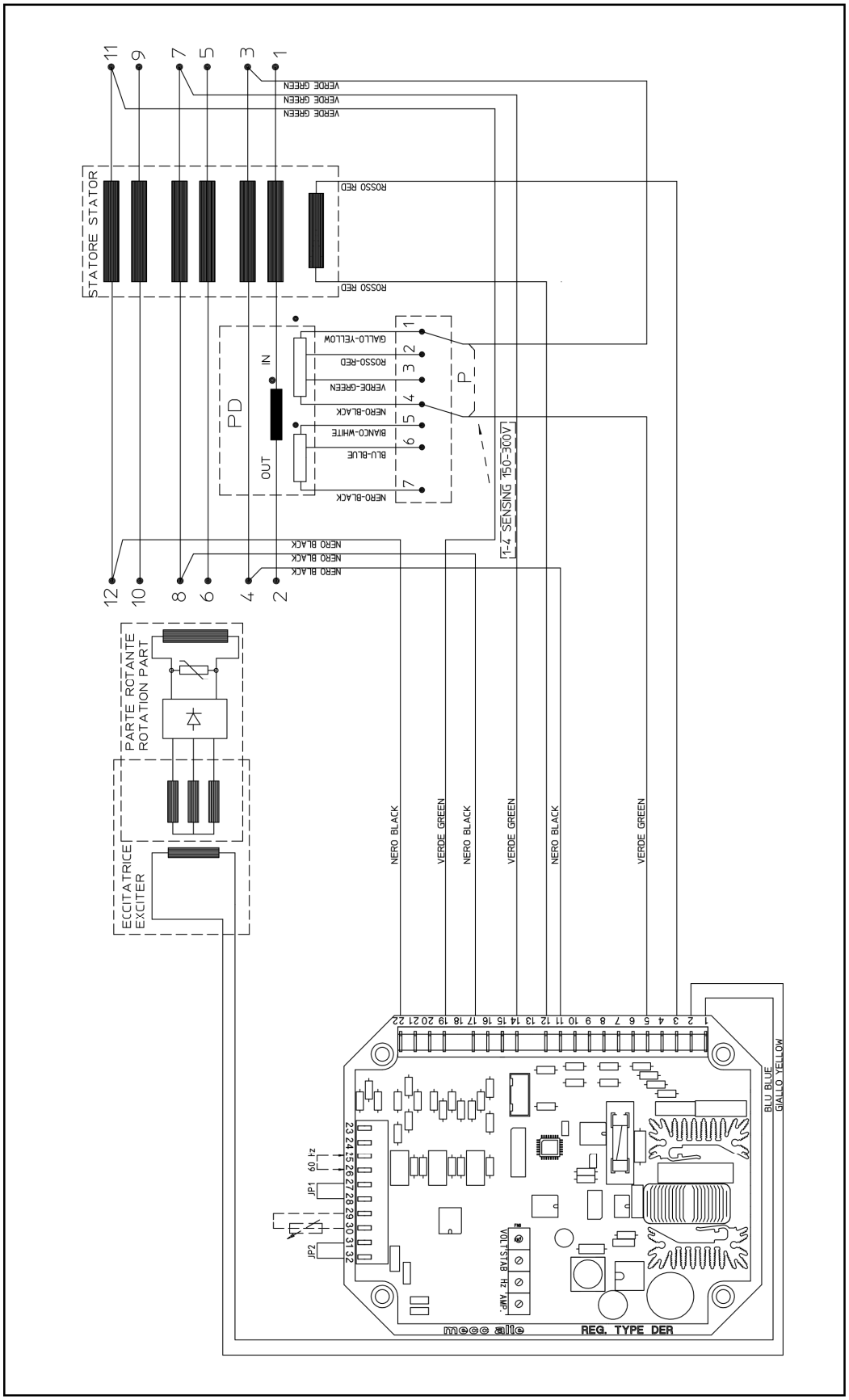
A jumper is located on the 50/60 input (terminals 25 and 26); if enabled from the **Configuration** Menu, it provokes the commutation of the underspeed protection threshold from 50·(100%-αHz%) to 60·(100%-αHz%), where αHz% represents the position relative to the Hz trimmer or the percentage value entered in location L[21] (where 10% corresponds to 16384).

7. APO Contact

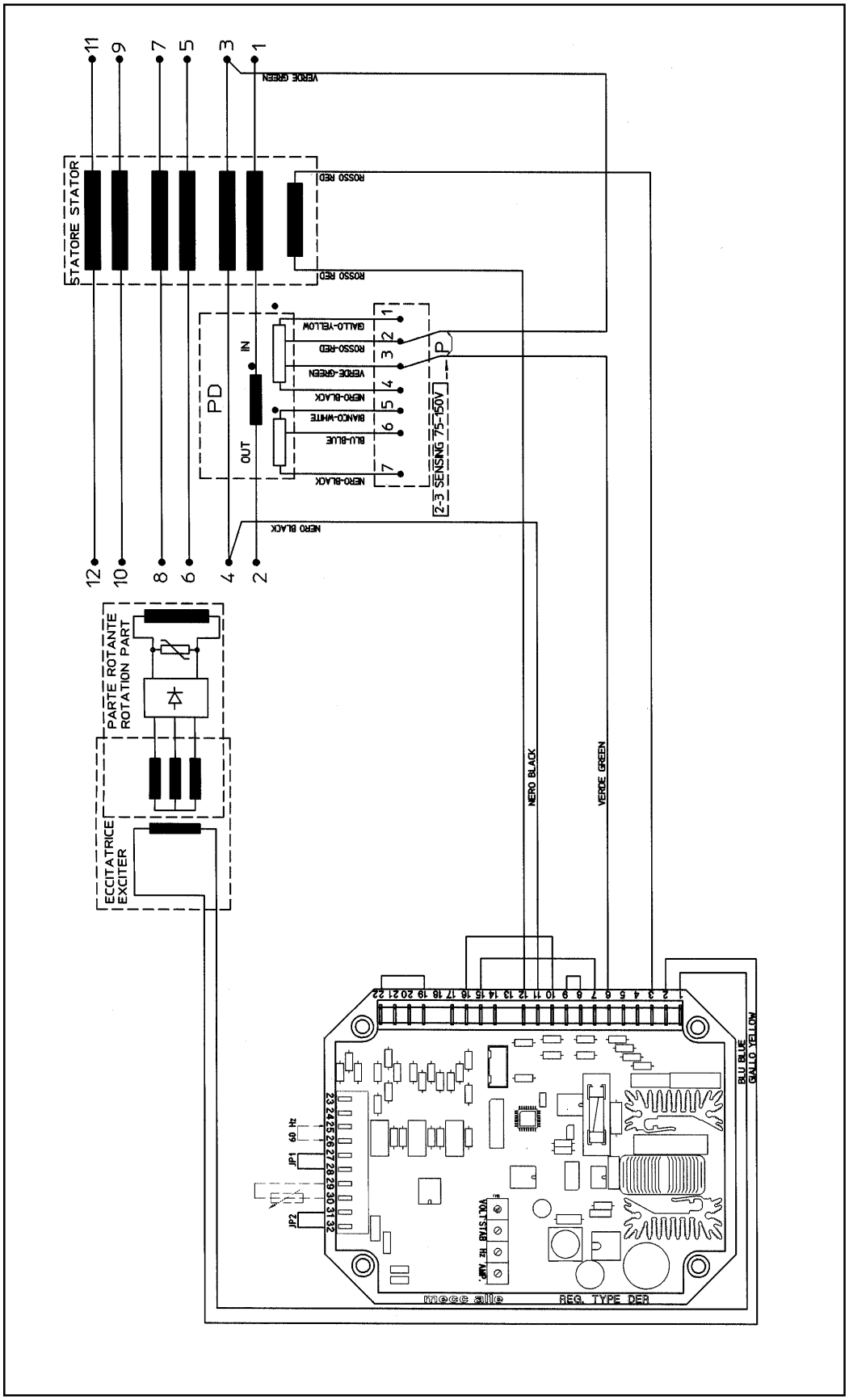
The acronym **APO** stands for **A**ctive **P**rotection **O**utput: terminals 23 (common) and 24 (collector) 30V-100mA non-insulated open collector transistor, normally opened, is closed (with a delay that can be programmed from 1 to 15 seconds) when, among all the alarms, one or more of the active ones can be selected separately.



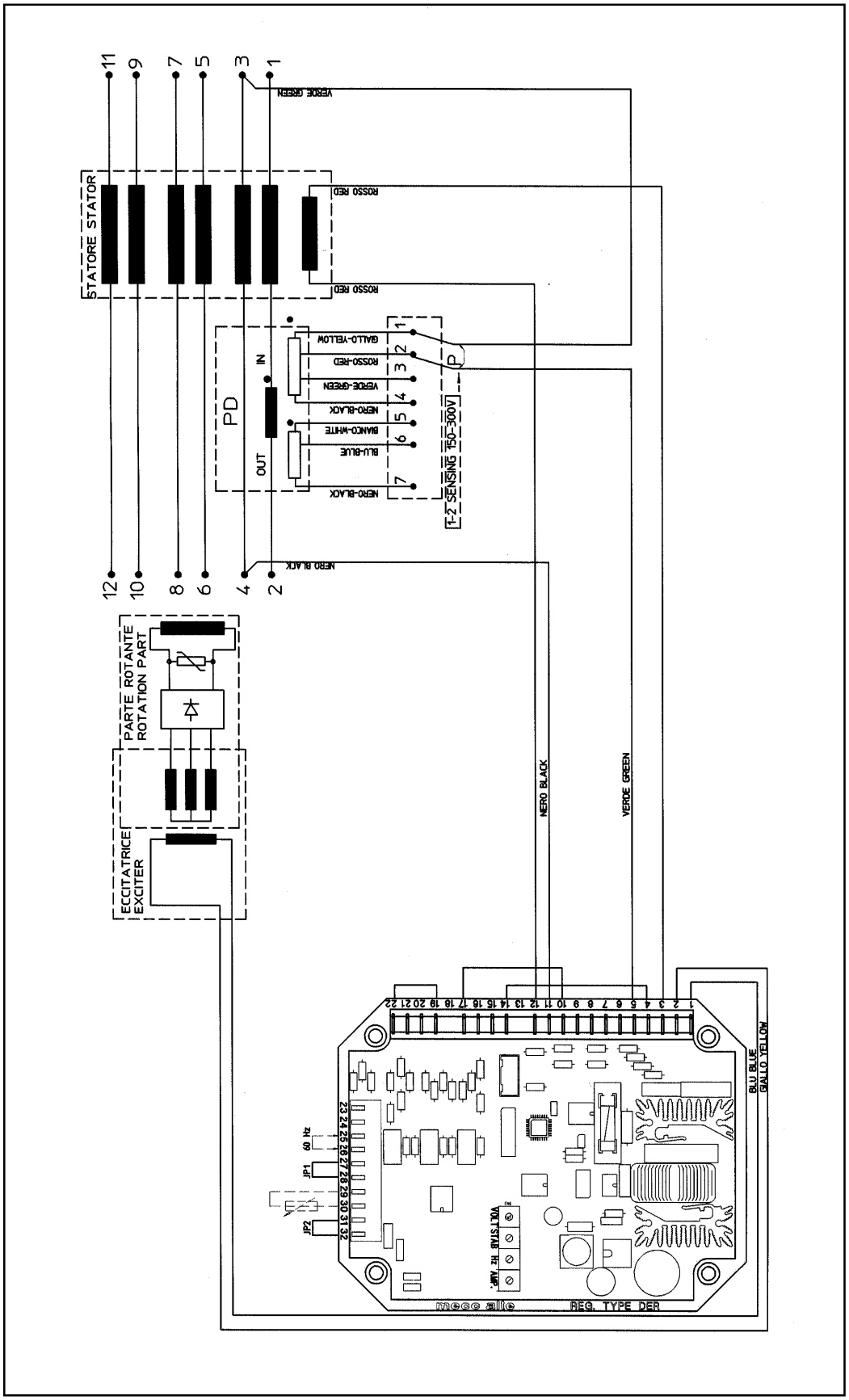
SCC0158: Three phase sensing 75V-150V



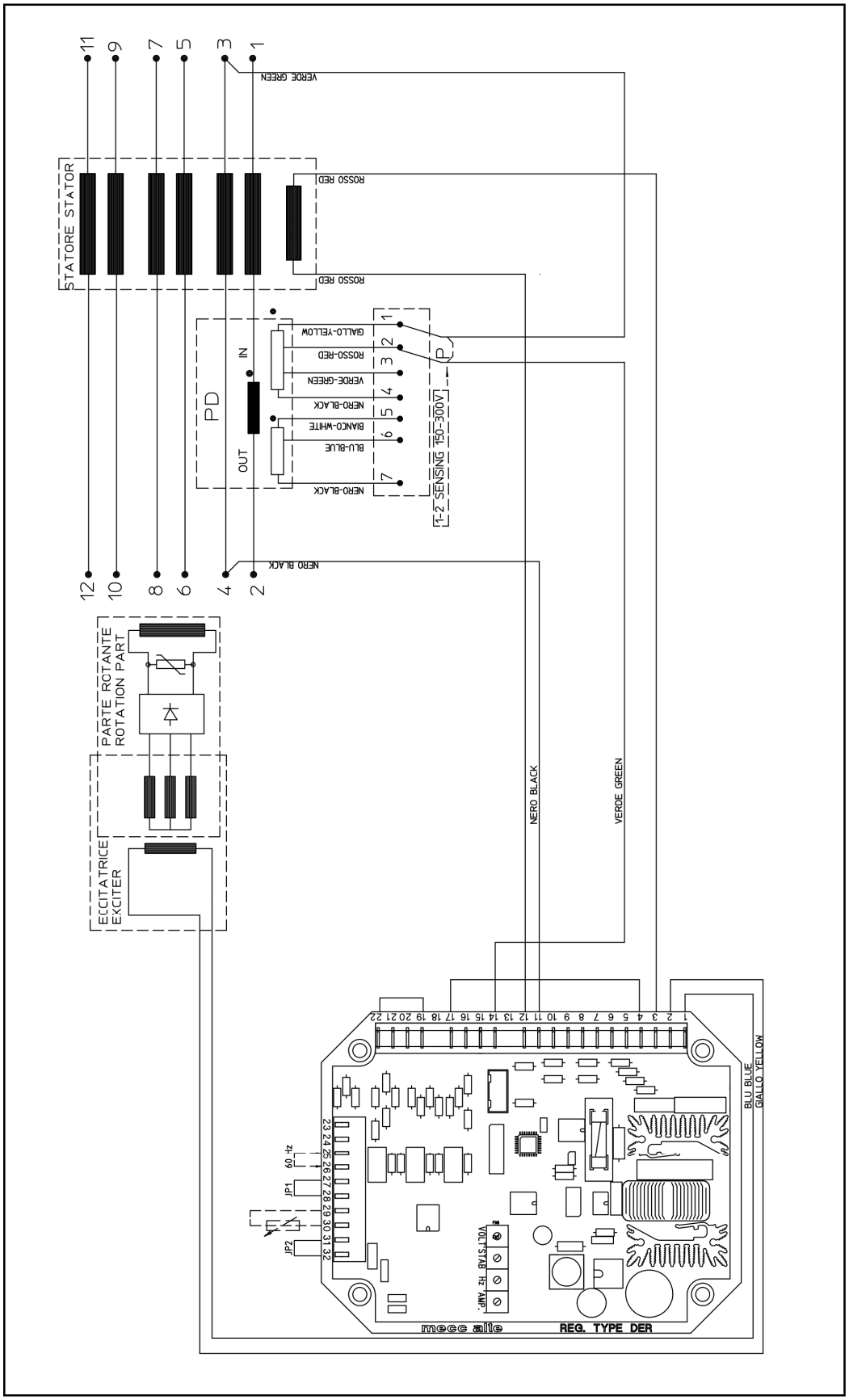
SCC0159: Three phase sensing 150V-300V



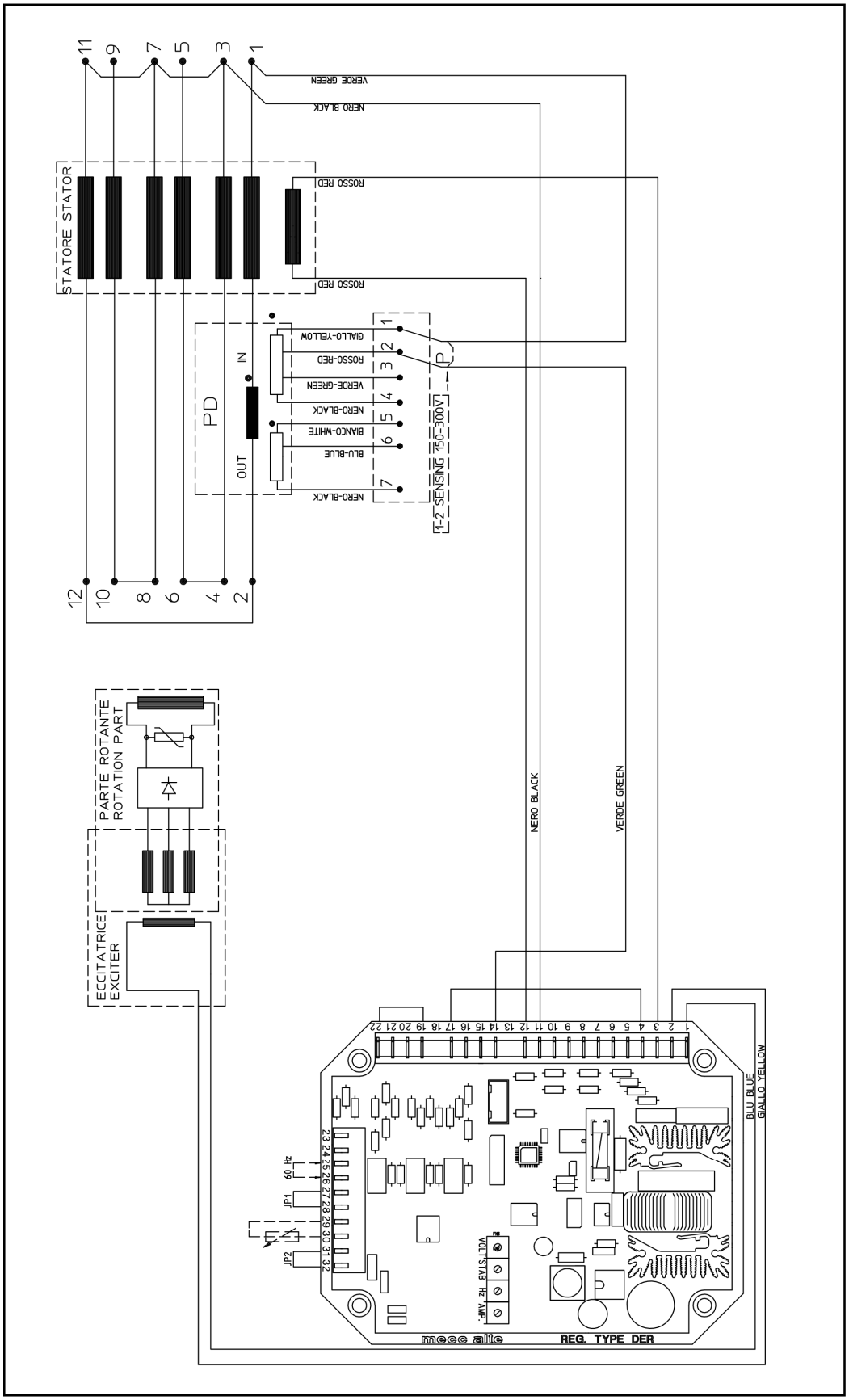
SCC0160: Single phase sensing 75V-150V



SCC0161: Single phase sensing 150V-300V



SCC0202: Single phase sensing 300V-600V



SCC0203: Single phase sensing 300V-600V
(generator in threephase ZIG-ZAG connection)

8. Remote control of voltage

The Pext input (terminal 30) and ±10V (terminal 32) allow to obtain remote control of the output voltage by means of a DC signal or an external potentiometer. The output voltage can be controlled by software as well with the P[19]. The excursion range and gain of the remote control can be set independently by software despite the output voltage control device system used (potentiometer, VDC signal or P[19]). If DC voltage is used, it will take effect if it is within the range 0Vdc/2,5Vdc or -10Vdc/+10Vdc, when connected between terminals 30 and 29 and subjected by jumpers JP1 and JP2; for values exceeding the aforementioned limits (or in the event of disconnection), two options are possible: not to take the set point of external input and return to regulation to the voltage value set with the trimmer (if enabled) or with parameter P[19], or keep the minimum (or maximum) value of voltage that can be reached (see figures 3a and 3b). The two options can be set with the **RAM Voltage CTRL** flag in the **configuration** menu corresponding to the bit B7 of the configuration word P[10] (see PARAMETERS AND OPERATIONAL DATA - Para. 2). The setting relative to the Vext input are summarised in table 5.

NOTE: the source of DC voltage must be capable of absorbing at least 2 mA.
In making adjustments it is reccomended not to exceed the nominal value of voltage of the alternator beyond ± 10%

Relationship between analogical input and output voltage

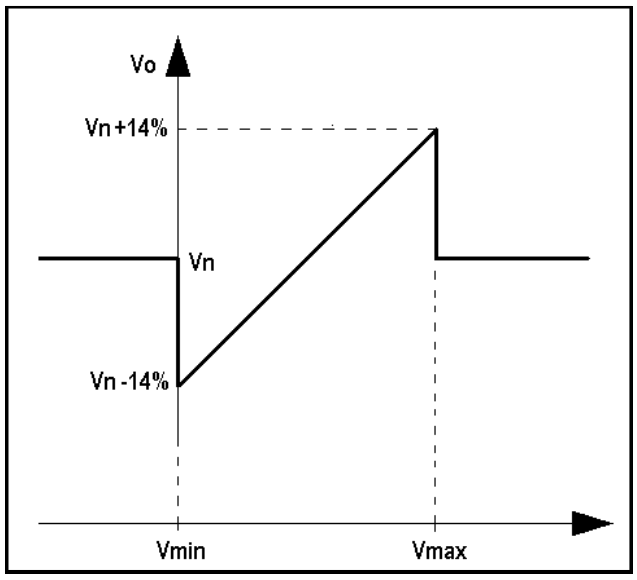


Figure 3a: without saturation of the output voltage upon reaching the input voltage limits.

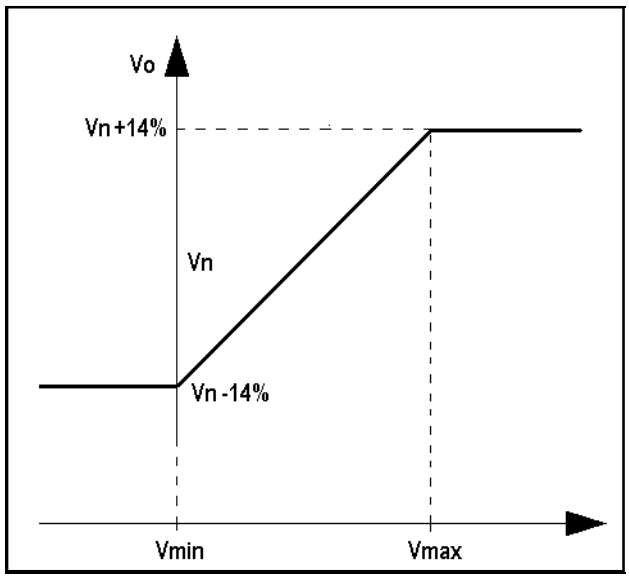


Figure 3b: with saturation of the output voltage upon reaching the input voltage limits.

TABLE 5: HARDWARE AND SOFTWARE CONFIGURATION OF VOLTAGE REMOTE CONTROL

Type	Input	Jumpers		Flags (configuration menu) or Parameter P[10]	
		JP1 (27-28)	JP2 (31-32)	RAM Voltage CTRL	Ext. Input
Potentiometer	0Ext - Pext (29-30)	Close	Close	Disabled (Bit B7=0)	Enabled (Bit B12=1)
0V/2,5V without saturation	0Ext - Pext (29-30)	Close	Close	Disabled (Bit B7=0)	Enabled (Bit B12=1)
0V/2,5V with saturation	0Ext - Pext (29-30)	Close	Close	Enabled (Bit B7=1)	Enabled (Bit B12=1)
-10V/+10V without saturation	0Ext - ±10V (29-32)	Open	Open	Disabled(Bit B7=0)	Enabled (Bit B12=1)
-10V/+10V with saturation	0Ext - ±10V (29-32)	Open	Open	Enabled (Bit B7=1)	Enabled (Bit B12=1)
Parameter P[15]	EEPROM	Close	Close	Disabled(Bit B7=0)	Disabled (Bit B12=0)
Location L[49]	RAM	Close	Close	Enabled (Bit B7=1)	Disabled (Bit B12=0)

With a 100Kohm linear potentiometer connected as shown in figure 4a, you have the full excursion set with parameter P[16] (with the default value P[16]=4608 there is an excursion of ± 14%); with a 25Kohm linear potentiometer in series with a 3.9Kohm resistor, connected as shown in figure 4b, the effect of the external potentiometer is cut in half (with the default value P[16]=4608 there is an excursion of approximately ± 7%).

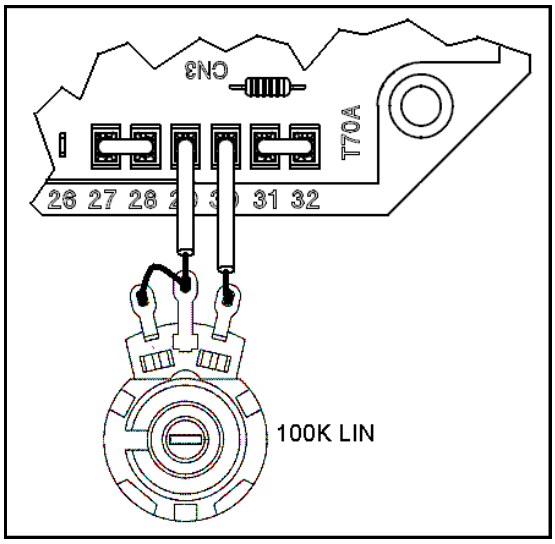


Fig. 4a: 100K external potentiometer connection

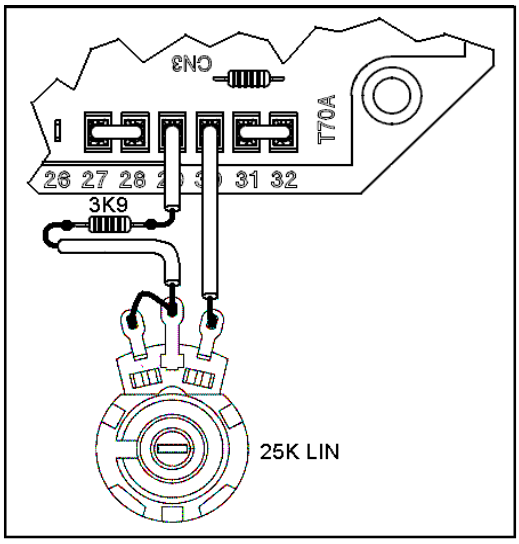


Fig. 4b: 25K external potentiometer connection

9. VOLT, STAB, Hz and AMP Trimmers

The trimmers are enabled by the software from the **Configuration** Menu; if they are not enabled, they **DO NOT** perform any function.

The **VOLT** trimmer allows adjustment from about 75V to about 150V or from about 150V to about 300V.

The **STAB** trimmer adjusts the dynamic response (statism) of the alternator under transient conditions.

The **Hz** trimmer allows for a variation of the "low speed protection" of up to –20% with respect to the nominal speed value set by the 50/60 jumper (if activated) or by the 50/50 box in the **Configuration** menu (at 50 Hz the threshold can be calibrated from 40 Hz to 50 Hz, at 60 Hz the threshold can be calibrated from 48 Hz to 60 Hz).

The **AMP** trimmer adjusts the excitation overcurrent protection intervention threshold.

10.Serial Communications

The COM connector is RESERVED for connection to the DI1 communications module with the special cable provided with the module itself.

The serial interface of the DI1 communications unit is of the RS232 or RS485 type: it will therefore be possible to connect several DER1-DI1 groups as well (and therefore several generators) in parallel on the same 485 Bus, in order to monitor the operation with a single supervising unit. The regulator implements a subsystem of the MODBUS standard for communications; the DI1-DER1 set performs slave operation, whose address is memorised in the EEPROM and is set during the phase of configuration.

When necessary, the DI1 interface permits insertion of the regulator in a RS485 network with other regulators or other devices of a different type, but with the same type of bus. Contact the Mecc Alte technical office for detailed descriptions of the ModBus commands implemented.

The “Master Unit” is made up of a PC or other dedicated equipment and can access the parameters and functions of the regulator.

The master unit has the following possible functions:

- Repetition, or visualisation, of the generator status variables, even from a remote location
- Setting of single parameters
- Uploading and downloading of settings files
- Status readings (alarms, measuring variables)
- Readings of the alarm memory information

PARAMETERS AND OPERATING DATA

1. ModBus registry list

An EEPROM memory is used to store configuration parameters and other information that must not be lost when the generator goes off. Parameters can be read/written and machine operational settings entered through serial connections. Two versions of the regulator are available, called DER1 and DER 1/A; they differ primarily in the default value of several parameters. Table 6 shows a complete list of the parameters that can be set, which define all the operational conditions of the regulator.

Note:Locations are ordered to separate the parameters of individual regulators (S.N:, SW versions and calibration) from settings foreseen, in order to facilitate programming of regulators with the same settings but different S.N., SW versions and calibrations. The parameters from 0 to 9 are adjusted at the factory for each regulator. The parameters from 10 to 30 can therefore be freely copied from one to another.

TABLE 6 : EEPROM SETTING REGISTRIES					
Add.	**Description of Parameter**	**Range**	**Default**		**NOTES**
			DER1	**DER1/A**	
0	Firmware revision	0..65535	13	13	Reserved - Do not write
1	ModBus slave address	1..31	1	1	Identification of RS485 network (or broadcast)
2	Software configuration	0..65535	16402	18962	Reserved - Do not write
3	Serial number, high part	16bit	0	0	Reserved - Do not write
4	Serial number, low part	16bit	0	0	Reserved - Do not write
5	Three phase sensing calibration	0..32767	16384	16384	Calibration of voltage channels in 3 ph adjustment
6	Single Phase sensing calibration	0..32767	16384	16384	Calibration of voltage channels in 1 ph adjustment
7	Measured voltage calibration	0..32767	16384	16384	Calibration of location L 36 (first “STATUS” box)
8	Current limit time	0..32767	0	0	Duration of limiting in number of periods
9	Current limit level	0..32767	32767	32767	Excitation voltage limit upon start-up
10	Word configuration	16bit	7956	7956	Set from “Configuration” Menu”, see Tab. 7
11	Shift to LEFT proportional gain	0..6	4	5	n=0…6 is equivalent to a multiplication by 2^n
12	Shift to LEFT integral gain	0..6	3	1	namely 1, 2, 4, 8, 16, 32, 64.
13	Coefficient tieing Ki to Kp	0..32767	16384	26624	Coefficient to set Ki and Kp separately
14	Vout / Vaux Ratio	±32767	6000	6000	Limit to voltage reduction as a function of frequency
15	Reference equivalent to Vext	0..32767	16384	16384	Value used if the Vext input and location L[49] are disabled
16	Limitation of Vext Variation	0..3277	4608	4608	Limits the effect of external analogical input (0->0; 3277->10%)
17	APO delay & alarm settings	0..65535	126	126	Selects alarms that activate the APO contact and sets the delay intervention
18	Step limitation reference	1..1000	20	20	For rapid variations of voltage setpoint, the passage from one value to another takes place through added or subtracted steps at each period.
19	Vout Reference	0..32767	0	0	Value used if the VOLT trimmer is disabled
20	Stability	0..32767	16384	16384	Value used if the STAB trimmer is disabled
21	Freq. threshold ± 10% $freq_{nom}$	0..32767	16384	16384	Value used if the Hz trimmer is disabled
22	Excitation overcurrent threshold	0..32767	16384	16384	Value used if the AMP trimmer is disabled
23	V/F Slope	0..32767	9000	9000	V/F curve slope during normal operation
24	V/F curve slope at start up	0..32767	6000	6000	Used only upon start up
25	Short circuit time	0..255	20	20	Operating time with short circuited alternator, expressed in tenths of seconds (0 ….. 25.5 seconds) [0=excluding STOP]
26	Overspeed threshold	±32767	0	0	Variation (±10%) of overspeed alarm intervention with respect to the default value of 55/66Hz
27	Shutdown threeshold	0..32767	6553	6553	Reserved - Do not write
28	Ki over-excitement Regulator	0..32767	12287	12287	Integral and proportional gain of excitation voltage regulator
29	Kp over-excitement Regulator	0..32767	24575	24575	in the event of AMP alarm
30	Thermal dispersion coefficient	0..65535	63600	63600	Used by AMP alarm temperature estimator
31	Reserved	0..65535	-	-	Do not write

2. Configuration word (Parameter P[10])

Configuration of the regulator takes place by setting the individual bits of parameter P[10]. Each of them enables or disables at least one function, on the basis of the fact that its value is respectively 1 or 0.

If the "DSR Terminal" programme is used (see the Chapter on "Use of DSR Terminal monitoring and programming software"), the setting is facilitated with the *Configuration* menu, where each box enables or disables a function and corresponds to the respective bit.

Alternatively, the DER1 can be configured by directly setting the value of the P[10] parameter; in this case the value is calculated before entry, summing the numbers indicated in the column "Value" of Table 7, corresponding to the functions it is desired t enable.

For example, the default configuration calls for the bits B2, B4 and those from B8 to B12 to be enabled. The corresponding value is therefore: P[10]=4+16+256+512+1024+2048+4096=7956.

TABLE 7 : BIT FUNCTION OF THE CONFIGURATION WORD (PARAMETER P[10])			
Bit	**Value**	**Function**	**Default**
B0	1	Not used	0
B1	2	Periodical reference variation	0
B2	4	Automatic voltage offset compensation(1)	1
B3	8	Not used	0
B4	16	Enable hardware jumper 50/60Hz	1
B5	32	Free for future use	0
B6	64	Force three-phase sensing	0
B7	128	External location reference L[49] (2) and activation of saturation in the event of overflow	0
B8	256	Enable VOLT TRIMMER	1
B9	512	Enable STAB TRIMMER	1
B10	1024	Enable Hz TRIMMER	1
B11	2048	Enable AMP TRIMMER	1
B12	4096	Enable external analogical input	1
B13	8192	Enable external DAC	0
B14	16384	60 Hz setting in the event of disabling of the 50/50 Hz hardware jumper	0
B15	32768	Reserved	0

NOTE 1: only with single phase reference

NOTE 2: if analogical input is disabled

NOTE 3: for analogical input

3. RAM location reference, activation of saturation in analogical remote control

The **RAM Voltage CTRL** Flag (corresponding to bit 7 of the P[10] configuration word) performs two functions:

1. If the Pext hardware input is enabled (Flat Ext. Input corresponding to bit 12 of the P[10] configuration word), as previously described, the **RAM Voltage CTRL Flag** activates saturation of output voltage when the analogical control voltage reaches the limit foreseen for input, to which it is applied (see Para. 8 Remote control of voltage).

If saturation is enabled, in the event of removal of the Vext/Pext connection (due to accidental opening, for example) the voltage goes to the maximum value set in parameter P[16] (+14% by default).

2. When Pext is disabled by hardware, the indicated flag defines the value to be used by the software control of the output voltage. If RAM Voltage CTRL is deactivated (B7=0), the non volatile parameter P [15] is used (therefore following shut down and restart of the regulator, the last value memorised remains set): on the start up the location L[49] is initialised with the value of parameter P[15] and is kept aligned to that value. Editing of location L[49] has no effect in this working condition. If RAM Voltage CTRL is active (B7=1) the volatile location L[49] is used for software remote control of the output voltage (when the regulator is energized, the value is stored. If the regulator is shut down, the value is lost). This function is particularly useful for the applications of alternators in parallel with grid, when the regulation of the reactive power exchanged is controlled by means of a third party supplied digital supervisor.

TABLE 8 : REMOTE VOLTAGE CONTROL FLAGS FUNCTION				
FLAG **RAM Voltage CTRL**	P[10] Bit B7	FLAG **Ext. Input**	P[10] Bit B12	Output voltage control type
❒	0	✓	1	Analogical without saturation
✓	1	✓	1	Analogical with saturation
❒	0	❒	0	Digital - Parameter P[15]
✓	1	❒	0	Digital - Location L[49]

4. Volatile memory addresses

TABLE 9 : VOLATILE MEMORY ADDRESSES				
Add.	**Add name**	**Range**	**Access**	**Description**
32	VOLT Trimmer	0..32767	Read only	VOLT Trimmer Position
33	STAB Trimmer	0..32767	Read only	STAB Trimmer Position
34	Hz Trimmer	0..32767	Read only	Hz Trimmer Position
35	AMP Trimmer	0..32767	Read only	AMP Trimmer Position
36	First status word	0..3200	Read only	Regulated voltage [tenths of volts]
37	Second status word	0..900	Read only	Frequency [tenths of Hz]
38	Third status word	16bit	Read only	Active alarms
39	Fourth status word	16bit	Read only	Active configuration
40	Commands	16bit	Write	Reserved Word Commands – Do not use
41	Pext/Vext Inputs	0..32767	Read only	Analogical input or external potentiometer value
42	Setpoint	0..32767	Read only	Setpoint value
43	Setpoint	0..32767	Read only	Value modified by regulator in case of alarms, soft-start, etc.
44	Measured Voltage	0..32767	Read only	Internal variable
45	Estimated temperture	0..32767	Read only	Estimates temperature of exciter windings
…	…			…
49	Reference corresponding to Vext	0..32767	Write	Used if Vext input is disabled and voltage remote control by RAM location is enabled (P[10]-Bit B7=1)
50	Peak to peak voltage	0..32767	Read only	Internal variable
51	Three phase switch threeshold	0..32767	Read only	Internal variable
52	Offset voltage	0..32767	Read only	Internal variable (active only in single phase sensing)
…	…	0..32767		…

5. Fourth Status Word (Location L[39])

Location L[39] indicates (almost in real time) the active configuration at any given time; it is not a simple replication of the value recorded in parameter P[10], however, inasmuch as the bits B2, B6 and B14 adjust their value only on the basis of the configuration set, but also of the effective operational status of the DER1 at that time; for example, if the regulator is connected with three phase sensing, even if bit B6 of the configuration word is set on 0 (automatic recognition of single phase – three phase activation), bit B6 of location L[39] will have a value of 1; similarly, if the 60 Hz jumper is engaged and reading is enabled 8Bit B4 of parameter P[10] set on 1), bit B14 of location L[39] will have a value of 1 even if the corresponding bit B14 of the configuration word is set on 0.
The values of the fourth word of status (location L[39]) are shown in table 10, on the basis of the type of sensing and nominal frequency.

TABLE 10 :STANDARD VALUES OF THE FOURTH STATUS WORD (LOCATION L[39])		
	Rated frequency:	
Sensing	50Hz	60Hz
Single phase	7956	24340
Three phase	8016	24400

TABLE 11 : BIT FUNCTION OF THE FOURTH STATUS WORD L[39] (ACTIVE CONFIGURATION)			
Bit	Function	**Value**	**Default**
B0	Not used	1	0
B1	Bit activating a periodical variation of reference voltage	2	0
B2	Bit activating automatic compensation of the offset in voltage acquisition channels	4	0/1 (1)
B3	Not used	8	0
B4	Bit enabling reading of 50/60 Hz jumper hardware	16	1
B5	Free for future use	32	0
B6	Three phase sensing active	64	0
B7	Voltage remote control by RAM location L[49] or input saturation (in case of overflow)	128	0
B8	Bit enabling reading of reference voltage by VOLT Trimmer	256	1
B9	Bit enabling reading of stability parameter by STAB Trimmer	512	1
B10	Bit enabling reading of underspeed protection threshold by Hz Trimmer	1024	1
B11	Bit enabling reading of excitation current threshold by AMP Trimmer	2048	1
B12	Bit enabling reading of external voltage input	4096	1
B13	Bit enabling DAC	8192	0
B14	60Hz active setting (jumper 60Hz closed and/or 60Hz active setting on configuration menu)	16384	0/1 (1)
B15	Reserved	32768	0

NOTE 1: depending on the sensing and nominal frequency

SETTING OF VOLT, STAB, AMP and Hz PARAMETERS.

1. Voltage

1.1 Setting voltage.

Setting can take place through the trimmer or software: on sensing inputs 6/7 – 10/11/12 (with bridge 8-9), 15-16 and 20-21, the voltage can be set between 75÷150 Vac (scale H); on sensing inputs 4/5 - 9/10/11/12, 14-17 and 19-22 between 150÷300 Vac (scale F).
There are two ways to set from minimum to maximum value:

1. With the VOLT trimmer, which must be enabled by the Configuration menu
2. With parameter P[19] (The Volt trimmer must be enabled from the Configuration menu: the value 0 corresponds to minimum voltage, 16384 corresponds to the intermediate value (respectively 112.5 V and 225 V), while 32767 corresponds to maximum voltage.

It is possible to vary voltage with respect to the value set, with the Pext input (terminals 29-30) if enabled from the **Configuration** menu, with a 25Kohm or 100Kohm potentiometer, with a range of variation that can be programmed up to ±100% (parameter P[16]. The default setting is ± 14%, even if it is opportune not to exceed ±10%). Alternatively, variation can be made with continuous voltage applied on Pext (terminal 30) or ±10V (terminal 32), based on the value of that voltage. If the Pext voltage is disabled, it is possible to vary the voltage with parameter P[15] or location L[49]. For additional details see the paragraph "Remote control of voltage".

1.2 Soft Start

In the event of fast start up of the prime mover or sudden regulator excitation with the generator running at nominal speed an uncontrolled regulator could result in a temporary generator overvoltage or in a transitory prime mover overload due to the high peak of excitation current..
These effects can be minimised by setting parameter P[8] and P[9] appropriately. In the phase of start up, they determine a limit of the excitation current.
Parameter P[8] sets the duration of the excitation current limitation, namely the value of the parameter corresponds to the number of periods in which the limitation is active. The default value is P[8]=0 which corresponds to deactivation of the soft start. Considering that in most cases the alternator is already at nominal speed, an estimate in temporal terms may be obtained with the formula:

$$t_{\lim} = P[8] \cdot \frac{1}{f_n} = P[8] \cdot \frac{30}{\omega_n}$$ Where f_n = nominal frequency in Hz or ω_n = nominal speed in R.P.M

The parameter P[9] sets the excitation current limit: the value P[9]=0 is setting to zero the excitation current, while the maximum value P[9]=32767 is removing the current limitation. The default value is P[9] =32767. When the interval of action of the soft start has been exceeded, the output voltage moves to the value set. The rapidity of the change is set by parameter P[18] (see paragraph on "Slow voltage variations")

The optimal values of parameters P[8] and P[9] depend a great deal on the type of alternator and final application and it must be found through experimentation. An inappropriate setting of parameters P[8] and P[9] could cause failure of the alternator to excite itself.

By way of example, for high power alternators of the ECO46 series, the following settings may be experimented: P[8]=64 and P[9]=16384; for low power alternators of the ECO/ECP3 series, the effects of a reduction of both the duration and limitation of the current may be experimented, such as P[8]=16 and P[9] =4096.

1.3 Slow voltage variations

In the event of rapid variation of the reference, a procedure of "slow" variation has been foreseen: in response to a step variation, parameter P[18] determines the rapidity with which the transition is made.
A value of 1 involves the slowest possible variation; a value exceeding 100 involves an almost immediate variation. The value 0 disables any variation.

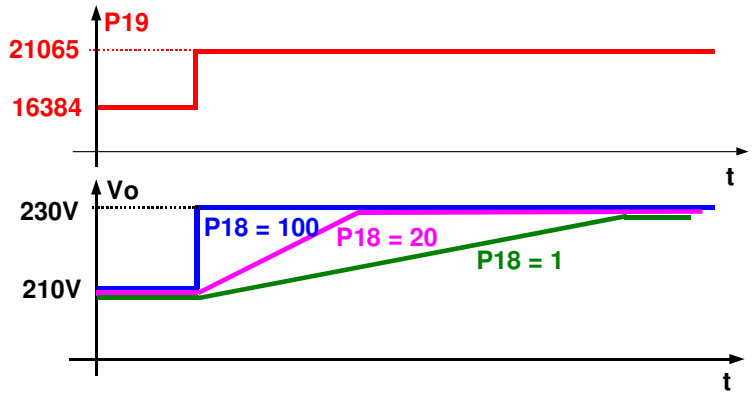


fig. 5

2. Stability

2.1 Adjustment of stability

The proportional gain (to voltage error) of the regulator takes its value either from the position of the **STAB** trimmer, if it has been enabled from the **Configuration** Menu, or from parameter P[20], whose value varies from 0 to 32767. Do not set this trimmer in a position lower than two notches counted counterclockwise.
Integral gain depends on the proportional gain according to the value entered in parameter P[13] (a value of 0 corresponds to an integral gain of nil, while a value of 32767 corresponds to an integral gain commensurate with the proportional one).
Each of the two gains can be multiplied by a coefficient, which can be a value of 1, 2, 4, 8, 16, 32 or 64, according to the value entered in parameter P[11] (for proportional gain) and P[12] (for integral gain). This value represents the exponent assigned to base 2 (fixed) to obtain the desired gain (i.e. parameter P[11] = 4 = > coefficient = 2^4= 16).
The regulator diagram is shown in figure 6.

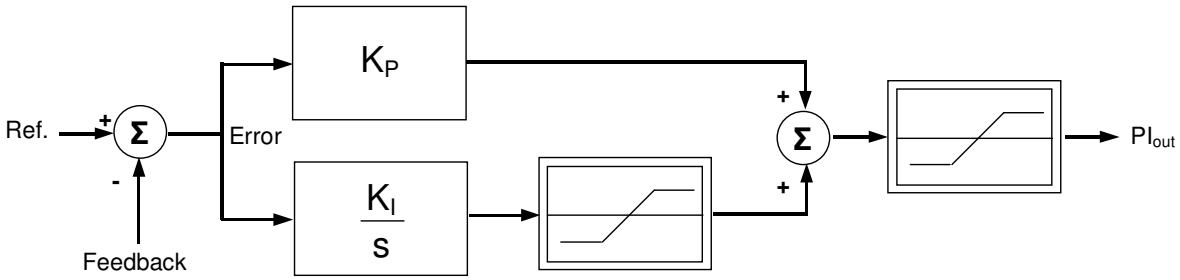


figure 6 : Regulator Diagram

3. EXCITATION OVERCURRENT

3.1 Description

The DER1 regulator is equipped with an excitation (main rotor) winding temperature estimator. An estimate of the temperature is memorised in real time (and can be read) at location L[45]. The progress of the temperature is of the exponential type (see figure 7).

Through parameter P[22] or the AMP trimmer, it is possible to define a limit (which involves intervention of alarm 5) to the excitation voltage and therefore to the temperature.
The function of this alarm is not only to signal an excessive temperature, but it also has an active function in reducing the cause. In fact, an adjustment ring takes control of the voltage generated when the threshold set is exceeded: This reduces the voltage to the point of reducing the excitation current by a value compatible with the ability of thermal dissipation of the machine. The stability of the adjustment in the event of over-excitation alarm can be set with parameters P[28] and P[29]. The default values are suitable for the great majority of machines.

If the magnetic gain of the alternator is high, unstable situations can be created upon intervention of the protection, therefore it is necessary to adjust parameters P[28] and P [29] (in general it is sufficient to lower parameter P[28]).

As you can see in figure 7, when the estimated temperature (represented by the continuous line) reaches the threshold value set in parameter P[22], the reduction of excitation current (and consequent drop in voltage generated) brings about the stabilisation of the temperature near a limit value.

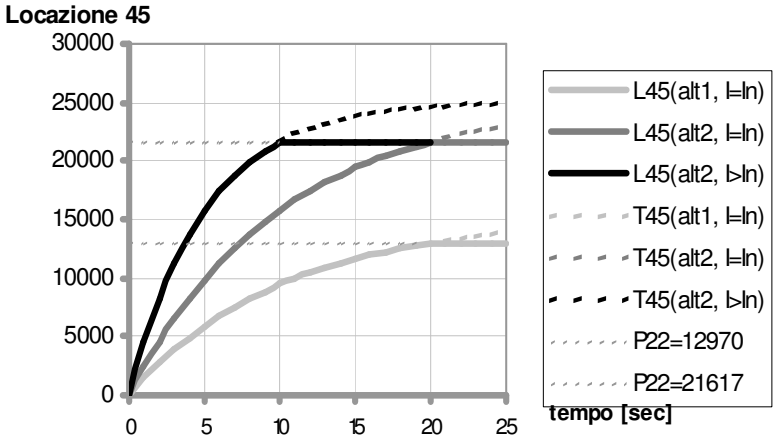


fig. 7

Curve Description

L[45] (alt1, I=In) : value read at location L[45] with a certain alternator (1)
L[45] (alt2, I=In) : value read at location L[45] with a second alternator of a different type (1)
L[45] (alt2, I>In) : value read at location L[45] with the second alternator during overloading (2)
T[45] (alt1, I=In) : value that would be read at location L[45]with the first alternator, without protection (1)
T[45] (alt2, I=In) : value that would be read at location L[45] with the second alternator, without protection (1)
T[45] (alt2, I>In) : value that would be read at location L[45] with the second alternator during overloading, without protection (2).
P[22]=12970 : value that must be entered at parameter P[22] for the first alternator
P[22]=21617 : value that must be entered at parameter P[22] for the second alternator

(1) at the nominal charge and frequency, amounting to 90% of the nominal value
(2) with a charge greater than the nominal load.

3.2 Calibration with a supervising unit

Use the following procedure in order to calibrate the overload protection:
1) Lower the underspeed protection threshold, rotating the Hz trimmer counter clockwise (if it has been enabled from the **Configuration** Menu) or by entering 0 at parameter P[21].
2) Rotate the AMP trimmer completely in the clockwise direction (if it has been enabled from the **Configuration** Menu) or enter 32767 at parameter P[21].
3) Apply the nominal load to the alternator.
4) Decrease the speed by 10%
5) Read the value shown at location L[45], two minutes after reducing the speed.
6) If the AMP trimmer is enabled, rotate it counter clockwise until the value shown at location 35 becomes the same as the value read at point 5 (location L[45]); otherwise (trimmer not enabled) enter the value read at point 5 (location L[45]) at parameter P[22].
7) Alarm 5 should come on (visible from both the DSR Terminal control panel and because there is a change in the flashing indicator light) and the voltage should start to drop.
8) By going back to the nominal speed, alarm 5 should disappear in a few seconds and the voltage of the generator should increase to the nominal value.

3.3 Calibration without a supervising unit

NOTE: This calibration can be performed only if the AMP trimmer has been previously enabled.
Use the following procedure in order to calibrate the overload protection:
1) Rotate the Hz trimmer entirely in the counter clockwise direction
2) Apply the nominal load to the alternator.
3) Decrease the speed by 10%

4) Two minutes later slowly rotate the AMP trimmer in the counter clockwise direction until there should be a decrease in the voltage value of the generator and alarm 5 should come on (visible due to a change in the flashing indicator light) .
5) Under these conditions, adjust the AMP trimmer, until the output voltage value is 97% of the nominal value: alarm 5 is still activated.
6) Return to the nominal speed; alarm 5 should disappear in a few seconds and the generator voltage should increase to the nominal value.
7) Adjust the trimmer as indicated in the following paragraph.

4. Underspeed

4.1 Description

For speeds lower than a programmable threshold, the machine voltage is no longer constant, but is regulated proportionately with the frequency at a ratio, which is also programmable, as shown in figure 8. The intervention threshold depends upon:

- the status of jumper 50/60 (terminals 25 and 26) if enabled from the **Configuration** Menu.
- the status of the 50/60 setting in the **Configuration** Menu
- the position of the Hz trimmer if enabled from the **Configuration** Menu
- the value entered at parameter P[21]

Activation of the function with voltage proportionate to the frequency is signalled by activation of alarm 6 (visible from the DSR Terminal control panel and due to a change in the flashing indicator light).

Parameter P[21](equivalent to the Hz trimmer) sets the Underspeed protection intervention threshold; if this is set on 16384, the protection cuts in at 45 Hz (if the 50/60 jumper and 50/60 flag in the Configuration Menu are not present) or at 54 Hz (if the 50/60 jumper is enabled or the 50/60 flag is active in the Configuration Menu). Values between 0 and 16384 proportionately lower the threshold, respectively to 40 Hz and 48 Hz; values between 16384 and 32767 proportionately raise the threshold, respectively to 50 Hz and 60 Hz.

Once the underspeed protection has intervened, the frequency is proportionately reduced, as indicated in figure 8. **Parameter P[23]** sets the slope of the voltage/frequency curve; the default value is 9000. An increase in the value of P[23] involves a greater reduction of the voltage as a function of the reduction in frequency. A decrease in the value of P[23] involves a lower reduction of the voltage until the limit of P[23] =0, which means that there is no reduction in voltage.

WARNING: Overheating could occur, which is dangerous for the machine, if the voltage is not lowered enough to decrease the excitation when the alternator is functioning at a reduced speed.

4.2 Calibration with a supervision unit

Use the following procedure in order to calibrate the underspeed protection:
1) If the machine has to operate at 60 Hz, make sure the bridge, between terminals 25 and 26 of connector CN1, is inserted, if it is enabled from the **Configuration** Menu, or activate 50/60 from the same menu.
2) If the Hz trimmer is enabled, the value of the protection intervention threshold is read at location L[34], otherwise it is entered directly at parameter P[21].
   The value 16384 entered at parameter P[21] (or read at location L[34]) corresponds to an intervention at 45/54 Hz (depending on whether 50/60 is activated or not).
   Values between 0 and 16384 correspond to an intervention that varies from 40/48 Hz to 45/54Hz.
   Values between 16384 and 32767 correspond to an intervention that varies from 45/54 Hz to 50/60Hz.
3) When the speed drops below the threshold value, generator voltage begins to drop and the alarm is shown simultaneously through the indicator light and DSR Terminal control panel.
4) By increasing speed, the generator voltage will normalise and the 6 alarm will disappear.

4.3 Calibration without a supervision unit

NOTE: This calibration can be performed only if the Hz trimmer and 50/60 jumper have been previously enabled.
Use the following procedure in order to calibrate the under speed protection:
1) Rotate the Hz trimmer entirely in the counter clockwise direction.
2) If the machine has to operate at 60 Hz, ensure that the bridge is inserted between terminals 25 and 26
3) Bring the generator to 90% of the nominal speed.

4) Slowly turn the “Hz” trimmer, rotating it clockwise until the generator voltage begins to drop and ascertain that the indicator light simultaneously begins flashing rapidly.
5) By increasing speed, the generator voltage will normalise and the alarm will disappear.
6) Set the speed to the nominal value

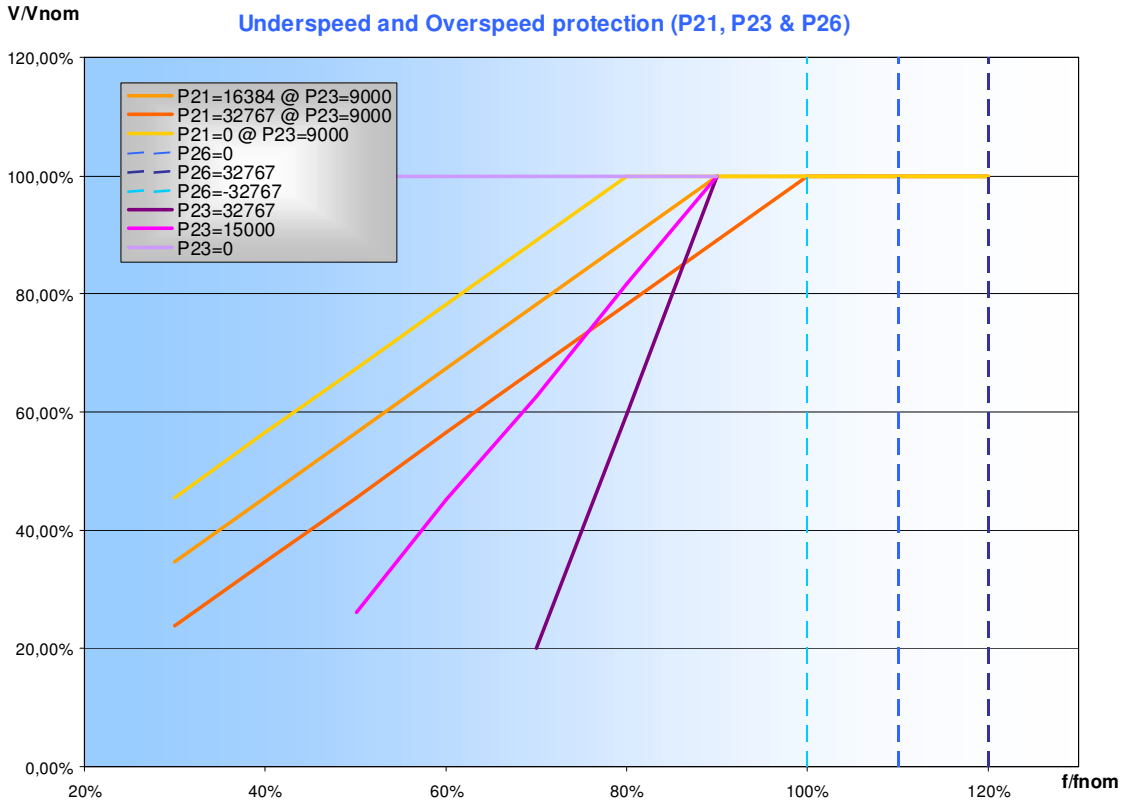


fig. 8: Parameters 21, 23 and 26

5. Overspeed

Parameter P[26] sets the overspeed alarm intervention threshold; if it is set on 0, the signal cuts in at 55 Hz (if the 50/60 jumper and 50/60 setting in the Configuration Menu are absent) or at 66Hz (if the 50/60 jumper is present and enabled or the 50/60 flag in the Configuration Menu is activated). Values between 65535 (-1) and 32768 (-32767) lower the threshold proportionately to 50 Hz and 60 Hz, respectively; values between 0 and 32767 raise the threshold proportionately, respectively to 60 Hz and 72 Hz; refer to the broken lines in figure 8.

6. Other parameters

6.1 Vout / Vaux Ratio

In order to guarantee sufficient feeding voltage at speeds lower than the Hz protection intervention threshold, a limit to the reduction of voltage has been foreseen, as a function of frequency.
The limit concerns regulated voltage (Vout). Should the DER1 be powered through an auxiliary winding, it must be born in mind that the voltage generated by the winding (Vaux) may not have the same Vout value; Vaux is considered proportionate to Vout and the proportional coefficient is determined by **parameter P [14].**
If the DER1 is powered directly by the regulated phase, parameter 14 should be set on 0; in case it is powered by auxiliary winding or PMG, the voltage (Vaux) must be measured, in no-load conditions and with output voltage regulated on the nominal value (Vout); the value of parameter P[14] can be obtained with the following formula:

$$P[14] = 32767 \cdot \left(\frac{Vout}{Vaux} - 1 \right)$$

6.2 V/F slope at start up

Parameter P[24] sets the slope proper voltage / frequency at start up. After the underspeed alarm frequency threshold has been exceeded (set by parameter P[21] or by the Hz trimmer), the work ramp is used (parameter P[23]).
The default value is 6000; an increase in the value of P[24] will cause a greater reduction of low frequency voltage; a decrease in the value of P[24] will cause a lower reduction in voltage, up to the limit of P[24]=0, which means that no reduction in voltage will take place.

WARNING: If the voltage is not lowered enough with low frequency and the alternator is operating in these points, overheating could develop that is dangerous for the machine.

6.3 Short circuit time

Parameter P[25] defines the operating time with the alternator short circuited, which is expressed in tenths of a second (from 0.1 seconds to 25.5 seconds); after this period of time the regulator goes to the blocked status; a value of 0 disables the blockage.

CONTROLLING OF REGULATOR ALARMS

TABLE 12 : ALARMS LIST		
N.	**Description of event**	**Action**
1	Checksum EEprom	Reset default data - Blockage
2	Over voltage (at rated speed)	APO
3	Under voltage (at rated speed)	APO
4	Short circuit	APO, Maximum current - Blockage
5	Excitation Overcurrent	APO, Reduction of excitation current
6	Underspeed	APO, V/F Ramp
7	Overspeed	APO

The status of active alarms is stored at location L[38], which can be read with the serial connection.
The index of bits that have a value of 1 corresponds to the active alarm. If the regulator is correctly working (no alarm active) the bit 11 will be high.

TABLE 13 : ALARM FLAGS AT LOCATION L[38]															
Location L[38] (third "STATUS" box)															
B_{15}	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
32768	16384	8192	4096	2048	1024	512	256	128	**64**	**32**	**16**	**8**	**4**	**2**	1
				A12	A11	A10	A9	A8	**A7**	**A6**	**A5**	**A4**	**A3**	**A2**	A1
J50/60	-	Reserved	Reserved	OK	-	-	-	-	Over	Under speed	Over Excitation	Short	Under	Over	Check sum

Example:
Location 38 = 48 = 0000000000110000_2 : it means that Bits B5 and B4 are at 1, therefore alarms A6 and A5 are active.

1. Alarm signals with the indicator lights

During normal operation and a duty cycle of 50% (OK in fig. 9) an indicator light mounted on the board flashes every 2 seconds; it flashes differently in the event of intervention or alarm, as indicated in fig. 9.

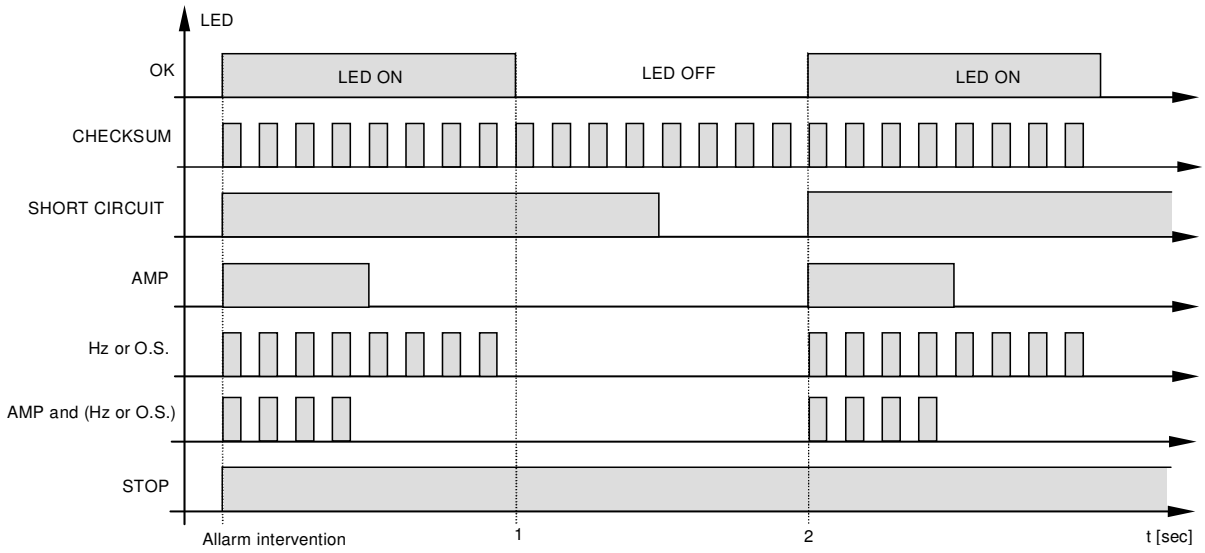
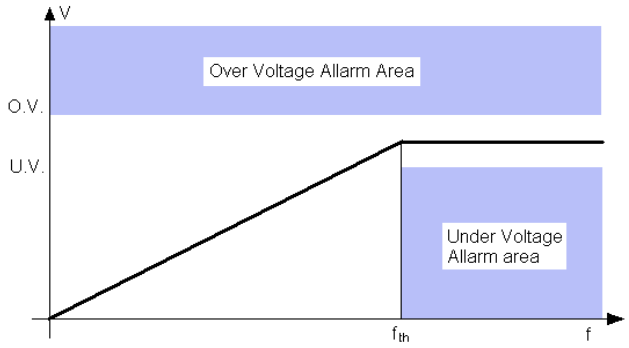


fig. 9

2. Description of alarms

TABELLA 14 : DESCRIPTION OF ALARMS		
N.	**Description of event**	**Action**
1	EEPROM checksum	Verified upon start up (after DSP reset and initialisation of the peripheral). The actions undertaken are: signalling, locating of default settings, saving in EPPROM and regulator blockage. When the machine is switched on again, if the EEPROM is damaged, the alarm will be repeated. Otherwise the regulator will begin to function with default parameters.
2	Over Voltage	The alarm is not visualised by the LED, it activates the APO output and is memorised. This can be caused by abnormal operating conditions (such as overspeed or overloading) or by a breakdown of the regulator. The over voltage alarm is activated if the output voltage is lost. The over voltage is calculated using an opportune template, as a function of the speed and is inhibited during transition, for 2 seconds. In the template for the calculation the threshold is set at 5% above the nominal value. 
3	Under voltage	The alarm is not visualised by the LED, it activates the APO output and is memorised. The under voltage is calculated using an opportune template as a function of the speed (which can be seen in the description of the over voltage alarm); in the template for the calculation the threshold is set at under 5% the nominal value. It intervenes only above the underspeed alarm threshold; it is practically inhibited by this. It is also inhibited in the ent of intervention of the Excitation over voltage and during transients.
4	Short circuit	The alarm is disabled under 20 Hz, is visualised upon activation of the action and memorised. Tolerated short circuit time goes from 0,1 to 25,5 seconds (programmable in 100 ms steps); then the regulator is blocked after saving DD and TT and signals the STOP status. With the time in short circuit set on zero, the blockage is disabled. The STOP condition causes a fall in excitation, with consequent switching off and successive restarting of the regulator and therefore repetition of the cycle.
5	Excitation Overcurrent	The function of this alarm is not only to signal an excessive temperature, but it also has an active function in reducing the cause. In fact, there is an adjustment ring that takes control of voltage after the threshold has been exceeded; the action involves reduction of the excitation current and therefore output voltage.The available parameter is the "current threshold", which determines the balanced value at which the system is stabilised. The alarm is signalled and stored. For calibration see the paragraph on excitation overcurrent.
6	Underspeed	Signalling (immediate) and activation of the V/F ramp. This alarm also appears when the machine is started and stopped. The alarm is not saved among EEPROM data. The alarm intervention threshold depends upon the status of the 50/60 jumper (hardware or software) and on the position of the Hz trimmer or the value of parameter P[21]. Under the threshold the V/F ramp is active.
7	Overspeed	This is visualised in the same manner as the underspeed alarm and does not involve actions on control, but the alarm is stored. The overspeed condition may provoke an over voltage as in the case of capacitive load. The threshold can be set with parameter P[26].

NOTE: Though the voltage is continuously regulated, the DER1 will switch off if the frequency goes under 20Hz. To reset the system it is necessary to stop completely the alternator.

3. APO output

The APO output (Active Protection Output-open collector transistor - terminals 23 and 24 is normally open during normal operation. It closes (with a programmable delay between 0 to 15 seconds) when, among all the alarms, one or more than one, separately selectable, is active.
The selection of which alarms involve the activation of the APO depends on the value entered at parameter P[17].
The transistor is also open when no alarm is activated and with the alarm active, the corresponding enabling bit is set on 0.
The value to set at parameter P[17] is made up of two parts: one allows selection of the alarms that activate the contact, while the other permits setting of the delay for intervention. Use the following procedure to calculate the value to set at parameter P[17]:

a) With reference to table 15 add up the decimal numbers corresponding to the alarms for which the APO must be activated, obtaining a number, "B". (Example: since it is desired to activate the APO in the case of over voltage and overspeed, the formula is B = 2 + 64 = 66)
b) Multiply the delay it is desired to set (whole numbers from 0 to 15 seconds) for the fixed value of 4096. The number A= (0..15) * 4096 is obtained. (Example: since a delay of 5 seconds is required, the formula is obtained A = 5 * 4096 = 20480).

The sum of A + B must be entered at parameter P[17] (in the previous example 20480 + 66 = 20546).

TABLE 15 : ALARM SETTINGS THAT ACT ON THE APO

A12	A11	A10	A9	A8	**A7**	**A6**	**A5**	**A4**	**A3**	**A2**
-	-	-	-	-	Overspeed	Underspeed	Over Excitation	Short	Under voltage	Over voltage
2048	1024	512	256	128	**64**	**32**	**16**	**8**	**4**	**2**

4. DSR operation time

If the regulator is working correctly (no alarm) A12 will be active and the bit 11 will be High at location L [38].
When we see one alarm, the A12 is deactivated, bit 11 is reset at location L[38] and operation time is stored.
The total operation time of the regulator is obtained, after the download of the alarms, by adding all the times TT (last column of the file .alr).
For the procedure please refers to the function "Download Alarm" at the paragraph "Description of function" of chapters "USE OF PROGRAMMING AND MONITORING SOFTWARE DSR TERMINAL".

DI1 COMMUNICATIONS UNIT

1. Description

The DI1 interface device (fig. 10) permits connection of the DSR/DER1 digital regulator to a programming and monitoring device, whose functions may include the following:
- Repetition, or visualisation, of the status variable of the generator, even from a remote location
- Setting of single parameters
- Uploading and downloading of settings files
- Status readings (alarms, measured values)
- Readings of information of the alarm memory
- Interface conversion towards other field buses or communications networks

The DI1 interface must be positioned near the DSR or the DER1. The COM connector of the DSR/DER1 regulator is connected to the CN2 connector of the DI1 interface with the special cable supplied by Mecc Alte. The programming and control unit may be made up of a PC, a PLC or other equipment, providing it has at least one of the interfaces of the DI1 device.
The following serial interfaces available on the DI1 communications unit are:

- RS232 without handshake (3 wires) on CN3 connector
- RS485 two wires half duplex on CN4 connector (DTE(1), Tx,RTSRx $\overline{\text{RTS}}$)

The connection between one DER1 regulator and a PC is shown in fig. 12.
When necessary, the DI1 interface permits insertion of the regulator in an RS485 network with other regulators or devices of a different type, but with the same type of bus, as shown in fig. 13.

The DI1 interface also permits isolation of the A.P.O. contact of the regulator : terminal 24 of the DER1 must be connected to terminal 5 of CN1 (as indicated with the dotted line in fig. 11).
Two types of APO insulated contacts are available on connector CN5 (which cannot be used simultaneously):
- Solid state switch, Max. 30V - 100mA (terminals 3 and 4)
- Electro-mechanical switch, 24Vdc/120Vac – 6A(2) (terminals 5, 6 and 7)

WARNING: for the correct operation of the APO insulated contacts, the cable between the COM connector of the DSR/DER1 regulator and the CN2 connector of the DI1 interface MUST be connected.

Nota 1) DTE = Data Terminal Equipment

Nota 2) Current on resistive load

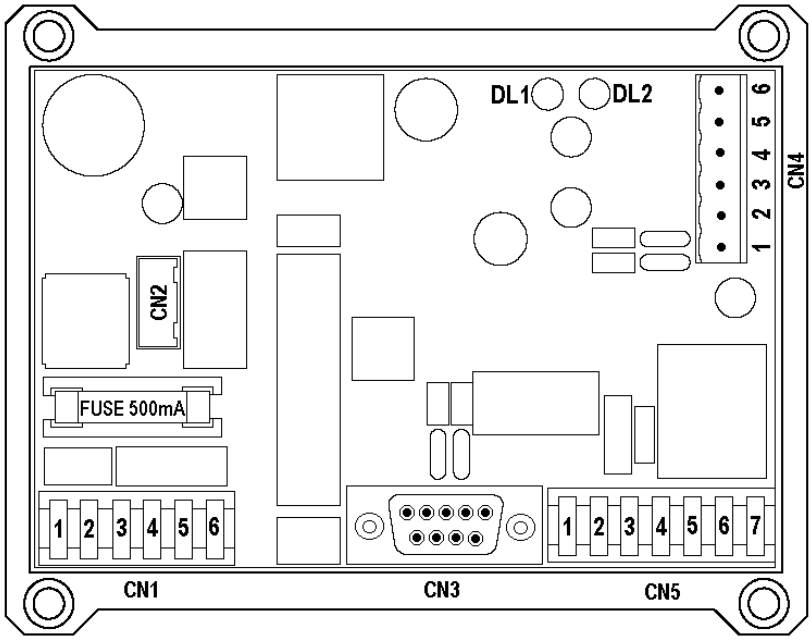


Fig. 10: layout of the DI1 communications interface

2. Powering DI1

The DI1 board must be powered separately :

1) On connector CN1 (terminals 1-2 and 3-4)[(1)] through the same power as the DSR/DER1; for this purpose, the power terminals on CN1 have been duplicated (Fig. 11)
2) On connector CN1 (terminals 1 and 4)[(1)] through a dedicated source (AC: 40V/15Hz - 270V/72Hz or DC: 40V - 380V)
3) Alternatively, on connector CN5 (terminals 1 and 2) through a completely isolated source in DC (9 – 14V).

WARNING: The use of a non-isolated power on connector CN5 may cause communication problems that damage the DSR/DER1 regulator, the DI1 interface and the connected devices.

(1) Power supply protected by 500mA fast acting fuse

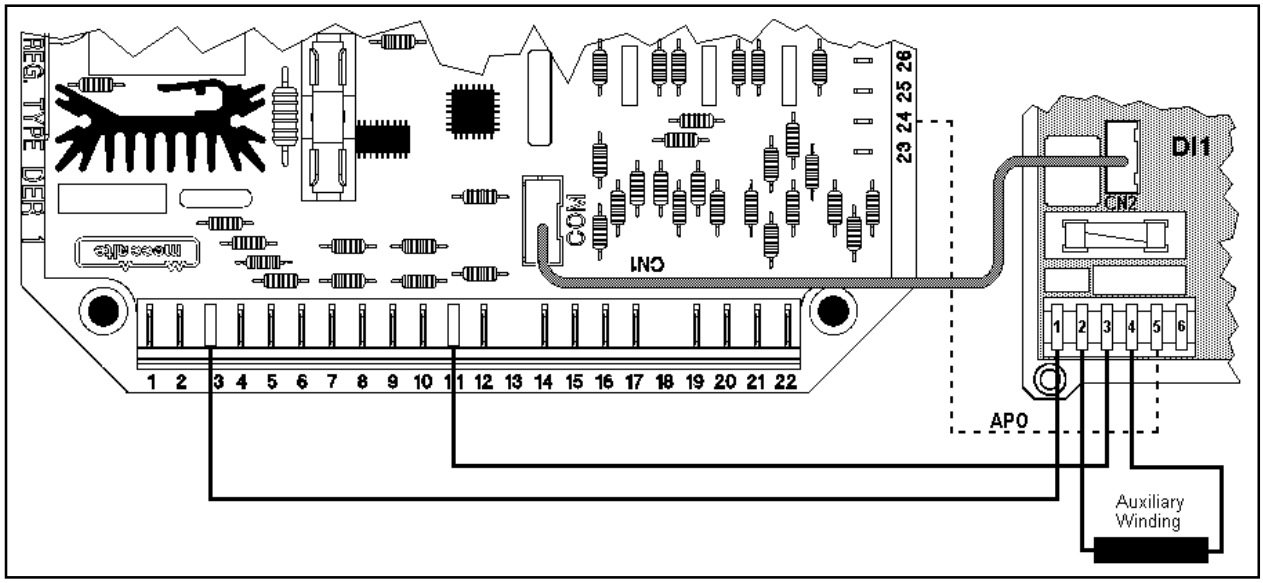


fig. 11: Example of power and connection (optional) of APO signal

3. Inputs and Outputs: Technical Characteristics

TABLE 16: CONNECTOR CN1				
Terminal	**Name**	**Function**	**Specifications**	**Notes**
1	Aux/Exc+	Power	AC voltage: 40V - 270V Frequency: 15Hz - 72Hz\ DC Voltage: 40V - 380V	The terminals are connected together on the board: 1 with 2 and 3 with 4
2	Aux/Exc+			
3	Aux/Neutral			
4	Aux/Neutral			
5	A.P.O.	Active protections input	Voltage: 3,3V	Connection to the APO output of the DSR/DER1 to have the APO output isolated by solid state switch (CN5 3-4) or Relay (CN5 5-6-7)
6	Common			

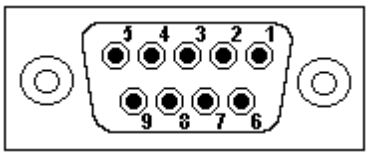
TABLE 17: CONNECTOR CN3				
DIAGRAM	**Pin N°**	**Function**	**Specifications**	**Notes**
	1	-	Not connected	Reading and writing of operational parameters, reading of stored alarms. A standard serial cable may be used with 9 pins SUB-D connectors.
	2	232 - TX	RS232 TX - Insulated	
	3	232 - RX	RS232 RX - Insulated	
	4	-	Not connected	
	5	232/485 GND	Common RS232/RS485 - Insulated	
	6	-	Not connected	
	7	-	Not connected	
SUB-D 9 pin connector, female, top view	8	-	Not connected	
	9	-	Not connected	

TABLE 18: CONNECTOR CN4			
Pin N°	**Name**	**Description**	**Notes**
1	485 A	RS485 channel A - Insulated	The terminals are connected together on the board: 1 with 4, 2 with 5 and 3 with 6 for the realisation of a regulators network (see fig. 13)
2	485 B	RS485 channel B - Insulated	
3	232/485 GND	Common RS232/RS485 - Insulated	
4	485 A	RS485 channel A - Insulated	
5	485 B	RS485 channel B - Insulated	
6	232/485 GND	Common RS232/RS485 - Insulated	

TABLE 19: CONNECTOR CN5				
Terminal	**Name**	**Function**	**Specifications**	**Notes**
1	232/485 GND		Voltage: 9 - 14V Current : 100mA	
2	VDC	External power		
3	APO1		Contact type:Insulated Current: 100mA Voltage: 30V	Do not use as contact if the bridge is inserted between terminals 1 and 3 of CN5
4	APO2			
5	APO-NC	Normally closed, opens with APO active	Contact type:Insulated Current: 6A Voltage DC 24V Voltage AC 120V	Current specifications on resistive load. For use of relay insert a bridge between terminals 1 and 3 of CN5
6	APO-C	Common of relay		
7	APO-NO	Normally open, closes with APO active		

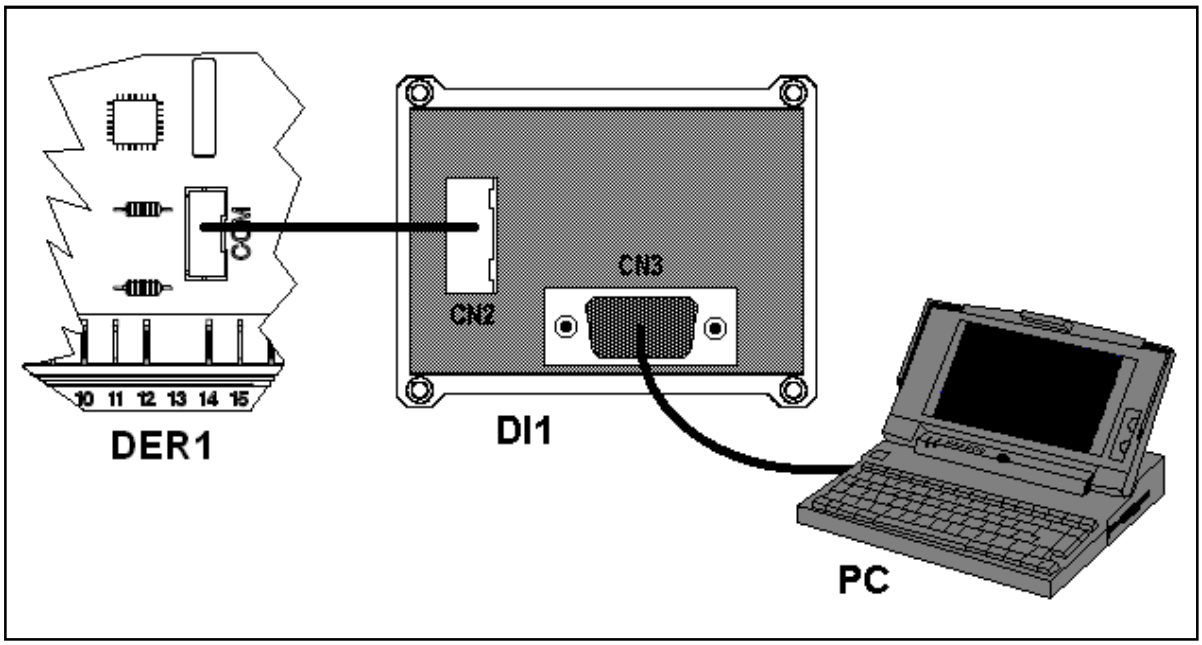


Fig. 12: RS232 connection between one DSR regulator and PC, through DI1 digital interface.

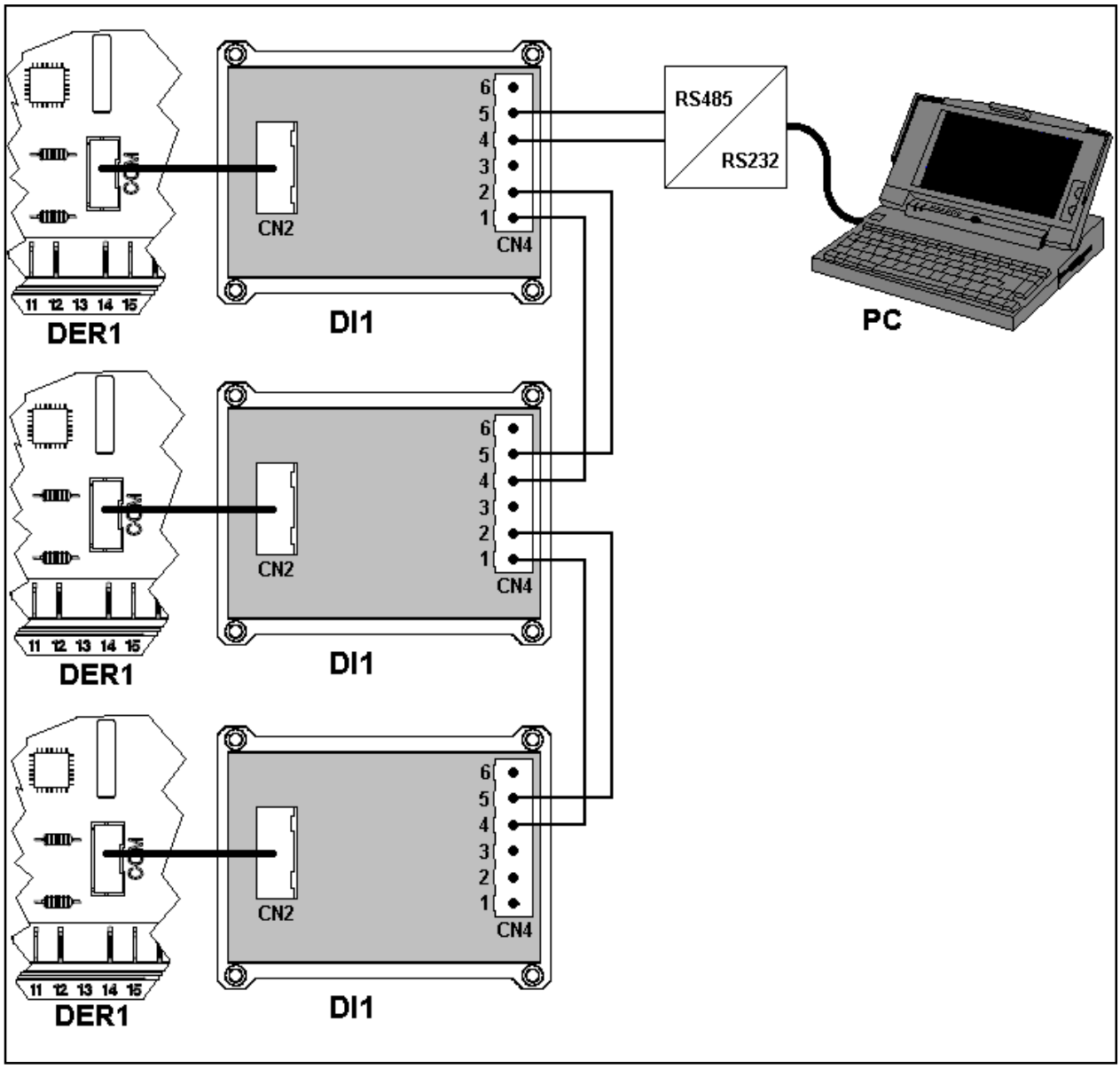


Fig. 13: R485 connection between DSR regulators and PC, through DI1 digital interface.

USE OF PROGRAMMING AND MONITORING SOFTWARE DSR TERMINAL

1. Installation

Run the “install.exe” programme from Windows
This creates the directory ***C:\dsrterm***, with the executable code, and creates the link on the desktop.
Launch the DSR Terminal program from the Windows desktop.
In case of lack of shortcut dsr_terminal.lnk on the desktop, it can be copied from ***C:\dsrterm***

2. Introduction

Upon opening the user interface, the program is presented as indicated in the left part of figure 14.
The connection is confirmed when the indicator ***Connected*** (16) goes from yellow to green.
If the communication takes place without errors, the ***Com STAT*** indicator (15) goes from red to green.

IMPORTANT: The communication may take place only if all three of the indicators ***Connected*** (16) ***Com STAT*** (15) ***and Com ERROR*** (14) are green. The ***ADDRESS*** window indicates the slave address with which it is communicating, almost in real time.

Communication

The ***ComPort*** menu has 2 functions:

1. ***Connect/Disconnect*** activates or deactivates the connection with the slave unit (DSR/DER1 regulator)
2. ***Settings*** opens a window (as shown in figure 11), through which several parameters, concerning communications, can be set:
   - The ***Port*** setting determines which serial port it is intended to use for communications (COM1 or COM2).
   - The parameter ***Slave ADDR*** refers to the device with which it is intended to communicate (location L [1]).
   - The parameter ***Baud*** sets the transmission speed with which the master unit (system supervisor) exchanges data with one or more slave units (digital regulators).

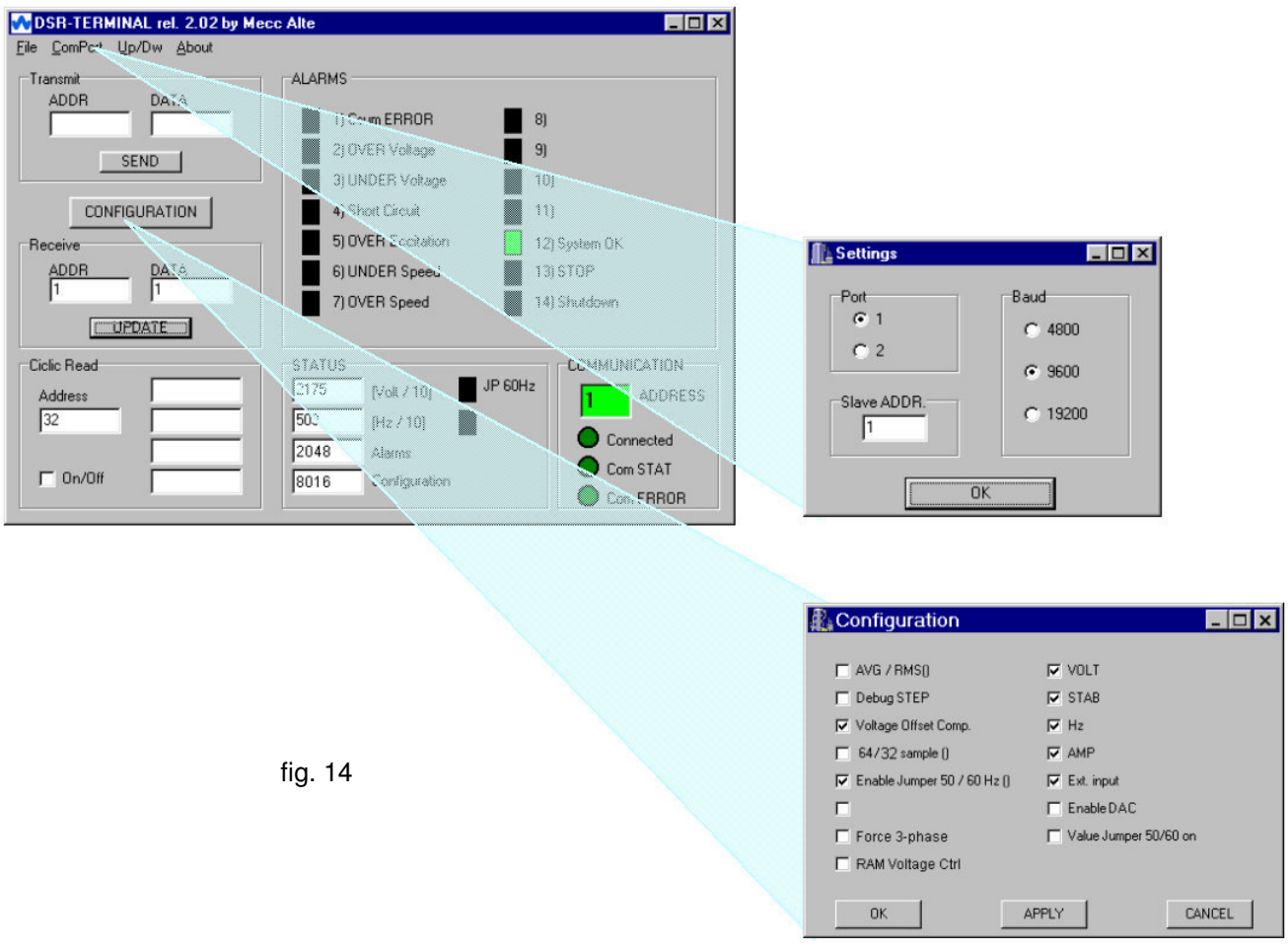


fig. 14

3. Description of Function

The DSR Terminal user Interface is presented as shown in figure 15 and permits programming and monitoring from 1 to 32 slave units connected through serial RS485 or a single unit connected through RS232. The functions available are shown in table 20.
The DSR Terminal user interface is divided into 6 areas with different functions.

Transmit : Handles data transmitted towards slave units (DSR/DER1)

Receive : Displays a single datum requested from slave units (DSR/DER1)

Cyclic Read : Displays, almost in real time, four pieces of information memorised on consecutive locations in the slave unit (DSR/DER1)

STATUS : Displays registries from 36 to 39 (measured voltage, measured frequency, active alarm flags and configurations)

ALARMS : Displays active alarms (alarms and individual word alarm flags are shown in table 13).

COMMUNICATION : Displays the status of communication

The ***Configuration*** Menu

The ***Configuration*** Menu is indicated in figure 16; it permits setting of configuration flags of the DSR/ DER1 regulator (parameter P[10]).

File Menu

The ***File*** Menu presents the single option of Exit, to close the DSR/DER1 Terminal user interface.

Up/Dw Menu

The ***Up/Dw*** Menu is used to load and unload settings files to and from the regulator (which have the extension .dat). The list of parameters is shown in table 6.
There are three possible options:

1. **Upload Data** The “Upload” window opens
   - The key **Open** allows selection of files with the .dat or .set extension, which must be loaded.
   - The **Upload** key unloads the parameters of settings files into the DSR/DER1 regulator; if the file has been opened with the .dat extension, all of the parameters are updated, if the file has been opened with the .set extension, only the parameters from 10 to 30 are updated, leaving those from 0 to 9 unaltered.
   - The key **Done** closes the Upload window
2. **Download Data:** The “DownLoad” window opens
   - The **DownLoad** key transfers the settings files to the personal computer.
   - The key **SaveAll** permits the operator to save the entire settings file (from 0 to 30) with the .dat extension.
   - The key **SaveSettings** allows you to save the file with customised data (parameters from 10 to 30) with the .set extension.
   - The key **Done** closes the DownLoad window.
3. **DownLoad Alarm:** The “DownLoad Alarm” window opens
   - The key **DownLoad** transfers the list of memorised alarms to the personal computer, as many times as the alarms intervened and, for each of them, the duration of the last event and the overall duration.
   - The key **Save** allows the operator to save the alarms file with the .alr extension.
   - The key **Done** closes the DownLoad Alarm window.

The **About** Menu

The **About** Menu signals the current release of the DSR Terminal software.

4. Settings files

These are appropriately formatted text files; each line:

- starts with a number that represents the **address** of the parameter;
- this number must be followed by a **space** as a separating character;
- the space is followed by a number, which represents the **value** of the parameter;
- it is possible to write an **optional text** alongside the value of the parameter, providing it is separated by at lease one **space.**
- In case of upload, only parameters, whose address is present, are modified, the others remain unaltered;
- The entire text that follows the symbol “%” is evaluated as a comment and is not taken into consideration

```
% MECC ALTE S.p.A.
% Digital Regulator for Syncronous Alternators DER1/A
% Settings file
%
% Parameters release:   12
% Alternator type:      ECO40, ECO43, ECO46
% Date:                 25/03/11
% Configuration:         AVG, Offset compensation, 64 samples, 3phase
%                       autosensing, Jp 50/60, Trimmers and Vext enabled
%                       Connected HW JP2 and JP1
%
% ATTENTION:            Refer to DER1 manual for text formatting
%
8  0        Current limit time
9  32767    Current limit level
10 7956     Configuration Word
11 5        Shift to LEFT proportional gain
12 1        Shift to LEFT integral gain
13 26624    Coefficient tying Ki to Kp
14 6000     Vout/Vaux Ratio
15 16384    EEPROM Reference equivalent to Vext
16 4608     Limitation of Vext Variation
17 126       APO delay and alarm settings
18 20        Step limitation reference
19 0         Reference voltage equivalent to VOLT
20 16384     Stability equivalent to STAB
21 16384     Low frequency protection threshold equivalent to Hz
22 16384    Excitation overcurrent threshold equivalent to AMP
23 9000    V/F slope
24 6000    V/F slope at start up
25 20      Short circuit time (in tenths of a second)
26 0       Overspeed threshold
27 6553    Frequency shutdown (6553 -> 20 Hz)
28 12287   Ki Regulator alarm over excitation
29 24575   Kp Regulator alarm over excitation
30 63600   Resistance discharge accumulator over excitation
```

Example of .set file

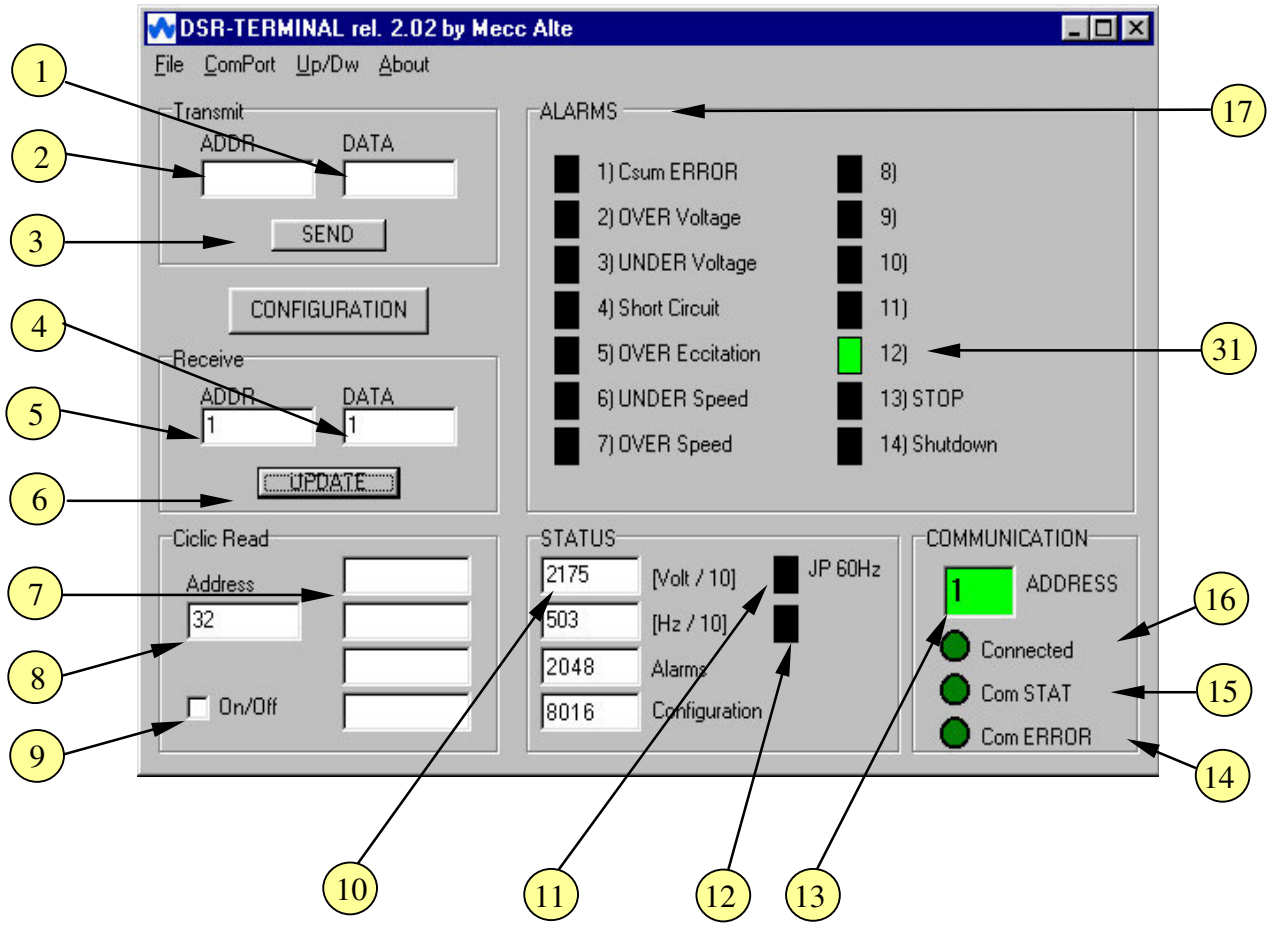


Fig.15 DSR Terminal User Interface

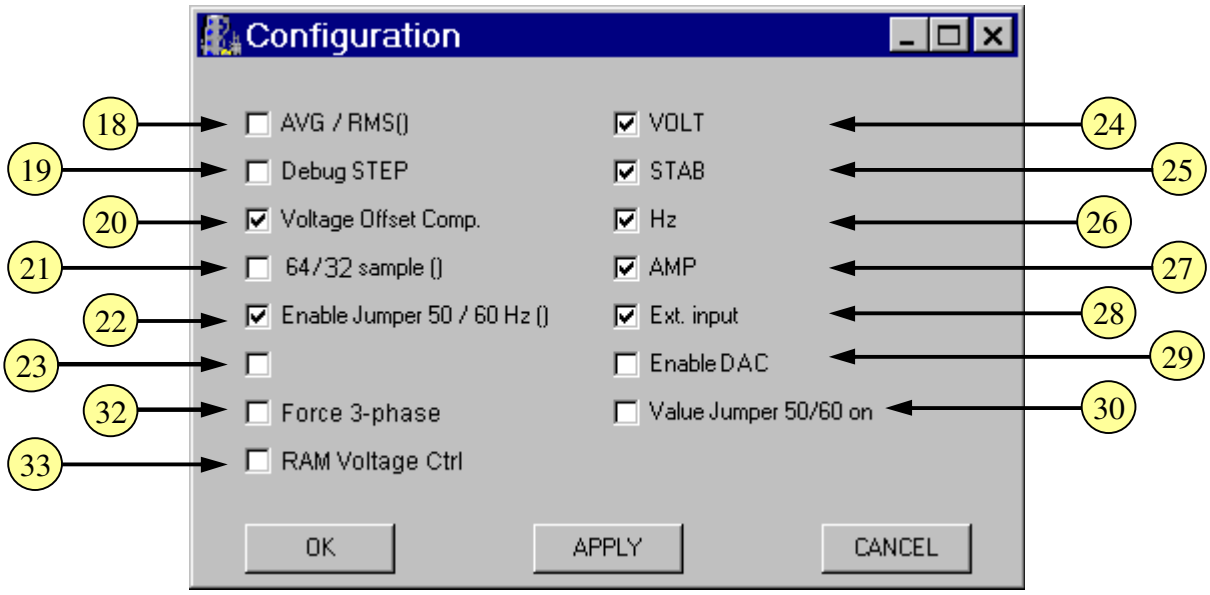


Fig. 16 Configuration Menu

TABLE 20 : FUNCTIONS OF THE MAIN PANEL REV. 2.02 AND CONFIGURATION MENU OF THE DSR TERMINAL	
Ref.	***Description of Function***
1	Value of parameter to be transmitted to the regulator
2	Address of parameter to be transmitted to the regulator
3	Transmission command
4	Value of parameter requested from regulator (updated following command indicated in 6)
5	Address of parameter requested from regulator
6	Updating command
7	Values of 4 parameters allocated to 4 consecutive addresses (starting from the address indicated in 8 included)
8	Address of the first of the 4 parameters requested from the regulator
9	Activation of updating almost in real time
10	Visualisation of the regulator status (voltage, frequency, active alarms, configuration)
11	50/60Hz Jumper inserted
12	Free for future use
13	Address of Slave with which the unit is communicating
14	Communications error (yellow indicator)
15	Connection fault (red indicator)
16	Connection and communications working indicator
17	Active alarms signal
18	Setting the regulation on the RMS value (not active in DER1)
19	Flag activating a periodical variation of reference voltage (for preliminary calibration)
20	Flag activating automatic compensation of the offset in voltage acquisition channels
21	Flag to set sampling on a semi-period (not active in DER1)
22	Flag enabling reading of 50/60 Hz jumper hardware
23	Not used
24	Flag enabling reading of reference voltage by VOLT Trimmer
25	Flag enabling reading of stability parameter by STAB Trimmer
26	Flag enabling reading of underspeed protection threshold by Hz Trimmer
27	Flag enabling reading of excitation current threshold by AMP Trimmer
28	Flag enabling reading of external voltage input
29	Flag enabling DAC
30	Flag to set nominal machine frequency
31	Correct working (starting from revision 11 of the Firmware)
32	Flag forcing the three phase sensing
33	Flag, which enables reading of the location value of L[49] or activates saturation in remote control.