Hazardous Area ATEX & IECEx Certified Power Generation Alternator

Pyroban Zone 2

II 3G

A60411M43G (60 kVA)
A80411M43G (80 kVA)

Installation, Operation and Maintenance Manual

 Document number: OG030 Date of Issue: 22/02/2022 Revision 3
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REVISION HISTORY

ISSUE	DATE	NATURE OF CHANGE
1	27th October 2014	Initial Issue
2	6th April 2016	Removed SIRA certification label Certification Labels amended All labels revised Text added throughout document. Alternator connections section updated Appendices updated and amended Unit dimensions moved from appendices to main body Changed all AVR references to DSR Re-ordered sections Reworded special conditions of use in line with Ex and IECEx certificates. Coupling and additional maintenance information added.
3	22nd February 2022	UKCA marking additions Change protection concept from nA to ec Change of address Addition of Appendix D relating to DER1 AVR Amendments to capture DER1

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REFERENCED DOCUMENTS

Document /Drawing No.	Date	Title
300830106	3/2016	Alternator layout drawing extracts

1 Introduction

The 4 pole alternators are brushless, self-regulating and incorporate a rotating inductor with damper cage winding and a fixed stator with skewed slots.
PT100 temperature sensors are fitted to measure the temperature on each phase winding and on the 2 drive bearings. The stator windings have a shortened pitch to reduce the harmonic content of the output waveform.

The alternators are made in compliance with the 98/37, 73/23, 89/336 CEE directives and their amendments, and the CEI 2-3, EN 60034-1, IEC 34-1, VDE 0530, BS4999-5000 regulations.

The robust mechanical construction gives good access to the alternator output connections, and allows the user to inspect the various components with ease. The casing is made of aluminium alloy, the shields of cast iron, and the rotor shaft of C45 steel and it has a keyed fan.

The mechanical protection level meets standard IP54. Insulation materials meet Class H requirements, and all rotating components are epoxy resin impregnated; higher voltage parts, such as the stators, are vacuum-treated.

The 12 wire output connections must comply with the Series Star arrangement.

Figure 1 - Alternator General Features

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2 Safety

Only suitably trained and competent personnel may carry out installations, maintenance or repair work on Pyroban equipment.

The component parts supplied must be installed correctly and the complete installation approved by the Person in Authority before the equipment is used in a hazardous area.

The units are suitable for use in hazardous areas when installed, maintained and inspected in accordance with EN60079-14:2014, EN60079-19:2019 and EN60079-17:2014 respectively, as well as Machinery Directive 2006/42/EC. Parts must only be used as described in this manual.

Do NOT modify any part without authorisation from Pyroban. Failure to observe any instructions in this manual may invalidate any certificate or warranty agreement.

Most of the components described in this manual are of special manufacture either in duty or specification, but for specific applications consult the Pyroban Customer Services Department.

Only genuine Pyroban parts should be used for replacements.

2.1 Safety Points

All personnel are expected to use safe working practices and to observe all relevant safety requirements and regulations, relevant to the country or locality in which the equipment is being used.

The following safety precautions must be observed, where applicable:

- Read and understand all warning, caution, prohibition and mandatory notices and labels on the equipment before operating or carrying out any maintenance or servicing.
- Do not operate the equipment until you have read and implemented the instructions in this manual and its appendices.
- Do not perform maintenance while the engine is running.
- Do not perform any servicing or maintenance on this equipment until you have read and understood the instructions in the maintenance sections of this manual.
- When safety equipment has been installed or serviced it must be checked and approved by the Person in Authority before placing it in service.
- Ensure that all operators, maintenance and service personnel are adequately trained, have the relevant experience or are under supervision of someone qualified for the task. Pyroban offer servicing and operator training.

- Pressure systems must be installed, tested and maintained in accordance with applicable regulations specific to the country or locality the equipment is operated in.
- Protection devices must be periodically tested to determine that they are in satisfactory operating condition. Pyroban operates a component service exchange scheme.
- Installation and initial inspection should be performed in accordance with EN 60079-14:2014 and EN60079-17:2014 respectively, also the Machinery Directive 2006/42/EC.
- Scheduled inspection and maintenance should be performed in accordance with EN 60079-17:2014 and Machinery Directive 2006/42/EC.
- Repair, overhaul and reclamation should be performed in accordance with EN 60079-19:2019 and Machinery Directive 2006/42/EC.
- Ensure the equipment has adequate lighting during operation.

2.2 Loading Constraints

1. Each phase of the alternator should be loaded to a maximum of 1/3 of the total continuous rated load at 0.8 power factor.
2. A maximum transient overload of 3 times rated load on any phase is permitted for a maximum period of 20 seconds, to facilitate motor starting conditions.
3. The Pyroban machine is fitted with 3 phase sensing which permits a maximum 60% load unbalance between phases.
4. Variable loading between phases including single phase loads is permissible with the caveat of condition 1.

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3 Certifications and Ratings

3.1 Certification

This machine is certified to the following ratings via the referenced certificates:

ATEX : Ex ec IIC T3 Gc IP54: ATEX Certificate No. ITS12ATEX47498X
IECEx : Ex ec IIC T3 Gc IP54: IECEx Certificate No. IECEx.ITS12.0006X
UKCA: Ex ec IIC T3 Gc IP54: UKEX Certificate No. ITS21UKEX0394X

It achieves its Ex Zone 2 capability via Ex e Increased safety protection.

It is certified for use in ambient temperatures from **-20° C to +60° C.**

⚠ WARNING

3.1.1 Special Conditions of Safe Use

1. Any gaskets breached during a maintenance procedure shall be replaced.
2. The equipment must be mounted with the rotor in the horizontal plane.
3. 12 wire output connections must comply with the Series Star arrangement.
4. The output cables and auxiliary supply must be provided with electrical isolation by the final installation owner.
5. Only connections in the terminal box are user-serviceable and ensure machine has cooled down for 15 minutes before any maintenance can begin.
6. Customers load and neutral terminal cables should have a minimum conductor cross sectional area of 25 mm² (A60411M43G) or 35 mm² (A80411M43G). They should also be rated for a minimum temperature of 100°C, with a minimum of 1 mm thick solid insulation along the full length of the conductor up to the terminal block.
7. The customer cables must use Cembre A5-M12 or A7-M12 ring terminals respectively at the connection points to the terminal block. Refer 'Load Connection' in section 7.4, Figure 25.
8. The control modules shall be situated in the non-hazardous area.
9. For A60411M43G, a nominal load rating of 60kVA @ 40°C/380V_{rms}/1000m ASL/50Hz. For ratings at other conditions refer to the manual and appendices.
   For A80411M43G, a nominal load rating of 80kVA @ 40°C/380V_{rms}/1000m ASL/50Hz. For ratings at other conditions refer to the manual and appendices.

⚠ WARNING

NOTE THAT THE DRIVE END MOUNTING SAE 4 FLANGE REQUIRES ALL 12 SCREWS M10 X 1.5 TO BE FITTED TO PROVIDE SEALING AS THESE ARE THROUGH HOLES (REFER TO Figure 19).

3.2 Ratings

The equipment is designed to deliver 3 phase L – L output voltages as follows for the 60kVA unit :

380V rms @ 50Hz - Maximum applied total load = 60kVA @ 0.8
400V rms @ 50Hz - Maximum applied total load = 60kVA @ 0.8
415V rms @ 50Hz - Maximum applied total load = 60kVA @ 0.8
440V rms @ 50Hz - Maximum applied total load = 49kVA @ 0.8
415V rms @ 60Hz - Maximum applied total load = 66kVA @ 0.8
440V rms @ 60Hz - Maximum applied total load = 72kVA @ 0.8
460V rms @ 60Hz - Maximum applied total load = 72kVA @ 0.8
480V rms @ 60Hz - Maximum applied total load = 72kVA @ 0.8

And for the 80kVA unit :

380V rms @ 50Hz - Maximum applied total load = 80kVA @ 0.8
400V rms @ 50Hz - Maximum applied total load = 80kVA @ 0.8
415V rms @ 50Hz - Maximum applied total load = 80kVA @ 0.8
440V rms @ 50Hz - Maximum applied total load = 67kVA @ 0.8
415V rms @ 60Hz - Maximum applied total load = 80kVA @ 0.8
440V rms @ 60Hz - Maximum applied total load = 90kVA @ 0.8
460V rms @ 60Hz - Maximum applied total load = 96kVA @ 0.8
480V rms @ 60Hz - Maximum applied total load = 96kVA @ 0.8

Operation of the system outside these voltages may impair the hazardous area certification.

For ambient temperature and altitude operational derates refer to section 3.4.

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3.3 Output Ratings

3.3.1 A60411M43G

Electrical Characteristics									
Frequency		Hz	50				60			
Voltage (series star)		V	380	400	415	440	415	440	460	480
Rated power class H		kVA	60	60	60	49	66	72	72	72
		kW	48	48	48	39,2	52,8	57,6	57,6	57,6
Rated power class F		kVA	54	54	54	45	60	65	65	65
		kW	43,2	43,2	43,2	36	48	52	52	52
Regulation with		UVR6	±1% with any power factor and speed variations between -5% +30%							
Insulation class			H							
Execution			Brushless							
Stator winding			12 ends							
Rotor			with damping cage							
Efficiencies class F	4/4	%	88,9	89	88,7	88,5	89,8	90,3	90,4	90,5
(see graph. for details)	3/4	%	87,2	87,5	87,4	87,1	88,5	88,7	88,8	89
	2/4	%	85,9	86	86	85,8	86,7	86,8	86,9	87
	1/4	%	84,7	84,5	84,3	84,3	85,7	85,7	85,7	85,5
Reactances (f. l.cl. F)	Xd	%	145,2	131	121,7	88,4	160,6	155,9	142,6	131
	Xd'	%	11,1	10,0	9,3	6,7	12,3	11,9	10,9	10,0
	Xd"	%	3,5	3,2	3,0	2,2	3,9	3,8	3,5	3,2
	Xq	%	94,7	85,5	79,4	57,7	104,8	101,8	93,1	85,5
	Xq'	%	94,7	85,5	79,4	57,7	104,8	101,8	93,1	85,5
	Xq"	%	19,7	17,8	16,5	12,0	21,8	21,2	19,4	17,8
	X_2	%	11,7	10,6	9,8	7,2	13,0	12,6	11,5	10,6
	X_0	%	0,8	0,7	0,7	0,5	0,9	0,9	0,8	0,7
Short Circuit Ratio	Kcc		0,72	0,82	1,07	1,57	0,56	0,61	0,72	0,82
Time Constants	Td'	sec.	0,0393							
	Td"	sec.	0,0055							
	Tdo'	sec.	1,70							
	Tα	sec.	0,0146							
Short Circuit Current Capacity		%	>400				>450			
Excitation at no load		Amp.	0,5	0,6	0,8	1,1	0,2	0,3	0,4	0,5
Excitation at full load		Amp.	1,3	1,35	1,4	1,8	1,3	1,35	1,4	1,5
Overload (long-term)		%	1 hour in a 6 hours period 110% rated load							
Overload per 20 sec.		%	300							
Stator Winding Resistance (20°C)		Ω	0,02							
Rotor Winding Resistance (20°C)		Ω	2,951							
Exciter Resistance (20 °C)		Ω	Rotor : 0,410				Stator : 15,28			
Heat dissipation at f.l.cl.F		W	5394	5339	5503	4678	5452	5586	5522	5459
Telephone Interference			FHT < 2%				TIF < 40			
Radio interference			VDE 0875 N. For others standards apply to factory							
Waveform Distors.(THD) at f. load		LL/LN %	1,8 / 1,9							
Waveform Distors.(THD) at no load		LL/LN %	2,8 / 2,9							
Mechanical characteristics										
Protection			IP 55							
DE bearing			6314.2RS							
NDE bearing			6212.2RS							
Weight of wound stator assembly		kg	126							
Weight of wound rotor assembly		kg	80							
Weight of complete generator		kg	376							
Maximun overspeed		rpm	2250							
Unbalanced magnetic pull at f.l.cl.F		kN/mm	5,1							
Cooling air requirement		m³/min	-				-			
Inertia Constant (H)		sec.	0,1715				0,2047			
Noise level at 1m/7m		dB(A)	-				-			

Figure 2 – 60 kVA Alternator Electrical Characteristics

3.3.2 A80411M43G

Electrical Characteristics									
Frequency		Hz	50				60			
Voltage (series star)		V	380	400	415	440	415	440	460	480
Rated power class H		kVA	80	80	80	67	80	90	96	96
		kW	64	64	64	53,6	64	72	76,8	76,8
Rated power class F		kVA	72	72	72	60	70	80	87	87
		kW	57,6	57,6	57,6	48	56	64	69,6	69,6
Regulation with		UVR6	±1% with any power factor and speed variations between -5% +30%							
Insulation class			H							
Execution			Brushless							
Stator winding			12 ends							
Rotor			with damping cage							
Efficiencies class F	4/4	%	90,9	91	90,7	90,5	92,1	92,6	92,7	92,8
(see graph. for details)	3/4	%	89,7	90	89,9	89,6	91,2	91,4	91,5	91,7
	2/4	%	88,7	88,8	88,8	88,6	89,5	89,6	89,7	89,8
	1/4	%	86,2	86	85,8	85,8	87,2	87,2	87,2	87
Reactances (f. l.cl. F)	Xd	%	141,8	128	118,9	88,6	142,7	142,8	139,4	128
	Xd'	%	8,8	7,9	7,3	5,5	8,8	8,8	8,6	7,9
	Xd"	%	3,7	3,3	3,1	2,3	3,7	3,7	3,6	3,3
	Xq	%	72,1	65,1	60,5	45,1	72,6	72,6	70,9	65,1
	Xq'	%	72,1	65,1	60,5	45,1	72,6	72,6	70,9	65,1
	Xq"	%	15,6	14,1	13,1	9,8	15,7	15,7	15,4	14,1
	X_2	%	9,8	8,8	8,2	6,1	9,8	9,8	9,6	8,8
	X_0	%	1,4	1,3	1,2	0,9	1,4	1,5	1,4	1,3
Short Circuit Ratio	Kcc		0,82	0,90	0,97	1,33	0,72	0,77	0,82	0,90
Time Constants	Td'	sec.	0,0401							
	Td"	sec.	0,0095							
	Tdo'	sec.	1,90							
	Tα	sec.	0,017							
Short Circuit Current Capacity		%	>400				>450			
Excitation at no load		Amp.	0,3	0,48	0,6	0,7	0,2	0,3	0,4	0,5
Excitation at full load		Amp.	1,4	1,45	1,5	1,7	1,15	1,35	1,45	1,65
Overload (long-term)		%	1 hour in a 6 hours period 110% rated load							
Overload per 20 sec.		%	300							
Stator Winding Resistance (20°C)		Ω	0,015							
Rotor Winding Resistance (20°C)		Ω	3,735							
Exciter Resistance (20 °C)		Ω	Rotor : 0,370				Stator : 15,15			
Heat dissipation at f.l.cl.F		W	5766	5697	5906	5039	4803	5114	5481	5400
Telephone Interference			FHT < 2%				TIF < 40			
Radio interference			VDE 0875 N. For others standards apply to factory							
Waveform Distors.(THD) at f. load		LL/LN %	1,7 / 1,8							
Waveform Distors.(THD) at no load		LL/LN %	2,3 / 2,4							
Mechanical characteristics										
Protection			IP 55							
DE bearing			6314.2RS							
NDE bearing			6212.2RS							
Weight of wound stator assembly		kg	168							
Weight of wound rotor assembly		kg	106							
Weight of complete generator		kg	430							
Maximun overspeed		rpm	2250							
Unbalanced magnetic pull at f.l.cl.F		kN/mm	5,6							
Cooling air requirement		m³/min	-				-			
Inertia Constant (H)		sec.	0,1837				0,2197			
Noise level at 1m/7m		dB(A)	-				-			

Figure 3 – 80 kVA Alternator Electrical Characteristics

3.4 Ambient and Altitude Derating

3.4.1 Temperature and Altitude

Ambient temperature and altitude, individually or combined, have an effect on the alternator power available. Temperature may be considered as both the air inlet to the Alternator and also the ambient air around the alternator. When the ambient air or air entering the alternator exceeds 40°C, or 104°F, it becomes necessary to de-rate the output of the alternator. The chart below gives the recommended derate for the higher temperatures.
Higher altitudes also require a derate, specifically when it exceeds 3300 ft., or 1000 meters. Again, please refer to the Altitude deration chart below to determine the necessary derate.

3.4.2 Environmental Concerns

Alternators are often exposed to harmful airborne pollutants, like sand and saltwater which may require some form of protection to reduce or eliminate these harmful agents. Common substances like dirt, gravel or rock dust can create abrasive and potentially damaging effects on the windings of the alternator. While the addition of filters, baffles or housings will certainly help extend the life of the protective insulation, it may be equally effective to overcoat the windings at the point of manufacture. It is also extremely important to recognise that filters and other devices can affect the airflow through the alternator and create additional heat in the windings. It is also important to understand that the use of filters requires a strict maintenance regime.
Pyroban has a variety of insulation treatments which can add years of life to your alternator, and ensure that the windings are protected in these harmful environmental applications. Please refer to our separate technical guide: Insulation Protection Systems for further guidance.

3.4.3 Humidity and Moisture

Another common enemy of the insulation system is high humidity, salt air and moisture. While the windings are certainly protected against these conditions, protection space heaters can be added protection to promote long life and trouble free operation. The location of the unit and operating conditions with proper ventilation are both important considerations when determining what protection is required. Once again, please consult your Pyroban representative for assistance in selecting proper protection and modifications.

	Ambient Temperature (°C)					
Altitude (Meters)	25	40	45	50	55	60
<1000	1.07	1	0.96	0.93	0.91	0.89
1000-1500	1.01	0.96	0.92	0.89	0.87	0.84
1500-2000	0.96	0.91	0.87	0.84	0.83	0.79
2000-3000	0.90	0.85	0.81	0.78	0.76	0.73

Figure 4 - Altitude and Temperature Deration Coefficients

4 Markings (Rating and Safety)

Figure 5 – 60 kVA Alternator Hazardous Area Rating Label

Figure 6 – 80 kVA Alternator Hazardous Area Rating Label

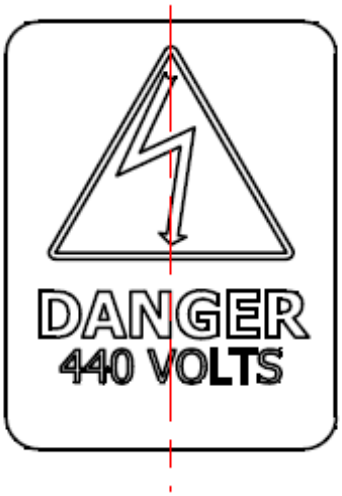

Figure 7 – High Voltage Warning Label

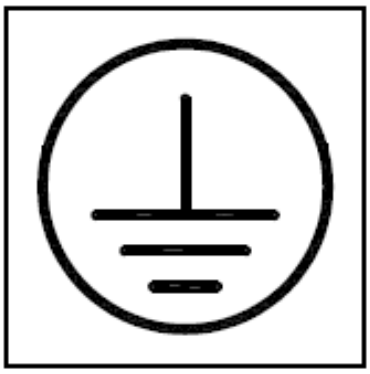

Figure 8 – Earthing Point Label

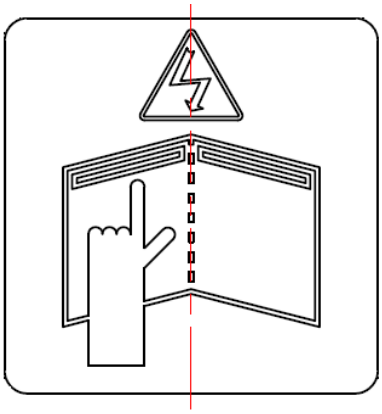

Figure 9 – Consult Manual Warning Label

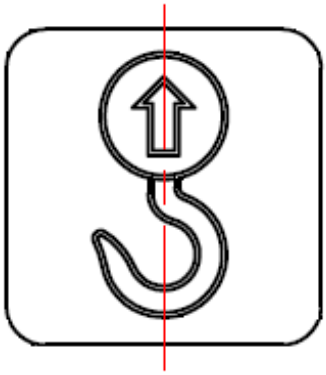

Figure 10 – Lifting Point Warning Label

Figure 11 – Do Not Open Warning Label

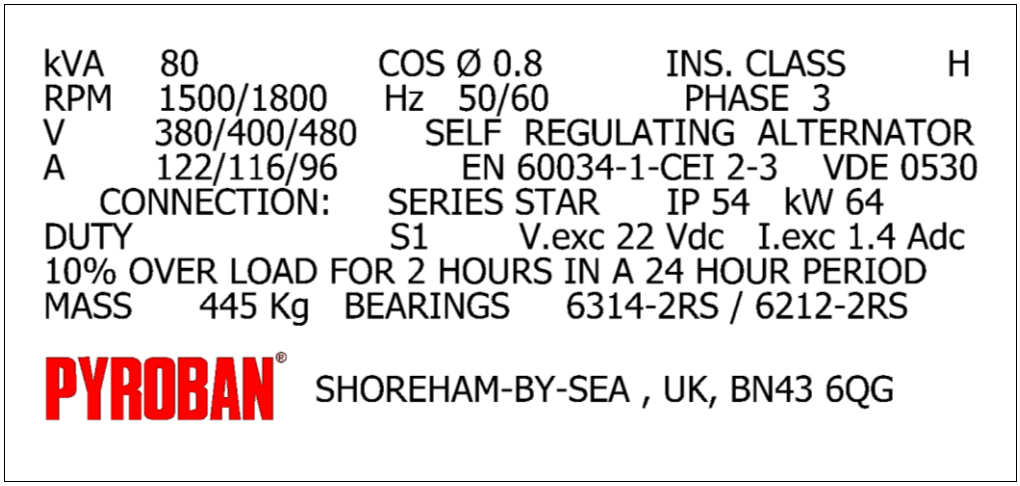

Figure 12 – 80 kVA Alternator Power Rating Label

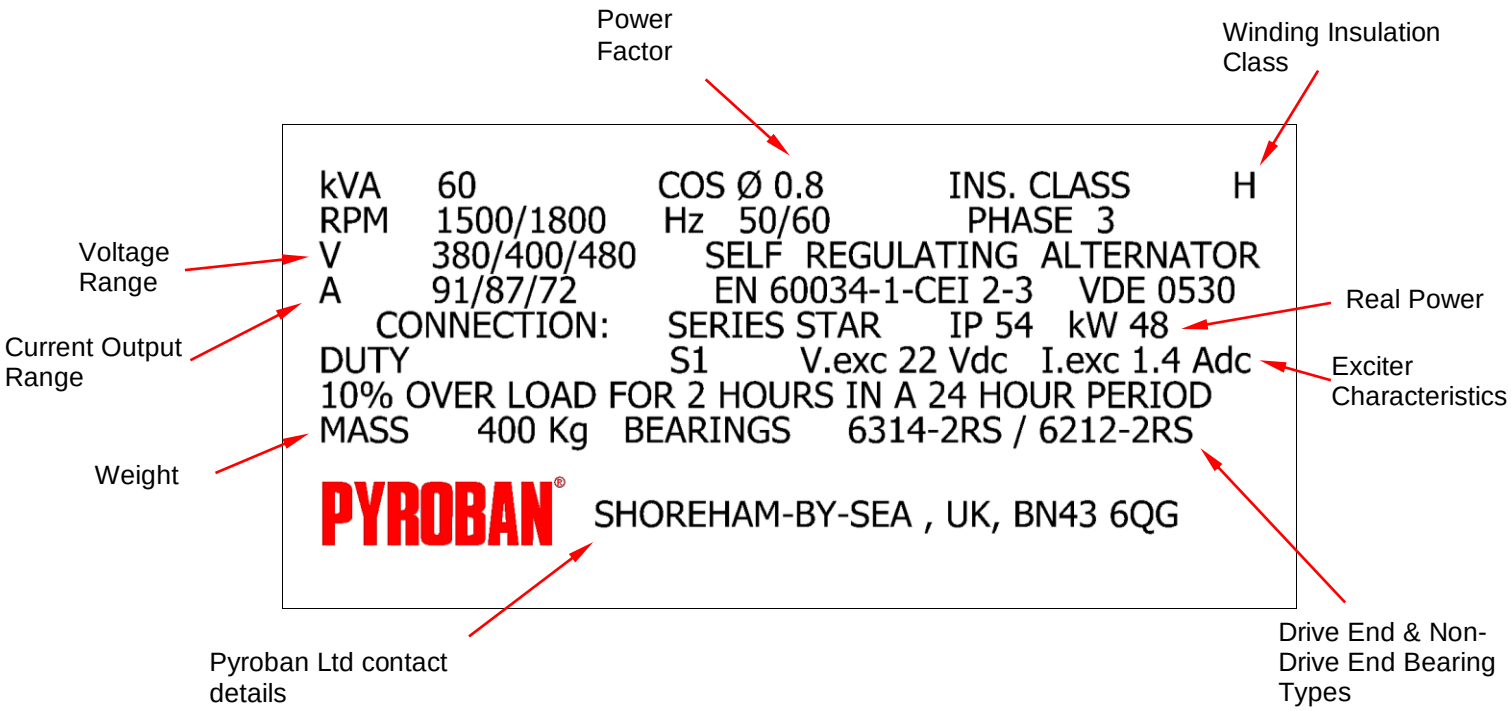

Figure 13 – 60 kVA Alternator Power Rating Label

4.1 Safety Marking Locations

Apply any replacement hazard protection labels in the positions indicated in the following diagrams.

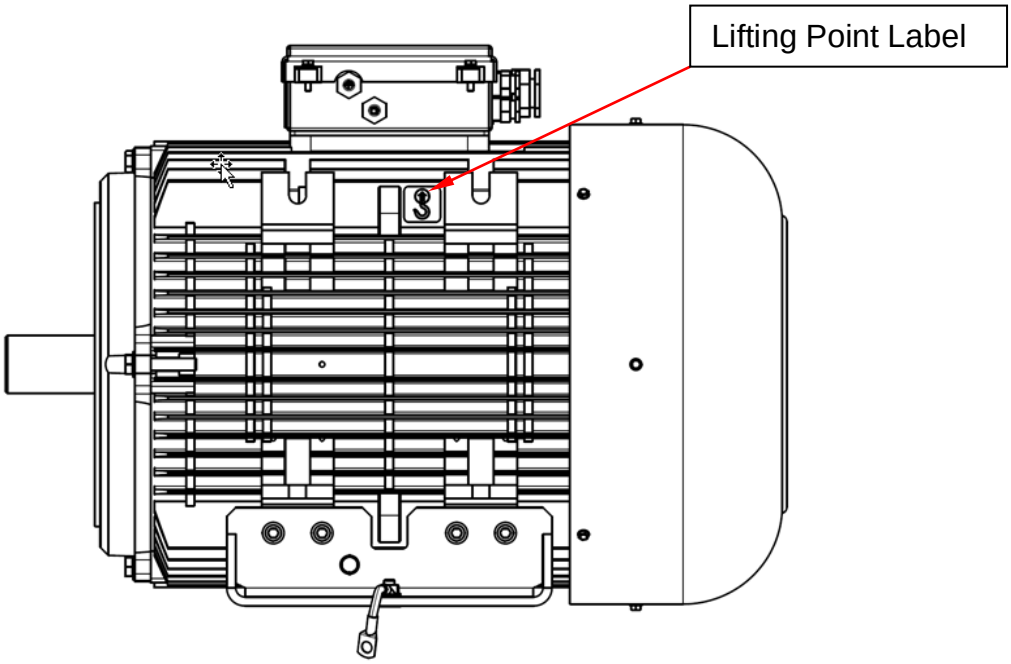

Figure 14 – Left Hand Side of Alternator

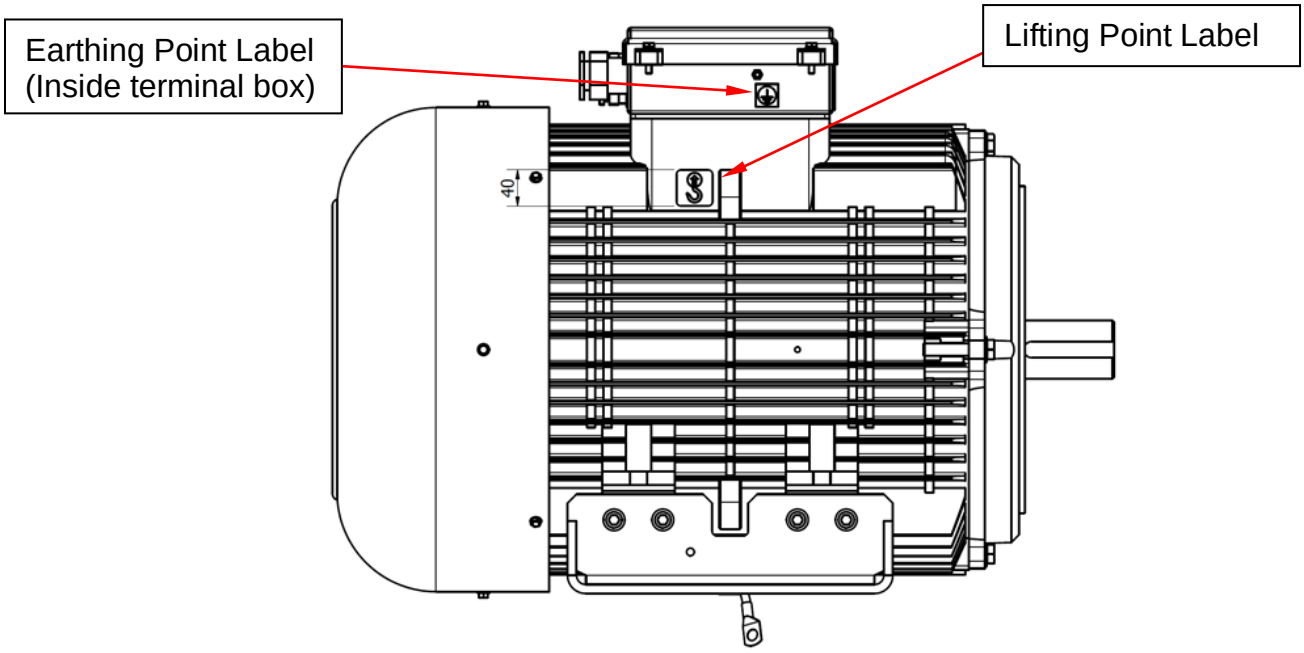

Figure 15 – Right Hand Side of Alternator

Earthing points also at two other points: Mounting foot & Cable Gland Exit (Not shown), refer to the figure in section 5.

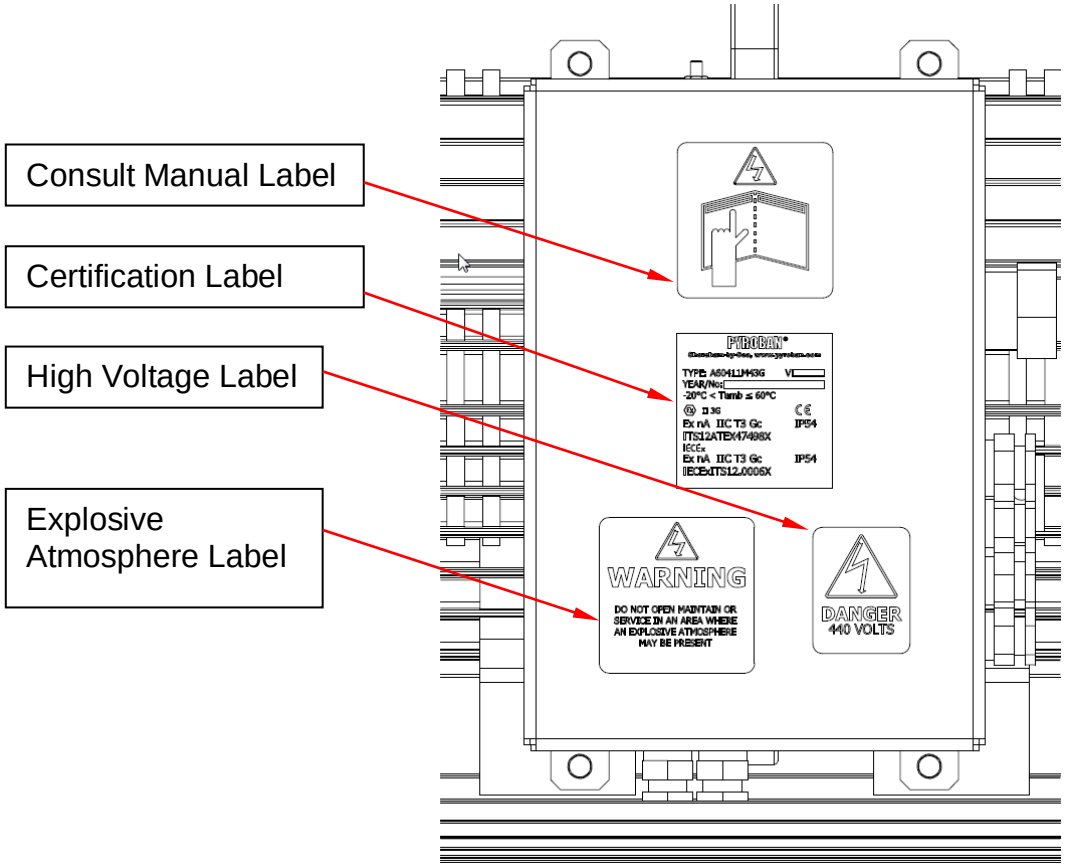

Figure 16 – Terminal Box Lid

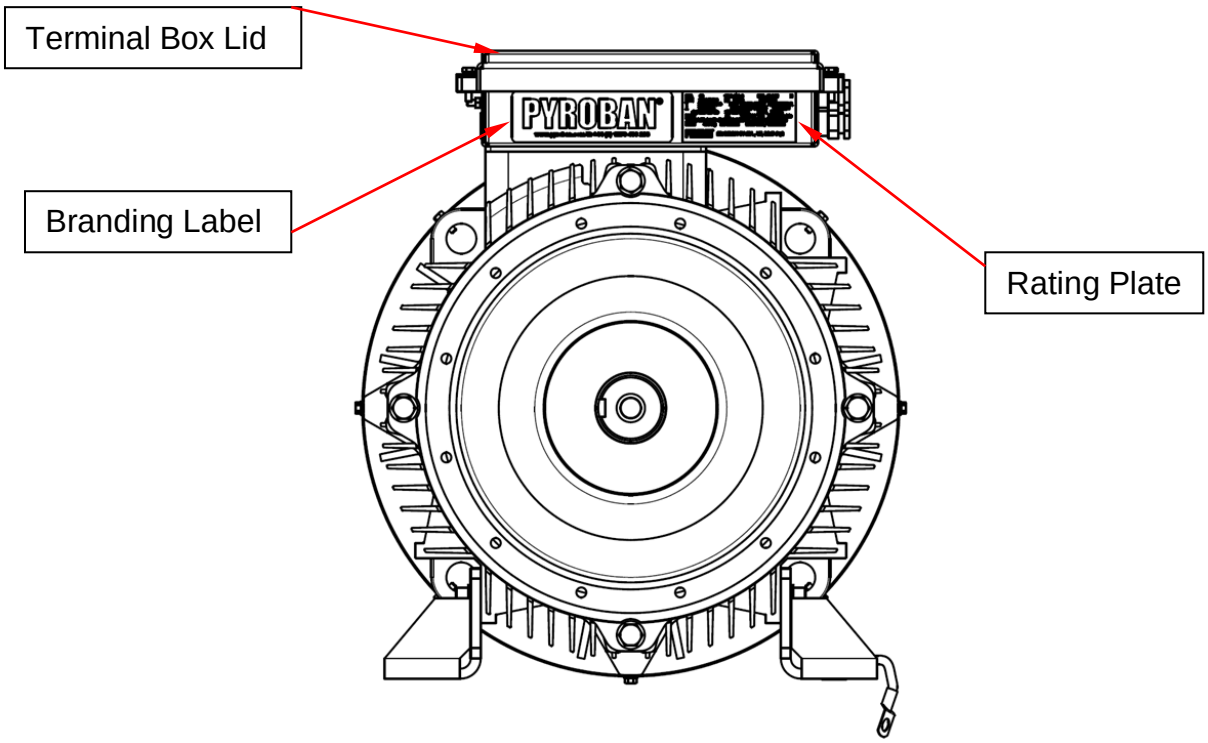

Figure 17 – Drive End of Alternator

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5 Alternator Dimensions

The following figures show the alternator overall dimensions.

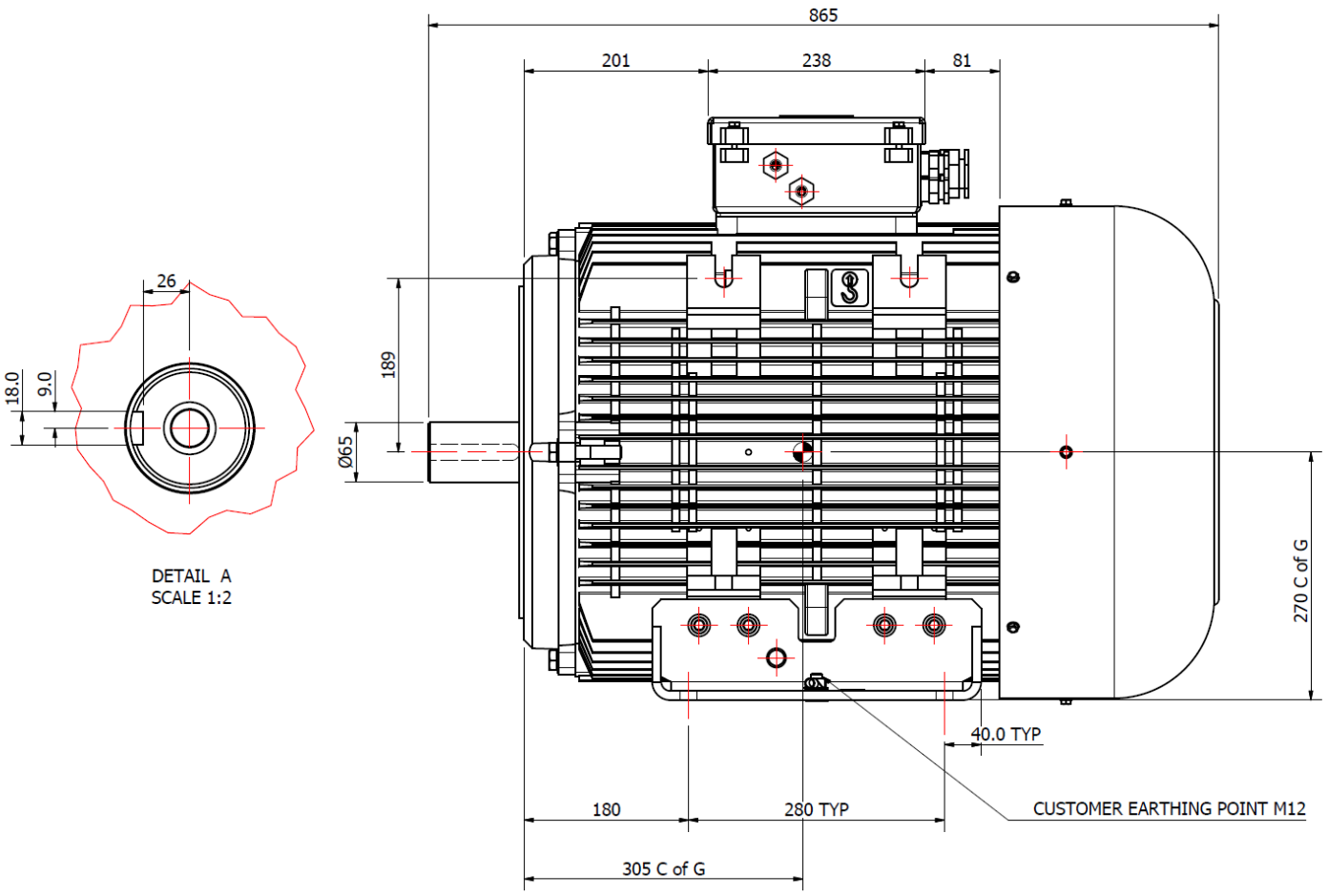


Figure 18 – Left-Hand Side View

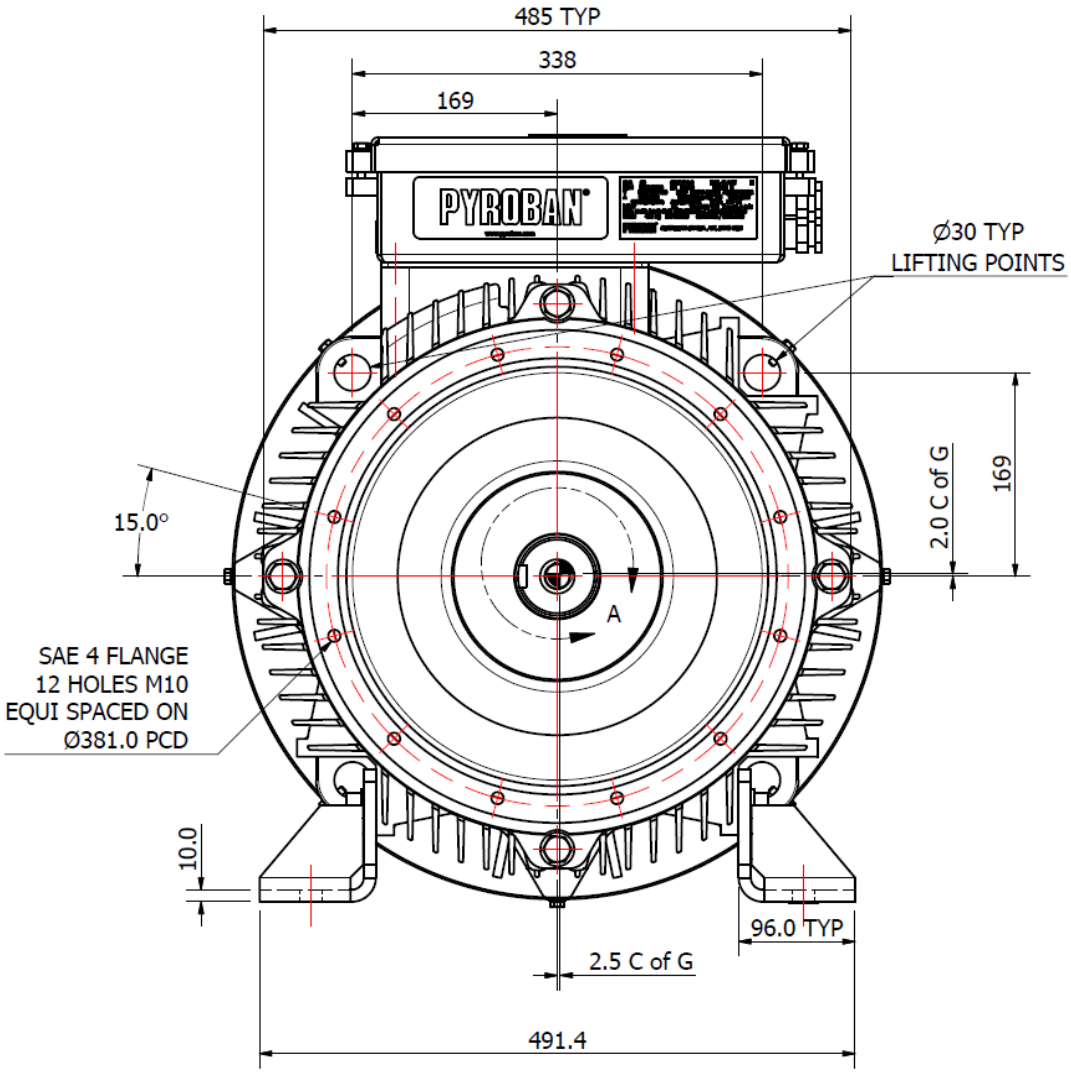


Figure 19 – Drive End View

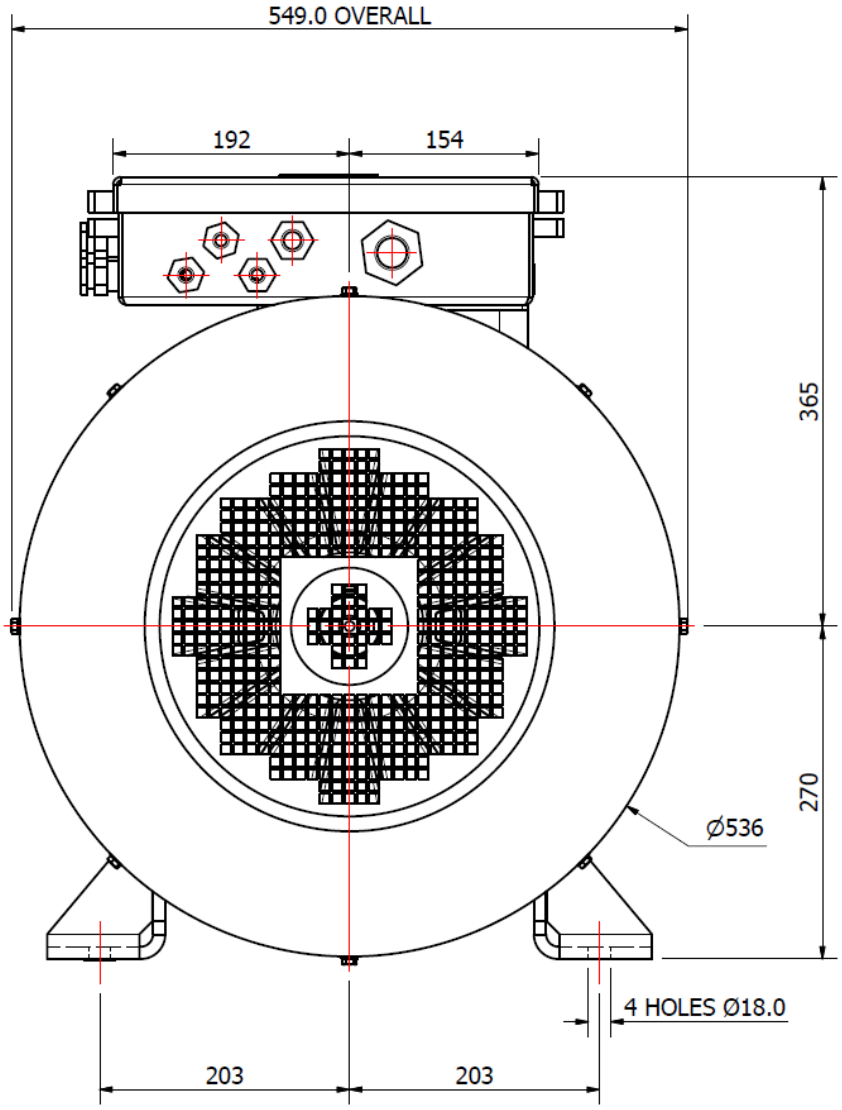


Figure 20 – Non Drive End View

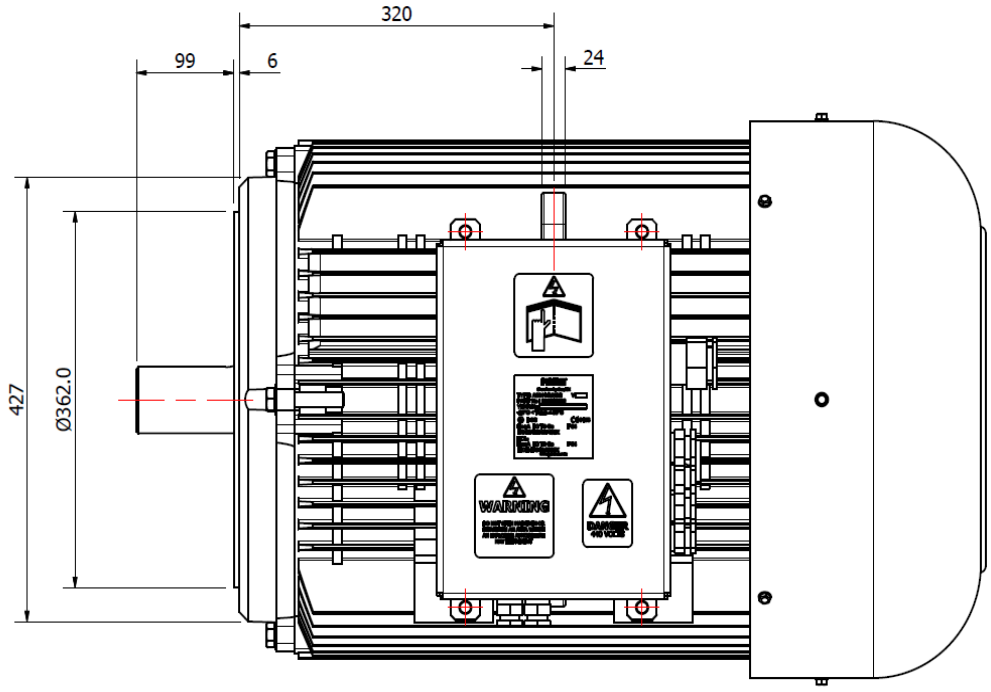
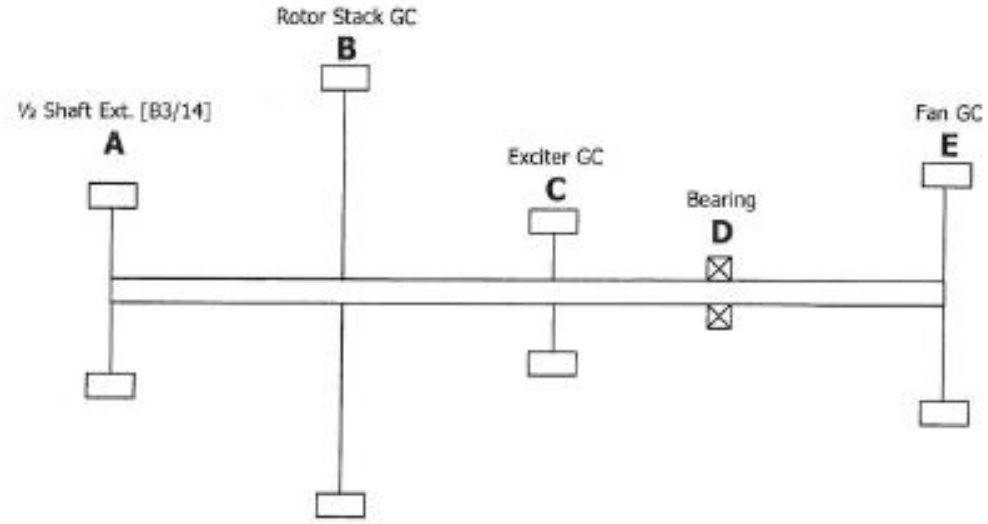


Figure 21 – Plan View

6 Mass and Inertia Data

6.1 Mass Elastic Data

TE34 /4 Shaft stiffness [Nm/rad]



Shaft steel main characteristic:

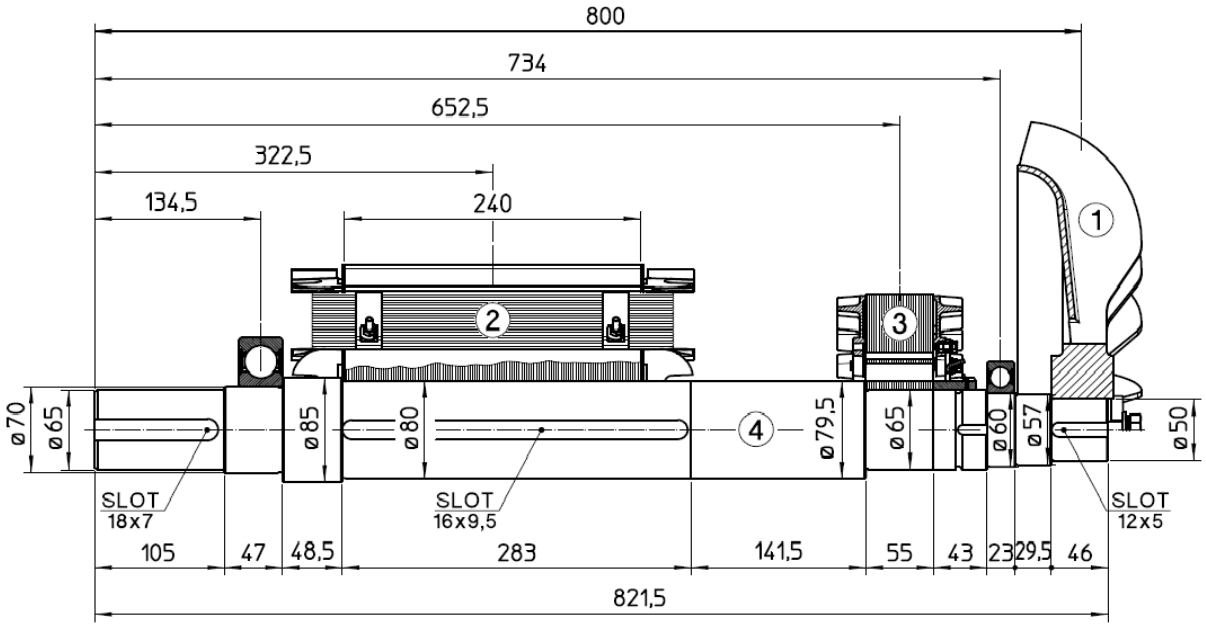
Steel grade:	C45 according to UNI EN 10083/1
Elasticity Module [Kg/mm]	8600
Maximum allowable shaft stress [N/mm^2]	50

Model	A - B	B - C	C - E
TE34 1S/4	1,03E+06	8,45E+05	6,06E+04
TE34 2S/4	9,45E+05	9,13E+05	6,06E+04
TE34 1L/4	9,07E+05	9,51E+05	6,06E+04
TE34 2L/4	8,50E+05	1,02E+06	6,06E+04

All values are given in Nm/Rad.

Figure 22 – Distribution of Mass – Elastic Data

6.2 Bearing Moments of Inertia



	COMPONENT	WEIGHT kg	J kgm ^{2}
1	FAN	5,7	0,1320
2	MAIN ROTOR	81	0.7896
3	EX. ROTOR	14,5	0,0874
4	SHAFT	26,5	0,0189
	TOTAL	127,7	1,0279

Figure 23 – Distribution of Mass and Inertia

7 Electrical Installation

7.1 General

The alternator is supplied with a Digital Simplified Regulator (DSR) and a 3 phase sensing module, or a Digital Electronic Regulator (DER1). Only while the alternator enclosure provides Ex nA protection, the DSR/DER1 and phase sensing module must be located in a separate suitable Ex d protected enclosure or located in a safe area.

7.2 Alternator Connection

All alternator connections are made through the terminal box located at the top of the machine. The entry cable glands and terminals are factory fitted and hazardous area approved. If replaced, these must be replaced with direct equivalents to maintain the system certification.

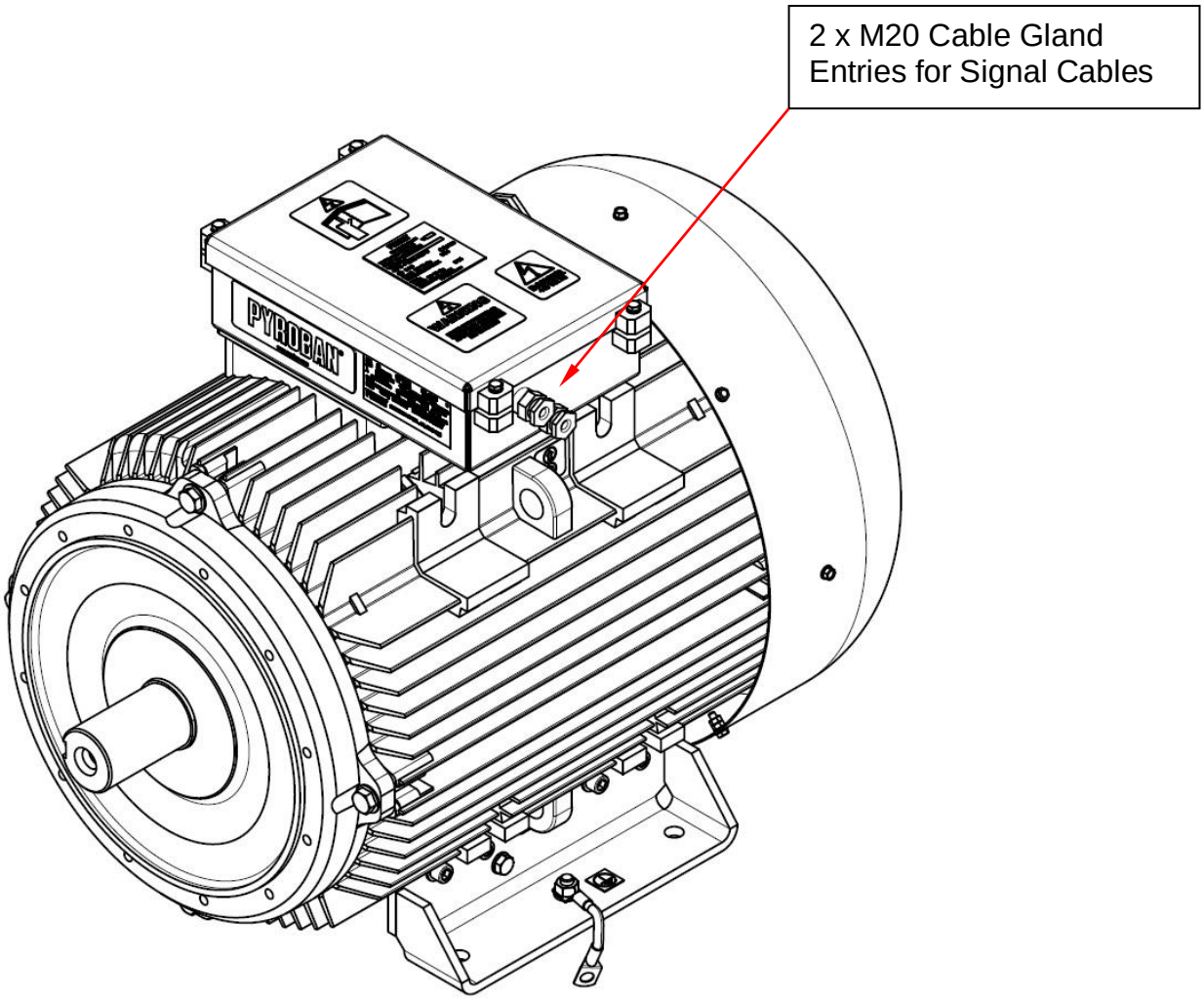
Installer selection of cable and terminal ratings to section 3.1.1 is mandatory to ensure certification and rating compliance. The output cables and auxiliary supply must be provided with means of electrical isolation by the installer.

To access the terminal box, remove the top lid using the existing 4 off M6x16 screws. These should be replaced in their original positions.

Terminal Box Glands				
Quantity	Size	Type	Cable Size	Location
3	M20	EExd A3LF/NP	3.4-8.4 mm	Terminal Box Side
2	M20	EExd A3LF/NP	3.4-8.4 mm	Terminal Box End
1	M20	EExd A3LF/NP	9.6-14 mm	Terminal Box Side
1	M32	E3WBFV1/NP	19-26.3 mm (Inner) 26.7-34 mm (Outer)	Terminal Box Side

7.3 Customer Cable Entries

The glands are Ex certified and should only be replaced by direct equivalents or sourced from Pyroban Ltd., refer to the following figures for thread sizes.



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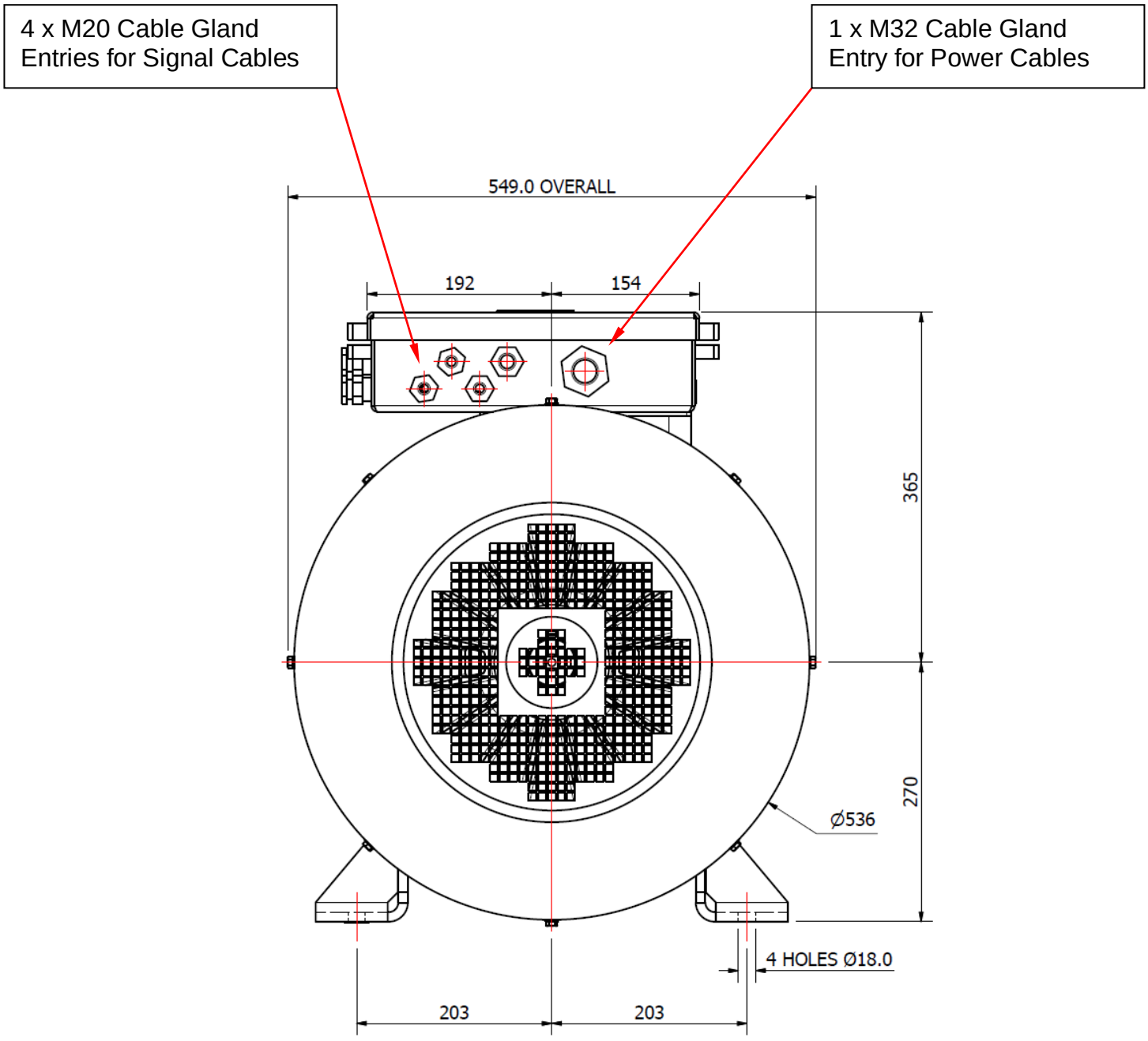

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7.4 Load Connection

Feed a 4-core cable through the M32 cable gland to connect to the load terminals. Add crimped ring terminals conforming to section 3.1.1 to the cable ends using a calibrated crimping tool. Sleeve the phase cable crimp tubes with heat-shrink maintaining a reduced solid thickness of 0.8 mm. Connect the phase and neutral connections in accordance with the diagram below, using the Series Star connection arrangement. Load constraints should be respected and can be found in section 2.2.

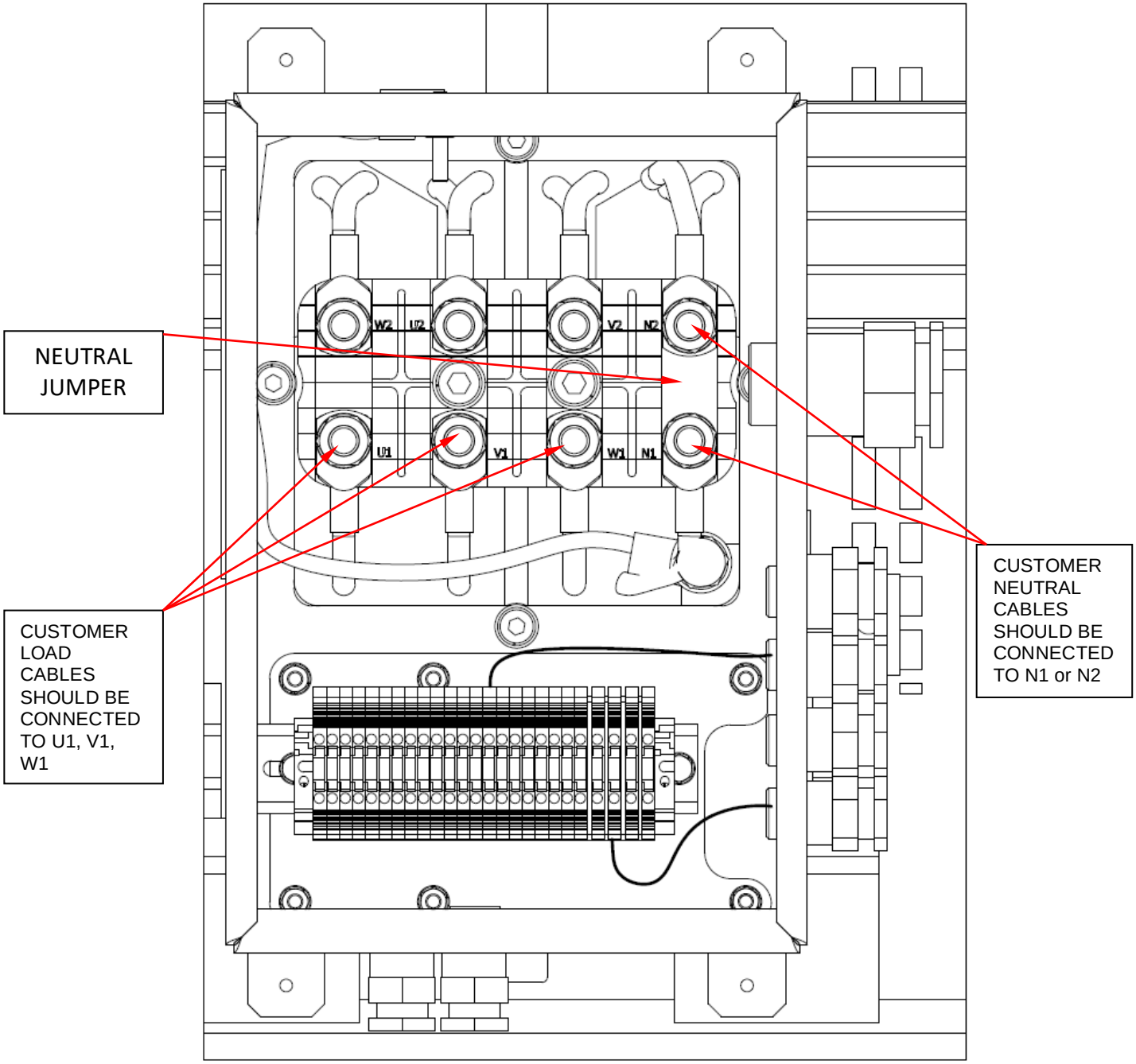


Figure 24 – Customer Load Connections

Refer to the figure below for detail of load cable clamping arrangements using the stainless steel M12 nuts, spring washers and brass washers supplied. For torque values refer to page 53, Appendix B.

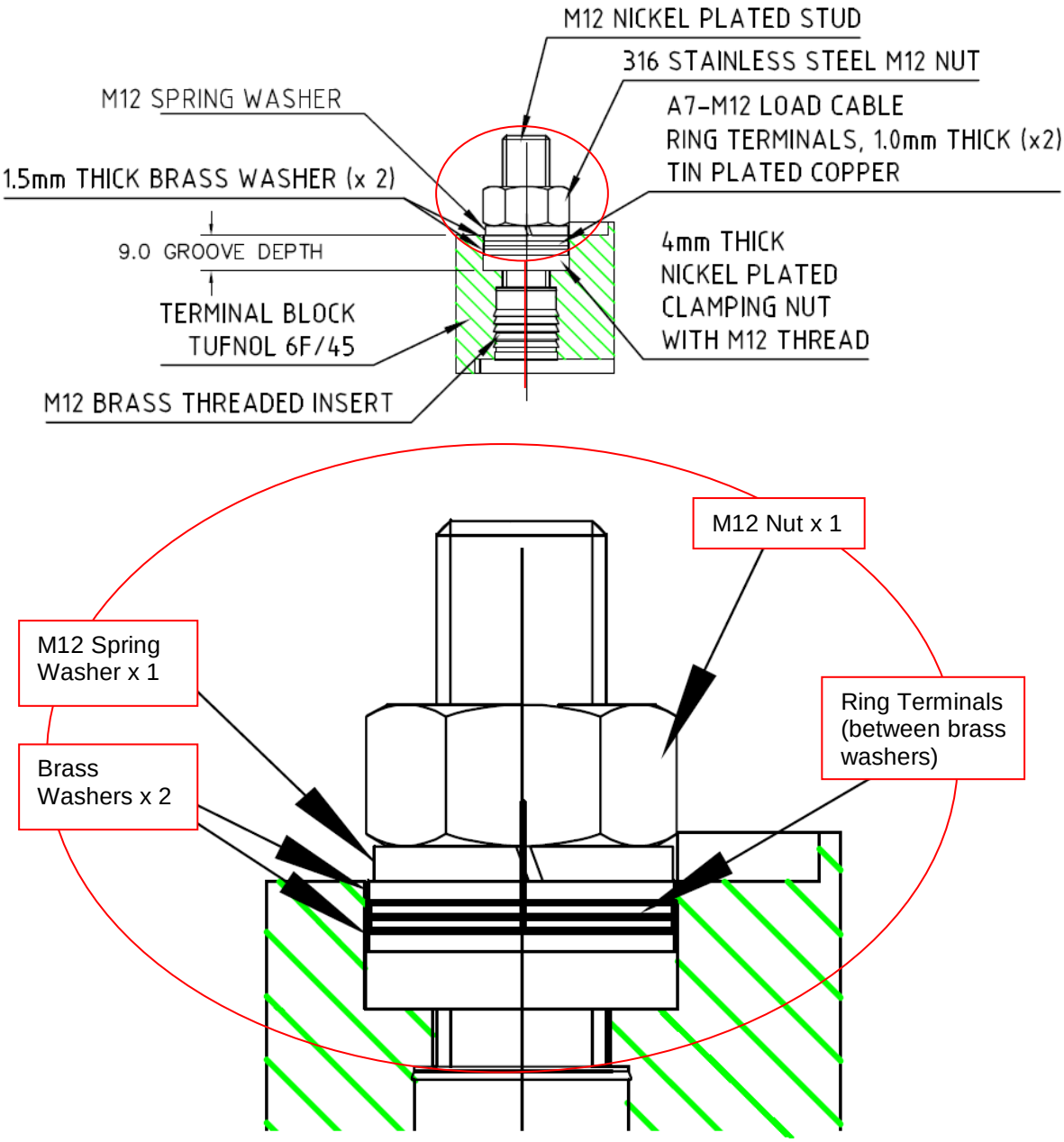


Figure 25 – U1, V1 and W1 Nut, Washer and Ring Terminal Arrangement

Note:

- Where ring terminals are stacked together, the tubes should face away from each other.
- N1-N2 has a neutral jumper fitted under the lower washers (refer to Figure 24).

7.5 Signal Cable Connection For DSR type AVR

The signal connections are factory fitted in accordance with the arrangement below. Select cables with an appropriate rating to the cable connection table in Figure 27.

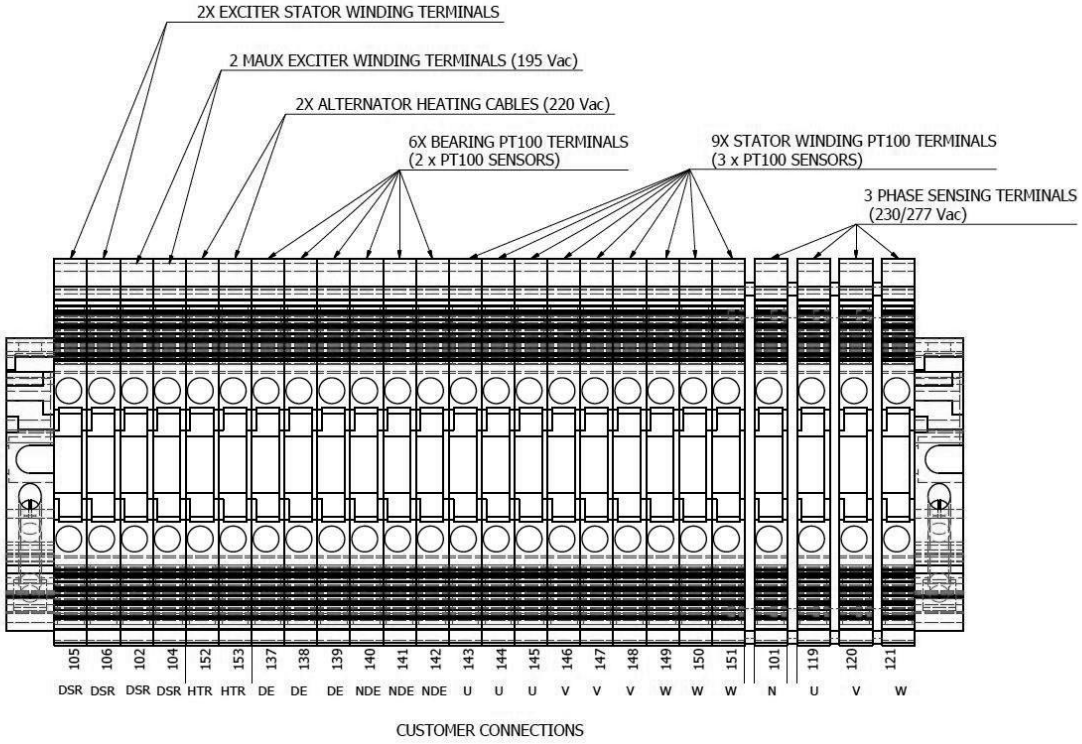


Figure 26 – Ex Terminal Block Connections (DSR)

CUSTOMER INTERCONNECTION TABLE				
CABLE No	SYSTEM NODE	VOLTAGE 60K VA	VOLTAGE 80K VA	MINIMUM CABLE INSULATION (mm)
101	NEUTRAL PHASE SENSING	230/277 Vac rms	230/277 Vac rms	0.8
102	MAUX	195 Vac rms	176 Vac rms	0.6
104	MAUX	195 Vac rms	176 Vac rms	0.6
105	STATOR EXCITATION	40 Vdc	45.5 Vdc	0.3
106	STATOR EXCITATION	40 Vdc	45.5 Vdc	0.3
119	U PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
120	V PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
121	W PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
137	DE BEARING, TEMP PT100	24 Vdc	24 Vdc	0.2
138	DE BEARING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
139	DE BEARING, TEMP PT100	0 Vdc	0 Vdc	0.2
140	NDE BEARING, TEMP PT100	24 Vdc	24 Vdc	0.2
141	NDE BEARING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
142	NDE BEARING, TEMP PT100	0 Vdc	0 Vdc	0.2
143	U' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
144	U' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
145	U' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
146	V' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
147	V' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
148	V' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
149	W' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
150	W' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
151	W' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
152	ALTERNATOR HEATOR	220 Vac	220 Vac	0.6
153	ALTERNATOR HEATOR	220 Vac	220 Vac	0.6

Figure 27 – Cable Connection Table - DSR

Cables for connection to the signal terminals are to be brought in via the 6 off M20 glands in the terminal box.
Terminate the ends of the cable cores with appropriately sized stainless steel bootlace ferrules prior to connecting to the terminal block. Use high temperature cable ties (COT>90°C) to secure cables as required.

7.6 Signal Cable Connection For DER1 type AVR

The signal connections are factory fitted in accordance with the arrangement below. Select cables with an appropriate rating to the cable connection table in Figure 29.

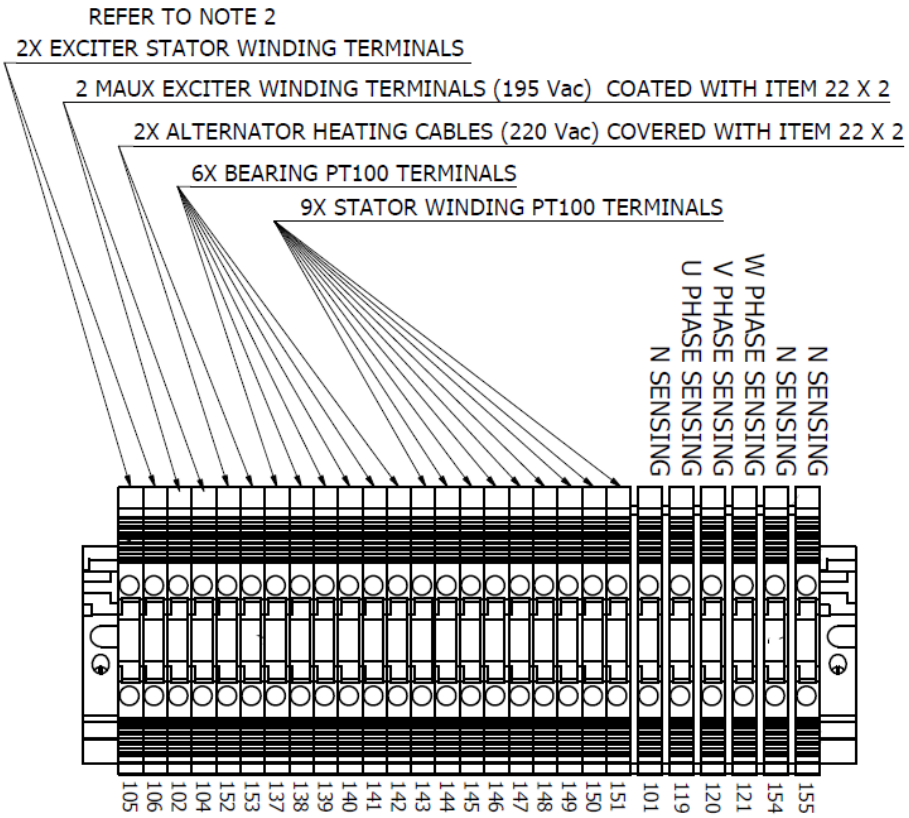


Figure 28 - Ex Terminal Block Connections (DER1)

CUSTOMER INTERCONNECTION TABLE				
CABLE No	SYSTEM NODE	VOLTAGE 60K VA	VOLTAGE 80K VA	MINIMUM CABLE INSULATION (mm)
101	NEUTRAL PHASE SENSING	230/277 Vac rms	230/277 Vac rms	0.8
102	MAUX	195 Vac rms	176 Vac rms	0.6
104	MAUX	195 Vac rms	176 Vac rms	0.6
105	STATOR EXCITATION	40 Vdc	45.5 Vdc	0.3
106	STATOR EXCITATION	40 Vdc	45.5 Vdc	0.3
119	U PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
120	V PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
121	W PHASE SENSING	230/ 277 Vac rms	230/ 277 Vac rms	0.8
137	DE BEARING, TEMP PT100	24 Vdc	24 Vdc	0.2
138	DE BEARING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
139	DE BEARING, TEMP PT100	0 Vdc	0 Vdc	0.2

CUSTOMER INTERCONNECTION TABLE continued

CABLE No	SYSTEM NODE	VOLTAGE 60K VA	VOLTAGE 80K VA	MINIMUM CABLE INSULATION (mm)
140	NDE BEARING, TEMP PT100	24 Vdc	24 Vdc	0.2
141	NDE BEARING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
142	NDE BEARING, TEMP PT100	0 Vdc	0 Vdc	0.2
142	NDE BEARING, TEMP PT100	0 Vdc	0 Vdc	0.2
143	U' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
144	U' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
145	U' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
146	V' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
147	V' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
148	V' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
149	W' PHASE WINDING, TEMP PT100	24 Vdc	24 Vdc	0.2
150	W' PHASE WINDING, TEMP PT100	0-24 Vdc	0-24 Vdc	0.2
151	W' PHASE WINDING, TEMP PT100	0 Vdc	0 Vdc	0.2
152	ALTERNATOR HEATOR	220 Vac	220 Vac	0.6
153	ALTERNATOR HEATOR	220 Vac	220 Vac	0.6
154	NEUTRAL PHASE SENSING	230/277 Vac rms	230/277 Vac rms	0.8
155	NEUTRAL PHASE SENSING	230/277 Vac rms	230/277 Vac rms	0.8

Figure 29 - Cable Connection Table – DER1

Cables for connection to the signal terminals are to be brought in via the 6 off M20 glands in the terminal box.
Terminate the ends of the cable cores with appropriately sized stainless steel bootlace ferrules prior to connecting to the terminal block. Use high temperature cable ties (COT>90°C) to secure cables as required.

7.7 Load and Signal Cable Glands and Routing

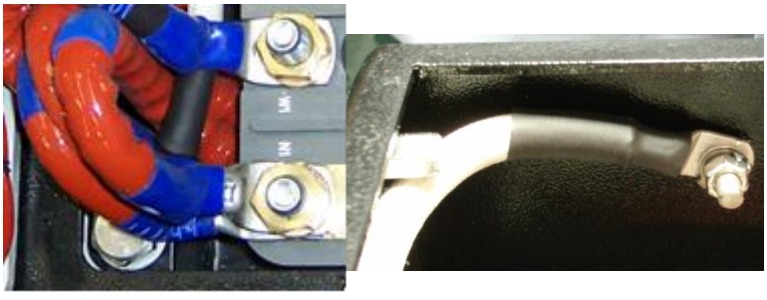
Ensure all cables are properly gripped in the cable glands to maintain IP54 protection. Any unused entries are to be filled with suitable Ex rated stopping plugs.

Ensure all external power and signal cables are routed to avoid mechanical and temperature damage. Support and clamp all cables to avoid pulling, twisting and vibration being transmitted into the cable glands.

7.7.1 Re-fitting Terminal Box Lid

Before re-fitting the lid:

- Check all cables have no residual strain (internally and externally).
- Check the condition of the heat shrink on all the load and equi-potential bonding crimped ring terminals (Ex protection relies on good creepage distances).



- Check the condition of the gasket seal as the Ex protection concept relies on an ingress protection rating of IP54. Replace if damaged. The gasket assembly includes copper stops to ensure the gasket is not over-compressed. Ensure these are re-fitted when re-fitting the lid.

Fix the lid in position with the existing 4off M6x16 screws, spring and plain washers. Torque values are found in Appendix B.

7.8 Connection to the AVR and Sensing Module

Connections between the alternator terminal block (Figure 26), AVR and phase sensing module are shown in Figure 30 and Figure 31.

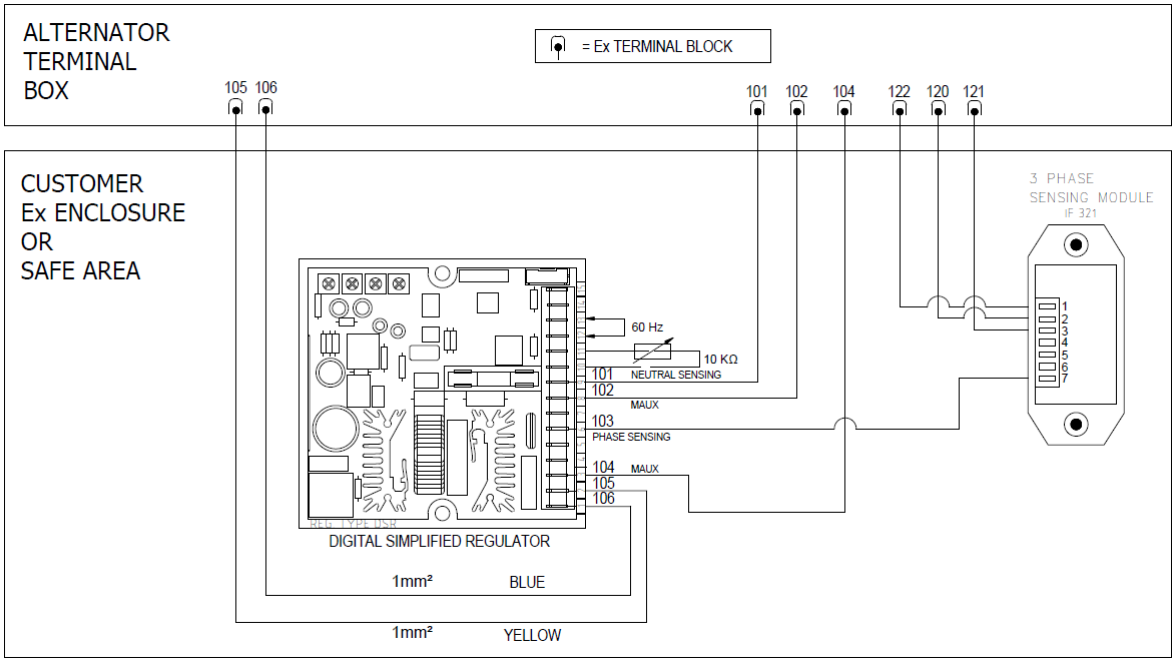


Figure 30 - DSR & Sensing Module Connections

NODE	EXC BLUE	EXC YELLOW	MAUX IN	U PHASE SENSING	NEUTRAL SENSING	MAUX OUT	V PHASE SENSING	NEUTRAL SENSING	W PHASE SENSING	NEUTRAL SENSING
DER1	1	2	3	5	11	12	14	17	19	22
TE34 2L/4	106	105	104	119	101	102	120	154	121	155

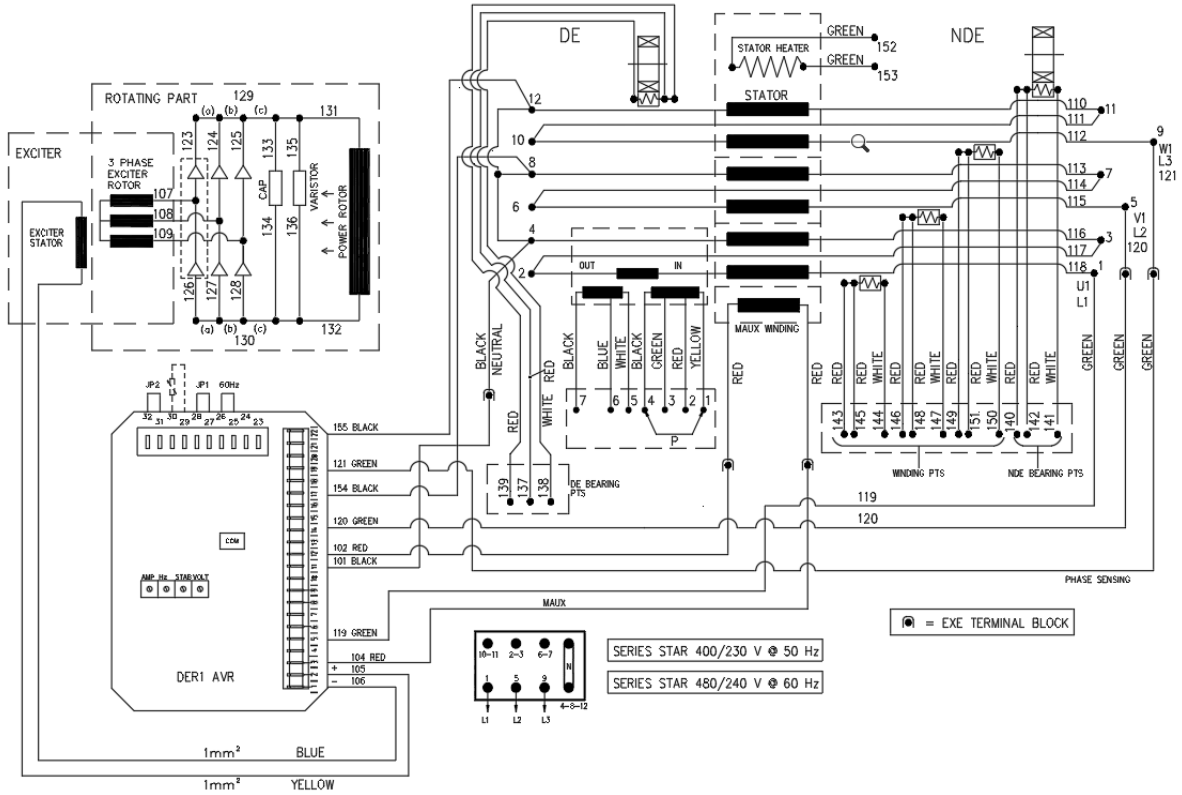


Figure 31 - DER1 & Sensing Module Connections

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8 Maintenance

8.1 Maintenance of Safety Equipment

The preventative and protective measures described in this manual will not provide the required level of safety and protection, unless the equipment is operated and maintained in accordance with its intended use as stated by PYROBAN LIMITED.

Maintenance must be carried out in accordance with the maintenance charts in Appendix B.

In addition to the maintenance operations stated in Appendix B, carry out the following checks every 6 months:

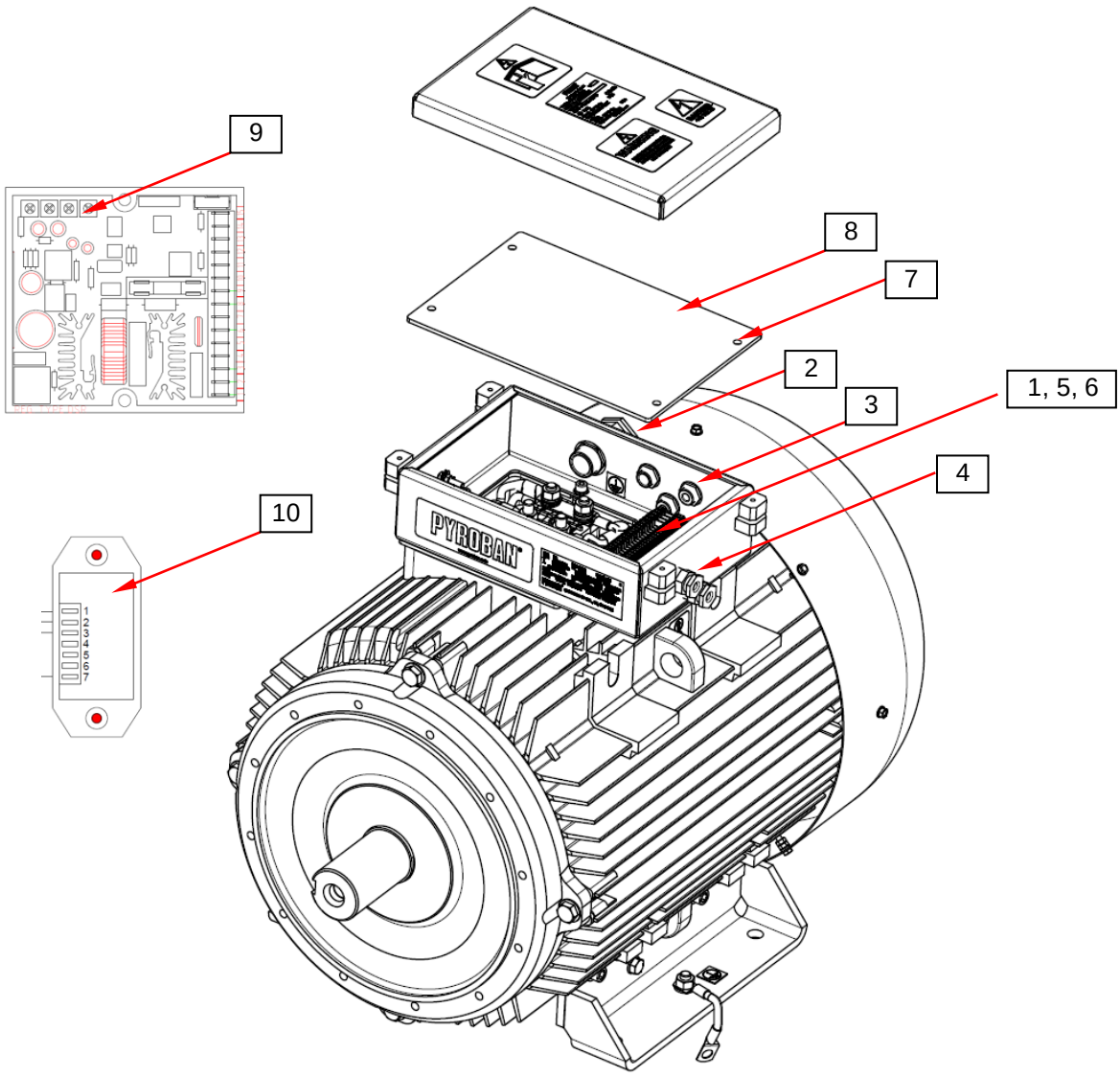
- Check the 12 off M10 x 1.5 drive end mounting screws are present and secure.
- Check the 4 off terminal box screws are present and secure.
- Check the terminal box cable glands are secure and in good order.
- Check the external supply cables are fixed firmly and in good order.

Keep a log of all maintenance, repair work and servicing. The frequency and extent of repairs can reveal item deterioration which may lead to unsafe conditions.

After maintenance or repair work, the Person in Authority must inspect and approve the equipment before its return to service.

8.2 Sundries and Replacement Parts

Spare parts should be ordered directly from Pyroban Limited quoting the part number, item description and the original Sales order the equipment was purchased under. The original Manufacturer's Name label, part number and serial number are marked on the component. Refer to the table below for part numbers.



ID	Description	Part Number	Quantity
1	End Stop Screw Rail Terminal	300931002	2
2	M32 x 1.4 ATEX Cable Gland	3010006544	1
3	M20 Gland (9.6-14 mm cable)	3010006543	1
4	M20 Gland(3.4-8.4 mm cable)	3010006542	5
5	Guard Cover	300931003	6
6	Terminal WDU2.5	931623	27
7	Lid Stop	815947	4
8	Terminal Box Lid Gasket	815898	1
9a	Digital Simplified Regulator (DSR)	3010007920	1
9b	Digital Electronic Regulator (DER1)	3010020613	1
10	3 Phase Sensing Module	3010007944	1

Figure 32 - Part Numbers of Replacement Parts

9 Waste and Disposal

The careful disposal of hazardous materials is a public responsibility to prevent damage to humans, animals and the environment. The Person in Authority is responsible for ensuring that all potentially hazardous wastes produced during cleaning processes are correctly identified at each stage of the process and that appropriate measures are taken to protect the health of employees and those who are contracted to transport or dispose of waste substances. These provisions are built into UK law under the *Health and Safety at Work Act 1974* and the *Control of Substances Hazardous to Health Regulations (COSHH) 1999 (SI 1999 No. 437)*. For non-UK applications the Authorised Person is responsible to ensure compliance with legislation and regulations applicable in the country of use. A list of hazardous wastes can be obtained from the Consolidated TEXT produced by the CONSLEG system of the Office for Official Publications of the European Communities (CONSLEG: 2000D0532 – 01/01/2002). Relevant sections would cover:

- Wastes from thermal processes.
- Wastes from chemical surface treatment and coating of metals and other materials; non-ferrous metallurgy.
- Oil wastes and wastes of liquid fuels.
- Waste organic solvents, refrigerant and propellants.

APPENDICES

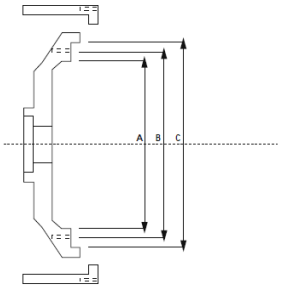
Appendix A – Coupling and Mounting Guide

SAE Coupling and Mounting Guide

SAE Flywheel Housing Dimensions

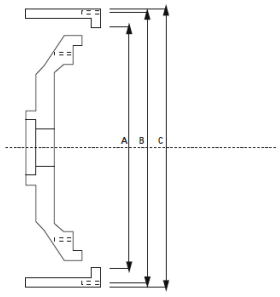
SAE Flywheel Housing Dimensions

SAE No.	A	B	C	Holes	Size
00	31	33.5	34.75	16	1/2-13
0	25.5	26.75	28	16	1/2-13
1/2	23	24 3/8	25.5	12	1/2-13
1	20 1/8	20 7/8	21.75	12	7/16-14
2	17 5/8	18 3/8	19.25	12	3/8-16
3	16 1/8	16 7/8	17.75	12	3/8-16
4	14.25	15	15 7/8	12	3/8-16
5	12 3/8	13 1/8	14	8	3/8-16
6	10.5	11.25	12 1/8	8	3/8-16



SAE Flywheel Dimensions

Flywheel	A	B	C	XG	Holes	Size
21	23	25.25	26.5	0	12	5/8-11
18	19 5/8	21 3/8	22.5	5/8	6	5/8-11
16	18 1/8	19 1/4	20 3/8	5/8	8	1/2-13
14	16 1/8	17.25	18 3/8	1	8	1/2-13
11 1/2	12.375	13.125	13 7/8	1 9/16	8	3/8-16
10	10 7/8	11 5/8	12 3/8	2 1/8	8	3/8-16
8	8 7/8	9 5/8	10 3/8	2 7/16	6	3/8-16
7 1/2	8 1/8	8.75	9 1/2	1 3/16	8	5/16-18
6 1/2	7.25	7 7/8	8 1/2	1 3/16	6	5/16-18
17.75 D	--	15.5	17.75	.72	8	5/8-11
15.50 D	--	13 7/8	15.50	.72	8	5/8-11
12.75 D	--	11	12.75	0	4	1/2-13



Available Mounting Arrangements

Adaptor	Coupling	ECP3	ECO28	ECP32	ECP34	ECP38	ECO40	ECO43	ECO46	NPE 32
6	6.5	•								
	7.5	•								
5	6.5	•	•	•						•
	7.5	•	•	•						•
	8	•	•	•						•
4	6.5	•	•	•						•
	7.5	•	•	•						•
	8	•	•	•						•
	10	•	•	•						•
	11.5	•	•	•						•
3	8	•	•	•						•
	10	•	•	•	•					•
	11.5	•	•	•	•	•				•
2	10		•	•	•	•				
	11.5		•	•	•	•				
1	11.5			•	•	•				
	14				•	•	•			
	17.75 D			•	•	•	•			
1/2	14					•	•			
	18					•	•	•		
	17.75 D					•	•	•		
0	14						•	•	•	
	18						•	•	•	
00	18						•	•	•	
	21							•	•	
	24									

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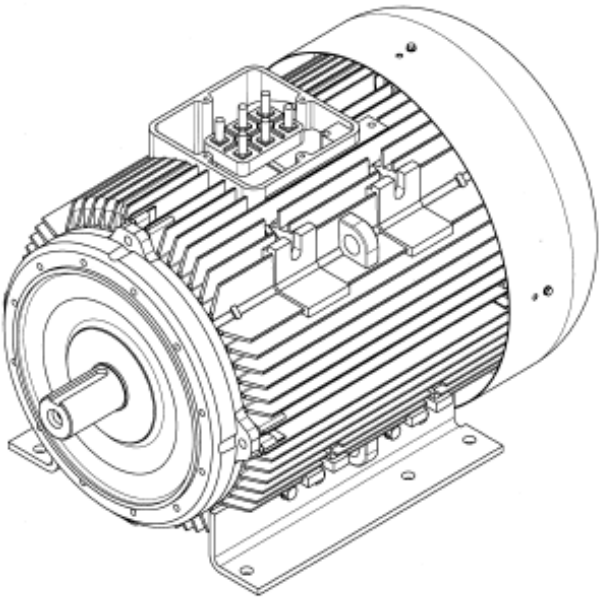
Appendix B – Maintenance Instructions

SELF- REGULATING ALTERNATORS

MAINTENANCE INSTRUCTIONS

A60411M43G & A80411M43G



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INSULATION SYSTEM

CE

 Document number: OG030 Date of Issue: 22/02/2022 Revision 3

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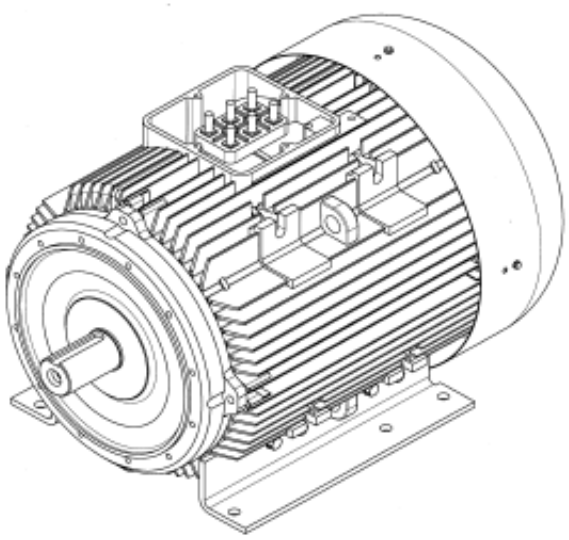
MACHINE DESCRIPTION



The 4 pole alternators are brushless, self-regulating and incorporate a rotating inductor with damper cage winding and a fixed stator with skewed slots.
The stator windings have a shortened pitch to reduce the harmonic content of the output waveform.

The alternators are made in compliance with the 98/37, 73/23, 89/336 CEE directives and their amendments, and the CEI 2-3, EN 60034-1, IEC 34-1, VDE 0530, BS4999-5000 regulations.

Tests to verify the electromagnetic compability have been carried out in the foreseen conditions by the standards with the neutral connected to the earth.

The robust mechanical construction gives good access to the generator output connections, and allows the user to inspect the various components with ease. The casing is made of aluminium, the shields of cast iron, and the shaft of C45 steel and it has a keyed fan.
The mechanical protection level meets standard IP55.

Insulation materials meet Class H requirements, and all rotating components are epoxy resin impregnated; higher voltage parts, such as the stators, are vacuum-treated.

INTRODUCTION

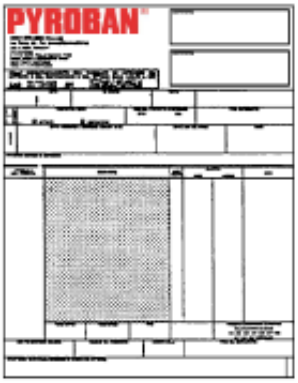
The alternators comply with the EEC 98/37, 73/23, 89/336 directives and their amendments; therefore they pose no danger to the operator if they are installed, used and maintained according to the instructions given by Pyroban and provided the safety devices are kept in perfect working conditions.

Therefore a strict observance of these instructions is required.

MACHINE IDENTIFICATION

Always indicate the generator type and code when contacting Pyroban or the authorized after-sales service centres.

INSPECTION ON DELIVERY



When the alternator is delivered, check that unit conforms with the delivery note and ensure that there are no damaged or defective parts; should there be any, please inform the forwarding agent, the insurance company, the seller or Pyroban immediately.

SAFETY REQUIREMENTS

Before any cleaning, lubrication or maintenance operation, ensure that the generator is stationary and disconnected from the power supply.

When stopping the generator, ensure the compliance with the procedures for stopping the prime mover.
The generator, in fact, has no Emergency Stop, but is controlled by the device arranged by the installer.

SAFETY REQUIREMENTS

Symbols having specific meanings have been used throughout this instruction and maintenance manual.

CONVENTIONAL SYMBOLS AND SYMBOL DESCRIPTION

IMPORTANT

IMPORTANT
This symbol warns the personnel concerned that the described operation may cause damage to the machine if it is not carried out according to the safety standards.

CAUTION
This symbol warns the personnel concerned that the described operation may cause damage to the machine and/or injury to the personnel if it is not carried out according to the safety standards.

WARNING
This symbol warns the personnel concerned that the described operation may cause serious injuries or death to the personnel if it is not carried out according to the safety standards.

DANGER
This symbol warns the personnel concerned that the described operation may immediately cause serious injuries or death to the personnel if it is not carried out according to the safety standards.

SAFETY REQUIREMENTS (Continued)

HANDLER
This symbol identifies the type of operator in charge of the operation described.
This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills about the hoisting means, slinging methods and features and safe handling procedures.

MECHANICAL SERVICE
This symbol identifies the type of operator in charge of the operation described.
This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills necessary to perform installation, adjustment, maintenance, cleaning and/or repair

type of
operation
described.
This qualification requires a complete knowledge and understanding of the information contained in the manufacturer's instruction manual as well as specific skills necessary to perform electrical operations such as connections, adjustment, maintenance and/or repair.
The electrical service man must be able to work even in case electrical cabinets and panels are live.

In case of exceptional operations and upon written request of servicing operations please apply to Pyroban authorized centers.

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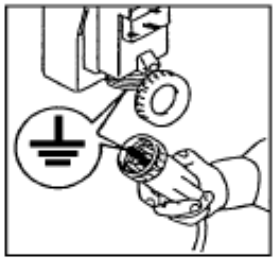
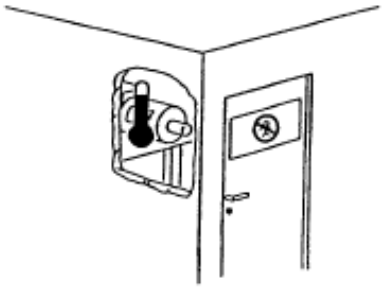
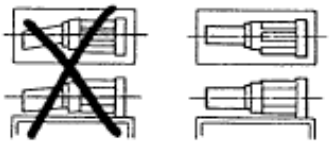
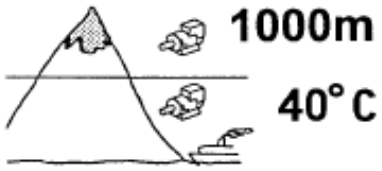
SAFETY REQUIREMENTS (Continued)









Before installing the generator, arrangements must be made to earth the machine. This is the reason why you must make sure that the grounding system is in good condition and in compliance with the regulations of the country where the generator will be installed.

CAUTION
THE FINAL INSTALLER IS RESPONSIBLE FOR THE INSTALLATION OF ALL THE PROTECTIONS (SECTIONING DEVICES, PROTECTION AGAINST DIRECT AND INDIRECT CONTACTS, OVERCURRENT AND OVERVOLTAGE PROTECTIONS, EMERGENCY STOP, ETC.) NECESSARY FOR THE MACHINE TO COMPLY WITH THE EXISTING INTERNATIONAL/EUROPEAN SAFETY REGULATIONS.

For handling the unpacked generators, always use the special eyebolts only; use ropes having a suitable carrying capacity and do not lift the generator too much from the floor (max 30 cm.).

When the machine is worn cut, contact the companies in charge of the disposal of ferrous material and do not throw away its parts into the environment.

The operators in charge of the installation, operation and maintenance of the generators must be skilled technicians who know the characteristics of the generators.

The people in charge of the handling must always wear work gloves and safety shoes. In case the generator or the whole plant must be lifted from the floor, the operators must wear a safety helmet.

The generator must be installed in an airy room. If there is not enough air, a malfunction or an overheating may occur.
All entry doors into generator room should be clearly marked "Authorized persons only".

Make sure that gen-set foundations and baseframe are suitable to bear the combined weight of the alt[illegible] mover.

[illegible]connected
[illegible]e mover,
otherwise dangerous vibrations may occur.

The machine has been designed to ensure the rated output when it is installed in rooms having a max temperature of 40°C and at an altitude not exceeding 1000 meters; in case of different conditions, please make reference to our catalogue (brochure).

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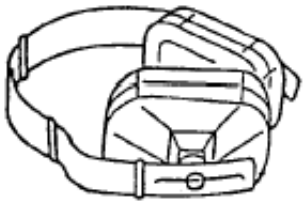
SAFETY REQUIREMENTS

No person must wear fluttering clothes (such as scarves, etc.) near the machine and any garment must be fastened with elastic bands at its ends.

The generators must never and for no reason run whith following guards removed:
-) terminals cover
-) fan guards.

Regulators are equipped with 3 leds:
Green led - correct operation
Yellow led - overload protection on
Red led - low speed protection on.



The generators are noisy; even if the sound level is certainly lower than that of the prime motor, they must be installed in soundproof rooms (engine room, etc.) where it is necessary to wear antinoise protectors.

The generators produce heat proportional to the output. Therefore, do not touch the generator if you do not wear antiscorch gloves and, after switching it off, do not touch it until it has cooled down.

Even if all the machine components are protected, keep away from the machine.

Do not lean or sit on the generator for whatever reason.

Do not remove the labels for whatever reason; on the contrary, if necessary, replace them.

In case of replacement of spare parts, use original spare parts only.

For the replacement of worn parts, carefully follow the maintenance instructions; these operations must be carried out by skilled technicians.

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TRANSPORT AND STORAGE

DANGER

Alternators will be packed for shipment in a manner suitable to their mode of transport and final destination.

Prior to handling goods, please ensure that lifting equipment is of sufficient capacity. Under lifting conditions machinery should be elevated to a minimal distance from the ground.

When lifting or moving goods by forklift apparatus, care should be taken to ensure that forks are correctly positioned to prevent slipping or falling of pallet or crate.

Both packed and unpacked alternators shall be stored in a cool and dry room, and shall never be exposed to the indemency of the weather.

lternators, always lift them by using their eyebolts.

IMPORTANT :

AFTER PROLONGED STORAGE OR IF THE MACHINES SHOW SIGNS OF CONDENSATION, ALL WINDINGS SHOULD BE SUBJECTED TO INSULATION TESTS PRIOR TO OPERATING.

THE INSULATION TEST SHALL BE MADE BY SKILLED PERSONNEL.

G OUT THE TEST, THE VOLTAGE REGULATOR MUST BE DISCONNECTED; IF THE TEST RESULTS ARE TOO LOW (LOWER THAN 1 MΩ) THE ALTERNATOR MUST BE DRIED IN AN OVEN AT 50-60°C.

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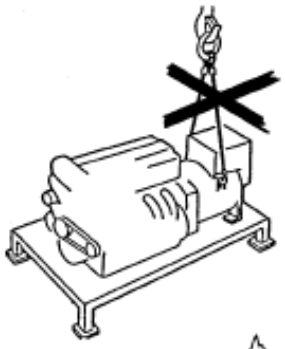
TRANSPORT AND STORAGE



Once the generator is coupled with an engine, mounted on a baseframe, or installed on a complete generating set, it cannot be lifted by its lifting bolts. The relevant instructions for lifting a complete generating set should be followed.

Any packing materials should be disposed of via correct waste disposal methods. Do not discard waste materials into the environment.

MECHANICAL COUPLING

For transit and storage purposes the generator flange spigot and the generator end shaft have been coated with a rust preventer that can be removed easily. This must be removed before assemblying to the engine.

The mechanical coupling is under the sole responsibility of the final user, and has to be done at his discretion.

Warnings:

BEFORE STARTING THE ALTERNATOR, CHECK THAT THE AIR INLETS ARE FREE OF ANY OBSTRUCTIONS.

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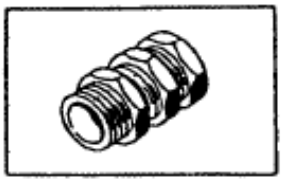
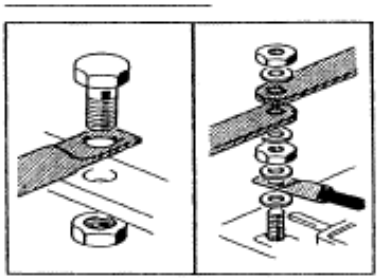
ELECTRICAL CONNECTIONS





DANGER

All electrical output connections are the responsibility of, and are at the discretion of, the end user.
When making terminal box connections, all cable and terminal lugs should meet the relevant standards of the country of final destination.

WINDINGS CONNECTION
All alternators feature star (Y) connections (

The alternator must always be earthed by sufficiently rated cable, using one of the inside or outside terminals.
After completing output connections (for tightening torque see tab. 5), ensure that the terminal box cover is securely in place.

IMPORTANT: frequency variations.
A standard production machine wound for 50 Hz can also function at 60 Hz (and vice versa) by resetting the A.V.R. voltage potentiometer to the new nominal voltage value. When changing from 50 to 60 Hz the alternator power, and nominal voltage will increase by 20%. Should voltage stay at 50 Hz nominal value, then the output power may be increased by 5% due to improved ventilation.
For machines wound for 60 Hz, changing to 50 Hz, the voltage and power values have to decrease by 20% of 60 Hz value.

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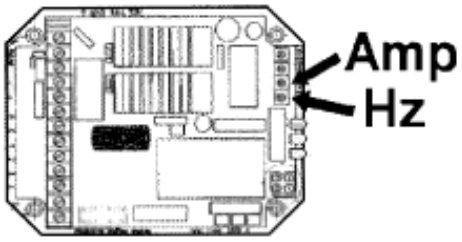
ELECTRICAL CONNECTIONS



PROTECTION

Regulators are provided with an underspeed protection with an intervention threshold which can be adjusted by the potentiometer marked "Hz". This protection intervenes instantaneously by reducing the alternator voltage to a safe value when frequency falls below 10% of the nominal value. These regulators also have inherent overload protection which senses the exciter field voltage value. Should this field voltage value exceed the nominal value for a period of more than 20 seconds, then again the alternator voltage is automatically reduced to a safe operating level. This overload function has a built -in delay to allow for the overload when starting motors (normally 5-10 seconds). The operating threshold of this protection device is adjustable by the potentiometer marked "AMP".

DIGITAL SIMPLIFIED REGULATOR

Please refer to the 'DSR Digital Regulator Instruction Manual' for the Digital Simplified Regulator

IMPORTANT

In normal functioning, only the green led has to be lit.

All these indicators can be remotely controlled and adjusted, for any type of use, by utilizing the SPD 96/A accessory which is available on request.

INTERVENTION OF PROTECTION DEVICES.

Underspeed protection instantaneous intervention :
1 - speed reduced by 10% of nominal RPM

Delayed intervention of overload protection :
2 - overload by 20% of nominal rating.
3 - power factor (cos φ) lower than the nominal one.
4 - ambient temperature above 50°C.

Intervention of both protections :
5 - combination of factor 1 with factors 2, 3, 4.

In case of intervention the output voltage will drop down to a value which will depend on the fault.
The voltage will return automatically to its nominal value as soon as the fault is removed.

For further details on regulators, please see the specific manual.

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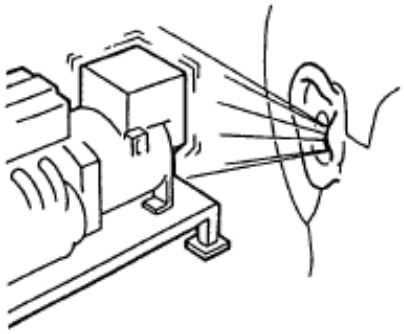
STARTING AND STOPPING OPERATIONS



All the instrumentation for starting, running and stopping the system shall be provided by the installer.

THE STARTING, RUNNING AND STOPPING OPERATIONS MUST BE CARRIED OUT BY SKILLED PERSONNEL WHO HAVE READ AND UNDER-STOOD THE SAFETY INSTRUCTIONS AT THE BEGINNING OF THIS MANUAL.

IMPORTANT :
When the system is set to work for the first time, which has to be done at a reduced speed, the operator shall check that no anomalous noises can be detected.
If an anomalous noise is detected, stop the system immediately and improve the mechanical coupling.

CLEANING AND LUBRICATION

Prior to approaching or touching the alternator, ensure that it is not live and it is at room temperature; at this stage it is possible to clean it on the outside using compressed air.

NEVER USE LIQUIDS OR WATER.

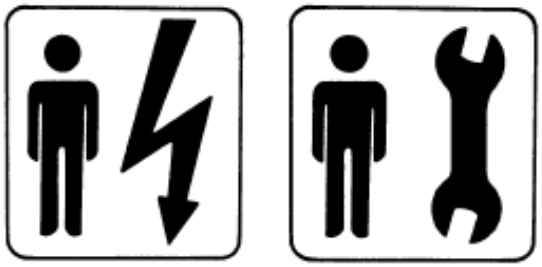
MAINTENANCE

DANGER

The A60411M43G & A80411M43G alternators are designed to give a long maintenance free working life.

BEFORE PERFORMING THIS OPERATION, READ THE SAFETY REQUIREMENTS AT THE BEGINNING OF THIS MANUAL CAREFULLY.

MAINTENANCE



Maintenance operations on Pyroban generators can be divided into routine and extraordinary maintenance operations; in both cases, all operations must be authorised by the safety representative and they must be carried out when the machine is turned off and insulated from the electric installation or from the power mains.
Qualified mechanical or electrical technicians must carry out maintenance operations and any fault search since all operations described hereunder could put personnel in serious danger.
It is also highly recommended to take all the necessary precautions so as to prevent an inadvertent starting of the machine during maintenance and fault search operations.

Routine maintenance operations can be summed up as follows:

a) Assessment of correct functioning (absence of anomalous noises or vibrations)

b) Mechanical inspections on all fastening bolts and, in particular, on electric connections

c) External cleaning of generator

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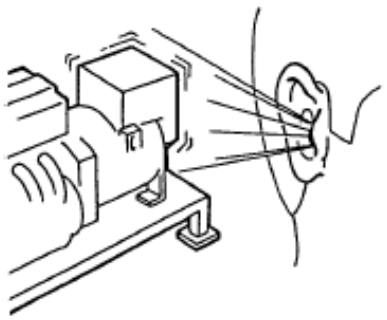
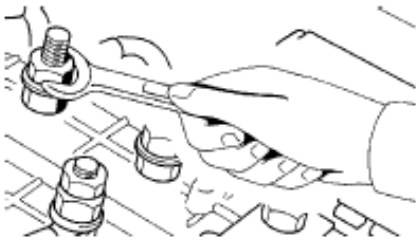


Assessment of correct functioning (absence of anomalous noises or vibrations).

We recommend users to check regularly (every 3 months at least) the correct functioning of the generator, and to verify that there are no anomalous noises or vibrations; their presence might indicate damage of bearings.

May we remind you that the alternator itself has no particular vibration since the rotating parts are perfectly balanced. Provided that the rotor balancing has not been altered and that the rotor's bearings have not been damaged, vibrations in the generator set may occur due to alignments of couplings, due to stress upon the combustion engine, or to vibration mounts.

We also recommend checking of performance data which must comply with the data on the generator's plate.



Mechanical checks of fastening bolts and, in particular, of electric connections.

We recommend a regular check (every 6 months at least) of all fastening bolts, which must be perfectly tightened up. Special attention should be paid to all electric connections; this inspection must be carried out in the complete absence of voltage.

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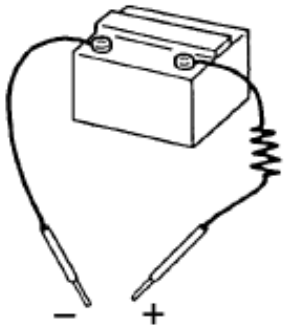
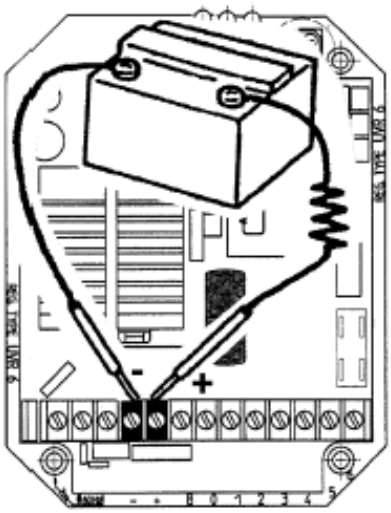
MAINTENANCE



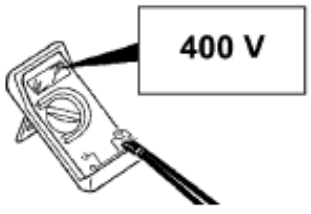
Remove lid from the terminals case

-) Connect two connecting wires to a 12 Vdc battery with a 30Ω in-series resistance



-) Follow the electrical diagram supplied by Pyroban, locate positive and negative terminals of electronic regulator

-) Start generator



-) Connect, only for a moment, the two connecting wires to the previously located terminals. Make sure to match polarities (positive terminal of regulator with positive terminal of battery, negative terminal of regulator with negative terminal of battery)

-) Use a voltmeter or the right

Internal and external cleaning of the generator.

For the external cleaning of the generator, you can use compressed air. The use of hydro-cleaners and detergent fluids is strictly forbidden.

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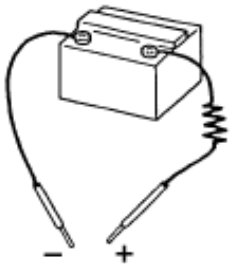
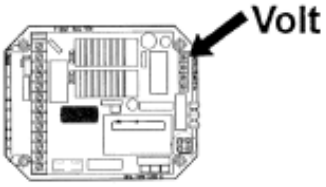
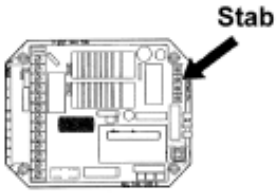
DEFECTS AND REMEDIES

	**ALTERNATOR DOES NOT EXCITE** - Substitute fuse in DSR - Increase speed by 15%. - For an instant apply on "+" and " -" of the electronic regulator a 12 V battery voltage with a 30 Ω resistor in series, respecting the polarities.
	AFTER BEING EXCITED ALTERNATOR DOES NOT EXCITE - Check connection cables as per attached drawings.
	LOW VOLTAGE AT NO LOAD - Reset voltage potentiometer - Check speed
	HIGH VOLTAGE AT NO LOAD - Reset voltage potentiometer. - Substitute regulator.
	**AT LOAD CONDITIONS, VOLTAGE LOWER THAN RATED VALUE** - Reset voltage potentiometer - Current too high, power factor lower than 0.8, speed lower than 4% of rated speed - Substitute regulator
	AT LOAD CONDITIONS, VOLTAGE HIGHER THAN RATED VOLTAGE - Reset voltage potentiometer. - Substitute regulator.
	**UNSTABLE VOLTAGE** - Check uniformity of rotation. - Regulate stability of regulator by acting on "STAB." potentiometer.
Dolphin Road, Shoreham-by-sea, Sussex BN43 6QG, UK t: +44 (0) 1273 456800	For any other defect, please contact Pyroban directly.

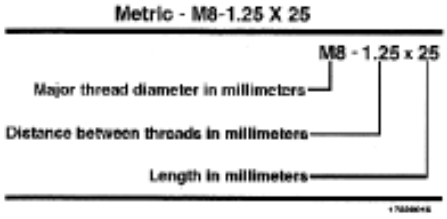
Capscrew Markings and Torque Values

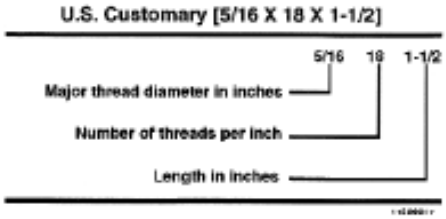
△ CAUTION △

When replacing capscrews, always use a capscrew of the same measurement and strength as the capscrew being replaced. Using the wrong capscrews can result in engine damage.

Metric capscrews and nuts are identified by the grade number stamped on the head of the capscrew or on the surface of the nuts. U.S. Customary capscrews are identified by radial lines stamped on the head of the capscrew.

The following examples indicate how capscrews are identified:

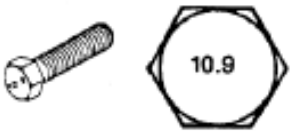




NOTES:

1. **Always** use the torque values listed in the following tables when specific torque values are **not** available.
2. Do **not** use the torque values in place of those specified in other sections of this manual.
3. The torque values in the table are based on the use of lubricated threads.
4. When the ft-lb value is less than 10, convert the ft-lb value to in-lb to obtain a better torque with an in-lb torque wrench. Example: 6 ft-lb equals 72 in-lb.

Capscrew Markings and Torque Values - Metric

Commercial Steel Class	8.8	10.9	12.9
Capscrew Head Markings			

Body Size	Torque				Torque				Torque			
Diameter	Cast Iron		Aluminum		Cast Iron		Aluminum		Cast Iron		Aluminum	
mm	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb	N•m	ft-lb
6	9	5	7	4	12	9	7	4	14	9	7	4
7	14	9	11	7	18	14	11	7	23	18	11	7
8	25	18	18	14	33	25	18	14	40	29	18	14
10	45	33	30	25	60	45	30	25	70	50	30	25
12	80	60	55	40	105	75	55	40	125	95	55	40
14	125	90	90	65	165	122	90	65	195	145	90	65
16	180	130	140	100	240	175	140	100	290	210	140	100
18	230	170	180	135	320	240	180	135	400	290	180	135

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WARRANTY

A
Pyroban warrants the good manufacture and quality of all its products during the 12 months starting from the time of delivery to the user.

B
During the said period, Pyroban obliges to repair and replace at its cost, all those parts which failed without any other liability of any type, direct or indirect.

C
The decision for warranty approval is Pyroban's exclusive right and subject to a previous examination of the failed parts which are to be forwarded to Pyroban in Shoreham-by-Sea for analysis.

D
All the eventual expenses concerning travel, board, transport, and labour for assembly/disassembly of the alternator from the drive unit are always at the user's charge.

E
The warranty shall be void if during the above prescribed period the following anomalies should occur

1
Inadequate storage

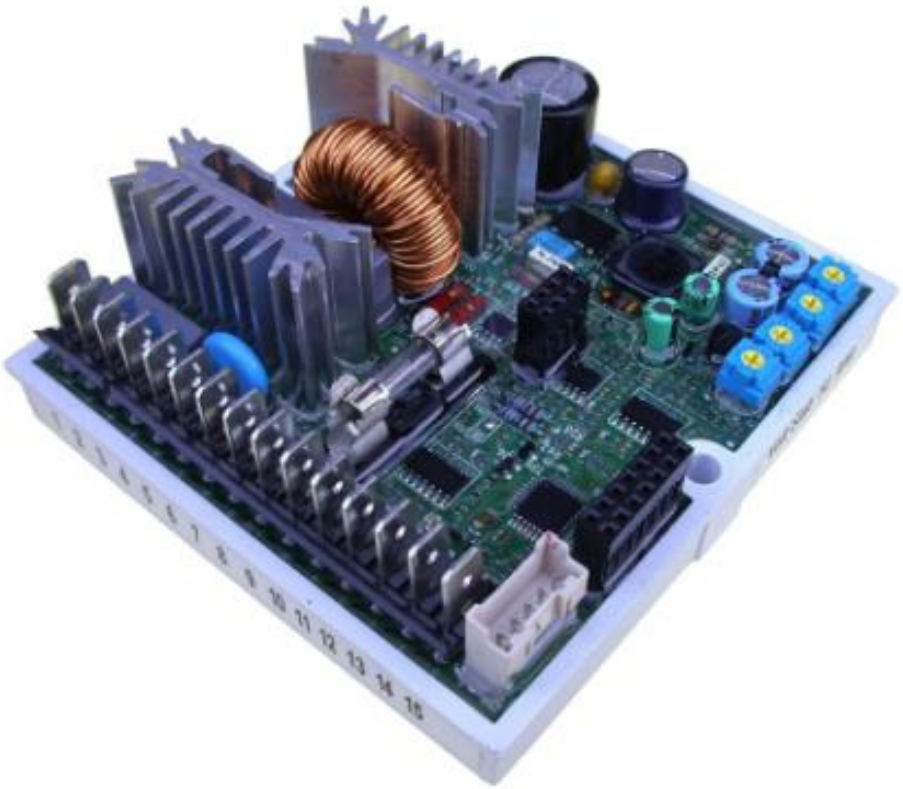
2
Repair or modification by unauthorized personnel

3
Use or maintenance conditions which do not conform with norms established by Pyroban

4
Overload or application other than what the product was meant for

Warranty coverage also expires whenever the client, for whatever reason is late in payment,

Appendix C – DSR Operation



DSR DIGITAL REGULATOR

INSTRUCTION MANUAL

CE

 Document number: OG030 Date of Issue: 22/02/2022 Revision 3
Pyroban Ltd, 23 Dolphin Road, Shoreham-by-Sea, West Sussex, BN43 6PB, United Kingdom
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INTRODUCTION

This manual contains information on the operation and use of the DSR 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 DSR is a voltage regulator for synchronous alternators, designed for stand alone working and calibration; to maximize performance, the regulator should be understood as part of a system made up of at least three components: the DSR (control unit), a communications module (DI1, for example) and a supervision unit, as illustrated in figure 9 or 10.
The connectors for connection to and from the power generator and communications module are located on the DSR 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 DSR.
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.
The regulator is available in two versions called DSR and DSR/A, the first is the standard one, optimized for Pyroban alternators from series 3 to 40, the second is optimized for Pyroban alternators series 43-46; the two versions differ only in some 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 DSR) 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

- Full digital controlled regulator, based on DSP
- On-board machine installation
- Suitable for all self-regulated alternators
- Voltage supply: 40Vac÷270Vac (from auxiliary winding, output voltage or PMG)
- Frequency range: 12Hz ÷ 72Hz
- "Sensing" of voltage with true rms or average measurement (70÷280 Vac)
- Maximum continuous output current: 4Adc;
- 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.
- Transient power drops and overvoltage within ± 15%

- Voltage recovery time within ± 3% of the value set, in less than 300 msec.
- Transient overvoltage during start up: less than 5% of nominal voltage.
- Single phase sensing
- Parameters: VOLT, STAB, AMP and Hz can be set with trimmers (default) 50/60Hz through a "jumper" (default); all parameters can be programmed via software.
- Analogical remote control of output voltage is possible through external voltage (0÷2,5Vdc) or with a 10 Kohm linear potentiometer.
- Environmental temperature: -25°C ÷ +70°C
- 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 intervention of protective devices (insulation on optional DI1 module) with programmable activation with respect to the individual alarms and the possibility to delay intervention.
- Abnormal operation conditions storage (type of alarm, number of events, duration of the last event, total time)
- Memorization of the regulator operation time (starting from revision 11 of the Firmware)
- RS232 and RS485 serial communications interface (with optional DI1 module).

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

3. Inputs and Outputs: technical specifications

TABLE 1 : CONNECTOR CN1

Terminal [1]	Name	Function	Specifications	Notes
1	Exc-	Excitation	Continuous Rating: 4Adc Transitory Rating: 12Adc at peak	
2	Aux/Exc+			
3	Aux/Exc+	Power	frequency: from 12Hz to 72Hz Range: 40Vac - 270Vac	
9	Aux/Neutral			
4	F_phase	Sensing	Range: 140Vac - 280Vac Burden: <1VA	Measurement of average value (rectified) or actual effective value for voltage adjustment
5	F_phase			
6	H_phase		Range: 70Vac - 140Vac Burden: <1VA	
7	H_phase			
8	Aux/Neutral			
10	Vext/Pext	Input for remote voltage control	Type: Not insulated Range: 0 - 2,5 Vdc or 10K Potentiometer Adjustment: from – 14% to + 14%[3] Burden: 0-2mA (sink) Max length: 30 m[2]	Tolerates voltages from – 5V to + 5V but for values exceeding the range it is automatically disabled
11	Common			
12	50/60Hz	50/60 Hz Jumper Input	Type: Not insulated Max length: 3 m	Selection of underspeed protection threshold 50·(100%-αHz%) or 60·(100%-αHz%) αHz% is the position relative to the Hz trimmer or the parameter 21
13	Common			
14	A.P.O.	Active protections output	Type: Non-insulated open collector Current : 100mA Voltage: 30V Max length: 30 m[2]	Both activating alarm and delay time are programmable
15	Common			

Note 1) The terminals are connected to each other on the board: 2 with 3, 4 with 5, 6 with 7, 8 with 9, 11 with 13 and 15.
Note 2) With external EMI filter (3m without EMI filter)
Note 3) starting from revision 10 of the Firmware. It is convenient do not exceed ±10%

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TABLE 2 : TRIMMERS		
Name	**Function**	**Notes**
VOLT.	Voltage Calibration	From 70Vac to 140Vac or from 140Vac to 280Vac, 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

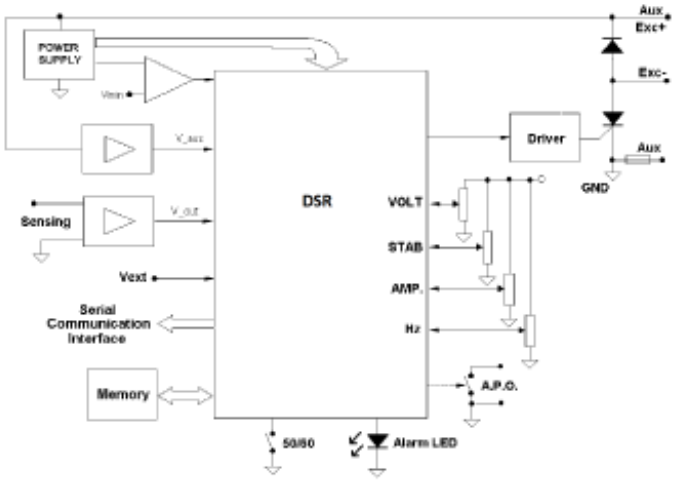

fig.1

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 Pyroban immediately. If the regulator is not installed immediately, store it in its original packaging in a dust and humidity-free environment.
The regulator is fixed with two M4x20 or 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

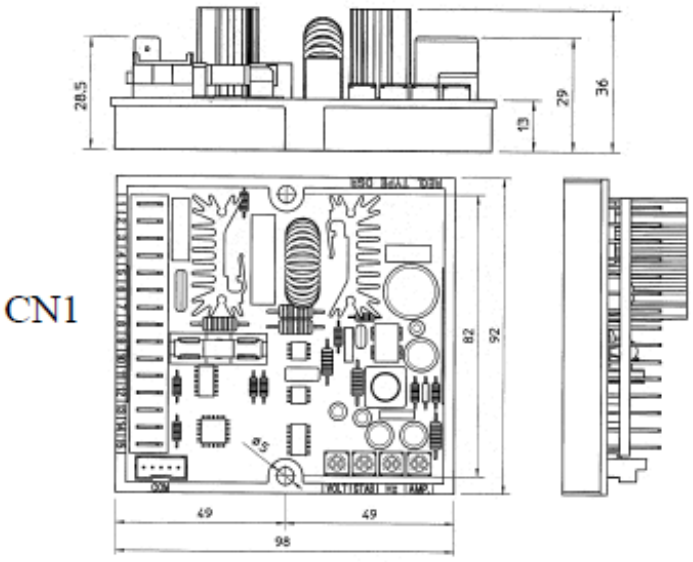

fig.2

dimensions in mm

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2. Connections

The digital regulator connections depend on the application and excitation system.

An error in connection may have serious 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:

- for power cables on terminals 1, 2, 3 and 9 (Exc-, Aux/exc+, Aux): **1.5 mm²**
- for signal cables: **1 mm²**

4. DSR connections for typical applications

Refer to the diagram on page 7

5. Setting up the regulator

Refer to the block drawing on figure 1.

5.1 Alternator voltage signals

Terminals 4, 5, 6, 7 and 8 of connector CN1 are used for voltage sensing.

5.2 Calibrating sensing

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

1. Write **16384** on location 19
2. disable the Trimmers (from the **Configuration** Menu)
3. Disable Vext (from the **Configuration** Menu)
4. Set the adjustment on the average or effective value (from the **Configuration** Menu)
5. Measure the voltage with a suitable instrument for the type of adjustment made (average value or rms value)
6. Set the value at location 5 (or 6) until the voltage value, measured with the instrument, reaches 210 V (if the sensing is connected to terminals 4 or 5) or 105V (if the sensing is connected to terminals 6 or 7), keeping in mind that an increase in the value set provokes an increase in adjusted voltage and vice versa.
7. In order to ensure that the value of voltage (available also at location 36) is the same as the value measured at point 6, calibrate the data at location 7, reading the value in the first "STATUS" box (ref. DSR Terminal Software).
8. Enable the trimmers you want to be active (from the **Configuration** Menu)
9. Enable Vext (from the **Configuration** Menu) if you want to be active

5.3 50/60 Signal

A jumper is located on the 50/60 input (connector CN1, terminals 12 and 13); 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 21 (where 10% corresponds to 16384).

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6. Serial communications

The DI1 communications module (which is provided for connection to the COM connector of the DSR) 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.
Given the type of communications bus, it is possible to connect several DI1-DSR groups (and therefore several generators) in parallel on the same 485 Bus, so as to monitor their operation with a single supervision unit.

7. APO Contact

The acronym **APO** stands for Active Protection Output: (connector CN1 – terminals 14 and 15) 30V-100mA non-insulated open collector transistor, normally open, 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.

8. 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 70V to about 140V or from about 140V to about 280V.
The **STAB** trimmer adjusts the dynamic response of the alternator under transient conditions.
The **Hz** trimmer allows a variation up to - 20% with respect to the nominal speed value set by jumper 50/60 (if it is active) or from box 50/60 of 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.

9. Vext Input

The Vext input (connector CN1 – terminals 10 and 11) permits analog remote control of output voltage through a 10Kohm potentiometer with a programmable variation range through parameter 16 with respect to the value set (by default the setting is ±14% starting from revision 10 of the Firmware); if you want to use continuous voltage, it will be effective if it is in the range between 0V and +2,5V. The input tolerates voltages from –5V to +5V, but for values exceeding the limits of 0V / +2,5V (or in the event of disconnection) it is automatically disabled and the voltage adjustment goes back to the value set through the trimmer (if enabled) or through parameter 19.

NOTE : The DC voltage generator must be able to sink at least 2mA
During regulation it is convenient to not exceed more than ±10% of the alternator nominal voltage.

SERIAL CONNECTION

The serial communications interface unit DI1 is of the RS232 or RS485 type; the regulator implements a subsystem of the MODBUS standard for communications; the DI1 - DSR 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 Pyroban 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.
- Interface conversion towards other field buses or communications networks.

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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 this regulator are available: DSR and DSR/A; they differ only in some default parameters. Table 3 shows a complete list of the parameters that can be set, which define all the operational conditions of the regulator.

Add.	Description of Parameter	Range	Default		NOTES
			DSR	DSR/A*	
0	Reserved	0..65535	11	11	Firmware revision - Do not write
1	ModBus slave address	1..31	1	1	Identification of RS485 network (or broadcast)
2	Reserved	0..65535	18	2578	Software configuration - Do not write
3	Reserved	16bit	0	0	Serial number, high part - Do not write
4	Reserved	16bit	0	0	Serial number, low part - Do not write
5	RMS sensing calibration	0..32767	16384	16384	Calibration of voltage channel in RMS adjustment
6	AVG sensing calibration	0..32767	16384	16384	Calibration of voltage channel in AVG adjustment
7	Measured voltage calibration	0..32767	16384	16384	Calibration of location 36 (first "STATUS" box)
8	Free for future use	16bit	0	0	Do not write
9	Free for future use	16bit	0	0	Do not write
10	Word configuration	16bit	7965	7965	Set from "Configuration" Menu
11	Shift to LEFT proportional gain	0..6	4	5	n=0…6 is equivalent to a multiplication by 2, namely 1, 2, 4, 8, 16, 32, 64.
12	Shift to LEFT integral gain	0..6	3	1	
13	Coefficient tying 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 is disabled
16	Limitation of Vext Variation	0..3277	4608*	4608*	Limits the effect of external analog 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 in 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 Gradient	0..32767	9000	9000	V/F curve gradient during normal operation
24	V/F curve gradient at start up	0..32767	12000	12000	Used only upon start up
25	Short circuit time [0=excluding STOP]	0..255	20	20	Operating time with short circuited alternator, expressed in tenths of seconds (0 ..... 25.5 seconds)
26	Overspeed threshold	+- 32767	0	0	Variation (±10%) of overspeed alarm intervention with respect to the default value of 55/66Hz
27	Reserved	0..32767	6553	6553	Do not write
28	Ki over-excitement Regulator	0..32767	12287	12287	Integral and proportional gain of excitation voltage regulator in the event of AMP alarm
29	Kp over-excitement Regulator	0..32767	24575	24575	
30	Thermal dispersion coefficient	0..65535	63600	63600	Used by AMP alarm temperature estimator
31	Reserved	0..65535	-	-	Do not write

** Starting from revison 10 of the Firmware*

Table 3: EEPROM setting registries

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.

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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	STATUS 0	0..3200	Read only	First status word (Vout) [tenths of volts]
37	STATUS 1	0..900	Read only	Second status word (freq.) [tenths of Hz]
38	STATUS 2	16bit	Read only	Third status word (Alarms)
39	STATUS 3	16bit	Read only	Fourth status word (Configuration)
40	Commands	16bit	Write	Reserved Word Commands – Do not use
41	VEXT_SAMP	0..32767	Read only	Vext Trimmer Value
...	...			...
45	Estimated temperature	0..32767	Read only	Estimates temperature of excitement windings
...	...			...

Table 4: Recapitulation of the locations used during the calibration

SETTING OF VOLT, STAB, AMP AND Hz PARAMETERS

1. Voltage

1.1 Setting voltage

Measurement of the rms or average value is decided from the **Configuration** Menu.
The voltage setting may take place through the trimmer or software; the sensing input range on CN1-6 and CN1-7 is 70÷140 Vac; the sensing input range on CN1-4 and CN1-5 is 140÷280 Vac.

There are two ways to set the value from the minimum to the maximum:

1. Through the VOLT trimmer, which must be enabled from the Configuration Menu.
2. Through parameter 19 (the Volt trimmer must be disabled from the Configuration Menu: A value of 0 corresponds to minimum voltage, 16384 corresponds to the intermediate value (respectively, 105V and 210V), while 32767 corresponds to the maximum voltage.

For standard voltage values refer to table 5.

Voltage CN1 4&5	Voltage CN1 6&7	Volt Trimmer (Location 32)	Parameter 19
173	-	7724	7724
-	127	26683	26683
200	100	14043	14043
208	104	15916	15916
220	110	18725	18725
230	115	21065	21065
240	120	23406	23406
266	133	29491	29491
277	138,5	32066	32066

tab. 5

It is possible to vary the voltage through the Vext input as well (connector CN1-10 and CN1-11), providing it has been enabled from the **Configuration** Menu, through a 10Kohm potentiometer with a programmable variation range of up to ±100% (parameter 16; the default setting is ±14%, even if it is convenient do not exceed more than ±10%), or through a continuous voltage, which will be effective it is in the range between 0V and +2,5V, or even through parameter 15 (if the Vext input is disabled).

1.2 Slow voltage variations

In the event of rapid variations of the reference due to sudden power being supplied to the regulator, or setting of voltage from a remote location (through the Vext analog input or serial input), a "soft" mode of variation has been provided. In response to a small step variation, parameter 18 determines the speed at which the transition will be performed.

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A value of 1 determines the slowest possible variation, while a value over 100 permits almost immediate variation (see fig. 3). A value of 0 disables any variation.

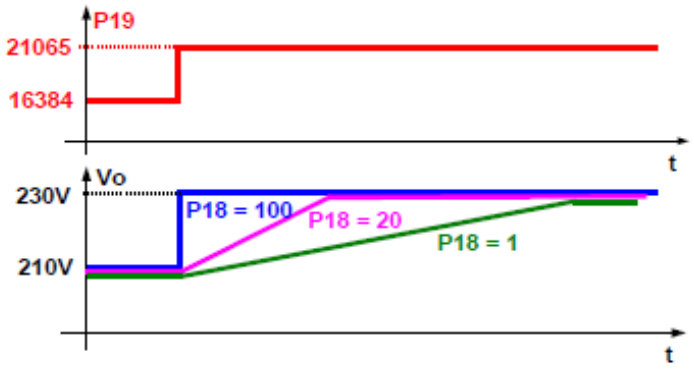

fig. 3

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 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 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 location 11 (for proportional gain) and 12 (for integral gain). This value represents the exponent assigned to base 2 (fixed) to obtain the desired gain (i.e. parameter 11 = 4 = > coefficient = 2^4= 16).
The regulator diagram is shown in figure 4.

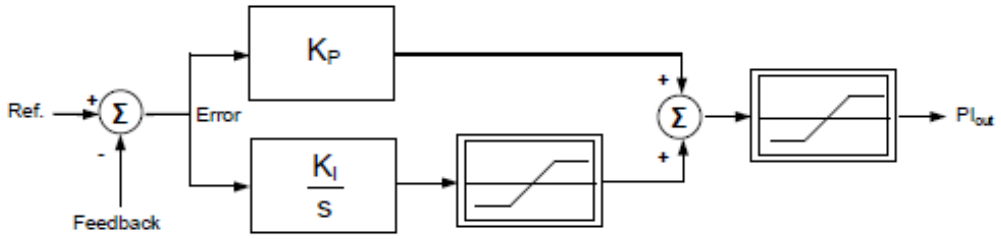

figure 4 : Regulator Diagram

3. EXCITATION OVERCURRENT

3.1 Description

The DSR 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 45. The progress of the temperature is of the exponential type (see figure 5).

Through parameter 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 28 and 29. The default values are suitable for the great majority of machines.

WARNING !
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 28 and 29 (in general it is sufficient to lower parameter 28).

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As you can see in figure 5, when the estimated temperature (represented by the continuous line) reaches the threshold value set in parameter 22, the reduction of excitation current (and consequent drop in voltage generated) brings about the stabilisation of the temperature near a limit value.

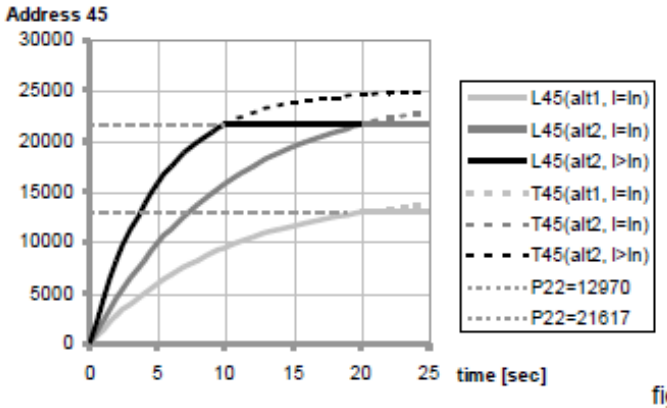

fig.5

Curve Description

L45 (alt1, I=In) : value read at location 45 with a certain alternator [1]
L45 (alt2, I=In) : value read at location 45 with a second alternator of a different type [1]
L45 (alt2, I>In) : value read at location 45 with the second alternator during overloading [2]
T45 (alt1, I=In) : value that would be read at location 45 with the first alternator, without protection [1]
T45 (alt2, I=In) : value that would be read at location 45 with the second alternator, without protection [1]
T45 (alt2, I>In) : value that would be read at location 45 with the second alternator during overloading, without protection [2].
P22=12970 : value that must be entered at location 22 for the first alternator
P22=21617 : value that must be entered at location 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 location 21.
2) Rotate the AMP trimmer completely in the clockwise direction (if it has been enabled from the **Configuration** Menu) or enter 32767 at location 22.
3) Apply the nominal load to the alternator.
4) Decrease the speed by 10%
5) Read the value shown at location 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 45); otherwise (trimmer not enabled) enter the value read at point 5 (location 45) at location 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) .

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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 6. The intervention threshold depends upon:

- the status of jumper 50/60 (connector CN1 - terminals 12 and 13) 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 location 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 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 6. **Parameter 23** sets the slope of the voltage/frequency curve; the default value is 9000. An increase in the value of P23 involves a greater reduction of the voltage as a function of the reduction in frequency. A decrease in the value of P23 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 frequency and 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 12 and 13 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 34, otherwise it is entered directly at location 21.
   The value 16384 entered at location 21 (or read at location 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 12 and 13 of the CN1 connector.
3) Bring the generator to 90% of the nominal speed.

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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.
4) By increasing speed, the generator voltage will normalise and the alarm will disappear.
6) Set the speed to the nominal value

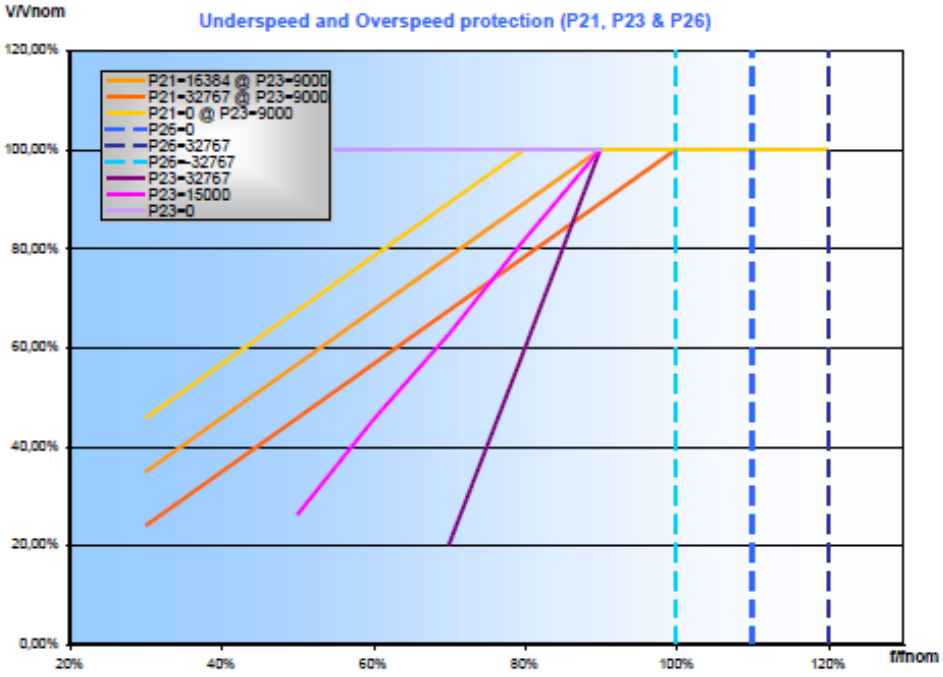

figure 6 : Parameters 21, 23 and 26

5. Overspeed

Parameter 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 6.

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 DSR be powered through an auxiliary winding, it must be borne in mind that the voltage generated by the winding (Vaux) may not have the same Vout value; Vaux is considered to be proportionate to Vout and the proportional coefficient is determined by **parameter 14.**

If the DSR is powered directly by the regulated phase, parameter 14 should be set on 0; in case it is powered by auxiliary winding, the voltage (Vaux) must be measured, in no-load conditions and with output voltage regulated on the nominal value (Vout); the value of parameter 14 can be obtained with the following formula:

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

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6.2 V/F slope at start up

Parameter 24 sets the gradient of 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 12000; an increase in the value of P24 will cause a greater reduction of low frequency voltage; a decrease in the value of P24 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 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

1. Summary of events

N.	Description of event	Action
1	Checksum EEprom	Reset default data - Blockage
2	Over voltage (@ $\dot{u}_N$)	APO
3	Under voltage (@ $\dot{u}_N$)	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

Table 6 : Alarms list

The status of active alarms is stored at location 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.

Location 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	-	-	-	-	Overspeed	Underspeed	OverExcitation	Cto.Cto.	Under voltage	Over voltage	Check sum

Table 7 Alarm flags at location 38

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

Alarm signals with the indicator lights

During normal operation and a duty cycle of 50% (OK in fig. 7) 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. 7.

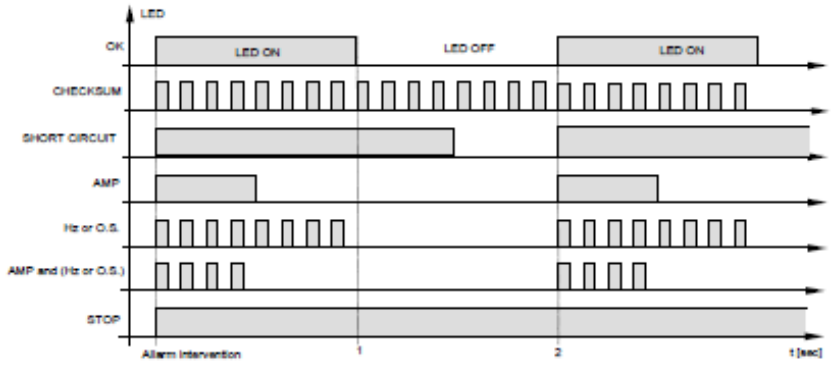
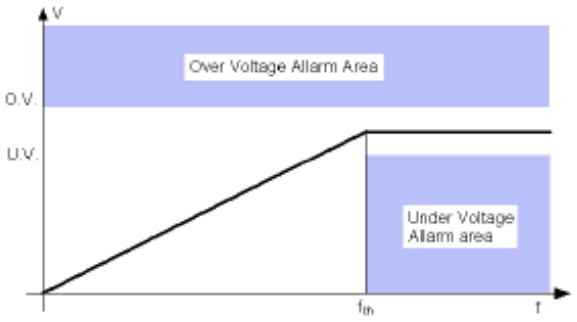


figure 7

2. 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	Overvoltage	The alarm is not visualised, the APO output is active and 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 overvoltage is calculated 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	Undervoltage	The alarm is not visualised, is stored and the APO output is active. The undervoltage is calculated as a function of the speed (which can be seen in the description of the overvoltage alarm): in the template for the calculation the threshold is set at under 5% off the nominal value. It intervenes only above the underspeed alarm threshold; it is practically inhibited by this. It is also inhibited in the event of intervention of the Excitation overvoltage 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, an adjustment ring takes control of the voltage generated when the threshold set is exceeded. The action involves reduction of the excitation current and therefore output voltage. The available parameter is the "threshold", which determines the value of equilibrium 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 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 overvoltage as in the case of capacitive load. The threshold can be set with parameter 26.

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

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3. APO Output

The APO output (Active Protection Output-open collector transistor – connector CN1 - terminals 14 and 15) 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 **location 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 location 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 location 17:

a) With reference to table 8 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 location 17 (in the previous example 20480 + 66 = 20546).

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

Table 8: alarm settings that act on the APO

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 38.
When we see one alarm, the A12 is deactivated, bit 11 is reset at location 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 refer to the function "Download Alarm" at the paragraph "Description of function" of chapters "USE OF PROGRAMMING SOFTWARE. AND MONITORING OF THE DSR TERMINAL" and "APPENDIX A".

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DI1 COMMUNICATIONS UNIT

Description:

The DI1 interface device (fig. 7) permits connection of the DSR digital regulator to a programming and monitoring device, whose functions may include the following:

- Repetition, or visualisation, of the status 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. The COM connector of the DSR regulator is connected to the CN2 connector of the DI1 interface with the special cable supplied by Pyroban.
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], TxRTS, RxRTS)

The connection between one DSR regulator and a PC is shown in fig. 9.
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. 10.

The DI1 interface also permits isolation of the A.P.O. contact of the regulator : terminal 14 of the DSR must be connected to terminal 5 of CN1 (as indicated with the dotted line in fig. 8).
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 regulator and the CN2 connector of the DI1 interface MUST be connected.

Note 1) DTE = Data Terminal Equipment
Note 2) Current on resistive load

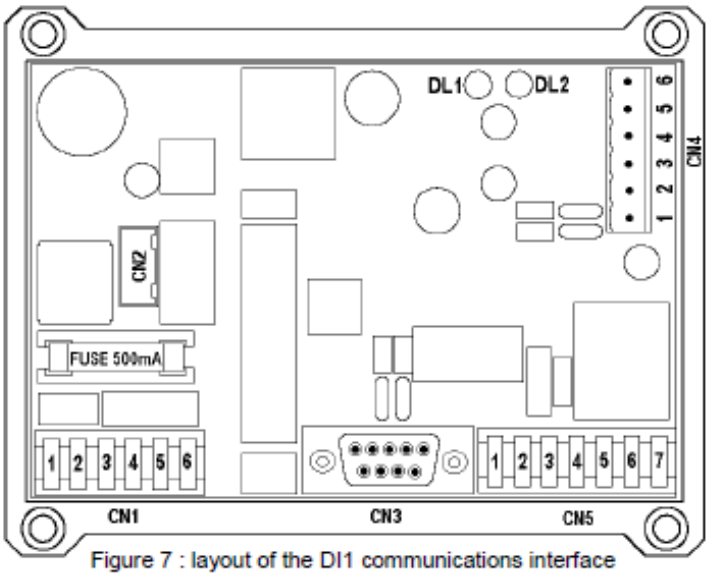

Figure 7 : layout of the DI1 communications interface

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Powering DI1

The DI1 board must be powered separately :

1) On connector CN1 (terminals 1-2 and 3-4) through the same power as the DSR; for this purpose, the power terminals on CN1 have been duplicated (Fig. 8)
2) On connector CN1 (terminals 1 and 4) 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 regulator, the DI1 interface and the connected devices.

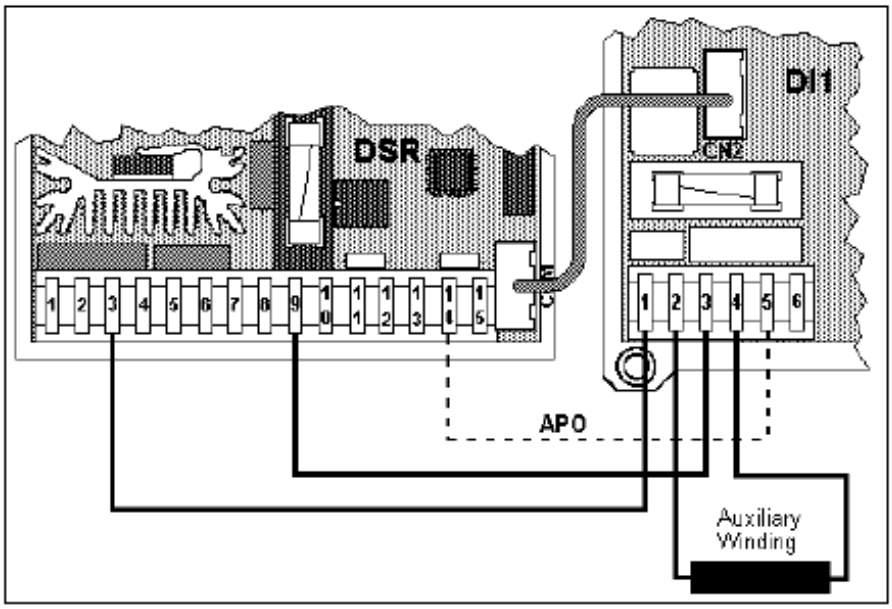


Figure 8 : Example of power and connection (optional) of APO signal

3. Inputs and Outputs: Technical Characteristics

TABLE 9: 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 to have the APO output isolated (CN5 3-4) or APO Relay (CN5 5, 6 and 7)
6	DSR Common			

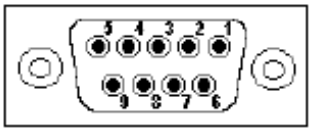
TABLE 10: CONNECTOR CN3				
DIAGRAM	**Pin N°**	**Function**	**Specifications**	**Notes**
	1	-	Not connected	Reading and writing of operational parameters, reading of stored alarms. A standard serial cable may be used with 9 pin SUB-D connectors.
	2	232 - TX	RS232 TX - Insulated	
	3	232 - RX	RS232 RX - 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 11: 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. 10)
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 12: CONNECTOR CN5				
Terminal	**Name**	**Function**	**Specifications**	**Notes**
1	232/485 GND		Voltage: 9 - 14V Current : 100mA	
2	VDC	External power		
3	APO1		Type of contact: Insulated 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	Type of contact: Insulated 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		

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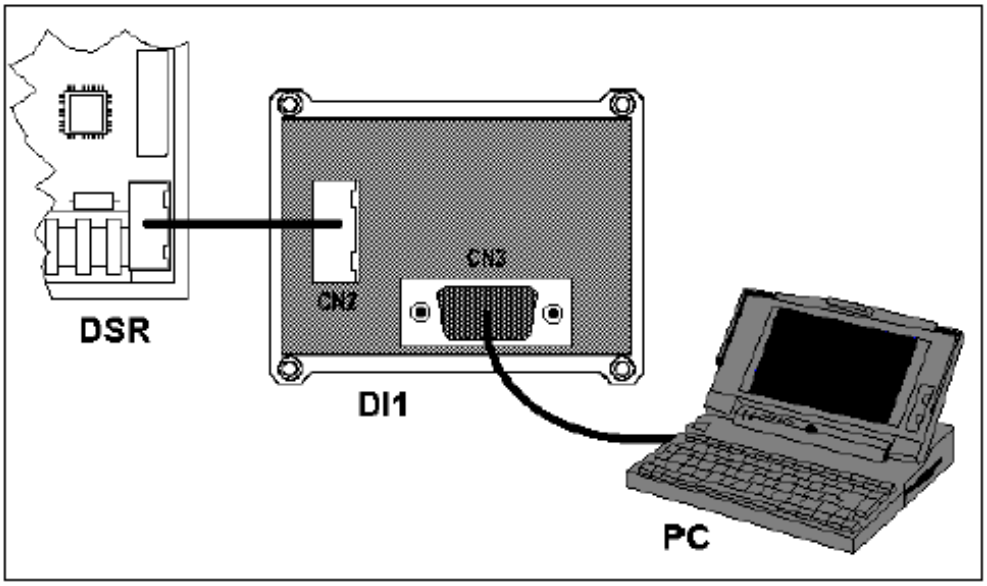

Figure 9 : RS232 connection between one DSR regulator and PC, through DI1 digital interface.

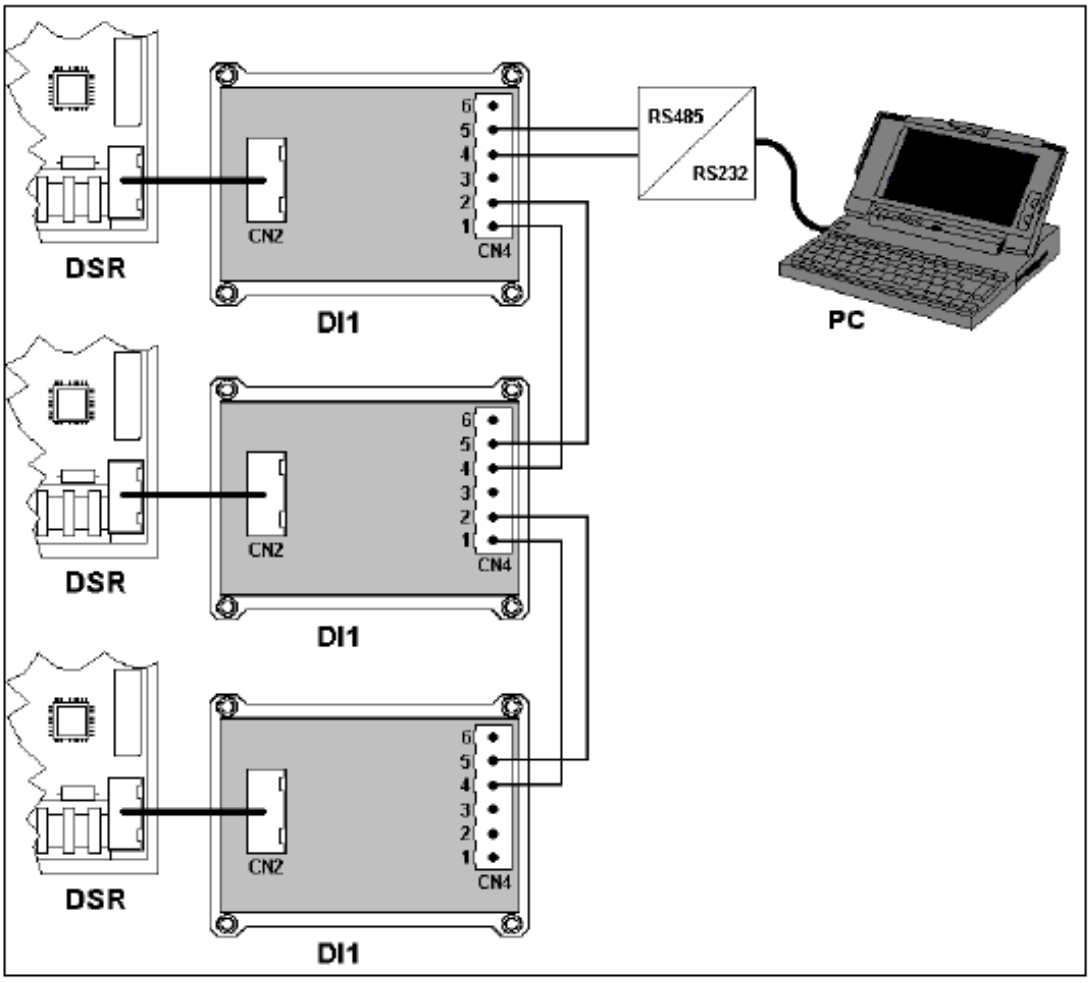

Figure 10 : R485 connection between DSR regulators and PC, through DI1 digital interface.

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USE OF PROGRAMMING SOFTWARE AND MONITORING OF THE 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 a 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 11.
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 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 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).

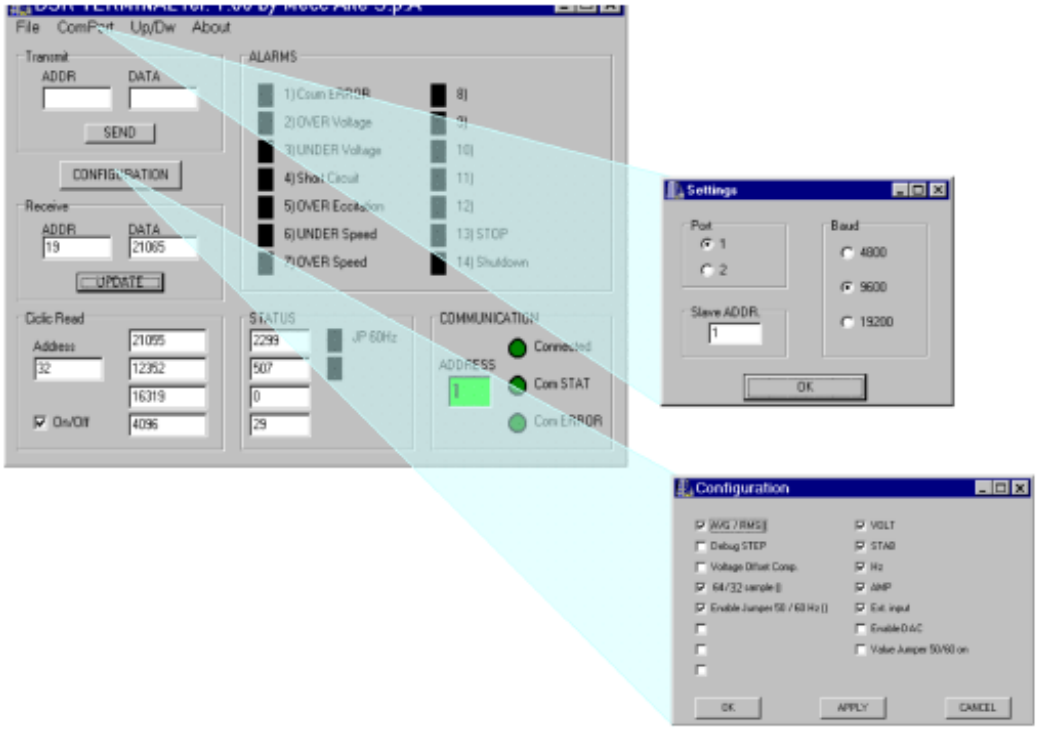

Fig. 11. DSR Terminal user Interface: Settings and Configuration Menu

3. Description of Function

The DSR Terminal user Interface is presented as shown in figure 12 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 13.
The DSR Terminal user interface is divided into 6 areas with different functions.

Transmit : Handles data transmitted towards slave units (DSR)

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

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

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

ALARMS : Displays active alarms (alarms and individual word alarm flags are shown in table7).

COMMUNICATION : Displays the status of communication

The *Configuration* Menu

The *Configuration* Menu is indicated in figure 13; it permits setting of configuration flags of the DSR regulator (parameter 10).

File Menu

The *File* Menu presents the single option of Exit, to close the DSR 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 3.
There are three possible options:

1. **Upload Data** The "Upload" window opens
   - The key **Open** allows selection of files with the .dat or .set etension, which must be loaded.
   - The **Upload** key unloads the parameters of settings files into the DSR 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.

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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.**
- 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

```
% PYROBAN Ltd.
% Digital Regulator for DSR Synchronous Alternators
% Settings file
%
% Version of parameters: 11
% Alternator type:       ECO3, ECO28, ECP34, ECO38, ECO40
% Date:                  23/03/09
% Configuration: RMS, Offset compensation, 32 samples,
%                Jp 50/60, trimmers and Vext enabled
%                Connected HW 50/60 and Jp on Pext
%
8  0      Not used
9  0      Not used
10 7965   Configuration Word
11 4      Shift to LEFT proportional gain
12 3      Shift to LEFT integral gain
13 16384  Coefficient tying Ki to Kp
14 6000   Vout/Vaux Ratio
15 16384  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 12000  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
```

Example of .set file

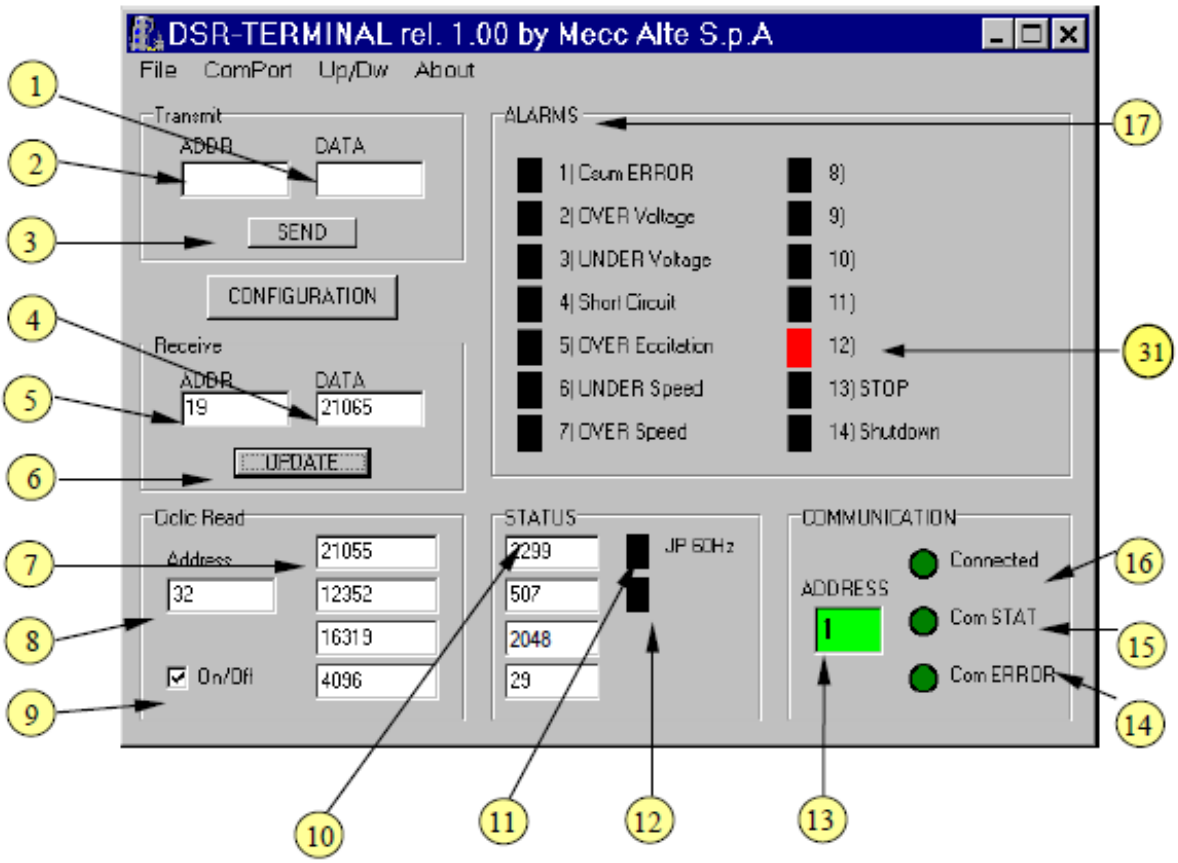

Fig. 12 DSR Terminal User Interface

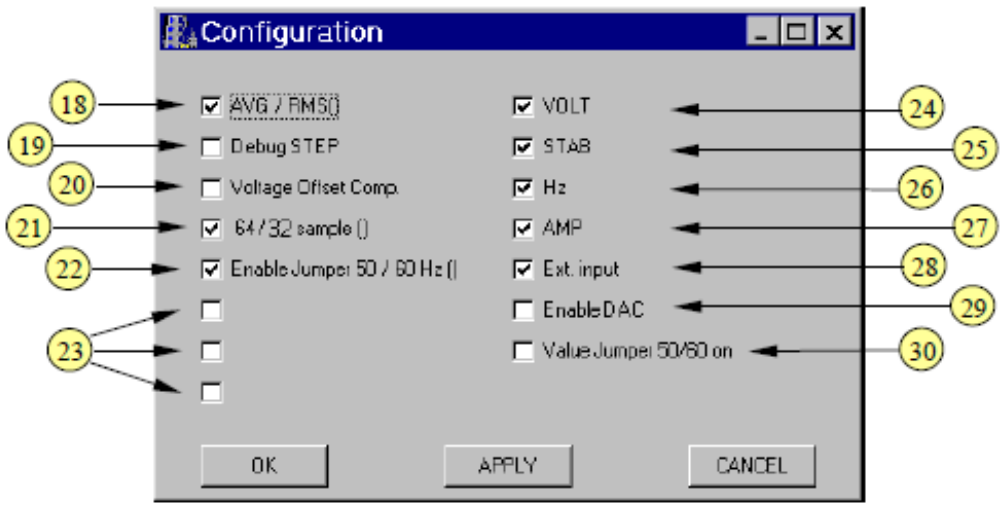

Fig. 13 Configuration Menu

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	Not used
13	Address of Slave with which the unit is communicating
14	Communications error (red indicator)
15	Connection fault (red indicator)
16	Connection and communications working indicator
17	Active alarms signal
18	Setting the regulation on the RMS value
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
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)

Table 13: Functions of the main DSR Terminal panel of the Configuration Menu

APPENDIX C1: USE OF MONITORING SOFTWARE "DSR_Reader"

1. Installation

Run the "install.bat" program from Windows
This creates the directory C:\dsrread, with the executable code, and creates the shortcut on the desktop.
Launch the DSR_Reader program from the Windows desktop.

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*** (10) goes from yellow to green.
If the communication takes place without errors, the ***Com STAT*** indicator (11) goes from red to green.

IMPORTANT: The communication may take place only if all three of the indicators ***Connected*** (10) ***Com STAT*** (11) ***and Com ERROR*** (12) are green.

The ***ADDRESS*** window (9) indicates the slave address with which it is communicating, almost in real time.

The ***Connect / Disconnect*** pushbutton (2) activates or deactivates the connection with the slave unit (DSR regulator)

Communication

The *ComPort* menu has 2 functions:
1. Connect activates or deactivates the connection with the slave unit (DSR regulator)
2. Settings opens a window (as shown in figure 14), 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 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).

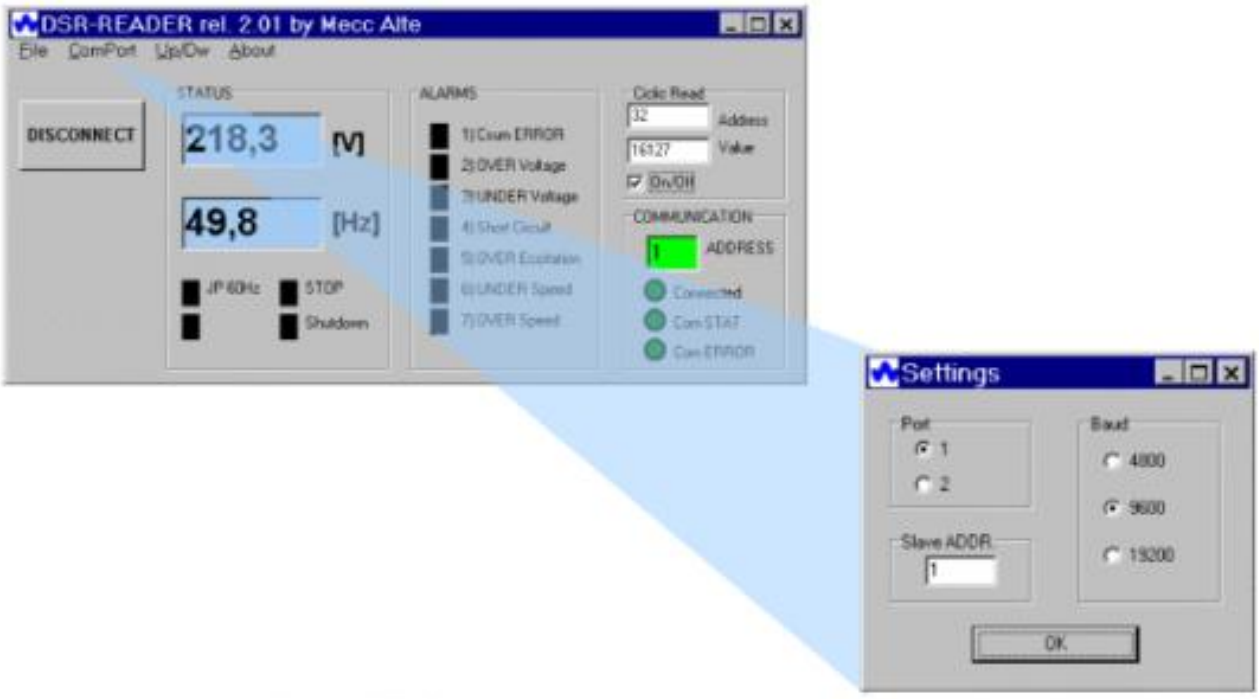

Fig. 14: DSR_Reader user interface and Settings menu

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3. Description of Function

The DSR_Reader user Interface is presented as shown in figure 15 and permits 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 14.
The DSR Terminal user interface is divided into 4 areas with different functions.

STATUS : Displays the measured voltage and the measured frequency (registries 36 and 37).

ALARMS : Displays active alarms.

Cyclic Read : Displays, almost in real time, a single datum requested from slave units (DSR)

COMMUNICATION : Displays the status of communication

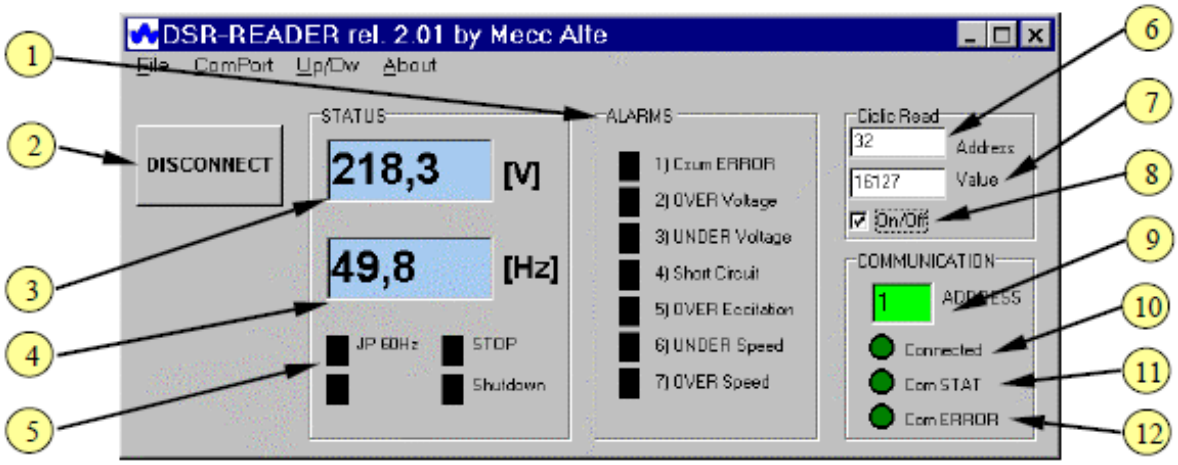


Fig. 15 : DSR_Reader user interface

Ref.	Description of Functions
1	Active alarms signal
2	Pushbutton activating or deactivating the connection
3	Regulated voltage at pins 4 - 5 (if connected, or double that voltage at pins 6 - 7)
4	Measured frequency
5	50/60Hz Jumper inserted
6	Address of parameter requested from regulator
7	Value of parameter requested from regulator (updated following command indicated in 8)
8	Activation of updating almost in real time
9	Address of Slave with which the unit is communicating
10	Connection and communications working indicator
11	Connection fault (red indicator)
12	Communications error (red indicator)

Table 14: Functions of the main DSR_Reader panel

Others functional menu

File Menu

The *File* Menu presents the single option of Exit, to close the DSR_Reader user interface.

Up/Dw Menu

The *Up/Dw* Menu is used to unload settings files from the regulator (which have the extension .dat or .set). The list of parameters is shown in table 3 of the Instruction manual. The possible options are limited:

1. Upload Data is not a permitted function

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.

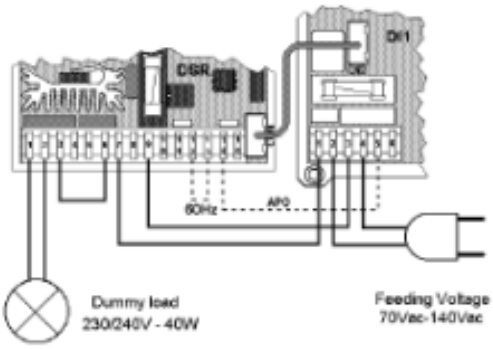
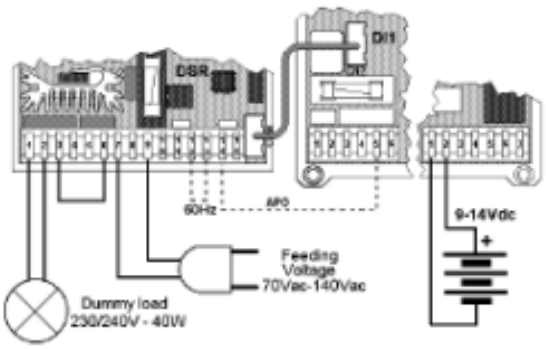
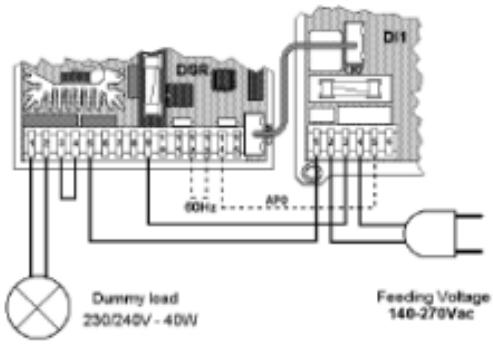
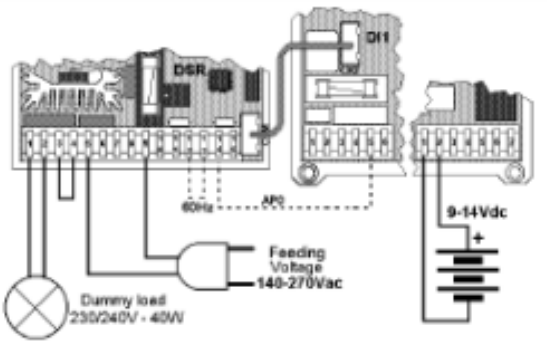
The **About** Menu

The **About** Menu signals the current release of the DSR_Reader software.

APPENDIX C2: DSR SET UP ON A TEST BENCH

The use of a test bench will result in a much easier set up of the DSR and its communication devices.
The connection schemes of the DSR and the communication board DI1 are reported from figures 1 to 4, depending on the power source available.

> Some of the DSR and DI1 components are working at high voltage and can be potentially dangerous. For this reason it is mandatory to insulate the power source of the regulator from the grid by means of an insulation transformer.
>
> The connection must be accomplished by trained and skilled personnel, perfectly aware of the potential risks of high voltages for health and safety. A full knowledge of this manual is also required for a safe operation on the DSR.
>
> Referring to figures B2 and B4, the 9-14 Vdc power source must be insulated. If not, communication troubles can arise as well as damages to the DSR or DI1 units, or even to any other device connected to the system.

	Common feeding	Separated feeding
DSR sensing: 70V - 140V	 *Fig. B1: 70-140Vac DSR - DI1 common feeding (Note sensing on terminal 7 and jumper between terminals 6 and 3 of DSR)*	 *Fig. B2: 70-140Vac - DSR feeding - Isolated 9-14Vdc DI1 feeding (Note sensing on terminal 7 and jumper between terminals 6 and 3 of DSR)*
DSR sensing: 140V - 280V	 Fig. B3: 140-280Vac DSR - DI1 common feeding *(Note sensing on terminal 5 and jumper between terminals 4 and 3 of DSR)*	 *Fig. B4: 140-280Vac DSR feeding - Isolated 9-14Vdc DI1 feeding (Note sensing on terminals 7 and jumper between terminals 6 and 3 of DSR)*

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Appendix D – 3 Phase Sensing Module Operation

IF321 Interface

The IF321 interface is an auxiliary board for the digital electronic voltage regulator DSR. The IF321 allow the DSR to have a three phase voltage sensing. The IF321 can work only if properly connected to the DSR voltage regulator, and only if the alternator cables are star connected (1). Moreover the DSR must be properly settled according to paragraph n.3.

1. Installation and Mechanical Dimensions

The IF321 interface should be installed nearby the DSR's terminals.
It is fixed by means of two M4X25 screws bolted on two threaded holes. All the major dimensions are reported in picture n. 1.
The IF321 interface has got a male Faston connector terminal board for all the inputs and outputs. The cables and the female terminals are not supplied with the interface. It is recommend the use insulated cables with a minimum section of 0.75 mm_2 for the connections.
In Figure n.2 it is shown the connection diagram on a typical application. The scheme is referred to the series from the ECO28 to the ECO38, and for the ECO40-1S, the ECO40-2S, the ECO40-1L and the ECO40-2L. As the sensing is on a full phase, the scheme is valid both for 6 or 12 leads machines. Please note that if you are refurbishing a single phase sensing, most likely the reference was only on half a phase.
If the alternator connections are looking differently from the ones reported in picture n.2, please **do not connect** the IF321 interface and ask Pyroban for more information. A wrong connection could result in damage both to the voltage regulation system and the alternator.

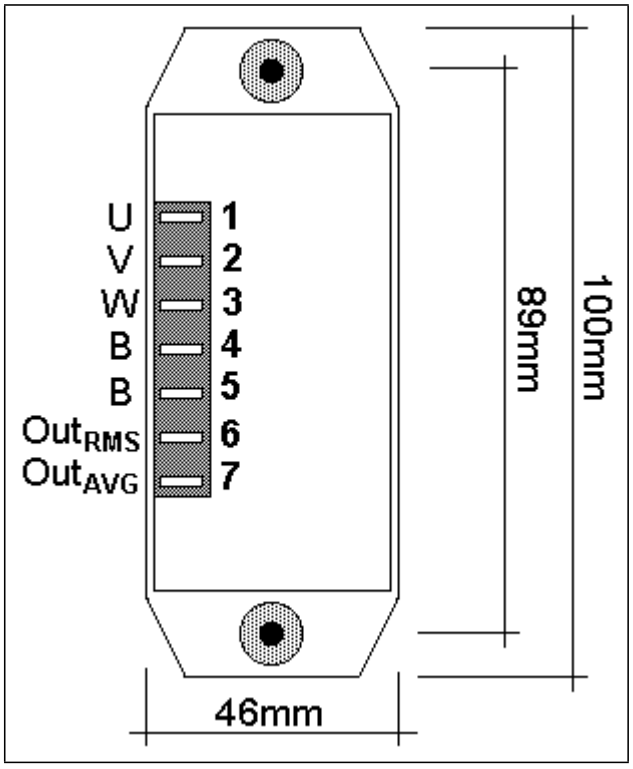

Fig. 1: Mechanical dimensions and terminal numbers

2. Inputs and Outputs: Technical Specifications

IF321- THREE PHASE INTERFACE FOR THE DSR				CONNECTIONS		
Terminal (2)	**Name**	**Function**	**Specs**	**Hardware**	**Terminal**	**FUNCTION**
1	U	U Sensing	140-280Vac	Alternator	U1	U phase
2	V	V Sensing	140-280Vac	Alternator	V1	V phase
3	W	W Sensing	140-280Vac	Alternator	W1	W phase
4	B	Neutral(2)		Alternator	N(2)	Neutral
5	B	Neutral(1)		DSR	8 o 9 (2)	Common
6	OutRMS	RMS Output		DSR	6 o 7	½ phase reference
7	OutAVG	AVG Output		DSR	6 o 7	½ phase reference

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NOTES

1) The alternator series A60411M43G and A80411M43G must be connected in the series star arrangement.

2) Terminals 4 and 5 are short-circuited internally. They can be used as a link between the alternator neutral and the common terminal of the DSR, in order to organize more efficiently the cabling.

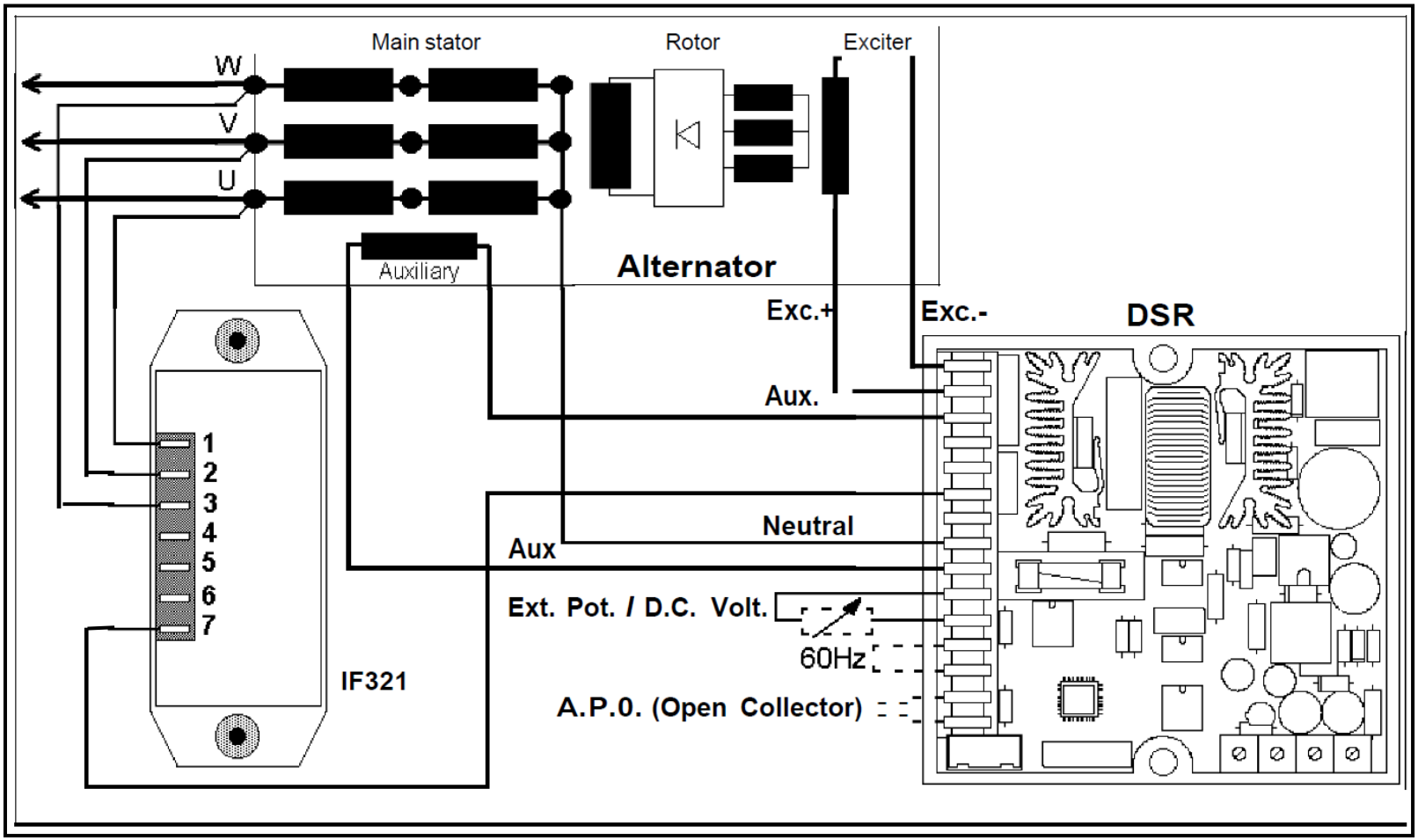

Fig. 2:Cabling scheme of the IF321 with the DSR

3. Configuration of digital regulator DSR

The following procedure is referred to the main “instruction manual” of the digital regulator DSR. It is not advisable to change other parameters than the following, if you do not have a full comprehension of the DSR configuration system.
In order to have the IF321 installed, the DSR must be settled through the configuration panel with the following options selected:
64 samples sampling (mandatory)
Voltage Offset compensation turned off (Mandatory)
Average voltage sensing regulation (recommended)(3)
In order to set up the configuration menu of the DSR, the communication interface DI1 is needed connected to a supervisor (like a personal computer) by means of an RS232 or protocol.
The DSR, the DL1 interface and the supervisor must be connected like described in the DSR instruction manual, mentioned above. The DSR and the DL11 must be power supplied.

If for the DSR set up it is used the PC program called “DSR Terminal”, please proceed as follows:

3.1. Run DSR_Terminal from Windows.
3.2. Establish a link with the DSR pushing the button *Connect*
3.3. If the communication is established, the *Connected* turns from yellow to green.
3.4. If the DSR does not reply with a communication error, also the *Com STAT* indicator turns from yellow to green
3.5. By means of the *Configuration* button it is possible to open the menu shown in fig.3
3.6. Remove the selection from the AVG/RMS () box, like it is indicated in Fig. 3 (recommended) (3)
3.7. Remove the selection from the Voltage Offset Comp. box, like it is indicated in Fig. 3 (mandatory)
3.8. Remove the selection from the 64/32 sample () box, like it is indicated in Fig. 3 (mandatory)
3.9. Click on *Apply* button and then click on *OK* to close the “configuration” menu and store the set up on the DSR internal memory.

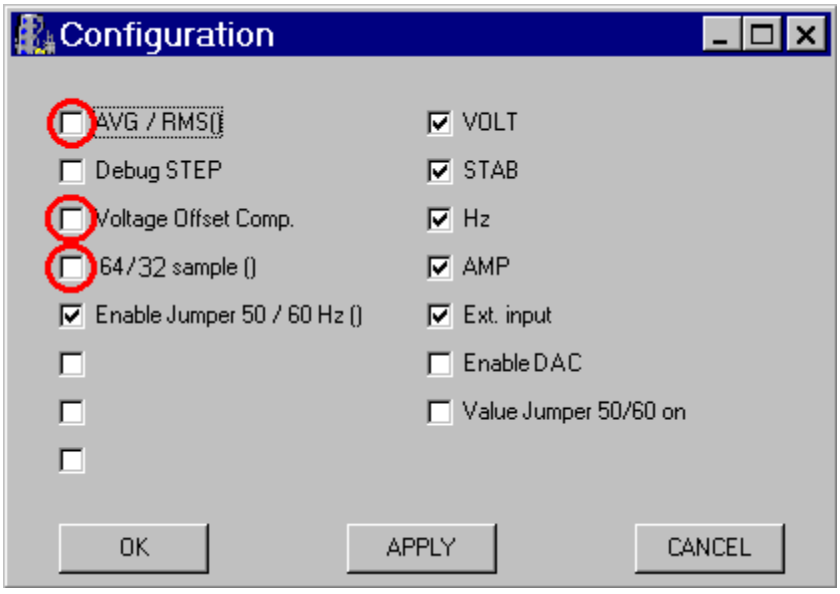

Fig. 3: Set up in the “configuration” menu for a correct IF321 usage

NOTES

3) If RMS sensing is requested, it is necessary to leave selected the AVG/RMS() box and to connect DSR terminal 6 or 7 to the terminal 6 (instead of terminal 7) on the IF321 interface.

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Appendix E – DER1 Operation

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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 (USB2DxR, for example) and a supervision unit, as illustrated in figure 6.
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 USB interface, it's possible to use the USB2DxR communications module 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 USB2DxR communications module (which is provided for connection to the COM connector of the DER1) is equipped with a USB port, through which it is possible to set the parameters (for both configuration and operation) and "monitor" operation of the generator.

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2. Technical Characteristics of the device installed on board

- Digital controlled regulator, based on DSP
- Suitable for all Mecc Alte self-regulated alternators
- Power connections through 20 poles[1] 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: 5Adc
- 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
- Underexcitation alarm/loss os excitation[6]
- Management of temporary short circuits (start up of asynchronous motors)
- Open collector output (not insulated) signalling some allarm intervention with programmable activation in respect of each alarm and possibility of the intervention delay and selectable active level[6]
- Allarm conditions storage (type of alarm, number of events, duration of the last event, total time)
- Memorization of the regulator operation time
- USB communications interface (with optional USB2DxR module)

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

NOTE (2) : with EMI external filter SDR 128/K, see Fig.4 (3m without EMI filter)
NOTE (6) : Starting from rev. 19 of the firmware

3. Inputs and Outputs: technical specifications

TABLE 1 : CONNECTOR CN1				
Terminal[1]	Name	Function	Specification	Notes
1	Exc-	Excitation	Continuous Rating: 5Adc 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]	Programmable : active level[6], activating alarm and delay time
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 182/K (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 percentage value of parameter P[21]
Note 5) Value not to be exceeded. The effective range depends on parameter P[16]
Nota 6) Starting from revision 19 of the firmware

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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

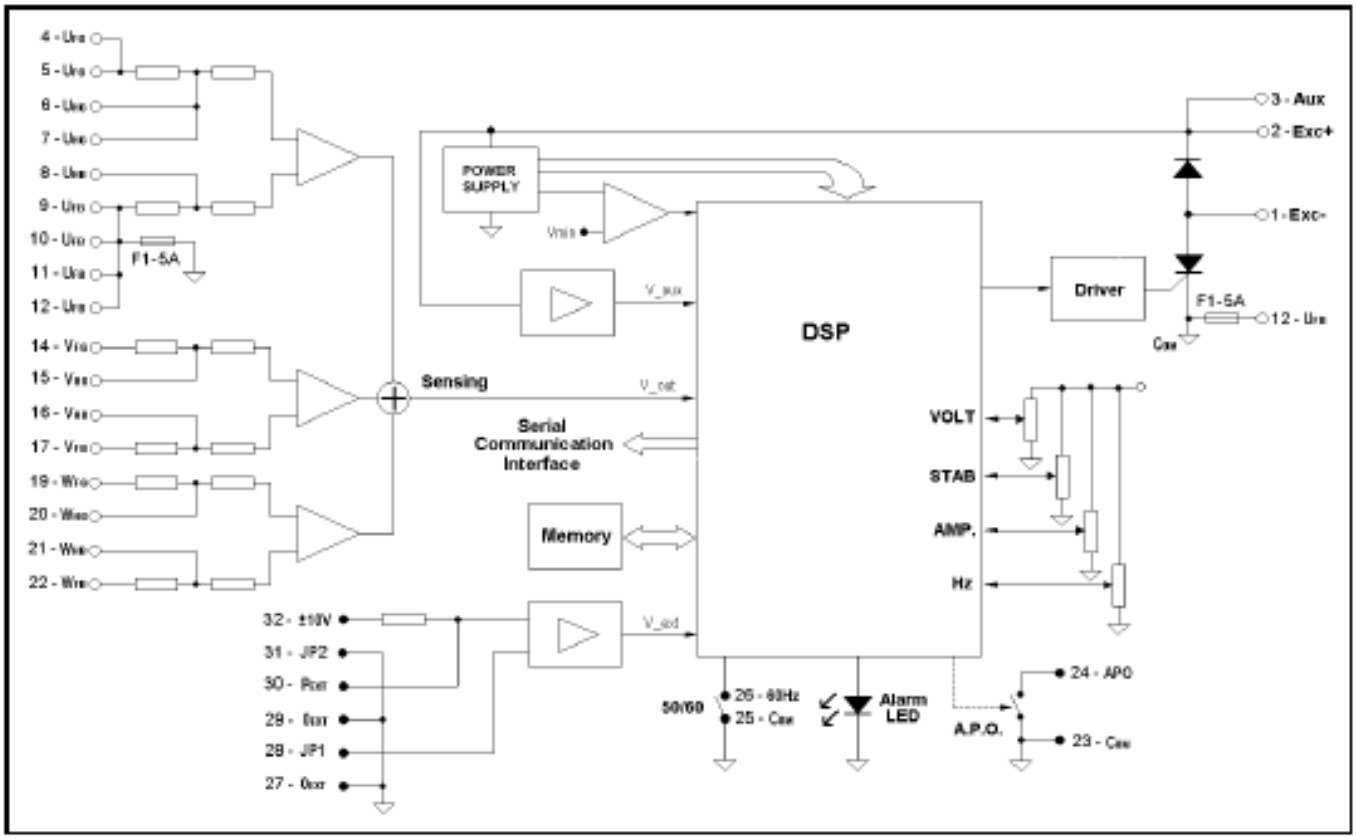

Fig 1

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. The regulator is equipped with a 5A fast-acting protection fuse. If necessary, the fuse must be replaced only with a fuse of the same type and rating.

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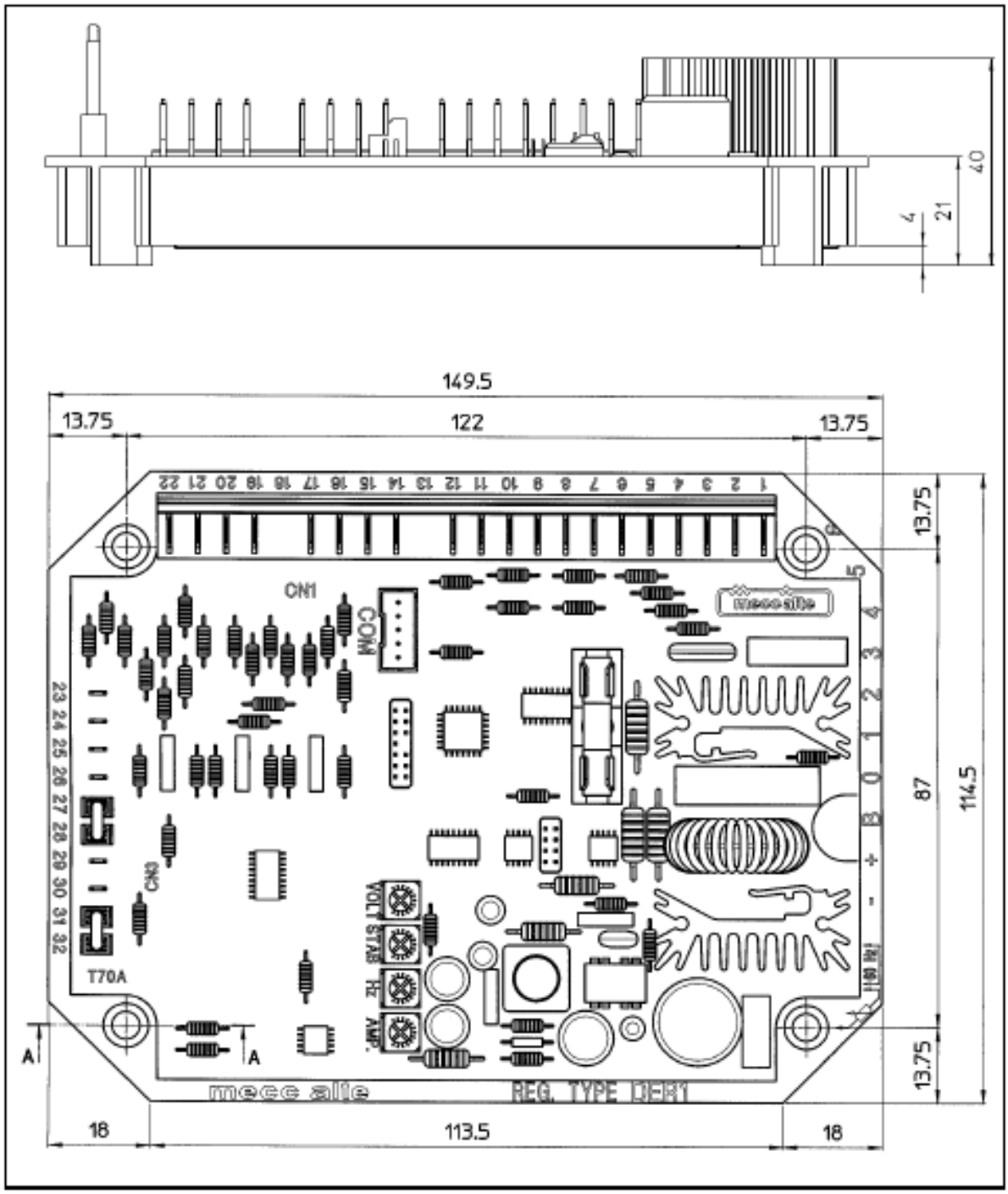
1. Overall dimensions drawings



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.

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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	SCC0160/02	
		Three phase on half phase	H	SCC0158/04	
		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	SCC0161/02	
		Three phase on half phase	F	SCC0159/04	
	1200 (from 1100 to 2000)	Single phase on half phase	F	SCC0202/00	2 channels in series
Parallel star	190-200-208-220-230-240-250 (from 130 to 250)	Single phase	H	SCC0160/02	
		Three phase	H	SCC0158/04	
	380-400-415-440-460-480-500 (from 260 to 500)	Single phase	F	SCC0161/02	
		Three phase	F	SCC0159/04	
Series delta	220-230-240-254-265-277-290 (from 150 to 300)	Single phase on half phase	H	SCC0160/02	
		Three phase on half phase	H	SCC0158/04	
	305-320-330-440-460-530-555 (from 300 to 600)	Single phase on half phase	F	SCC0161/02	
		Three phase on half phase	F	SCC0159/04	
	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	SCC0160/02	
		Three phase	H	SCC0158/04	
	152-160-165-220-230-265-277 (from 150 to 300)	Single phase	F	SCC0161/02	
		Three phase	F	SCC0159/04	
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	SCC0203/00	2 channels in series
Single phase parallel	220-230-240-254-265-277-290 (from 150 to 300)	Single phase - Partial	H	SCC0160/02	
		Single phase - Complete	F	N.A.	
	305-320-330-440-460-530-555 (from 300 to 600)	Single phase - Partial	F	SCC0161/02	
		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

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4.2 DER1 connections for typical applications

Drawings SCC158/04, SCC159/04, SCC160/02, SCC161/02 show DER1 regulator connections for typical applications.

In case of sensing 75V-150V, with half-phase reference the typical drawing for three-phase connection is SCC158/04, while for single phase it is SCC160/02.

In case of sensing 150V-300V, with half-phase reference the typical drawing for three-phase connection is SCC159/04, while for single phase it is SCC161/02.

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 25 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** at location 19 (from the **Settings/Advanced**[1] Menu)
2. Disable VOLT trimmer (from the **Settings/Potentiometers**[1] Menu)
3. Disable Vext (from the **Settings/Advanced**[1] 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. In order to ensure that the value of voltage (available also at location 36) is the same as the value measured at point 6, calibrate the data at location 7, reading the value of Volt box in the "status" area of **Settings/Advanced** [1] menu.
6. Enable the trimmers again, if it is desired to have them active (from the **Settings/Potentiometers**[1] menu).
7. Enable Vext (from the **Settings/Advanced**[1] 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 at parameter [21 (where 10% corresponds to 16384).

7. APO Contact

The acronym **APO** stands for **A**ctive **P**rotection **O**utput: (connector CN1 terminals 23 and 24) 30V-100mA non-insulated open collector transistor, normally closed, if the "APO Invert" flag ([2] is active (default), opens (with a delay that can be programmed from 1 to 15 seconds) when, of all the alarms, one or several separately selectable alarms are active.

NOTE [1]: Software DxR Terminal
NOTE [2]: Starting from rev. 18 of the firmware, if the "APO Invert" flag is not active or for firmware revisions up to 17 the transistor is normally open and it closes in case of an active alarm

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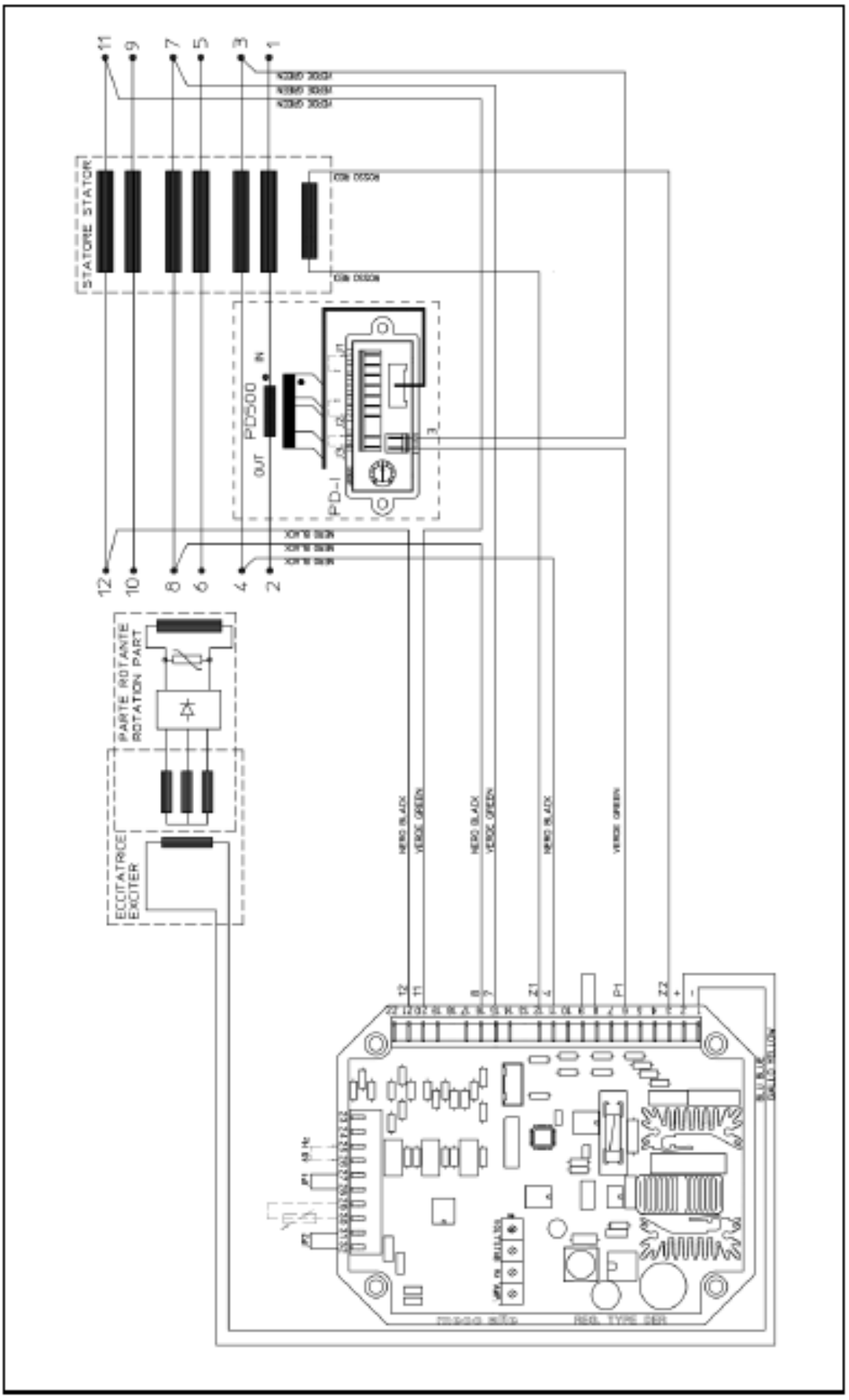

SCC0158/05: Three phase sensing 75V-150V

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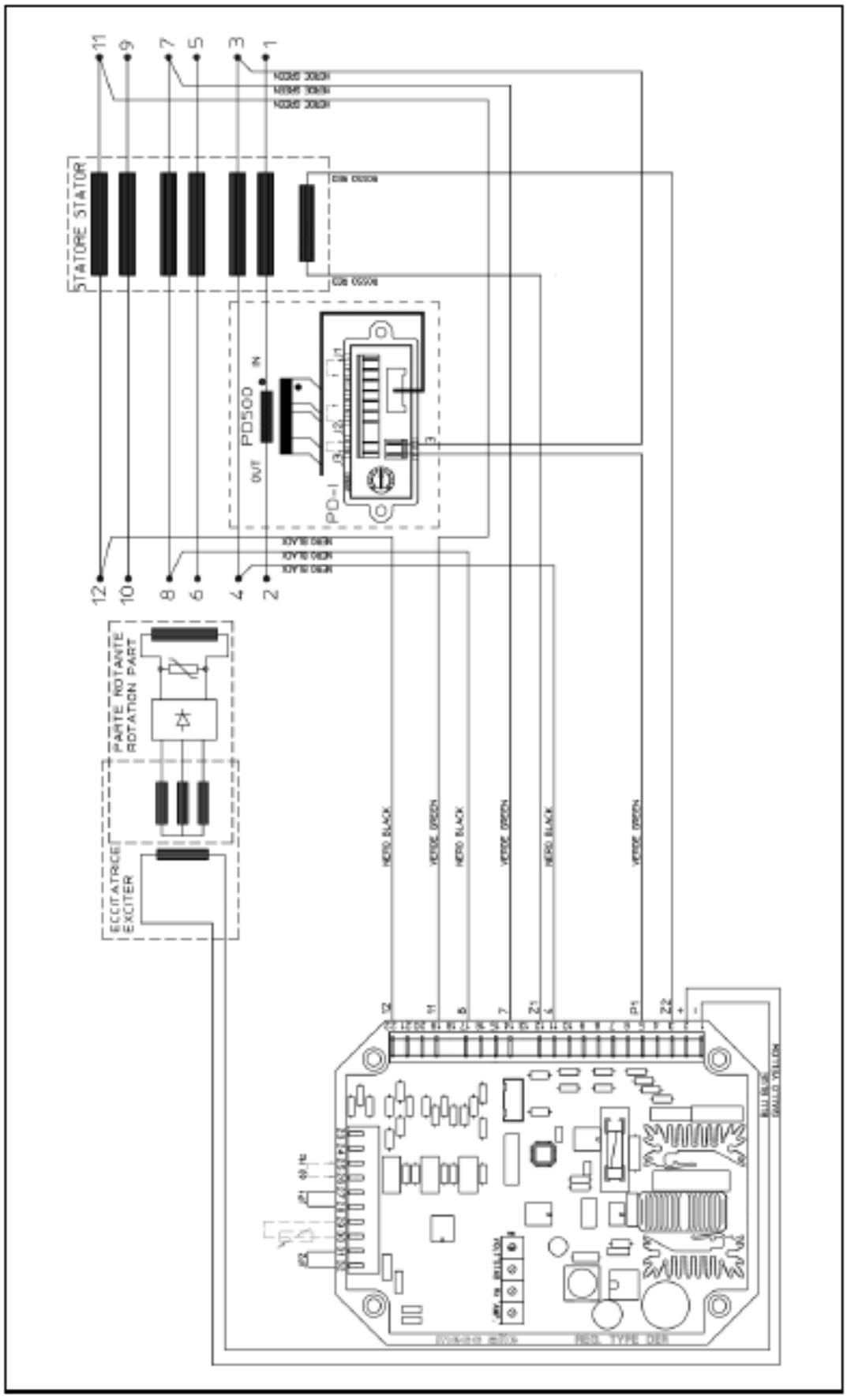

SCC0159/05: Three phase sensing 150V-300V

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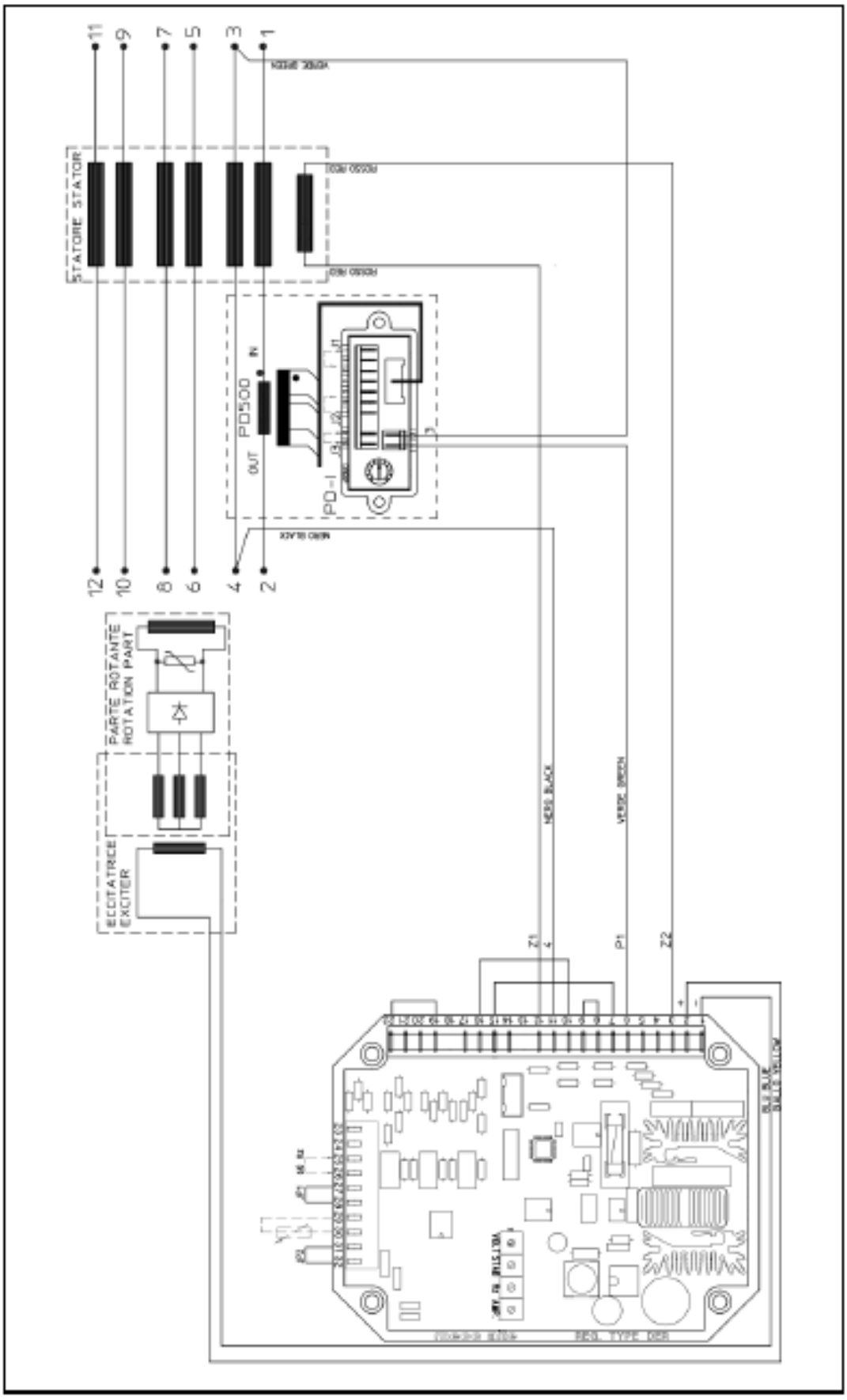

SCC0160/03: Single phase sensing 75V-150V

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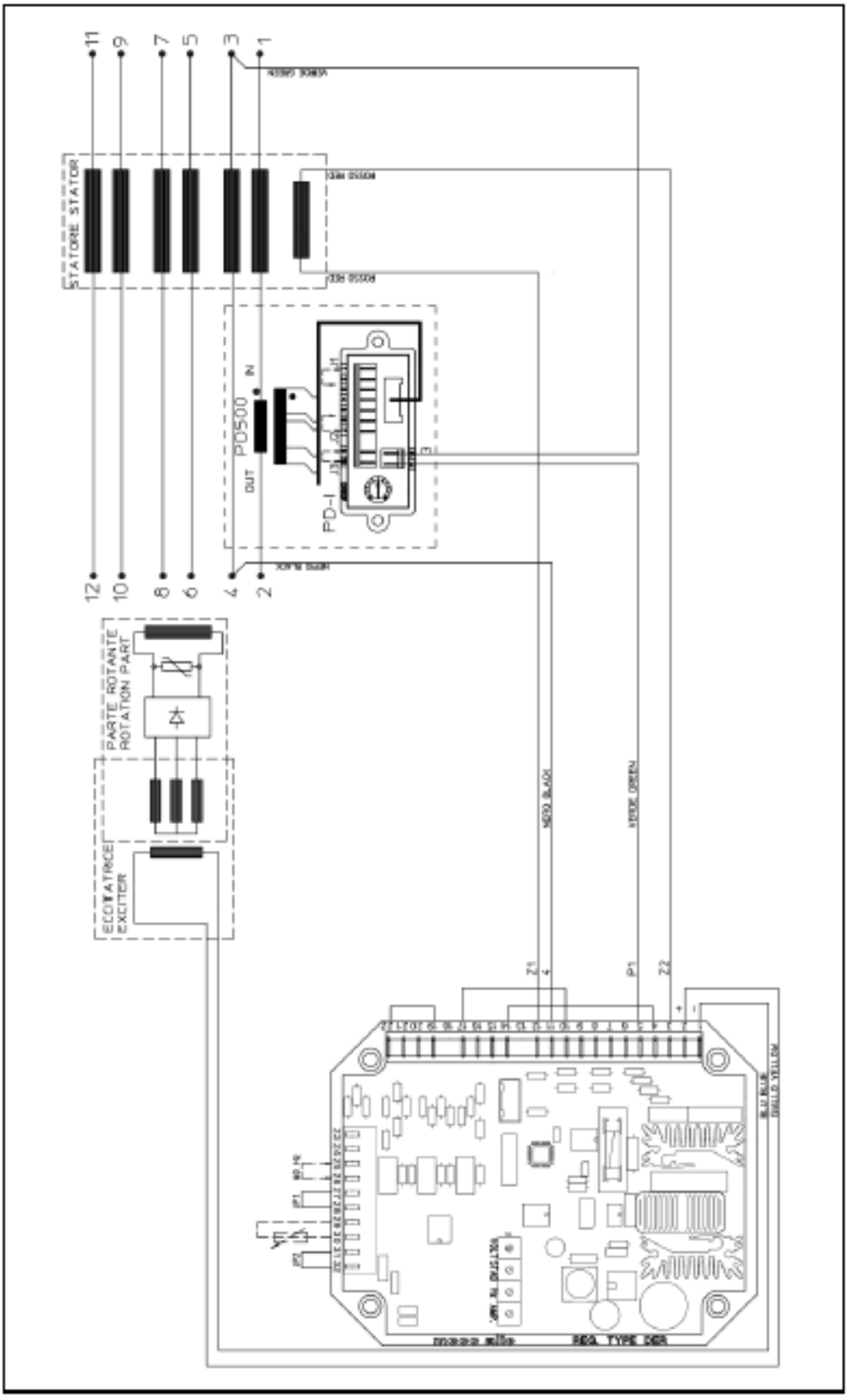

SCC0161/03: Single phase sensing 150V-300V

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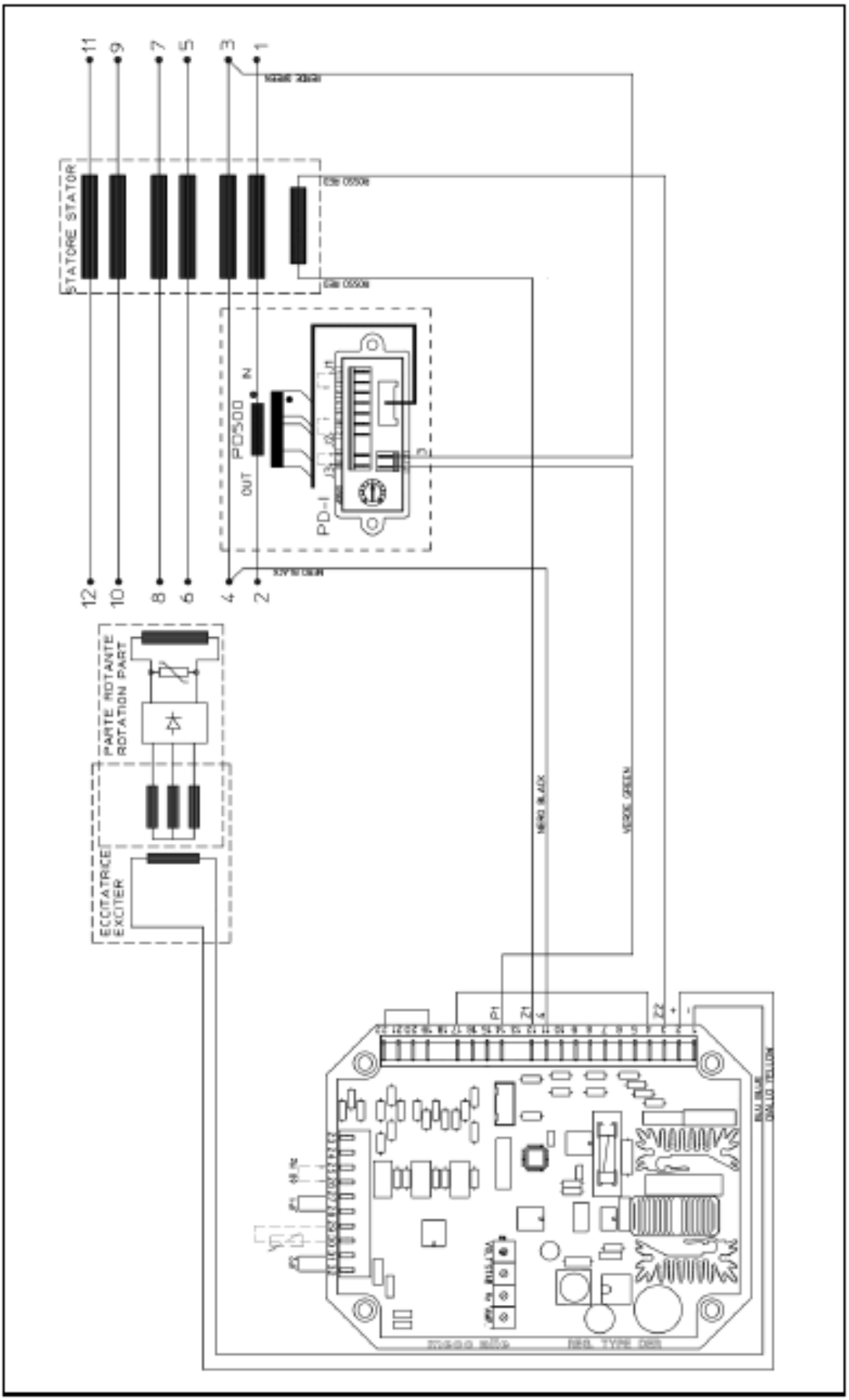

SCC0202/01: Single phase sensing 300V-600V

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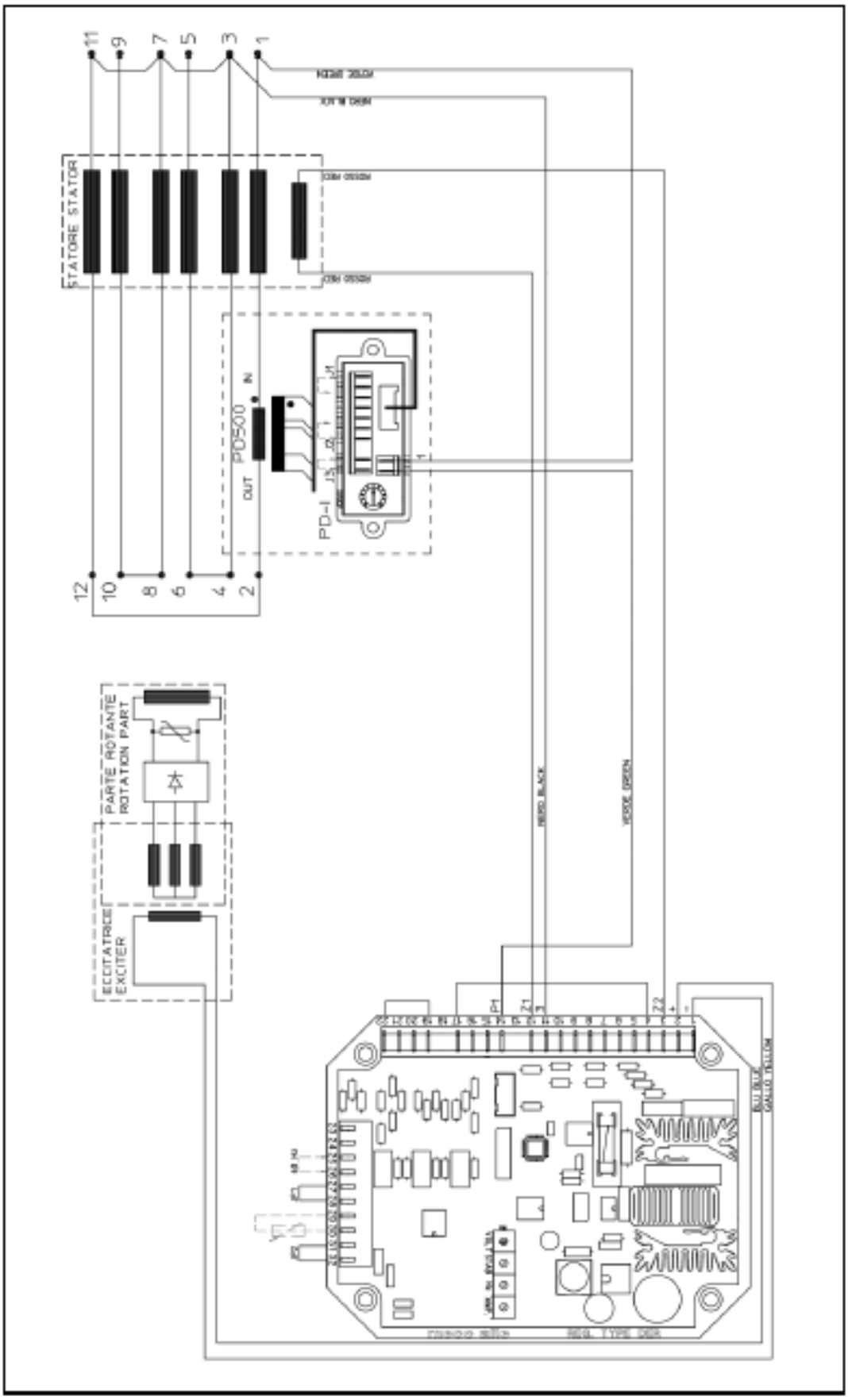

SCC0203/01: Single phase sensing 300V-600V
(generator in threephase ZIG-ZAG connection)

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 **Settings/Advanced** 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

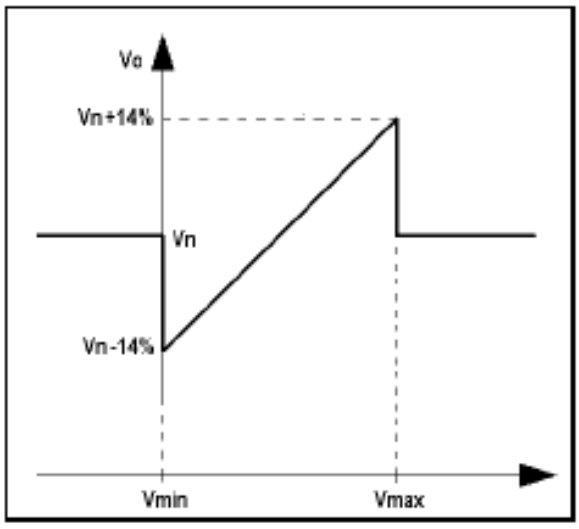

Figure 3a: without saturation of the output voltage upon reaching the input voltage limits.

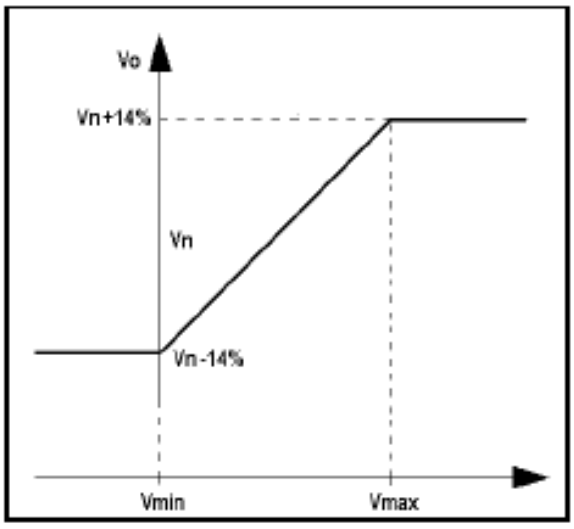

Figure 3b: with saturation of the output voltage upon reaching the input voltage limits.

TABLE 5: HARDWARE AND SOFTWARE CONFIGURATION OF VOLTAGE REMOTE CONTROL

		Jumpers		Flags (configuration menu) or Parameter P[10]	
		JP1 (27-28)	JP2 (31-32)	RAM Voltage CTRL	Ext. Input
Type	Input	Close	Close	Disabled (Bit B7=0)	Enabled (Bit B12=1)
		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%).

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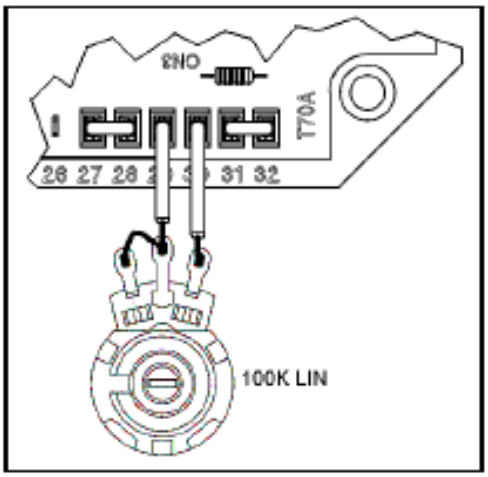

Fig. 4a: 100K external potentiometer connection

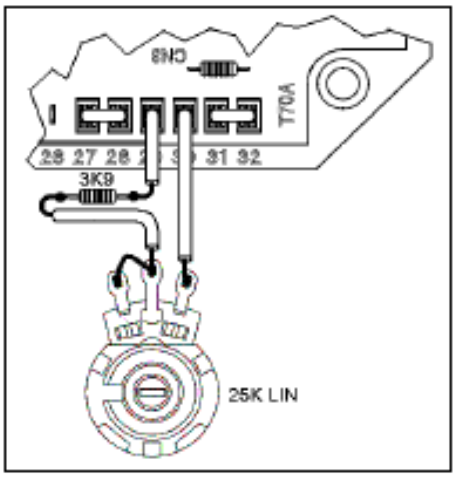

Fig. 4b: 25K external potentiometer connection

9. VOLT, STAB, Hz and AMP Trimmers

The trimmers are enabled by the software DxR_Terminal; 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 **Settings/ UFLO&LAM** 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.

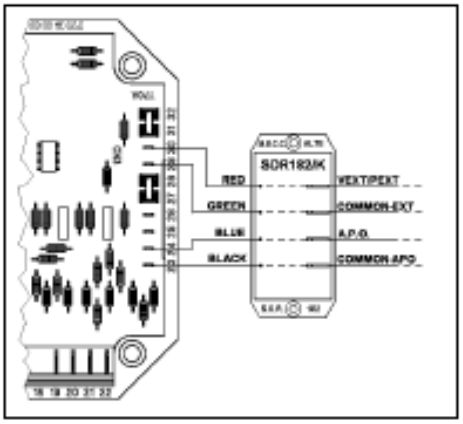

Fig. 5: Connessione filtro EMI SDR182/K

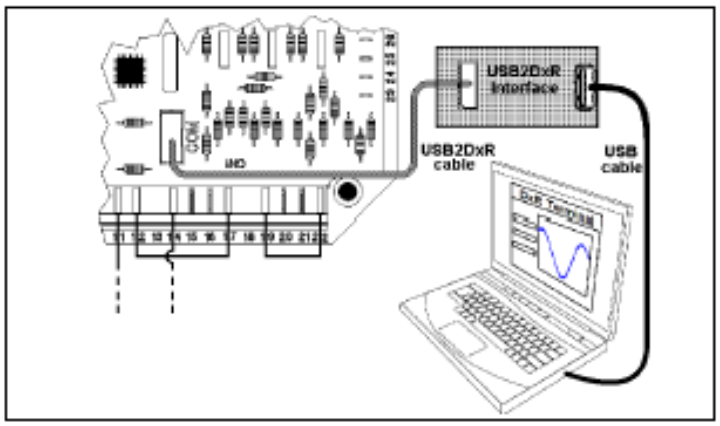

Fig. 6: Connessione tra DER/1 e PC tramite interfaccia digitale USB2DxR

10. USB Communications

The COM connector is RESERVED for connection to the USB2DxR communications module through the dedicated cable provided together with the module (see fig. 6).

For the communication, the regulator implements a subsystem of the ModBus standard; the DER1-USB2DxR system performs a "slave" operation the address of which is stored in the DER1 EEPROM and is set during configuration.

Detailed descriptions of the ModBus commands implemented are into the Technical Guide "Digital Regulators Comunication Protocol" available on the web site www.meccalte.com.

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

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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 USB connections (with module USB2DxR). Two versions of the regulator are available, called DER1 and DER1/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.

TABLE 6 : EEPROM SETTING REGISTRIES

Add.	Description of Parameter	Range	Default		NOTES
			DER1	DER1/A	
0	Firmware revision	0..65535	19	19	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	7988	7988	Detailed descriptions paragraph 2 table 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..6553	4608	4608	Limits the effect of external analogical input (0->0; 4608->14%)
17	APO delay & alarm settings	0..65535	254[1]	254[1]	Selects alarms that activate the APO contact and sets the delay intervention
18	Step limitation reference	1..1000	50	50	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	Underexcitation threshold [1][3]	0..32767	512	512	Under-excitation alarm threshold [1]
28	Ki over-excitement Regulator	0..32767	12287	12287	Integral gain of excitation voltage regulator
29	AMP slope (f) [1][3]	0..32767	15154	15154	AMP (f) [1][3] overexcitation protection slope
30	Thermal dispersion coefficient	0..65535	63600	63600	Used by AMP alarm temperature estimator
31	Reserved	0..65535	-	-	Do not write

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.

NOTE (1): starting from rev. 18 of the firmware
NOTE (2): shutdown intervention threshold not to be changed in the versions preceding the 18*
NOTE (3): proportional gain of excitation voltage regulator in the versions preceding the 18*

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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 "DxR Terminal" programme is used (see technical guide "Interface communication USB2DxR"), the setting is simplified by the use of the dedicated flags in the different menu corresponding to the specific bit which enables/disables each function.

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, B5 and those from B8 to B12 to be enabled. The corresponding value is therefore: P[10]=4+16+32+256+512+1024+2048+4096=7988.

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	Inversion APO[4]	1
B6	64	Force three-phase sensing	0
B7	128	External location reference L[49] [2] and activation of saturation in the event of overflow[3]	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
NOTE (4): starting from rev. 18 of the firmware

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]

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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)
53	$Kp/2^{P[11]}$	0..32767	Read only	Proportional gain not considering factor $2^{P[11](1)}$
54	$Ki/2^{P[12]}$	0..32767	Read only	Integral gain not considering factor $2^{P[12](1)}$
55	AMP protection threshold	0..32767	Read only	Intervention threshold of overexcitation protection(1)
56	Underexcitation observer	0..32767	Read only	Observer of underexcitation or loss of excitation (2)

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 the regulation and nominal frequency.

TABLE 10 :STANDARD VALUES OF THE FOURTH STATUS WORD (LOCATION L[39])		
	Rated frequency:	
Sensing	50Hz	60Hz
Single phase	7988	24372(2)
Three phase	8048(2)	24432(2)

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	Inversion APO(2)	32	1
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)(3)	16384	0/1 (1)
B15	Reserved	32768	0

NOTE (1): depending on the sensing and nominal frequency
NOTE (2): starting from revision 18 of the firmware
NOTE (3): software configuration, with jumper 50/60 disabled

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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 **Settings/potentiometers** menu of DxR Terminal software
2. With parameter P[19] (The Volt trimmer must be enabled from the **Settings/Potentiometers** 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.
   The setting is facilitated using the software DxR Terminal, through **Settings/Potentiometers menu.**

It is possible to vary voltage with respect to the value set, with the Pext input (terminals 29-30) if enabled from the area Pext/Vext in the **Settings/Advanced** 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 "Delay" and "Excitation Limit" in the area "Soft-Start" of the **Settings/Advanced** menu, corresponding to parameters P[8] and P[9] : during starting, 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 (corresponding to the setting "Delay" in Soft-Start area) for 4 pole machines, 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 "Delay" and "Excitation limit" (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: Delay=1280ms (P[8]=64) and Excitation limit=50% (P[9]=16384); for low power alternators of the ECP3 series, the effects of a reduction of both the duration and limitation of the current may be experimented, such as Delay=320ms (P[8]=16) and Excitation limit=3,72% (P[9]=4096).

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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.

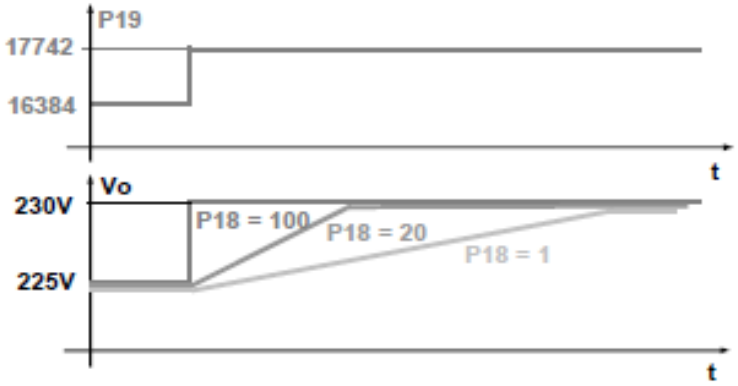

fig. 7

2. Stability

2.1 Adjustment of stability

The regulator diagram is shown in figure 8.

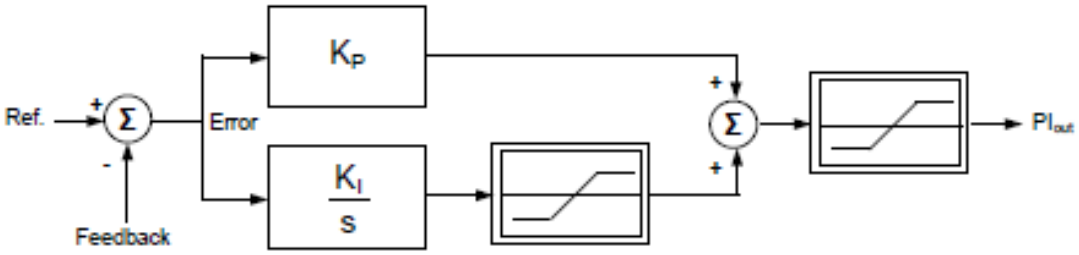

figure 8 : Regulator Diagram

The values of the proportional and integral gain (K_P and K_I respectively) depend on the position of the STAB trimmer if enabled, or the value of parameter P[20] if the trimmer is disabled. The value of the proportional gain K_P also depends on the value of the P[11] parameter. The value of the integral gain K_I depends on the values of parameters P[12] and P[13] and, only for the standard DER1 (grey box) with the STAB trimmer enabled, even on the 50/60Hz[1] setting. In the other DER1 versions, for example DER1/A (blue box), the integral gain K_I does not differ no matter how the 50/60Hz[4] setting is set.
The numeric elaborations carried out by the DER1 for obtaining the proportional and integral gain values are given in the block diagrams in figures 8a[2], 8b[2] and 8c .

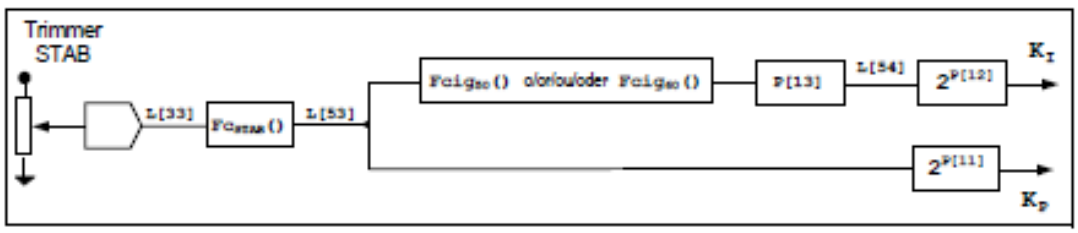

fig. 8a: drawing of the numeric elaboration of the proportional and integral gain by a DER1 (standard) with the STAB trimmer enabled

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If the STAB trimmer is enabled (STAB Flag Trimmer present) its angular position, available at location L[33], is transformed by the Fc_{STAB}[2] function into the numeric value available at location L[53][3] (figs. 8a and 8b). If the STAB trimmer is disabled, the value of location L[53][3] directly becomes the value set using the P[20] parameter (fig. 8c).
The proportional gain K_P is obtained by multiplying the value of location L[53][3] by a coefficient that depends on the value given in parameter P[11][4].

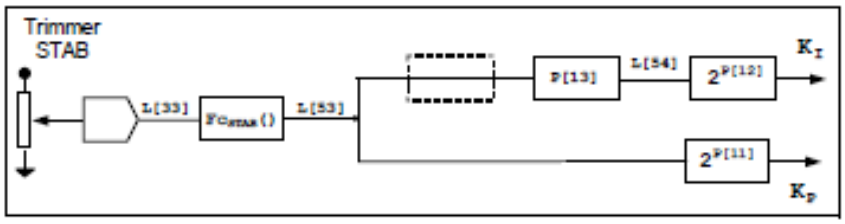

fig. 8b: drawing of the numeric elaboration of the proportional and integral gain by a DER1/A with the STAB trimmer enabled

The integral gain, available at location L[54][3] minus the multiplication by a coefficient, depends on the value of the proportional gain at location L[53][3]; in the standard DER1 (grey box) with the STAB trimmer enabled (STAB Flag Trimmer present) the value of location L[53][3] at 50Hz is transformed by the function $Fcig_{50}$[2] and by the multiplication of the value of parameter P[13], in the numeric value available at location L[54][3]; at 60Hz the transformation function is $Fcig_{60}$[2], different from that at 50Hz, (fig. 8a); in the other versions of the DER1 (fig. 8b), for example DER1/A (blue box), or if the STAB trimmer is disabled[4] (fig. 8c), not only is there a difference between the integral value at 50Hz and at 60Hz, but even the value of location L[54][3] is obtained by simply multiplying the proportional gain at location L[53][3] by the value of parameter P[13].

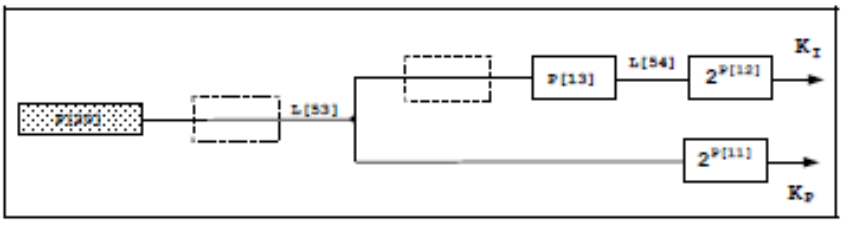

fig. 8c: drawing of the numeric elaborations of proportional and integral gain by all DER1 with STAB trimmer disabled

In both cases, the effective integral gain K_I is obtained by multiplying the value of location L[54][3] by a coefficient that depends on the value given in parameter P[12][4].

The mentioned coefficients can take on values of 1, 2, 4, 8, 16, 32 or 64 according to the values written in parameters P[11] (for proportional gain) and P[12] (for integral gain); these values represent the value assigned to base 2 (fixed) to obtain the required coefficient (e.g. parameter P[11] = 4 => multiplication coefficient of the proportional gain = 2^4 = 16, P[12] = 3 => multiplication coefficient of the integral gain = 2^3 = 8).

The following tables show, for every three-phase machine on 50Hz and 60Hz, the STAB trimmer calibration which allows increased speed of response to the transistor with the generator in stand-alone operation. In case of different applications (for example alternators reconnected in single-phase, in parallel among them or in parallel with the grid, with motors having less than 4 cylinders and so on) it may be necessary to readjust the STAB trimmer calibration.
If the voltage cannot be stably adjusted for permanent operation and/or in the transient by the STAB trimmer settings, it may be necessary to vary one or more stability adjustment parameters: P[11], P[12] and P [13] the description of which is given in table 6.

NOTE [1] Starting from Rev. 15 of the firmware
NOTE [2] The Fc_{STAB}, $Fcig_{50}$ and $Fcig_{60}$ functions are not implemented in the DER1s with firmware up to version 14, and in the block diagram they are considered as identities, i.e. L[53][3]=Fc_{STAB}(L[33])=L[33] e $Fcig_{60}$(L[53]) = $Fcig_{50}$(L[53])=L[53][3]. With these regulators the STAB trimmer needs to be rotated by less than two notches counted clockwise.
NOTE [3] Location available to the user from firmware Rev. 15.
NOTE [4] Structure valid also for DER1s with firmware up to version 14 but without location L[53] and L[54] availability

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TABLE 12 ECO/ECP SERIES: RECOMMENDED SETTINGS OF DER1 STAB TRIMMER Fw Rel. ≥ 15								
Alternator		Nominal frequency = 50Hz						
Type	Pole	S [KVA]	Singlephase			Threephase		
			STAB	L[33]	L[53]	STAB	L[33]	L[53]
ECO38-1SN/4 (1)	4	180	n.d.	n.d.	n.d.	**6**	16384	8192
ECO38-2SN/4 (1)	4	200	n.d.	n.d.	n.d.	**8**	24191	17859
ECO38-3SN/4 (1)	4	225	n.d.	n.d.	n.d.	**8,5**	26176	20910
ECO38-1LN/4 (1)	4	250	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO38-2LN/4 (1)	4	300	n.d.	n.d.	n.d.	**8**	24191	17859
ECO38-3LN/4 (1)	4	350	**11**	32704	32640	**9**	28096	24090
ECO40-1S/4 (2)	4	400	**11**	32704	32640	**9**	28096	24090
ECO40-2S/4 (2)	4	450	**11**	32704	32640	**8,5**	26176	20910
ECO40-3S/4 (2)	4	500	**9,5**	30077	27607	**9**	28096	24090
ECO40-1L/4 (2)	4	550	**9**	28096	24090	n.d.	n.d.	n.d.
ECO40-1.5L/4 (2)	4	620	**9**	28096	24090	**9,5**	30077	27607
ECO40-2L/4 (2)	4	680	**11**	32704	32640	n.d.	n.d.	n.d.
ECO40-VL/4 (2)	4	720	**9,5**	30077	27607	n.d.	n.d.	n.d.
ECO43-1SN/4 (2)	4	800	**9**	28096	24090	n.d.	n.d.	n.d.
ECO43-2SN/4 (2)	4	930	**9**	28096	24090	n.d.	n.d.	n.d.
ECO43-1LN/4 (2)	4	1100	**9**	28096	24090	n.d.	n.d.	n.d.
ECO43-2LN/4 (2)	4	1300	**9**	28096	24090	n.d.	n.d.	n.d.
ECO43-VL/4 (2)	4	1400	**9**	28096	24090	n.d.	n.d.	n.d.
ECO46-1S/4 (2)	4	1500	**8**	24191	17859	n.d.	n.d.	n.d.
ECO46-1.5S/4 (2)	4	1650	**9,5**	30077	27607	**9,5**	30077	27607
ECO46-2S/4 (2)	4	1800	**11**	32704	32640	**9,5**	30077	27607
ECO46-1L/4 (2)	4	2100	**9,5**	30077	27607	n.d.	n.d.	n.d.
ECO46-1.5L/4 (2)	4	2300	**11**	32704	32640	**9**	28096	24090
ECO46-2L/4 (2)	4	2500	**9**	28096	24090	n.d.	n.d.	n.d.

Alternator		Nominal frequency = 60Hz						
Type	Poli	S [KVA]	Singlephase			Threephase		
			STAB	L[33]	L[53]	STAB	L[33]	L[53]
ECO38-1SN/4 (1)	4	216	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO38-2SN/4 (1)	4	240	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO38-3SN/4 (1)	4	270	n.d.	n.d.	n.d.	**8**	24191	17859
ECO38-1LN/4 (1)	4	300	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO38-2LN/4 (1)	4	360	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO38-3LN/4 (1)	4	420	**8,5**	26176	20910	**9**	28096	24090
ECO40-1S/4 (2)	4	480	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO40-2S/4 (2)	4	540	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO40-3S/4 (2)	4	600	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO40-1L/4 (2)	4	660	**8,5**	26176	20910	n.d.	n.d.	n.d.
ECO40-1.5L/4 (2)	4	744	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO40-2L/4 (2)	4	816	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO40-VL/4 (2)	4	864	**9**	28096	24090	n.d.	n.d.	n.d.
ECO43-1SN/4 (2)	4	960	**8,5**	26176	20910	n.d.	n.d.	n.d.
ECO43-2SN/4 (2)	4	1116	**8,5**	26176	20910	n.d.	n.d.	n.d.
ECO43-1LN/4 (2)	4	1320	**8,5**	26176	20910	n.d.	n.d.	n.d.
ECO43-2LN/4 (2)	4	1560	**8**	24191	17859	n.d.	n.d.	n.d.
ECO43-VL/4 (2)	4	1700	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO46-1S/4 (2)	4	1800	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ECO46-1.5S/4 (2)	4	1980	n.d.	n.d.	n.d.	**9**	28096	24090
ECO46-2S/4 (2)	4	2160	**9,5**	30077	27607	**9**	28096	24090
ECO46-1L/4 (2)	4	2520	**8,5**	26176	20910	n.d.	n.d.	n.d.
ECO46-1.5L/4 (2)	4	2760	n.d.	n.d.	n.d.	**8,5**	26176	20910
ECO46-2L/4 (2)	4	3000	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

NOTE (1) **DER1**: P[11] = 4, P[12] = 3, P[13] = 16384, with trimmer STAB enabled
NOTE (2) **DER1/A**: P[11] = 5, P[12] = 1, P[13] = 26624, with $Fclg_{60}(L[53]) = Fclg_{50}(L[53]) = L[53]$

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3. EXCITATION OVERCURRENT

3.1 Description

The DER1 regulator is equipped with an excitation (main rotor) winding temperature estimator. An estimate of the temperature (in relative values) is available in real time (and it can be read) in location 45; in the lower part of the main window of the DxR terminal software there is a graphic representation of location 45. The progress of the temperature is of the exponential type (see figure 9).
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 regulation in case of overexcitation alarm, if necessary, may be adapted to the application by varying the value of parameter 28[5]
For an increased protection of the electrical machine, starting from rev. 18 of the firmware, the excitation overcurrent protection was extended to the whole speed interval (frequency) of the alternator, particularly for the lower frequencies, to a preset threshold (56.7Hz with the jumper inserted between the 25 and 26 terminals of connector CN1, if enabled, or, otherwise, if the 50/60, 49Hz setting is enabled) the protection intervenes with an effective threshold (relative to the one set through the AMP trimmer or parameter 22) reduced proportionally to the frequency.
The extent of this reduction depends on parameter 29 which is by default set to an adequate value for the standard alternators, used in three-phase in nominal voltage.
An increment of the value of P[29] determines a bigger reduction of the intervention threshold, based on the frequency reduction, a decrease of the value of P[29] determines a smaller reduction of the intervention threshold.

> **Caution !**
> If the magnetic gain of the alternator is high, unstable events may occur when the protections intervenes, therefore it is necessary to adjust parameter 28 (usually by reducing its value).
> When the alternator works with reduced load and speed, overheating, which is dangerous to the integrity of the machine, might occur, if the overcurrent protection threshold is not sufficiently reduced when reducing the frequency.

As you can see in figure 9, when the estimated temperature (represented by the continuous line) reaches the threshold value, the reduction of excitation current (and consequent drop in voltage generated) brings about the stabilisation of the temperature near a limit value.

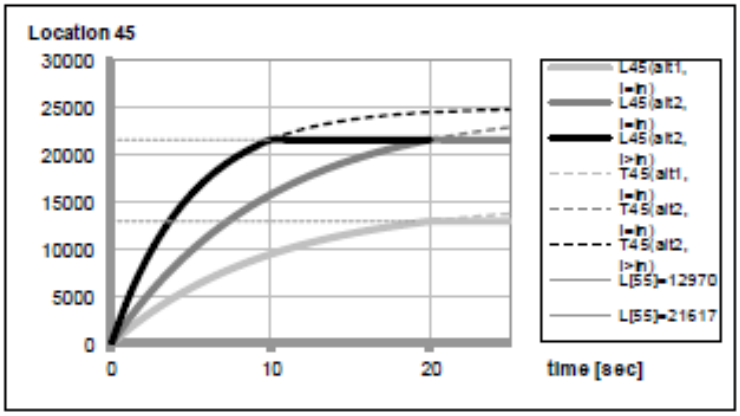

fig. 9

(1) Nominal load and 90% of nominal frequency
(2) with load greater than the nominal one
(3) starting from rev.15 of the Firmware
(4) starting from rev.15 of the Firmware, L[35] for the previous versions
(5) Starting from rev. 18 of the firmware only the integral gain of the excitation overcurrent regulator can me modified.

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].
L[55]=12970 : Represents the value of the current limit set using the AMP trimmer or the P[22] parameter for the first alternator[3]
L[55]=21617 : Represents the value of the current limit set using the AMP trimmer ot the P[22] parameter for the second alternator[3]

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3.2 Calibration with a supervision unit

To calibrate the overload protection, when the machine is cold, perform the following procedure:

1) turn the AMP trimmer fully clockwise (if enabled from the **Settings/Potentiometers** menu) or write 32676 in location 22
2) feed the alternator an overload having cosphi = 0.8 or cosphi = 0 respectively equal to 125% or 110% of the nominal load
3) read the value displayed at location 45 2 minutes after overload application
4) if the AMP trimmer is enabled turn it anti-clockwise until the value read at location 55[4] becomes equal to the value read at point 3 (location 45); the operation is simplified a lot by using the DxR terminal software which provides, in the lower part of the main window, a graphic representation of the time evolution of locations 45 ("real excitation", red line) and 55 ("excitation threshold" - yellow line): the intervention threshold must be calibrated so that the yellow line should intersect the red line when, from the application of the overload, the time specified at point 3 has passed.
5) if the AMP trimmer is not enabled, write the value read at point 3 (location 45) in location 22.
6) Alarm 5 should set off (visible both on the main panel of the DxR Terminal and through a change in the LED flash) and the voltage should start to decrease
7) If the load is removed, alarm 5 disappears after a few seconds and the generator voltage goes back to the nominal value.

3.3 Calibration without a supervision unit

NB: this calibration can be performed only if the AMP trimmer was previously enabled.
To calibrate the overload protection, perform the following procedure:

1) turn the AMP trimmer fully clockwise
2) feed the alternator an overload having cos phi = 0.8 or cos phi = 0 respectively equal to 125% or 110% of the nominal load
3) after two minutes slowly turn the AMP trimmer anti-clockwise until you get a reduction of the generator's voltage value and the activation of alarm 5 (visible through a change in the LED flash)
4) Calibrate the AMP trimmer so as to get an output voltage value of 97% of the nominal value: alarm 5 is still active.
5) If the load is removed, alarm 5 disappears after a few seconds and the generator voltage goes back to the nominal value.

NOTES: If the machine is used in single phase or voltages different to the ones set by the producer, a recalibration of the overexcitation protection might be necessary.
If it is not possible to apply the prescribed overload, the overexcitation condition may be simulated by adequately increasing the regulated voltage so as to get an excitation current equivalent to the overload current.

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 10a e 10b. The intervention threshold depends upon:

- the status of jumper 50/60 (terminals 25 and 26) if enabled from the **Settings/UFLO&LAMS** Menu.
- the status of the 50/60 setting in the **Settings/UFLO&LAMS** Menu
- the position of the Hz trimmer if enabled from the **Settings/Potentiometers** Menu
- the value entered at parameter P[21] **(ref. Settings/UFLO&LAMS menu** or area Transmit/Receive of Settings/Advanced menu).

Activation of the function with voltage proportionate to the frequency is signalled by activation of alarm 6 (visible from the DER1 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 **Settings/UFLO&LAM** menu are not present) or at 54 Hz (if the 50/60 jumper is enabled or the 50/60 flag is active in the **Settings/UFLO&LAM** 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 9a and 9b.

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. . The above-mentioned calibrations are simplified a lot by using the DxR terminal software which allows, in the **Settings/UFLO&LAMS** menu, through a graphic interface, to change parameters 21 and 23 (with a concurrent disabling of the Hz trimmer) providing the preview of the V/f ratio in the setting phase.

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 is inserted, or activate 50/60 (ref. **Settings/UFLO&LAMS** 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.
   The operation is much facilitated by the use of the DxR terminal software which provides a graphic representation of the time evolution of the measured frequency (red line) and of the intervention threshold (green line)
3) when the speed decreases under the threshold value the voltage of the generator starts to diminish and alarm 6 is simultaneously visualized on the LED and on the main window of the DxR Terminal software
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

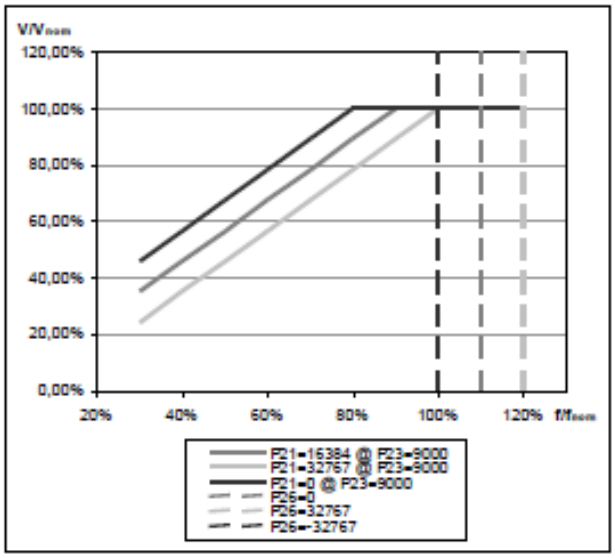

fig. 10a: Underspeed and Overspeed protection, P[21] and P[26]

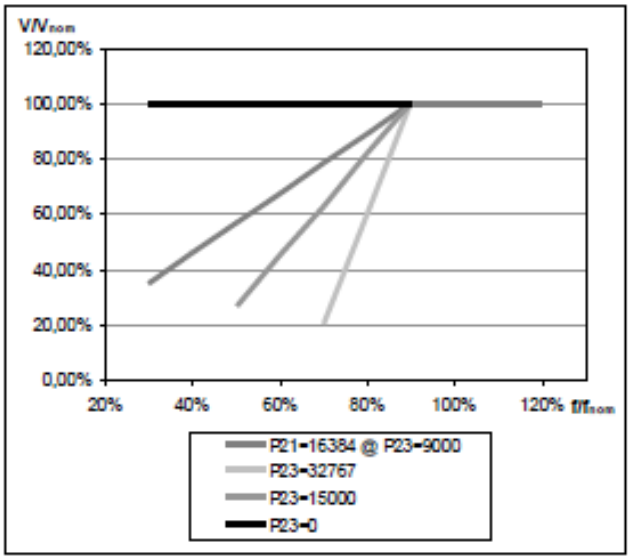

fig. 10b: Voltage slope in underspeed protection, P[23]

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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 **Settings/UFLO&LAMS** Menu are absent) or at 66Hz (if the 50/60 jumper is present and enabled or the 50/60 flag in the **Settings/UFLO&LAMS** 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 10a.

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.

6.4 Intervention threshold of low excitation alarm

Starting from rev. 18 of the firmware a warning (alarm A-08) was added in case of low excitation or loss of excitation: if the measured value of excitation voltage does not fall within a preset value range, the anomalous operating condition is signaled (visible on the main panel of the DxR Terminal through the A-08 alarm indicator); no other action is performed by the regulator, except for the switching of APO (if set).
The numeric value identifying in real time the excitation condition is available at location L[56]; the upper detection threshold cannot be modified while the lower threshold can be configured through parameter P[27].
The alarm is activated when the value assumed by location L[56] is higher than the upper threshold or lower than the value assumed by parameter P[27]
For the generators in stand-alone operations, the loss of excitation, on a working regulator, implies also the activation of the low voltage alarm. The underexcitation / loss of excitation alarm is mainly intended for the applications in grid-parallel mode, provided that the regulator stay fully operational (for instance with sufficient residual voltage, direct supply from the phase or from PMG).

CAUTION! :In case of parallel operation of the generators and, most of all, in case of grid-parallel mode, given that the activation of the underexcitation/loss of excitation alarm does not imply any other action, except for the signalling and switching of APO (if enabled), the protection of the system is transferred to at least an appropriate management of the above-mentioned signalling. However, no guarantee is offered for the capacity of the exclusive use of this protection to safeguard the system from all the possible functional anomalies correlated to underexcitation / loss of excitation.

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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
8	Underexcitation / loss of excitation	APO

The status of active alarms is stored at location L[38], which can be read with the USB 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	-	-	-	Underexcitation	Over speed	Under speed	Over Excitation	Short	Under voltage	Over voltage	Check sum EEPROM

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. 11) 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. 11.

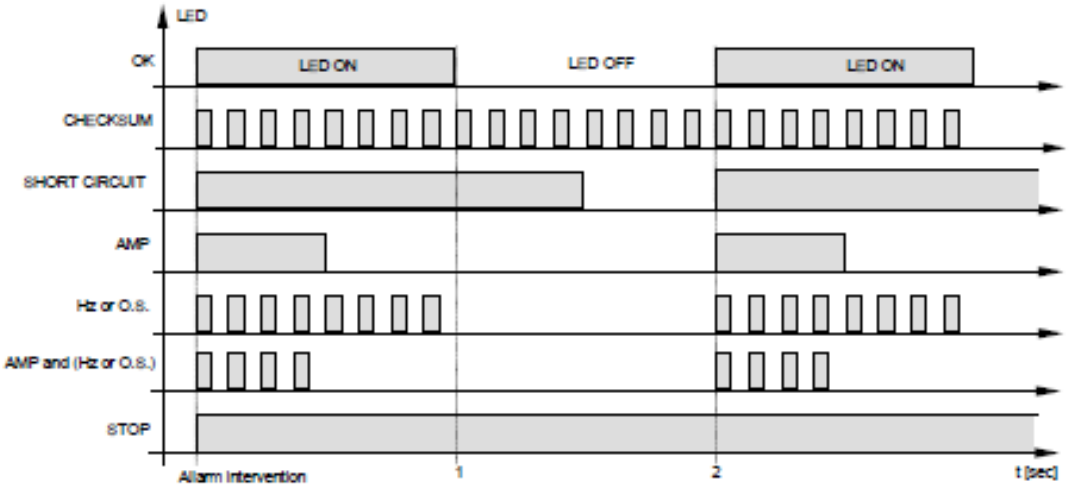

fig.11

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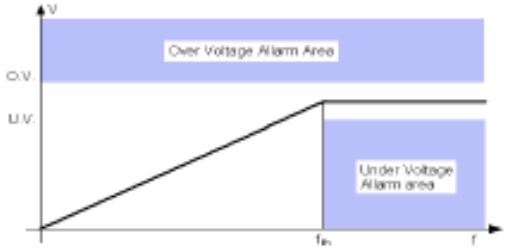
2. Description of alarms

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 does not determine a change in the LED flash, the APO output is active and the alarm 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 (@ ω_N)	The alarm does not determine a change in the LED flash, is stored and the APO output is active. 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].
8	underexcitation /loss of excitation	The alarm does not determine a change in the LED flash, enables APO output and is memorized. The alarm condition is recognized by a underexcitation / loss of excitation observer, available for reading at location L[56]: if the value of L[56] is higher than the upper (fixed) threshold or lower than the value of the lower threshold (parameter P[27]), A-08 is activated. The alarm is inhibited during transients.

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 status ((Transistor open collector Active Protection Output - connector CN1 terminals 14 and 15)
depends on:
- whether some alarms are activated or not
- setting of parameter P[17]
- setting of the "APO Invert" flag [2]

In normal operating conditions it is closed [2] [3]. It opens [2] (with a configurable delay from 0 to 15 seconds) when, of all the alarms, one or several separately selectable alarms are active and the "APO Invert" flag [2] is active or, immediately, in case of absence of power supply to the regulator; if the "APO Invert" flag [2] is inactive (or for firmware revisions lower than 18) the APO output is inverted (open in normal operating conditions or with regulator switched off, closed, with a configurable delay, in case of one or several active selected alarms).
The selection of which alarms trigger the activation of A.P.O. depends on the value written at location 17. The transistor is closed [2] [3] both when no alarm is active and when, even if the alarm is active, the corresponding enabling bit is set to 0.
The value to set at location 17 is made up of 2 parts: one part allows selection of the alarms which activate the contact, the other one allows setting the intervention delay. To calculate the value to set at location 17 use the following procedure:

a) In relation to table 15. Add up the decimal numbers corresponding to the alarms for which you want APO to be activated obtaining number B. (Example: if you want APO to be activated for overvoltage and overspeed, you get B = 2 +64 = 66)
b) Multiply the delay you want (integer values from 0 to 15 seconds) by the fixed value 4096. You get number A = (0..15) * 4096. (Example: if you want a 5 seconds delay, you get A = 5 * 4096 = 20480)

The sum A + B must be written at location 17 (In the preceding example 20480 + 66 = 20546)
The configuration is simplified a lot by the use of the DxR terminal software which has the APO settings menu dedicated to this purpose.

TABLE 15 : ALARM SETTINGS THAT ACT ON THE APO

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

4. DER1 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 this procedure please refer to the "DownLoad Alarm" function of the Upload/Download Menu of DxR Terminal Software, see Technical guide “Interface communication USB2DxR".

NOTE (1): starting from rev.18 of the Firmware
NOTE (2): Open for firmware revisions lower than 18

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APPENDIX : DER1 SET UP ON A TEST BENCH

The operations of functional checkout and parameter setting may turn out to be easier if they are performed on a test bench rather than with the regulator connected to the alternator.
The connection diagrams of the DER1 and the USB2DxR communication interface are shown in figures 12a, 12b or 12c based on the requested function and on the available supply voltage.

Given that some parts of the DER1 which work at high voltage are not isolated, for the safety of the operator, it is necessary for the power source to be isolated from the electrical grid, for instance by a transformer.

The use of these types of connection is reserved to qualified personnel, able to assess the operational risks of high voltage and who have a full knowledge of the content of this manual.

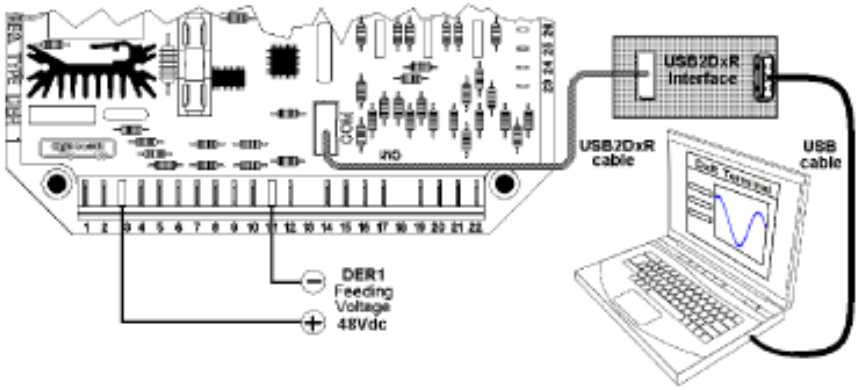

Fig. 12a: DER1 48Vdc power supply (please note that no other connections, other than the power source, are necessary) for the download of the alarms without risking to modify the content of the EEPROM because of the test.

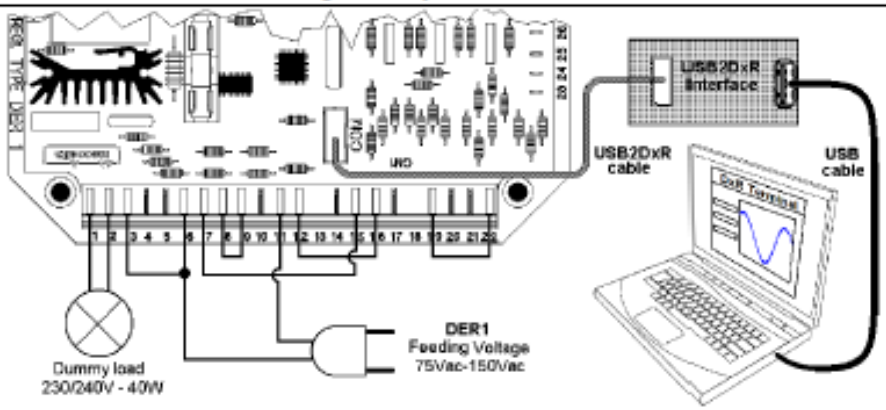

Fig. 12b: DER1 75-145Vac power supply (Please note the sensing on terminal 7 and the jumper between terminals 6 and 3 of the DER1) for test and setup

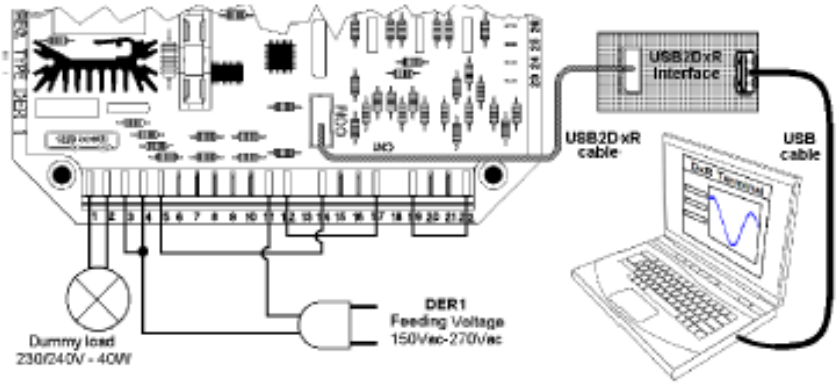

Fig. 12c: DER1 150-270Vac power supply (Please note the sensing on terminal 5 and the jumper between terminals 4 and 3 of the DER1) for test and setup

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TECHNICAL REFERENCE GUIDES	
Titolo	**Link**
Communication interface USB2DxR	http://www.meccalte.com/send_file.php?fileid=Usb2DxR.pdf
Digital Regulators MODBUS communication protocol	http://www.meccalte.com/send_file.php?fileid=MODBUS
Parallel operation	http://www.meccalte.com/send_file.php?fileid=parallel%20manual_PD500.pdf

REVISION HISTORY		
Revision	**Date**	**Description**
rev.00	07/11	Initial Release
rev.01	03/12	Edited Note 1) page 5 and added new drawings SCC0158 and SCC0159
rev.02	09/12	Edit Technical specifications - new drawings SCC0202 and SCC0203
rev.03	09/12	Modified drawings SCC0158 and SCC0159
rev.04	05/15	Firmware update rev. 19, added connection scheme filter EMI182/K, cancelled : DI1, software DSR Terminal
rev.05	07/15	Corrections at pages 9, 18 and 19 .
rev.06	09/16	Update of: all SCC with PD500 , PD-I and AVR wires markers, and fig.6,12a,12b,12c

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Appendix F – Fault Finding Procedure

BASIC FAULT FINDING PROCEDURE A60411M43G & A80411M43G RANGE

Refer to machine handbook to obtain correct winding resistances.

MAIN STATOR WINDING

1. Remove customer's output cables and disconnect any earth-neutral connections.
2. Dis-connect DSR / DER1 connections.
3. Megger main stator winding to earth. Insulation resistance must be above 1MΩ @ 500 Volts.
4. Test auxiliary stator winding for continuity of two red leads connected to DSR/DER1. If auxiliary is open circuit the machine may be operated by linking terminals plus and zero on the DSR/DER1. However this will eliminate overload protection device. If in doubt consult Pyroban Ltd.
5. Refer to handbook for resistance (nominal 1-1.5Ω).
6. If necessary run machine with field leads disconnected or the fuse removed, and check voltage balance across phases or between phases and neutral. Any major imbalance would indicate a blown stator.
7. Split neutral point and megger test insulation between phases.

EXCITER FIELD

1. Check for continuity, nominal resistance 15Ω. (Yellow and Blue Leads)
2. Check insulation resistance to earth.

ROTOR AND EXCITER ARMATURE

Because of the construction of this machine, access to the main rotor and exciter stator assembly is restricted. To gain access the cowl, fan and non-drive end bracket assembly require removal.
To facilitate a rapid diagnosis, measure the excitation voltage across the blue and yellow leads. In a no load condition this should be approximately 7 Volts DC ± 20%. Readings in excess of this would indicate a faulty diode or faulty exciter rotor winding.
Low residual stator voltages i.e. < 30 Volts AC could indicate either failure of the exciter stator winding or an open circuit rotor.

DSR

Test DSR/DER1 fuse. If necessary, separately excite machine with a 12 Volt battery. Connect positive to yellow lead of exciter field and negative to blue lead of exciter field. Remember to only run like this for short period of time. Connect 33Ω resistor in series to limit field current if required to run for longer period.
If machine operates OK separately excited. DSR/DER1 is faulty.
Ensure engine speed is within acceptable limits i.e. 1410 to 1560 RPM for correct operation.

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FOR FURTHER ADVICE

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Appendix G – Bearing Inspection/Replacement Procedure

BEARING INSPECTION AND REPLACEMENT PROCEDURE A60411M43G & A80411M43G

Refer to Appendix B for complete description of maintenance operations.

The Drive End bearing (shaft end) is an SKF 6314-2RS2/MT33/R806 with Viton seals on the inner and outer races. The Non-Drive End bearing is an SKF 6212-2RS2/MT33/R806 with Viton seals on the inner and outer races. The bearings have a continuous ambient operating temperature limit defined by -20°C < COT < +60°C.

The A60411M43G & A80411M43G alternators are designed to give a long maintenance free working life. All bearings are greased during assembly. Use SKF 28 or equivalent grease for normal operation. No maintenance is necessary for their entire working life (approximately 30000 hours). If the application environment is regularly polluted with a high concentration of dust or fine sand the replacement interval should be reduced to 16000 hours. Assessment of correct functioning is a routine maintenance operation. (Absence of anomalous noises or vibrations).

ASSESSMENT OF CORRECT FUNCTIONING

We recommend users to check regularly (every 3 months as a maximum interval) the correct functioning of the alternator, and to verify that there are no anomalous noises or vibrations. Their presence may indicate damage to the bearings.
We remind you that the alternator itself has no noticeable vibration since the rotating parts are statically and dynamically balanced. Provided that the rotor balancing has not been impacted nor the rotor's bearings damaged, vibrations in the generating set may occur due to misalignments of couplings, due to exceptional stress upon the prime mover or to anti-vibration mounts. We also recommend checking of the user operation mode, which must comply with the data on the alternator's plate. If exceptional vibration is encountered, the rotor assembly should be extracted and the outer race checked for radial movement. The running temperature of the bearing may be monitored from the PT100 analogue output. If the temperature exceeds 120°C, it should be investigated.

Replacement of the rotor bearings may be classed as an extraordinary maintenance operation.

REPLACEMENT OF THE BEARINGS

During the alternator assembly process all bearings are greased with SKF 28 grease.
All alternators are equipped with sealed bearings; for this type of bearing no maintenance is required for the total operating time (normally 30000 hours). During this time, checks to detect presence of either overheating or abnormal noises must be carried out on a regular basis (every 3 months as maximum). If the bearing is worn out, it can cause excessive vibrations. Vibrations in excess of the limits defined in ISO8528 part 9 should drive a bearing replacement. In such a case the bearing must be removed, examined and if necessary replaced.

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Here follows a procedure for bearing replacement:

To disassemble alternator version A60411M43G & A80411M43G, follow this procedure (refer Appendix C) :

1. Remove the terminal box lid unscrewing the 4x M6 captive screws.
2. Remove the bush locking the fan, by first unscrewing the M14 screw.
3. Extract the ventilation fan using a suitable puller.
4. Release the bearing PT100 leads from the terminal block and extract them back to the Drive End and Non-Drive End endplates.
5. Remove the Non-Drive End bracket unscrewing the 4x M14 screws.
6. Remove the Drive End bracket unscrewing the 4x M14 screws.
7. Use a lifting device equipped with soft ropes of an adequate lifting capacity to extract the rotor. Make sure that the lifting devices are suitable for the weight of the parts to be shifted.
8. To pull the bearings out, use an appropriately sized puller.
9. To insert the new bearing to the specification defined in the introduction to this Appendix, heat it to 100°C with a suitable magnetic device.
10. Put on heat proof gloves and insert each bearing up to its shoulder on the rotor shaft.

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