



POWER FROM WITHIN

GUIDA TECNICA
**REGOLATORI
DIGITALI MxK**

MxK DIGITAL REGULATORS

TECHNICAL GUIDE

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The information quoted in this manual may be changed without notice.



This revision cancels and replaces all previous ones.

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1 INTRODUCTION

This technical guide provides information on how the **M2K**, **M2K^S**, **M3K**, **M3K^S** and **M3K^{SHD}**, digital regulators, hereinafter generically referred to as **MxK**, operate and how to use them in the application.

In general, the information detailed here applies on all the digital regulators; with parts that refer to specific devices, the relevant device is indicated in the heading.

	To prevent equipment damages or personnel injuries, only qualified technicians/engineers with full understanding of the application must carry out the procedure detailed in this document; whilst the unit powered, care should be taken as the device consists of high voltage and it could result personnel injury or loss of life.
	Unless otherwise specified, only connect when the unit is not being powered. The plastic protection must not be removed from the J2 connector for any reason.

2 GENERAL INFORMATION

The **MxK** devices are voltage regulators for synchronous alternators, designed for stand-alone operation and calibration.

2.1 System Architecture

The family is made up of 5 devices whose different hardware characteristics are outlined in Tab. 2.1-I

AVR TYPE		M2K	M2K^S	M3K	M3K^S	M3K^{SHD}
Overall dimension	[mm]	99x93x36	99x93x36	184,5x 114,5x37	184,5x 114,5x37	184,5x 114,5x37
Plastic tray	[color]	BLUE	BLACK	BLUE	BLACK	BLACK
Power converter		Half-bridge	Half-bridge	Full bridge	Full bridge	Full bridge
Voltage sensing	(channels)	Single-phase ⁽¹⁾	Single-phase ⁽¹⁾	Single/Three-phase ⁽¹⁾	Single/Three-phase ⁽¹⁾	Single/Three-phase ⁽¹⁾
Current sensing	(channels)	NO	NO	YES ⁽¹⁾	YES ⁽¹⁾	YES ⁽¹⁾
High Dynamic	(HDR)	NO	NO	NO	NO	YES
Potentiometers	(functions)	3 (VOLT, STAB, AMP)	3 (VOLT, STAB, AMP)	4 (VOLT, DROOP, STAB, AMP)	4 (VOLT, DROOP, STAB, AMP)	4 (VOLT, DROOP, STAB, AMP)
Dip-Switches	(functions)	2 (Autotuning)	2 (Autotuning)	4 (LAM, DROOP, Autotuning)	4 (LAM, DROOP, Autotuning)	4 (LAM, DROOP, Autotuning)
CAN Bus		NO	YES	NO	YES	YES
ModBus connection additional device	(wired)	USB2MxK	USB2MxK	USB2MxK	USB2MxK	Embedded
	(wireless)	MxKconnect	MxKconnect	MxKconnect	MxKconnect	MxKconnect
Active Protection Out	(isolated)	NO	NO	NO	NO	YES

Tab. 2.1-I: MxK regulator hardware characteristics

To maximise performance, MxK regulators should be considered as part of a system made up of at least two main components: the device (control unit) and a supervisor.

The supervisor can be a personal computer/smartphone by Mecc Alte App, a group controller, or both; it does not control in real time, but can be used to set and see all the operation parameters of the **MxK** regulator.

M2K **M2K^S**

An additional device is required to connect to the supervisory unit; the connection, wired or wireless, can be made through one of the devices named USB2MxK and MxKconnect; the use of one or the other depends on the supervisory unit (PC or Smartphone) and the type of connection (USB or wi-fi).
Kits consisting of said device and its connection cables are available upon request.

M3K **M3K^S**

An additional device is required to connect to the supervisory unit; the connection, wired or wireless, can be made through one of the devices named USB2MxK and MxKconnect; the use of one or the other depends on the supervisory unit (PC or Smartphone) and the type of connection (USB or wi-fi).
Kits consisting of said device and its connection cables are available upon request.

M3K^{SHD}

Connection can be wired or wireless: in the first case (to a PC) it is via the USB port mounted on the board and only a suitable cable is needed, in the second case (PC or Smartphone) the additional device MxKconnect is needed USB cable (male type A - male type A) or Kit consisting of MxKconnect and related connection cables are available upon request.

M2K^S **M3K^S** **M3K^{SHD}**

The unit can be connected by CANBus to the supervisor (e.g. a group controller) using the dedicated connector on the board. For more information please refer to chap. 11.2 titled "CAN Bus".

The **MxK** regulators have got connectors for connection from and to the electric generator and the supervisor, using the additional USB2MxK device where necessary.

2.2 Main Functions

Being suitable to control various types of alternators, the regulators must be adequately configured to obtain the best performance on the generator; most settings are stored in an integrated non-volatile memory (EEPROM) in the regulator. When switched on for the first time, the regulator configuration is at its default which allows it to meet the most common characteristics and help to simplify the installation: the trimmers are enabled, the inputs that modify the setpoint (analogue voltage and potentiometer), the 60Hz jumper, and the DIP switches are enabled; and therefore additional devices are not required for the basic calibration. The main functions implemented in each of the 5 devices are outlined in Tab. 2.2-I

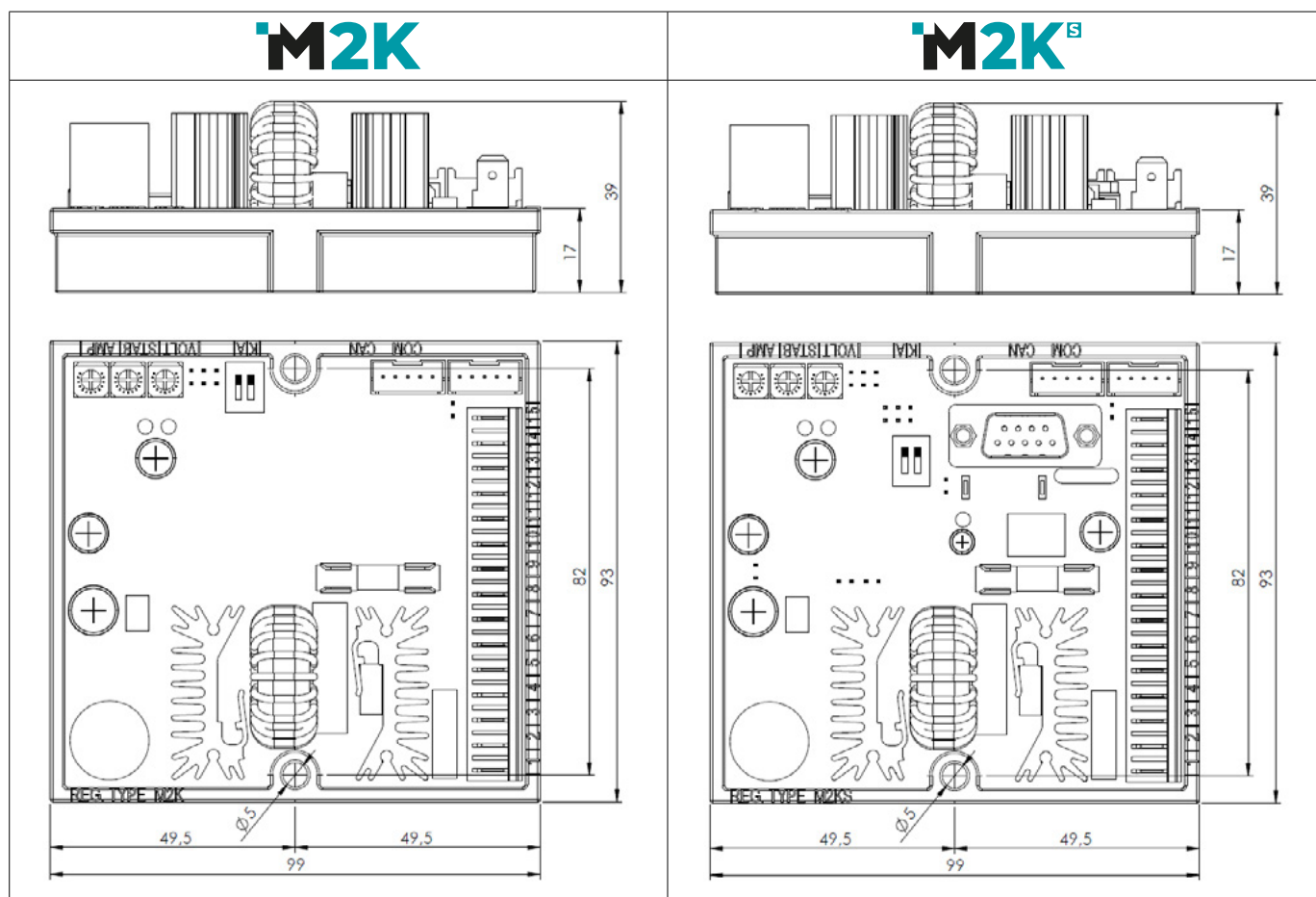
Main Features	M2K	M2K^S	M3K	M3K^S	M3K^{SHD}
Sensing range: 55÷150V or 150÷405V	•	•	•	•	•
Three phase sensing			•	•	•
2 separate inputs for Potentiometer and DC Voltage (±10V)	•	•	•	•	•
Adjustable stability (by trimmer STAB or parameter settings)	•	•	•	•	•
Self stability setting by adaptive algorithm (auto tuning)	•	•	•	•	•
Frequency range 20÷90Hz	•	•	•	•	•
Selectable rated frequency (50Hz or 60Hz)	•	•	•	•	•
Effective L.A.M.S. functionality (Load Acceptance Module System)	•	•	•	•	•
External E2PROM (calibrations, settings and alarm LOG)	•	•	•	•	•
Adjustable Excitation Overcurrent (by trim. AMP or parameter setting)	•	•	•	•	•
Board temperature sensing	•	•	•	•	•
Power Supply Overvoltage Protection (Feeding Voltage Limiter)	•	•	•	•	•
Current and Power measurement			•	•	•
Adjustable voltage droop on reactive current			•	•	•
Overcurrent alarm on capability curve			•	•	•
Excitation boost (up to 18Adc)			•	•	•
CAN Bus J1939 communication protocol		•		•	•
Configurable Active Protection Output (A.P.O.)					•
High Dynamic Response					•

Tab. 2.2-I: MxK regulator hardware characteristics

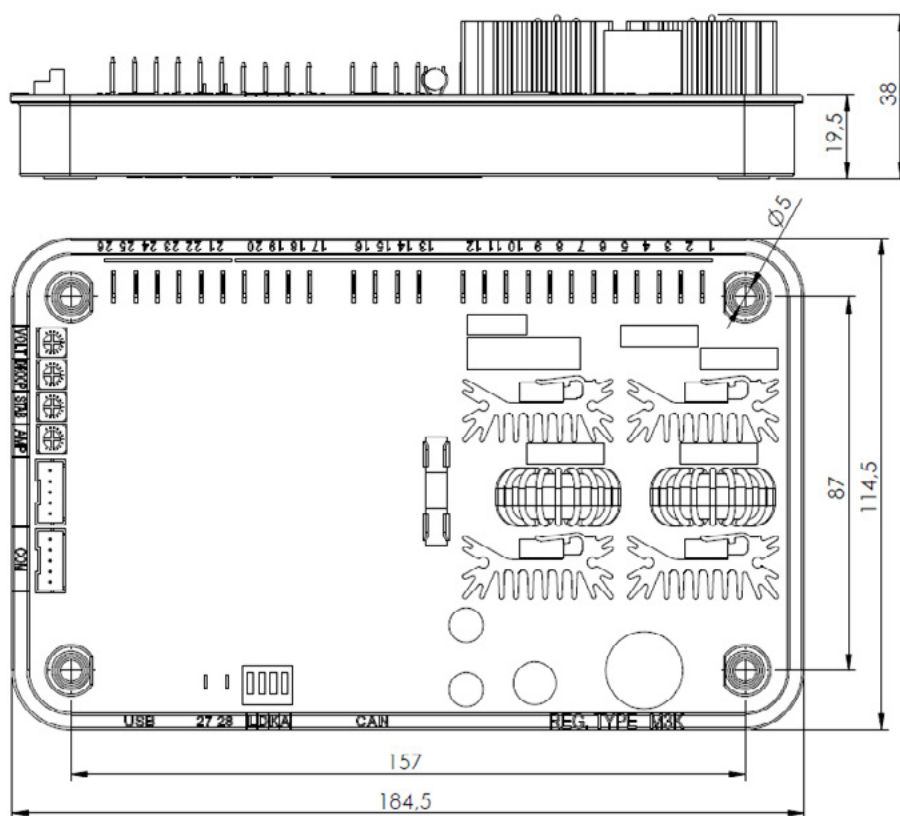
2.3 Maximum Rating

- Power winding protective fuse: 5A (fast blow)
- Room temperature: -25°C to +70°C
- Supply voltage: 50Vrms - 270Vrms (440V peak; from auxiliary, phase or PMG)
- Maximum direct current output: 5Adc
- Maximum peak current: 12Adc (**M2K**, **M2K^S**) and 18Adc - excitation boost (**M3K**, **M3K^S**, **M3K^{SHD}**)
- Frequency operation interval: 20Hz - 90Hz
- Voltage regulation field (sensing): 55Vrms - 405Vrms
- Analogue input voltage for modifying the voltage setpoint -10V - +10V
- Maximum current at C.T. secondary: 5Arms continuous (5.5Arms in transitory overload)

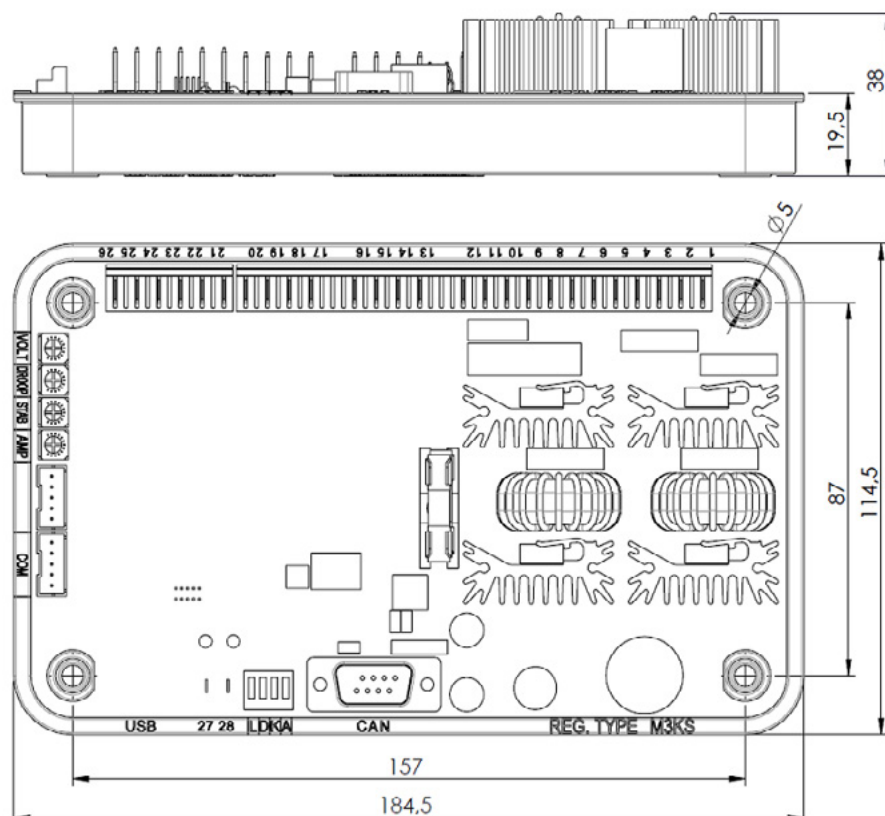
2.4 Overall Dimensions

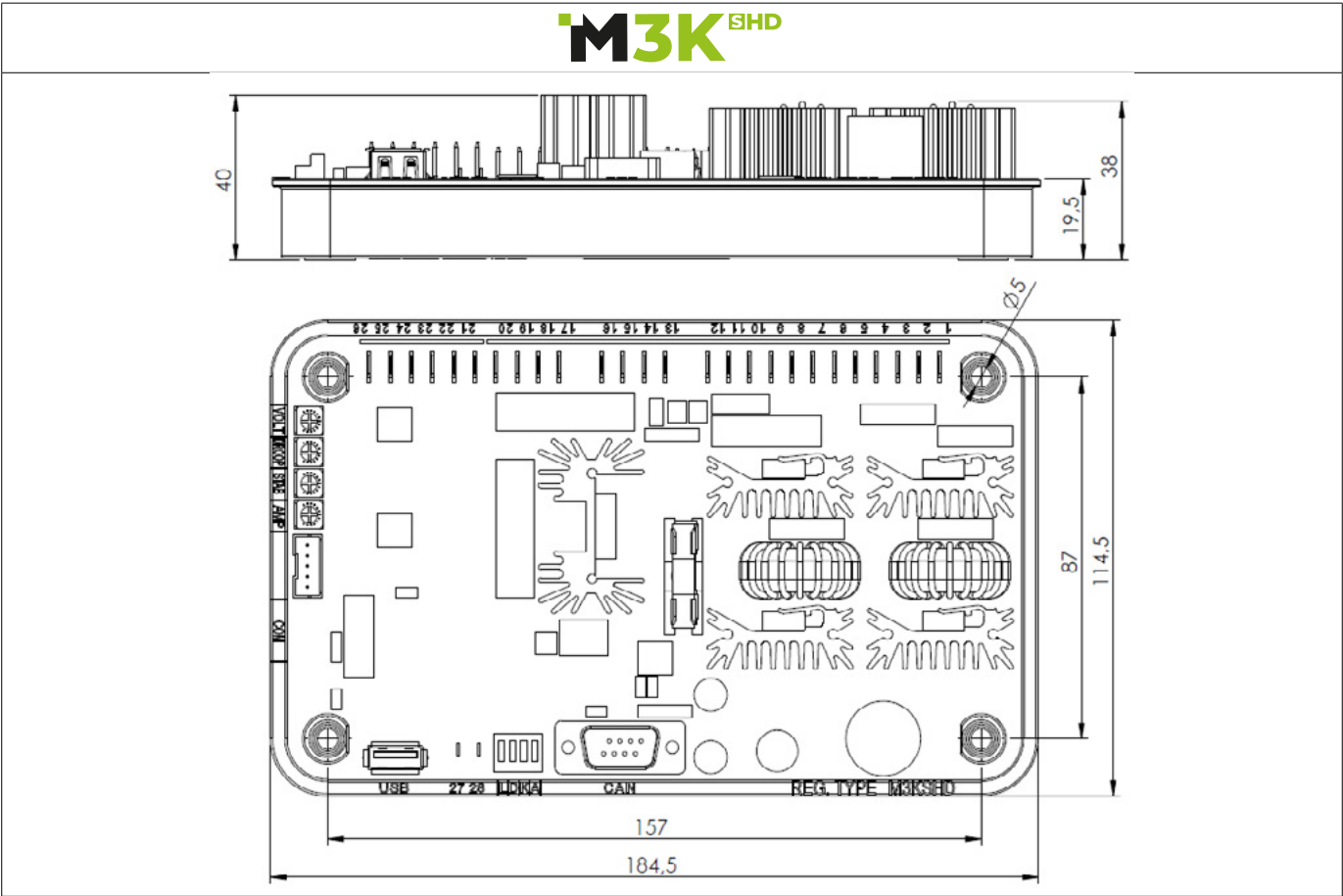


M3K



M3K^S





2.5 Inputs and Outputs: technical specifications

M2K M2K^B

Minimum cable sizes:

- 1,5 mm² for the power cables on terminals 1 to 9
- 0,5 mm² for the control cables on terminals 10 to 15

Tab. 2.5-I - CN1 CONNECTOR

Terminal ⁽¹⁾	Name	Purpose	Specifications	Notes
1	Exc-	Excitation	Continuous reg.: 5Adc max Transient reg.: peak 12Adc	
2	Aux/Exc+			
3	Aux1/Exc+	Supply	50÷270 Vrms, 440Vpk	Frequency 20÷90Hz
4	Ufg	Sensing scale 2	Scale 2: 150Vac ÷ 405Vac Burden: <1VA	Effective value for voltage regulation
5	Ufg			
6	Uhg	Sensing scale 2	Scale 1: 55Vac ÷ 150Vac Burden: <1VA	Effective value for voltage regulation
7	Uhg			
8	Aux2/Neutral			
9	Aux2/Neutral			
10	Zero	Jumper input 50/60Hz	Type: non-insulated Maximum length: 3m	UFLO: 50·(1-P[64]) or 60·(1-P[64])
11	50/60Hz			
12	Pext - C	Setpoint modification potentiometer	Type: non-insulated Maximum length: 30m ⁽²⁾	Potentiometer: 10K Variation: -7% ÷ +7%
13	Pext - W			
14	Zero_Ext	Analogue input for modifying the voltage setpoint	Type: non-insulated Range: ±10Vdc Burden: 0÷1mA (sink) Maximum length: 30m ⁽²⁾	Variation: -14% ÷ +14%
15	Vext			

NOTE (1): These terminals are connected on the board: 2 with 3, 4 with 5, 6 with 7, 8 with 9

NOTE (2): With external EMI filter (3m without EMI filter)

M3K M3K^B M3K^{BHD}

Minimum cable sizes:

- 1,5 mm² for the power cables on terminals 1 to 22
- 0,5 mm² for the control cables on terminals 23 to 28

Tab. 2.5-II - CN1 CONNECTOR

Terminal ⁽¹⁾	Name	Purpose	Specifications	Notes
1	Exc-	Excitation	Continuous reg.: 5Adc max Transitory reg.: peak 18Adc	
2	Exc+			
3	Aux1	Supply	50÷270 Vrms, 440Vpk	Frequency: 20÷90Hz
4	Ufg ⁽¹⁾	Sensing scale 2	Scale 2: 150÷405 Vac Burden: <1VA	Channel U
5	Ufg ⁽¹⁾			
6	Uhg	Sensing scale 1	Scale 1: 55÷150 Vac	
7	Uhb	Bridge scale 1	Short-circuit for sensing at scale 1 55÷150 Vac	
8	Ufb ⁽¹⁾			
9	Ufb ⁽¹⁾			
10	Ufb ⁽¹⁾	Bridge for non-diffe- rential sensing	Do not install for sensing differential at channel U	Star YY or Y centre in common with supply
11	Aux2 ⁽¹⁾			
12	Aux2 ⁽¹⁾		Board reference	
	-		Not present	
13	Vfg	Sensing	Scale 1: 55÷150 Vac Burden: <1VA	Channel V
14	Vhg	Sensing scale 1		
15	Vhb		Scale 2: 150÷405 Vac Burden: <1VA	
16	Vfb	scale 2		
	-		Not present	
17	Wfg	Sensing	Scale 1: 55÷150 Vac Burden: <1VA	Channel W
18	Whg	Sensing scale 1		
19	Whb		Scale 2: 150÷405 Vac Burden: <1VA	
20	Wfb	scale 2		

NOTE (1): These terminals are connected on the board: 4 with 5, 8 with 9 and 10, 11 with 12

Tab. 2.5-III - CN2 CONNECTOR

Terminal ⁽¹⁾	Name	Purpose	Specifications	Notes
21	CT2	C.T. secondary winding input 5A	Type: non-insulated shunt Range: 0÷5,5A Maximum length: 3m	Maximum 5A at nominal current 5.5A in overload
22	CT1			
23	Pext - C	Setpoint modification parameter	Type: non-insulated Maximum length: 30m ⁽²⁾	Potentiometer: 10K Variation: -7% ÷ +7%
24	Pext - W			
25	Zero_Ext	Analogue input for modifying the voltage setpoint	Type: non-insulated Range: ±10Vdc Burden: 0÷1mA (sink) Maximum length: 30m ⁽²⁾	Variation: -14% ÷ +14%
26	Vext			

NOTE (2): With external EMI filter (3m without EMI filter)

Tab. 2.5-IV - CN5 CONNECTOR

Terminal ⁽¹⁾	Name	Purpose	Specifications	Notes
27	Zero	Jumper input 50/60Hz	Type: non-insulated Maximum length: 3m	UFLO: 50·(1-P[64]) or 60·(1-P[64])
28	50/60Hz			

2.6 Installation

A visual inspection is required when receiving the device to check that there are no marks of damages on the unit due to its transportation. If a damage is observed then immediately notify the carrier, or the insurance company, or the retailer or Mecc Alte. If the regulator is not to be installed then store it safely within its original package in an area free from dust and humidity. The regulator is normally installed on the generator terminal block. It is fastened by four M4x25 screws and must be positioned where the ambient temperature does not exceed the indicated environmental conditions. The regulator has a 5A “fast type” fuse for protection; if the fuse is blown, make sure it is replaced with the same type and rating.

The connections to the regulator depend on the application and the excitation system; schematics suitable for most of the applications are shown in chapter 12 “ELECTRICAL SCHEME”

Wrong connections could cause serious damages to the unit.



Carefully check and make sure that all the connections are correct and in line with the attached drawings before powering.

3 VOLTAGE SETTING: SENSING AND SETPOINT

The **MxK** device are **voltage regulators**; the setpoints and the regulations vary depending from the alternator type and the voltag levels, and similarly the relative measurements, refer to the previously mentioned size expressed in VOLTS.

M2K **M2K[®]**

The regulators have an input for the voltage scale selection. The voltage scale is selected via the terminal connections

- scale “H” for voltages from 55V to 150V
- scale “F” for voltages from 150V to 405V

The voltage scale selection depends on the connections with the machine and the voltage that needs regulation.

M3K **M3K[®]** **M3K^{SHD}**

The regulators have 3 differential inputs with 2 scales that can be selected by connecting to different terminals in each of them

- scale “H” for voltages from 55V to 150V
- scale “F” for voltages from 150V to 405V

Use the three-phase, two-phase or single phase sensing from one of the two available scales according to the machine connections, the voltage to be regulated, and the voltages to be used for sensing.

The regulator automatically identifies whether it is setup as a single phase or three phase by using a threshold level on its voltage sensing terminals.

The sensing value is calculated as the arithmetic mean of the signals identified as being valid (1, 2 or 3).

Bits B₃, B₄ and B₅ of the STATUS variable (address A[470]) indicate in real time the sensing sources considered for determining feedback (channel U, channel V, and channel W respectively).

Single phase sensing can be implemented using 1, 2 or 3 channels connected in parallel or series, keeping the others short circuited to minimise the S/N ratio of the feedback.

3.1 Outline of voltage regulation settings

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
29	58	External Voltage operative range	VEXT_Gain	Float	0,14	0,2	0	[%]
30	60	External Voltage channel Gain(A2)	VEXT_Sclng	Float	0,00048828		0	NA
31	62	External Voltage channel Offset(A2)	VEXT_Ofst	Float	-1			[%]
32	64	External Voltage Time constant	VEXT_LPFTau	Float	0,05		0	[s]
35	70	Configuration flags part 1	CONFIGURATION_1	Integer	Device dependent ⁽¹⁾	2 ³² -1	0	NA
36	72	Configuration flags part 2	CONFIGURATION_2	Integer	6168 ⁽²⁾	2 ³² -1	0	NA
45	90	Voltage Setpoint	USR_VltgSetpt	Float	231	0	500	[V]
60	120	Setpoint rate limitation	SETPT_MaxRate	Float	200	500	0	[V/s]

Tab. 3.1-I: Voltage parameters (Sensing and Setpoint)

NOTE⁽¹⁾: see Chapter 8 "CONFIGURATIONS"

NOTE⁽²⁾: P[36] = 6168 (**AUTUNEonce**=0, **AUTUNE**done=0, **AUTUNEfreeze**=1)

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₁	2	0000 0002	Trim1_En	TRIMMER VOLT Enable	Active	1	2
B ₅	32	0000 0020	VExt_En	External Voltage/Potentiometer Enable	Active	1	32

Tab. 3.1-II: Flags pertinent to the voltage (Sensing and Setpoint) at P[35] **CONFIGURATION_1**

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₁₁	2048	0000 0800	Sensing_gain (SG)	Sensing Scale (55-150V) or (150-405V)	150-405V	1	2048
B ₁₂	4096	0000 1000	Sensing_winding (SW)	Sensing winding (Half phase or Full phase)	Full phase	1	4096
B ₁₃	8192	0000 2000	Sensing_source (SS)	Sensing Line-to-Neutral or Line-to-Line	L-N	0	0

Tab. 3.1-III: Flags pertinent to the voltage (Sensing and Setpoint) at P[36] **CONFIGURATION_2**

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
0	400	Commands	R/W	ADDR_COMMANDS	Integer	2 ³² -1	0	NA
1	402	VOLT Trimmer position	R	VOLTTRIM_ADCOutp	Integer	4096	0	NA
5	410	Ext. potentiometer position	R	PEXT_ADCOutp	Integer	4096	0	NA
6	412	External voltage measured	R	VEXT_ADCOutp	Integer	4096	0	NA
7	414	Digital External voltage	R/W	VEXT_RAM	Integer	2000	0	NA
8	416	Setpoint modified by Vext	R	SETPS_VltgSetPt	Float			NA
9	418	Setpoint modified by freq.	R	VSE_VltgSetpt	Float			[V]
10	420	Setpoint reduction by Feeding O.V.	R	OVC_VltgDrop	Float			[V]
11	422	Setpoint reduction by AMP	R	AMP_VltgDrop	Float			[V]
12	424	Setpoint effective	R	TVS_SnsnVltgSetpt	Float			[V]
13	426	Sensing voltage (AVG value)	R	MEC_SnsnVltgRMS	Float			[V]
14	428	Ch. 1 sensing voltage (L-N)	R	PU_VltgRMS	Float		0	[V]
15	430	Ch. 2 sensing voltage (L-N)	R	PV_VltgRMS	Float		0	[V]

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
16	432	Ch. 3 sensing voltage (L-N)	R	PW_VltgRMS	Float		0	[V]
28	456	Volt. Setpoint with DROOP	R	TVS_UnlimitedSnsng-VltgSetpt	Float			NA
35	470	Active Status	R	STATUS	Integer	2 ³² -1	0	NA
50	500	Ch1 - Ch2 Voltage (Line-Line)	R	VuVv_CnctVltg	Float	465,75	0	[V]
51	502	Ch2 - Ch3 Voltage (Line-Line)	R	VvVw_CnctVltg	Float	465,75	0	[V]
52	504	Ch3 - Ch1 Voltage (Line-Line)	R	VwVu_CnctVltg	Float	465,75	0	[V]

Tab. 3.1-IV: Voltage operation values (Sensing and Setpoint)

Bit	Dec. Weight	Hex Wieght	Mnemonic	Flag Description
B ₃	8	0000 0008	LOSU	Phase U sensed (Loss of sensing phase U if 0)
B ₄	16	0000 0010	LOSV	Phase V sensed (Loss of sensing phase V if 0)
B ₅	32	0000 0020	LOSW	Phase W sensed (Loss of sensing phase W if 0)

Tab. 3.1-V: Voltage status flags (Sensing and Setpoint), address A[470] STATUS

3.2 Voltage values (Sensing and Setpoint)

The setpoint setting and voltage measuring variables must be expressed unique. The regulator, however, does not distinguish the scale effectively being used, and as such the real voltage value applied at the sensing inputs, therefore:

1. if sensing is connected to the high scale (150÷405V), the variables used to regulate (setpoint and feedback) are expressed as the actual voltage value (150÷405V).
2. if sensing is connected to the lower scale (55÷150V), the internal setpoint and feedback variable values are correlated with the high scale (150÷405V), and are therefore scaled by a factor of 2.733 from the actual ones.

The value of parameter P[45] **USR_VltgSetpt** (address A[90]) is the value correlated with the high scale (150-405V), so if sensing is connected to the high scale terminals, the real regulated voltage at the inputs will be the value defined directly by P[45]; if instead sensing is connected to the low scale, the real regulated voltage at those inputs will be P[45] / 2.733: as an example, to control 115V use P[45] **USR_VltgSetpt** = 314.3V (115V x 2.733).

The default value is P[45] **USR_VltgSetpt** = 231V, which leads to a regulation of 231V with sensing connected to the high scale, and of 84.5V if connected to the low scale.



If the setpoint was set to regulate a certain voltage on the low scale, for example 115V with A[424] **TVS_SnsngVltgRMS**=314.3V, and the connection is moved to the high scale, the regulator tries to regulate the latter value, dangerous above all for the integrity of the users connected to the machine.

Also the setpoint values of all the operative variables - which can be read by the communication buses (addresses A[416]-A[432], A[456] and A[500]-A[504]) - refer to the voltage value (in Volts) on the high scale (150-405V).

The setting of the VOLT trimmer, the external potentiometer, and the external analogue voltage (addresses A[402], A[410] and A[412] respectively) are instead expressed by an integer value in the range 0-4096 that is proportional to the trimmer or potentiometer position, or to the voltage value applied in relation to the range -10V/+10V (e.g. A[412]=2048 with an analogue voltage of 0V).

3.3 Setting of the setpoint

The voltage setpoint has a fixed part (the nominal voltage), which is determined by the VOLT trimmer or the corresponding parameter P[45] **USR_VltgSetpt** (address A[90]), and a (possible) variable part, which is determined by the Pext (external Potentiometer) or Vext (external DC voltage +10/-10V) analogue inputs - selection is automatic and considers one as an alternative to the other but with priority given to Pext - or by the corresponding value at address A[414] **VEXT_RAM**, which can be modified in almost real time using the provided communication interfaces. For both Vext and the corresponding value at address A[414] **VEXT_RAM**, the variation is established by the value set at parameter P[29] **VEXT_Gain** (address A[58]); the variation of Pext is limited to 50% of the variation of Vext.



Pay attention in the variations of the nominal voltage not to exceed the maximum ratings of the specific alternator to which the regulator is applied, (e.g. setting the maximum possible variation by parameter P[29] **VEXT_Gain**)

Fig. 3.3-A shows a block diagram of setpoint setting

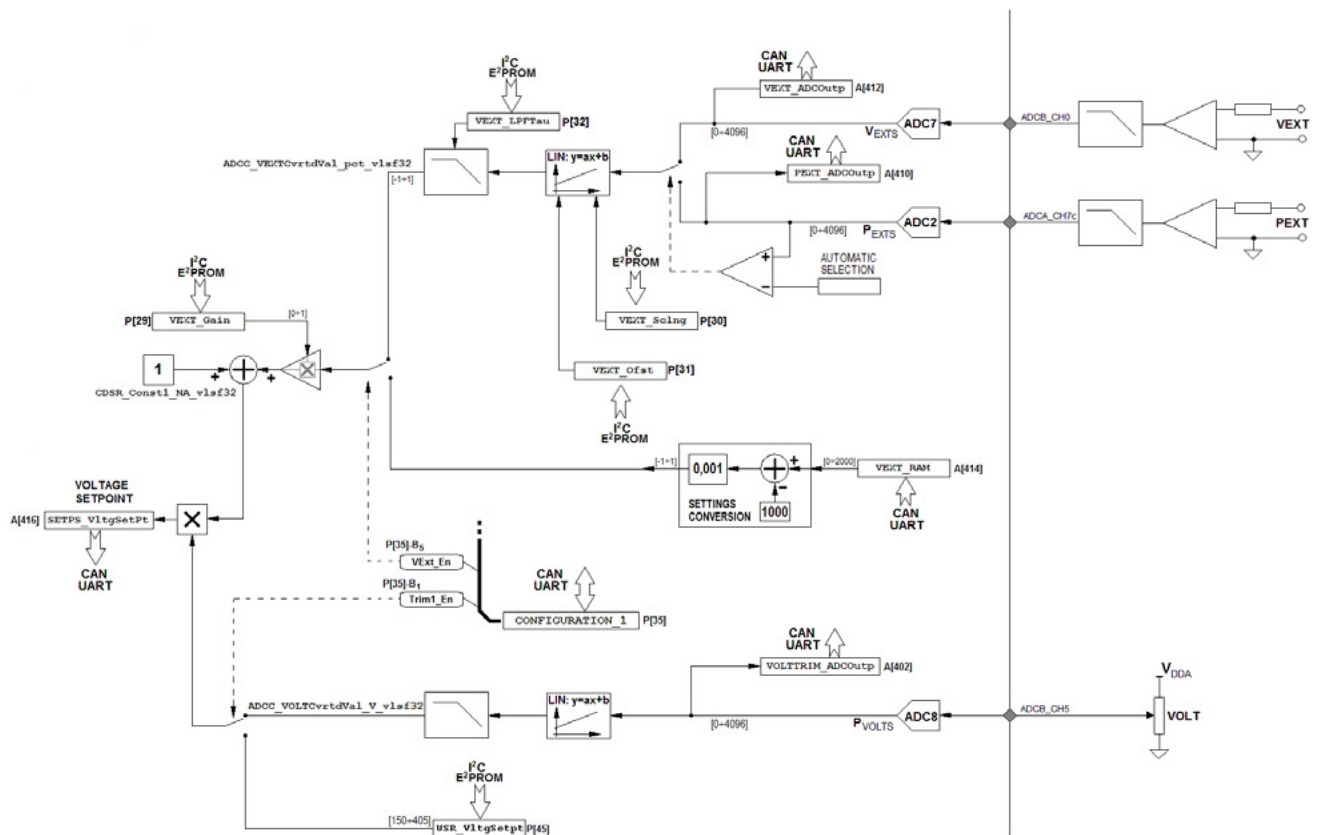


Fig. 3.3-A: MxK Voltage Setpoint

The Pext (external Potentiometer) and Vext (external DC voltage -10/+10V) inputs are separate but they modify the setpoint exclusively, not additionally; if the input is enabled (Bit B5 of parameter P[35] **CONFIGURATION_1** set at 1) the regulator automatically recognises if the potentiometer is connected or not: if it is not connected, the voltage applied at the Vext input determines setpoint modification, otherwise it is determined by the Pext input (the Vext voltage is not considered).

If, instead, the input is disabled (Bit B5 of parameter P[35] **CONFIGURATION_1** set at 0), the voltage setpoint is modified by writing a value between 0 and 2000 to address A[414] **VECT_RAM** that expresses the millesimal variation (with a fixed offset of -1000); for example A[414]=1000 (default) does not vary the setpoint in any way; A[414]=0 reduces the setpoint by the maximum defined by parameter P[29] **VEXT_Gain** (-14% of the default); A[414]=2000 causes an increase that is equal to the maximum defined by the previously mentioned parameter (+14% of the default). Intermediate values cause proportional variations.

If the setpoint is varied (using the VOLT trimmer or the corresponding parameter P[45] **USR_VltgSetpt**, through the Vext or Pext input, or by modifying the value at the address A[414] **VECT_RAM**), the variation speed can be "slow": in reply to a "fast" variation (up to the limit case of the step), Parameter P[60] **SETPT_MaxRate** (address A[120]) defines how fast the transition to the new setpoint will take place.

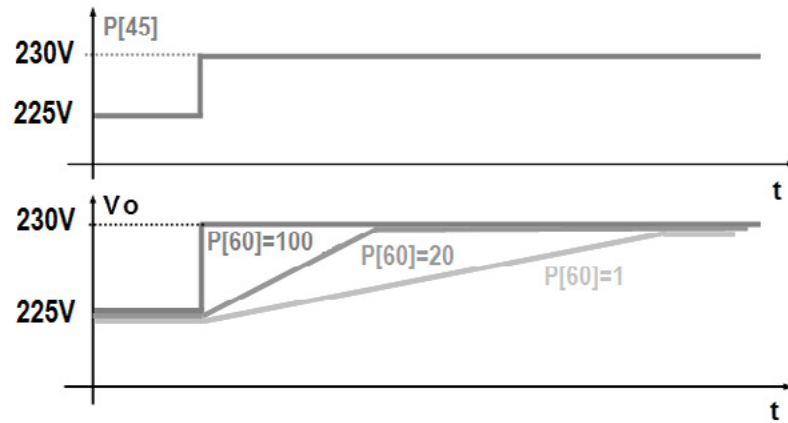


Fig. 3.3-B: MxK Slow voltage variations

When one or more of the configured protections are activated (see Ch. 9 "PROTECTIONS"), in order for the alternator to operate in a safe integrity range, the setpoint is reduced to lower the voltage. The voltage DROOP acts in the same way, according to the reactive current (see DROOP chap.). Fig. 3.3-C shows the block diagram of the possible sources of setpoint modification, highlighting what the values that can be found at addresses A[416]-A[432] and A[456] refer to.

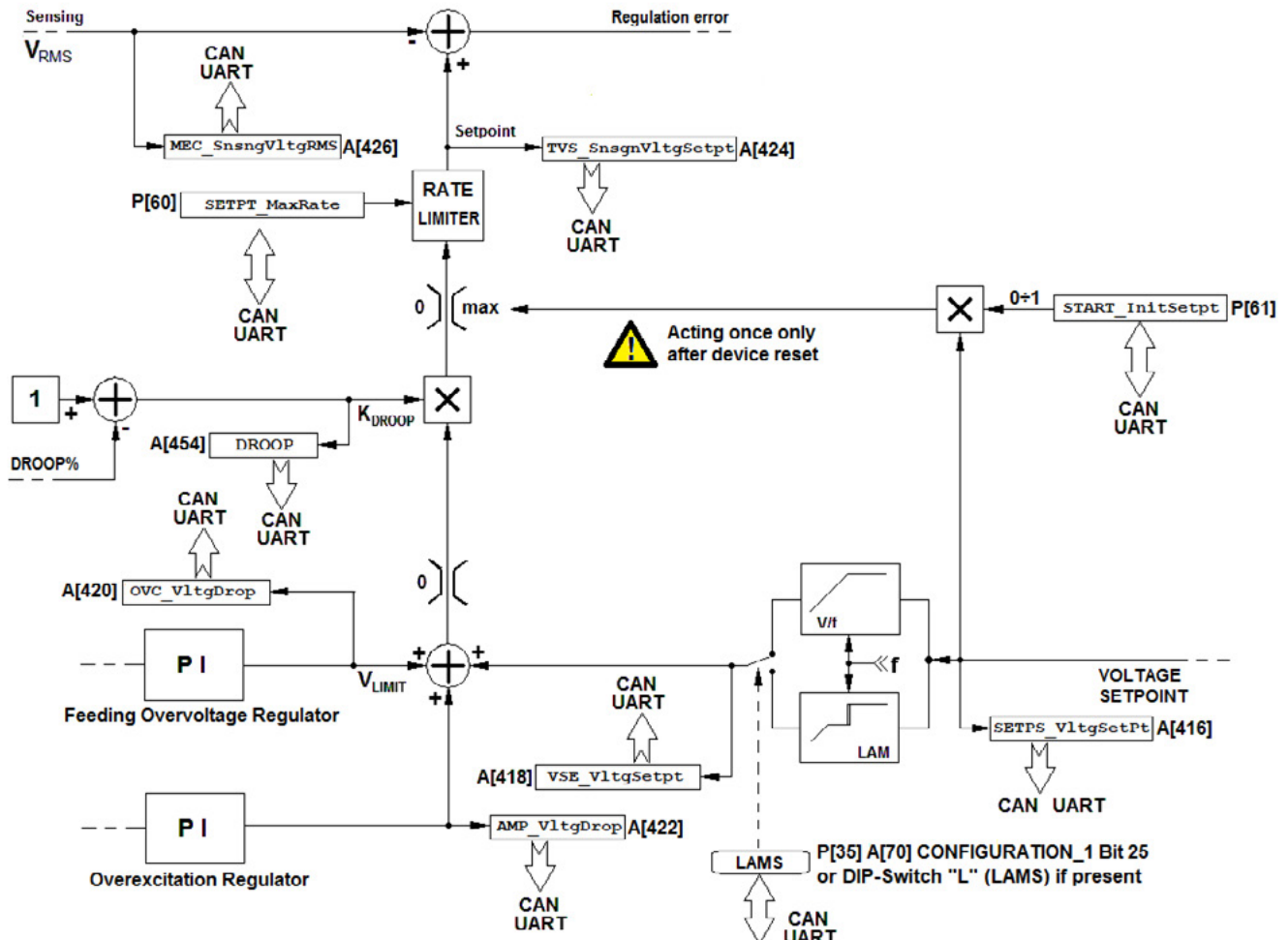


Fig. 3.3-C: MxK Setpoint Tree

4 SOFT START

4.1 Outline of the Soft-Start settings

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
45	90	Voltage Setpoint	USR_VltgSetpt	Float	231	0	500	[V]
61	122	Start-up setpoint limitation	START_InitSetpt	Float	0,4	1	0	[%]
62	124	Start-up setpoint rate limitation	START_MaxRate	Float	100	500	0	V/s
63	126	Start-up full excitation additional time	START_FullExc_Time	Float	0		0	ms

Tab. 4.1-I: First starting parameters (Soft start)

4.2 Outline of the Soft-Start operative variables

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
9	418	Setpoint modified by freq.	R	VSE_VltgSetpt	Float			[V]
12	424	Setpoint effective	R	TVS_SnsngVltgSetpt	Float			[V]
13	426	Sensing voltage (AVG value)	R	MEC_SnsngVltgRMS	Float			[V]
28	456	Volt. Setpoint with DROOP	R	TVS_UnlimitedSnsngVltg-Setpt	Float			NA

Tab. 4.1-II: Operative variables involved in first starting (Soft start)

In the event of a fast build-up of engine speed, or if the regulator is switched ON while the engine is already running at nominal speed, a fast response of the regulator would result in a sudden variation of excitation current in order to ensure nominal voltage. This could result in a braking effect on the engine, or a transient overvoltage situation. These effects can be minimised by setting parameters P[61] **START_InitSetpt**, P[62] **START_MaxRate** and P[63] **START_FullExc_Time** appropriately.

Setting the optimisation values according to the individual application can make it possible to obtain, at first starting, an increasing monotone progress of the voltage that is regulated by a settable time interval, with limited or no overshoot (dependent, however, also on a correct dynamic setting, see chap. 5 "SETTING DYNAMIC RESPONSE (STABILITY)").

As in the case of setpoint variation at the "working condition" where a "slow" variation is possible in answer to a "fast" variation (up to the limit case of the step, chap. 3.3 "Setting of the setpoint", fig. 3.3-B), even in the "start-up phase" it is possible to set the speed at which the effective setpoint transition is carried out, factually obtaining a "soft start". In this case, the parameter that determines the setpoint increase speed in phase is P[62] **START_MaxRate** (address A[124]).

Parameter P[61] **START_InitSetpt** (address A[122]) expresses the percentage value of the initial setpoint at first starting, e.g. the default value P[61] **START_InitSetpt** = 0.2 (20%) indicates that when the device is switched on, the setpoint will be set at 20% of the value indicated by the V/f curve and will then increase gradually according to the value of parameter P[62] **START_MaxRate**.

When the drive motor is started, the device generally starts at a speed that is lower than the threshold that defines the "start-up phase"; the setpoint is therefore reduced according to the speed itself on the basis of the current settings (see chap. 9.2 "Low speed protection"). If the voltage is already greater than the setpoint when the device is started, the setpoint and the voltage become aligned, so as to prevent self-excitation anomalies. Particularly critical is the time needed for complete control starting, however it cannot be null no matter how much care was taken with its optimisation. During first starting, this can cause irregular self-excitation, or relative overvoltage in relation to the setpoint, or absolute respect at nominal value.

To optimise self-excitation, mainly in the event of power from an auxiliary winding, a forced self-excitation time (Timed Field Flash) can be set with parameter P[63] **START_FullExc_Time**, whose value is expressed in ms. Setting become much easier using the Mecc Alte App software which, from the Settings>Base>Soft Start menu, can be used to modify the indicated parameters through a graphic interface.

5 SETTING DYNAMIC RESPONSE (STABILITY)

The voltage regulator is of the P.I.D. type, and its parameters (proportional gain, integral and derivative time constants) can be set by the user or calculated automatically by the auto-tuning algorithm.

The method used is selected through the combination of two hardware DIP-switches (named K and A, fig. 5.3-A: Auto-tuning DIP Switches) or the corresponding flag **Autotuning** (bit B28 of parameter P[35] **CONFIGURATION_1**, address A[70]); source selection depends on the status of the flag **JP_Autotuning_En** (bit B12 of parameter P[35] **CONFIGURATION_1**, address A[70]); fig. 5.4-A: Auto-tuning Selection scheme.

5.1 Outline of the dynamic response settings (Stability)

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
35	70	Configuration flags part 1	CONFIGURATION_1	Integer	Device dependent ⁽¹⁾	2 ³² -1	0	NA
36	72	Configuration flags part 2	CONFIGURATION_2	Integer	6168 ⁽²⁾	2 ³² -1	0	NA
37	74	Voltage Regulator Proportional Gain	USR_KP	Float	0,5		0	NA
38	76	Voltage regulator Integral Time const.	USR_Ti	Float	0,2		0	[s]
39	78	Voltage regulat. Derivative Time const.	USR_Td	Float	0,05		0	[s]
40	80	Voltage reg. Anti wind-up Time const.	USR_Tt	Float	0,1		0	[s]
44	88	HDR recovery preset percentage	HDR_Preset	Float	0,5*	1	0	[%]
93	186	Autotuning regressor lower time const.	Gmd_TauSlow	Float	0,42		0	[ms]
94	188	Autotuning regressor upper time const.	Gmd_TauFast	Float	0,35		0	NA
95	190	Gmd_K with autotuning switches disabled	Gmd_K	Float	3		0	NA
96	192	Autotuning estimated Proportional Gain	Kp_ATUNE	Float	0,016	7,229	0	NA
97	194	Autotuning estimated Integral Gain	Ki_ATUNE	Float	0,0811	29,995	0	[s]
98	196	Autotuning estimated Derivative Gain	Kd_ATUNE	Float	0,001039	0,4359	0	[s-1]
105	210	Injected disturb period	disturbPeriod	Float	20		0	[s]
106	212	Start-up disturb injection delay	disturbDelay	Float	30		0	[s]
109	218	Injected disturb amplitude	stepDV	Float	0		0	NA
110	220	Gmd_K for small alternators	Gmd_K_S	Float	10			NA
111	222	Gmd_K for medium alternators	Gmd_K_M	Float	5			NA
112	224	Gmd_K for large alternators	Gmd_K_L	Float	3			NA

Tab. 5.1-I: Dynamic response parameters (stability and auto-tuning)

NOTE⁽¹⁾: see Chapter 8 "CONFIGURATIONS"

NOTE⁽²⁾: P[36] = 6168 (**AUTUNEonce**=0, **AUTUNE**done=0, **AUTUNEfreeze**=1)

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₃	8	0000 0008	Trim3_En	TRIMMER STAB Enable	Active	1	8
B ₁₂	4096	0000 1000	JP_Autotuning_En	Autotuning Switch Enable	Active	1	4096

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₁₈	262144	0004 0000	HDR_En	High Dynamic Response Enable	Note*	0/1	0/262144
B ₂₈	268435456	1000 0000	Autotuning	Autotuning activation	Autotuning	1	268435456

Tab. 5.1-II: Dynamic response flags (stability and auto-tuning) at P[35] **CONFIGURATION_1**

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₁	2	0000 0002	ATUNEonce	Autotuning to execute once	Once	0	0
B ₂	4	0000 0004	ATUNEdone	Autotuning executed at least one time	Not executed	0	0
B ₃	8	0000 0008	ATUNefreeze	Automatic Freeze Autotuning	Active	1	8

Tab. 5.1-III: Dynamic response flags (stability and auto-tuning) at P[36] **CONFIGURATION_2**

5.2 Outline of operational variables concerning dynamic response

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
0	400	Commands	R/W	ADDR_COMMANDS	Integer	2 ³² -1	0	NA
3	406	STAB Trimmer position	R	STABTRIM_ADCOutp	Integer	4096	0	NA
35	470	Active Status	R	STATUS	Integer	2 ³² -1	0	NA
39	478	Gmd_K active	R	Gmd_K	Float			NA
40	480	Autotuning Volt. Reg. Kp active	R	Kp_ATUNE_tmp	Float			NA
41	482	Autotuning Volt. Reg. Ki active	R	Ki_ATUNE_tmp	Float			[s]
42	484	Autotuning Volt. Reg. Kd active	R	Kd_ATUNE_tmp	Float			[1/s]
43	486	Volt. Reg. effective Prop. gain	R	trueKp	Float		0	NA
44	488	Volt. Reg. Integral output	R	PID_Int	Float		0	NA

Tab. 5.2-I: Dynamic response operative variables

Bit	Dec. Weight	Hex Weight	Mnemonic	Flag Description
B ₁₄	16384	0000 4000	OL	Open Loop Active (Excitation voltage forcing)
B ₁₅	32768	0000 8000	HDR	HDR active (Excitation voltage reverse)*
B ₂₂	4194304	0040 0000	AUTO	Autotuning Active
B ₂₃	8388608	0080 0000	UPAR	Use Autotuning Parameters

Tab. 5.2-II: Dynamic response state flags, address A[470] **STATUS**

* NOTE

M2K, M2K[®], M3K e M3K[®]: HDR inactive regardless of the value of B₁₈, P[44] has no effect (HDR not present);
M3K^{®HD}: HDR active (B₁₈ = 1) by default, P[44] see HDR chap.

5.3 Dynamic response manual setting

If auto-tuning is disabled, the dynamic response can be set using the STAB trimmer or the direct setting of the P.I.D. parameters, fig. 5.3-B: P.I.D. Manual Settings.

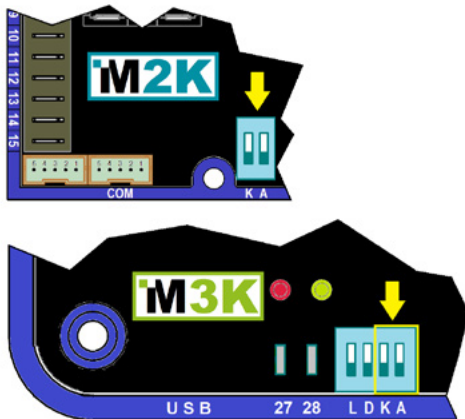


Fig. 5.3-A: Autotuning DIP Switches

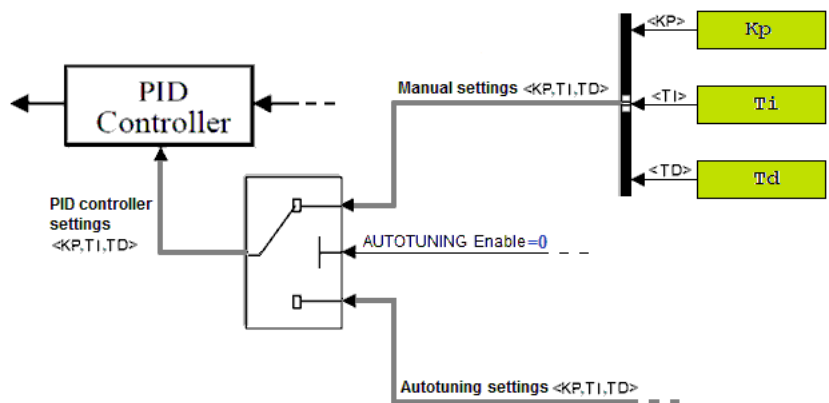


Fig. 5.3-B: P.I.D. Manual Settings

The STAB trimmer position can always be read at address A[406]; with the trimmer enabled the position is mapped in the three P.I.D. settings (Kp, Ti and Td), which determine the dynamic response.

With the trimmer disabled, the P.I.D. settings are defined by the three independent parameters P[37], P[38] and P[39] (USR_KP, USR_Ti and USR_Td) stored in E2PROM and which can be modified by the user at addresses A[74], A[76], A[78]].

The source of this setting (trimmer position or parameters) depends on the state of the Trim3_En flag (bit B3 of parameter P[35] CONFIGURATION_1, address A[70]).

fig. 5.3-C: Dynamic response settings selection.

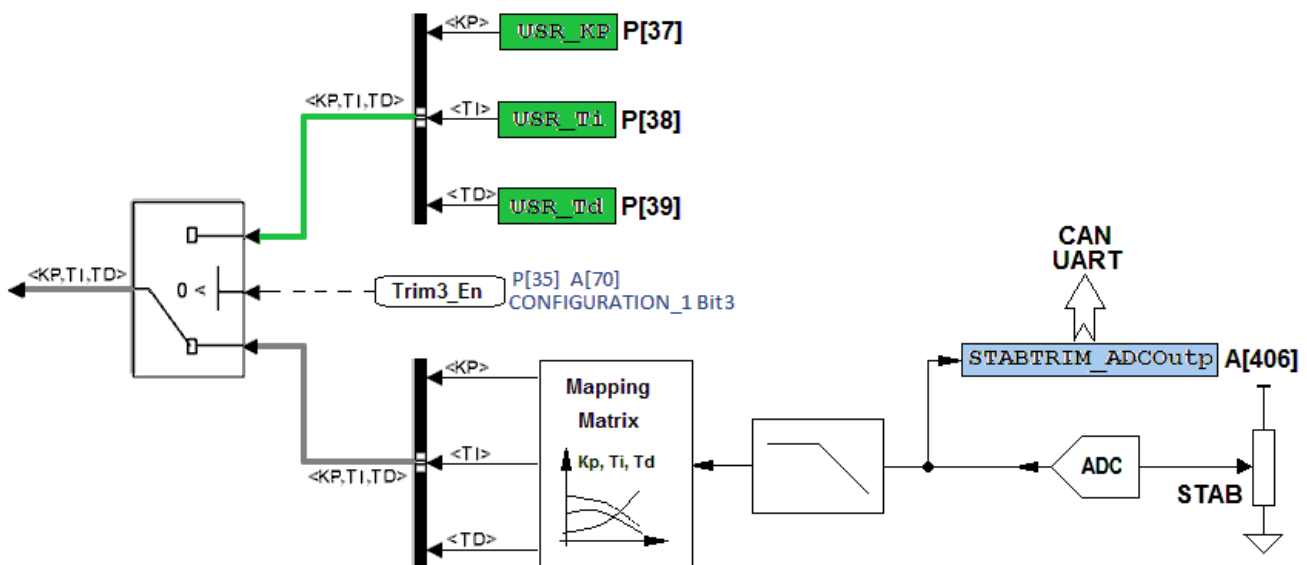


Fig. 5.3-C: Dynamic response settings selection

Setting the dynamic response becomes easier using the Mecc Alte App which, from the Settings>Base>Stability, can be used to modify the indicated parameters and flags through a graphic interface.

5.4 Dynamic response autonomous setting (Auto-tuning)

When enabled, the auto-tuning algorithm estimates the dynamic parameters during the alternator start-up phase starting from the initial values that were set previously (ref. Tab. 5.4-I). When the running speed has been reached, different operating modes are available according to:

- the value of parameter P[109] **stepDV** (address A[218])
- the configuration flags **ATUNEonce**, **ATUNEdone** and **ATUNefreeze** respectively bit B₁, B₂ and B₃ of parameter P[36] **CONFIGURATION_2** (address A[72])

After being carried out at least once, execution can be stopped or not at subsequent starts; if not stopped, the settings calculated at first starting are maintained.




The value taken by the variable **Gmd_K** which can be read at address A[478], fig. 5.4-A: Auto-tuning Selection and fig. 5.5-A: Auto-tuning P.I.D. controller settings is essential for correct auto-tuning operation.

The setting of the value taken by the variable **Gmd_K** is determined:

- by the combination of the two DIP switches “K” and “A”
- alternatively, by the direct setting of parameter P[95] at the address A[190]

If enabled, the 3 DIP switch “K” and “A” combinations, in which at least one of the two is “ON”, select one of the 3 values set by the 3 parameters P[110] **Gmd_K-S**, P[111], **Gmd_K-M** and P[112] **Gmd_K-L** (addresses A[220], A[222] and A[224]), fig. 5.4-A: Auto-tuning Selection

The recommended values according to the alternator size, unified for all devices and default settings, are given in tab. 5.4-I

Alternator group	Description	Gmd_K (address A[478])			DIP Switches selector (when enabled) (P[35] CONFIGURATION_1 Bit B ₁₂ =1)		
		Parameter	Name	Default	DIP SWITCH	K	A
ECP4-xx/4÷ECP34-xS/4	Small	P[110]	Gmd_K_S	10		ON	OFF
ECP34-xL/4÷ECO38-xS/4	Medium	P[111]	Gmd_K_M	5		OFF	ON
ECO38-xM/4÷ECO46-xx/4	Large	P[112]	Gmd_K_L	2		ON	ON

Tab. 5.4-I: Recommended settings for the **Gmd_K** value

Enabling or disabling both DIP switches depends on the status of the flag **JP_Autotuning_En** (bit B12 of parameter P[35] **CONFIGURATION_1**, address A[70]), ref. fig. 5.4-A: Auto-tuning Selection.

The dynamic settings calculated by the auto-tuning algorithm can be read at addresses A[480] **Kp_ATUNE_tmp**, A[482] **Ki_ATUNE_tmp** and A[484] **Kd_ATUNE_tmp** fig. 5.5-A: Auto-tuning P.I.D. controller settings.

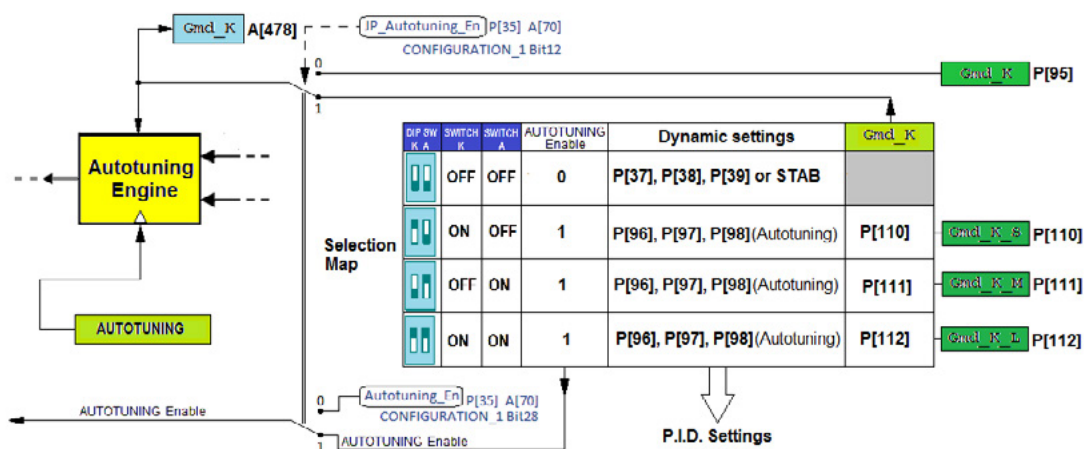


Fig. 5.4-A: Auto-tuning Selection scheme

At starting, auto-tuning algorithm activation and the initial dynamic settings values (**Kp_ATUNE**, **Ki_ATUNE**, **Kd_ATUNE**) depend on how bits B1 and B2 (**ATUNEonce** e **ATUNEdone**) of parameter P[36] **CONFIGURATION_2** (address A[72]) are set.

P[36]-Bit2 ATUNEdone	P[36]-Bit1 ATUNEonce	Auto-tuning	Initial dynamic settings (at device RESET) Kp_ATUNE, Ki_ATUNE, Kd_ATUNE
0	0	Active, never carried out (settings not saved, to be calculated)	Pre-set with default values of parameters P[96] Kp_ATUNE , P[99] Ki_ATUNE , P[102] Kd_ATUNE (addresses A[192], A[198] and A[204])
1	0	Active, carried out (settings to be recalculated)	Pre-set with values of parameters P[96] Kp_ATUNE , P[99] Ki_ATUNE , P[102] Kd_ATUNE (addresses A[192], A[198] and A[204])
1	1	Not active, carried out (settings saved to be used)	Pre-set with values of parameters P[96] Kp_ATUNE , P[99] Ki_ATUNE , P[102] Kd_ATUNE (addresses A[192], A[198] and A[204])

Tab. 5.4-II: Settings and effects of the configuration bits B₁ and B₂ of P[36] **CONFIGURATION_2**

5.5 Auto-tuning operating mode

When P[109] **StepDV** = 0 (address A[218])

after the time defined by parameter P[106] **disturbDelay** (address A[212]), has elapsed you can:

[B3=0]: keep the auto-tuning algorithm active for an unspecified period of time

[B3=1]: stop the continual updates of the variables **Kp_ATUNE**, **Ki_ATUNE** and **Kd_ATUNE** (Freeze automatic auto-tuning)

The alternative is determined by how B₃ (flag **ATUNEFreeze** flag) of parameter P[36] **CONFIGURATION_2** (address A[72]) is set.

Writing **0xA0FF** at the word commands (ADDR_COMMANDS, address A[400]) stops the updating of variables **Kp_ATUNE**, **Ki_ATUNE** and **Kd_ATUNE** (Freeze manual auto-tuning)

When P[109] **StepDV** ≠ 0 (address A[218])

- The setting of B₃ (flag **ATUNEFreeze**) of parameter P[36] **CONFIGURATION_2** (address A[72]) is not considered
- A disturbance injection of undetermined time is activated at the StepDV amplitude P.I.D., with periodicity defined by parameter P[105] (**disturbPeriod**, address A[210]),
- the auto-tuning algorithm is active

Writing **0xD0FF** at the word commands (ADDR_COMMANDS, address A[400])

- causes the disturbance injection to disable
- stops the updating of variables **Kp_ATUNE**, **Ki_ATUNE** and **Kd_ATUNE** (Freeze manual auto-tuning)

If the B₁ bit of parameter P[36] **CONFIGURATION_2** (address A[72]) is set at 1 (**ATUNEonce** = 1), stopping dynamic settings updating (Freeze auto-tuning) also, in addition to what has already been described, results in

- the previously mentioned settings being saved in the respective parameters P[96] **Kp_ATUNE**, P[97] **Ki_ATUNE**, P[98] **Kd_ATUNE** (addresses A[192], A[194] and A[196]) fig. 5.5-A: Auto-tuning P.I.D. controller settings.
- the SET at 1 of bit B₂ of parameter P[36] **CONFIGURATION_2** (address A[72]) (**ATUNEdone**=1)

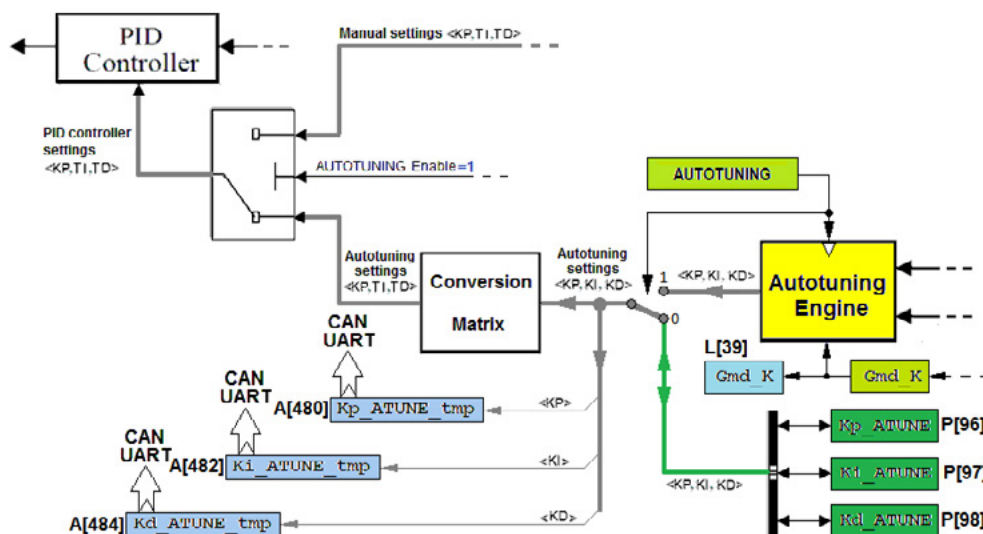


Fig. 5.5-A: Auto-tuning P.I.D. controller settings

As far as the dynamic settings are concerned, the default configuration at P[35] (**CONFIGURATION_1**) and P[36] (**CONFIGURATION_2**), addresses A[70] and A[72] is:

- STAB trimmer enabled: P[35] Bit B₃=1 (Trim3_En = 1)
- Auto-tuning enabled: P[35] Bit B₂₈=1 (Auto-tuning = 1)
- Enabling/disabling auto-tuning and Gmd_K selection from the combined DIP switches (K and A) P[35] Bit B₁₂=1 (JP_Autotuning_En=1, parameter P[95] Gmd_K, address A[190] disabled)
- Auto-tuning never carried out: P[36]-B₃=0 (**ATUNEdone** = 0)
- Auto-tuning to be carried out at every start-up, P[36]-B₁ = 1 (**ATUNEonce** = 0)
- with automatic stop of the setting updates: P[36]-B₃ = 1 (**ATUNEFreeze** = 1)
- without disturbance injection P[109] **StepDV** = 0 (address A[218])

The Mecc Alte App makes the auto-tuning configurations very easy. These are accessed from the Settings>Base>Auto-tuning menu, they are used to modify the related parameters & flags through a graphic interface.

6 HIGH DYNAMIC RESPONSE



The High Dynamic Response module, through excitation voltage inversion, provides a faster excitation current reduction compared to the conventional regulators, hence lower transient overvoltage upon load removal. Fig. 6-A compares the patterns of the output voltage and excitation voltage according to the **M3K^{SHD}** regulator with a conventional regulator that does not permit excitation voltage inversion.

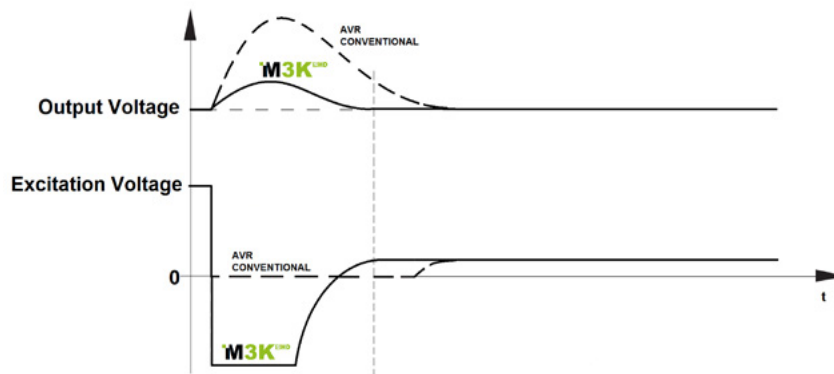


Fig. 6-A: Andamenti di Vo(t) e Vexc(t) di M3KS-HD e di un regolatore senza inversione di Vexc

Parameter P[44] **HDR_Preset** sets the initial excitation percentage after the intervention of the HDR (which, because of its nature, intervened when the excitation had already been reduced to zero) and further optimises the recover time with HDR enabled. The P[44] **HDR_Preset** = 0.5 default value is 50%; from this point onwards it is the voltage regulator that sets the necessary excitation value.

Bit B18 of parameter P[35] **CONFIGURATION_1** disables the HDR, the HDR is enabled by default (B₁₈ = 1), to disable set B₁₈ = 0.



The benefits that can be obtained from the High Dynamic Response also depends on an accurate regulator dynamic response setting. If the response is too slow, the control system may not request excitation voltage inversion; in this case the module would not operate and the response would be the same as that of a conventional regulator.

7 DROOP, CURRENTS, POWERS AND COSφ

7.1 OUTLINE OF THE DROOP, CURRENTS, POWER AND COSφ SETTINGS

M3K M3K^B M3K^{SHD}								
#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
23	46	Calibration of current channel (CT)	PUC_ADCScIn _g	Float	0,003798	500	0	NA
25	50	Current scaling for CAN	CURR_CANScIn _g	Float	1	0	2	NA
27	54	Rated reactive current scaling	DROOP_NomRctvCurr	Float	3	5	0	[A]
35	70	Configuration flags part 1	CONFIGURATION_1	Integer	device dependent ⁽¹⁾	2 ³² -1	0	NA
46	92	Droop setting	USRDROOP_VltgDrop	Float	0,04	1	0	[%]
55	110	C.T. Ratio (IR1/IR2 = IR1/5)	CT_RATIO	Integer	1		1	NA
79	158	Cosphi identification threshold	COS_PHI_TH	Float	0,02	1	0	NA
80	160	Currents identification threshold	I_MIN_TH	Float	0,05	5	0	[A]

Tab. 7.1-I: Droop, currents, powers and cosφ settings

NOTE⁽¹⁾: see Chapter 8 "CONFIGURATIONS"

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₂	4	0000 0004	Trim2_En	Trimmer DROOP Enable	Active	1	4
B ₁₁	2048	0000 0800	JP_Droop_En	Droop Switch Enable	Active	1	2048
B ₂₆	67108864	0400 0000	Droop_En	Droop activation	Not active	0	0

Tab. 7.1-II: Droop, currents, powers and cosφ flags at P[35] CONFIGURATION_1

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
1	404	DROOP Trimmer position	R	DROOPTRIM_ADCOutp	Integer	4096	0	NA
24	448	Channel 1 current (measured)	R	PUCurrRMS	Float			[A]
25	450	Channel 1 direct current	R	RCE_ActvCurrRMS	Float			[A]
26	452	Ch. 1 quadrature current	R	RCE_ReactvCurrRMS	Float			[A]
27	454	Voltage drop (by IQ and DROOP)	R	DROOPC_VltgSetptDrop	Float			NA
28	456	Volt. Setpoint with DROOP	R	TVS_UnlimitedSnsngVltg-Setpt	Float			NA
29	458	Apparent power (unsigned) ⁽¹³⁾	R	PU_AppPwr	Float			[VA]
30	460	Active Power (signed) ⁽¹³⁾	R	PU_ActPwr	Float			[W]
31	462	Cosφ (calculated) ⁽¹⁴⁾	R	LAE_CosPhi	Float			NA
32	464	Reactive Power (signed) ⁽¹³⁾	R	PU_ReactPwr	Float			[VAR]

Tab. 7.1-III: Droop, currents, powers and cosφ operative variables

NOTES

13. Apparent power is an unsigned quantity, Real Power must be signed since power may flow in both directions. Reactive power is a signed quantity, like Real Power. Negative values indicate reverse power flow. - ref. SAE J1939-75, § 3 "Definitions".
14. $\cos\phi$ is the cosine of the angle between voltage and current for the single phase U. It's used as approximation of AC Power Factor (measuring the ratio of real power to apparent power). The range is -1.0 to +1.0. Negative values indicate reverse power flow. A value of 1.0 indicates that all of the power flow is real power delivered to the load (i.e. a purely resistive load). A value of 0.0 indicates that no real power is delivered to the load (i.e. a purely reactive load). Power factor can be leading (a capacitive load) or lagging (an inductive load). This is not indicated by the sign of the power factor, but by a separate flag.

Bit	Dec. Weight	Hex Weight	Mnemonic	Flag Description
B ₂₀	1048576	0010 0000	DROP	Droop Active

Tab. 7.1-IV: Droop, currents, powers and $\cos\phi$, status flags, address A[470] **STATUS**

7.2 Current measuring and expression

M3Kx regulators have 1 non-insulated input (shunt 50mΩ - 3W) to detect the phase current to be applied using a proper C.T. with rated secondary current 5A.

The system considers the rated value at the C.T. secondary (5A) as the alternator rated current, the range covered by the C.T. can be estimated as between 48% and 96% of its nominal current (e.g. from 288A_{rms} to 577A_{rms}, for a C.T. 600/5), increased by 10% for the temporary possibility of alternator overload.

The value of the current used by the algorithm is therefore always considered expressed in p.u. ([0; 5.5A] equivalent to [0; 1.1]) where 5A is the nominal current of the alternator.

The internal variable A[448] **ASC_PUCurrRMS** expresses the current in p.u. (0-5.5A). To ensure that the corresponding measure is A[448] **ASC_PUCurrRMS** = 5A when the effective current of the shunt is $I_2=5A_{rms}$ parameter P[23] **PUC_ADCSc1ng** (address A[46]) must be set at the theoretic value of **0,003798**.

If the machine nominal current is lower than the nominal current of the C.T. primary, the difference can be compensated by increasing the current channel gain using parameter P[23] **PUC_ADCSc1ng** so that the current at the secondary which corresponds with the machine rated current (less than 5A) can be read as unitary [**ASC_PUCurrRMS** = 5]

If $I_R[A]$ is the machine nominal current, $I_1[A]$ is the nominal current of the CT primary, and $I_2[A]$ the current of the secondary, without any compensation it would mean that

$$A[448] \text{ ASC_PUCurrRMS} = I_2[A] = (I_R[A] / I_1[A]) * 5A$$

For the measured current to be expressed in p.u (0-5A) at A[448], a correction is necessary

$$P[23] \text{ PUC_ADCSc1ng} = (5A / I_2[A]) * P[23] \text{ PUC_ADCSc1ng}(\text{default}) = (5A / I_2[A]) * 0,003798$$

In compliance with protocol J1939, all the current and power variables must be expressed in absolute values with integer values resolution, so two additional parameters are used, one for the current channel gain and the other for the C.T. conversion ratio; P[25] **CURR_CANSc1ng** (address A[50]) e P[55] **CT_RATIO** (address A[110])

Parameter P[25] **CURR_CANSc1ng** acts as a scale factor in relation to the nominal current:

$$P[25] \text{ CURR_CANSc1ng} = 5A / I_2[A]$$

and is used together with P[55] **CT_RATIO** to determine the value in A[534] **Generator_Phase_A_U_AC_RMS_Current** (effective value) to be transmitted on CAN:

$$A[534] = P[55] \text{ CT_RATIO} * I_{mis}[A] = P[55] \text{ CT_RATIO} * A[448] \text{ ASC_PUCurrRMS} / P[25] \text{ CURR_CANSc1ng}$$

Setting becomes much easier using the Mecc Alte App, which makes the calculations starting from the nominal data of the alternator and the C.T. through the menu.

7.3 Identification of current and power components

Considering the voltage measured by channel U (terminals 4-10, ref. Tab. II.3) as a reference, the **M3Kx**, regulators, if equipped with C.T., in addition to the measured total current are able to estimate its direct and in quadrature components in relation to the aforementioned channel U voltage. As a result, in addition to the apparent power, they can also estimate the active and reactive powers and the current phase shift in relation to the voltage.

The active and reactive components remove to ease the reading are expressed as follows:

- A[428] **PU_VltgRMS rms Voltage**: value without sign
A[448] **PU_CurrRMS rms Current**: value without sign
A[450] **RCE_ActvCurrRMS Active current**: value with sign*
A[452] **RCE_ReactvCurrRMS Reactive power**: value with sign*
A[460] **PU_ActPwr Active power**: value with sign*
A[464] **PU_ReactPwr: Reactive power**: value with sign*
A[458] **PU_AppPwr: Apparent power**: value with sign*
A[462] **LAE_CosPhi: Cosφ**: value with sign (-1 ÷ +1) with generator convention, therefore
Positive, from 0 to 1 for the outgoing current ($-\pi/2 < \varphi < \pi/2$)
Negative, from -1 to 0 for the incoming current ($-\pi < \varphi < -\pi/2$ or $\pi/2 < \varphi < \pi$)
A[472] **ALARMS Bit B₂₅: Leading or lagging current in relation to the voltage**:
Bit B₂₅ = 0 lagging current = inductive load ($\varphi < 0$, Lagging)
Bit B₂₅ = 1 leading current = capacitive load ($\varphi > 0$, Leading)

NOTE* with generator convention: outgoing positive, incoming negative

If the current is null or close to zero, the estimate of its components may not be sufficiently precise, and similarly if $\cos\varphi$ is 1 or near to 1; to prevent inaccurate alarm signals there are two minimum thresholds for $\cos\varphi$ and current measurement:

- P[79] **COS_PHI_TH** sets the range around the unit value within which the value is measured as $\cos\varphi=1$; by default P[79] **COS_PHI_TH** = 0,02 causes all the values between 0.98 capacitive and 0.98 reactive to be estimated as $\cos\varphi=1$
- P[80] **I_MIN_TH** (in p.u. at 5A) sets a threshold below which the current is assumed as null; as a result even the power components are assumed null (in this case $\cos\varphi$ is represented as unity). By default, P[80] **I_MIN_TH** = 0,05 causes the current at the C.T. secondary to be estimated as not null ($I_2[A] \neq 0$) for values above 1% of its nominal value (0.05A for 5A nominal).

7.4 Voltage droop as a function of the reactive current

In case of parallel operation between generators or with the grid, it is possible to activate a voltage droop proportional to the reactive component of the output current only operational with a C.T. traditional additional devices (PD + PID) are no more needed. If equipped with a C.T., the regulator measures the current phase lead or lag in relation to the voltage; if the in quadrature component of the current lags behind the voltage, it determines a reduction of the setpoint as a function of its amplitude, while if leading it determines an increase of the setpoint as a function of its amplitude and the contextual signalling of a "Capacitive Load" alarm.

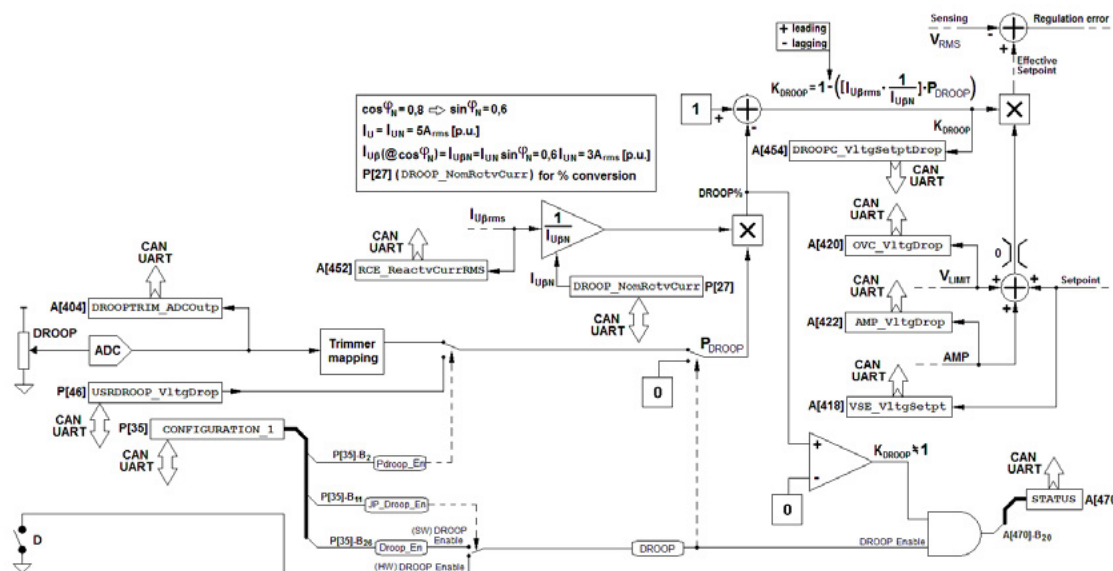


Fig. 7.4-A: Voltage DROOP diagram

A droop is activated by the DIP switch [D], if enabled, or with the corresponding flag **Droop_En** (P[35] **CONFIGURATION_1** Bit B₂₆); source selection depends on the configuration flag status **JP_Droop_En** (P[35] **CONFIGURATION_1** Bit B₁₁) as shown in fig. 7.4-A

Operation with an active voltage droop, no matter what the source of activation, is signalled by the DROOP flag (A[470] **STATUS** Bit B₂₀)

The setting of the droop extent is determined by the DROOP trimmer or by the corresponding parameter P[46] **USRDRDROOP_VltgDrop** (address A[92]); the source of this setting (trimmer or parameter) is selected through the configuration flag **P_Droop_En** (P[35] **CONFIGURATION_1** Bit B₂) as shown in fig. 7.4-A

With it being established that the droop setting ranges goes from 0% to about -5% of the setpoint, and having defined the range covered by the C.T. (factor from 1 to 2, ref. notes chap. 7.2 "Current measuring and expression"), the effect on the setpoint of the variable connected with droop setting can be derived: trimmer fully counter clockwise or parameter P[46] **USRDRDROOP_VltgDrop** = 0 does not cause setpoint variations in relation to the current; trimmer fully clockwise or parameter P[46] **USRDRDROOP_VltgDrop** = 0,1 causes the nominal reactive current setpoint to vary by up to -10%.

The default settings are:

- Trimmer enabled (parameter P[46] disabled): (P[35] **CONFIGURATION_1** Bit B₂=1)
- Enabling/disabling with DIP switch [D]: (P[35] **CONFIGURATION_1** Bit B₁₁=1)
- flag (**JP_Droop_En**) configured for droop not active: (P[35] **CONFIGURATION_1** Bit B₂₆=0)
- parameter P[46] **USRDRDROOP_VltgDrop** = 0,04: (variation of the set point till -4%)

The Mecc Alte App makes the configuration simpler. These are accessed from the Settings>Droop menu, they are used to modify the related parameters & flags through a graphic interface.

7.5 Phase overcurrent on the basis of the capability curve

M3Kx regulators have an A11 **alarm** for stator **overcurrent** in relation to the nominal value set by parameter P[54] **OVERCURRENT** (default 5 [P.U.]) and in any case conditioned by parameter P[23] **PUC_ADCScInlg** as described in chap. 7.2 "Current measuring and expression"; the alarm, that is only operational when a C.T. is used,, does not interfere with the control and refers to a current value function of $\cos\phi$, not a simple fixed value. In detail, having defined the current limit point areas, hereinafter "current limit", substantially based on the generic capability curve (P-Q curve shown in fig. 7.5-A by a dashed line) at the nominal voltage:

- For inductive loads where $0.8 < \cos\phi < 1$, the current limit matches with its rated value (in the P-Q diagram the position of the limit points is an arc of a circle with centre 0.0 and radius I_{Rms})
- For inductive loads where $PF < 0.8$, the current limit reduces progressively as a function of the PF by up to 80% of the nominal current when $PF=0$
- In the case of capacitive loads, the current limit depends also on the additional parameter P[124] **Leading_Current_Limit** (address A[248]), expressed in percentage values (from 0 to 1):

- If the reactive current is lower than the nominal current multiplied by this percentage, the current limit is the abovementioned nominal current value (in the P-Q diagram the limit point area is an arc of a circle with centre 0.0 and radius IR_{rms})
- otherwise the current limit is that of the capacitive reactive current set by parameter P[124] (in the P-Q diagram the limit point area is a segment of a straight line with abscissa P[124] IR_{rms})
- For voltages lower than the nominal, the limit is generally scaled automatically, being a limit on the current
- For voltages higher than the rated one and in general for all derated alternators, the nominal current setting parameter must be correct accordingly

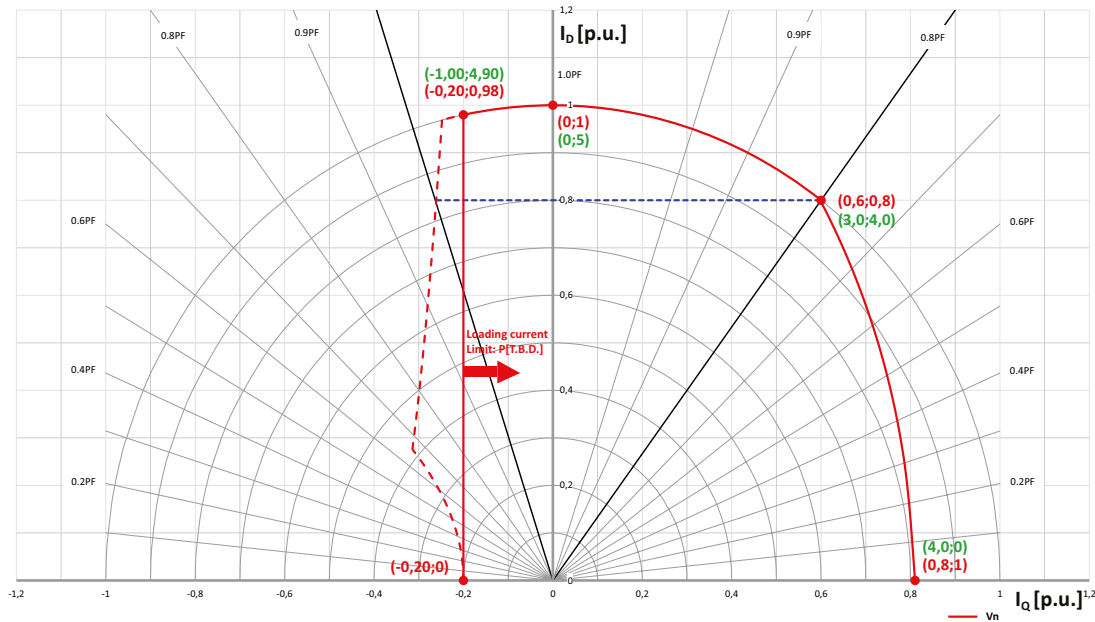


Fig. 7.5-A: Current limit point area

8 CONFIGURATIONS

TABLE CONFIGURATION_1 - Device dependent

AVR Type	Bit	B ₃₁	B ₁₈	B ₁₁	B ₁₀
	P[35] Default	CAN Proprietary	HDR	Jp_Droop_En	Jp_LAM_En
M2K	270028990	Disabled	Disabled	Disabled	Disabled
M2K[®]	2417512638	Enabled	Disabled	Disabled	Disabled
M3K	270032062	Disabled	Disabled	Enabled	Enabled
M3K[®]	2417515710	Enabled	Disabled	Enabled	Enabled
M3K^{SHD}	2417777854	Enabled	Enabled	Enabled	Enabled

Tab. 8-I: Table CONFIGURATION_1 device dependent

9 PROTECTION

9.1 Speed-dependent protections (V/F and L.A.M.S.)

OUTLINE OF THE SPEED-DEPENDENT PROTECTIONS SETTINGS

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
35	70	Configuration flags part 1	CONFIGURATION_1	Integer	device dependent ⁽¹⁾	2 ³² -1	0	NA
64	128	Under frequency threshold	VF_FreqDrop	Float	0,04	1	0	[%]
65	130	V/f slope in "start up"	START_SLOPE	Float	1,0379		0	[%V/%Hz]
66	132	Normal V/f slope (also LAMS m1)	VF_VFDrop	Float	1,0379		0	[%V/%Hz]
67	134	LAMS V/f slope (m3)	LAM_VF3VFDrop	Float	15		0	[%V/%Hz]
68	136	LAMS delay	LAM_T2SetIngTime	Float	10	100	0,001	[s]
69	138	LAMS Setpoint slope	LAM_DeltFreqDrop	Float	0,001			[Hz/s]
70	140	LAMS to standard V/f threshold	LAM_VF1FreqDrop	Float	0,15	1	0	[%]
71	142	LAMS end threshold	LAM_VF2FreqDrop	Float	0,04	1	0	[%]
72	144	LAMS exit time	LAM_T1WaitgTime	Float	0,3		0	[s]
73	146	LAMS secondary V/f slope (m2)	LAM_VF2VFDrop	Float	0,2139		0	[%V/%Hz]
74	148	LAMS threshold	LAM_VF3FreqDrop	Float	0,03	1	0	[%]
75	150	Over speed threshold	OVERSPEED	Float	0,1	1	0	[%]

Tab. 9.1-I: Parameters of the speed-dependent protections (V/f and L.A.M.S.)

NOTE ⁽¹⁾: see Chapter 8 "CONFIGURATIONS"

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₇	128	0000 0080	JP_Freq1_En	50/60 Jumper Enable	Enabled	1	128
B ₁₀	1024	0000 0400	JP_LAM_En	LAM Switch Enable	Enabled*	1	0/1024*
B ₂₂	4194304	0040 0000	60Hz	50/60Hz setting (60Hz activation)	50Hz	0	0
B ₂₅	33554432	0200 0000	LAMS	V/f operating mode or L.A.M.S.	V/f	0	0

*	M2K, M2K [®] , : L.A.M.S. can only be activated settable by flag (there is no switch)						
	M3K, M3K [®] e M3K ^{SHD} : L.A.M.S. activation settable by switch (default) or flag (with switch disabled)						

Tab. 9.1-II: Flags of the speed-dependent protections at P[35] CONFIGURATION_1

OUTLINE OF THE SPEED OPERATIVE VARIABLES

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
9	418	Setpoint modified by frequency	R	VSE_VltgSetpt	Float		0	[V]
20	440	Frequency	R	AF2P_Freq	Float		0	Hz
35	470	Active Status	R	STATUS	Integer	2 ³² -1	0	NA
36	472	Active Alarms	R	ALARMS	Integer	2 ³² -1	0	NA

Tab. 9.1-III: Speed operative variables

Bit	Dec. Weight	Hex Weight	Mnemonic	Flag Description
B ₁	2	0000 0002	VFSU	Start Up V/f relationship Active
B ₂	4	0000 0004	VF	Working V/f relationship Active
B ₁₇	131072	0002 0000	60Hz	50/60 Hz setting active
B ₂₁	2097152	0020 0000	LAM	LAM active

Tab. 9.1-IV: Speed status flags, address A[470] **STATUS**

9.2 Low speed protection

M2K M2K[®]

The nominal frequency setting depends on:

- the status of the 50/60 jumper (terminals 10 and 11), if enabled (P[35] **CONFIGURATION_1** Bit B₇=1)
- the status of the 50/60 setting (P[35] **CONFIGURATION_1** Bit B₁₇) if the jumper is disabled (P[35] **CONFIGURATION_1** Bit B₇=0)

M3K M3K[®] M3K^{SHD}

- the status of the 50/60 jumper (terminals 27 and 28), if enabled (P[35] **CONFIGURATION_1** Bit B₇=1)
- the status of the 50/60 setting (P[35] **CONFIGURATION_1** Bit B₁₇) if the jumper is disabled (P[35] **CONFIGURATION_1** Bit B₇=0)

With frequencies below a settable threshold and dependent on the nominal value, the protection intervention causes the voltage to be regulated according to the linear relationship $V_0 = K \cdot f + c$ (see “V/f” block in fig. 3.3-C: MxK Voltage Setpoint)

Parameter c is related to the intervention threshold of the frequency voltage linear relationship, parameter K is the slope. Both settings are only possible using suitable parameters (**MxK** regulators do not have an Hz trimmer).

According to the value of parameter P[64] **VF_FreqDrop**, as outlined in Tab. 9.2-I, the threshold is:

- 50·(1-P[64]) [Hz] if the nominal frequency is 50Hz (A[470] Bit B₁₇=0)
- 60·(1-P[64]) [Hz] if the nominal frequency is 60Hz (A[470] Bit B₁₇=1)

With frequencies lower than the established threshold, the setpoint, and in consequence the regulated voltage, is reduced proportionally to the speed (figs. 9.2-A, 9.2-B and 9.2-C).

Having defined the “start-up phase” as the functional condition beginning from alternator starting to the previously mentioned threshold, exceeding for the first time that threshold is the condition that causes the change to the functional condition defined as “working phase”.

The slope of the V/f separately settable for the two phases: at the “start-up phase” it depends on the value of parameter P[65] **START_SLOPE** (address A[130]), at the “working phase” it depends on the value of parameter P[66] **VF_VFDrop** (address A[132]); Both parameters have the same range and the same effect: an increase in the value causes the slope to increase (greater voltage reduction as a function of the frequency reduction), a value decrease causes the slope to decrease to the limit case of the null value that causes null slope (no voltage reduction).

The slope is expressed by parameters P[65] and P[66] in terms of $\Delta V\% / \Delta f\%$, so that each value corresponds with the same slope at both nominal frequencies (50Hz or 60Hz).

The default and limit values are given in Tab 9.2-I. Some examples appear in figure 9.2-A, 9.2-B and 9.2-C

P[#]	A[#]	Parameter	Function	Minimum		Default		Maximum	
				Value ^(A)	Real value ^(C)	Value	Real value ^(C)	Value ^(A)	Real value ^(C)
64	128	VF_FreqDrop	Threshold	0,2	80% fN	0,04	96% fN ^(B)	0	100% fN
65	130	START_SLOPE	Starting slope	0	0	1,0379	4,79	21,65	100
66	132	VF_VFDrop	Working slope	0	0	1,0379	4,79	21,65	100
NOTE (A):		Slope defined as $\Delta V\% / \Delta f\%$							
NOTE (B):		48,0Hz for settings: 50Hz and variable 40÷100Hz 57,6Hz for settings: 60Hz							
NOTE (C):		Slope defined as $\Delta V / \Delta f$ and expressed in [V/Hz]							

Tab. 9.2-I: Valori per l'impostazione della relazione tensione frequenza

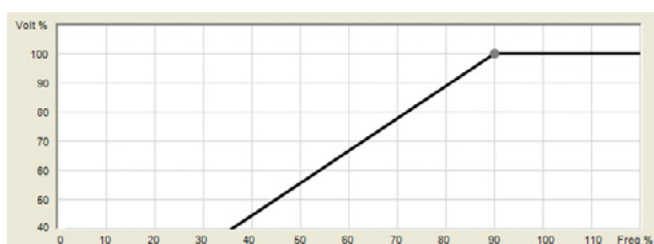


Fig.: 9.2-A: V/f connection with P[64]=0.1 and P[66]=1,1010
Threshold=90% Slope=5,128V/Hz

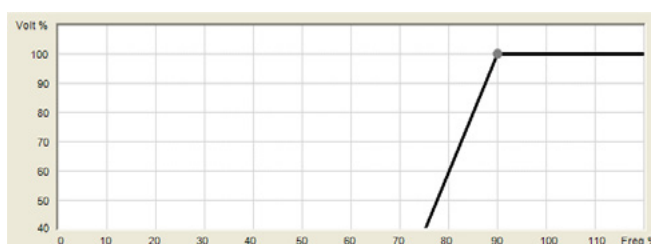


Fig.: 9.2-B: V/f connection with P[64]=0,1 and P[66]=3,9957
Threshold=90% Slope=18,46V/Hz

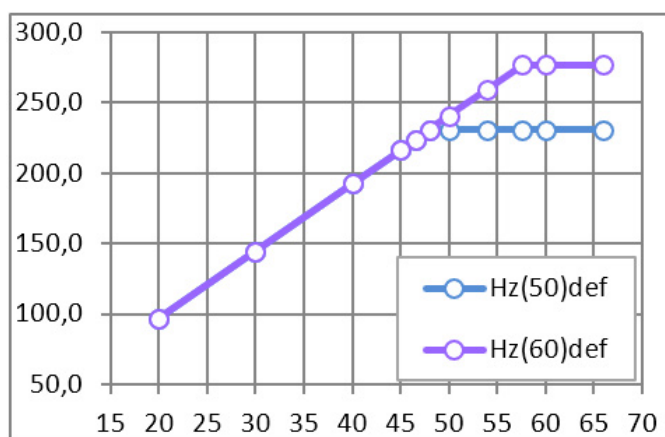


Fig.: 9.2-C: Default V/f connection P[64]=0,04 and P[66]=1,0379 (Threshold=96%fN, Slope=4,79V/Hz)

Activating of the operative condition with voltage proportional to the frequency is signalled by activation of alarm 13 (A[472] ALARMS Bit B13=1), visible also by the LEDS (see ALARMS chapter).

These calibrations become much easier with the Mecc Alte App which, from the **Settings>Base>V/F Slope** menu, can be used to modify the parameters and give a preview of the V/f relationship when setting by means of a graphic interface.



Overheating that can damage machine integrity can occur when the voltage is lowered too much at low frequency and the alternator has to operate at those points.

9.3 L.A.M.S. (Load Acceptance Module System)

L.A.M.S. (Load Acceptance Module System) functionality creates a V/f curve with two breacking points, frequency hysteresis and delay settable by dedicated parameters (tab. 9.4-I and fig. 9.3-A).

L.A.M.S. activation can make it possible to support the unexpected connection of the load with an alternator driven by a motor of comparable power which, given the torque variation on the shaft, reduces the motor speed to below its nominal value; The amplitude of the speed reduction and the relative recovery time depend on the motor performances, on the relative speed regulator settings, and the entity of the connected load (all variables outside the control of the voltage regulator); with the same conditions, the higher the inserted load the greater the speed reduction and recovery time.

If the voltage is reduced notably in correspondence with a reduced frequency variation, the load, and as such the torque, on the input shaft is reduced by the same amount, making recovery of the nominal conditions faster. Only when the speed has returned close to its nominal value is the voltage slowly (as a function of the time) restored to the initial value.

M2K M2K[®]

The function only activates if the flag **LAMS** (P[35] **CONFIGURATION_1** Bit B₂₅=1) is set, under the condition that (P[35] **CONFIGURATION_1** Bit B₁₀=0) is enabled.
These devices do not have a DIP switch for L.A.M.S. activation [L]

M3K M3K[®] M3K[®]

The function is activated with the DIP switch [L], if enabled, or the corresponding flag **LAMS** (P[35] **CONFIGURATION_1** Bit B₂₅); source selection depends on the status of the configuration flag (P[35] **CONFIGURATION_1** Bit B₁₀). The default settings are:

- Enabling/disabling L.A.M.S. by DIP switch [L]: (P[35] **CONFIGURATION_1** Bit B₁₀=1)
- flag (**LAM_En**) configured for LAM not active: (P[35] **CONFIGURATION_1** Bit B₂₅=0)

If activated, the L.A.M.S. only becomes operative during the "working phase" and is not active during the "start-up phase", where the V/f start-up relationship remains (see definitions in 9.2 "Low speed protection")

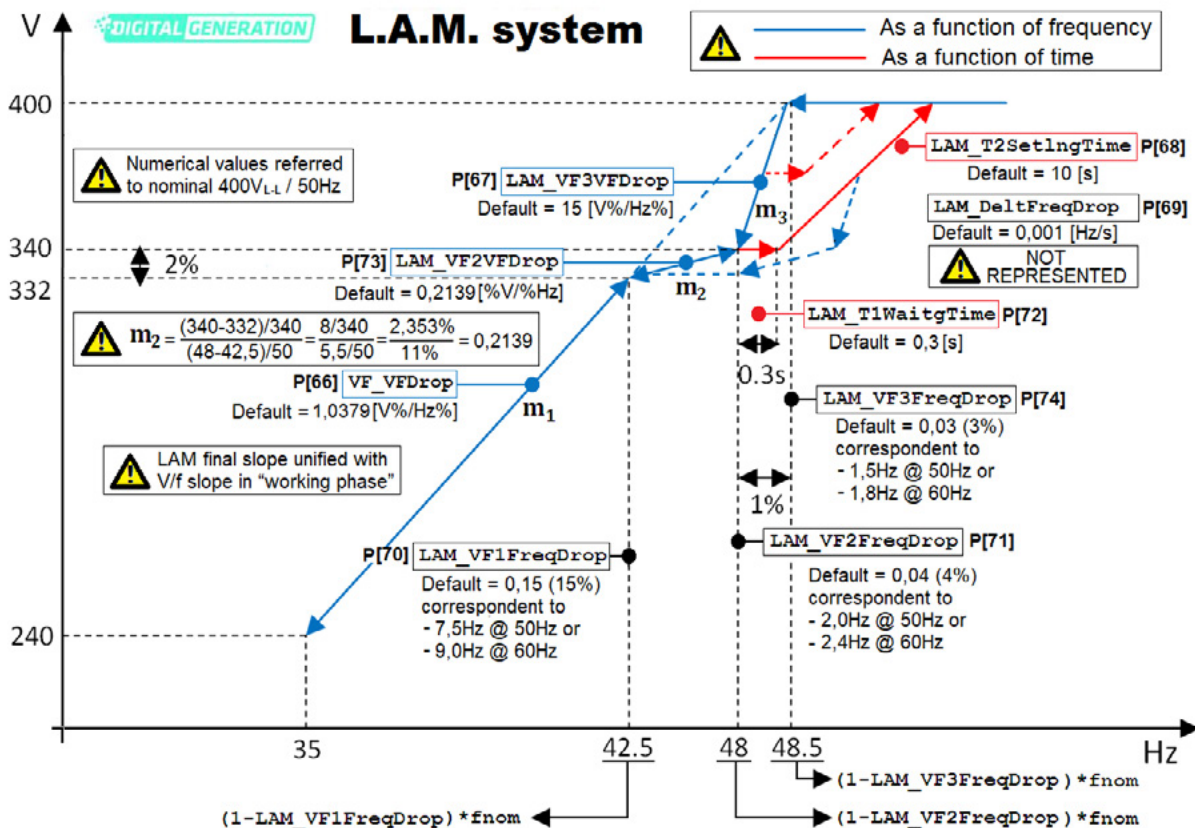


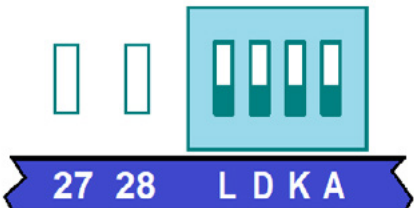
Fig. 9.3-A: L.A.M.S. (Load Acceptance Module System)

Following a speed reduction (generally cause by a load connection), if the frequency is lower than the threshold defined by P[74] **LAM_VF3FreqDrop**, the L.A.M.S. causes the voltage setpoint to decrease quickly as a function of the frequency with slope defined by P[67] **LAM_VF3VFDrop**;

For frequencies that are lower than the second threshold defined by P[71] **LAM_VF2FreqDrop** the voltage reduction is much less steep, with slope defined by P[73] **LAM_VF2VFDrop**;

For frequencies that are lower than the last threshold, defined by P[70] **LAM_VF1FreqDrop**, the voltage reduction as a function of the frequency has the same slope as that set for the V/f curve (without L.A.M.S.), namely the slope defined by P[66] **VF_VFDrop**;

When the frequency recovers to above the P[71] **LAM_VF2FreqDrop** set value and the setpoint has remained at the reduced value for the P[72] **LAM_T1WaitgTime** configured time, (to allow some time to the motor/engine to reach a stable operating condition), the return to the initial setpoint value occurs gradually at the P[68] **LAM_T2SetIngTime** predefined time. Hence resulting in a gradual increase of the regulated voltage, as well as the supplied power. Should the speed fall again during this time, the setpoint is again reduced as a function of the frequency on the basis of the connection defined by the L.A.M.S.

60Hz		SW1				
CN5B	CN5A	1	2	3	4	
27	28	L	D	K	A	

he Mecc Alte App makes the configuration easier. These are accessed from the Settings>Base>V/F Slope menu, they are used to modify the related parameters and provide a preview of the LAMS V/F connection whilst setting through a graphic interface.

9.4 Overspeed

The parameter for setting the overspeed threshold P[75] **OVERSPEED** (address A[150]) is a relative value (expressed as a nominal frequency f_R increase percentage) which acts according to the formula $(1+P[75])*f_R$ where f_R becomes:

- $f_R=50$ if setting is 50Hz,
- $f_R=60$ if setting is 60Hz,

The default value P[75] **OVERSPEED**=0.1 creates an overspeed threshold that is 110% of the nominal frequency, $(1+0.1)*f_R=55\text{Hz}$ or $(1+0.1)*f_R=66\text{Hz}$ as a function of the nominal frequency $f_R=50\text{Hz}$ or $f_R=60\text{Hz}$.

The alarm does not affect the control. Overspeed can cause overvoltage or undervoltage, for example in the case of capacitive load.

9.5 Over excitation (AMP) and Under excitation

OUTLINE OF THE OVER EXCITATION AND UNDER EXCITATION SETTINGS

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
48	96	Over Excitation Threshold	USR_ExcIttnTempSetPt	Float	110		0	[V]
49	98							
50	100	Over exc. regulator integral time const.	AMPCTRL_PITi	Float	0.1		0	[s]
51	102	Over exc. regulator proportional gain	AMPCTRL_PIKp	Float	0.75		0	NA
53	106	Under Excitation Threshold	U_EXC_THRESHOLD	Float	5		0	[V]
				Float				

Tab. 9.4-I: Parameters related to overexcitation and underexcitation

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₄	16	0000 0010	Trim4_En	TRIMMER AMP Enable	Enabled	1	16
B ₁₉	524288	0008 0000	Amp_Ctrl_En	Over Excitation Protection Enable	Enabled	1	524288

Tab. 9.4-II: Flags of the speed-dependent protective device at P[35] **CONFIGURATION_1**

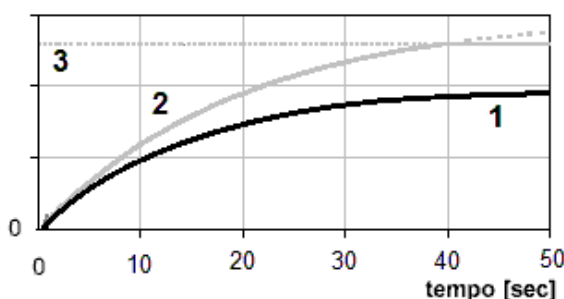
OUTLINE OF THE EXCITATION OPERATIVE VARIABLES

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
11	422	Setpoint reduction by AMP	R	AMP_VltgDrop	Float		0	[V]
18	436	Excitation voltage	R	avgExcVltg	Float		0	[V]
36	472	Active Alarms	R	ALARMS	Integer	2 ³² -1	0	NA
45	490	AMP threshold	R	EXC_RefDsrdVltg	Float			[V]
46	492	Accumulate heat estimator	R	avgExcVltgFiltered	Float			[V]
47	494	Excitation rms voltage	R	rmsExcVltg	Float		0	[V]

Tab. 9.4-III: Operational variables related to the power overvoltage protection

9.6 Excitation overcurrent

The regulator is equipped with an excitation overcurrent protection with a delayed action (substantially of the integral type); by modifying the voltage setpoint, the protection reduces the excitation current to a safe value that is within the whole operating frequency range. The protection serves for signalling the occurrence of high temperature on the excitation system, as well as actively eliminating the cause. When the threshold is crossed, the control loop adjusts itself; consequently, the voltage setpoint is reduced to the right amount to provide the appropriate excitation voltage, and lower the current to result in a safe margin for the machine's heat dissipation capacity; the accumulated energy is estimated and the excitation power is proportional to the dissipated power by the rotor.



Description of the heat model curves in Fig. 9.6-A

- 1) $I_o=80\%$ in P.F.=0 with the machine cold
- 2) $I_o=110\%$ in P.F.=0 with the machine cold
- 3) Protective device intervention threshold (105% of the excitation voltage under stabilised thermal conditions)

Fig. 9.6-A AMP protection - thermal model

If the estimated "accumulated energy" value tends to exceed the set threshold, the regulation error tends to become positive, which causes a non-null output from the over excitation regulator that is subtracted from the setpoint, fig. 9.4-B

The excitation limit setting (over excitation threshold) is determined by the AMP trimmer or the corresponding parameter P[48] **USR_ExcIttnTempSetPt**; the source of this setting (trimmer or parameter) is selected by the configuration flag **Trim4_En** (P[35] **CONFIGURATION_1** Bit B₄), fig. 9.4-B

An estimate of the "accumulated energy" is available in almost real time (and is available) at address A[492] **avgExcVltgFiltered**

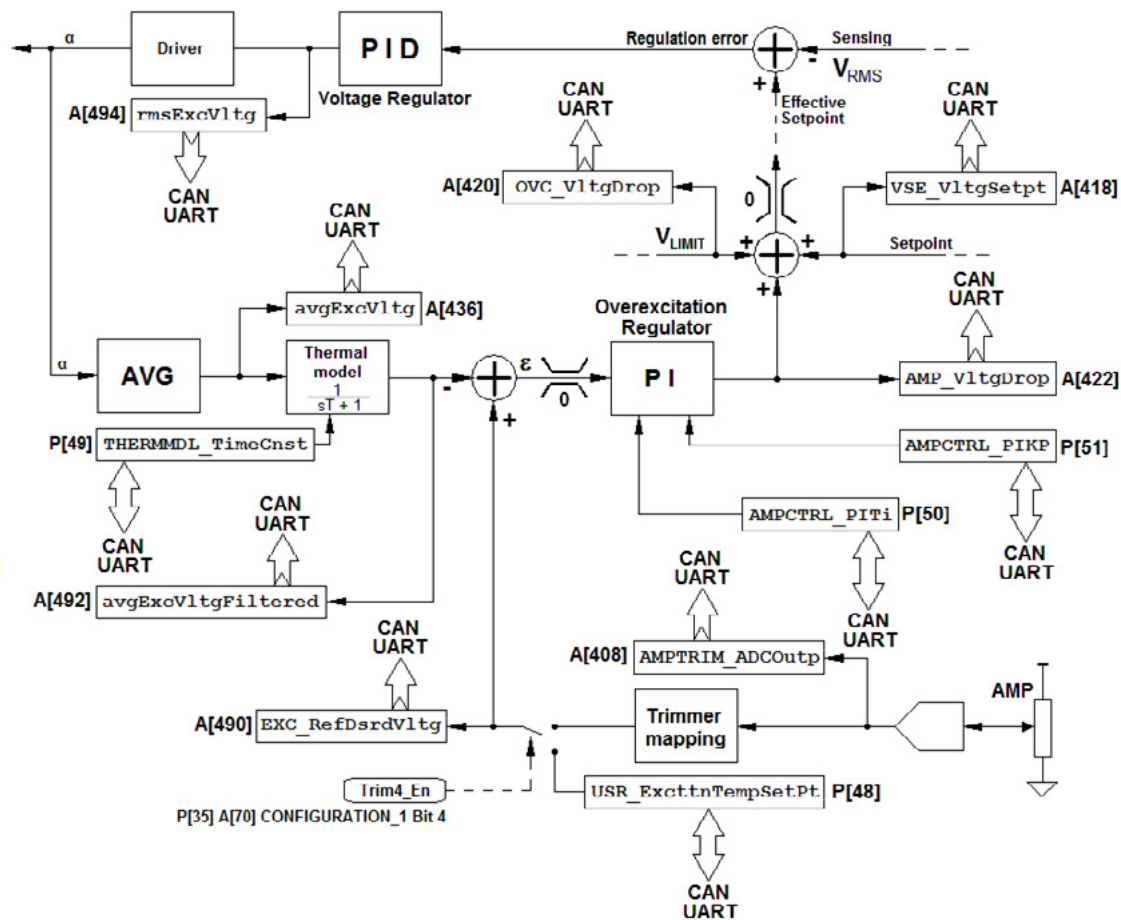


Fig. 9.4-B: Protection from excitation overcurrent (AMP)

The time constant of the heat model, in tenths of a second (Fig. 9.4-A), can be set by parameter P[49] **THERMMDL_TimeCnst**; the default value of 30s is suitable for most applications.

The dynamics of the over excitation regulator are generally slow, regulation stability in the event of an alarm can be set by parameters P[50] **AMPCTRL_PITi** and P[51] **AMPCTRL_PIKP**. The default values are suitable for most machines. Regulation stability in the event of an over excitation alarm can, if necessary, be adapted to the application by first varying the value of P[50] **AMPCTRL_PITi**, fig. 9.4-B

The status, signalled by the activation of alarm 08 (A[472] **ALARMS** Bit B₈=1), also visible with the LEDs (see **ALARMS** chap.) is maintained for all the time that the setpoint is reduced because the protective device has activated (i.e. when the regulator-limiter activates); in this way at least one reason why the regulated voltage is lower than the set value is signalled.

protection adjust becomes easier with the Mecc Alte App software which, on the main Dashboard gives a graphic representation of the “accumulated energy” (address A[492] **avgExcVltgFiltered**) and the protection threshold (address A[492] **EXC RefDsrdVltg** set by the AMP trimmer or Parameter P[48] **USR ExccttnTempSetPt**)

9.7 Under excitation

The regulator is equipped with an under excitation protection which depends on the rms value of the excitation voltage available at address A[494] **rmsExcVltg**: if lower than the threshold set by parameter P[53] **U_EXC_THRESHOLD** the A10 (A[472] ALARMS Bit B₉=1) alarm activates, also visible with the LEDs (see chap. 10 "ALARMS MANAGEMENT"), without affecting the control.

9.8 Short Circuit Protection

OUTLINE OF THE SHORT CIRCUIT PROTECTION SETTINGS

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
21	42	Voltage Setpoint in case of L.O.S.	LOS_SftyVltgSetpt	Float	100	200	50	[V]
56	112	Short circuit validation time	SCC_vldtnTime	Float	0,5	100	0,001	[s]
57	114	Short circuit trip delay	SCC_SCROnTimePr	Float	4,5	100	0,001	[s]

Tab. 9.8-I: Short circuit and reference loss parameters

Bit	Weight		Flag Name	Flag Description	Default		
	Dec	Hex			Function	value	weight
B ₂₀	1048576	0010 0000	SCC_Dtctn_En	Short Circuit Detection Enable	Enabled	1	1048576

Tab. 9.8-II: Short circuit flags at P[35] **CONFIGURATION_1**

9.8.1 Outline of the short circuit protection operative variables


#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
35	470	Active Status	R	STATUS	Integer	2 ³² -1	0	NA
36	472	Active Alarms	R	ALARMS	Integer	2 ³² -1	0	NA

Tab. 9.8-III: Short circuit operative variables

Bit	Dec. Weight	Hex Wiegth	Mnemonic	Flag Description
B ₃	8	0000 0008	LOSU	Phase U sensed (Loss of sensing phase U if 0)
B ₄	16	0000 0010	LOSV	Phase V sensed (Loss of sensing phase V if 0)
B ₅	32	0000 0020	LOSW	Phase W sensed (Loss of sensing phase W if 0)

Tab. 9.8-IV: Sensing status flags, address A[470] **STATUS**

The synchronous alternators were designed to supply a current that is well above the nominal value when in short circuit. They cannot, however, sustain this irregular operating condition for an unspecified time, therefore the regulator has a dedicated protective device.

	<p>When set correctly, the regulator protective device is limited to the alternator, so it should not be considered as enough protection for the system.</p> <p>It is considered that the user has implemented appropriate and suitable system protection within the stopping intervention time determined by the protective devices.</p>
---	---

Having identified the three-phase **short circuit** condition at the main stator, the excitation voltage is set by the regulator at maximum so as to guarantee maximum current; after a time that is settable, the regulator drops the excitation voltage completely and irreversibly (until reset). If the short circuit conditions stop within a period of time that is less than the one set, the device begins regulating the voltage as normal.

Identifying the short circuit condition requires a minimum time defined by parameter P[56] **SCC_vldtnTime**; in most cases a time of between 0.5s. and 1s. should be enough to reliably identify the condition. Setting an excessively short time may not make it possible to recognise the short circuit.

The time interval during which maximum excitation is applied is defined by parameter P[57] **SCC_SCROnTimePr**. The excitation voltage is set to zero after a time determined by the values of P[56] **SCC_vldtnTime** and P[57] **SCC_SCROnTimePr**.

The default values are:

P[56] **SCC_vldtnTime** = 0,5 [s]

P[57] **SCC_SCROnTimePr** = 4,5 [s]

As a result, by default, the excitation voltage is set to zero after 11s

The effects of excitation voltage deletion are generally different on the basis of the different possible sources of power:

- Power from separate auxiliary stator winding: almost surely the intervention of the stopping protective device causes insufficient power voltage for the regulator, which leads to RESET and restarting (in short circuit): if the regulator is kept permanently powered, the RESET will not occur and the stopping state would effectively be permanent.
- Power from a phase: the regulator is not being powered when the short circuit occurs, so it cannot manage the condition.
- Power from an auxiliary source (PMG): the regulator is permanently powered, therefore the sequence of events will be exactly as described and the stopping status will effectively be permanent.

9.9 Power overvoltage protection

OUTLINE OF THE POWER OVER VOLTAGE PROTECTION SETTINGS

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
76	152	Supply O.V. reg.. integral time constant	AUX_OVC_Ti	Float	0.2		0	[s]
77	154	Supply O.V. reg. proportional gain	AUX_OV_KP	Float	0.5		0	NA

Tab. 9.9-I: Power overvoltage protection parameters

OUTLINE OF THE POWER OVER VOLTAGE OPERATIVE VARIABLES

#	Add.	Description	Access	Parameter	Type	Max.	Min.	Unit
10	420	Setpoint reduction by supply Overvoltage	R	OVC_VltgDrop	Float		0	
36	472	Active Alarms	R	ALARMS	Integer	2 ³² -1	0	NA

Tab. 9.9-II: Power overvoltage protection variables

MxK regulators have a power voltage limiter to prevent the peak levels from the auxiliary winding source when at load which may contain high harmonic levels caused by the effects of the load applied on the main stator windings. The protective device not only signals that the regulator operation limit has been exceeded, but also has an active function to eliminate the cause: if the peak voltage value is near the maximum, the excitation value is reduced through setpoint reduction, and also the power voltage, if obtained from a winding coupled with the main magnetic flow (consequently also the outgoing voltage to a value lower than the one that is set). Fig. 3.3-C: MxK Voltage Setpoint. The protective device intervention value cannot be modified because it is linked to the hardware's maximum ratings. The dynamics of the power supply regulator-limiter can be modified by parameters P[77] **AUX_OV_KP** and P[76] **AUX_OVC_Ti**; the default values should be suitable for most cases, with only particular cases (e.g. elevated alternator magnetic gain values) requiring the possible necessity to modify the values.

The status, signalled by activation of alarm 11 (A[472] **ALARMS** Bit B₁₀=1), also visible via the LEDs (see chapter 10 "ALARMS MANAGEMENT") is maintained throughout the time of the setpoint reduction because the protective device has enabled (i.e. when the regulator-limiter is active), in this way at least one reason why the regulated voltage is lower than the set value is signalled.

10 ALARMS MANAGEMENT

10.1 Active Alarms

The state of the active alarms is represented on 32 bits at the address A[472] **ALARMS**, the index of the bits in the upper state correspond to an active alarm. If the regulator is operating correctly (no alarm active), no bit will be in the upper level and A[472]=0, but if, instead, one or more alarms are identified, then A[472]≠0. The alarms that are active can be identified through the value of A[472] **ALARMS**. This operation becomes much easier with the Mecc Alte App or a MeccAlte GC controller connected to the regulator by CANBus.

Active Alarms																															
A ₃₁	A ₃₀	A ₂₉	A ₂₈	A ₂₇	A ₂₆	A ₂₅	A ₂₄	A ₂₃	A ₂₂	A ₂₁	A ₂₀	A ₁₉	A ₁₈	A ₁₇	A ₁₆	A ₁₅	A ₁₄	A ₁₃	A ₁₂	A ₁₁	A ₁₀	A ₉	A ₈	A ₇	A ₆	A ₅	A ₄	A ₃	A ₂	A ₁	A ₀
Bits that correspond with the address A[472] ALARM																															
B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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

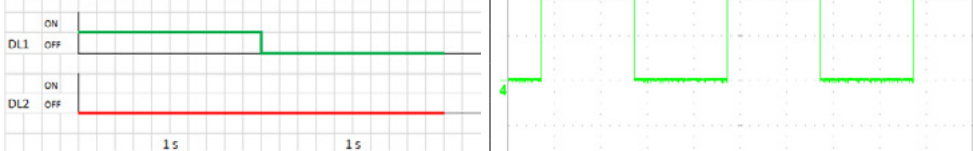
TABLE 10.1-I : ALARMS OUTLINE


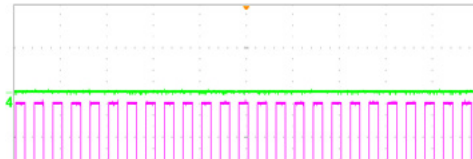
A[472]	Alarm name	Notes	Mnemonic	Dec weight	Hex weight
B ₀	Reserved			1	0000 0001
B ₁	Checksum EEprom		CS	2	0000 0002
B ₂	Reserved	En. P[36] Bit B6	LOS	4	0000 0004
B ₃	Reserved		RBDS	8	0000 0008
B ₄	Reserved		RBDF	16	0000 0010
B ₅	Over voltage		OV	32	0000 0020
B ₆	Under voltage		UV	64	0000 0040
B ₇	Short circuit		SC	128	0000 0080
B ₈	Over Excitation		OEXC	256	0000 0100
B ₉	Under Excitation		UEXC	512	0000 0200
B ₁₀	Supply Over Voltage		SOV	1024	0000 0400
B ₁₁	Phase Over current		OC	2048	0000 0800
B ₁₂	Reserved	En. P[36] Bit B7	OL	4096	0000 1000
B ₁₃	Under Speed (V/f or LAMS)		US	8192	0000 2000
B ₁₄	Over Speed		OS	16384	0000 4000
B ₁₅	Free for future use			32768	0000 8000
B ₁₆	Over Temperature (85°C)		OTR	65536	0001 0000
B ₁₇	Maximum Temperature (70°C)		LTR	131072	0002 0000
B ₁₈	Reserved		OTU	262144	0004 0000
B ₁₉	Reserved		OTV	524288	0008 0000
B ₂₀	Reserved		OTW	1048576	0010 0000
B ₂₁	Reserved		OTDE	2097152	0020 0000
B ₂₂	Reserved		OTNDE	4194304	0040 0000
B ₂₃	Free for future use			8388608	0080 0000
B ₂₄	Reserved	En. P[36] Bit B8	PS	16777216	0100 0000
B ₂₅	Capacitive Load(10)		CL	33554432	0200 0000
B ₂₆	Reserved		ERRVM	67108864	0400 0000
B ₂₇	Negative Power		NP	134217728	0800 0000
B ₂₈	Reserved		OOR	268435456	1000 0000
B ₂₉	Reserved		FPSW	536870912	2000 0000
B ₃₀	Reserved		UQ	1073741824	4000 0000
B ₃₁	Free for future use			2147483648	8000 0000


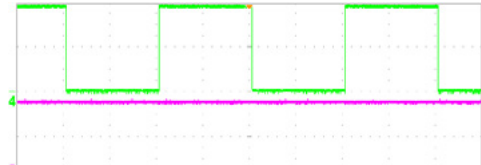
10.2 Alarm signalling by LED



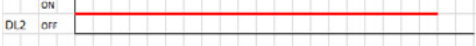


During normal operation (System OK at 10.3 "Alarms description"), the green LED indicator embedded in the board flashes at a period of 2sec with duty cycle 50%; in case of protection intervention or alarm signalling, the two LED indicators (green and red, 10.3 "Alarms description") flash in different ways.

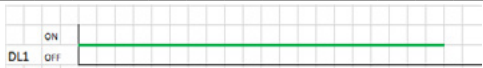
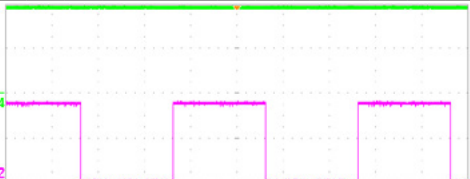
10.3 Alarms description


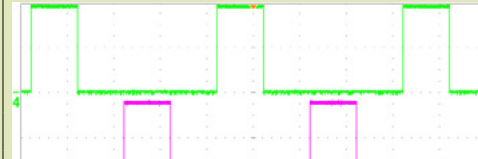
Alarm #	-		Mnemonic								-				Name				System OK								A[472] Hex				0000 0000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	B ₁₅	B ₁₄	B ₁₃	B ₁₂	B ₁₁	B ₁₀	B ₉	B ₈	B ₇	B ₆	B ₅	B ₄	B ₃	B ₂	B ₁	B ₀		
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Description	Correct operation (no alarm identified)																																	
LED*	DL1	δ[%]	0																															
		f[Hz]	0																															
	DL2	δ[%]	0																															
		f[Hz]	0																															
		φ[°]	0																															


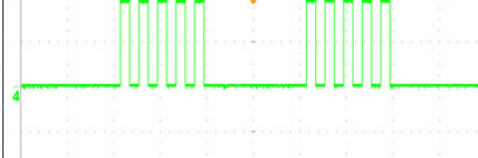
Alarm #	01		Mnemonic								CS				Name				Check-Sum EEPROM								A[472] Hex				0000 0002				
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	B ₁₅	B ₁₄	B ₁₃	B ₁₂	B ₁₁	B ₁₀	B ₉	B ₈	B ₇	B ₆	B ₅	B ₄	B ₃	B ₂	B ₁	B ₀			
ALARMS	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	1	0		
Description	Verified at the switching on. The actions undertaken are: signalling, default settings restoring, LOG updating and regulator stopping. The alarm repeats if the memory is faulty when the regulator is started again, otherwise it starts operating with no active alarm and with the default parameters..																																		
LED*	DL1	δ[%]	0																																
		f[Hz]	0																																
	DL2	δ[%]	100																																
		f[Hz]	5																																
		φ[°]	0																																

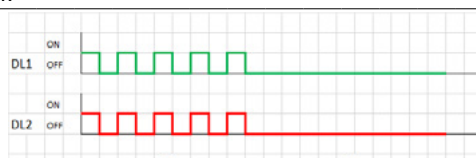
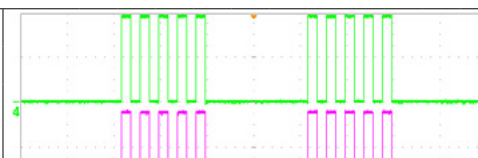
Alarm #	05								Mnemonic								OV				Name				Over voltage								A[472] Hex				0000 0020			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	B ₁₅	B ₁₄	B ₁₃	B ₁₂	B ₁₁	B ₁₀	B ₉	B ₈	B ₇	B ₆	B ₅	B ₄	B ₃	B ₂	B ₁	B ₀								
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0								
Description	The alarm, inhibited during the transients, can be stimulated by irregular operating conditions (such as overspeed or capacitive load), or by a regulator fault. The overvoltage alarm only activates if the excitation has already been reduced to minimum, and as such the outgoing voltage control has been lost. The threshold, which cannot be modified, is set at 5% above the setpoint value.																																							
LED*	DL1	δ[%]	50																																					
		f[Hz]	0																																					
	DL2	δ[%]	100																																					
		f[Hz]	0																																					
		φ[°]	0																																					



Alarm #	06								Mnemonic								UV								Name								Under voltage								A[472] Hex				0000 0040			
L[36] - A[472]	B31	B30	B29	B28	B27	B26	B25	B24	B23	B22	B21	B20	B19	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0																
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0																
Description	LThe alarm, inhibited during the transients and identified as being above the intervention threshold of the low starting speed alarm, only activates if the excitation has already been increased to maximum and, as such, the outgoing voltage control has been lost. The threshold, which cannot be modified, is set at 5% below the setpoint value.																																															
LED*	DL1	δ [%]	50																																													
		f[Hz]	0																																													
	DL2	δ [%]	100																																													
		f[Hz]	0																																													
		φ [°]	0																																													


Alarm #	10		Mnemonic								SOV				Name				Supply Over Voltage								A[472] Hex				0000 0400				
L[36] - A[472]	B31	B30	B29	B28	B27	B26	B25	B24	B23	B22	B21	B20	B19	B18	B17	B16	B15	B14	B13	B12	B11	B10	B9	B8	B7	B6	B5	B4	B3	B2	B1	B0			
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0			
Description	<p>The alarm not only signals if the regulator operating limit has been exceeded, but is also active in eliminating the cause. A regulating loop takes control of the voltage after a threshold has been exceeded, causing the excitation current to lower (therefore also the regulated voltage).</p> <p>The alarm status is present for the whole time during which the outgoing voltage is reduced because of protective device intervention. The intervention threshold cannot be modified.</p> <p>Detailed description of the actions in the chapter 9 "PROTECTION".</p>																																		
LED*	DL1	δ[%]	100																																
		f[Hz]	0																																
	DL2	δ[%]	50																																
		f[Hz]	0																																
		φ[°]	0																																



Alarm #	11	Mnemonic								OC				Name				Phase Over current										A[472] Hex				0000 1000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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			
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0		
Description	The alarm, instantaneous, is only operative with M3Kx if there is a C.T.; it does not affect the control, and is based on the capability curve through measurement of the current and cosφ of phase U. The threshold value is similar to that of the nominal current on the basis of the value of parameter P[54] OVERCURRENT (default 5 [P.U.]), conditioned by how parameter P[23] PUC_ADSCInlg .																																		
LED*	DL1	δ[%]	25																																
		f[Hz]	0																																
	DL2	δ[%]	25																																
		f[Hz]	0																																
		φ[°]	180																																



Alarm #	13	Mnemonic								US				Name				Under Speed										A[472] Hex				0000 2000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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			
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		
Description	The alarm signals V/F curve (or LAMS) activation, so it appears even at during start-up and shut-down. The intervention threshold depends on the value of parameter P[64] VF_FreqDrop (o P[74] LAM_VF3_FreqDrop) and the status of the 50/60 setting (hardware or software). Detailed description of the actions in the chapter 9 "PROTECTION".																																		
LED*	DL1	δ[%]	50																																
		f[Hz]	5																																
	DL2	δ[%]	0																																
		f[Hz]	0																																
		φ[°]	0																																

Alarm #	14	Mnemonic								OS				Name				Over Speed										A[472] Hex				0000 4000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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			
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		
Description	The alarm does not affect the control. Overspeed can cause overvoltage or undervoltage, for example in the case of capacitive load. The threshold can be set with parameter P[75] OVERSPEED . Detailed description in the PROTECTION chapter.																																		
LED*	DL1	δ[%]	50																																
		f[Hz]	5																																
	DL2	δ[%]	50																																
		f[Hz]	5																																
		φ[°]	0																																

Alarm #	16	Mnemonic								OTR				Name				Over Temperature										A[472] Hex				0003 0000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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			
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Description	The alarm does not affect the control. The threshold, which cannot be modified, is 85°C. The setting of Bit B17 signalling limit temperature (Alarm 17) is also maintained (se θAVR>85°C it is just as true that θAVR>70°C)																																		
LED*	DL1	δ[%]	25																																
		f[Hz]	0																																
	DL2	δ[%]	100																																
		f[Hz]	0																																
		φ[°]	0																																

Alarm #	17		Mnemonic								LTR				Name				Maximum Temperature										A[472] Hex				0002 0000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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				
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Description	The alarm does not affect the control. The threshold, which cannot be modified, is 70°C																																			
LED*	DL1	δ[%]	25																																	
		f[Hz]	0																																	
	DL2	δ[%]	25																																	
		f[Hz]	0																																	
		φ[°]	0																																	

Alarm #	25		Mnemonic								CL				Name				Capacitive Load								A[472] Hex				0200 0000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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		
ALARMS	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Description	The alarm, which is only operative with M3Kx with C.T., does not affect the control and is determined by the measurement of the current lead condition rather than the voltage implemented by the calculation of the active and reactive components of the electrical sizes. The capacitive load self-excites the generator, which causes the control to reduce the angle; if the load is too capacitive, under excitation will occur (possibly also overvoltage and/or power overvoltage).																																	
LED*	DL1	δ[%]		50																														
		f[Hz]		0																														
	DL2	δ[%]		25																														
		f[Hz]		0																														
		φ[°]		180																														

Alarm #	27		Mnemonic								NP				Name				Negative Power								A[472] Hex				0800 0000			
L[36] - A[472]	B ₃₁	B ₃₀	B ₂₉	B ₂₈	B ₂₇	B ₂₆	B ₂₅	B ₂₄	B ₂₃	B ₂₂	B ₂₁	B ₂₀	B ₁₉	B ₁₈	B ₁₇	B ₁₆	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		
ALARMS	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Description	The alarm, operative only with M3Kx with C.T., does not affect the control and depends on the power sign, determined through calculation of the active and reactive components of the electrical sizes.																																	
LED*	DL1	δ[%]	50																															
		f[Hz]	0																															
	DL2	δ[%]	25																															
		f[Hz]	0																															
		φ[°]	180																															

NOTE *

Considering a period TLED=2sec for LED flashing, the following are reported:

- The duty cycle [%] of the green LED: δ DL1
- The frequency [Hz] of a possible modulating frequency for the green LED: fDL1
- The duty cycle [%] of the red LED: δ DL2
- The frequency [Hz] of a possible modulating frequency for the red LED: fDL2
- The phase ratio φ [°] between the red and green LEDs (where 0° indicates that the 2 LEDs Are lit simultaneously and 180° indicates that for each cycle the LEDs can only lit in different semi-periods)

10.4 Alarms log

An alarms LOG with a depth of 64 events is implemented through **two synchronised circular buffers**:

1. **AlarmLogHistory** is the log of the alarm events (where the index of the bits in the high state corresponds with the active alarm at the moment of saving),
2. **AlarmLogDD** is the duration, in seconds, of each event.

A[800] **AlarmLogIndex** is the **pointer to the first free location** where to save the next event that will occur and it:

1. assumes integer values **n** with **n=0÷63**
2. points at address **A[802+2*n]**
3. **The last status** The last status stored
 - a. **63** if **n=0**
 - b. **(n - 1)** if **n≠0**
4. if A[800]=0 (n=0), **A[800] points at A[802]** and indicates that the last status stored is at address 802+2*63=928
5. otherwise, **A[800] points at address A[802+2*n]** and indicates that the last status stored is at address **A[802+2*(n-1)]**
e.g. if **A[800]=5** (n=5) **A[800] points at A[812]** and indicates that the last status stored is at address 810] (see figure)
6. The status saved at address **A[802+2*n]** (pointed at by A[800]=n) is the oldest status in the circular buffer (destined to be overwritten when A[472] **ALARMS** is next varied).

800	801	802	803	804	805	806	807	808	809	810	811	812	813	814	815
pointer	n=0		n=1		n=2		n=3		n=4		n=5				

Cumulative registers are provided for each alarm there the following are saved:

1. the sum of the events **AlarmLogStatisticskNN** for each of the 31 alarms A[k] with k=1÷31
2. The overall duration **AlarmLogStatisticskTT** for each of the 31 alarms A[k] with k=1÷31

The AlarmLogStatistics area occupies the addresses from A[1058] to A[1184]

locations 1058 and 1060 refer to System OK

- A[1058] **AlarmLogStatistics0NN** = System OK event accumulator, not represented by the B0 bit of A[472] (not used, see §1 Active Alarms and §3 Alarms description, System OK)
- A[1060] **AlarmLogStatistics0TT** = System OK time accumulator

For each of the 31 alarms A[k] with k=1÷31

The AlarmLogStatisticskNN event accumulator is allocated to A[1058 + 4*k]

The AlarmLogStatisticskTT total time accumulator is allocated to A[1058 + 4*k + 2]

A[1062] **AlarmLogStatistics1NN** = Event accumulator A[1] (Check-sum EEPROM)

A[1064] **AlarmLogStatistics1TT** = Time accumulator A[1] (Check-sum EEPROM)

and so on until

A[1182] **AlarmLogStatistics31NN** = Event accumulator A[31] (Free for future use)

A[1184] **AlarmLogStatistics31TT** = Time accumulator A[31] (Free for future use)

Alarm LOG data access and interpretation become easier with the Mecc Alte App or one of the MeccAlte GC controllers connected to the regulator by CANBus.



10.5 APO output

The status of the APO (**A**ctive **P**rotection **O**utput) at CN6 depends:

- on the activation or not of some alarm
- how parameter P[116] **APO_SELECT**
- how parameter P[117] **APO_DELAY**
- how the "APO Inversion" flag, Bit B₁₄ of P[35] **CONFIGURATION_1** is set

The output is closed during normal operation. It opens (with a programmable delay) when one or more of the alarms that can be selected separately with P[116] **APO_SELECT** are active, and the "APO invert" flag is enabled (P[35] Bit B₁₄=1), and the time set by P[117] **APO_DELAY**, or it opens immediately if the regulator is not being powered. If the "APO invert" flag is disabled (P[35] Bit B₁₄=0) the APO output is inverted (opened during normal operation or when the regulator is off, closed, with a programmable delay, in the event of one or more active alarms that were selected using P[116] **APO_SELECT**).

The selection of which alarms cause the A.P.O. to activate depends on the value written at location P[116] **APO_SELECT**. The output becomes inactive when no alarm is active and when the corresponding enabling bit is set to 0, even if there is an active alarm.

The intervention delay in seconds can be set using the value of parameter P[117] **APO_DELAY**.

APO output management becomes easier using Mecc Alte App which, from the Settings>Advanced>Config part 1>APO Inversion, can be used to modify the parameters values and flags.

11 COMMUNICATION

MxK regulators are equipped with a communication system (embedded hardware and software which, when combined with proper software on external platforms, allows the devices to become part of more complex systems as indicated in §II.1 or, more simply, to set machine operating parameters, interrogate the regulator on the current operating status, and download the saved data about protections and alarms previously happened). There are up to 2 ports equipped of relative ModBus and CANbus serial communication protocols.

11.1 MOD Bus

Communication speed of this channel is 9600bit/s with ModBus communication protocol complying with the Technical Guide (MeccAlte) "Digital Regulator communication protocol".

If the system supervisor indicated in §II.1 is made up of a PC (Windows™) or a Mobile device (Android™ or iOS™), communication can run through the specific applications made available by Meccalte:

For PCs: Mecc Alte App available for download at www.meccalte.com.

For Mobile devices: Mecc Alte App available at App Store and Play Store

M2K **M2K^B**

An additional device is required to connect to the supervisory unit; the connection, wired or wireless, can be made through one of the devices named USB2MxK and MxKconnect; the use of one or the other depends on the supervisory unit (PC or Smartphone) and the type of connection (USB or wi-fi). Kits consisting of said device and its connection cables are available upon request.

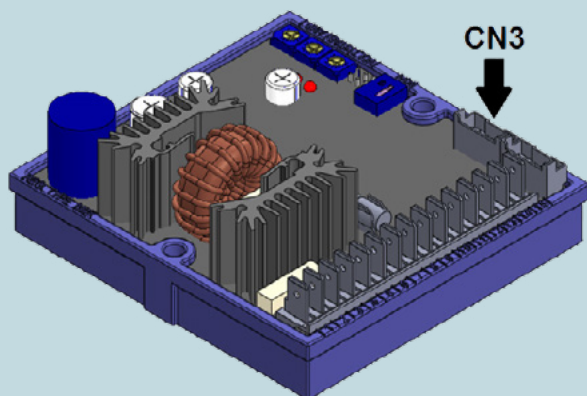


Fig. 11.1-A: COM connector (ModBus) on **M2K**

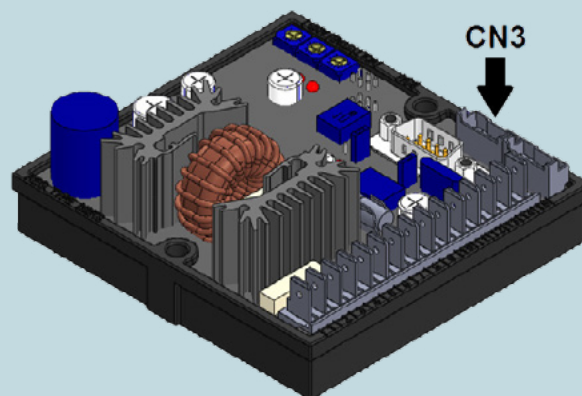


Fig. 11.1-B: COM connector (ModBus) on **M2K^B**

M3K **M3K^B** **M3K^{BHD}**

Connection can be wired or wireless: in the first case (to a PC) it is via the USB port mounted on the board and only a suitable cable is needed, in the second case (PC or Smartphone) the additional device MxKconnect is needed USB cable (male type A - male type A) or Kit consisting of MxKconnect and related connection cables are available upon request.

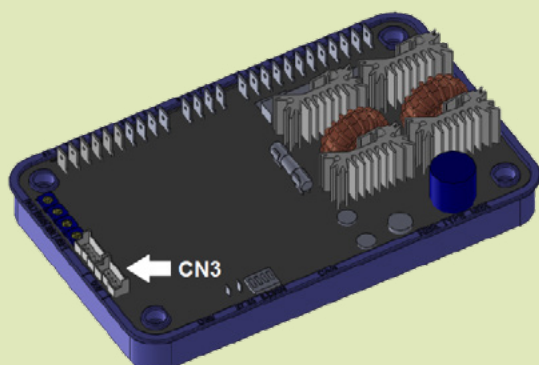


Fig. 11.1-C: COM connector (ModBus) on **M3K**

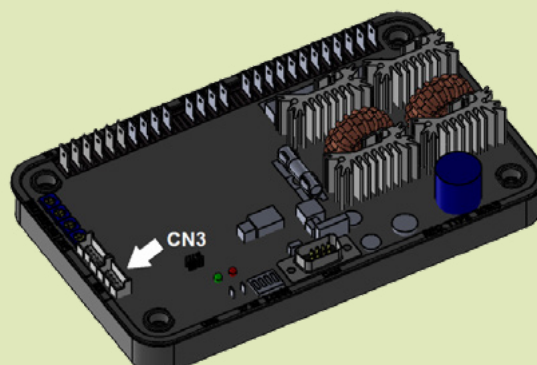


Fig. 11.1-D: COM connector (ModBus) on **M3K^B**

M3K^{SHD}

Connection can be wired or wireless: in the first case (to a PC) it is via the USB port mounted on the board and only a suitable cable is needed, in the second case (PC or Smartphone) the additional device MxKconnect is needed
USB cable (male type A - male type A) or Kit consisting of MxKconnect and related connection cables are available upon request.

Whether the connection to the PC is made via one of the two additional USB2MxK or MxKconnect devices (regulators **M2K** - **M2K^S** - **M3K** - **M3K^S**) or direct (regulator **M3K^{SHD}**), it also involves the power supply, isolated from the PC, to the controller: in this way it is therefore possible to modify the controller settings even completely off-line (on the bench, without any other connection) or at any rate with the alternator stopped.

For a detailed description of the additional devices, their connections and communication software, refer to the specific Technical Guide.

11.2 CAN Bus

M2K^S **M3K^S** **M3K^{SHD}**

Communication on this channel is compliant with the SAE J-1939 standard; more specifically, the reference standard of the protocol is SAE J1939-75. The **MxK** family of devices can be configured to operate almost in sole conformity with this protocol or in a proprietary method that includes additional messages and functions.

The MeccAlte group controllers (GC250, GC315, GC400) or the high end SICES ones are already equipped with the software required for communication through CANBus with regulators **M2K^S** - **M3K^S** - **M3K^{SHD}** (system supervisor indicated at §II.1

Connect to the Bus by the CAN connector (tab. 11.2-I)

The received and transmitted signals are galvanically isolated from the control and power part of the regulator (fig. 11.2-A)

CAN CONNECTOR (SUBD-9)				
Pin	Name	Function	Specification	Note
1	-			Unwired
2	CAN_L	Signal CAN-L	-	
3	GND_CAN			
4	-			Unwired
5	-			Unwired
6	-			Unwired
7	CAN_H	Signal CAN-H	-	
8	-			Unwired
9	CAN_V+	Supply	12÷24Vdc	

tab. 11.2-I: CAN connector pinout



For operation of the part isolated from the driver controller, it is necessary to supply the CAN module with a voltage, isolated, between 12VDC and 24VDC, (fig. 11.2-II)

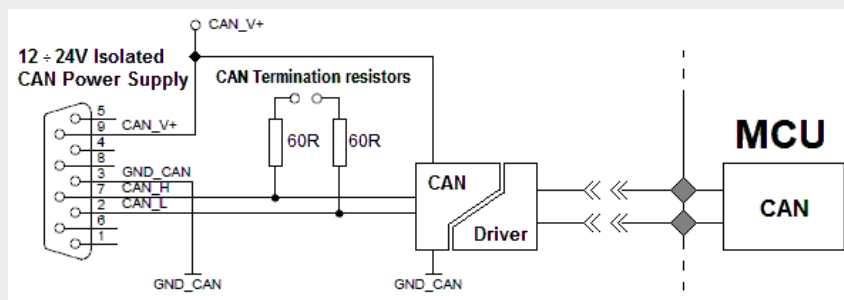


fig. 11.2-A: Functional diagram of the CANBus connection



CANBus connection requires proper line termination; if the female SUB-D9 connector of the CAN connection cable in use does not have a built-in termination resistor (fig. 12.2-II), it is possible to use the one already provided on the board by insertion of the CAN TERM jumper on the board.

The PGNs effectively published by each device are outlined in table 11.2-III

PGN #	Description	Mnemonic	Ref. Std.	M2K^S	M3K^S	M3K^{SHD}
64934	AVR EXCITATION STATUS	VREP	J1939-75	•	•	•
65021	PHASE C (W) BASIC AC	GPCAC	J1939-75		•	•
65024	PHASE B (V) BASIC AC	GPBAC	J1939-75		•	•
65025	PHASE A (U) AC REACTIVE POWER	GPAACR	J1939-75		•	•
65026	PHASE A (U) AC POWER	GPAACP	J1939-75		•	•
65027	PHASE A (U) BASIC AC	GPAAC	J1939-75	•	•	•
65028	TOTAL AC REACTIVE POWER	GTACR	J1939-75		•	•
65029	TOTAL AC POWER	GTACP	J1939-75		•	•
65030	AVERAGE BASIC AC	GAAC	J1939-75		•	•
65226	ACTIVE DIAGNOSTIC MESSAGE	DM1	J1939-73	•	•	•
61184	REAL TIME CONTROLS	RTC	PROPRIETARY	•	•	•
65281	ALARMS		PROPRIETARY	•	•	•
65283	STATUS		PROPRIETARY	•	•	•
65287	AUXILIARY BASIC AC	GAUXAC	PROPRIETARY	•	•	•
65312	CONFIGURABLE DATA		PROPRIETARY	•	•	•
1639378	READ VALUE		PROPRIETARY	•	•	•
1642706	PEER TO PEER WRITE PARAMETER		PROPRIETARY	•	•	•
1700050	BROADCAST WRITE PARAMETER		PROPRIETARY	•	•	•

tab. 11.2-III: Outline of the published messages

With a proper field format (compliant with SAE J1939) Meccalte specific parameter groups are supported even if they do not appear in the indicated standard. All **MxK** parameters can be read and written.

The specific protocol is encapsulated inside the CAN frame in accordance to the standard and specific content of the recommended usage procedures appearing in the standard.

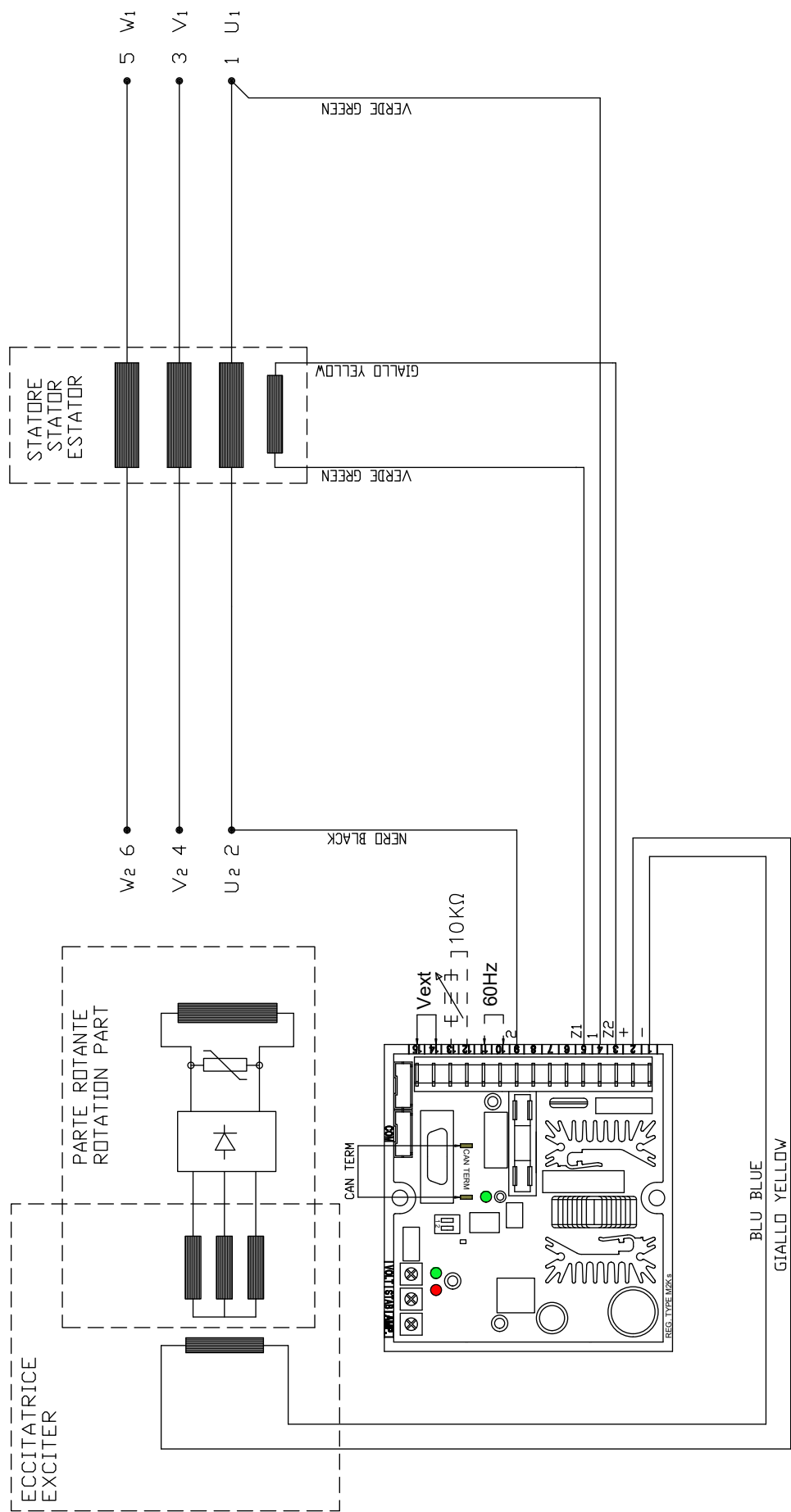
The definitions of the proprietary messages, divided into functional groups, are:

- Proprietary Broadcast: PGN65281, PGN65283, PGN65287, PGN65312
- Proprietary Destination Specific Messages: PGN61184
- Proprietary Commands and Requests: PGN1639378, PGN1642706, PGN1700050

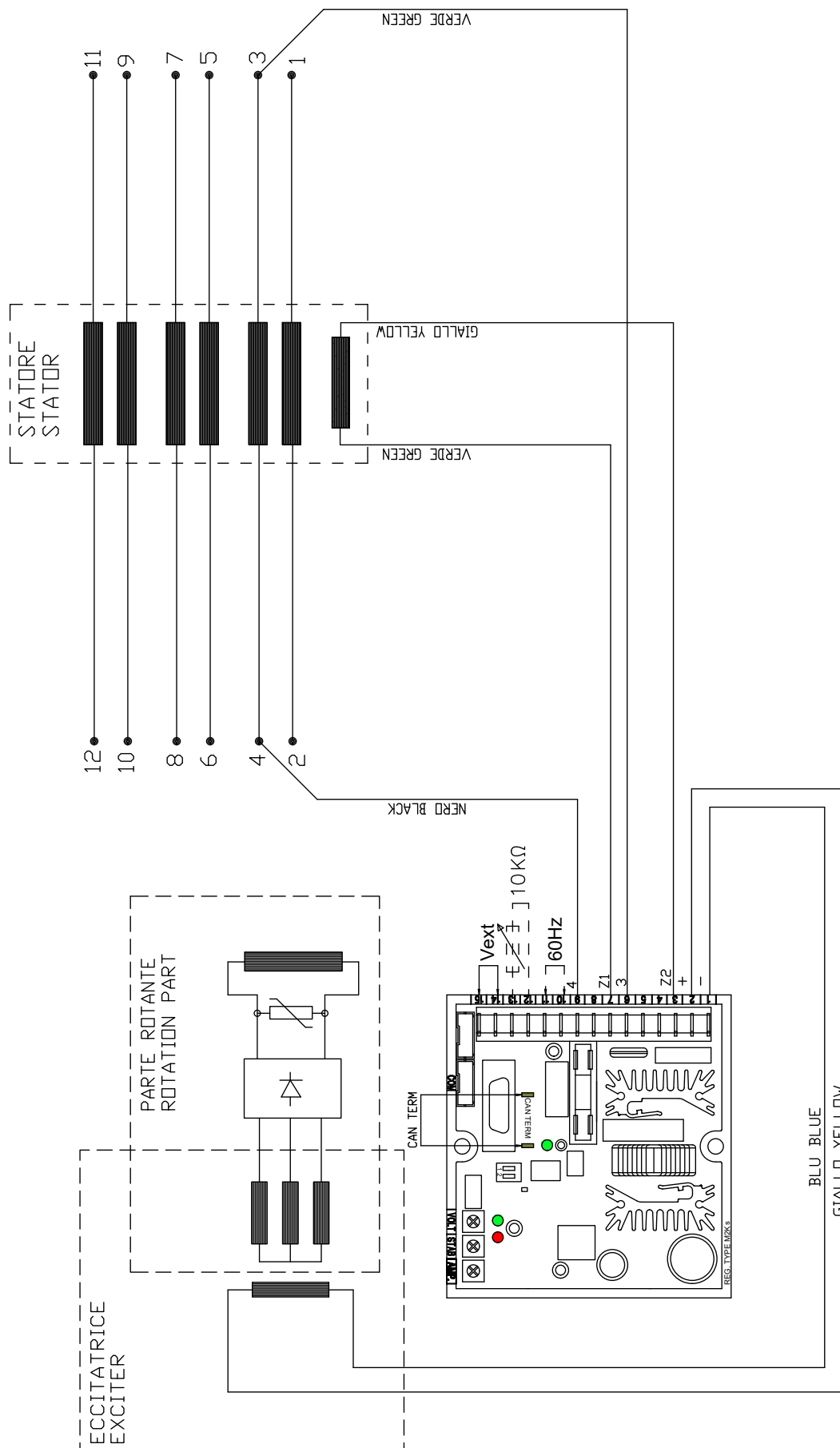
12 ELECTRIC SCHEME

Type of regulator	Description	Phase	Leads	N. drawing
M2K M2K^S	single phase sensing from 150V (series ECP 3/4)	3	6	SCC03022
M2K M2K^S	single phase sensing from 55V to 150V (series ECP 3/4)	3	12	SCC03024
M2K M2K^S	single phase sensing from 150V	3	6	SCC03028
M2K M2K^S	single phase sensing from 55V to 150V	3	12	SCC03029
M2K M2K^S	single phase sensing from 150V to 405V	3	12	SCC03031
M2K M2K^S	single phase sensing from 150V to 405V (series star/delta)	3	12	SCC03030
M3K M3K^S M3K^{SHD}	three phase sensing from 55V to 150V	3	12	SCC03036
M3K M3K^S M3K^{SHD}	three phase sensing from 150V to 405V	3	12	SCC03037
M3K M3K^S M3K^{SHD}	single phase sensing from 55V to 150V	3	12	SCC03038
M3K M3K^S M3K^{SHD}	single phase sensing from 150V to 405V	3	12	SCC03039
M3K M3K^S M3K^{SHD}	three phase sensing from 150V to 405V (series star)	3	12	SCC03042
M3K M3K^S M3K^{SHD}	single phase sensing from 150V to 405V (series star)	3	12	SCC03043

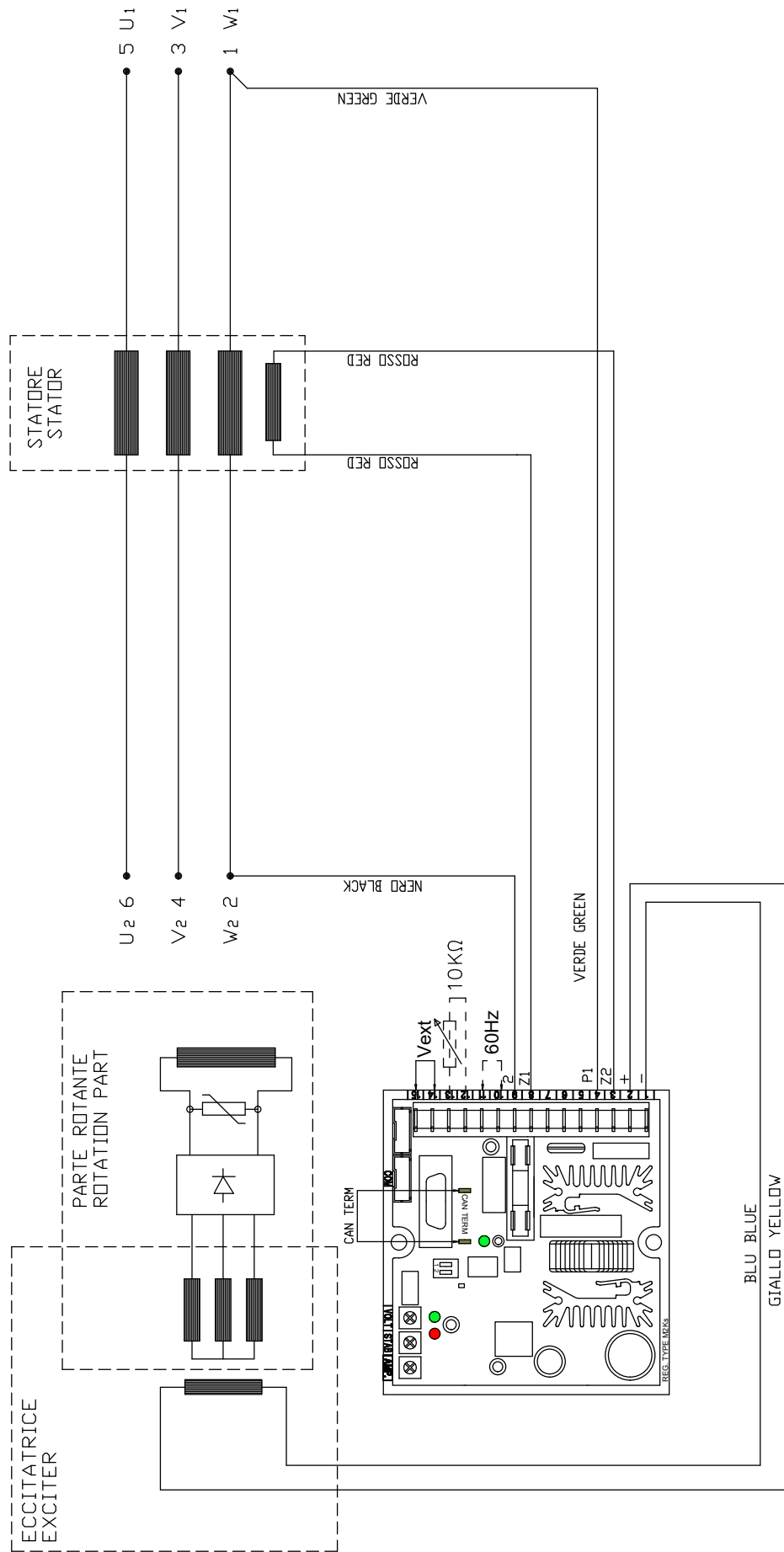
12.1 SCC03022: Sensing from 150V (M2K, M2K[®])



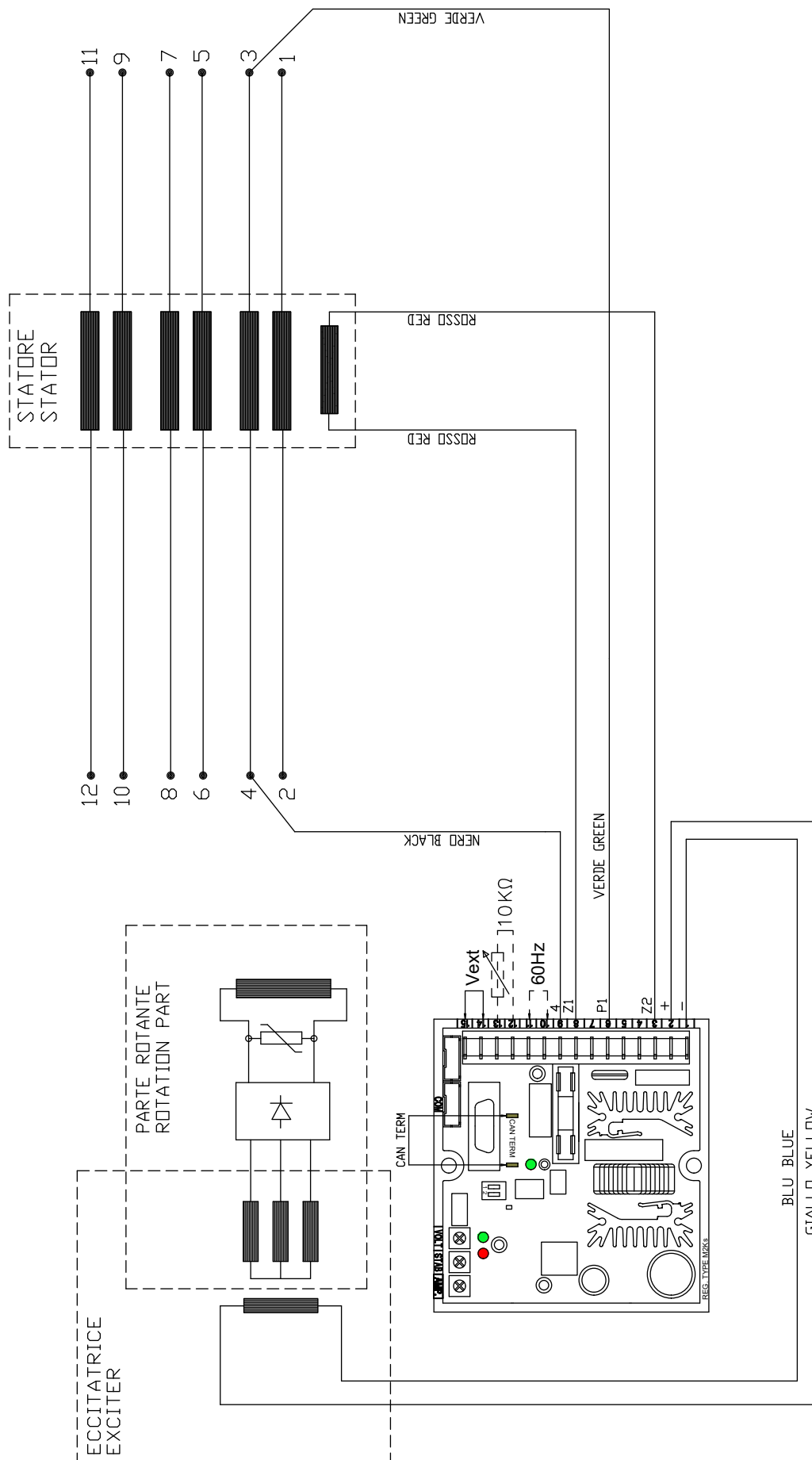
12.2 SCC03024: Sensing from 55V to 150V (M2K, M2K^B)



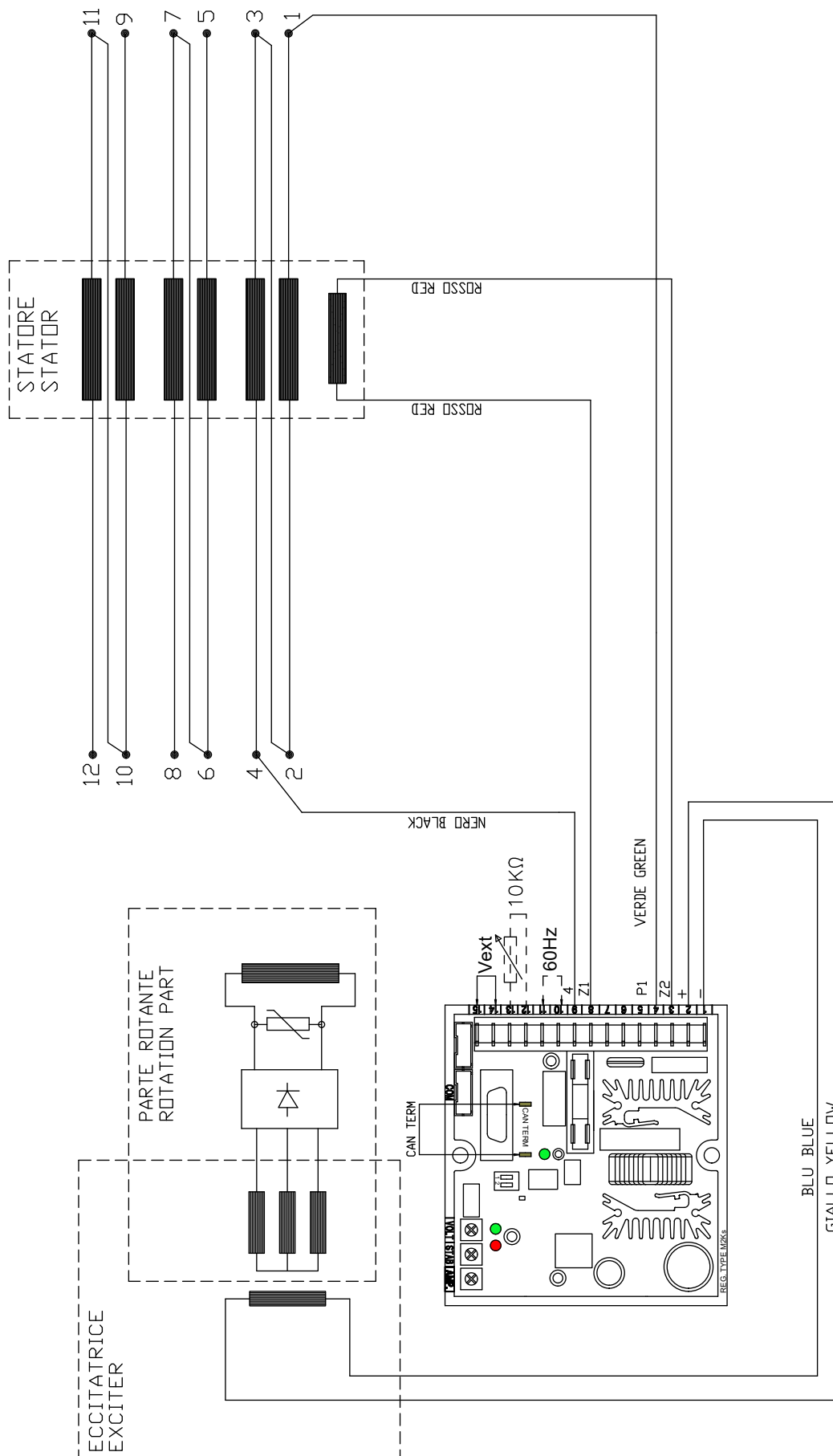
12.3 SCC03028: Sensing from 150V (M2K, M2K[®])



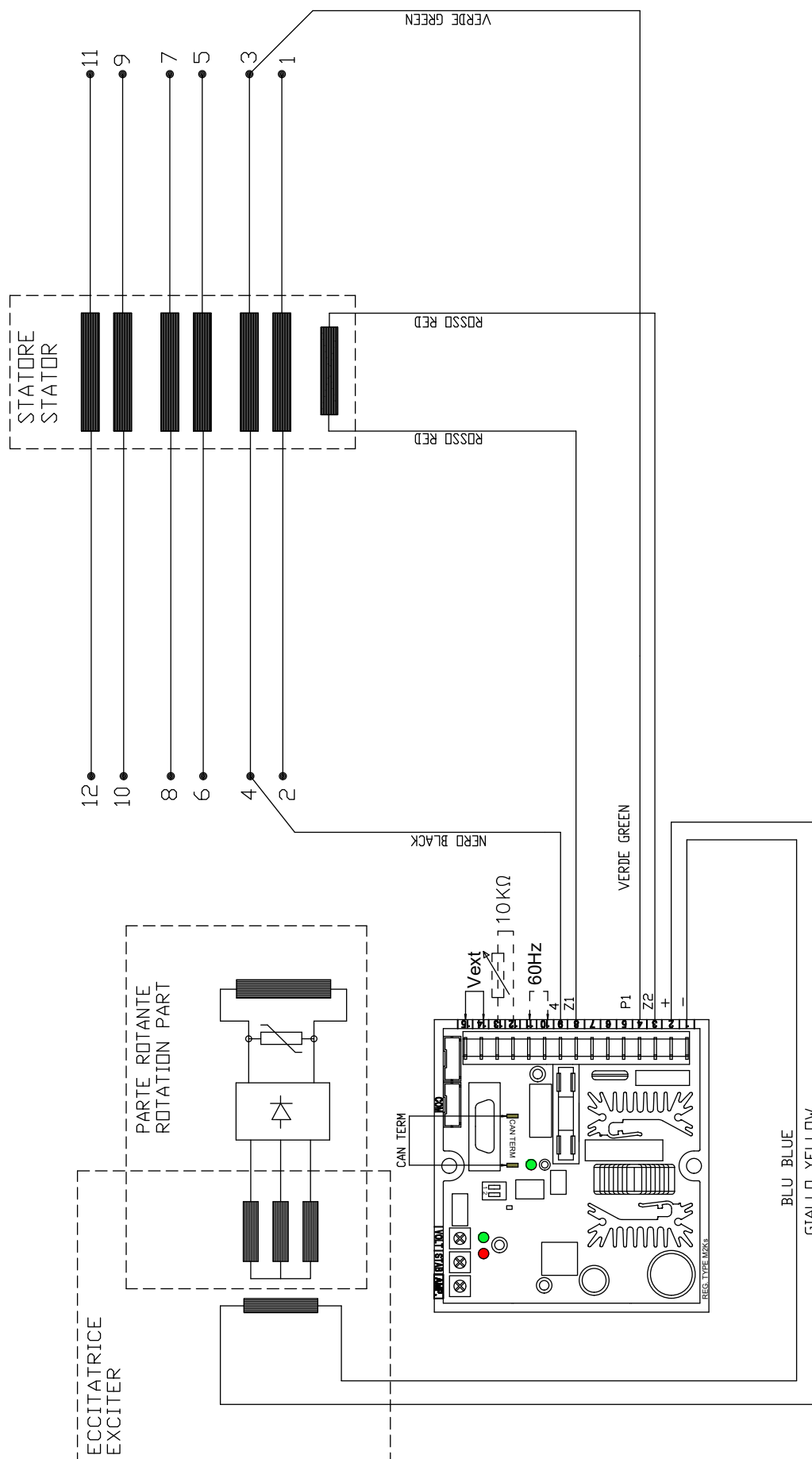
12.4 SCC03029: Sensing from 55V to 150V (M2K, M2K^B)



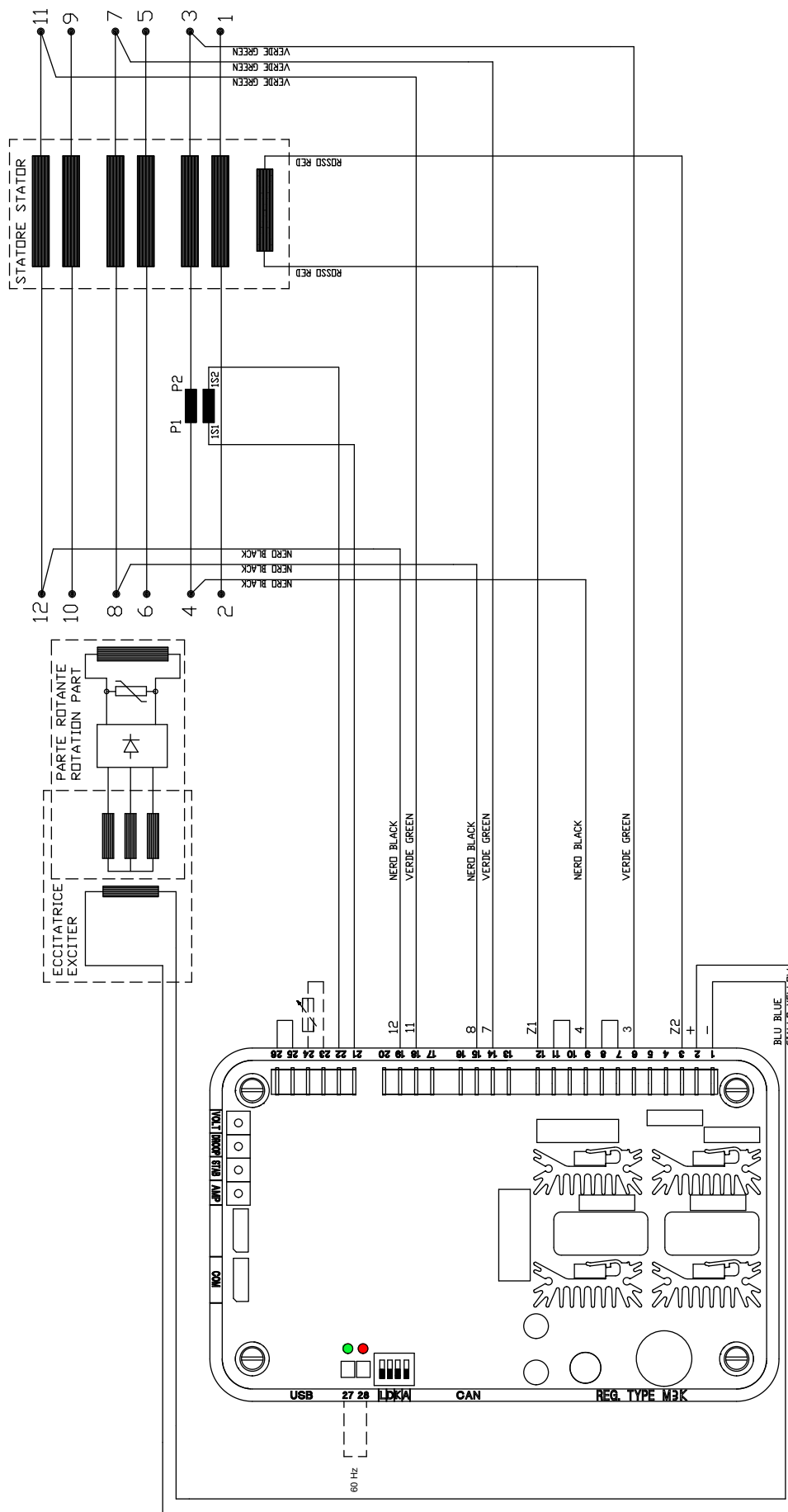
12.5 SCC03030: Sensing from 150V to 405V - Serie Star/Delta (M2K, M2K^B)



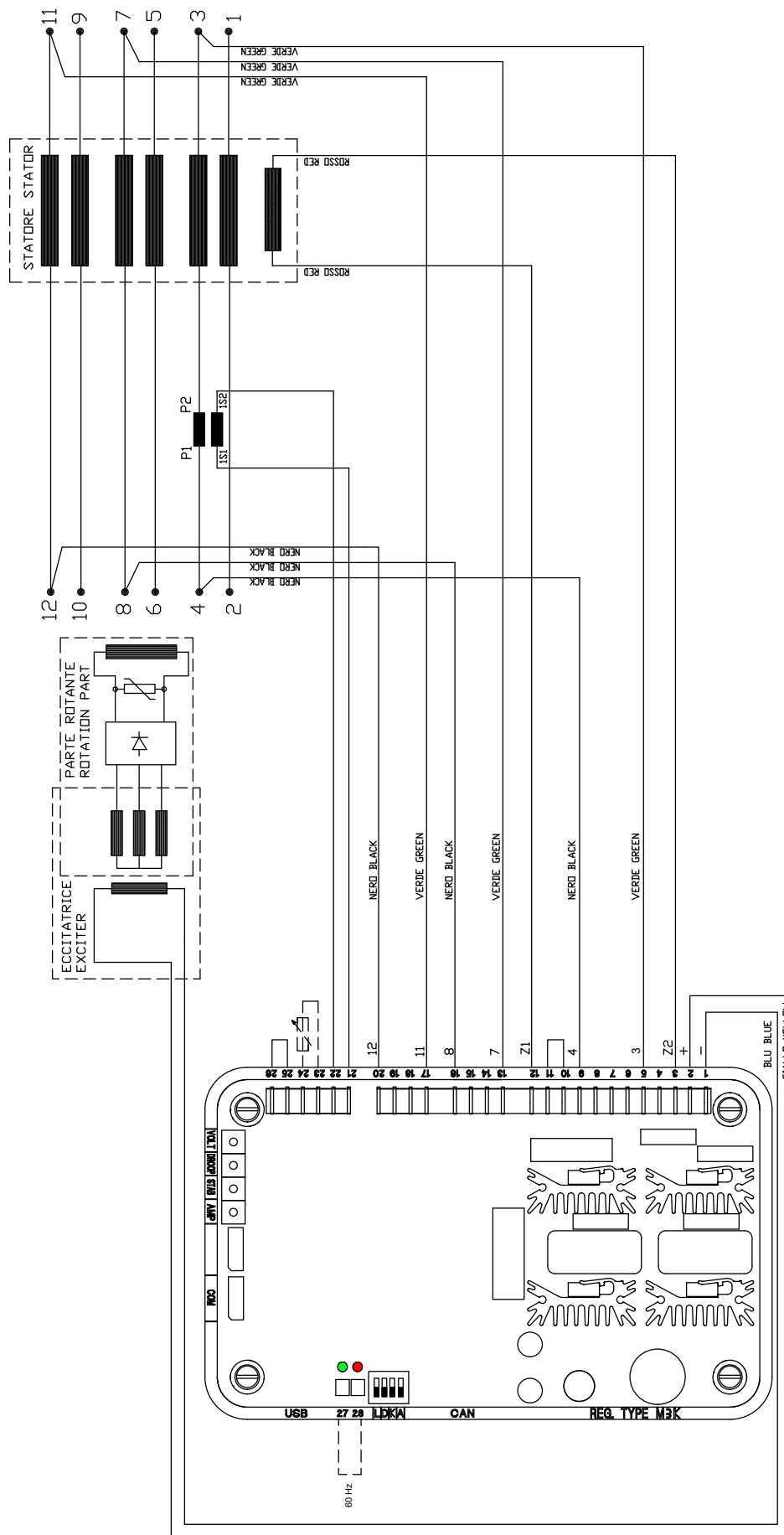
12.6 SCC03031: Sensing from 150V to 405V (M2K, M2K^S)



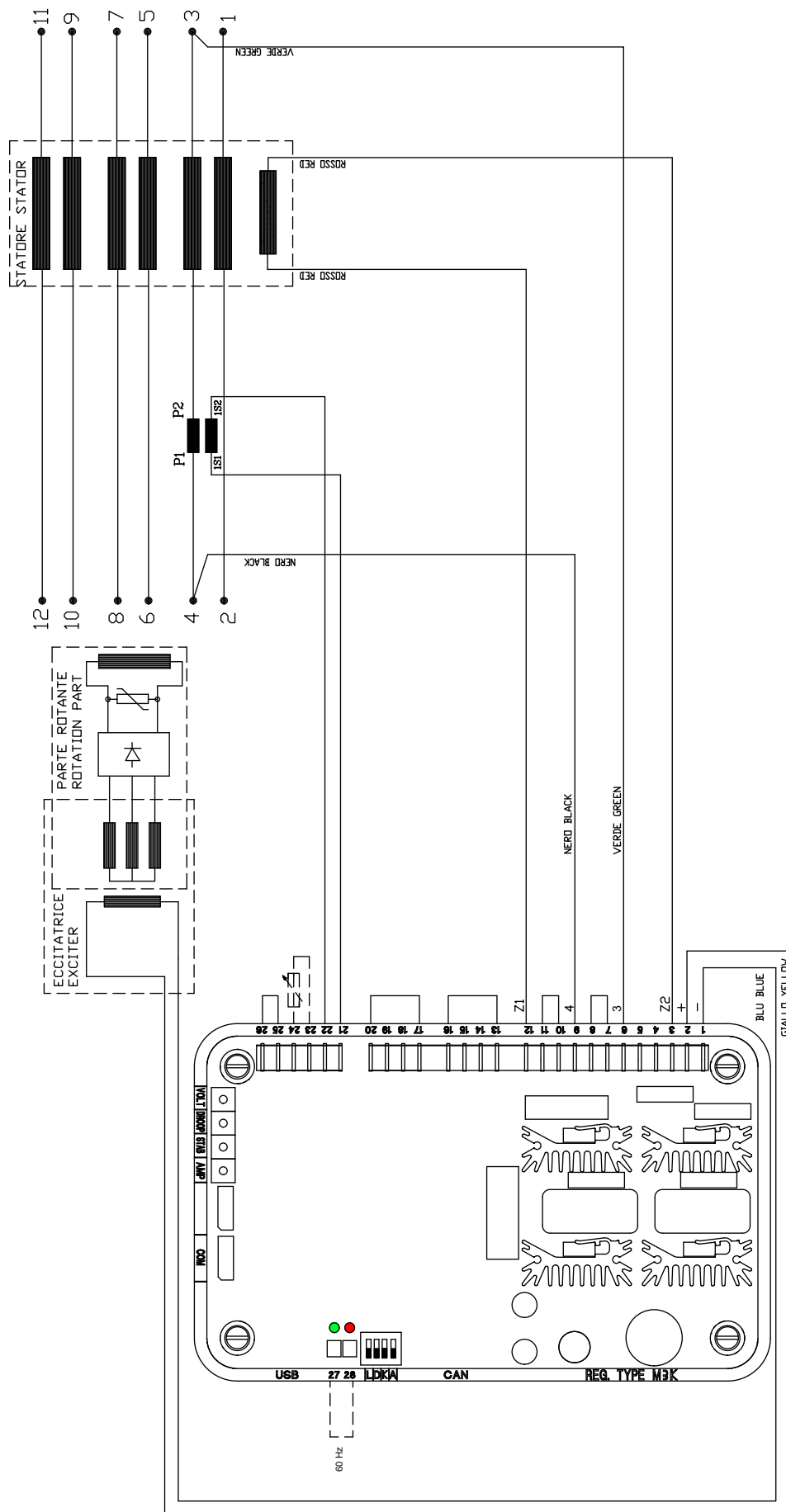
12.7 SCC03036: Sensing three-phase from 55V to 150V (M3K, M3K^B and M3K^{SHD})



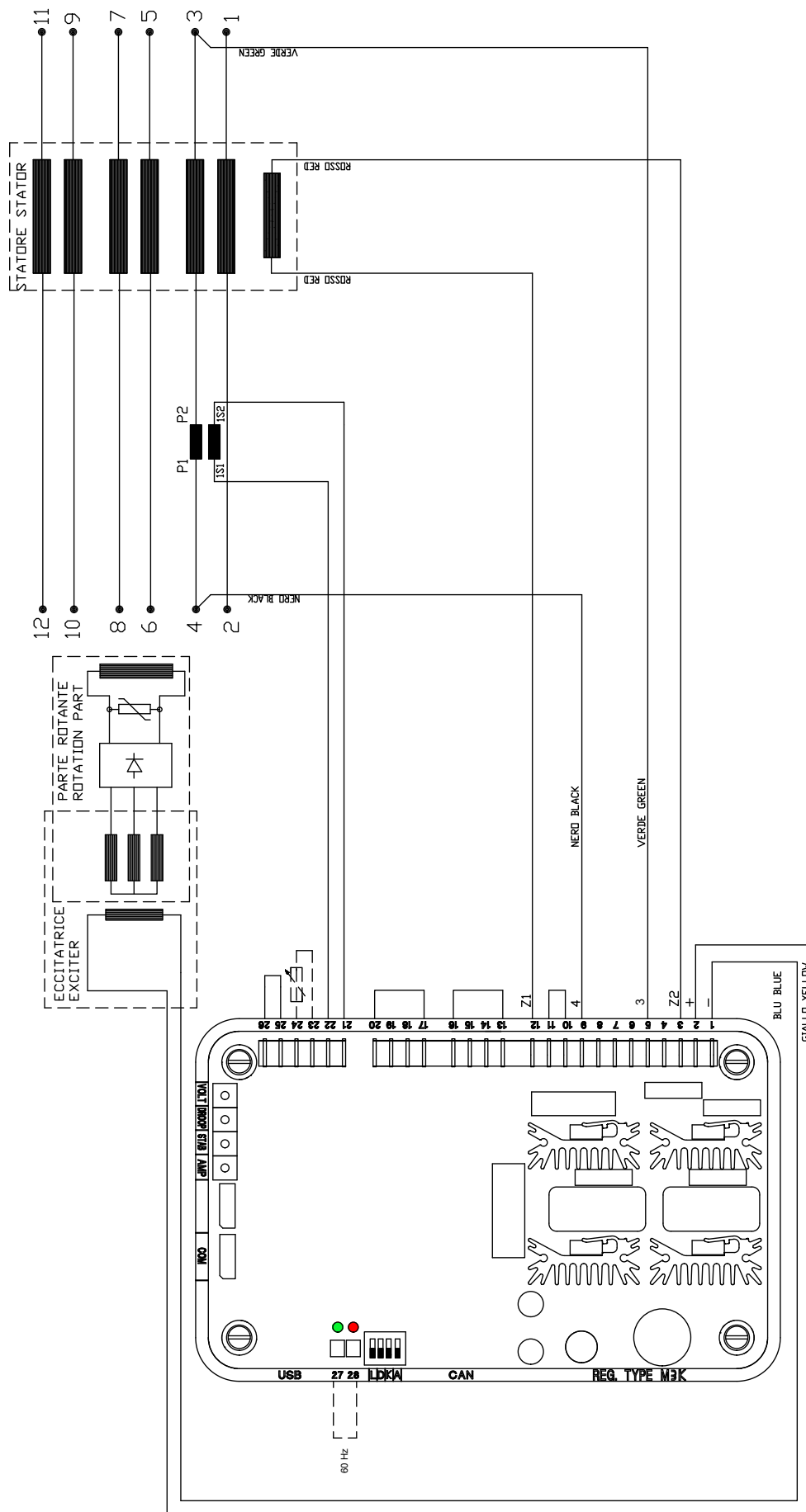
12.8 SCC03037: Sensing three-phase from 150V to 405V (M3K, M3K^B and M3K^{SHD})



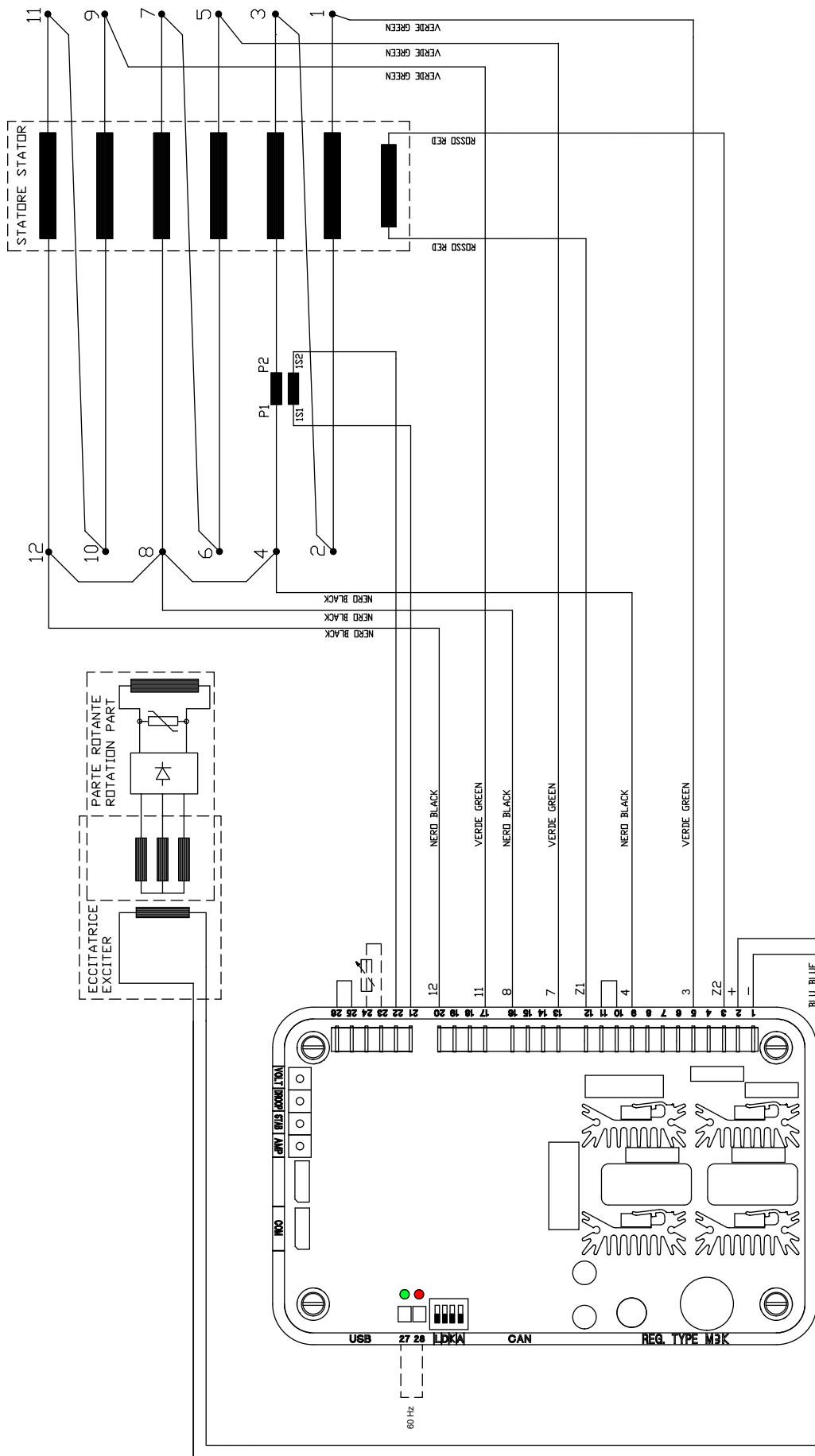
12.9 SCC03038: Sensing single-phase from 55V to 150V (**M3K**, **M3K^S** and **M3K^{SHD}**)



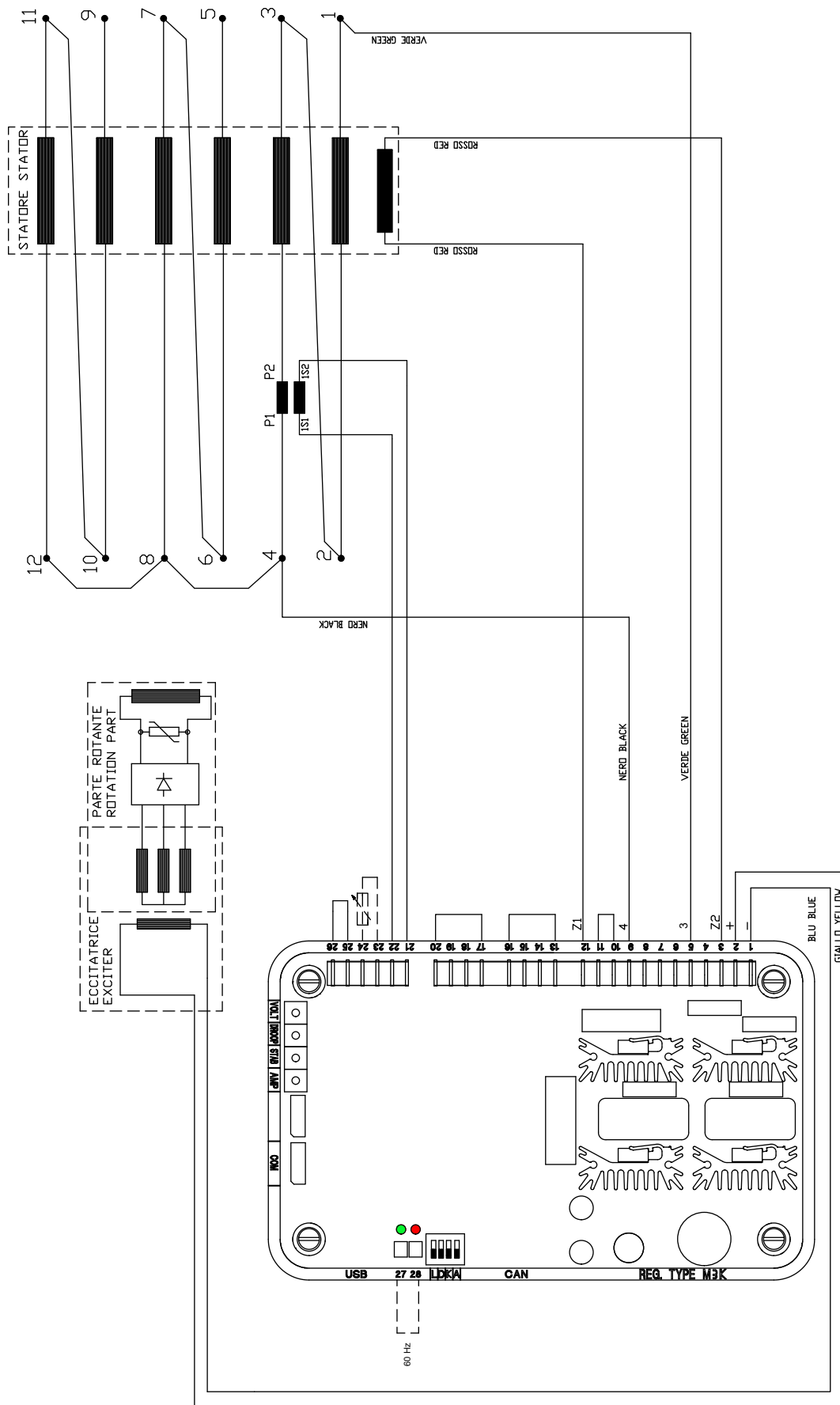
12.10 SCC03039: Sensing single-phase from 150V to 405V (M3K, M3K^B and M3K^{SHD})



12.11 SCC03042: Sensing three-phase from 150V to 405V - Serie Star (**M3K**, **M3K^B** and **M3K^{SHD}**)



12.12 SCC03043: Sensing single-phase from 150V to 405V - Serie Star (**M3K**, **M3K^S** and **M3K^{SHD}**)



REVISION		
Revision	Date	Description
00	04/23	Initial Release
01	05/23	Minor update
02	10/23	Text corrections, autotuning table modified, electrical scheme table and minor updates

MECC ALTE SPA (HQ)

Via Roma
20 - 36051 Creazzo
Vicenza - ITALY

T: +39 0444 396111
F: +39 0444 396166
E: info@meccalte.it
aftersales@meccalte.it

MECC ALTE PORTABLE

Via A. Volta
137038 Soave
Verona - ITALY

T: +39 0456 173411
F: +39 0456 101880
E: info@meccalte.it
aftersales@meccalte.it

MECC ALTE POWER PRODUCTS

Via Melaro
2 - 36075 Montecchio
Maggiore (VI) - ITALY

T: +39 0444 1831295
F: +39 0444 1831306
E: info@meccalte.it
aftersales@meccalte.it

ZANARDI ALTERNATORI

Via Dei Laghi
48/B - 36077 Altavilla
Vicenza - ITALY

T: +39 0444 370799
F: +39 0444 370330
E: info@zanardialternatori.it

UNITED KINGDOM

Mecc Alte U.K. LTD
6 Lands' End Way
Oakham
Rutland LE15 6RF

T: +44 (0) 1572 771160
F: +44 (0) 1572 771161
E: info@meccalte.co.uk
aftersales@meccalte.co.uk

SPAIN

Mecc Alte España S.A.
C/ Rio Taibilla, 2
Polig. Ind. Los Valeros
03178 Benijofar (Alicante)

T: +34 (0) 96 6702152
F: +34 (0) 96 6700103
E: info@meccalte.es
aftersales@meccalte.es

CHINA

Mecc Alte Alternator Haimen LTD
755 Nanhai East Rd
Jiangsu HEDZ 226100 PRC

T: +86 (0) 513 82325758
F: +86 (0) 513 82325768
E: info@meccalte.cn
aftersales@meccalte.cn

INDIA

Mecc Alte India PVT LTD
Plot NO: 1, Sanaswadi
Talegaon
Dhamdhare Road Taluka:
Shirur, District:
Pune - 412208
Maharashtra, India

T: +91 2137 673200
F: +91 2137 673299
E: info@meccalte.in
aftersales@meccalte.in

U.S.A. AND CANADA

Mecc Alte Inc.
1229 Adams Drive
McHenry, IL, 60051

T: +1 815 344 0530
F: +1 815 344 0535
E: info@meccalte.us
aftersales@meccalte.us

GERMANY

Mecc Alte Generatoren GmbH
Ensener Weg 21
D-51149 Köln

T: +49 (0) 2203 60541-0
F: +49 (0) 2203 60541-49
E: info@meccalte.de
aftersales@meccalte.de

AUSTRALIA

Mecc Alte Alternators PTY LTD
10 Duncan Road, PO Box 1046
Dry Creek, 5094, South
Australia

T: +61 (0) 8 8349 8422
F: +61 (0) 8 8349 8455
E: info@meccalte.com.au
aftersales@meccalte.com.au

FRANCE

Mecc Alte International S.A.
Z.E. la Gagnerie
16330 St. Amant de Boixe

T: +33 (0) 545 397562
F: +33 (0) 545 398820
E: info@meccalte.fr
aftersales@meccalte.fr

FAR EAST

Mecc Alte (F.E.) PTE LTD
10V Enterprise Road, Enterprise 10
Singapore 627679

T: +65 62 657122
F: +65 62 653991
E: info@meccalte.com.sg
aftersales@meccalte.com.sg



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