POWER FROM WITHIN

MxK DIGITAL REGULATORS

TECHNICAL GUIDE

GUIDA TECNICA
REGOLATORI DIGITALI MxK

1 INTRODUCTION

This technical guide provides information on how the **M2K**, **M2K^{S}**, **M3K**, **M3K^{S}** and **M3K$^{S HD}$**, 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$^{S HD}$
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
Potentiomenters	(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)	MxKonnect	MxKonnect	MxKonnect	MxKonnect	MxKonnect
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 MxKonnect; 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 MxKonnect; 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 MxKonnect is needed USB cable (male type A - male type A) or Kit consisting of MxKonnect 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

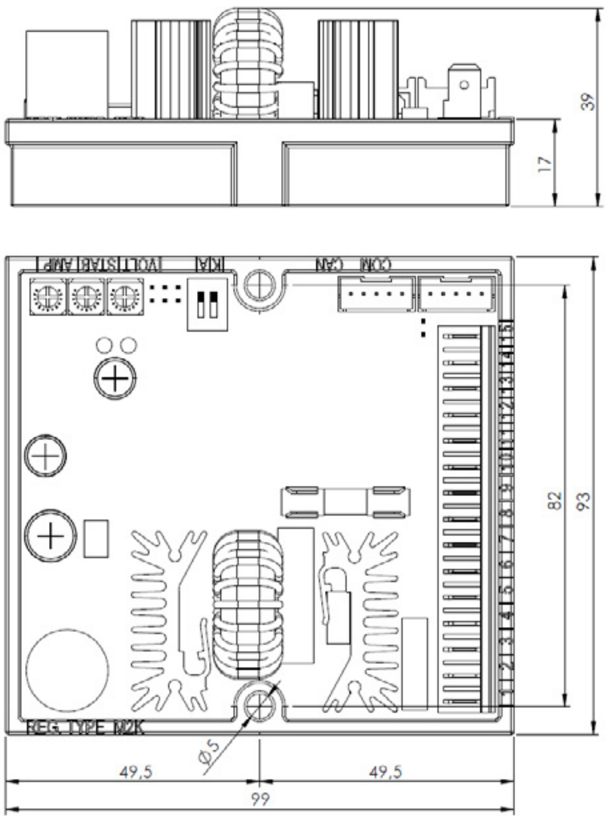
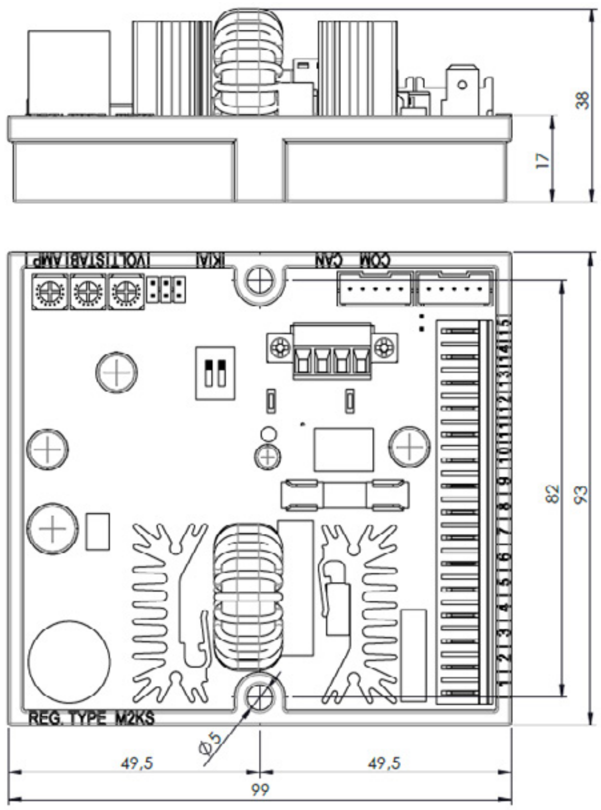
Main Features	M2K	M2K^S	M3K	M3K^S	M3K^S HD
Sensing range: 55÷150V or 150÷405V	●	●	●	●	●
Three phase sensing			●	●	●
2 separate inputs for Potentiometer and DC Voltage (±10V)	●	●	●	●	●
Adjustable stability (by trimmer STAB or parameter settings)	●	●	●	●	●
Self stability setting by adaptive algorithm (auto 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

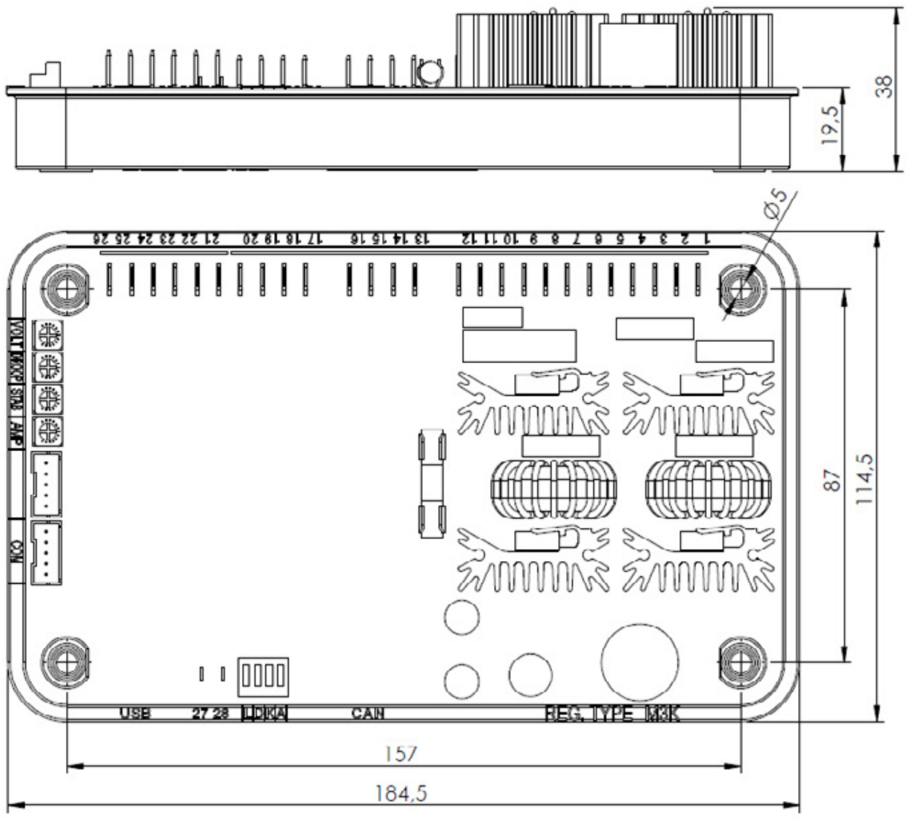
2.3 Maximum Rating

- 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)

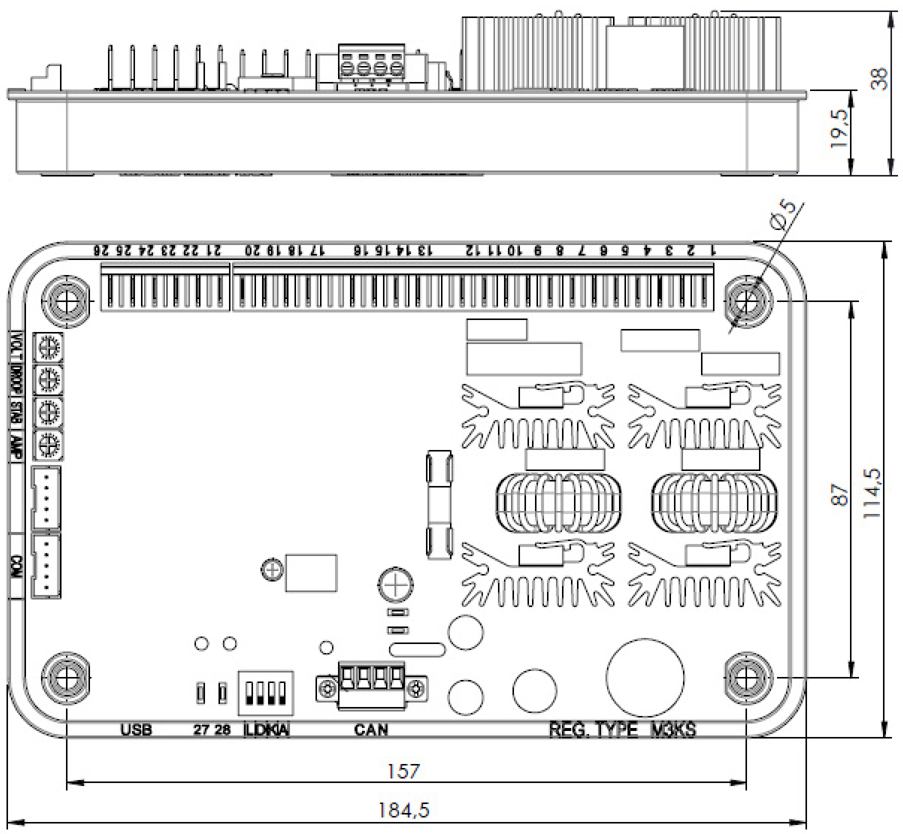
2.4 Overall Dimensions

M2K	M2K^S
	

M3K


38
19,5
Ø5
87
114,5
157
184,5
VOLT
DROOP
STAB
AMP
COM
USB
27 28
LDKA
CAN
REG. TYPE M3K

M3KS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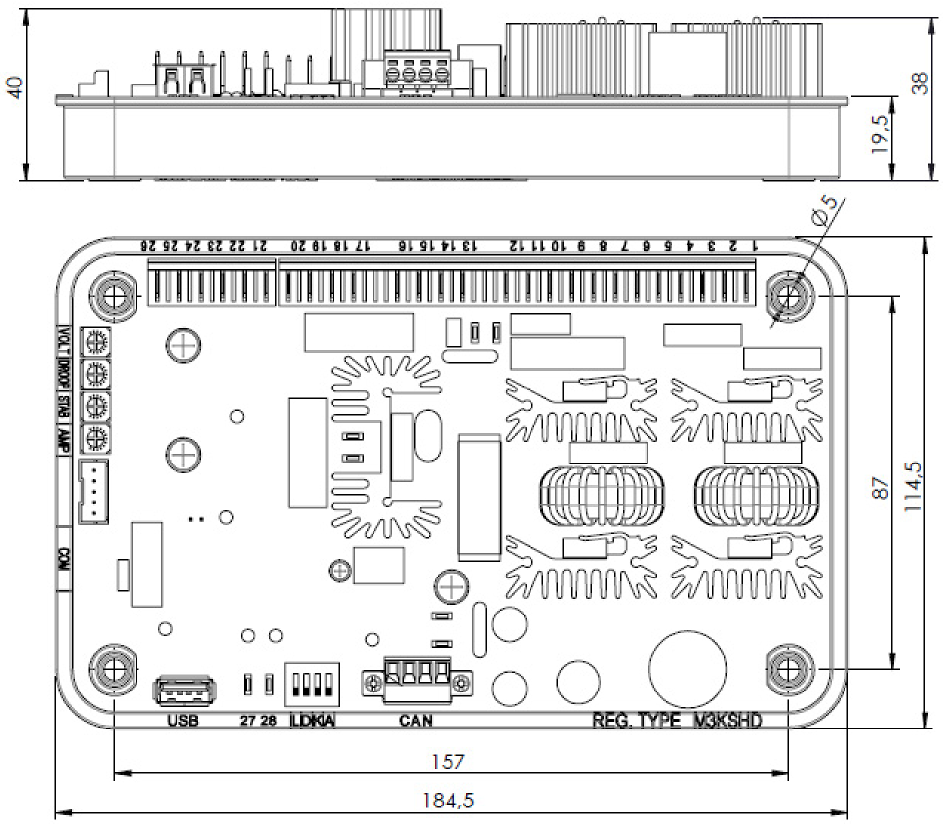
LDKA
CAN
REG. TYPE M3KS

M3K^SHD



2.5 Inputs and Outputs: technical specifications

M2K M2K^S

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^S M3K^SHD

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-differential 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 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 voltge levels, and similarly the relative measurements, refer to the previously mentioned size expressed in VOLTS.

M2K M2K[S]

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[S] 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 B_3, B_4 and B_5 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, **AUTUNEdone**=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_SnsgnVltgSetpt**	Float			[V]
13	426	Sensing voltage (AVG value)	R	**MEC_SnsgnVltgRMS**	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_SnsgVltgRMS**=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

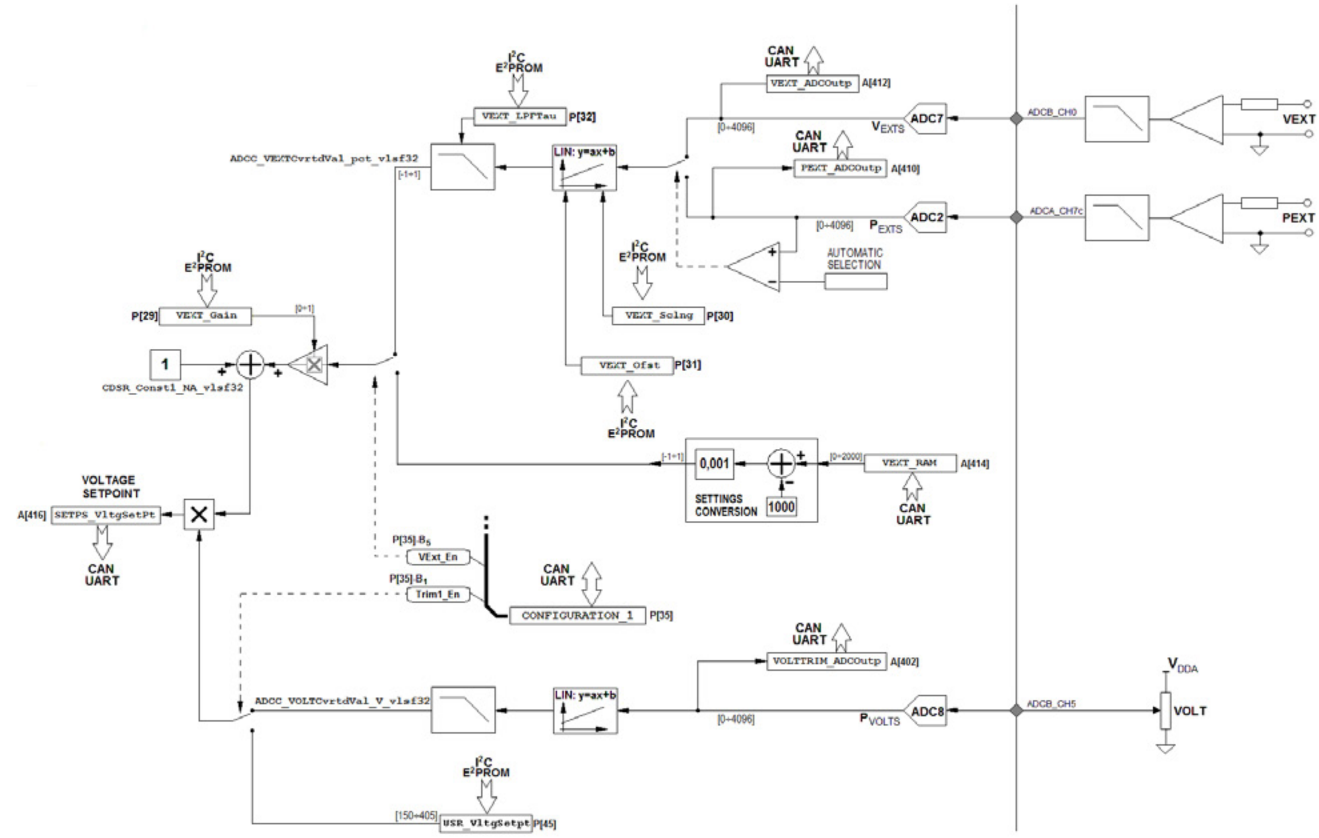


Fig. 3.3-A: MxK Voltage Setpoint

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] **VEXT_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] **VEXT_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.

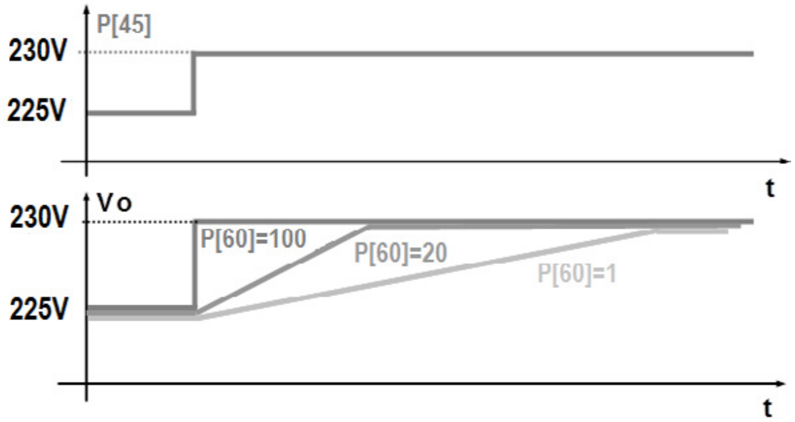


Fig. 3.3-B: MxK Slow voltage variations

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.

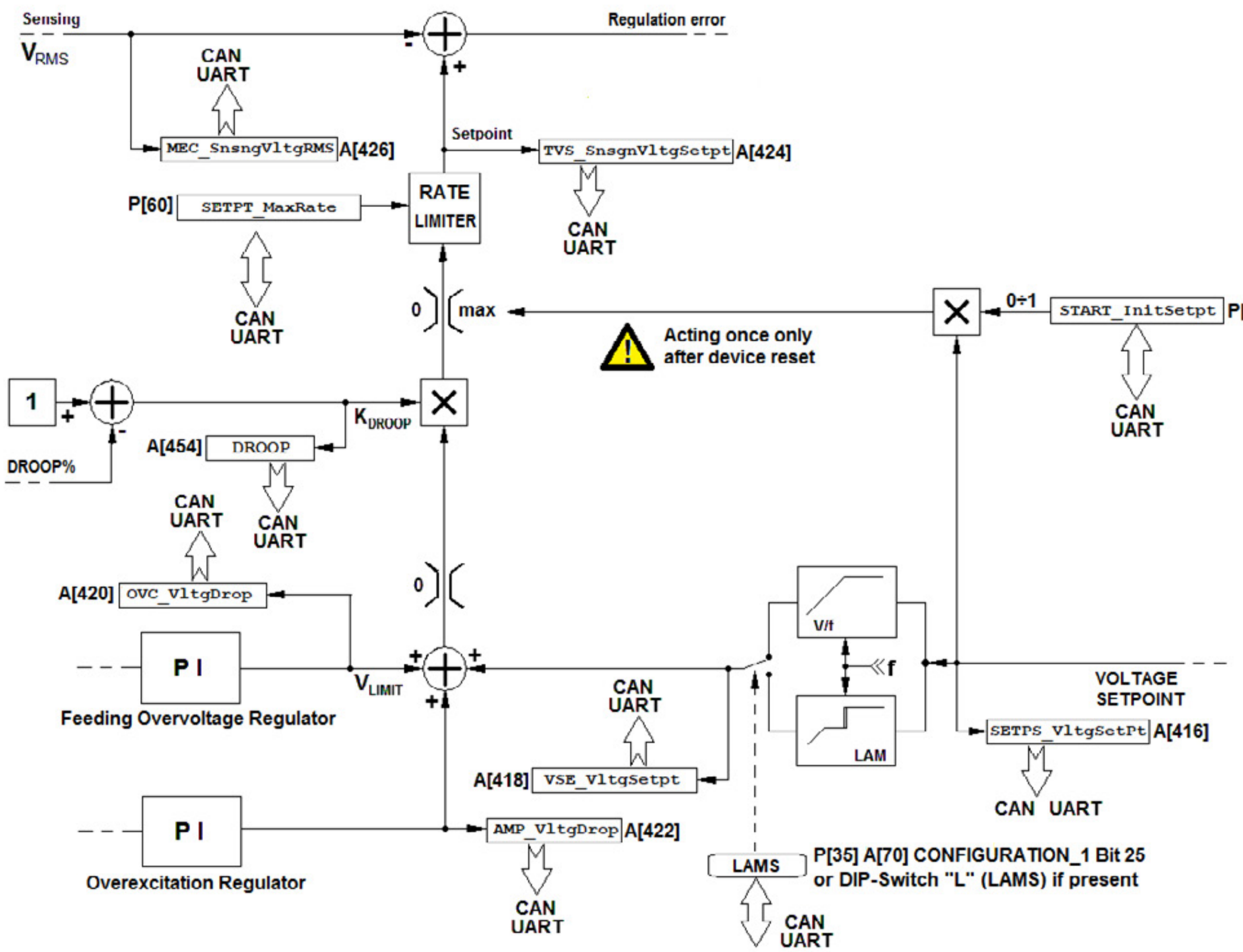


Fig. 3.3-C: MxK Setpoint Tree

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_SnsgnVltgSetpt**	Float			[V]
13	426	Sensing voltage (AVG value)	R	**MEC_SnsgnVltgRMS**	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, **AUTUNEdone**=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
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 Wieght	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,**M2KS**,**M3K**e**M3KS**: HDR inactive regardless of the value of B_{18}, P[44] has no effect (HDR not present);
M3KSHD: 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.

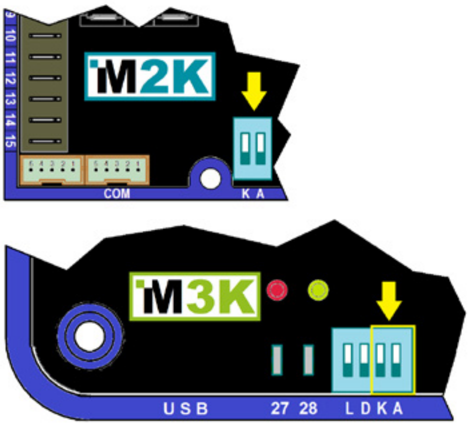


Fig. 5.3-A: Autotuning DIP Switches

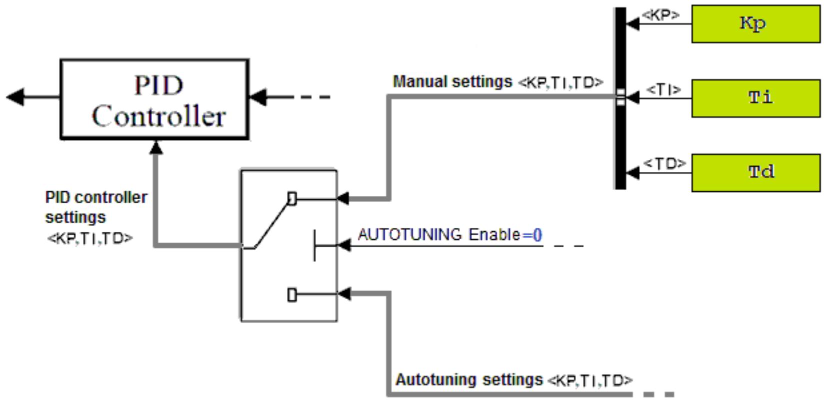


Fig. 5.3-B: P.I.D. Manual Settings

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.

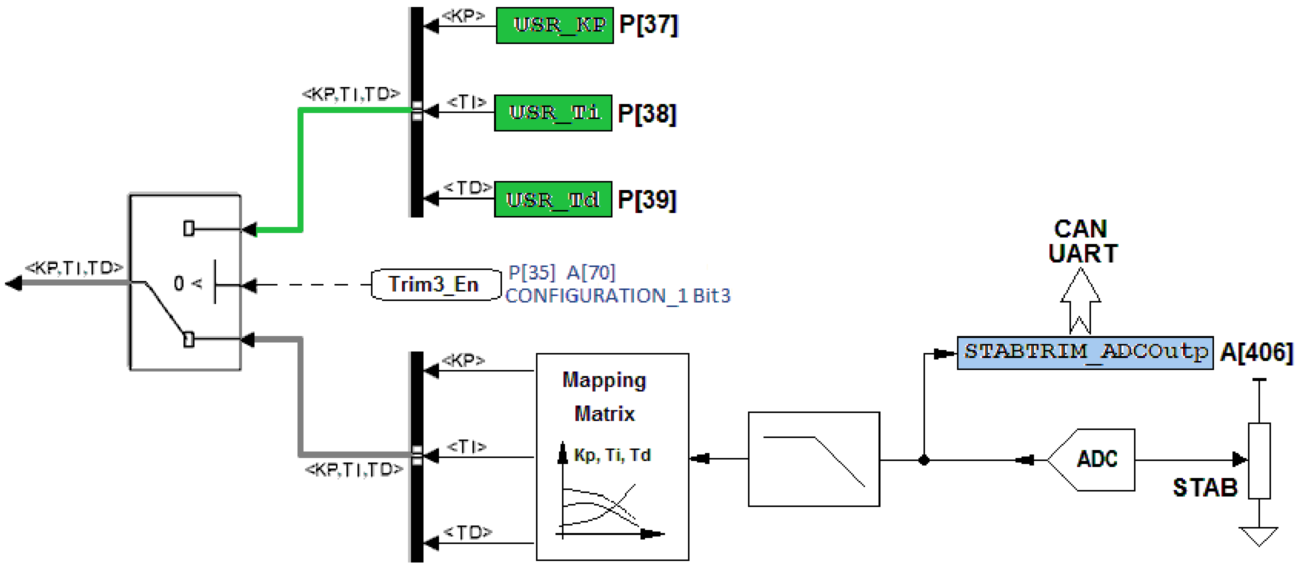


Fig. 5.3-C: Dynamic response settings selection

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 B_1, B_2 and B_3 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		**Gmd_K** (address A[478])			DIP Swiches selector (when enabled) (P[35] **CONFIGURATION_1** Bit B_{12}=1)		
	Description	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.

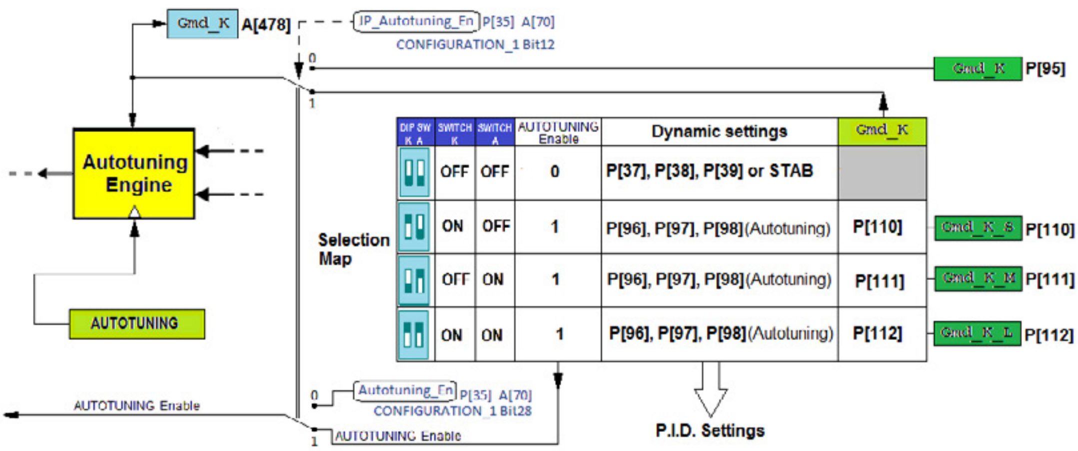


Fig. 5.4-A: Auto-tuning Selection scheme

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])
0	1		
1	0	Active, carried out (settings to be recalculated)	
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 B_1 and B_2 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 B_3 (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 B_3 (flag **ATUNEfreeze**) of parameter P[36] **CONFIGURATION_2** (address A[72]) is not considered
- A disturbance injection of undeterminated 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 B_1 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 B_2 of parameter P[36] **CONFIGURATION_2** (address A[72]) (**ATUNEdone**=1)

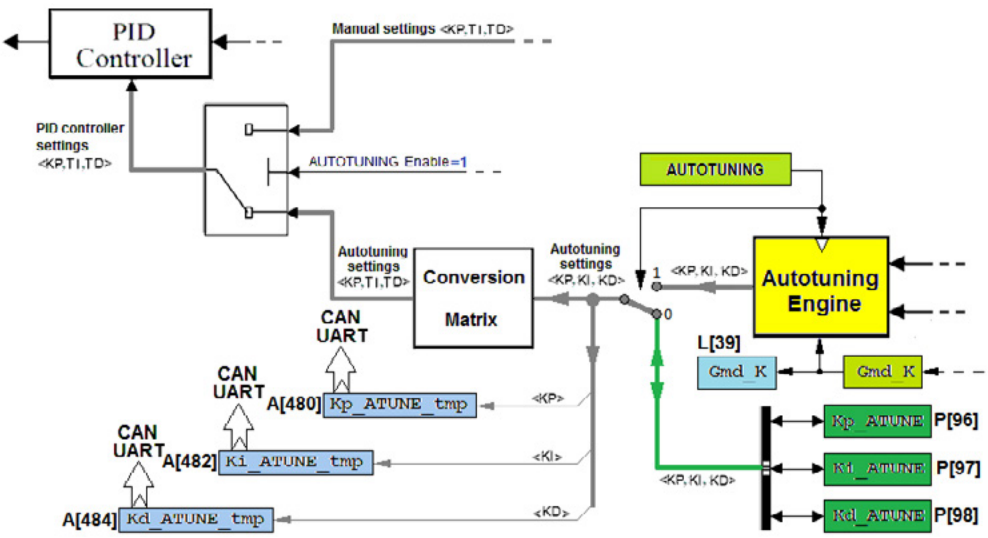


Fig. 5.5-A: Auto-tuning P.I.D. controller settings

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 B_3=1 (Trim3_En = 1)
- Auto-tuning enabled: P[35] Bit B_{28}=1 (Auto-tuning = 1)
- Enabling/disabling auto-tuning and **Gmd_K** selection from the combined DIP switches (K and A) P[35] Bit B_{12}=1 (**JP_Autotuning_En**=1, parameter P[95] **Gmd_K**, address A[190] disabled)
- Auto-tuning never carried out: P[36- B_3=0 (**ATUNEdone** = 0)
- Auto-tuning to be carried out at every start-up, P[36]-B_1 = 1 (**ATUNEonce** = 0)
- with automatic stop of the setting updates: P[36]-B_3 = 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> Autotuning menu, they are used to modify the related parameters & flags through a graphic interface.

6 HIGH DYNAMIC RESPONSE

M3K^SHD
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.

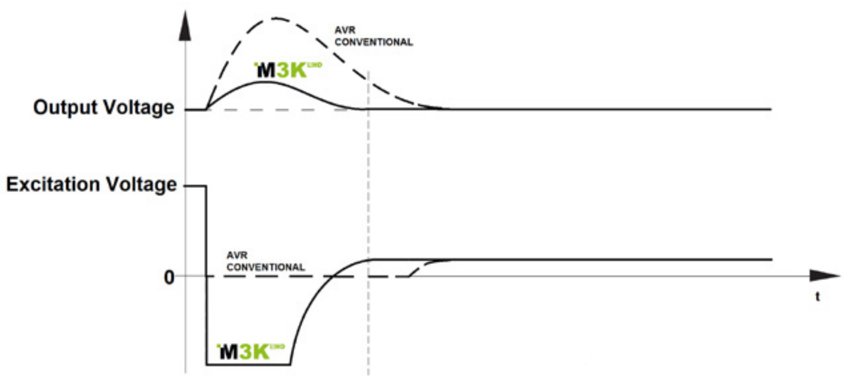


Fig. 6-A: Vo(t) and Vexc(t) trends of M3KS-HD and a regulator without Vexc inversion

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 (B_{18} = 1), to disable set B_{18} = 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^S M3K^SHD

#	Add.	Description	Parameter	Type	Default	Max.	Min.	Unit
23	46	Calibration of current channel (CT)	**PUC_ADCSclng**	Float	0,003798	500	0	NA
25	50	Current scaling for CAN	**CURR_CANSclng**	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	0,25	5	0	[A]

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

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

Bit	Dec. Weight	Hex Wieght	Mnemonic	Flag Description
B_{20}	1048576	0010 0000	DROP	Droop Active

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

NOTES [(1)]: see Chapter 8 "CONFIGURATIONS"

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. Cosφ 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.

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 correspon-ding measure is A[448] **ASC_PUCurrRMS** = 5A when the effective current of the shunt is I_2=5A_{rms} parameter P[23] **PUC_ADCSclng** (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 compen-sated by increasing the current channel gain using parameter P[23] **PUC_ADCSclng** so that the current at the secon-dary 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] lthe current of the secondary, without any compensation it would mean that

A[448] **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] **PUC_ADCSclng** = (5A / I_2[A]) * P[23] **PUC_ADCSclng**(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_CANSclng** (address A[50]) e P[55] **CT_RATIO** (address A[110])

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

P[25] **CURR_CANSclng** = 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] **CT_RATIO** * I_{mis}[A] = P[55] **CT_RATIO** * A[448] **ASC_PUcurrRMS** / P[25] **CURR_CANSclng**

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 B_{25}: **Leading or lagging current in relation to the voltage**:
Bit B_{25} = 0 lagging current = inductive load ($\varphi < 0$, Lagging)
Bit B_{25} = 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 cosφ is 1 or near to 1; to prevent inaccurate alarm signals there are two minimum thresholds for cosφ and current measurement:

- P[79] **COS_PHI_TH** sets the range around the unit value within which the value is measured as cosφ=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 cosφ=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 cosφ is represented as unity). By default, P[80] **I_MIN_TH** = 0,25 causes the current at the C.T. secondary to be estimated as not null (I2[A] ≠ 0) for values above 5% of its nominal value (0.25A 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.
A droop is activated by the DIP switch [D], if enabled, or with the corresponding flag **Droop_En** (P[35] **CONFIGURATION_1** Bit B_{26}); source selection depends on the configuration flag status **JP_Droop_En** (P[35] **CONFIGURATION_1** Bit B_{11}) cas 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 B_{20})
The setting of the droop extent is determined by the DROOP trimmer or by the corresponding parameter P[46] **USRDROOP_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 B_2) 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] **USRDROOP_VltgDrop** = 0 does not cause setpoint variations in relation to the current; trimmerfully clockwise or parameter P[46] **USRDROOP_VltgDrop** = 0,1 causes the nominal reactive current setpoint to vary by up to -10%.

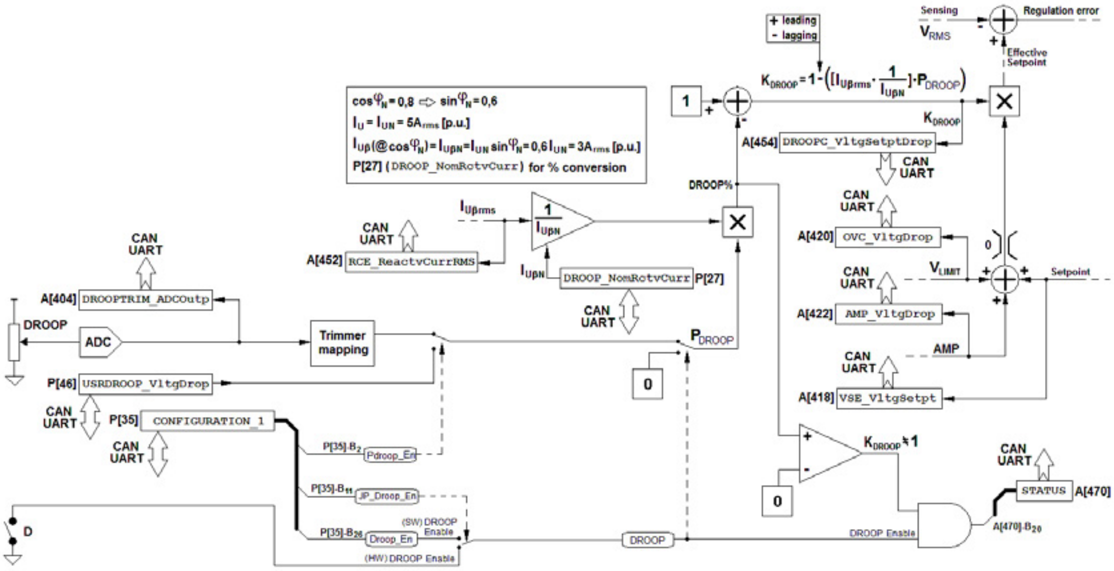


Fig. 7.4-A: Voltage DROOP diagram

The default settings are:

- Trimmer enabled (parameter P[46] disabled): (P[35] **CONFIGURATION_1** Bit B_2=1)
- Enabling/disabling with DIP switch [D]: (P[35] **CONFIGURATION_1** Bit B_{11}=1)
- flag (**JP_Droop_En**) configured for droop not active: (P[35] **CONFIGURATION_1** Bit B_{26}=0)
- parameter P[46] **USRDROOP_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_ADCSclng** 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 cosφ, 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:

a. For inductive loads where 0.8 < cosφ < 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 IR_{rms})
b. 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
c. 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

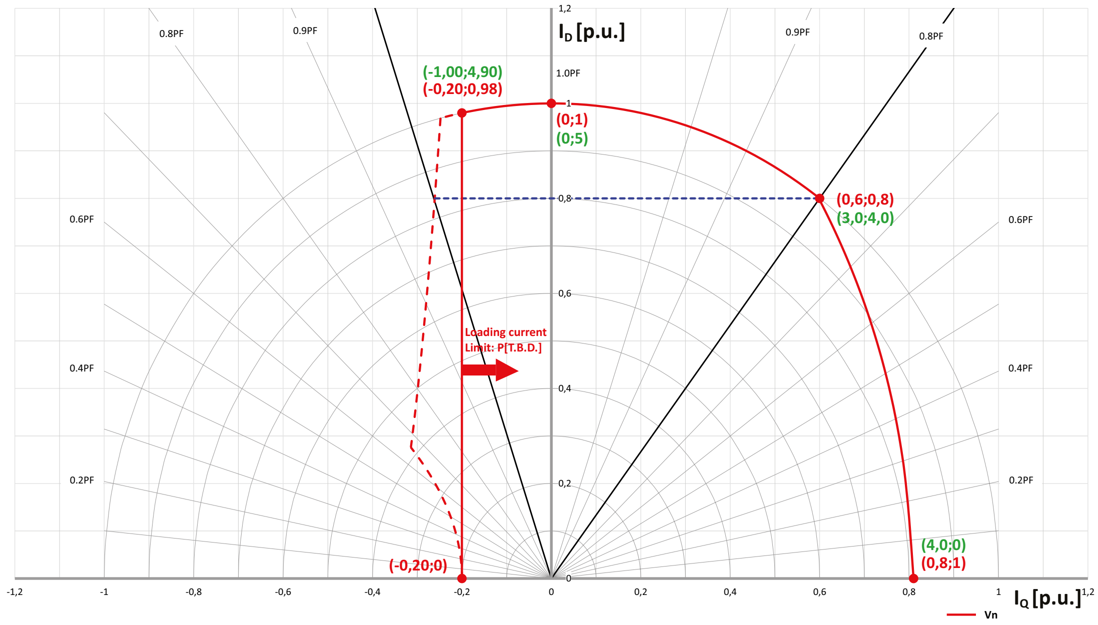


Fig. 7.5-A: Current limit point area

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^S	2417512638	Enabled	Disabled	Disabled	Disabled
M3K	270032062	Disabled	Disabled	Enabled	Enabled
M3K^S	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_T2SetlngTime	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^{S}**, : L.A.M.S. can only be activated settable by flag (there is no switch)
	M3K, **M3K^{S}** 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 Wieght	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^S

The nominal frequency setting depends on:
- the status of the 50/60 jumper (terminals 10 and 11), if enabled (P[35] **CONFIGURATION_1** Bit B_7=1)
- the status of the 50/60 setting (P[35] **CONFIGURATION_1** Bit B_{17}) if the jumper is disabled (P[35] **CONFIGURATION_1** Bit B_7=0)

M3K M3K^S M3K^SHD

- the status of the 50/60 jumper (terminals 27 and 28), if enabled (P[35] **CONFIGURATION_1** Bit B_7=1)
- the status of the 50/60 setting (P[35] **CONFIGURATION_1** Bit B_{17}) if the jumper is disabled (P[35] **CONFIGURATION_1** Bit B_7=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_O=K·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 B_{17}=0)
- 60·(1-P[64]) [Hz] if the nominal frequency is 60Hz (A[470] Bit B_{17}=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 ΔV%/Δf%, 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

				Minimum		Default		Maximum	
P[#]	A[#]	Parameter	Function	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 ΔV% / Δf%								
NOTE (B):	48,0Hz for settings: 50Hz and variable 40÷100Hz 57,6Hz for settings: 60Hz								
NOTE (C):	Slope defined as ΔV / Δf and expressed in [V/Hz]								

Tab. 9.2-I: Values for setting the voltage-frequency relationship

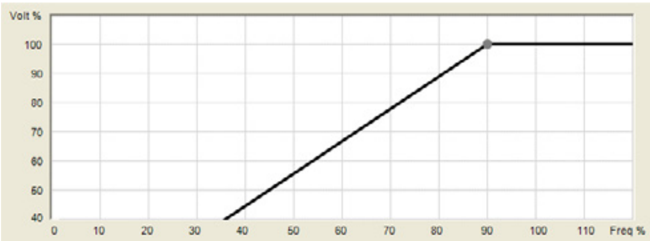


Fig.: 9.2-A: V/f connection with P[64]=0.1 and P[66]=1,1010
Threshold=90% Slope=5,128V/Hz

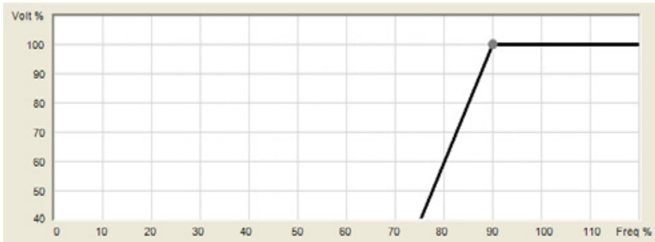


Fig.: 9.2-B: V/f connection with P[64]=0,1 and P[66]=3,9957
Threshold=90% Slope=18,46V/Hz

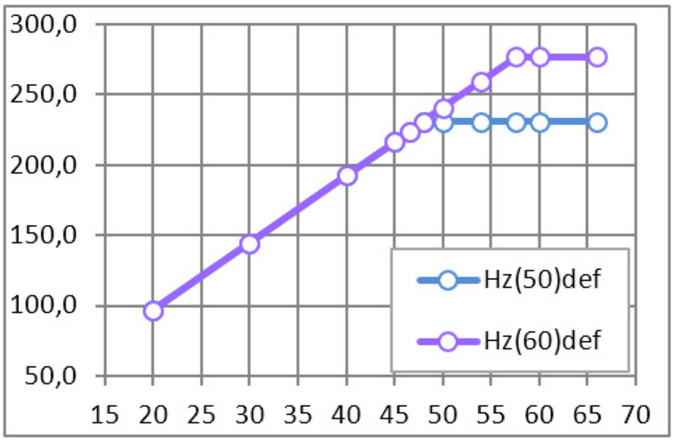


Fig.: 9.2-C: Default V/f connection P[64]=0,04 and P[66]=1,0379 (Threshold=96%fN, Slope=4,79V/Hz)

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 M2KS

The function only activates if the flag **LAMS** (P[35] **CONFIGURATION_1** Bit B_{25}=1) is set, under the condition that (P[35] **CONFIGURATION_1** Bit B_{10}=0) is enabled.
These devices do not have a DIP switch for L.A.M.S. activation [L]

M3K M3KS M3KSHD

The function is activated with the DIP switch [L], if enabled, or the corresponding flag **LAMS** (P[35] **CONFIGURATION_1** Bit B_{25}); source selection depends on the status of the configuration flag (P[35] **CONFIGURATION_1** Bit B_{10}). The default settings are:

- Enabling/disabling L.A.M.S. by DIP switch [L]: (P[35] **CONFIGURATION_1** Bit B_{10}=1)
- flag (**LAM_En**) configured for LAM not active: (P[35] **CONFIGURATION_1** Bit B_{25}=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")

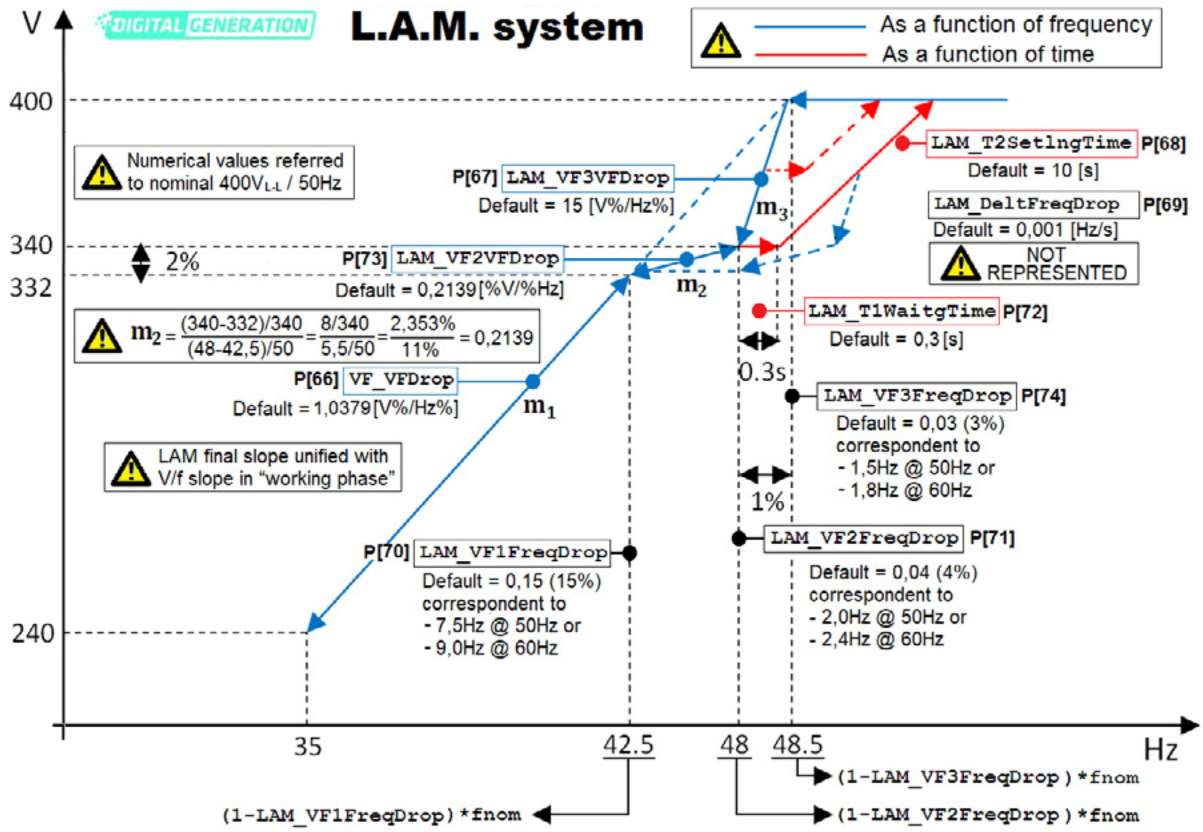
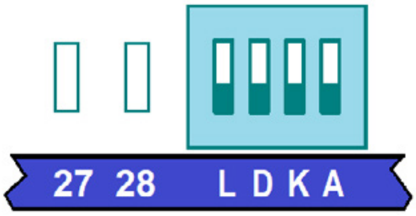


Fig. 9.3-A: L.A.M.S. (Load Acceptance Module System)

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_T2SetlngTime** 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=55Hz or (1+0.1)*f_R=66Hz as a function of the nominal frequency f_R=50Hz o f_R=60Hz.
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_ExcttnTempSetPt**	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. 9.5-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. 9.5-II: Flags of the speed-dependent protective device at P[35] **CONFIGURATION_1**

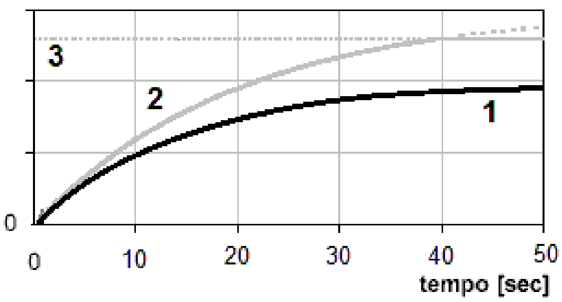
OUTLINE OF THE EXCITATION OPERATIVE VARIABLES

#	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. 9.5-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) Io=80%In P.F.=0 with the machine cold
2) Io=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. 9.6-B
The excitation limit setting (over excitation threshold) is determined by the AMP trimmer or the corresponding parameter P[48] **USR_ExcttnTempSetPt**; the source of this setting (trimmer or parameter) is selected by the configuration flag **Trim4_En** (P[35] **CONFIGURATION_1** Bit B_4), fig. 9.6-B
An estimate of the "accumulated energy" is available in almost real time (and is available) at address A[492] **avgExcVltgFiltered**

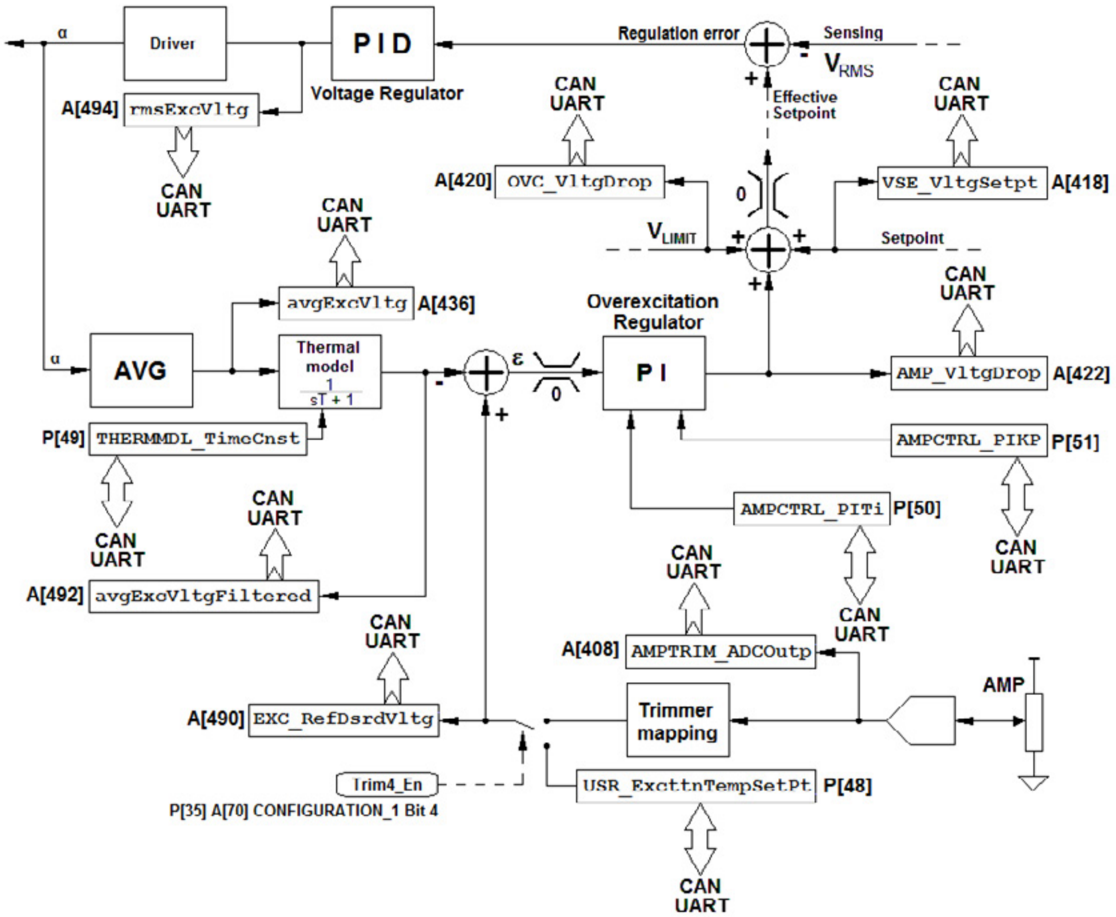


Fig. 9.6-B: Protection from excitation overcurrent (AMP)

The time constant of the heat model, in tenths of a second (Fig. 9.6-B), 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. 9.6-B
The status, signalled by the activation of alarm 08 (A[472] **ALARMS** Bit B_8=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_ExcttnTempSetPt**).
The intervention of the excitation overcurrent protection is not compatible with parallel operation with the mains; activation of the protection must involve opening the parallel switch.

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 B_9=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 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. 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.

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

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 5s

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

A. 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.
B. Power from a phase: the regulator is not being powered when the short circuit occurs, so it cannot manage the condition.
C. 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 B_{10}=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. The intervention of the excitation overcurrent protection is not compatible with parallel operation with the mains; activation of the protection must involve opening the parallel switch.

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

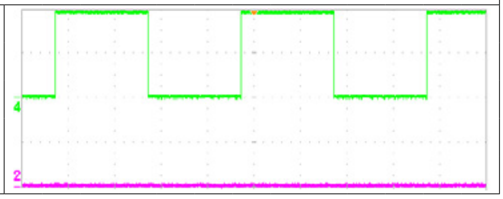
TABLE 10.1-I : ALARMS OUTLINE

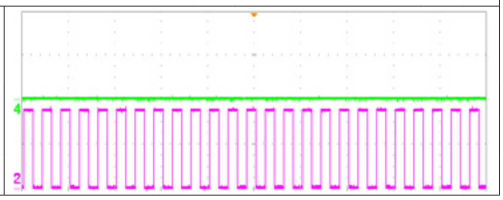
A[472]	Alarm name	Notes	Mnemonic	Dec weight	Hex weight
B_0	Reserved			1	0000 0001
B_1	Checksum EEprom		CS	2	0000 0002
B_2	Reserved	En. P[36] Bit B6	LOS	4	0000 0004
B_3	Reserved		RBDS	8	0000 0008
B_4	Reserved		RBDF	16	0000 0010
B_5	Over voltage		OV	32	0000 0020
B_6	Under voltage		UV	64	0000 0040
B_7	Short 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

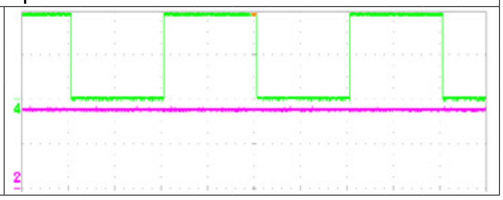
10.2 Alarm signalling by LED

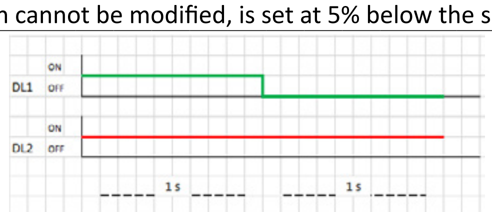
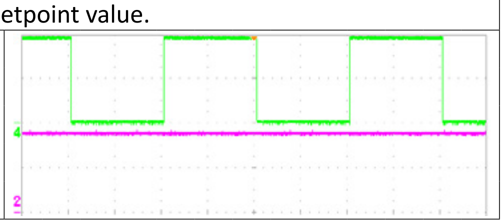
During normal operation (System OK at 10.3 "Alarms description"), the green LED indicator embedded in the board flashes at a period of 2sec with duty cycle 50%; in case of protection intervention or alarm signalling, the two LED indicators (green and red, 10.3 "Alarms description") flash in different 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
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	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	1	0	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																													

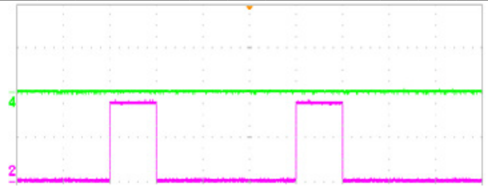
Alarm #	06		Mnemonic						UV				Name				Under voltage								A[472] Hex				0000 0040			
L[36] - A[472]	B_{31}	B_{30}	B_{29}	B_{28}	B_{27}	B_{26}	B_{25}	B_{24}	B_{23}	B_{22}	B_{21}	B_{20}	B_{19}	B_{18}	B_{17}	B_{16}	B_{15}	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
ALARMS	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	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 #	07	Mnemonic	SC	Name	Short circuit	A[472] Hex	0000 0080

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	1	0	0	0	0	0	0	0

Description: Condition identification does not depend on the presence of the C.T., only information on the sensing voltage is used. The tolerated short circuit time is set by parameter P[57] **SCC_SCROnTimePr**; after this time, the regulator stops.
If the alarm condition ends before the stop, normal regulation is restored. Detailed description of the actions in the chapter 9 "PROTECTION".

LED*			
	DL1	δ[%]	0
		f[Hz]	0
	DL2	δ[%]	25
		f[Hz]	0
		φ[°]	0

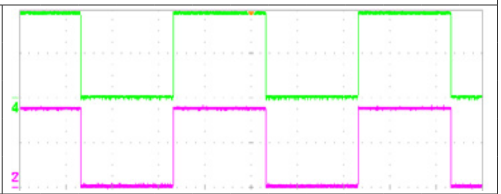


Alarm #	08	Mnemonic	OEXC	Name	Over Excitation	A[472] Hex	0000 0100

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	1	0	0	0	0	0	0	0	0

Description: The alarm non only signals if the excitation system is accumulating too much heat, 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). The AMP trimmer (if enabled) or parameter P[96] **USR_ExcttnTempSetPt** (in alternative to the trimmer) can be used to set the threshold that determines the equilibrium value at which the system stabilises. The alarm status is present for the whole time during which the outgoing voltage is reduced because of protective device intervention.
Detailed description of the actions in the chapter 9 "PROTECTION".

LED*			
	DL1	δ[%]	50
		f[Hz]	0
	DL2	δ[%]	50
		f[Hz]	0
		φ[°]	0

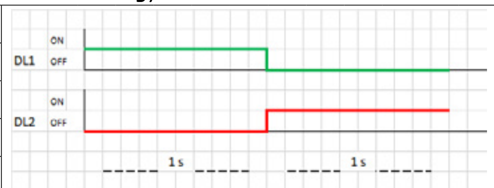


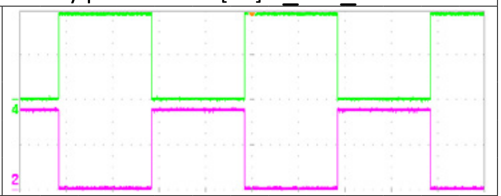
Alarm #	09	Mnemonic	UEXC	Name	Under Excitation	A[472] Hex	0000 0200

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	1	0	0	0	0	0	0	0	0	0

Description: The alarm, inhibited during transients, does not affect the control; it activates when the rms value of the excitation voltage (A[494] **rmsExcVltg**) is lower than the threshold defined by parameter P[53] **U_EXC_THRESHOLD**

LED*			
	DL1	δ[%]	50
		f[Hz]	0
	DL2	δ[%]	50
		f[Hz]	0
		φ[°]	180



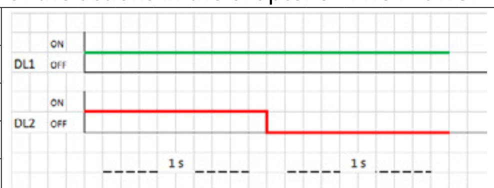


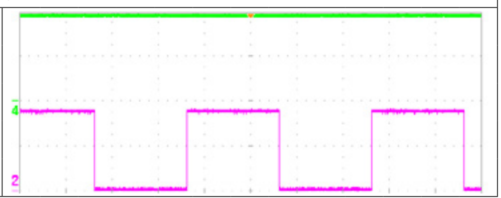
Alarm #	10	Mnemonic	SOV	Name	Supply Over Voltage	A[472] Hex	0000 0400

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	1	0	0	0	0	0	0	0	0	0	0

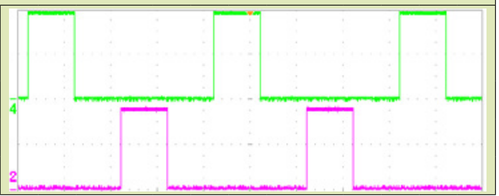
Description: The alarm not only signals if the regulator operating limit has been exceeded, but is also active in eliminating the cause. A regulating loop takes control of the voltage after a threshold has been exceeded, causing the excitation current to lower (therefore also the regulated voltage).
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.
Detailed description of the actions in the chapter 9 "PROTECTION".

LED*			
	DL1	δ[%]	100
		f[Hz]	0
	DL2	δ[%]	50
		f[Hz]	0
		φ[°]	0

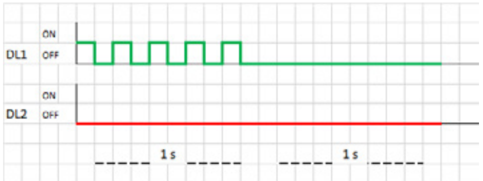
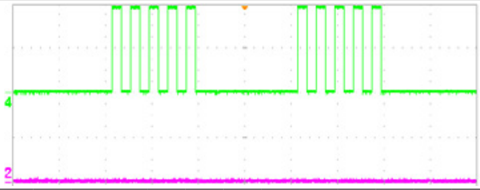




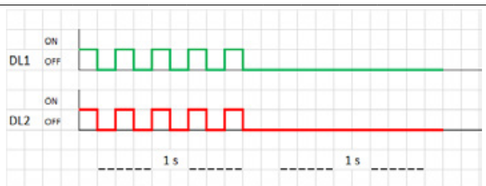
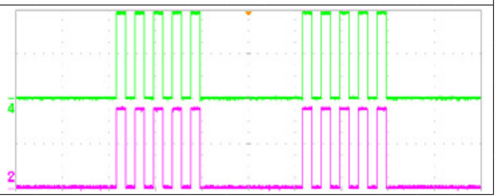
Alarm #	11	Mnemonic	OC	Name	Phase Over current	A[472] Hex	0000 1000																									
L[36] - A[472]	B_{31}	B_{30}	B_{29}	B_{28}	B_{27}	B_{26}	B_{25}	B_{24}	B_{23}	B_{22}	B_{21}	B_{20}	B_{19}	B_{18}	B_{17}	B_{16}	B_{15}	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
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
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_ADCSclng**.																															

LED*					
	DL1	δ[%]	25		
		f[Hz]	0		
	DL2	δ[%]	25		
		f[Hz]	0		
		φ[°]	180		

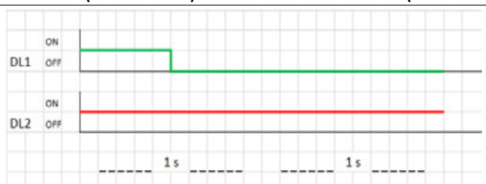
Alarm #	13	Mnemonic	US	Name	Under Speed	A[472] Hex	0000 2000																									
L[36] - A[472]	B_{31}	B_{30}	B_{29}	B_{28}	B_{27}	B_{26}	B_{25}	B_{24}	B_{23}	B_{22}	B_{21}	B_{20}	B_{19}	B_{18}	B_{17}	B_{16}	B_{15}	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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		

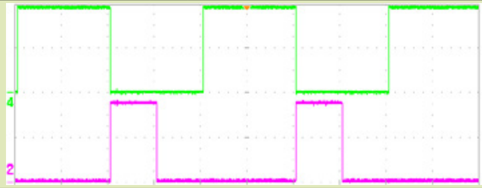
Alarm #	14	Mnemonic	OS	Name	Over Speed	A[472] Hex	0000 4000																									
L[36] - A[472]	B_{31}	B_{30}	B_{29}	B_{28}	B_{27}	B_{26}	B_{25}	B_{24}	B_{23}	B_{22}	B_{21}	B_{20}	B_{19}	B_{18}	B_{17}	B_{16}	B_{15}	B_{14}	B_{13}	B_{12}	B_{11}	B_{10}	B_9	B_8	B_7	B_6	B_5	B_4	B_3	B_2	B_1	B_0
ALARMS	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Description	LThe 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.																															

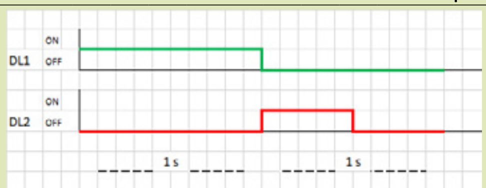
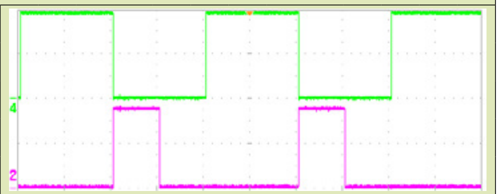
LED*					
	DL1	δ[%]	50		
		f[Hz]	5		
	DL2	δ[%]	50		
		f[Hz]	5		
		φ[°]	0		

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
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		

<table>
<tr><td>Alarm #</td><td colspan="2">17</td><td colspan="6">Mnemonic</td><td colspan="4">LTR</td><td colspan="4">Name</td><td colspan="8">Maximum Temperature</td><td colspan="4">A[472] Hex</td><td colspan="4">0002 0000</td></tr>
<tr><td>L[36] - A[472]</td><td>B_{31}</td><td>B_{30}</td><td>B_{29}</td><td>B_{28}</td><td>B_{27}</td><td>B_{26}</td><td>B_{25}</td><td>B_{24}</td><td>B_{23}</td><td>B_{22}</td><td>B_{21}</td><td>B_{20}</td><td>B_{19}</td><td>B_{18}</td><td>B_{17}</td><td>B_{16}</td><td>B_{15}</td><td>B_{14}</td><td>B_{13}</td><td>B_{12}</td><td>B_{11}</td><td>B_{10}</td><td>B_9</td><td>B_8</td><td>B_7</td><td>B_6</td><td>B_5</td><td>B_4</td><td>B_3</td><td>B_2</td><td>B_1</td><td>B_0</td></tr>
<tr><td>ALARMS</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Description</td><td colspan="32">The alarm does not affect the control. The threshold, which cannot be modified, is 70°C</td></tr>
<tr><td rowspan="5">LED*</td><td rowspan="2" colspan="2">DL1</td><td colspan="2">δ[%]</td><td colspan="2">25</td><td rowspan="5" colspan="13">
</td><td rowspan="5" colspan="13"></td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td rowspan="3" colspan="2">DL2</td><td colspan="2">δ[%]</td><td colspan="2">25</td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td colspan="2">φ[°]</td><td colspan="2">0</td></tr>
</table>

<table>
<tr><td>Alarm #</td><td colspan="2">25</td><td colspan="6">Mnemonic</td><td colspan="4">CL</td><td colspan="4">Name</td><td colspan="8">Capacitive Load</td><td colspan="4">A[472] Hex</td><td colspan="4">0200 0000</td></tr>
<tr><td>L[36] - A[472]</td><td>B_{31}</td><td>B_{30}</td><td>B_{29}</td><td>B_{28}</td><td>B_{27}</td><td>B_{26}</td><td>B_{25}</td><td>B_{24}</td><td>B_{23}</td><td>B_{22}</td><td>B_{21}</td><td>B_{20}</td><td>B_{19}</td><td>B_{18}</td><td>B_{17}</td><td>B_{16}</td><td>B_{15}</td><td>B_{14}</td><td>B_{13}</td><td>B_{12}</td><td>B_{11}</td><td>B_{10}</td><td>B_9</td><td>B_8</td><td>B_7</td><td>B_6</td><td>B_5</td><td>B_4</td><td>B_3</td><td>B_2</td><td>B_1</td><td>B_0</td></tr>
<tr><td>ALARMS</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Description</td><td colspan="32">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).</td></tr>
<tr><td rowspan="5">LED*</td><td rowspan="2" colspan="2">DL1</td><td colspan="2">δ[%]</td><td colspan="2">50</td><td rowspan="5" colspan="13">
</td><td rowspan="5" colspan="13"></td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td rowspan="3" colspan="2">DL2</td><td colspan="2">δ[%]</td><td colspan="2">25</td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td colspan="2">φ[°]</td><td colspan="2">180</td></tr>
</table>

<table>
<tr><td>Alarm #</td><td colspan="2">27</td><td colspan="6">Mnemonic</td><td colspan="4">NP</td><td colspan="4">Name</td><td colspan="8">Negative Power</td><td colspan="4">A[472] Hex</td><td colspan="4">0800 0000</td></tr>
<tr><td>L[36] - A[472]</td><td>B_{31}</td><td>B_{30}</td><td>B_{29}</td><td>B_{28}</td><td>B_{27}</td><td>B_{26}</td><td>B_{25}</td><td>B_{24}</td><td>B_{23}</td><td>B_{22}</td><td>B_{21}</td><td>B_{20}</td><td>B_{19}</td><td>B_{18}</td><td>B_{17}</td><td>B_{16}</td><td>B_{15}</td><td>B_{14}</td><td>B_{13}</td><td>B_{12}</td><td>B_{11}</td><td>B_{10}</td><td>B_9</td><td>B_8</td><td>B_7</td><td>B_6</td><td>B_5</td><td>B_4</td><td>B_3</td><td>B_2</td><td>B_1</td><td>B_0</td></tr>
<tr><td>ALARMS</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Description</td><td colspan="32">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.</td></tr>
<tr><td rowspan="5">LED*</td><td rowspan="2" colspan="2">DL1</td><td colspan="2">δ[%]</td><td colspan="2">50</td><td rowspan="5" colspan="13">
</td><td rowspan="5" colspan="13"></td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td rowspan="3" colspan="2">DL2</td><td colspan="2">δ[%]</td><td colspan="2">25</td></tr>
<tr><td colspan="2">f[Hz]</td><td colspan="2">0</td></tr>
<tr><td colspan="2">φ[°]</td><td colspan="2">180</td></tr>
</table>

NOTE *

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

- The duty cycle [%] of the green LED: δDL1
- The frequency [Hz] of a possible modulating frequency for the green LED: fDL1
- The duty cycle [%] of the red LED: δDL2
- 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.

M3K^SHD

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 B_{14} 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 B_{14}=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 §2.1 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^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 MxKonnect; 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.

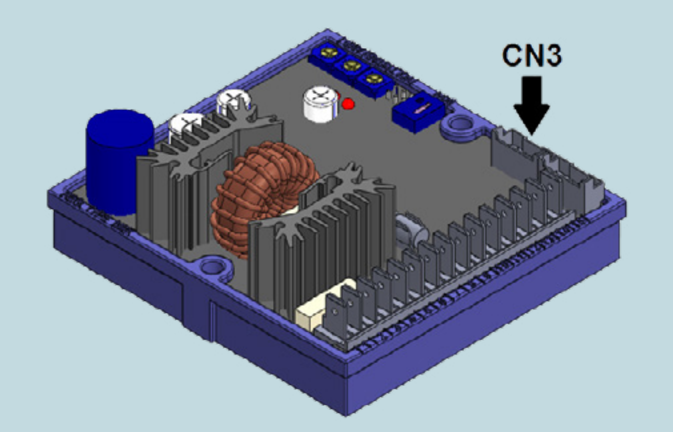


Fig. 11.1-A: COM connector (ModBus) on **M2K**

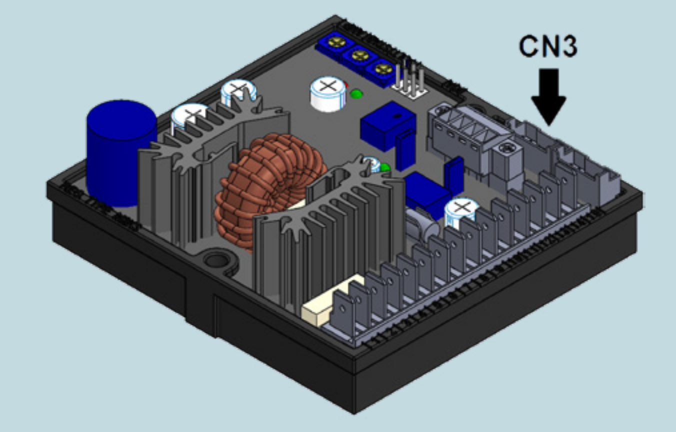


Fig. 11.1-B: COM connector (ModBus) on **M2K^S**

M3K M3K^S 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 MxKonnect is needed USB cable (male type A - male type A) or Kit consisting of MxKonnect and related connection cables are available upon request.

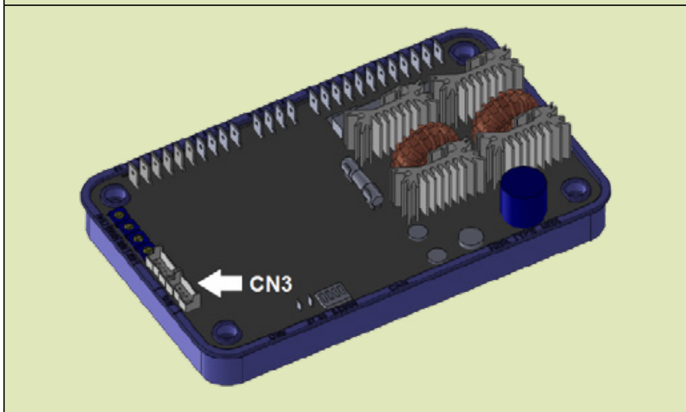


Fig. 11.1-C: COM connector (ModBus) on **M3K**

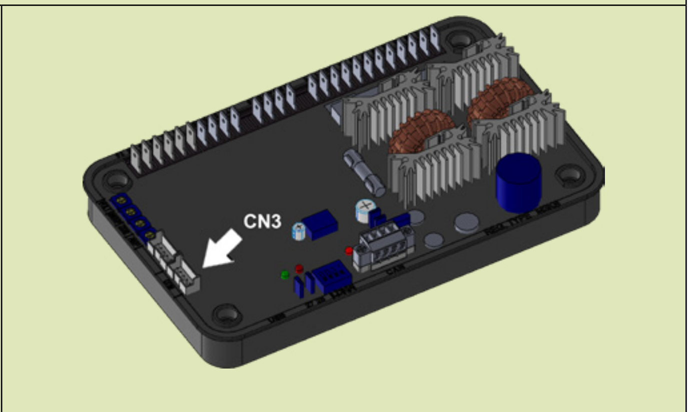


Fig. 11.1-D: COM connector (ModBus) on **M3K^S**

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 MxKonnect is needed USB cable (male type A - male type A) or Kit consisting of MxKonnect and related connection cables are available upon request.

Whether the connection to the PC is made via one of the two additional USB2MxK or MxKonnect 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-II)

CAN CONNECTOR (4 PIN PCB-Header)					
Terminal	Name	Function	Specifications		Notes
1	CAN_L	Signal CANL	Receiver	recessive: $V_{rec(RX)max}$=0,5V dominant: $V_{dom(RX)min}$=0,9V threshold voltage: 0,5V<$V_{th(RX)dif}$<0,9V	
			Output	recessive: -50mV≤$V_{O(dif)}$≤+50mV, dominant: $V_{O(dif)min}$=1,5V - $V_{O(dom)max}$=2,25V	
2	CAN_H	Signal CANH	Receiver	recessive: $V_{rec(RX)max}$=0,5V, dominant: $V_{dom(RX)min}$=0,9V, threshold voltage: 0,5V<$V_{th(RX)dif}$<0,9V	
			Output	recessive -50mV≤$V_{O(dif)}$≤+50mV, dominant $V_{O(dif)min}$=1,5V - $V_{O(dom)min}$=2,75V	
3	GND_CAN		Bus side reference for signals and power supply		
4	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)

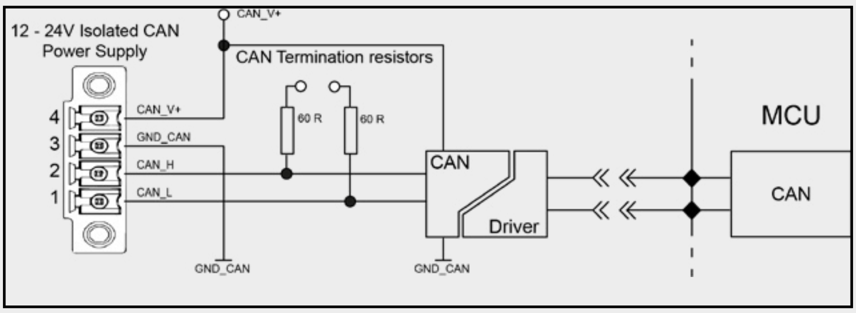


fig. 11.2-II: Functional diagram of the CANBus connection

CANBus connection requires proper line termination; if the connector of the CAN connection cable in use does not have a 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:

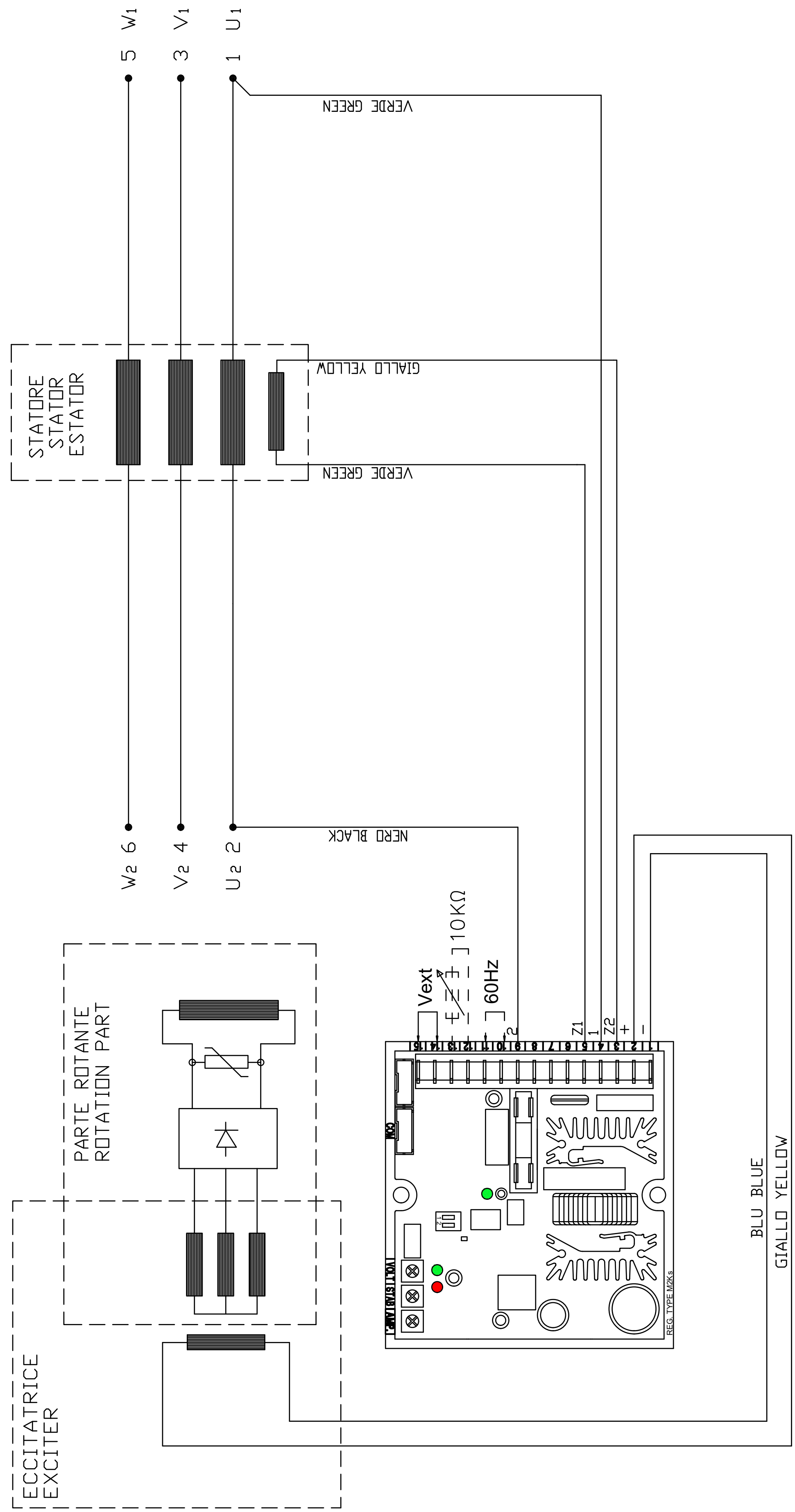
- Proprietary Broadcast: PGN65281, PGN65283, PGN65287, PGN65312
- Proprietary Destination Specific Messages: PGN61184
- Proprietary Commands and Requests: PGN1639378, PGN1642706, PGN1700050

*) NOTE: Planned but not yet available

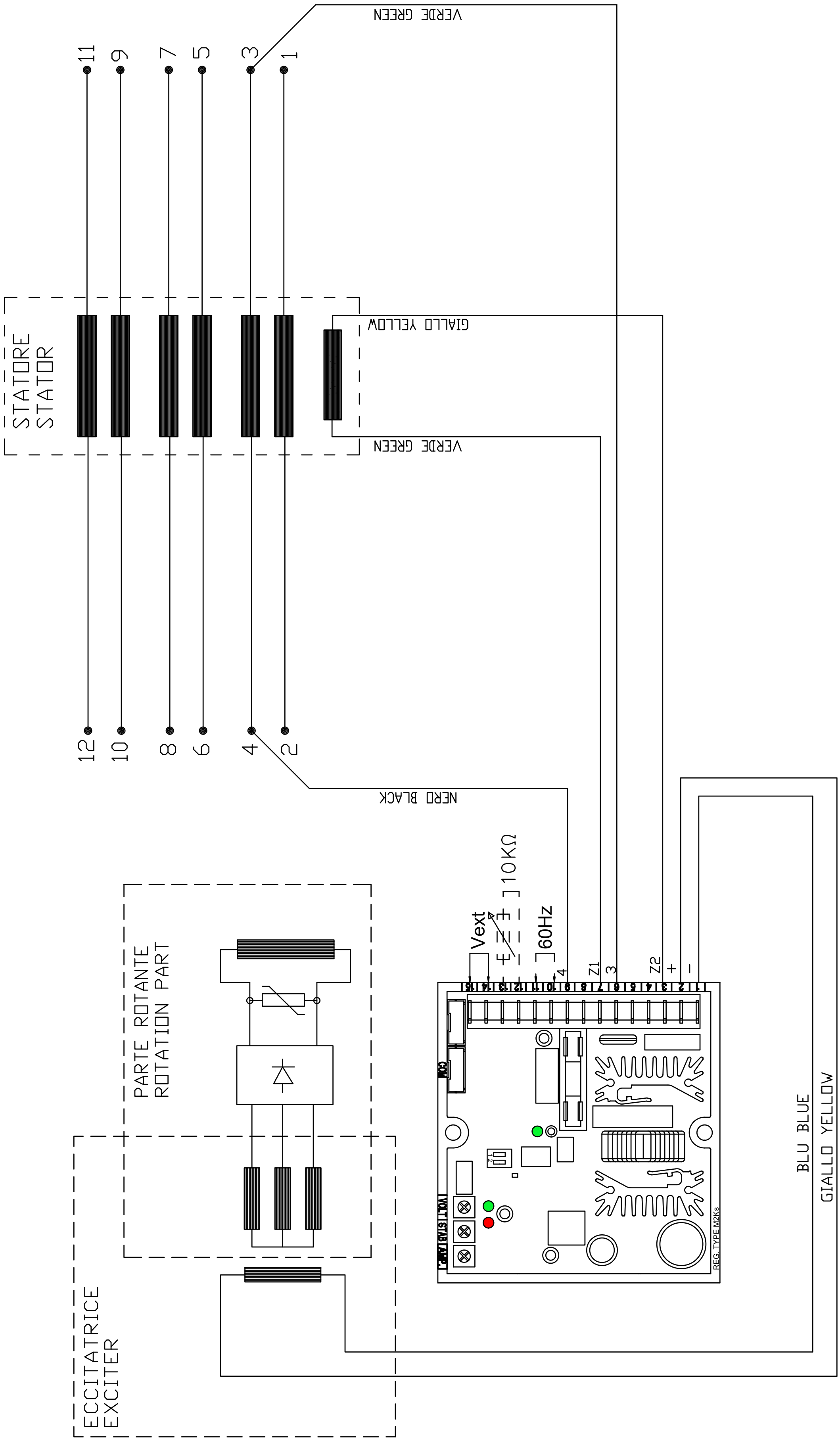
12 ELECTRIC SCHEME

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

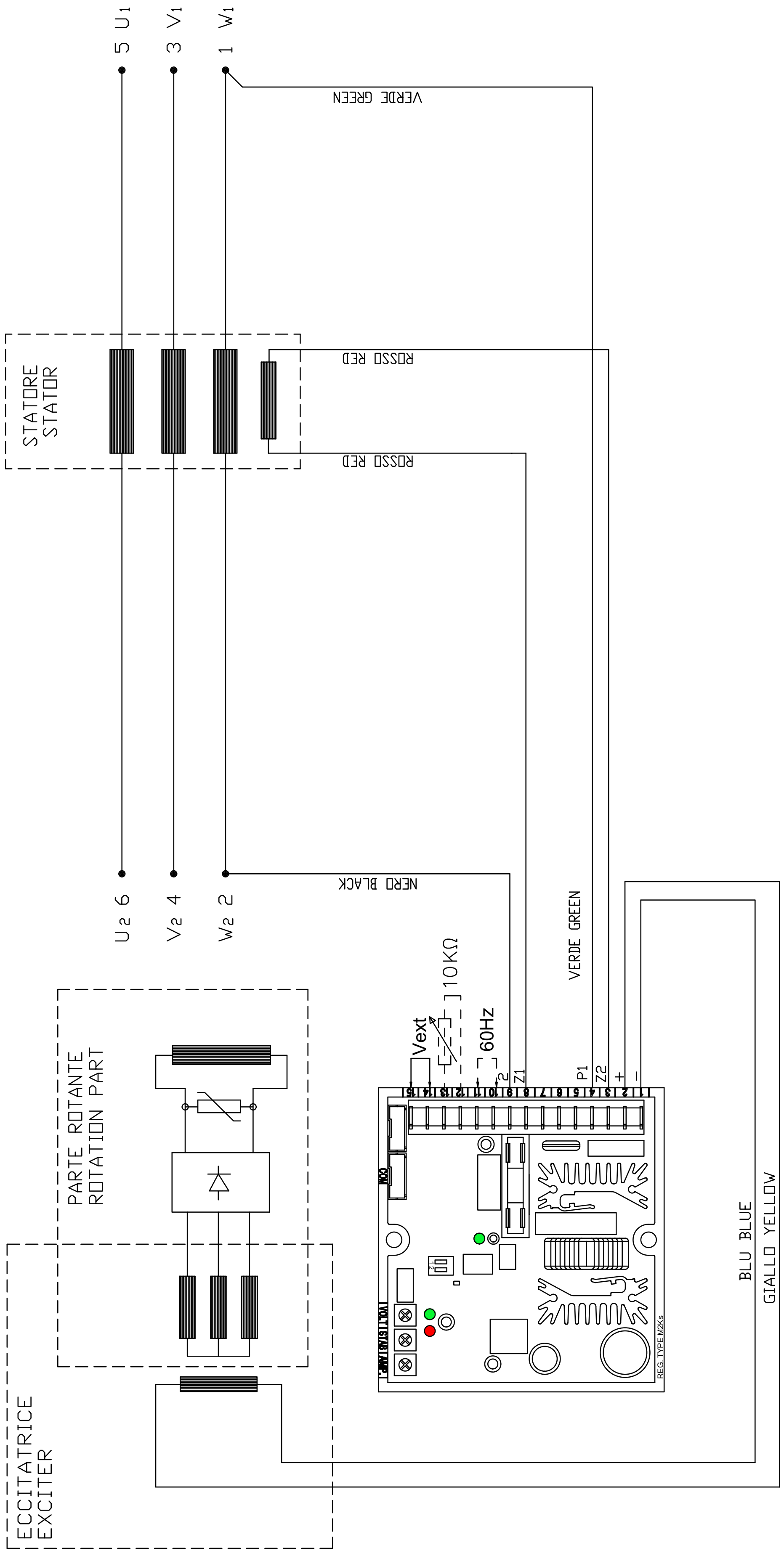
12.1 SCC03022: Sensing from 150V (M2K, M2K[S])



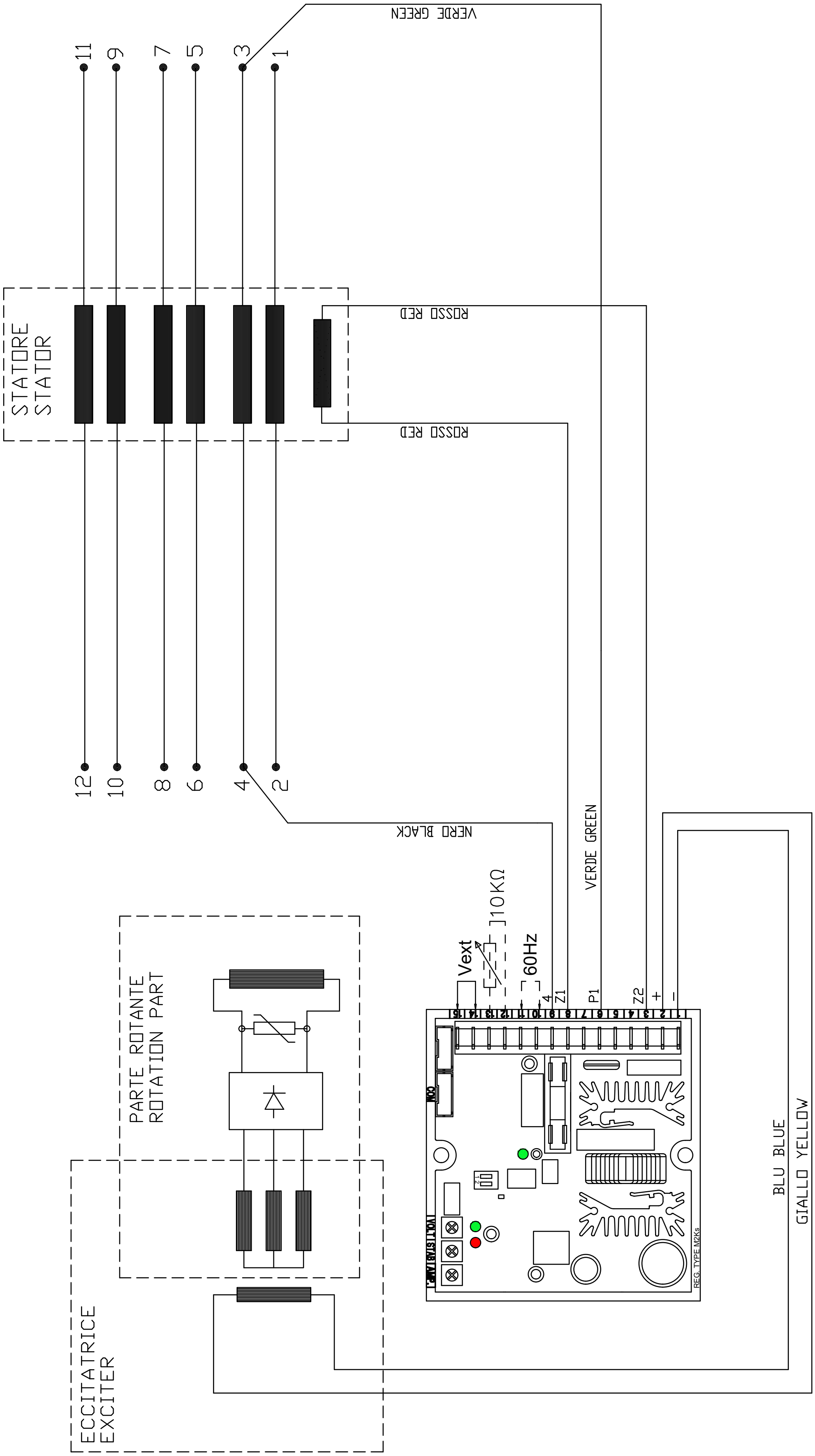
12.2 SCC03024: Sensing from 55V to 150V (M2K, M2K^S)



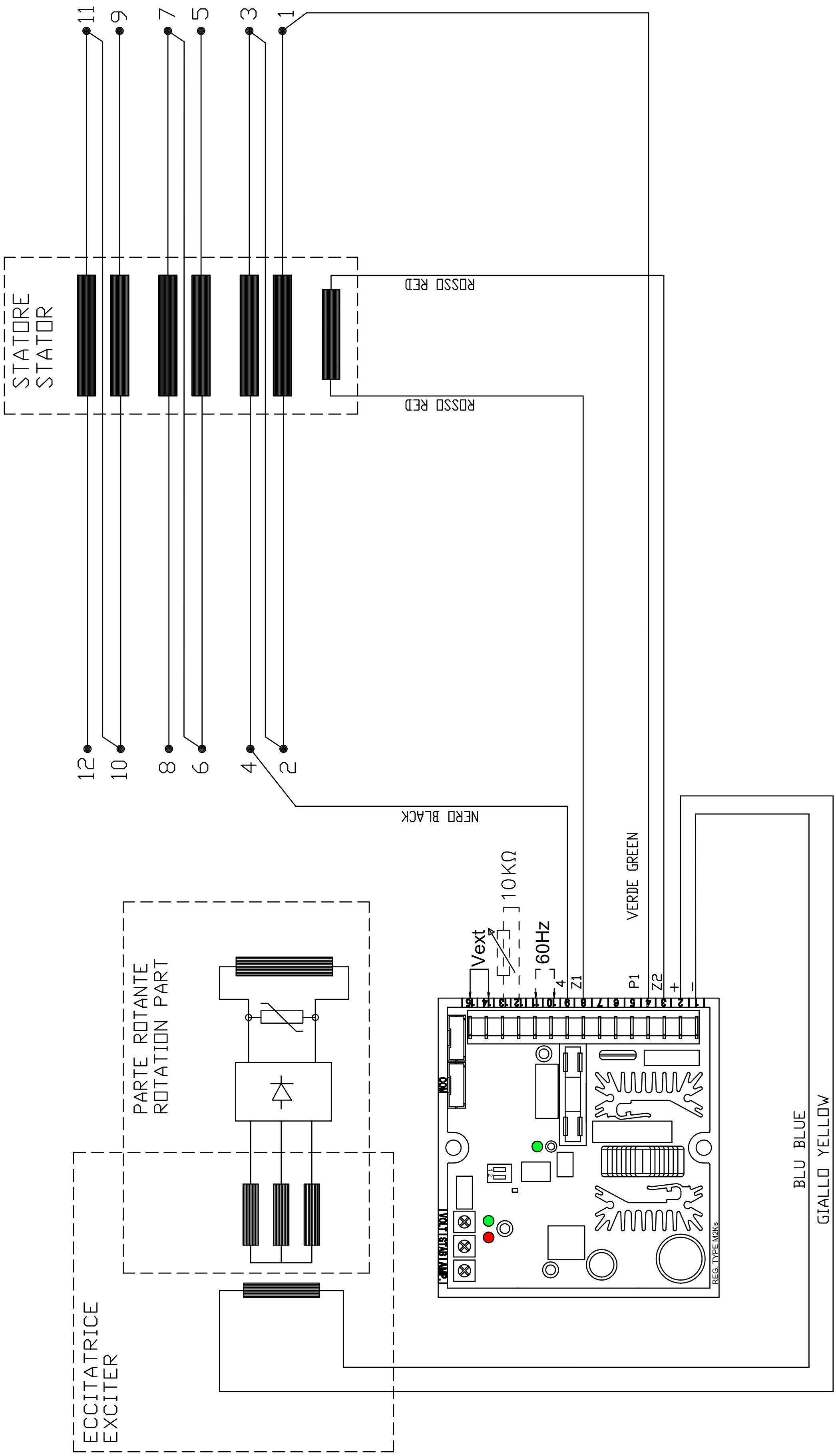
12.3 SCC03028: Sensing from 150V (M2K, M2K^S)



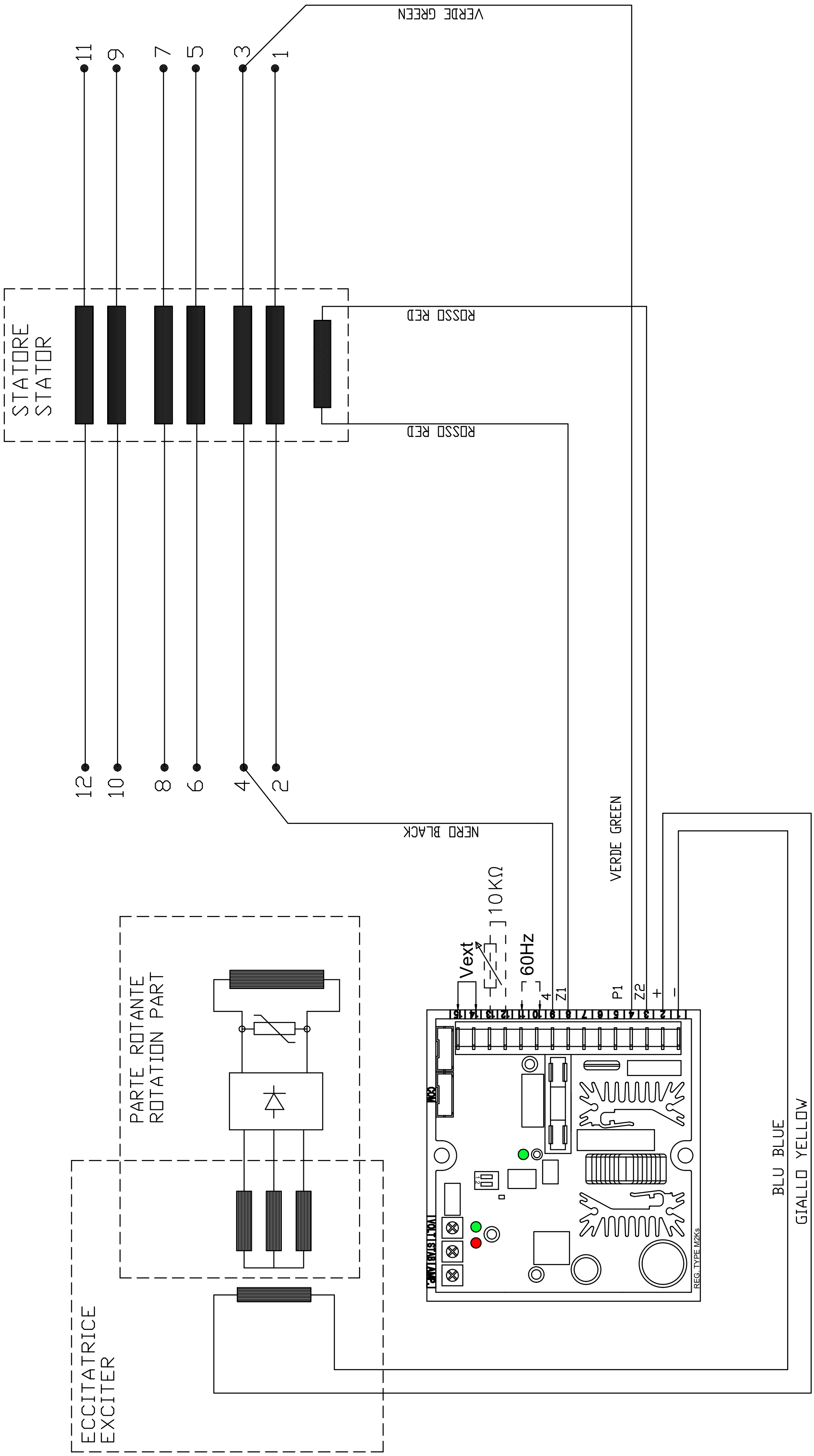
12.4 SCC03029: Sensing from 55V to 150V (M2K, M2K^S)



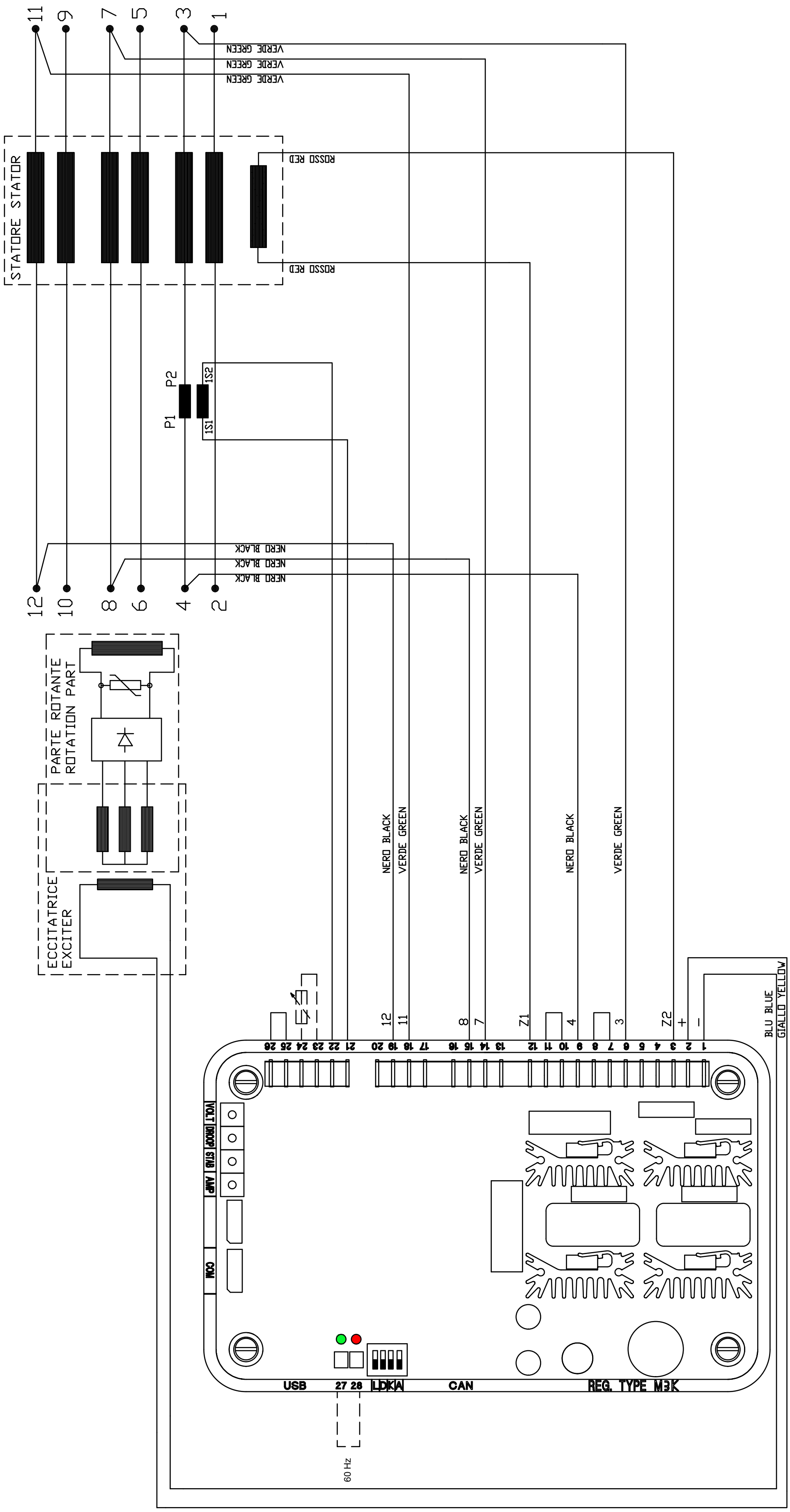
12.5 SCC03030: Sensing from 150V to 405V - Serie Star/Delta (M2K, M2K^S)



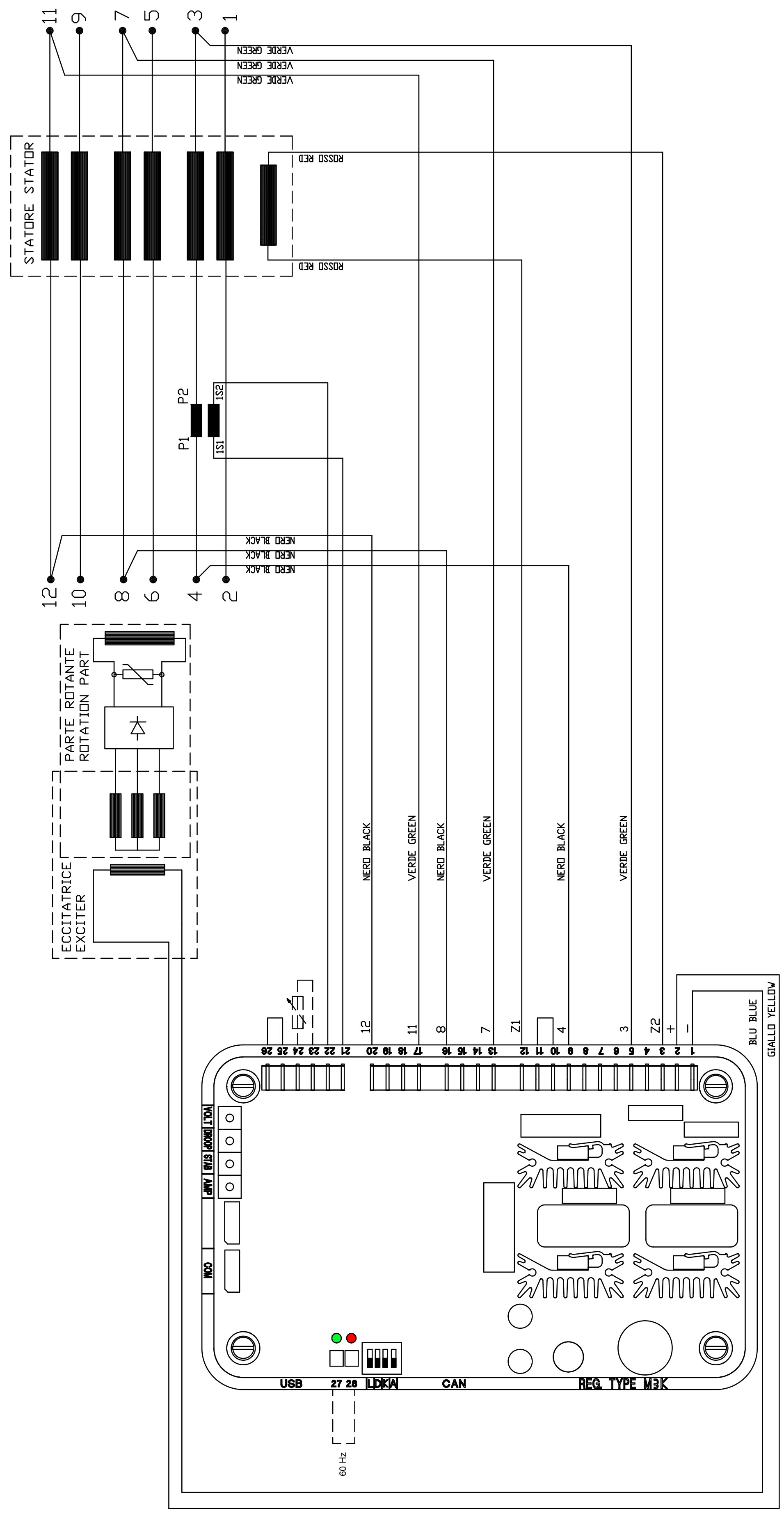
12.6 SCC03031: Sensing from 150V to 405V (M2K, M2K^S)



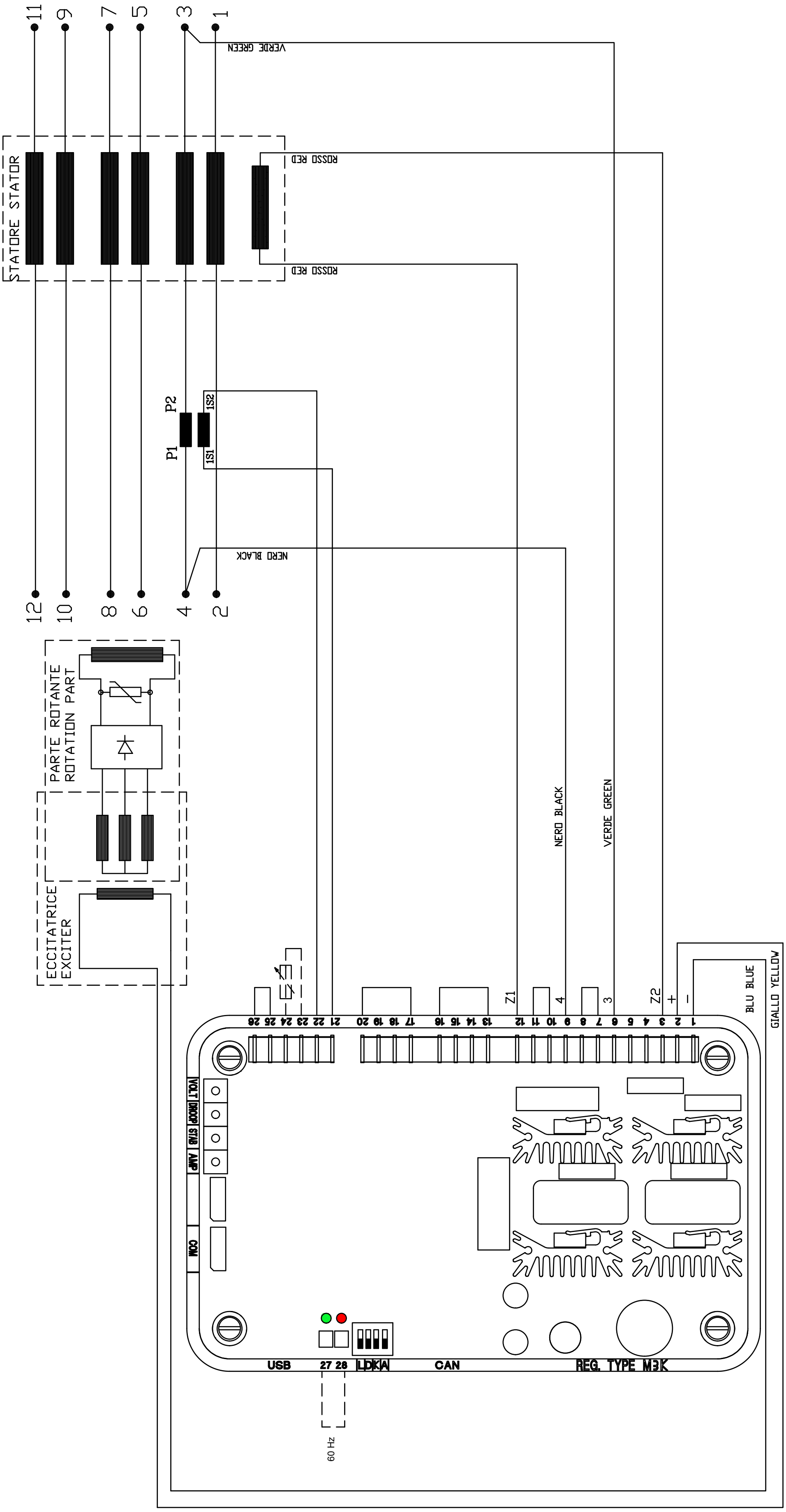
12.7 SCC03036: Sensing three-phase from 55V to 150V (M3K, M3K^{S} and M3K^{SHD})



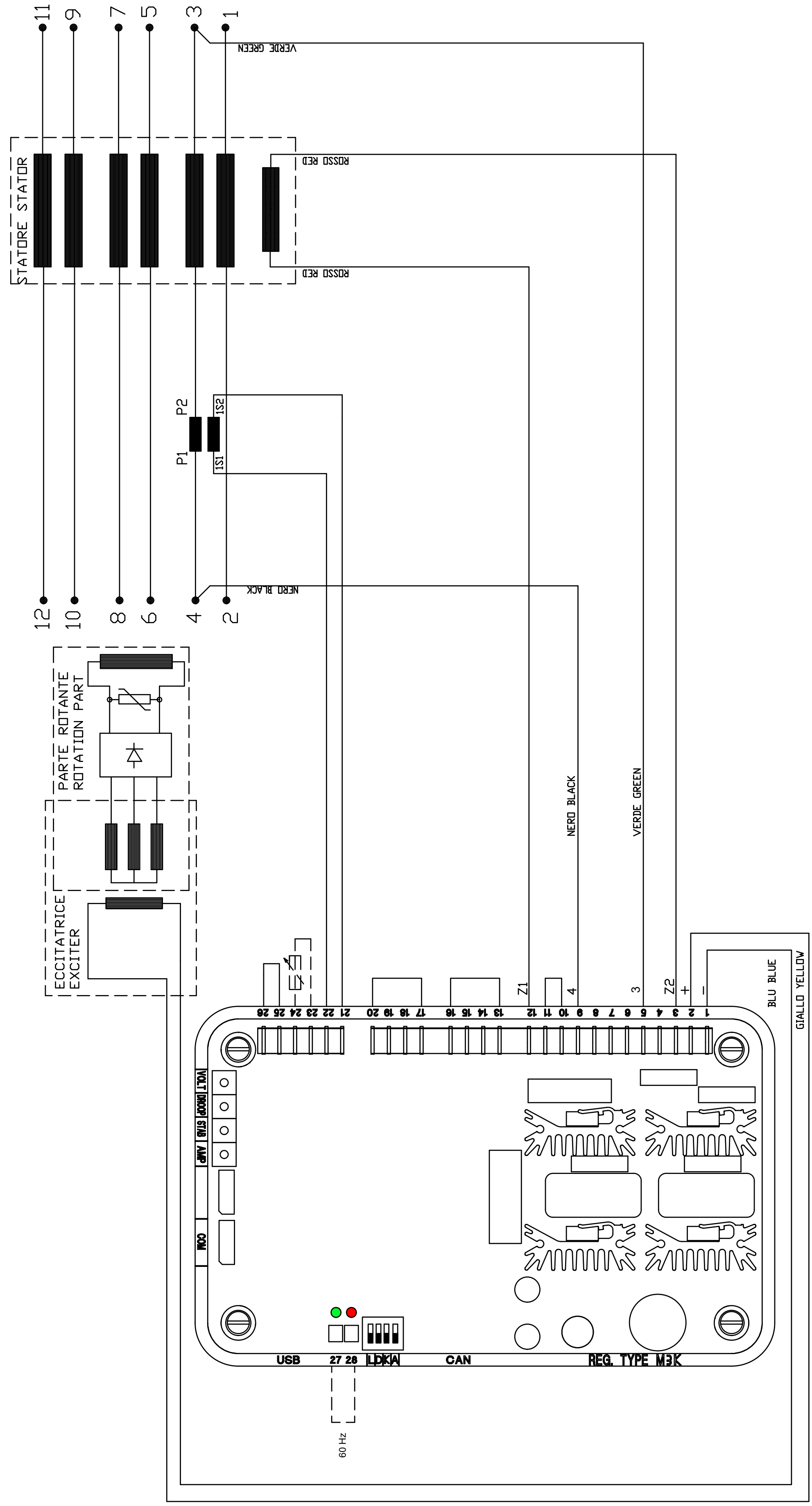
12.8 SCC03037: Sensing three-phase from 150V to 405V (M3K, M3K[S] and M3K[SHD])



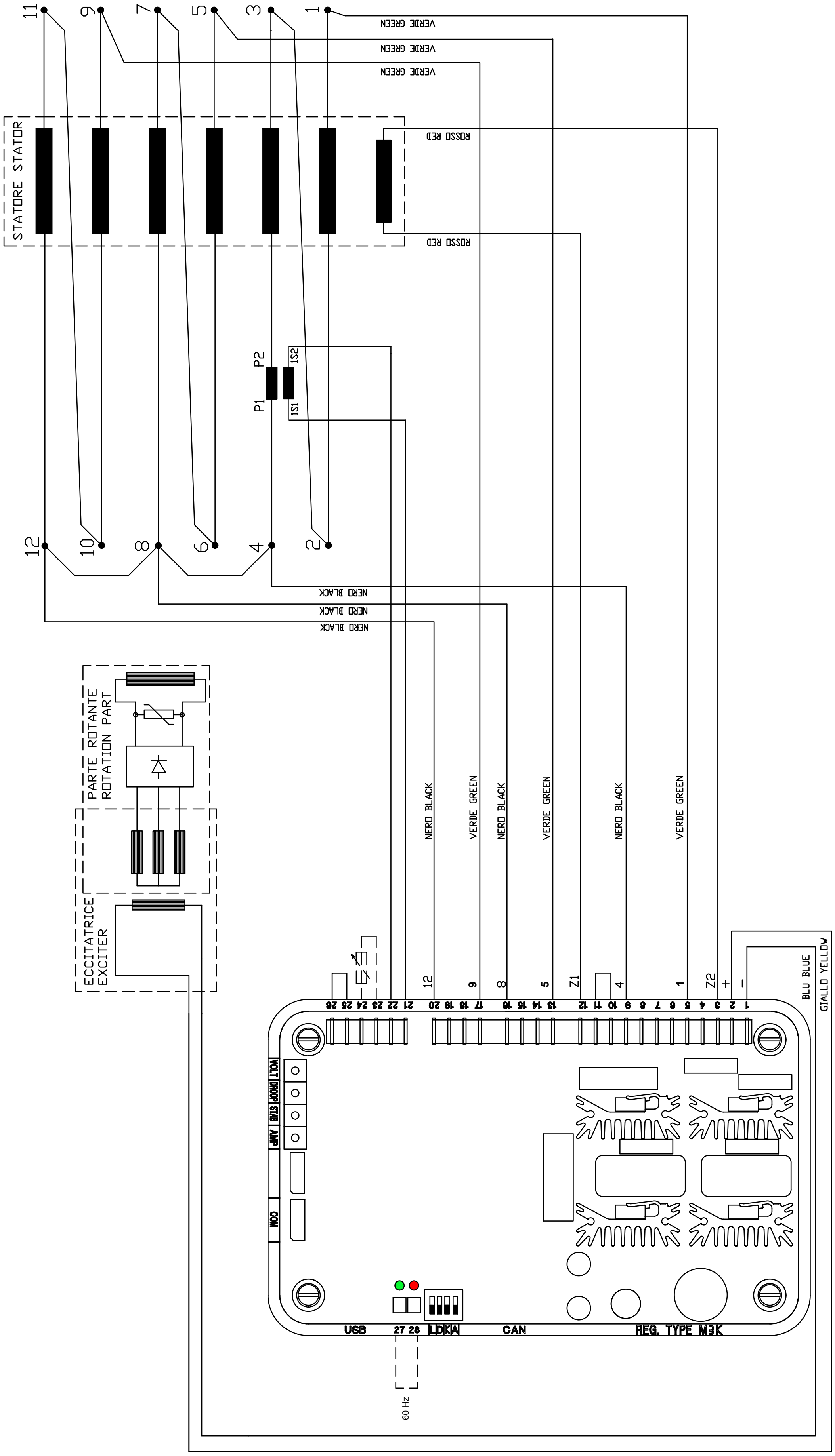
12.9 SCC03038: Sensing single-phase from 55V to 150V (M3K, M3K^S and M3K^SHD)



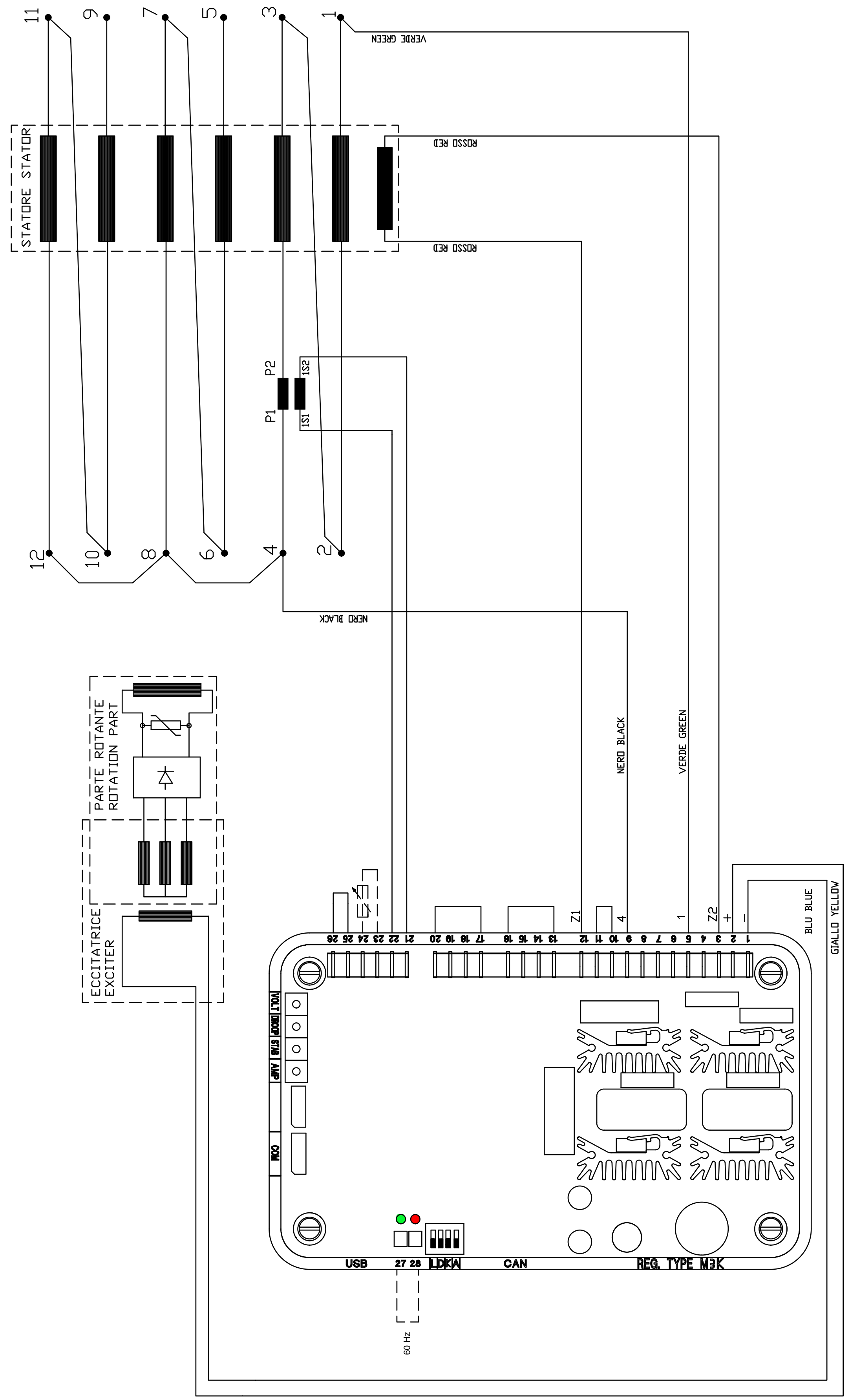
12.10 SCC03039: Sensing single-phase from 150V to 405V (M3K, M3K^S and M3K^SHD)



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



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



13 CALIBRATION PROCEDURE

The basic settings of the MxK regulators can be made via trimmers, DIP switch and jumpers (enabled by default):

– When starting the alternator for the first time (on the production line or in case of device replacement), adjust the trimmers as follows:

- Trimmer “VOLT” approximately in the middle, based on the sensing connection as shown in Tab. 13 A (for further details on the sensing connection refer to the appropriate connection diagrams SCCxxxxx).

Sensing	Regulator terminals		Initial setting
	M2K	M3K	
55V÷150V	Between 6/7 e 8/9	Between 6 e 9/10	about in the middle
150V÷405V	Between 4/5 e 8/9	Between 4/5 e 9/10	completely counterclockwise

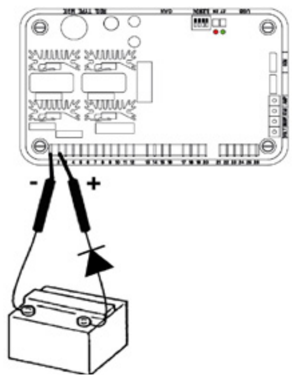
Tab.13 A

- Trimmer "STAB" based on the type of machine as indicated in Tab. 13 B, counting the notches clockwise or based on the closest power range if the alternator is not among those indicated.

Power	Alternator Range	Initial setting
Lower	ECP3÷ECP30	completely counterclockwise
Mid-Low	ECP32÷ECP34-S	approximately 3rd notch
Mid	ECP34-M÷ ECP34-L	about 4th or 5th notch
High	ECO38÷ECO40	not more than the central position.
Higher	ECO43÷ECO46	about in the middle or a bit more

Tab.13 B

- Trimmer "AMP" completely clockwise.
- **M3K**, **M3K^S** and **M3K^SHD**: trimmer "DROOP" at the middle.



– Accelerate the generator at the nominal speed (see nameplate data).

- In case of use at 60Hz connect 60Hz jumper as per SCCxxxxx diagrams

– Excite the alternator by applying a continuous voltage (+/- 12Vdc) for a few moments:

- Terminals 2 (positive) and 1 (negative).
  Note: Use a diode in series from the power supply to the regulator.

– Set up no load voltage (VOLT) (see nameplate data):

- V-LL ±1% (e.g. Vn=400V V-LL=396 ÷ 404) at the nominal frequency ±1% (e.g. fn=50Hz f=49.5÷50.5Hz) by slowly rotating the VOLT trimmer, the correct operation of the regulator is also signaled by the different lighting modes of the green and red LEDs (see §10.3).

– Set up the STAB trimmer (STAB):

- With the alternator running no-load at rated speed, with a lamp or analog voltmeter connected to the output terminals of the machine, as follows:
- if with the setting made before, you notice an oscillation in the brightness of the lamp or the indication of the voltmeter, rotate the STAB trimmer anti-clockwise until the brightness or the indication are perfectly stable.
- if by rotating the STAB trimmer anti-clockwise no changes are detected or the instability tends to increase, bring the STAB trimmer back as indicated and then rotate it clockwise until the brightness or the voltmeter indication are perfectly stable.

- Please note that below 1.5 notches the setting is at its minimum value and above 10.5 notches it is at its maximum value, and therefore no further variations will be obtained.

– **Check the voltage range**

- To check the range of variation of the excitation voltage in function of the regulated voltage at no load: turn the “VOLT” potentiometer counterclockwise until the voltage decreases by -30% (e.g.
- Vn=400V V-LL=280V) and detect the excitation voltage value; turn the “VOLT” potentiometer clockwise until the voltage increases by +20% (e.g. Vn=400V V-LL=480V) and detect the excitation voltage value; finally, bring the alternator back to nominal voltage tol. ±1% (e.g. Vn=400V V-LL=396÷404V) and detect the corresponding excitation voltage value.

– **Apply the load and check that with the STAB trimmer setting made in the previous points, when attaching and detaching the load, one of the following phenomena does not occur:**

- permanent oscillation of the brightness of the lamp or the indication of the voltmeter
- overvoltage or voltage drop exceeding ± 20% of the set voltage value
- permanent overvoltage or voltage drop for more than 1 second and exceeding ± 15% of the set voltage value
- restoration within ± 3% of the set voltage in a time greater than 2 seconds the calibration of the STAB trimmer is not adequate and must be corrected.

– **In the case of M3K with active DROOP function, check the voltage drop as follows (DROOP):**

- For rated load at cosφ 0.8: ΔV = -2% ÷ -4% Vn (es. Vn=400V ΔV = 8V ÷ 16V).
- For rated load at cosφ 0: ΔV = -2,5% ÷ -5% Vn (es. Vn=400V ΔV = 10V ÷ 20V).
- Calibrate the “DROOP” trimmer if the setting made in point previously (“DROOP” trimmer at center scale) does not allow the voltage drop to return within the established limits. Also depending on the C.T. used (see §7.2 and §7.4), by acting on the “DROOP” trimmer it is possible to obtain a drop from 0% (with “DROOP” completely anti-clockwise) to approximately 13% (with “DROOP” completely clockwise) with load 80%In and cosϕ=0 or at approximately 10% with load 100% and cosϕ=0.8.

– **Overexcitation protection (AMP) calibration:**

- Apply in nominal conditions 110% of the nominal load at cosϕ 0 or 125% at cosϕ 0.8.
- In a stably set overload condition, wait 1 minute and 30 seconds.
- Then act on the “AMP” potentiometer, rotating it clockwise until the protection intervenes.
- If the available load is not sufficient, overload conditions can be simulated by acting on the excitation of the machine (decreasing the speed and increasing the output voltage if necessary).

– **Disengage the load and stop the machine.**

– **Repeat the machine start-up:**

- Start the alternator up to the nominal speed and check its self-excitation, the voltage must be the nominal Vn ±1% (e.g. Vn=400V V-LL=396÷404V, e.g. Vn=480V V-LL=475 ÷485V).

NOTE: The **MxK** regulators are not equipped with the Hz trimmer for setting the intervention threshold of the low speed protection which by default is set at -4% of the nominal frequency (48Hz for fn=50Hz and 57.6Hz for fn=60Hz); the modification can only be made via software setting (§9.2).

– **Stop the alternator.**

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
03	06/24	Added calibration procedure
04	10/24	Updated CANBus connector
05	04/25	Corrected text errors

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