

## AUTOMATIC VOLTAGE REGULATOR R630

Installation and maintenance

# R630 AUTOMATIC VOLTAGE REGULATOR

## WARNING

IN ORDER TO AVOID ANY HARM TO EITHER PERSONNEL  
OR THE INSTALLATION, THIS DEVICE MUST ONLY BE SET UP  
BY A QUALIFIED ENGINEER

## CAUTION

DO NOT USE HIGH-VOLTAGE MEASURING APPARATUS.  
INCORRECT USE OF CERTAIN APPARATUS MAY  
LEAD TO DESTRUCTION OF THE SEMICONDUCTORS  
CONTAINED IN THE AVR

## NOTE

THE CONNECTION DIAGRAMS IN THIS MANUAL ARE  
PROVIDED FOR INFORMATION ONLY - FOR ACTUAL  
CONNECTION, SEE THE DIAGRAMS SUPPLIED WITH THE GENERATOR

# R630 AUTOMATIC VOLTAGE REGULATOR

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# R630 AUTOMATIC VOLTAGE REGULATOR

## 1) GENERAL DESCRIPTION

### 1.1) APPLICATION

AVRs in the R600 series are designed for use on brushless self-excited generators, without slip-rings, with "SHUNT", "SHUNT with BOOSTER" or "PMG" or "AREP" excitation. In the case of "SHUNT with BOOSTER", the booster current is monitored by the AVR.

Depending on its constitution, the AVR is capable of solo operation, parallel operation between generators with similar power ratings, or parallel operation with the mains with  $\cos \emptyset$  or KVAR regulation.

### 1.2) DESCRIPTION

The R630 AVR is a modular analogue voltage regulator in a 19" rack designed to be mounted in a cabinet.

Its boards can be used to acquire and monitor the electrical values required for generator operation, while producing the corresponding current for the exciter field.

There are some free slots, allowing the 4-20 mA board or a board providing optional functions to be added without modifying the internal wiring.

### 1.3) OPTIONAL BOARDS

The basic AVR provides voltage regulation with reactive power sharing during operation in parallel with other machines.

The following boards can be plugged into the AVR without modifying the internal wiring:

- ▶  $\cos \emptyset$  or KVAR regulation (2F) (in parallel with the mains)
- ▶ Voltage matching with the mains (3F) (Synchro)
- ▶ Voltage and  $\cos \emptyset$  (or KVAR) digital potentiometers
- ▶ Manual mode control via a terminal block
- ▶ Stator current limiting
- ▶ Mains  $\cos \emptyset$  or KVAR regulation from a 4-20 mA converter
- ▶ Iexc Digital setting board

### 1.4) CONNECTIONS

Connections to external devices are located on the top of the rack in the form of two terminal blocks:

- ▶ A power/voltage terminal block (19 terminals including an MCB on the power)
- ▶ A command/control terminal block (45 terminals)

### 1.5) SPECIFICATIONS

- ▶ Sensing voltage:
  - ▶ 100/115 VAC 50 Hz
  - ▶ 100/130 VAC 60 Hz
  - ▶ 380/420 VAC 50 Hz
  - ▶ 380/450 VAC 60 Hz
- ▶ Power supply (maximum 270 VAC)
  - ▶ Shunt = power transformer (voltage)
  - ▶ Shunt + Booster = power transformers (voltage & current)
  - ▶ AREP = auxiliary windings
  - ▶ PMG = permanent magnet generator windings
- ▶ Field excitation output
  - ▶ 15 A rated, 25 A maximum for 10 s on 5  $\Omega$  minimum
- ▶ Regulation accuracy
  - ▶ +/-0.5% of the average of all three phases on a linear load, excluding quadrature droop
- ▶ Voltage adjustment range
  - ▶ +/-10% of the rated voltage by means of voltage-free contacts or an optional external potentiometer
- ▶ Quadrature droop adjustment range
  - ▶ -7% of the rated voltage at  $\cos \emptyset = 0$
- ▶ Underfrequency protection
  - ▶ Integrated, adjustable threshold, slope adjustable from V/Hz to 2V/Hz
- ▶ Field excitation ceiling
  - ▶ 110% of rated Iexc permanently, unlocked if voltage drops
- ▶ Protection: Heatsink overheating, short-circuit in the exciter field circuit
- ▶ Alarm output: Heatsink overheating, too much ceiling unlocked time
- ▶ Environment
  - ▶ Maximum ambient temperature -10°C to +50°C
  - ▶ Mounted in a cabinet without excessive vibration
- ▶ EMC
  - ▶ **Emission:** EN 61000-4-4 (EN55011-CI:A)
  - ▶ **Immunity:** EN 61000-6-2
  - ▶ Electrostatic discharges EN 61000-4-2
  - ▶ Radiation interference electric field strength EN 61000-4-3
  - ▶ Electrical fast transients/bursts EN 61000-4-4
  - ▶ Shock waves EN 61000-4-5
  - ▶ Conducted RF interference EN 61000

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## 2) PART NUMBERS

DESCRIPTION	Board no. included	REMARKS
Wired empty rack	C51950311	Three-phase SHUNT (+ booster)
Wired empty rack	C51950313	AREP
Wired empty rack	C51950314	PMG
Power block	C51950315	Three-phase SHUNT (+ booster)
Power block	C51950316	Single-phase SHUNT (+ booster)
Power block	C51950317	AREP
Power block	C51950318	PMG
Generator I/O board	C51950319	100/120 V - 50/60 Hz
Generator I/O board	C51950320	400/450 V - 50/60 Hz
3F mains I/O board	C51950321	100/120 V - 50/60 Hz
3F mains I/O board	C51950322	400/450 V - 50/60 Hz
2F mains I/O board	C51950323	
1F mains I/O board	C51950324	
Rack power supply	C51950042	
Sensing	C51950052	
PID	C51950062	
Generator cosØ	C51950082	
Power driver	C51950072	
LEM	C51950076	
Digital potentiometers	C51950112	
Manual mode	C51950103	
lexc Digital setting	C51950142	
4-20 mA board	C51950326	
I stator limit	C51950092	

<b>= Basic</b>
<b>= Options</b>

**NOTE:**

1F = Solo or parallel operation between machines (voltage regulation + reactive load sharing (quadrature droop))  
 2F = 1F + parallel operation with the mains (cosØ or KVAR regulation)  
 3F = 2F + automatic voltage matching between the generator and the mains

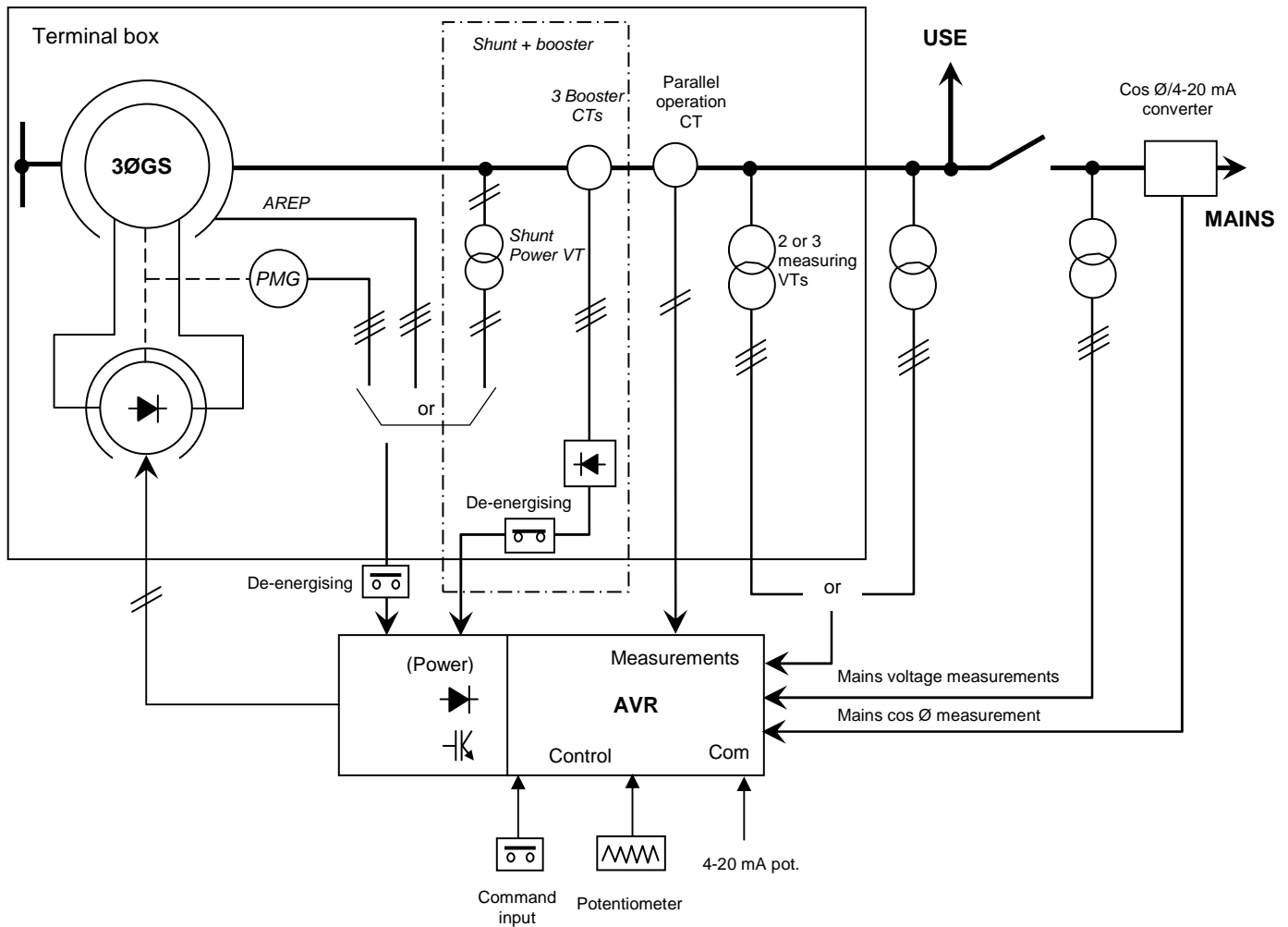
**IMPORTANT: The information given on this sheet will be useful when ordering spare parts.**

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## 3) EXCITATION SYNOPTIC DIAGRAM

The following diagrams and tables provide useful information about interconnections between the terminal block, the generator and mains I/O board connectors and the power block wiring.

### 3.1) EXCITATION-REGULATION SYNOPTIC DIAGRAM



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## 4) CONNECTIONS

TERM No.	VOLTAGE/POWER TERMINAL BLOCK	0F	1F	2F	3F
1	Machine phase 1 (measurement)	N	N	N	N
2	Machine phase 2 (measurement)	N	N	N	N
3	Machine phase 3 (measurement)	N	N	N	N
4	Field flashing + or pre-excitation input (optional)	O	O	O	O
5	Exciter field + output	N	N	N	N
6	Exciter field - output	N	N	N	N
7	Booster + input (nothing if AREP or PMG)	O	O	O	O
8	Booster – input (nothing if AREP or PMG)	O	O	O	O
9	Paralleling CT phase 2 S1		N	N	N
10	Paralleling CT phase 2 S2		N	N	N
11	Not connected				
12	Mains phase 1 (U) (measurement)				N
13	Mains phase 2 (V) (measurement)				N
14	Mains phase 3 (W) (measurement)				N
15	Auxiliary supply input				
16	Auxiliary supply input	N	N	N	N
17	Power supply input (circuit-breaker)	N	N	N	N
18	Power supply input (circuit-breaker)	N	N	N	N
19	Power supply input (circuit-breaker)	N	N	N	N

TERM No.	COMMAND/CONTROL TERMINAL BLOCK	0F	1F	2F	3F
20,20,20	Potentiometer shielding (3 bridged terminals)	O	O	O	O
21	External voltage potentiometer (maximum CW)	O	O	O	O
22	External voltage potentiometer (cursor)	O	O	O	O
23	External voltage potentiometer (minimum ACW)	O	O	O	O
24	External voltage command input (10 VDC, 0V to shielding)	O	O	O	O
25	Field current measurement output (+VDC)	O	O	O	O
26	Field current measurement output (0V)	O	O	O	O
27	External cosØ potentiometer (maximum CW)			O	O
28	External cosØ potentiometer (cursor)			O	O
29	External cosØ potentiometer (minimum ACW)			O	O
30	External KVAR potentiometer (maximum CW)			O	O
31	External KVAR potentiometer (cursor)			O	O
32	External KVAR potentiometer (minimum ACW)			O	O
33	CosØ regulation command input			N	N
34	CosØ regulation command input			N	N
35	Voltage matching command input				N
36	Voltage matching command input				N
37	Overheating or ceiling unlocked time alarm (common)	O	O	O	O
38	Overheating or ceiling unlocked time alarm (NC)	O	O	O	O
39	Overheating or ceiling unlocked time alarm (NO)	O	O	O	O
40	External +24 VDC supply input (relay latching)	O	O	O	O
41	External +24 VDC (relay latching) common: 28 VDC max)	O	O	O	O
42	Voltage or cosØ increase command	O	O	O	O
43	Voltage or cosØ decrease command	O	O	O	O
44	Common	O	O	O	O
45	lexc increase command (Man)	O	O	O	O
46	lexc decrease command (Man)	O	O	O	O
47	"AUTO/MANU" command input (Open = "AUTO")	O	O	O	O
48	"AUTO/MANU" command input (Open = "AUTO")	O	O	O	O
49	"AUTO/MANU" image output	O	O	O	O
50	"AUTO/MANU" image output	O	O	O	O
51	Field current setting potentiometer input	O	O	O	O
52	Manual mode board setting potentiometer input	O	O	O	O
53	"CosØ/KVAR" command input (Open = "CosØ")	O	O	O	O
62	Circuit-breaker aux contact (common)	O	O	O	O
63	Circuit-breaker aux contact (NC)	O	O	O	O
64	Circuit-breaker aux contact (NO)	O	O	O	O

1F = Solo operation or // between machines  
 2F = 1F + parallel operation with the mains  
 3F = 2F + automatic voltage matching before coupling (U/U)

O = Optional  
 N = Needed  
 Blank = Not Applicable

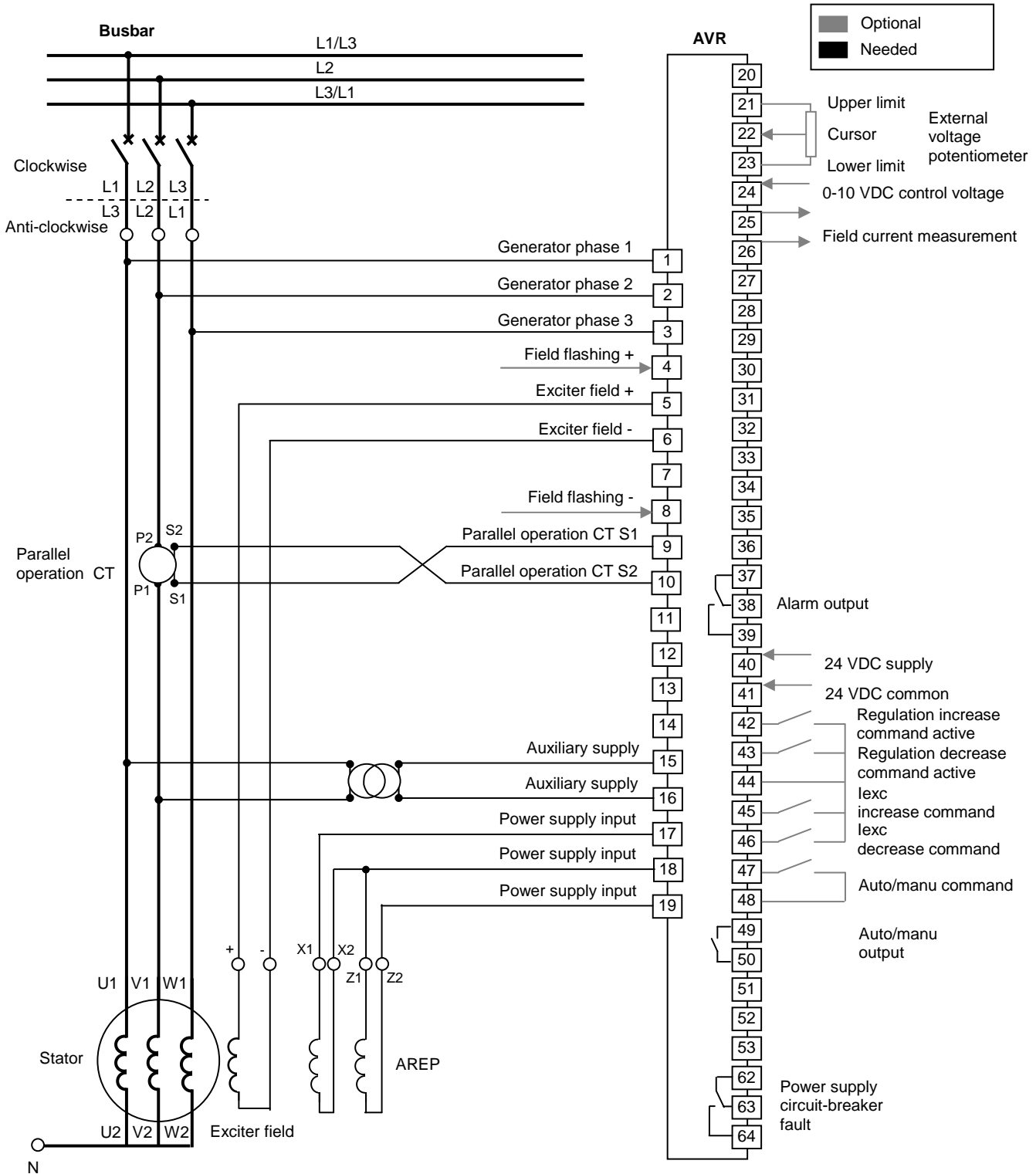


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## 5) "TYPICAL" INSTALLATION DIAGRAMS

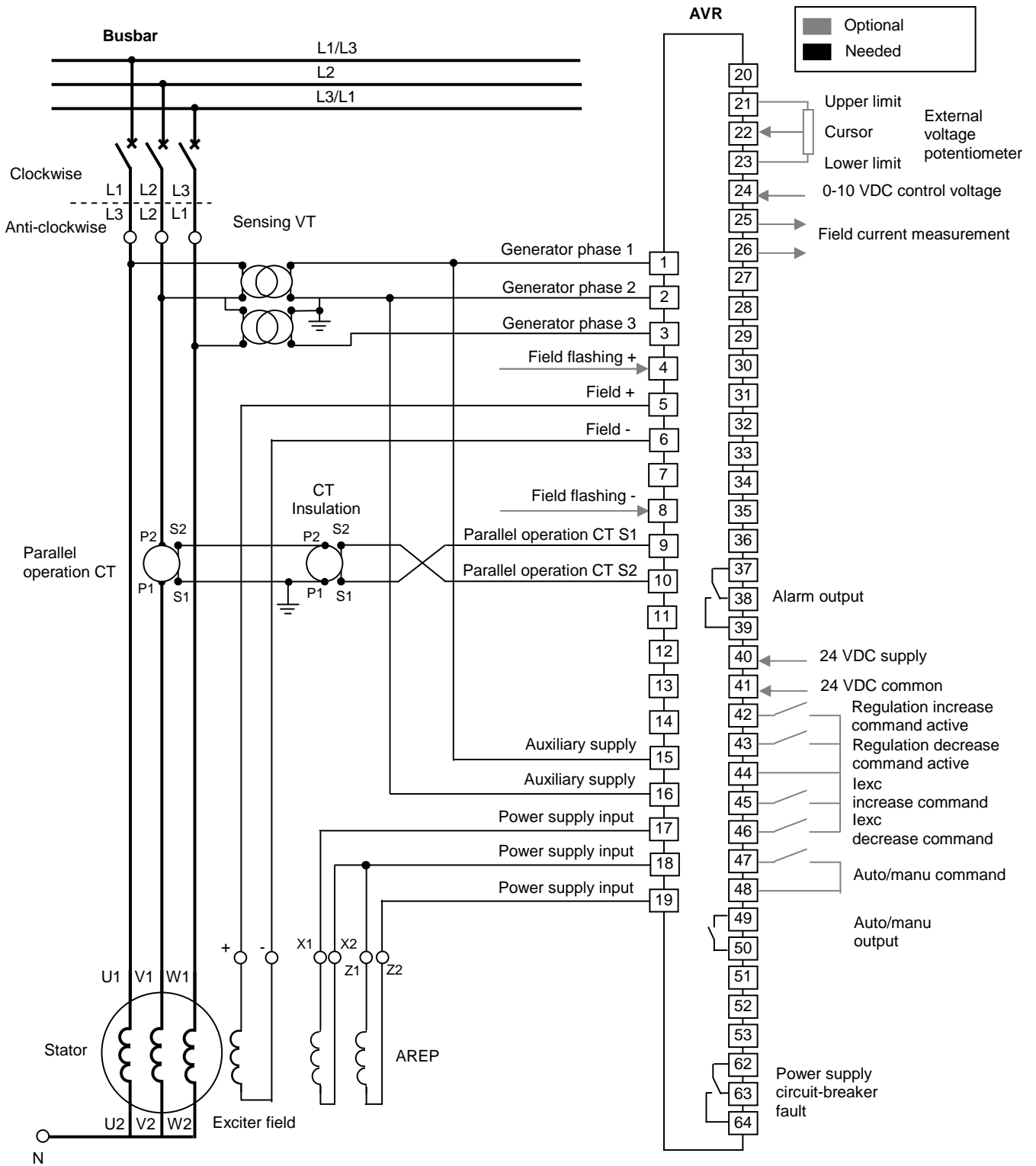
Note: The following diagrams are supplied for information only and are not to be used in place of the diagrams supplied with the generator. The options available depend on which optional boards are plugged into the AVR.

### 5.1) AREP EXCITATION – 1F – LV



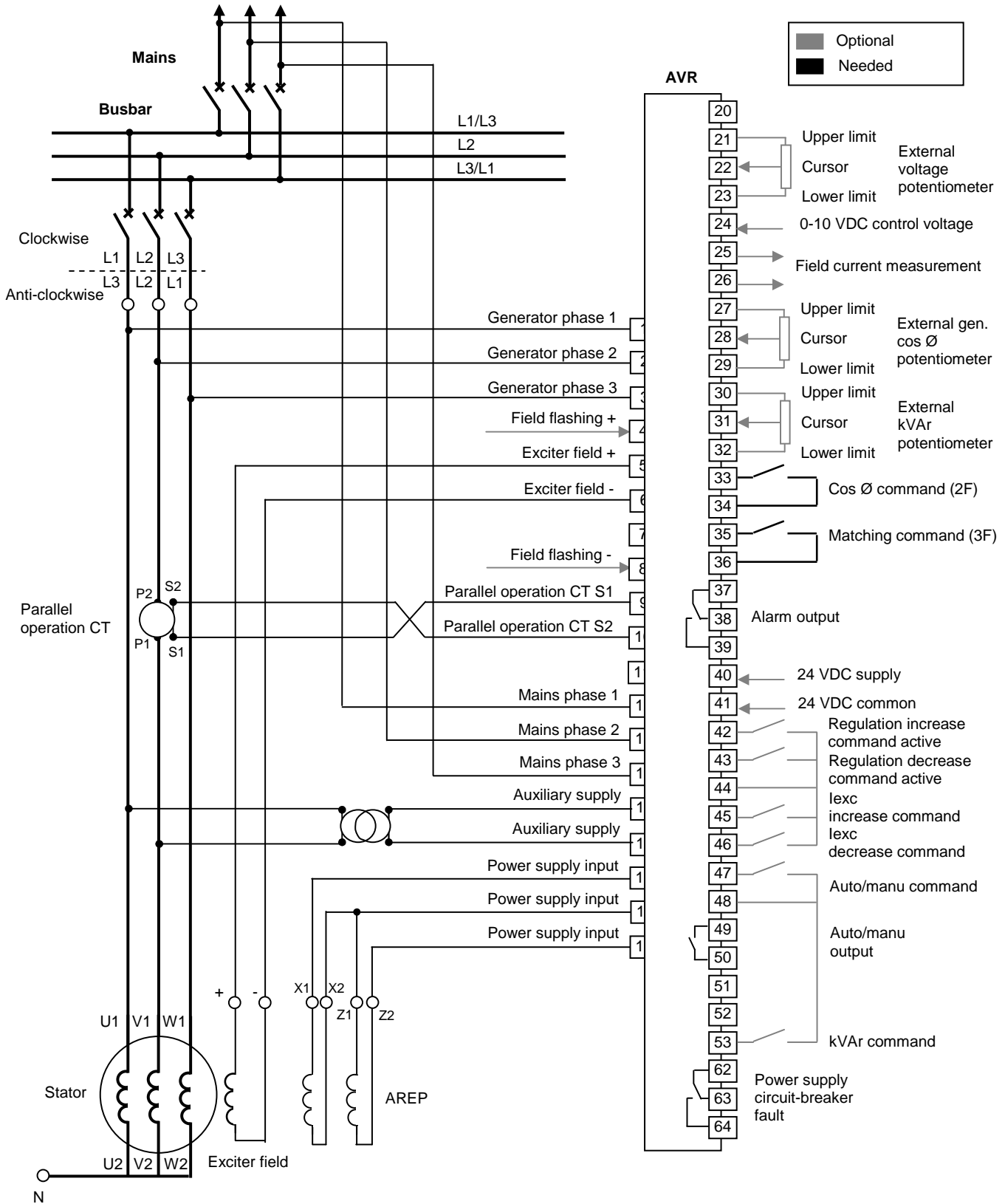
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## 5.2) AREP EXCITATION – 1F – MV/HV



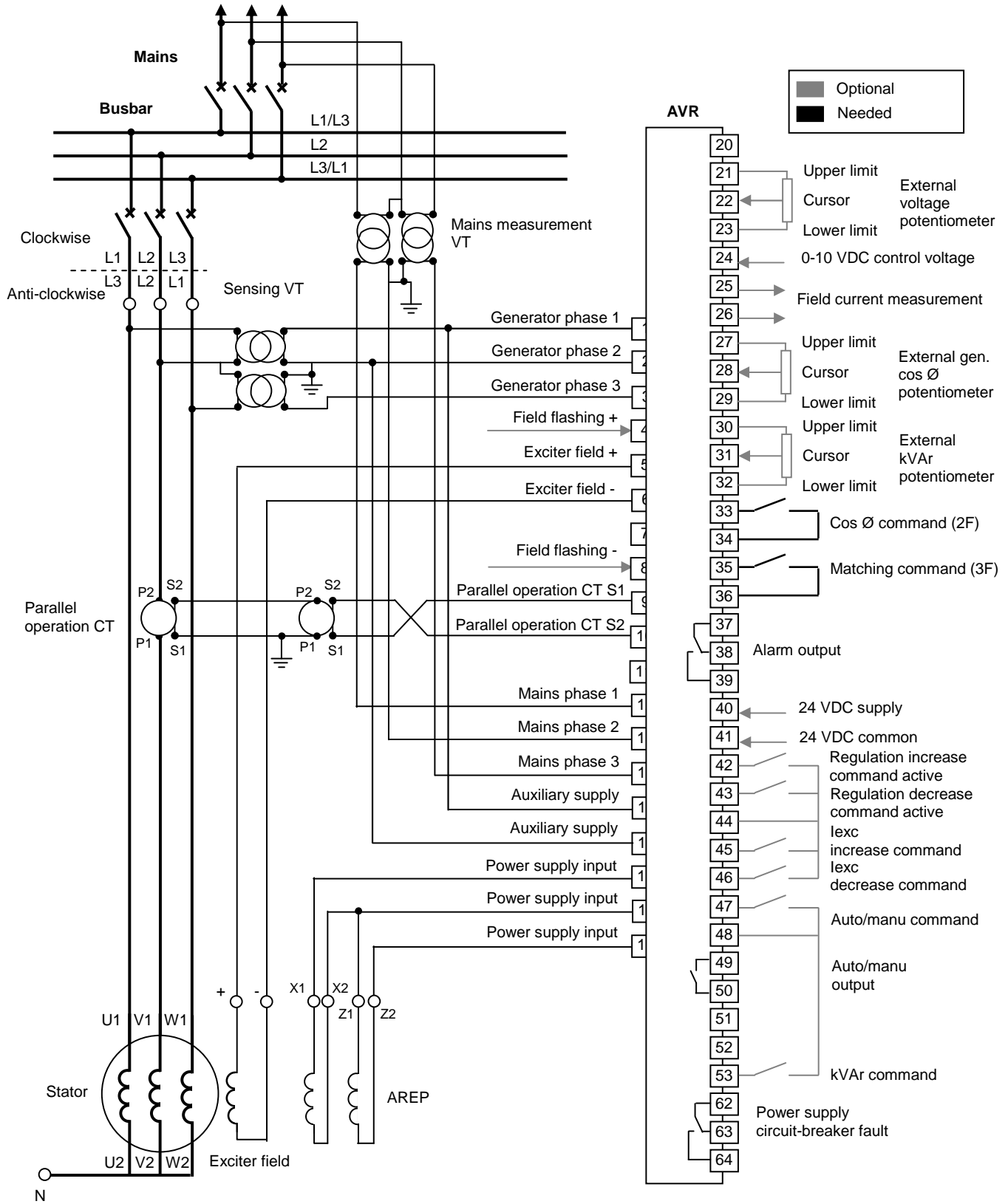
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## 5.3) AREP EXCITATION – 3F – LV



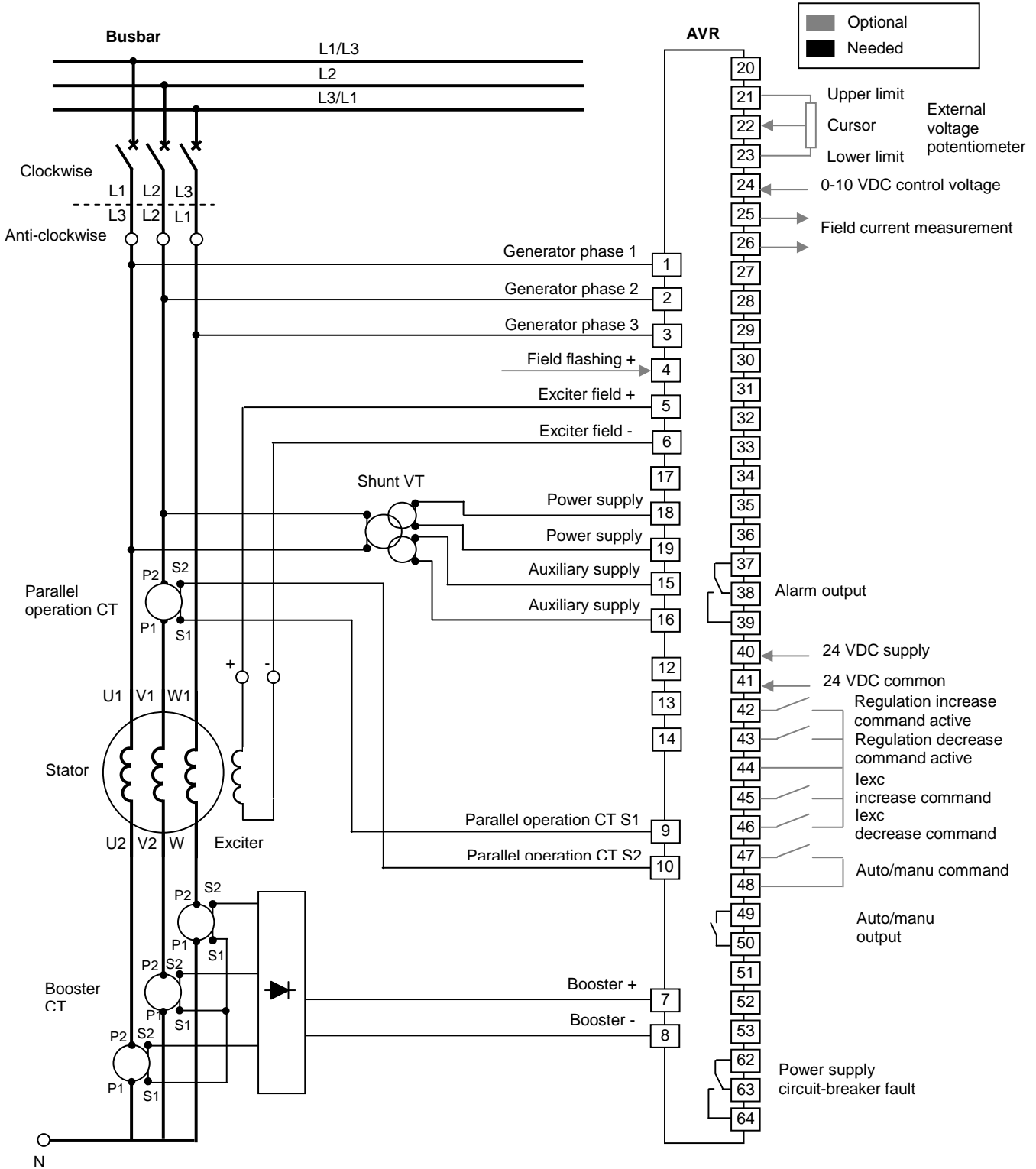
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## 5.4) AREP EXCITATION – 3F – MV



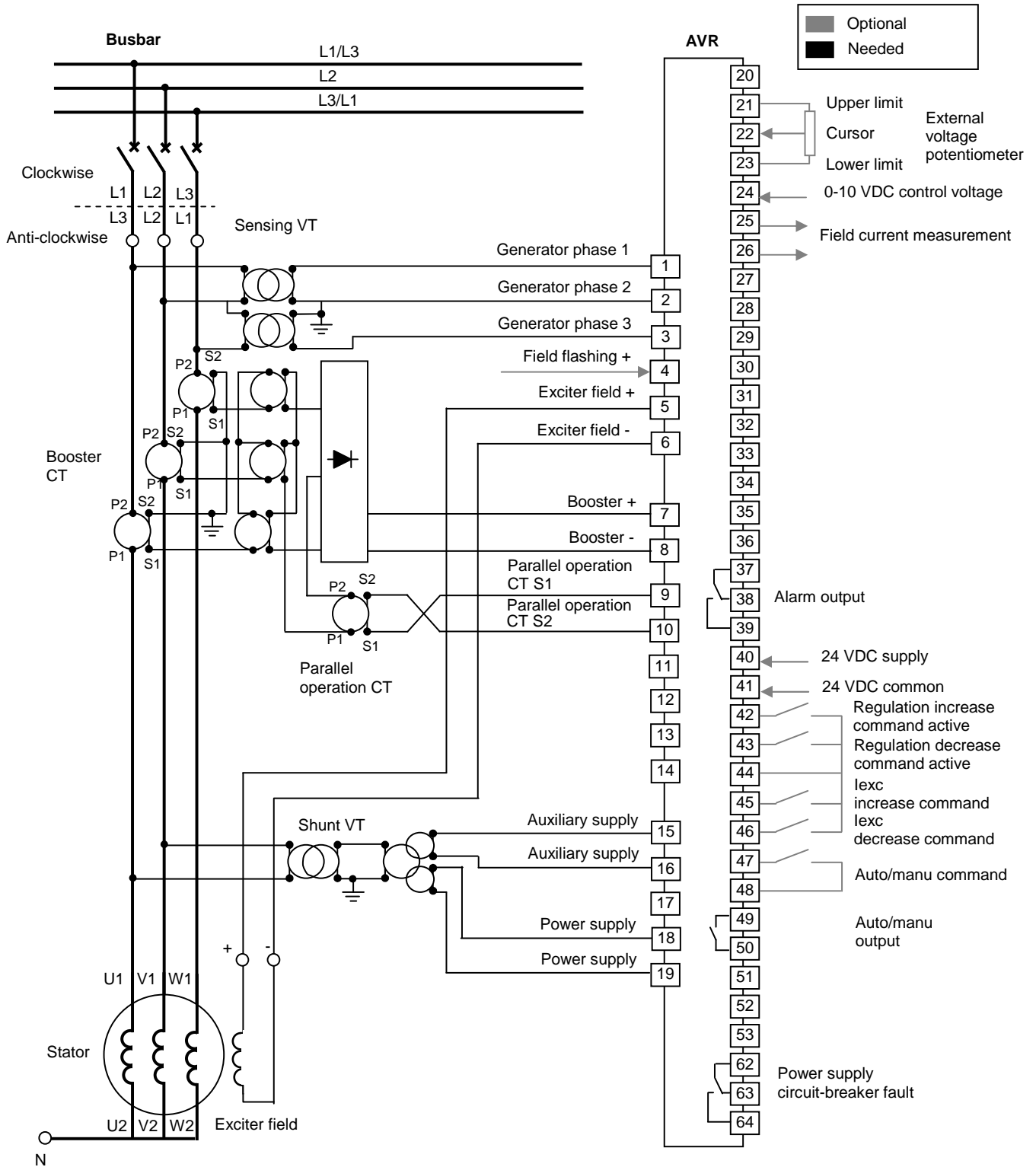
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## 5.5) SHUNT+BOOSTER EXCITATION – 1F – LV



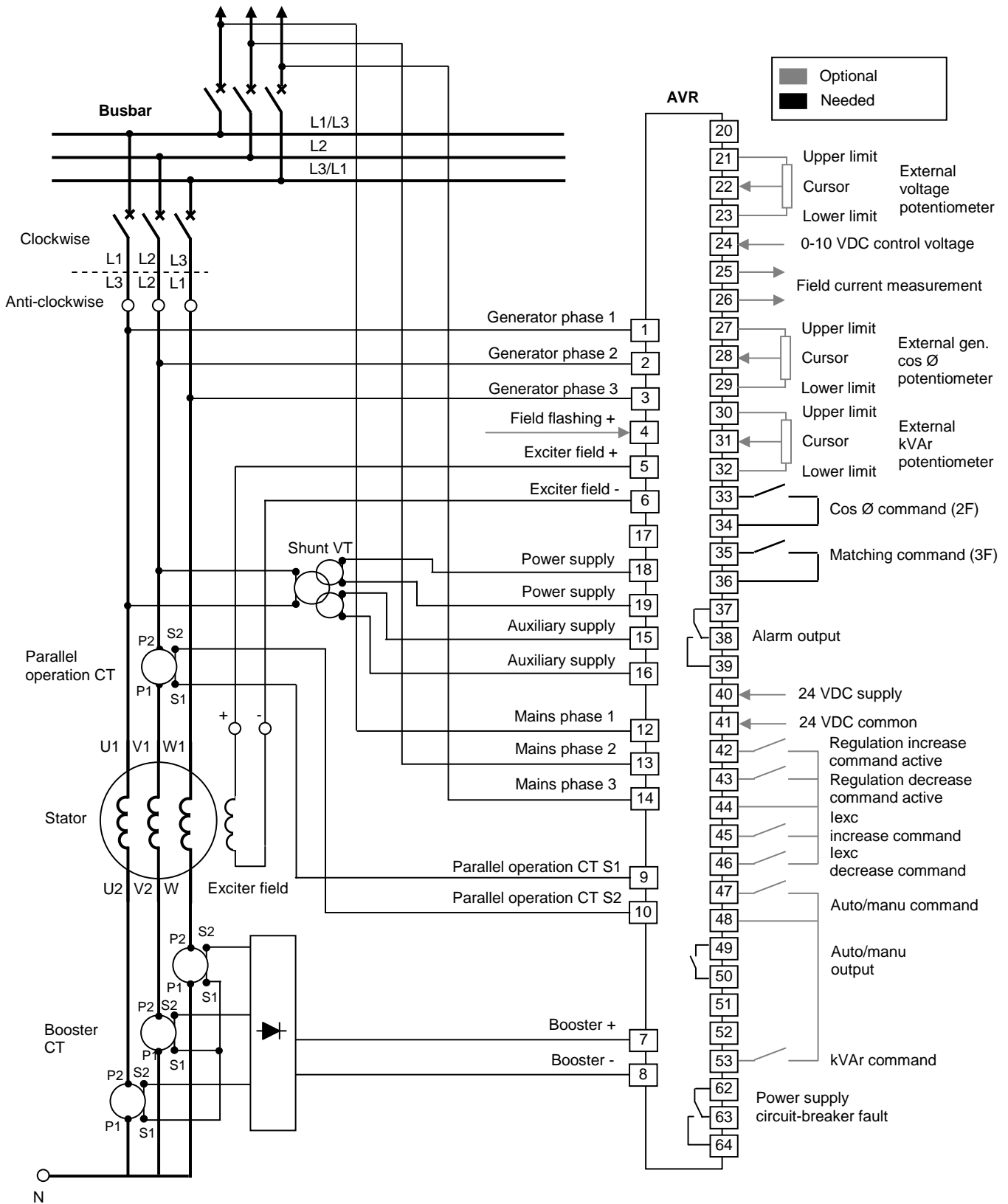
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## 5.6) SHUNT+BOOSTER EXCITATION – 1F – MV



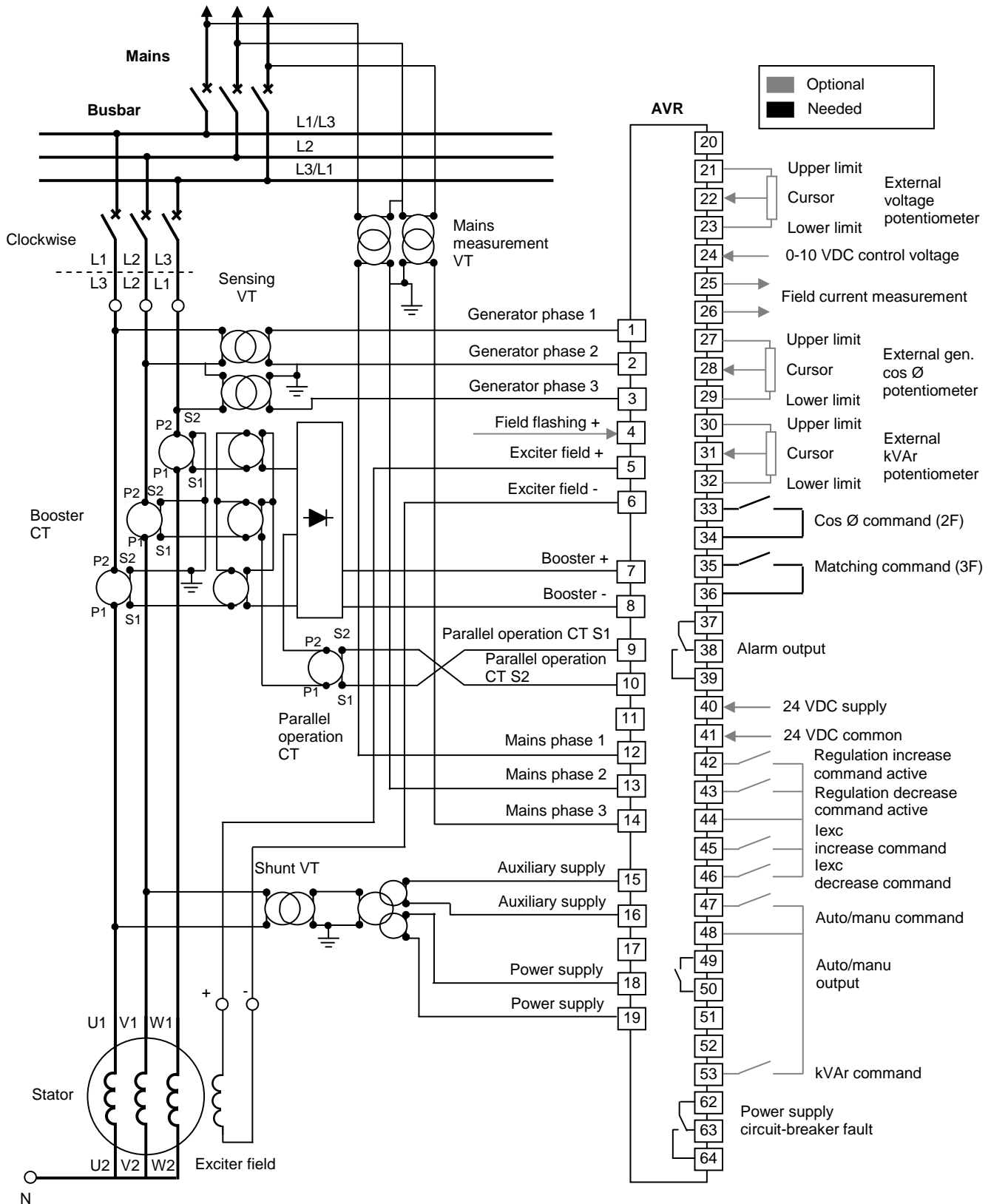
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## 5.7) SHUNT+BOOSTER EXCITATION – 3F – LV



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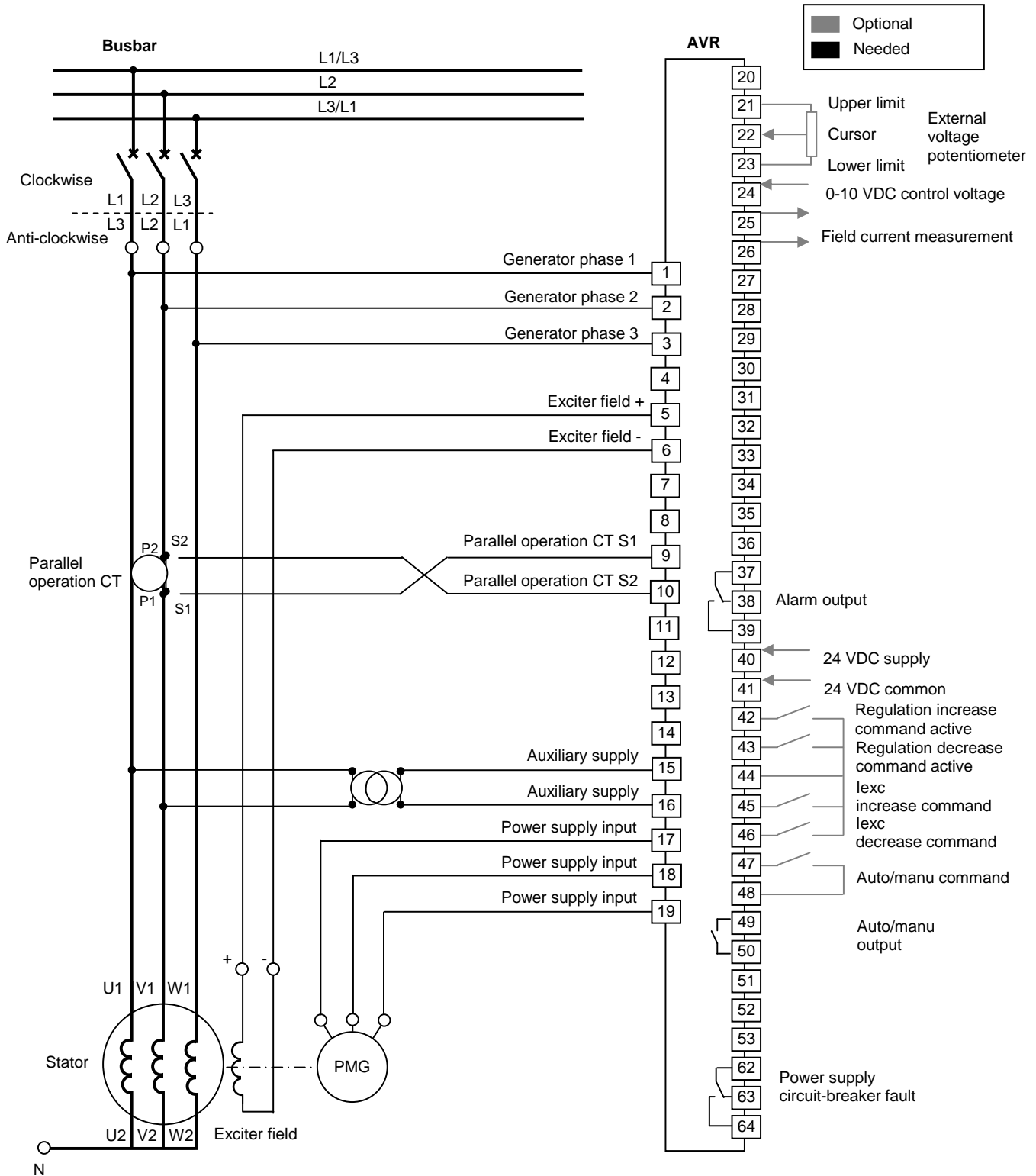
## 5.8) SHUNT+BOOSTER EXCITATION – 3F – MV





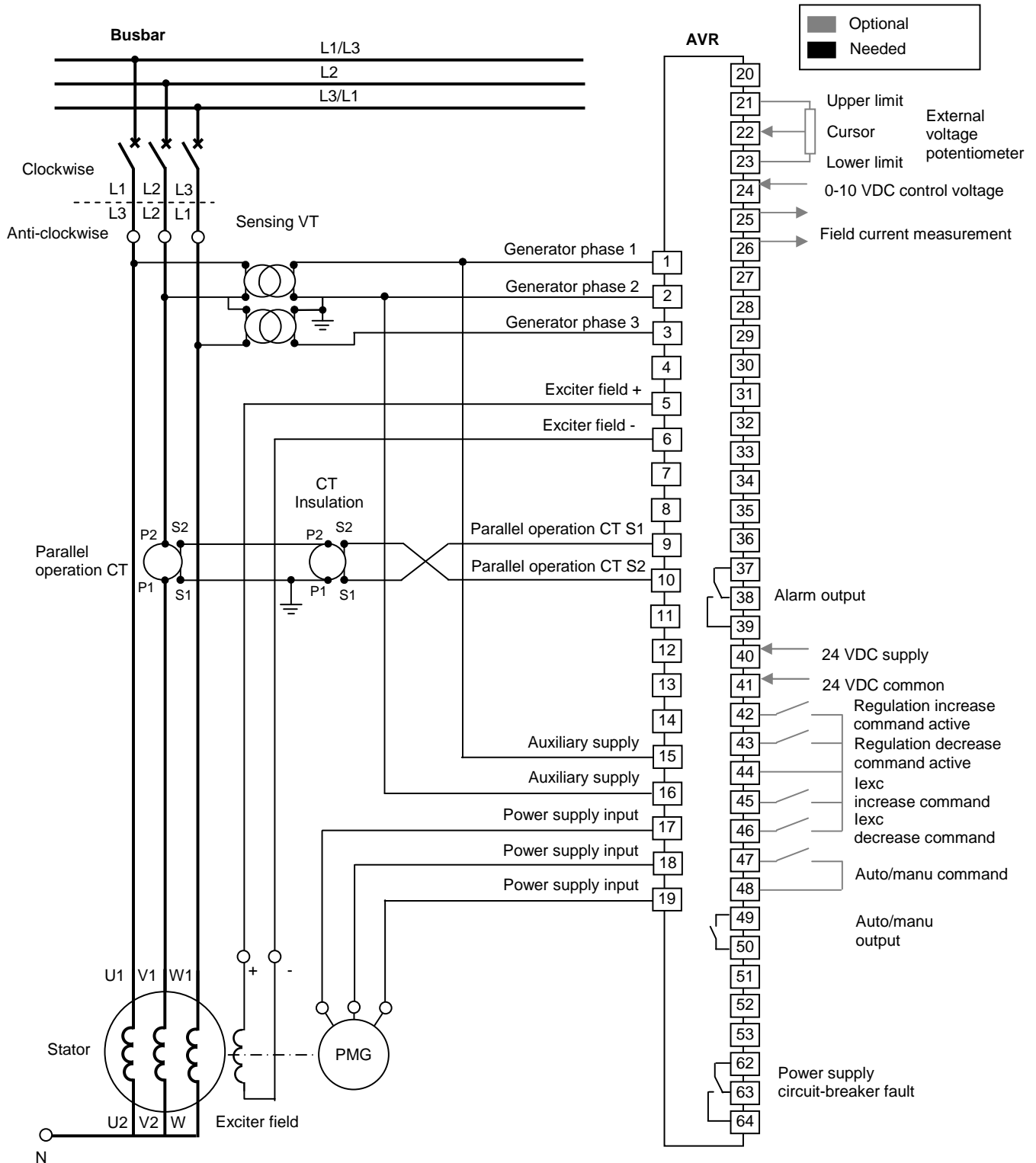
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## 5.9) PMG EXCITATION – 1F – LV



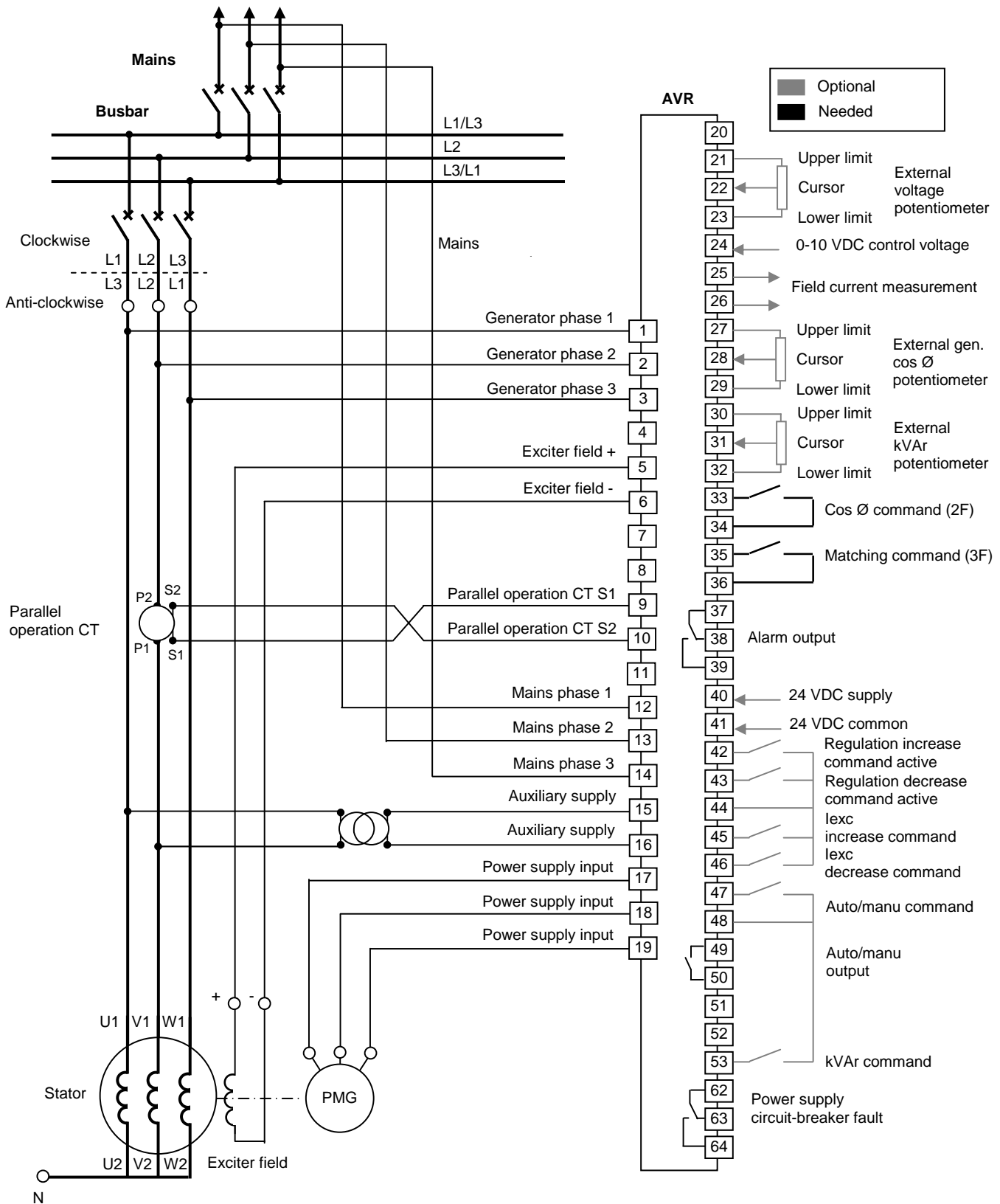
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## 5.10) PMG EXCITATION – 1F – MV



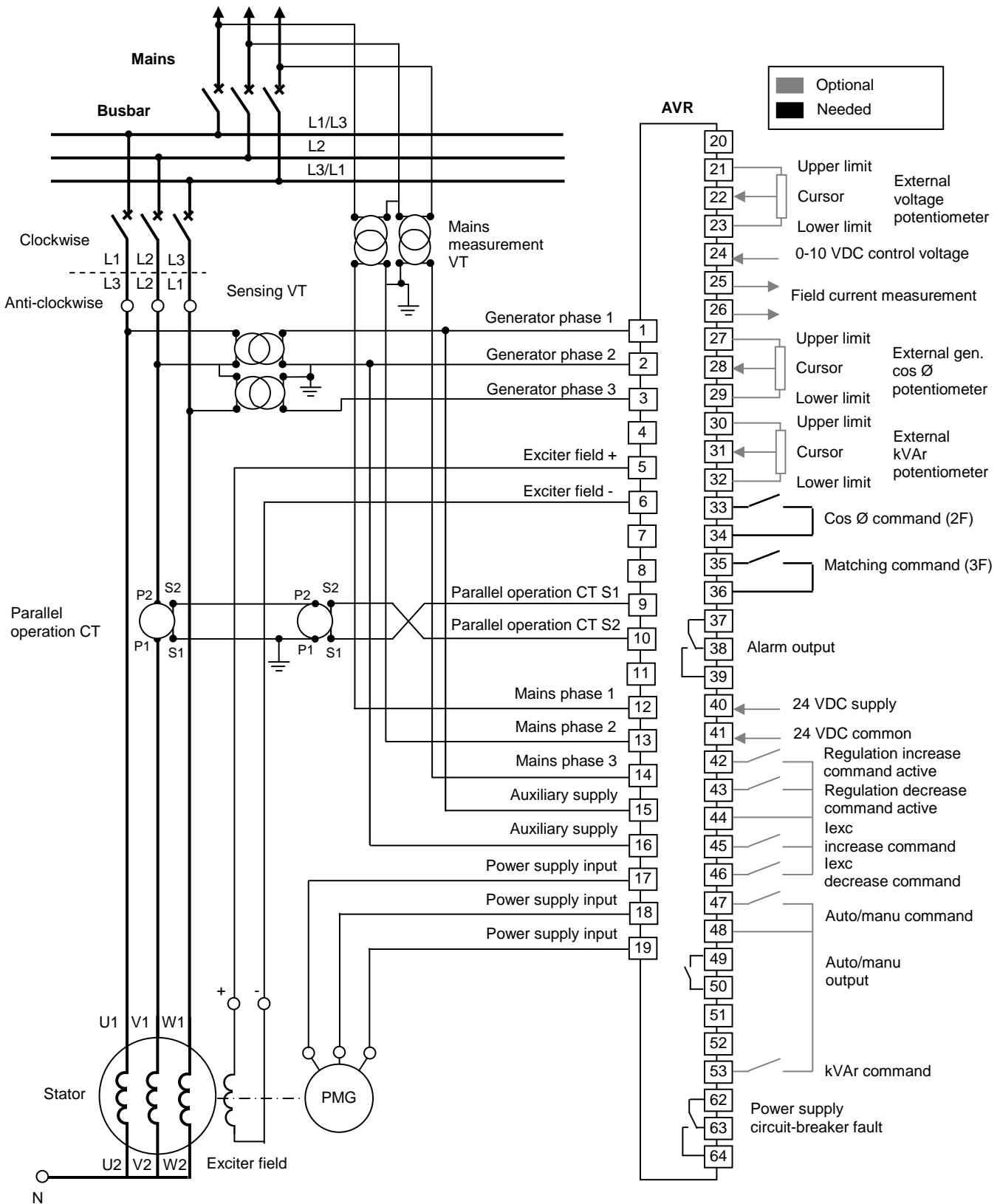
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## 5.11) PMG EXCITATION - 3F - LV



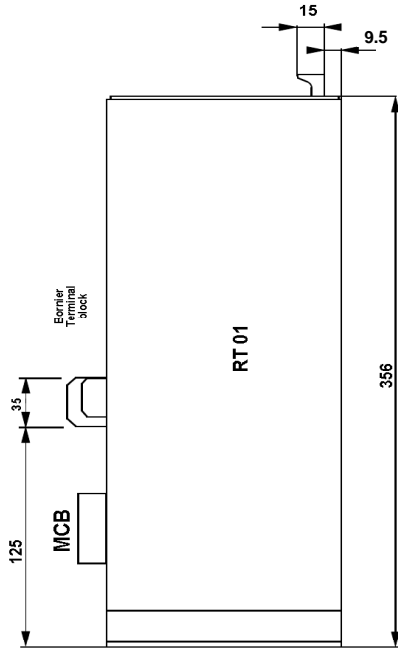
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## 5.12) PMG EXCITATION – 3F – MV

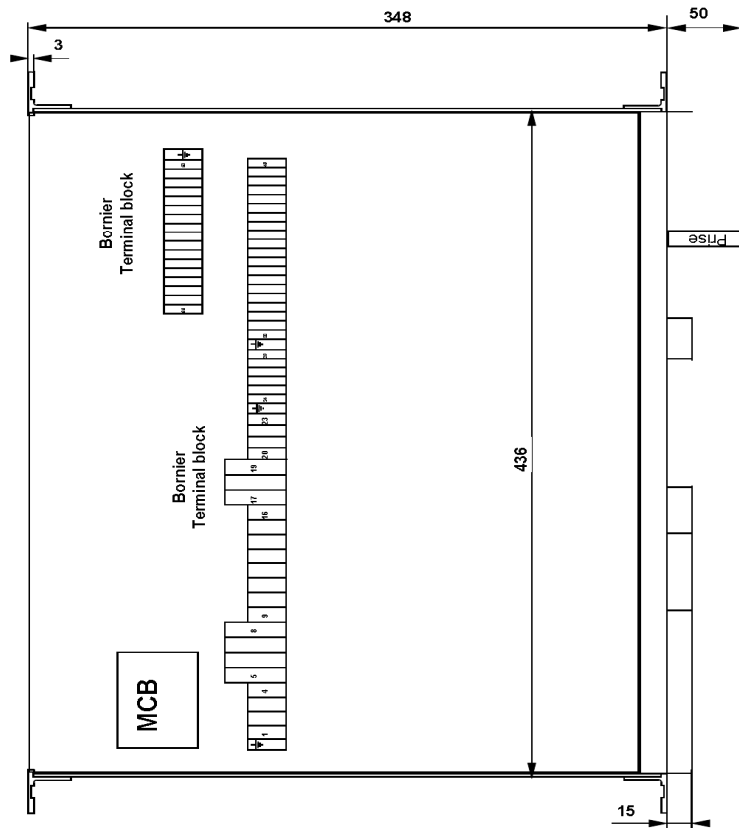
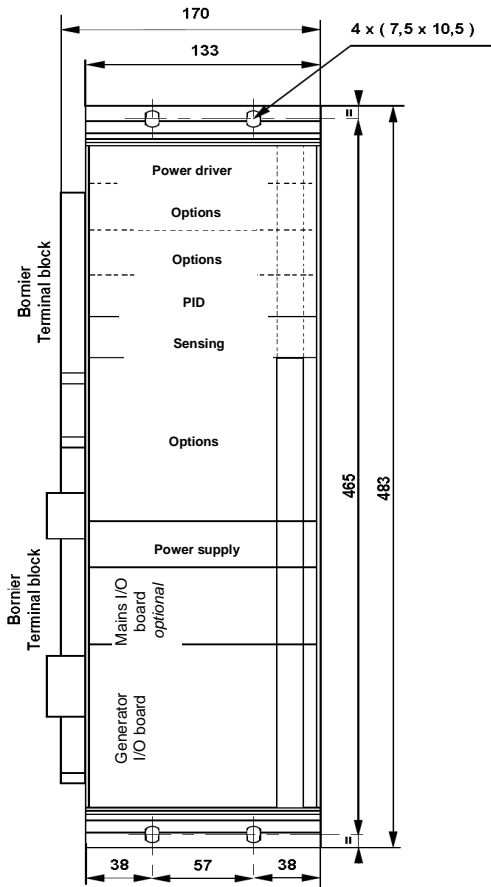


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## 6) AVR DIMENSIONS



Poids  
Weight 11 kg



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## 7) 1F GENERATOR I/O BOARD

### 7.1) FUNCTION

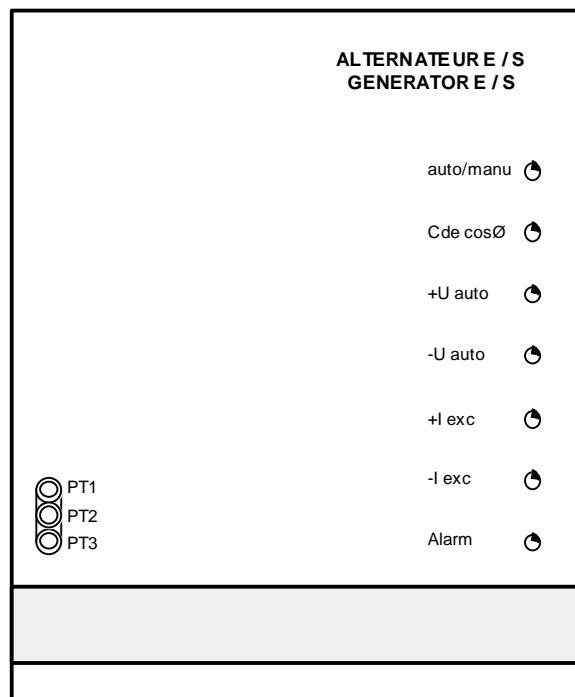
- ▶ This I/O board is principally an interface between external signals and the low-power electronics.
- ▶ It consists of:
  - ▶ The three-phase transformer for adapting the input voltage to the measurement circuits.
  - ▶ The parallel operation CT load resistor.

- ▶ The transformers for adapting the input voltage to the power supplies for the electronics.
- ▶ The I/O relay interfaces for the command/control terminal block.
- ▶ The interfaces between the 64-pt backplane bus and the terminal block for analogue signals.

### 7.2) SETTINGS

None

### 7.3) FRONT OF GENERATOR I/O BOARD



### 7.4) LEDs

- ▶ LED 1 – AUTO/MANU: On when the generator is controlled manually
- ▶ LED 2 – CMD COS Ø: On when the cos Ø command is closed on the terminal block (2F) 33-34
- ▶ LED 3 – +U AUTO: On when a regulation increase command is active (pushbutton for example) 44-42
- ▶ LED 4 – - U AUTO: On when a regulation decrease command is active (pushbutton for example) 44-43
- ▶ LED 5 – +Iexc: On when an Iexc increase command is active (pushbutton for example) 44-45
- ▶ LED 6 – -Iexc: On when an Iexc decrease command is active (pushbutton for example) 44-46
- ▶ LED 7 – ALARM: On when a fault occurs on the power block

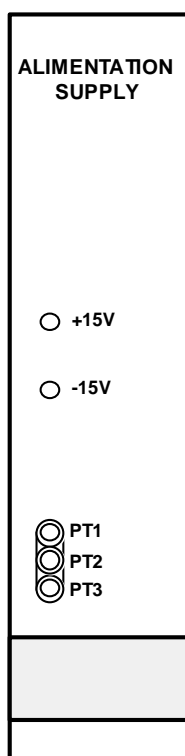
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## 8) POWER SUPPLY BOARD

### 8.1) FUNCTION

- ▶ Using unregulated symmetrical voltages, this board creates the +15 VDC and -15 VDC voltages.

### 8.2) FRONT OF POWER SUPPLY BOARD



### 8.3) LEDs

- ▶ LED 1 – +15V: On when the +15 VDC voltage is present.
- ▶ LED 2 – -15V: On when the -15 VDC voltage is present.

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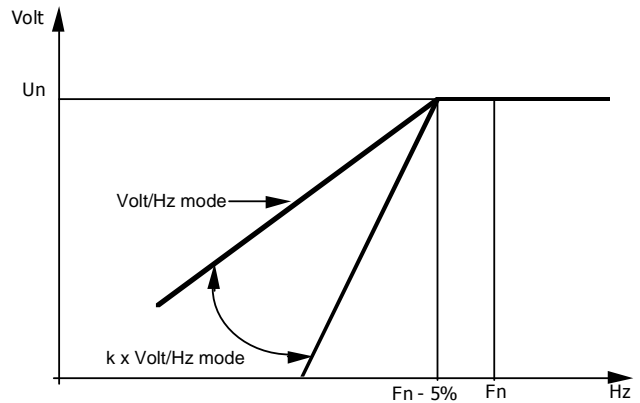
## 9) SENSING BOARD

### 9.1) FUNCTION

- ▶ Using the three-phase voltage, this board creates the image of the machine from the generator I/O board:
  - ▶ A filtered DC voltage which is the image of the machine which we will call  $V_m$ .
  - ▶ A DC voltage which is the image of the machine frequency and the reference which we will call  $V_{ref}$ .
- ▶ The  $V_{ref}$  voltage is constant above the underfrequency threshold (indicated by the LED lighting up) and decreases below this threshold according to a ratio defined by jumper CV1:
  - ▶ Either fixed V/Hz
  - ▶ Or adjustable kVolt/Hz (see curve below)

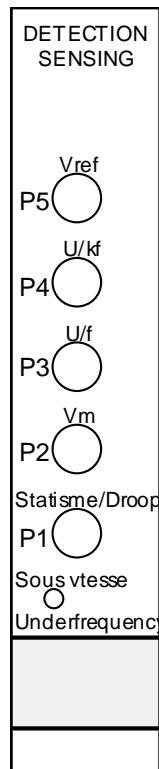
### 9.2) SETTINGS

- ▶ P1: Reactive quadrature droop setting with parallel operation between machines
- ▶ P2:  $V_m$  setting for the rated voltage (9 VDC at  $U_n$ )



- ▶ P3: Underfrequency threshold setting (normally  $F_n - 5\%$ ) indicated by the LED lighting up
- ▶ P4: Underfrequency slope ( $k$ ) setting in kVolt/Hz mode
- ▶ P5:  $V_{ref}$  reference setting for rated voltage (9 VDC at  $U_n$  and  $F_n$ )

### 9.3) FRONT OF SENSING BOARD





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## 9.4) LEDs

- ▶ LED 1 – Underfrequency: On in the event of underfrequency.

## 10) PID BOARD

### 10.1) FUNCTION

- ▶ Using the  $V_m$  (machine voltage),  $V_{ref}$  (reference voltage) information and additional information described later on, this board creates the power driver board control voltage, in other words the field current reference.
- ▶ It consists of three operating modes defined by external inputs:
  - ▶ Standalone operation or parallel operation between machines (1st function). This is the default mode.
  - ▶ Parallel operation with the mains in  $\cos\phi$  or KVAR regulation mode (2nd function). (The  $\cos\phi$  or KVAR board must be present for this).
  - ▶ Voltage matching with the mains before coupling (3rd function) (The mains I/O board must be present for this).
- ▶ 1F: The machine voltage  $V_m$  is compared to the sum of the voltages  $V_{ref}$ ,  $P_{ext}$ , etc depending on the options used and the resulting voltage (error voltage) actuates the PID.
- ▶ 2F: When the  $\cos\phi$  command input is activated, the machine voltage  $V_m$  is compared to the voltage from the  $\cos\phi$  board and the resulting voltage (error voltage) actuates the PID.
- ▶ 3F: When the U/U command input is activated, the machine voltage  $V_m$  is compared to the voltage from the mains I/O board and the resulting voltage (error voltage) actuates the PID.
- ▶ An external compensation input, designed for special applications, is added to the error voltage and the resulting voltage actuates the PID. The PID,

each branch of which (P, I, D) can be set independently of the others, can be used to adjust the time constants according to those of the machine. The integrator branch can be short-circuited, for example during field flashing.

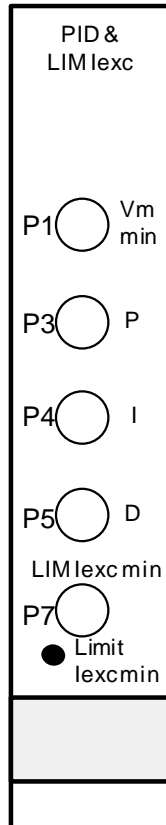
- ▶ All three outputs are then summed, after which the output is limited to 10 VDC and then corresponds to the field current reference for the "AUTO" channel which is sent to the power driver/command board.
- ▶ Limiting the minimum for this output can avoid total de-energising of the machine. In the case of parallel operation with the mains, this limiting changes according to the active power generated by the machine, with this information supplied by the  $\cos\phi$ /KVAR board.
- ▶ A secondary circuit can be used to detect whether the machine voltage is less than the reference voltage in order to unblock the driver board ceiling.

### 10.2) SETTINGS

- ▶ P1: Ceiling unblocking threshold setting (normally 90%  $U_n$ )
- ▶ P2: Proportional branch gain setting (large signals)
- ▶ P3: Proportional branch gain setting
- ▶ P4: Integration constant setting
- ▶ P5: Derivative branch gain setting
- ▶ P6: Derivative branch time constant setting
- ▶ P7: Field excitation minimum permanent limit setting
- ▶ P8: Field excitation minimum limit  $\cos\phi$  correction setting

# R630 AUTOMATIC VOLTAGE REGULATOR

## 10.3) FRONT OF PID BOARD



## 10.4) LEDs

- ▶ LED 1 – LIM lexc: On if the minimum lexc limit is reached

# R630 AUTOMATIC VOLTAGE REGULATOR

## 11) DRIVER BOARD

### 11.1) FUNCTION

- ▶ Using the "AUTO" reference, "MANU" reference information and additional information detailed later on, this board creates the field current supplied by the AVR.
- ▶ It consists of three operating modes defined by external information:
  - ▶ Normal operation with a ceiling of 110% of rated I<sub>exc</sub>, adjustable with P4. This is the default mode.
  - ▶ Ceiling unlocked operation (at least 160% of rated I<sub>exc</sub>) depending on the associated command input from the PID board, with a duration limit and an alarm if this time is too long.
  - ▶ Maximum ceiling operation if the synchronization voltage disappears (machine SCT) (machine short-circuit current limiting)
- ▶ The reference voltage, either "AUTO" or "MANU" depending on the state of the command input assigned to duty limits, is compared to the field current measurement and generates an error voltage. After integration, this is compared to a sawtooth obtained from the synchronization voltage and the resulting voltage (pulses with variable cyclical ratio) actuates the power transistors, via galvanic isolation (photocouplers).
- ▶ This board is supplied in three ways:
  - ▶ By the rack general power supply in normal operation
  - ▶ By a galvanically-isolated converter on the field voltage during field flashing or machine short-circuit (missing rack power supply)
  - ▶ By a voltage derived from the field voltage for controlling the power transistors

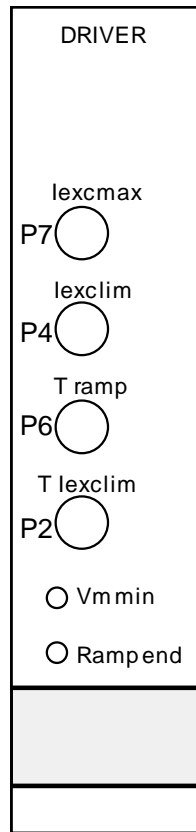
- ▶ Several phenomena can affect the permanent limit of rated I<sub>exc</sub>:
  - ▶ Ceiling unlocked on a decrease in machine voltage compared to the reference. The ceiling then changes from 110% (normal operation) to less than 160% of the rated field current for a limited time and is then brought back to 110%. An alarm is generated if this voltage decrease lasts after the return to 110%.
  - ▶ Ceiling unlocked on a disappearance of the synchronization voltage. The ceiling then changes to the maximum permitted by the presetting of P7 (generator short-circuited).
  - ▶ Reduction in the ceiling by power heatsink overheating. By altering the thermocontact fixed on the heatsink, the ceiling is reduced to a value determined by the setting of P8.

### 11.2) SETTINGS

- ▶ P1: Integrator time constant setting
- ▶ P2: Ceiling unlocking time setting (usually 5 s)
- ▶ P3: Alarm time setting on too much ceiling unlocked time
- ▶ P4: Permanent ceiling setting (usually 1.1 rated I<sub>exc</sub>)
- ▶ P5: I<sub>exc</sub> measurement HALL converter range setting
- ▶ P6: Field flashing ramp increase time setting
- ▶ P7: Field excitation maximum permanent limit setting (machine short-circuited)
- ▶ P8: Maximum ceiling setting in power heatsink overheating mode

# R630 AUTOMATIC VOLTAGE REGULATOR

## 11.3) FRONT OF DRIVER BOARD



## 11.4) LEDs

- ▶ LED 1 – Vm min: On if the machine voltage is at minimum.
- ▶ LED2 – Ramp end: On at the end of the starting ramp.

# R630 AUTOMATIC VOLTAGE REGULATOR

## 12) COS Ø/KVAR BOARD (OPTION)

### 12.1) FUNCTION

- ▶ Using the machine voltage and current information, this board creates the following signals:
  - ▶ An image of the reactive machine current called (KVAR) is used for KVAR regulation.
  - ▶ An image of the lag between the machine voltage and current called ( $\emptyset$ ) is used for  $\cos\emptyset$  (Power factor) regulation.
  - ▶ An image of the active machine current called (KW) is used to compensate for the PID board field excitation minimum limit.

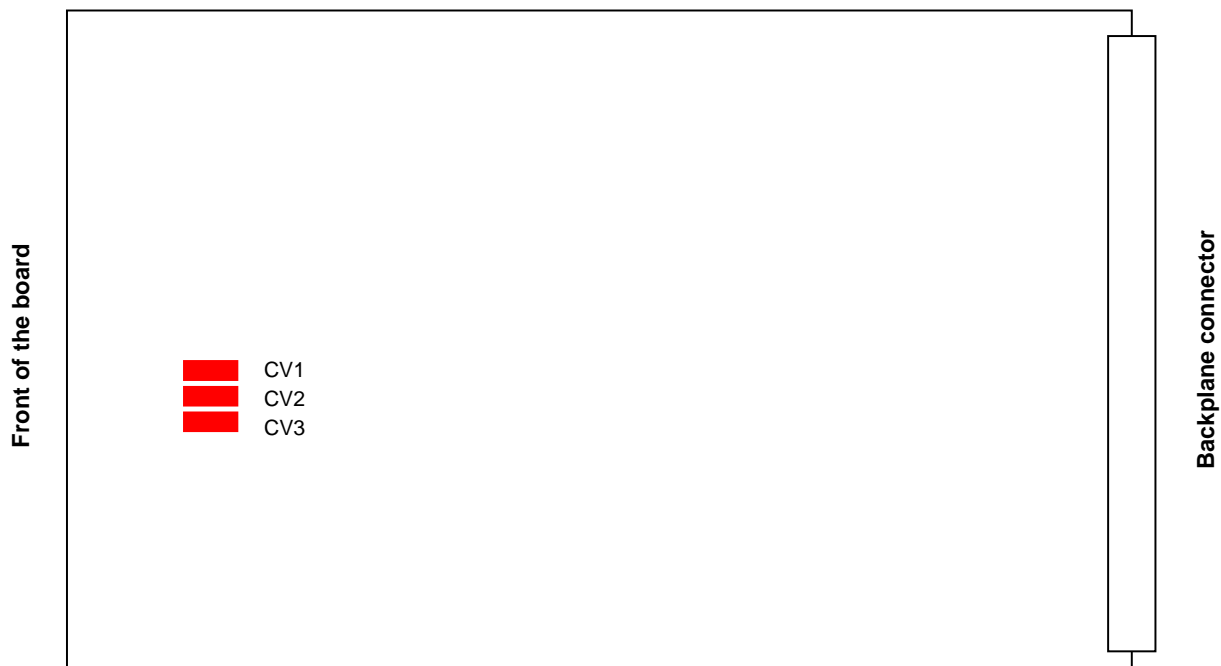
### 12.2) SETTINGS

- ▶ **Potentiometers**
  - ▶ P1: KVAR reference setting
  - ▶ P2:  $\cos\emptyset$  reference setting

- ▶ P3: Phase shifter setting (internal)
- ▶ P4:  $\cos\emptyset$  gain setting
- ▶ P5: KVAR gain setting
- ▶ P6: Differential quadrature droop setting
- ▶ P7: Pulse width setting (internal)
- ▶ **Jumper:** Selection of type of quadrature droop
  - ▶ None: Reactive quadrature droop set by P1 on the sensing board
  - ▶ CV1: Zero quadrature droop at  $\cos\emptyset=1$  and falling to 0.8
  - ▶ CV2: Zero quadrature droop at fixed KVAR (P1), falling if higher and rising if the value is lower
  - ▶ CV3: Zero quadrature droop at fixed  $\cos\emptyset$  (P2), falling if lower and rising if the value is higher

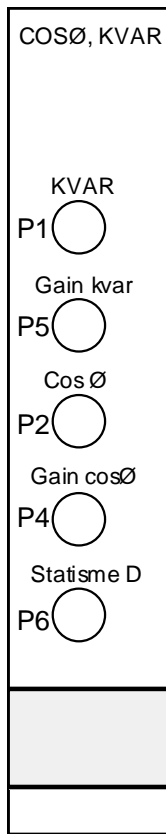
**Note:** If using this board's quadrature droop, potentiometer P1 on the sensing board must be set to zero.

### 12.3) TERMINAL WASHER POSITION



# R630 AUTOMATIC VOLTAGE REGULATOR

## 12.4) FRONT OF COSØ/KVAR BOARD



# R630 AUTOMATIC VOLTAGE REGULATOR

## 13) MAINS I/O BOARD (2F OR 3F OPTION)

### 13.1) FUNCTION

This I/O board is principally an interface between external signals and the low-power electronics.

It consists of:

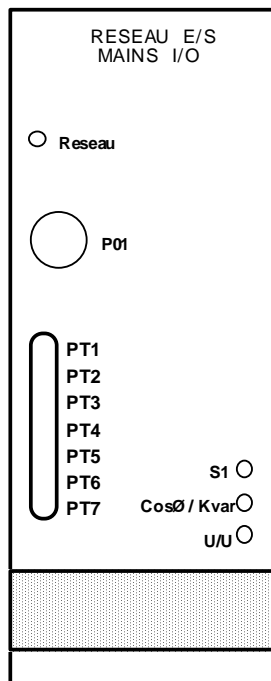
- ▶ The three-phase transformer for adapting the input voltage to the measurement circuits.
- ▶ The circuit creating the DC voltage which is the image of the mains voltage.

- ▶ The I/O relay interface for the command/control terminal block.
- ▶ The interfaces between the 64-pt backplane bus and the terminal block for analogue signals.

### 13.2) SETTINGS

- ▶ P01: Adjustment of generator voltage matching to the mains voltage

### 13.3) FRONT OF MAINS I/O BOARD



### 13.4) LEDs

- ▶ LED – MAINS: On when the mains voltage is present
- ▶ LED – S1: Reserved
- ▶ LED – CosØ/Kvar: On when the command is closed on the terminal block (terminals 48-53)
- ▶ LED – U=U: Matching request contact closed (terminals 35-36)

# R630 AUTOMATIC VOLTAGE REGULATOR

## 14) VOLTAGE/COSØ DIGITAL SETTINGS BOARD (OPTION)

### 14.1) FUNCTION

- ▶ This board replaces two conventional motorised potentiometers:
  - ▶ One for setting the voltage
  - ▶ One for setting the cosØ or KVAR
- ▶ Switching between these two functions is controlled by the cosØ regulation command (terminals 33 and 34) and the choice of cosØ or KVAR is made by the external contact on terminals 48, 53.
- ▶ Each of the most recent values is stored before changing function or when the machine is stopped.
- ▶ The increase/decrease command inputs are isolated by the low-level internal relay in the electronics.
- ▶ Jumpers (SW1 and SW2) are used to choose between a unipolar or bipolar output and the range can be adjusted using potentiometers P2 and P3.
- ▶ Jumpers SW3 and SW4 should be open during normal operation and can be used for special applications.

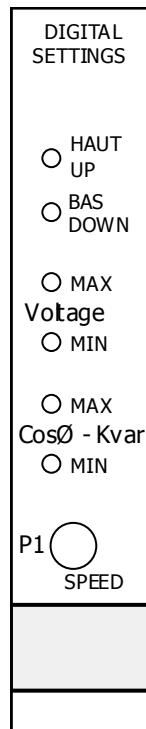
▶ The variable speed can be adjusted using potentiometer P1.

▶ **NOTE: When this board is installed, the internal voltage setting (P5 on the sensing board) must be used to give the median range position (if bipolar range) or the maximum setting if it is a unipolar range (same as for the internal setting of cosØ or Kvar on the cosØ board). An external potentiometer must not be used with this board, adjustments should only be made via the pushbuttons on the main terminal block in 42, 43, 44 on R630.**

### 14.2) SETTINGS

- ▶ P1: Clock speed (total range time)
- ▶ P2: Voltage range value
- ▶ P3: CosØ or KVAR range value
- ▶ SW1: Voltage range polarity (0/+ or +/-)
- ▶ SW2: CosØ/KVAR range polarity (0/+ or +/-)

### 14.3) FRONT OF DIGITAL SETTINGS BOARD





# R630 AUTOMATIC VOLTAGE REGULATOR

## 14.4) POSITION SWITCHES



## 14.5) LEDs

- ▶ LED 1 – HAUT/UP: On when the regulation increase command is closed on the terminal block (pushbutton for example) terminals 44-42
- ▶ LED 2 – BAS/DOWN: On when the regulation decrease command is closed on the terminal block (pushbutton for example) terminals 44-43
- ▶ LED 3 – MAX VOLTAGE: On when the Digital potentiometer is turned fully to MAX
- ▶ LED 4 – MIN VOLTAGE: On when the Digital potentiometer is turned fully to MIN
- ▶ LED 5 – MAX COSØ-KVAR: On when the Digital potentiometer is turned fully to MAX
- ▶ LED 6 – MIN COSØ-KVAR: On when the Digital potentiometer is turned fully to MIN

# R630 AUTOMATIC VOLTAGE REGULATOR

## 15) MANUAL MODE 2 BOARD (OPTION)

### 15.1) FUNCTION

- ▶ Using the internal reference (P2) and external reference information, this board creates the field current command signal controlling the "MANU" channel on the driver board.
- ▶ The Iexc output signal is limited or even reduced if the machine voltage exceeds the limiting value set by potentiometer P1 (on-load circuit-breaker opening for example). This operating scenario is indicated by the "LIMIT" LED and the field current setting must then be reduced to the point where control is regained.
- ▶ In MANU operation, the board continuously compares the MANU channel control voltage with that of the AUTO channel and creates a correction signal which is sent to the PID board so that these two channels always have identical values. This then allows smooth switching from the MANU channel to the AUTO channel. Operation will then continue with the appropriate references for AUTO operation.

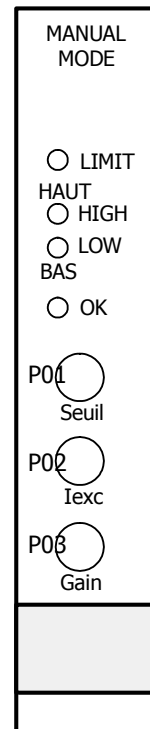
- ▶ Because the ceiling may have been unlocked during this operation, it is important to wait a few seconds after this switch and then eventually return to MANU mode.
- ▶ In AUTO operation, both these channels are also compared and the comparative state of the MANU channel is indicated by three LEDs (UP/DOWN/OK). The AUTO to MANU command is given on the main terminal block, terminals 47-48.

**NOTE: When an Iexc digital potentiometer is used, the field excitation setting of this board (P2) must be set to 0 or at least set below the rated stator voltage and an external adjustment potentiometer must not be used. Only pushbuttons on terminals 44, 45, 46 of the AVR terminal block can be used for adjustment.**

### 15.2) SETTINGS

- ▶ Threshold: Limit voltage setting
- ▶ Iexc: Field current reference internal setting
- ▶ Gain: PID correction gain setting

### 15.3) FRONT OF MANUAL MODE 2 BOARD



### 15.4) LEDs

- ▶ LED 1 – LIMIT: On when the machine voltage value exceeds the voltage value set by potentiometer P1
- ▶ LED 2 – HAUT/HIGH: Signals that the MANU channel is stronger than the AUTO channel

# R630 AUTOMATIC VOLTAGE REGULATOR

- ▶ LED 3 – LOW/BAS: Signals that the MANU channel is weaker than the AUTO channel
- ▶ LED 4 – OK: Signals that the MANU channel and the AUTO channel are balanced and that AUTO --->

MANU switching is possible without noticeable bumping

## 16) IEXC DIGITAL SETTING BOARD (OPTION)

### 16.1) FUNCTION

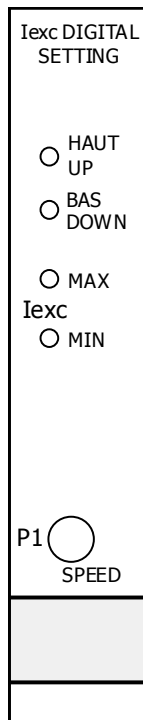
- ▶ This board replaces a conventional motorised potentiometer in "MANU" mode and makes the "MANU" channel output always equal to that of the "AUTO" channel to allow smooth switching between "AUTO" and "MANU" operation at any load (tracking in "AUTO" mode).
- ▶ Switching between these two modes is achieved by the "AUTO/MANU" command (terminals 47, 48).
- ▶ Jumper SW1 can be used to choose between an output voltage according to the sensing board U/F slope or from a fixed 5V. The range can be adjusted using potentiometer P3.
- ▶ Jumpers SW3 and SW4 should be open in normal operation and closed if tracking operation is desired.
- ▶ The speed of change can be adjusted using potentiometer P1 in manual operation, not P2 in tracking mode. P2 acts as a time delay between variation of the "AUTO" output and the response from the "MANU" channel.

**NOTE: When this board is used, the field current internal setting (P2 on the manual mode board) should be set to zero or below the no-load value. An external potentiometer must not be used with this board, adjustments should only be made using the pushbuttons on terminals 44, 45, 44 of the AVR terminal block.**

### 16.2) SETTINGS

- ▶ **Potentiometers:**
  - ▶ P1: Speed (tracking range time)
  - ▶ P2: Speed ("MANU" range mode time)
  - ▶ P3: Field current range
- ▶ **Switches**
  - ▶ SW1 : Fixed or U/f reference
  - ▶ SW3/4: Normal mode (open) or tracking (closed)

### 16.3) FRONT OF IEXC DIGITAL SETTING BOARD



# R630 AUTOMATIC VOLTAGE REGULATOR

## 16.4) SWITCH POSITIONS



## 16.5) LEDs

- ▶ LED 1 – HAUT/UP: On when there is a regulation increase command
- ▶ LED 2 – BAS/DOWN: On when there is a regulation decrease command
- ▶ LED 3 – MAX: On if the maximum adjustment position is reached
- ▶ LED 4 – MIN: On if the minimum adjustment position is reached

# R630 AUTOMATIC VOLTAGE REGULATOR

## 17) 4-20 MA INTERFACE BOARD (OPTION)

### 17.1) DESCRIPTION

- ▶ This board is needed when the user wishes to keep the  $\cos\phi$  constant or the KVAR constant not on the generator terminals, but on the incoming supply line. It therefore requires a  $\cos\phi$  or KVAR/4-20 mA converter placed where the  $\cos\phi$  or KVAR need to be regulated.

### 17.2) FUNCTION

- ▶ Using the reference information and a 4-20 mA signal which is the image of the  $\cos\phi$  on the mains, this board creates the error signal controlling the PID on the main PID board.
- ▶ The error signal gain can be adjusted and the signal can be inverted according to the direction of 4-20 mA signal variation.
- ▶ This operating scenario is indicated by LED3 and by a changeover switch projecting from the front face.
- ▶ This type of operation is selected by a contact available on the front connector and should be used during coupling when the contact is closed between terminals 33, 34 on the AVR:
  - ▶ Contact open: The  $\cos\phi$ /KVAR is regulated at the generator output
  - ▶ Contact closed: The 4-20 mA information controls the regulation function for the internal (P2 or 2nd 4-20 mA channel) and/or external references via the front connector.
- ▶ If the 4-20 mA measuring signal were to disappear during operation, the mode automatically returns to  $\cos\phi$  regulation on the generator and this fault is indicated on the front by LED 1 or LED2 and also by a changeover switch.
- ▶ An identical second 4-20 mA channel can be used either as a remote mains  $\cos\phi$  reference or as an additional AVR reference (voltage, machine  $\cos\phi$  or machine KVAR). In the same way as before, if the 4-20 mA information were to disappear, its action is cancelled and indicated by LED2.
- ▶ Additional limiting of the field current is included, enabled by closing of a contact projecting from the front connector and indicated by LED4. The limiting value is set by P7 (Limit 2 set) and can be adjusted between a max. value set by P7 on the driver board and a minimum value set by P8 on the driver board.
- ▶ An LED projects from a changeover switch to signal when one or more digital potentiometers (if used) are fully turned to their limit.

### 17.3) SETTINGS

- ▶ P1: 4-20 mA range channel 1 setting
- ▶ P2: Channel 1 internal reference
- ▶ P3: Channel 1 gain setting
- ▶ P4: 4-20 mA range channel 2 setting
- ▶ P5: Channel 2 internal reference
- ▶ P6: Channel 2 gain setting
- ▶ P7: Threshold 2 limit setting

#### Jumpers:

- ▶ CV1 A: Channel 1 used
- ▶ CV1 B: Channel 1 not used
- ▶ CV2 A: Channel 2 used
- ▶ CV2 B: Channel 2 not used
- ▶ CV3 A: Channel 1 forward error
- ▶ CV3 B: Channel 1 reverse error
- ▶ CV4 A: Channel 2 forward error
- ▶ CV4 B: Channel 2 reverse error
- ▶ CV5 A: Channel 1 in 4-20 mA channel 1 regulation mode
- ▶ CV6 B: Channel 2 in voltage reference mode
- ▶ CV6 C: Channel 2 in machine  $\cos\phi$  reference mode
- ▶ CV6 D: Channel 2 in machine KVAR reference mode
- ▶ CV6 E: Channel 2 in channel 1 reference mode

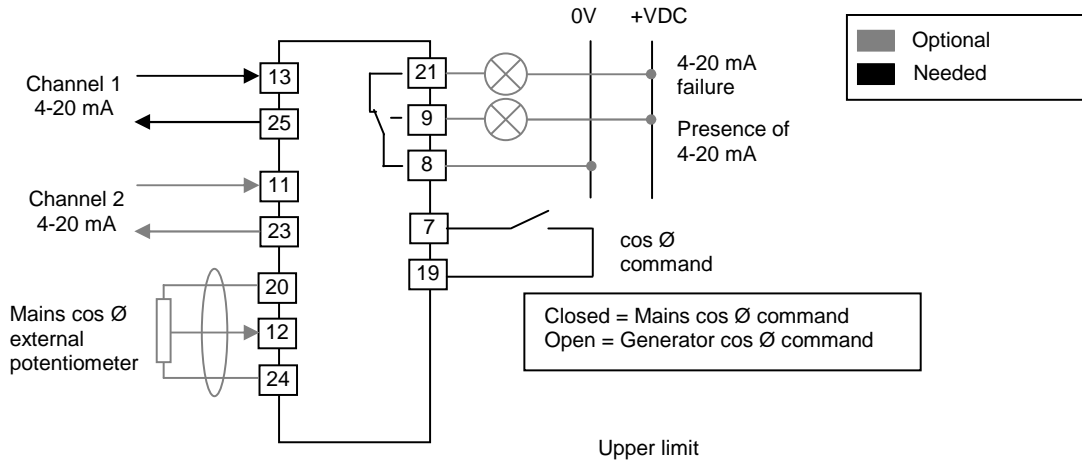
### 17.4) I/O

#### Connector on the front face (DB 25-pin)

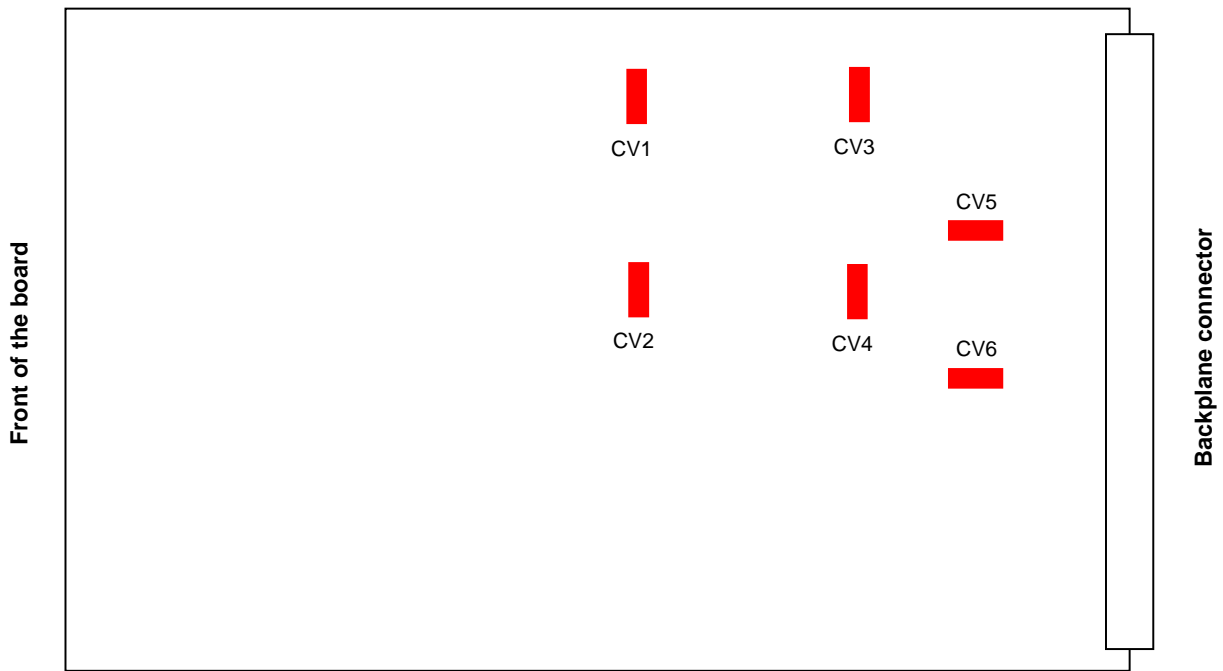
- ▶ 13: + 4-20 mA channel 1 input
- ▶ 25: 4-20 mA channel 1 output
- ▶ 11: + 4-20 mA channel 2 input
- ▶ 23: 4-20 mA channel 2 output
- ▶ 9: 4-20 mA break (NO)
- ▶ 21: 4-20 mA break (NC)
- ▶ 8: 4-20 mA break (Common)
- ▶ 7,19: Mains  $\cos\phi$  regulation command contact

# R630 AUTOMATIC VOLTAGE REGULATOR

## 17.5) 4-20 MA BOARD CONNECTION

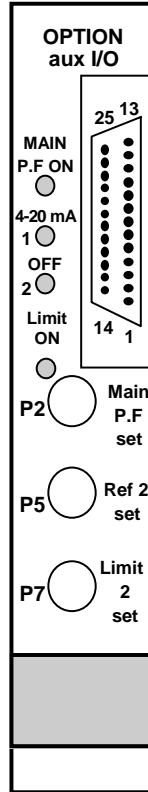


## 17.6) JUMPER POSITION



# R630 AUTOMATIC VOLTAGE REGULATOR

## 17.7) FRONT OF 4-20 MA BOARD



## 17.8) LEDs

- ▶ LED – MAIN P.F. ON: When on, this indicates that mains  $\cos\phi$  regulation has been activated
- ▶ LED – 4-20mA 1: When on, this indicates a 4-20mA break on channel 1
- ▶ LED – 4-20mA 2: When on, this indicates a 4-20mA break on channel 2
- ▶ LED – LIMIT ON: Not used

# R630 AUTOMATIC VOLTAGE REGULATOR

## 18) ISTATOR LIMIT BOARD (OPTION)

### 18.1) FUNCTION

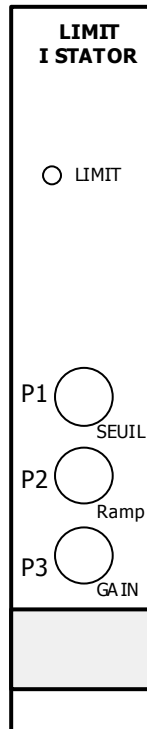
- ▶ This board is used to regulate the field current in order to keep the stator current below a preset value.
- ▶ An LED on the front face indicates current limiting operation.
- ▶ When this board is used for a soft-start mode (starting large auxiliaries with controlled current), the AVR must be supplied by a separate source during the starting phase. It can be switched to the generator output once the voltage has reached the

rated value. This switching must happen as quickly as possible. (Use relays, not a manual switch).

### 18.2) SETTINGS

- ▶ P1: Stator current limit threshold setting (around 2 In to 4 In)
- ▶ P2: Ramp increase time setting (around 0.5 to 4 s)
- ▶ P3: Board gain setting (output signal amplitude)

### 18.3) FRONT OF I STATOR LIMIT BOARD



### 18.4) LEDs

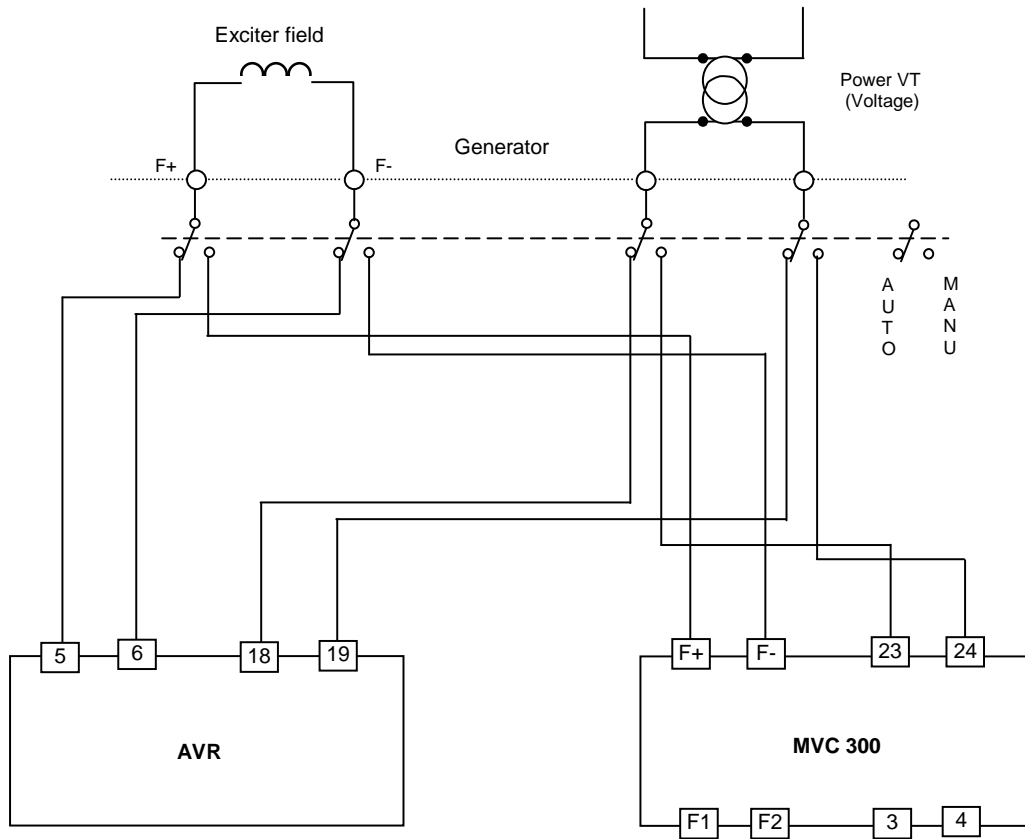
- ▶ LED 1 – MAIN P.F. ON: When on, this indicates that the max. stator current set has been reached.



# R630 AUTOMATIC VOLTAGE REGULATOR

## 19) WIRING AN R630 WITH EXTERNAL MANUAL MODE MVC300

To implement external manual mode on the AVR, the attached diagram must be followed. Any other type of wiring risks causing faults.



Switching the AVR to the MVC 300 (and vice versa) must be done when stopped.

The MVC300 manual mode must always be set to MANU.

# R630 AUTOMATIC VOLTAGE REGULATOR

## 20) COMMISSIONING

### CAUTION

Never energise the AVR when the driver board is disconnected, as there may be a voltage surge and the power block may be damaged.

### 20.1) GENERAL

- ▶ In order to be independent of the connections between machine measurement and the AVR, it is best to use manual mode for initial start-up.
- ▶ For this, a manual mode board must be plugged into the AVR. If not, go to section 2.
- ▶ Start up the manual mode board, terminals 47-48.
- ▶ Set potentiometer P2 on the manual mode board to maximum anti-clockwise, start the machine and increase up to rated speed.
- ▶ Slowly turn the potentiometer clockwise until you get the rated voltage.
- ▶ Check that all three phases are present and their value on the terminal block (terminals 1, 2, 3 on the AVR).
- ▶ Set the voltage to 5% above the rated voltage.
- ▶ Check that between terminals 25-26 the voltage is less than or around one volt.
- ▶ If yes, switch to automatic.
- ▶ The voltage should settle at the rated value.
- ▶ Go to section 3.

### 20.2) STARTING

- ▶ Start the machine and increase to rated speed.
- ▶ If the voltage does not appear, check the connections between the AVR and the exciter field (AVR terminals 5 and 6), and the connections between the AREP or PMG windings or the power transformer and AVR terminals 17, 18 and 19. Also check the circuit-breaker or fuses on the AVR terminal block.
- ▶ If the voltage increases rapidly, check that the sensing voltages on phase 1, 2, 3 of the AVR are actually present, as well as the auxiliary voltage on 15-16.

### 20.3) DE-ENERGISING (OPTION)

- ▶ Use external contacts E01 and E02 (see connection diagram supplied with the machine).
- ▶ E01 must be in series with terminal 17, 18 and 19 on the AVR (power input) and should be open for de-energising.
- ▶ E02 must short-circuit the booster output (if used) terminals 7 and 8 on the AVR) and should be closed for de-energising.

### 20.4) SETTINGS

- ▶ Refer also to the pages describing each board.
- ▶ The AVR is usually factory-preset.
- ▶ The rated voltage can be adjusted by potentiometer P5 (Vref) on the sensing board and can be fine-tuned by the digital potentiometer (if used) or external potentiometer (terminals 21, 22, 23) or by a 4-20 mA board.
- ▶ If a setting needs to be changed, make a careful note of the original position so you can go back to it in the event of problems.
- ▶ If the V/Hz jumper on the sensing board is in the KV/Hz position, the original setting is V/Hz and can be adjusted between V/Hz and 2V/Hz by potentiometer P4.
- ▶ The stability is usually adjusted on the machine in the factory. If necessary, the response time can be fine-tuned by setting potentiometer P4 on the PID board.
- ▶ **The other settings are tricky to implement without suitable equipment. We do not recommend altering them.**

### 20.5) FIELD FLASHING

- ▶ Field flashing is not usually necessary, however after a period of prolonged downtime or after a problem the voltage may not appear of its own accord. In this case, inject a 24 VDC to 48 VDC voltage between terminals 4 and 8 on the AVR terminal block, (the + on 4) for a few seconds until the voltage appears.

### 20.6) PARALLEL OPERATION (1F)

- ▶ The voltages of machines which need to operate in parallel should be as equal as possible.
- ▶ The same goes for the quadrature droop. If it is not possible to measure it, set all the sensing board P1 potentiometers in the same position (in the middle for example).
- ▶ The reactive currents (KVAR) should then be balanced, once coupling is complete, independently of the KW.
- ▶ If, immediately after coupling, the current increases abnormally, check that the connections with the parallel operation CT are not the wrong way round (terminals 9 and 10 on the AVR terminal block).
- ▶ If coupling occurs normally but while the load increases, the  $\cos\phi$  or the current changes abnormally, check that the phases at the AVR input are definitely connected (U, V, W respectively to terminals 1, 2, 3 if running clockwise or W, V, U, if running anti-clockwise) and also check the CT position on V, otherwise refer to the diagram for the U,V,W and CT connections.

# R630 AUTOMATIC VOLTAGE REGULATOR

## 20.7) COS Ø REGULATION (2F)

- ▶ The generator voltage should be as close as possible to the mains voltage (see section 8 if the mains I/O board is being used). The contact between terminals 30, 31 on the terminal block must be closed during coupling and must remain closed for as long as the generator is in parallel with the mains. It must be open when machines are connected in parallel.
- ▶ If immediately after coupling, the current increases abnormally, check that the parallel operation CT is not the wrong way round (9 and 10 on the terminal block).
- ▶ If coupling is correct but while the load increases, the  $\cos\phi$  or the current has an abnormal value, check that the sensing phase order is correct (U, V, W respectively on 1, 2, 3 of the terminal block when running clockwise).
- ▶ The value of  $\cos\phi$  is usually factory-set to 0.9. It can be adjusted by potentiometer P2 on the  $\cos\phi$  board, by the digital potentiometer (optional) or by an external potentiometer (10 k $\Omega$  1 W) connected to the terminal block (24, 25, 26).
- ▶ If KVAR regulation is used, short-circuit terminals 37 and 38 on the terminal block. It should be adjusted by potentiometer P2 on the  $\cos\phi$  board, by the digital potentiometer (optional) or by an external potentiometer (10 k $\Omega$  1 W) connected to the terminal block (27, 28, 29).

## 20.8) MAINS COS Ø REGULATION

- ▶ To perform this function, the AVR must have a 4-20 mA board, known as a mains  $\cos\phi$  board.
- ▶ The mains  $\cos\phi$  measurement converter must be connected to channel 1 and the reference can be set by an internal potentiometer, an external potentiometer, or by channel 2 with a 4-20 mA signal.
- ▶ Channel 2 of the board is reserved for other possible references.
- ▶ This regulation is implemented by activating a contact available on the connector on the front face of the mains  $\cos\phi$  board.

## 20.9) VOLTAGE MATCHING (3F)

- ▶ The following procedure should only be undertaken during commissioning to compensate for the mains transformer ratio.
- ▶ No-load with the image of the mains voltage present on terminals 11, 12, 13 of the terminal block.
- ▶ Short-circuit terminals 35-36 of the terminal block.
- ▶ Adjust P1 on the mains I/O board to obtain generator voltage identical to the mains voltage.
- ▶ Remove the strap between terminals 35-36.
- ▶ The initial setting is made.
- ▶ In normal operation, the contact between terminals 35-36 should be closed during synchronous coupler operation and open after coupling.

## 20.10) MANUAL OPERATION

- ▶ If a "manual mode" board is used, the field current can be controlled directly.
- ▶ In "AUTO" operation, adjust potentiometer P2 on the manual board so as to have the "UP" and "DOWN" LEDs off and the "OK" LED on. The Manual setting now equals AUTO Control.
- ▶ Closing the contact on terminals 47-48 gives control of the AVR to the manual channel. The field current should be adjusted by potentiometer P2 on the board.
- ▶ This type of operation can be used during commissioning or to conduct tests after a problem. It cannot be used in standalone operation because it will not be possible to track load variations quickly enough.
- ▶ During on-load operation in parallel with the mains, if a trip occurs, overvoltage will appear due to the fact that the field excitation is set for the load whereas the machine is at no-load. In this case, a circuit inside the board reduces the field excitation setting to limit the overvoltage to around 110% of the rated voltage. The "LIMIT" LED lights up to indicate this function and the field excitation setting must be reduced manually to make this LED go out and return to the rated voltage.

# R630 AUTOMATIC VOLTAGE REGULATOR

## 21) ANOMALIES AND PROBLEMS

Before commencing work, note carefully the potentiometer, strap and jumper positions.

PROBLEM	CAUSE	SOLUTION
No voltage at no load	No residual voltage	Field flashing is required
	De-energising contacts open	
	Load present or generator short-circuited	Remove the load from the generator if possible. If not, use an external source for field flashing.
	AVR faulty	Test it or change it
	Connection lost between the AVR and the exciter field.	Check the wiring
On starting, the voltage rises too quickly and significant overvoltage occurs.	The PID parameters are set incorrectly	Reduce the value of the integral (P4 on the PID board)
	Check the transformer ratios	
The field current measurement is not correct with an MVC300 manual mode board	The wiring between the MVC and the AVR is not correct	Correct in accordance with the wiring diagram.



Email: [parts@genpowerusa.com](mailto:parts@genpowerusa.com)



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