M40FA640A/A - Mark I

User Manual

Automatic Voltage Regulator for Three-phase Synchronous Generators

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SIN.NT.015.9

MarelliGenerators®

INTRODUCTION

This Technical Note provides general installation and operating information exclusively concerning the Marelli Motori regulator code specified in the document, mounted on the Marelli Motori synchronous generators specified in the next paragraph “APPLICATION”.
Before the generator start and any types of regulation operation, read carefully and completely this Technical Note.

IMPORTANT NOTE: It is not the intention of this document to cover all the installation or connection diagram variations, nor does this manual provide information for every possible contingency. The connection drawings provided with the generator, the generator user manual and all the technical information provided by Marelli Motori Technical Personnel can integrate this Note.

In particular, the connection drawings into this document are provided only for explanation purposes. They do not cover all the application cases and not substitute the connection drawings usually provided with the generator.

Should further information be required, please contact After Sales Department (see the reference at the end of the page).

SAFETY PRECAUTIONS

WARNING: when the regulation device is energized (generator running), a lethal voltage is present at the top panel (connection side) and at all the parts electrically connected to it. Furthermore, there are components into the card that can reach high working temperatures, with high danger for the user in case of direct contact.

Every wiring and/or mechanical installation operation on the regulator must be performed only in generator stop conditions, and only by skilled personnel. Furthermore, pay attention to wait a time interval sufficient for the device cooling-down.

Every regulation setting operation must be performed with generator running in no load conditions, by skilled personnel, using tools suitable to assure the user safety (i.e. isolated screwdriver, protection glasses and gloves).

Marelli Motori is under no liability for any damages which may occur to the AVR, the plant or the persons, or for lost earnings, or financial loss, or system stoppages, due to missed out Technical Note reading (both safety and installation/operating instructions).

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APPLICATION

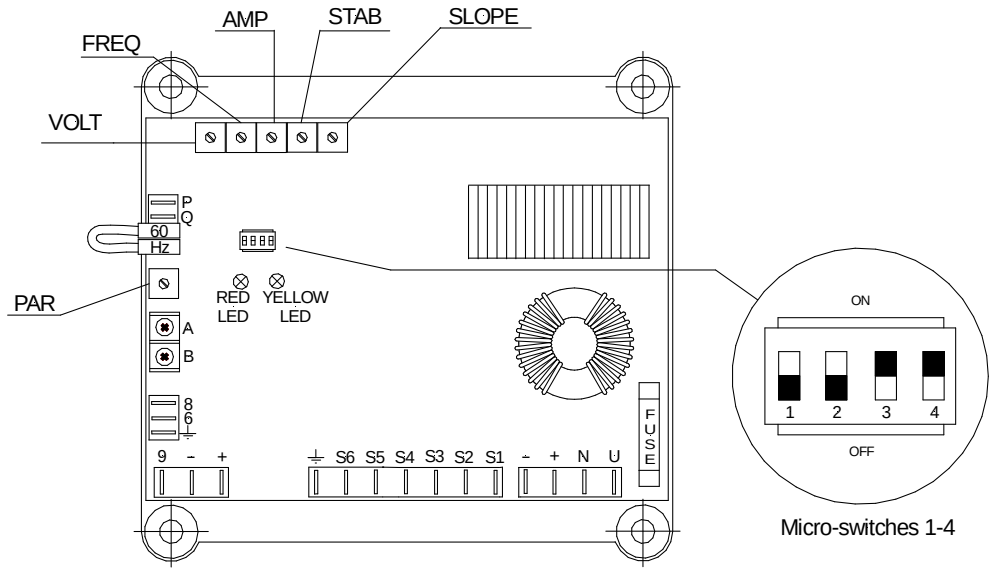
The voltage regulator type “MARK I”, is suitable for Synchronous Generators of MARELLI MOTORI make, MJB series, size range 160-500 frames. This regulator is proper to operate on machines rated from 10 up to 2000 kVA. The regulator is fully insulated in order to maintain high reliability also with severe ambient conditions (high level of humidity, dust, salt atmosphere), and in case of high vibrations level. The regulator is proper both for single and 3-phase operation.

TECHNICAL SPECIFICATION

Power supply voltage • ±10% of range tolerance, 50/60Hz	170÷277 V
Voltage sensing (single- or 3-phase) • ±10% of range tolerance, 50/60Hz	170÷480 V
Current sensing (1 phase) • 50/60Hz	0÷1 A
Maximum continuative field current	8 A
Maximum forcing field current • 1 minute forcing	15 A
Maximum field voltage	100 V
Field resistance	3.5 Ω ÷ 20 Ω
Regulation accuracy • No-load to full-load • Balanced and non deforming load • Constant frequency	±0.5 %
• With ±4% engine governing (steady state conditions for load and speed)	±1 %
Thermal Drift • For 50℃ change from T_{amb}, after 10 minutes)	±0.5 %
Response time	1 cycle
Operating temperature	-30℃ / +70℃
Weight	670 g

Functions

Protection	Under-frequency limiter
	Over-excitation limiter
	Internal fuse, replaceable
Control	With external potentiometer, 100 kΩ for ΔV = ±5 % of the rated voltage
	With external DC voltage signal (-3/+3 V) Suitable for connection to power factor regulator PFR M50FA400A
Parallel	Reactive droop compensation, ±20 %



TERMINALS

Connection terminals are performed through FAST-ON terminals. The terminals have to be connected according the applicable wiring diagram, in order to avoid any possible mistake in the wiring.

U **N**	*Power supply terminals*
S1…S6	*Generator voltage sensing terminals*
A **B**	*Generator current sensing terminals*
+ **-**	*Output terminals (to the exciter field)*
9 **-** **+**	*Terminals for connection to Varicomp M40FA621A*
60 **Hz**	*60Hz mode selection terminals*
P **Q**	*Terminals for connection to external potentiometer*
6 **8**	*Terminals for connection to external control device*
⏚	*Connection to ground for internal EMI filter* *Connection to ground of shield of shielded cables*

POTENTIOMETERS

- **VOLT** - potentiometer for adjusting the output voltage of the generator. Normally the internal potentiometer VOLT allows possibility of adjusting the voltage in a wide range (i.e. between 200 and 560 V); to obtain a finer possibility of voltage setting or to adjust the voltage from the control panel, or in order to limit the voltage range, an external potentiometer can connected to the terminal P and Q (resistance about 100 kΩ, 1 W, to obtain voltage regulation of ±5%).

VOLT 	Increases the voltage setpoint

- **FREQ** - potentiometer for changing the low speed protection corner frequency.
It is usually set at the factory in order to reduce the excitation when speed becomes lower than 90% of rated speed at 50 Hz (frequency lower than 45 Hz, or corner frequency). By removing the bridge which normally shorts the terminals Hz and 60, the speed protection acts properly for 60 Hz operation.

FREQ 	Decreases the corner frequency

- **AMP** - potentiometer for changing the over excitation limiter; that limiter permits to protect the generator in case of over excitation due to load conditions that could cause the rotor damage.

Even if correctly set, this function does not substitute external systems protections, it is only a completing device.

AMP 	Increases the excitation current threshold

- **STAB** - stability potentiometer: clockwise rotation permits to increase the regulation stability (the response time becomes larger).

STAB 	Increases stability and response time

- **SLOPE** - potentiometer to change the low speed protection characteristic slope: with the micro-switch 4 OFF, this potentiometer allows to increase or decrease the under speed ramp slope, and set the voltage droop for a fixed reduced speed.

SLOPE 	Decreases the voltage droop for a fixed frequency intervention

- **PAR** - potentiometer to change the droop: this potentiometer allows to change the voltage droop for reactive compensation.

PAR 	The droop increases

UNDERFREQUENCY LIMITER

The regulator is provided with internal circuits in order to reduce the excitation, when running at low speed, in order to avoid damages to the excitation system of the generator (i.e. to the regulator, to the exciter field, to the rotating rectifier, main rotor).

The potentiometer FREQ fixes the corner-frequency, that is the frequency at which the limiter operates. Below that particular frequency, red LED switches-on and the voltage of the generator reduces further together with the generator speed reduction.
By setting the micro-switch nr. 4 in OFF position, the voltage reduction is smaller and is close to be proportional to the speed reduction (voltage reduction is adjustable by the potentiometer SLOPE).

STABILITY ADJUSTMENT

The voltage regulator is provided with internal adjustable stability circuits in order to allow stable operation in a wide range of applications.
The stability of the regulator can be set on field to adapt it to the characteristics of the plant and/or the driving engine (diesel engine, water turbine, gas turbine) in order to obtain the best voltage response.

To change the stability characteristics of the regulator, it is necessary to act on the potentiometer STAB (for fine setting of stability).
An additional coarse setting of stability can be achieved by means of the micro-switches number 1 e 2.

OVER-EXCITATION LIMITER

This function permits to limit the over-excitation due to particular load conditions that could cause the generator damage.
As soon as the excitation voltage rises over a certain threshold, set by means of the potentiometer AMP, for a time larger than the limiter time delay, the over-excitation limiter steps-down the excitation voltage to the threshold value.
Limiter time delay depends on the amount of the over-load: more the over-load arisen, quicker the limiter action.
Limiting the excitation voltage leads to the generator excitation level decrease, partial or total, depending on the over-load occurred. In case of excitation shutdown due to the limiter, the de-excitation condition could be not maintained.
WARNING: Even if correctly set, this function does not substitute external systems protections, it is only a completing device.
WARNING: in case of generator paralleled with a grid, an over-excitation condition detected by the limiter can lead to a generator excitation shutdown, with risk of loss of synchronism.

LIMITER ADJUSTMENT:
for a quicker limiter setting, it is possible to momentarily disable the time delay, by means of the micro-switch 3 (see also the next paragraphs).
In order to properly adjust the limiter, the following procedure must be applied:

- when the generator is running at the rated speed, apply the maximum desired load;
- select position OFF for the micro-switch 3;
- carefully rotate counter-clockwise the potentiometer AMP, until the yellow LED lights up and the generator voltage decreases to a stable value, lower than the rated voltage;
- carefully rotate clockwise AMP until the yellow LED switches-off; the generator voltage must recover the rated value;
- select position ON for the micro-switch 3.

If the procedure is properly carried out, the excitation voltage threshold is set to a value 15-20% higher than the excitation voltage at the maximum desired load, previously applied.
Time delay depends on the amount of the over-load occurred: it can range from 10s minimum to some minutes maximum.

DROOP KIT DEVICE

The device is included in the voltage regulator, to allow parallel operation between similar generators: the device permits to share correctly the total reactive power required by the load among all generators operating in parallel.

The device is composed by an external current transformer (which senses the current in phase W) and the internal droop circuit of the regulator. The C.T. is placed on phase W; the phases U and V have to be connected to terminals S1 and S2.

The voltage regulator is provided with input terminals (terminals A and B) for easy connection to an external current transformer. Such terminals are normally shorted by a connection bridge, when the generator is used in single operation.
If the voltage is increasing as the load increases, it is necessary to reverse the leads of the current transformer at the terminals A-B.

CONTROL BY MEANS OF EXTERNAL DEVICE

External potentiometer

An external potentiometer for fine setting of the voltage reference can be connected to the terminals P and Q.
This permits to:

- change the voltage set-point by means of remote control device;
- set the generator voltage reference with accuracy higher than the one of the internal regulator potentiometer VOLT.

External potentiometer specifications are the following:

Setting range	*Potentiometer specifications*
±5%	100 kΩ - 1 W minimum
±10%	200 kΩ - 1 W minimum

As soon as the external potentiometer is connected to P and Q, a change in the global voltage reference of the regulation system will occur; the internal trimmer VOLT must be set again to the rated generator voltage.

In detail: put the external potentiometer cursor in mid position, and after that, turn VOLT counterclockwise until to reach approximately the desired generator voltage.

It's now possible to operate the fine setting of the voltage by means of the external potentiometer.

DC voltage signal from external control device

The AVR accepts a DC voltage analogue input of +/-3 V (maximum range), to control the exciter field of the generator.
This input has to be applied to terminals 6 and 8.

In case of single operation, a maximum change of +/-3 V of the analogue input leads to a maximum change of +/-25% of the generator voltage, with respect to the rated generator voltage.
A value of 0 V at 6 and 8 terminals does not lead to any change in excitation.

The analogue input is usually used for the voltage regulator control by means of the Marelli power factor regulator, for parallel operation with the grid.

This input can be also connected to external devices not made by Marelli, for remote control of the generator voltage or the excitation during parallel operations (voltage matching and power factor regulation), as long as those devices were equipped with suitable outputs (**insulated outputs**, and voltage regulation range not higher than +/-3 V).

WARNING: in the case of parallel with the grid, and voltage regulator controlled by an external device by means of the analogue input, **pay attention to the analogue input voltage value after the load rejection**.

In this particular case, in order to avoid any dangerous generator over-voltages, the voltage value between the terminals 6 and 8 must be reduced to 0 V or to any values leading to a generator voltage not exceeding the rated + 5%.

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MICRO-SWITCH

To change the stability characteristics of the regulator, it is possible to use the micro-switches.
In such a way it is possible obtain changes in the transient response of the regulator.

Micro-switch 1

ON — *Transient response becomes faster*

Micro-switch 2

ON — *Transient response becomes faster*

Micro-switch 3

ON — *Proper setting of the excitation limiter - IT MUST ALWAYS BE KEPT ON POSITION ON*

OFF — *Only for quick setting of the excitation limiter: it permits to disable the normal limiter time delay*

Micro-switch 4

ON — *Standard low speed protection*

OFF — *Low speed protection with V/f slope adjustment (see SLOPE potentiometer)*

FUSE

The voltage regulator is provided with an internal protecting fuse (which acts in case of faults on the regulator or very large overloads on exciter circuit).

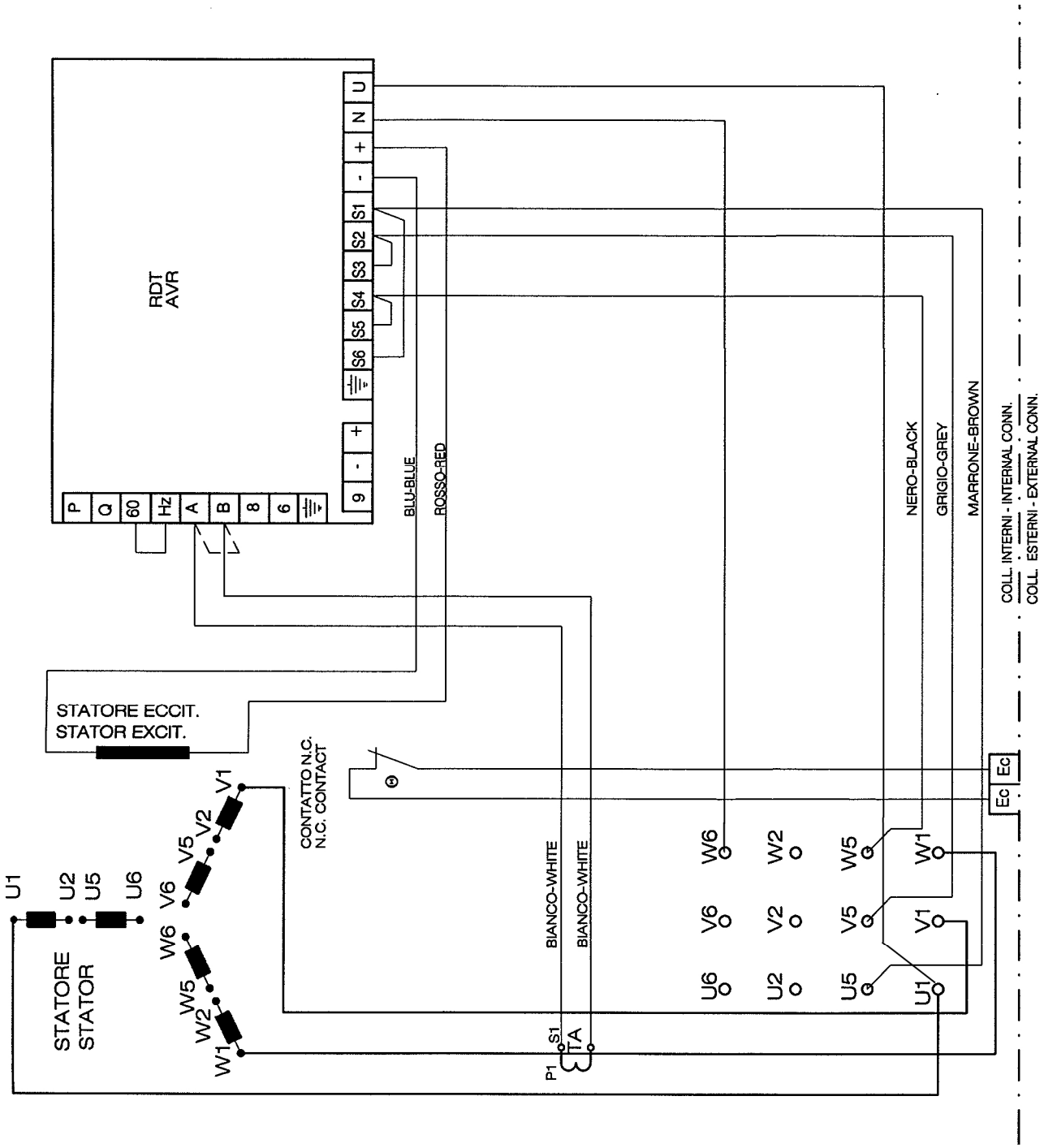
EMI SUPPRESSOR

The AVR is provided with an internal Electromagnetic Interference filter: this interference suppression system permits to obtain compliance with relevant EMC standards on MARELLI MOTORI generators.

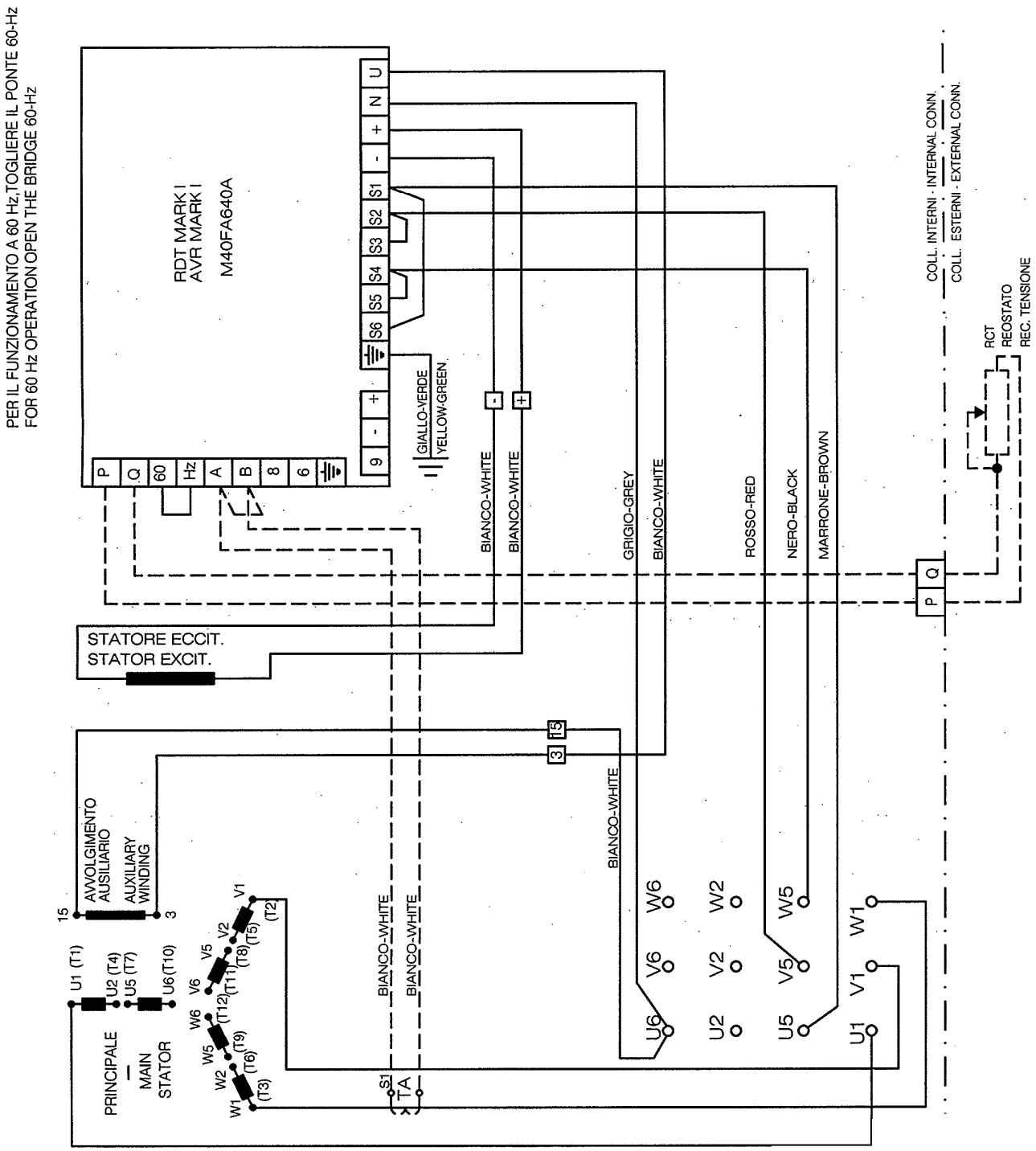
ACCESSORY

Description	Part number
Fuse Ultra rapid, ceramic, 10 A – 500 V	963823010
External potentiometer 100 kΩ - 2 W	963824430

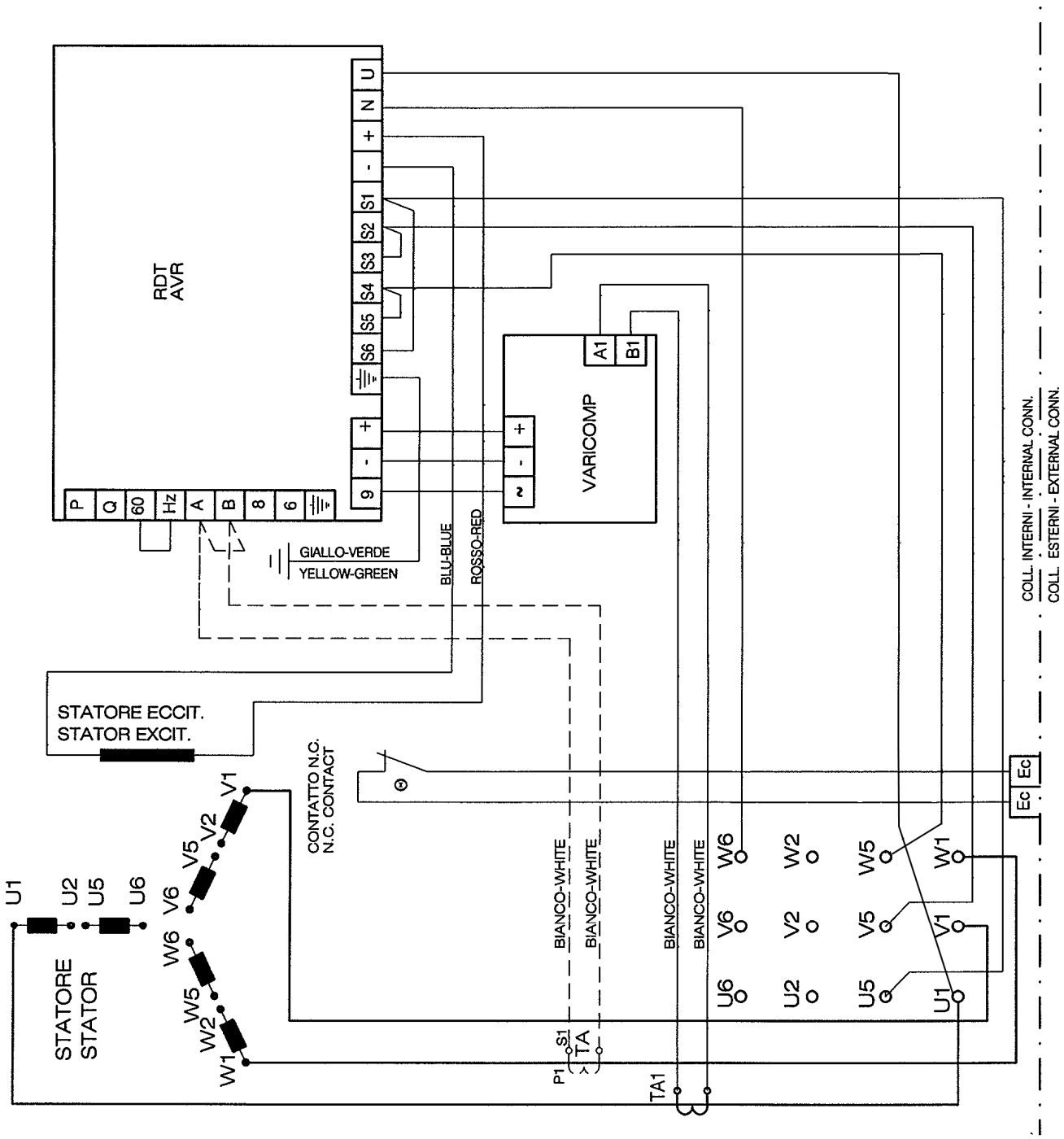
12 TERMINALS
SUPPLY BY MAINS



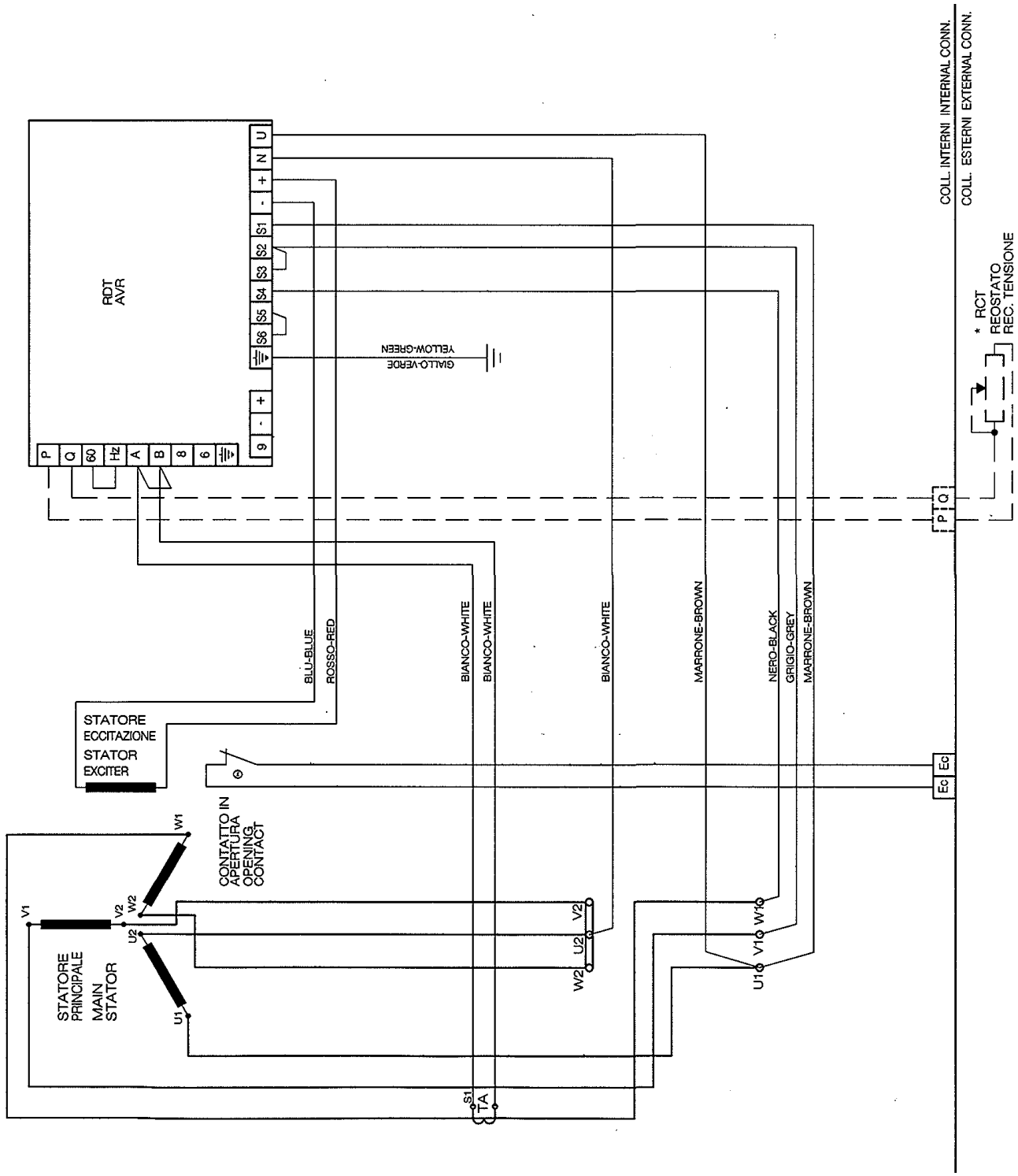
12 TERMINALS
SUPPLY BY AUXILIARY WINDING



12 TERMINALS
SUPPLY BY MAINS + OVER EXCITATION DEVICE VARICOMP



6 TERMINALS
SUPPLY BY MAINS



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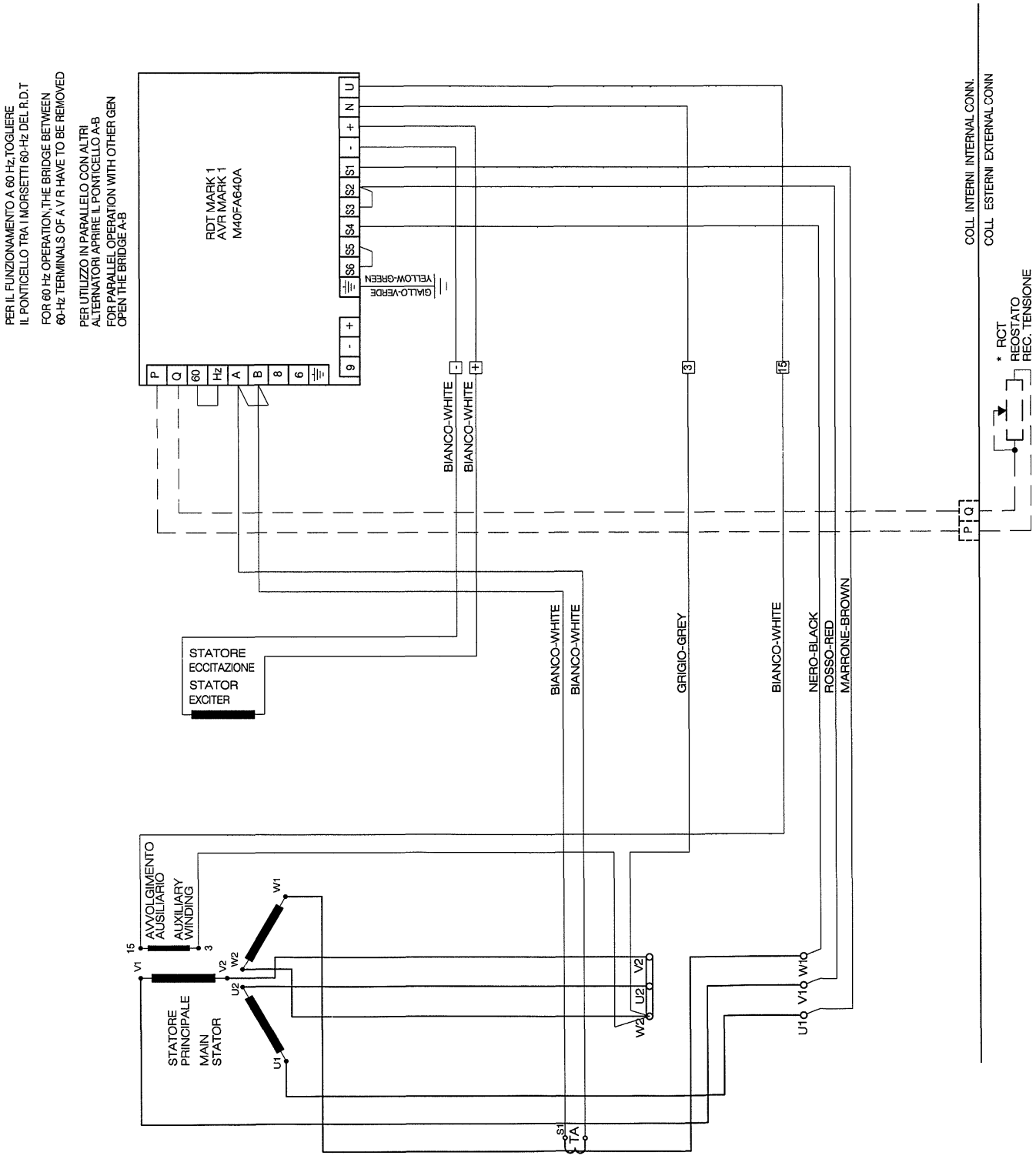
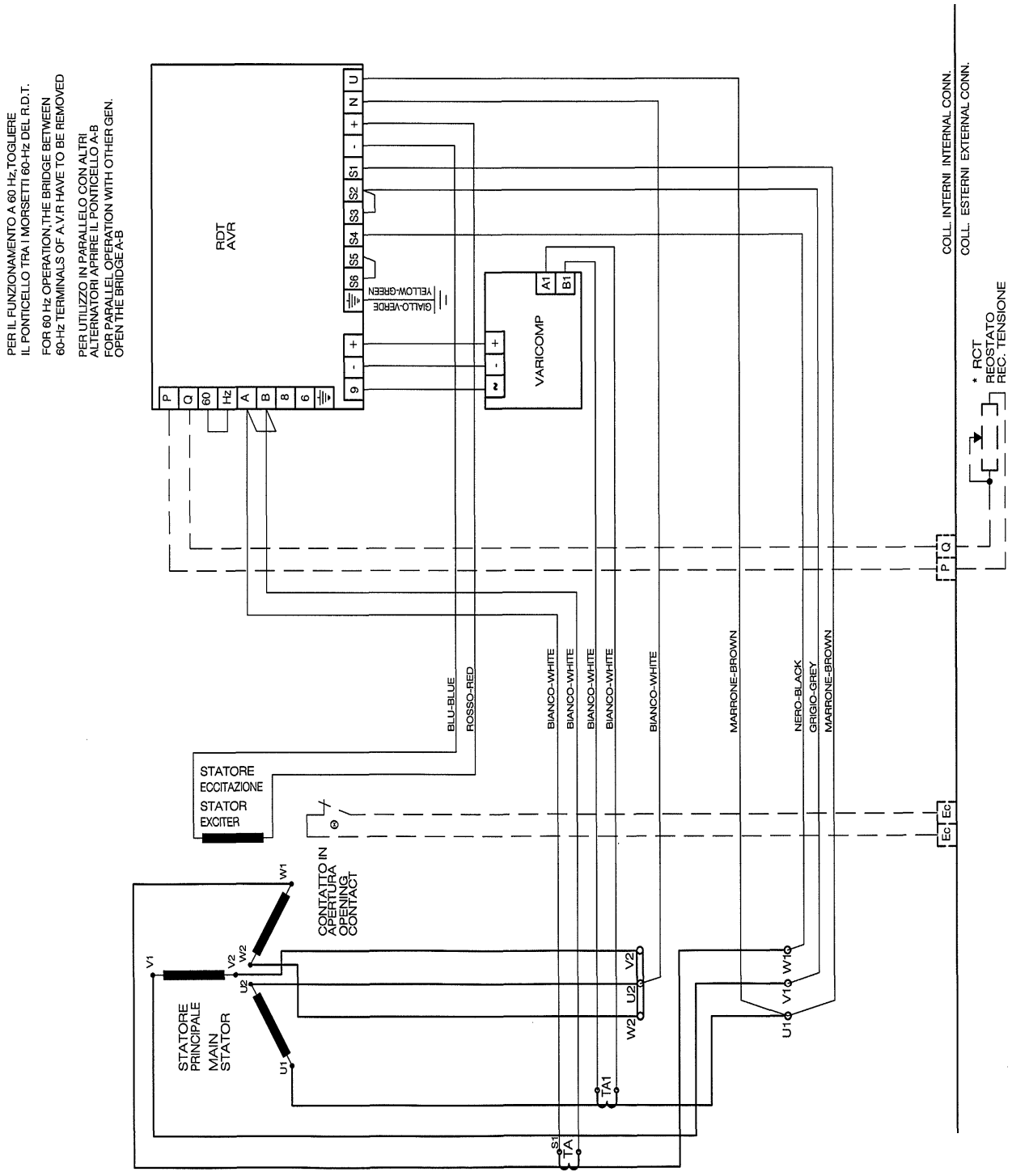


6 TERMINALS
SUPPLY BY MAINS + OVER EXCITATION DEVICE VARICOMP



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