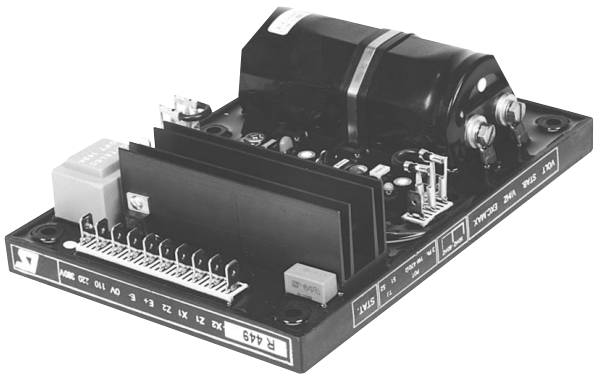
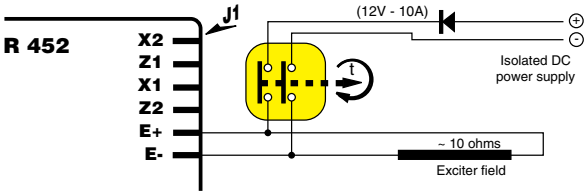
LEROY SOMER

Ref. 3563 GB - 4.33 / a - 01.02



This manual is to be given to the end user



VOLTAGE REGULATOR R452

Installation and maintenance

VOLTAGE REGULATOR R452

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 INCLUDED IN THE VOLTAGE REGULATOR.

NOTE

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

CAUTION

1) WHILE THE ALTERNATOR IS AT A STANDSTILL, MAINS VOLTAGE MAY REAPPEAR AT THE MODULE VOLTAGE SENSING TERMINALS.

LETHAL DANGER

2) DO NOT PERFORM DIELECTRIC TESTS WITHOUT DISCONNECTING THE MODULE AND ITS ASSOCIATED VOLTAGE REGULATOR.

RISK OF DESTRUCTION

VOLTAGE REGULATOR R452

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VOLTAGE REGULATOR R452

PRESENTATION OF THE R 452

1 - PRESENTATION OF THE R 452

1.1 - application

The R 452 regulator is of a shunt type. It is designed to fit as standard on alternators from the LSA 46.2 to the LSA 54, and is used to replace R 448 or R 449 AVRs for any application with high load impacts, leading to load reconnection difficulties for the generator set. It can be supplied with power either by a power VT, or by the AREP excitation system, or by a single-phase or 3-phase PMG.
Using the R 726 external module, the regulator can control the power factor (2F) and can match the alternator voltage to the mains voltage (3F).

1.2 - description

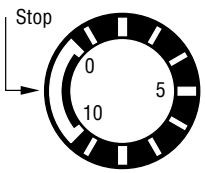
The electronic components mounted in a plastic casing are sealed with opaque elastomer. Connection is via 2 connectors (male "Faston" lugs 6.3).
The regulator includes:

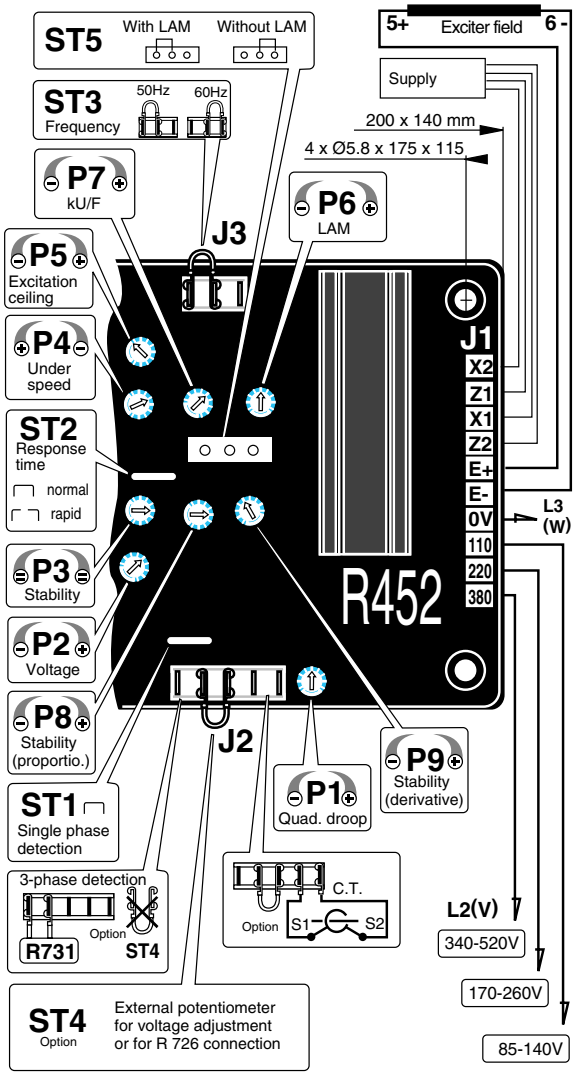
- A main terminal block (10 terminals)	J1
- A secondary terminal block (5 terminals)	J2
- A frequency selection terminal block (3 terminals)	J3
- A droop potentiometer	P1
- A voltage potentiometer	P2
- A stability potentiometer - Integral	P3
- An underspeed potentiometer	P4
- A maximum excitation potentiometer	P5
- A LAM potentiometer	P6
- A kU/F potentiometer	P7
- A stability potentiometer - (proportional)	P8
- A stability potentiometer - (derivative)	P9
- A sensing selection jumper (Single/3-phase with an external module)	ST1
- A response time jumper	ST2
- A frequency selection jumper	ST3
- An external voltage setting jumper	ST4
- A LAM (load adjustment module) jumper	ST5

Two fuses (F1 and F2) are connected to this regulator; they are mounted in the alternator on terminal block C.
Type: gG 10/38 16A 500V.

Simplified diagram of a potentiometer:

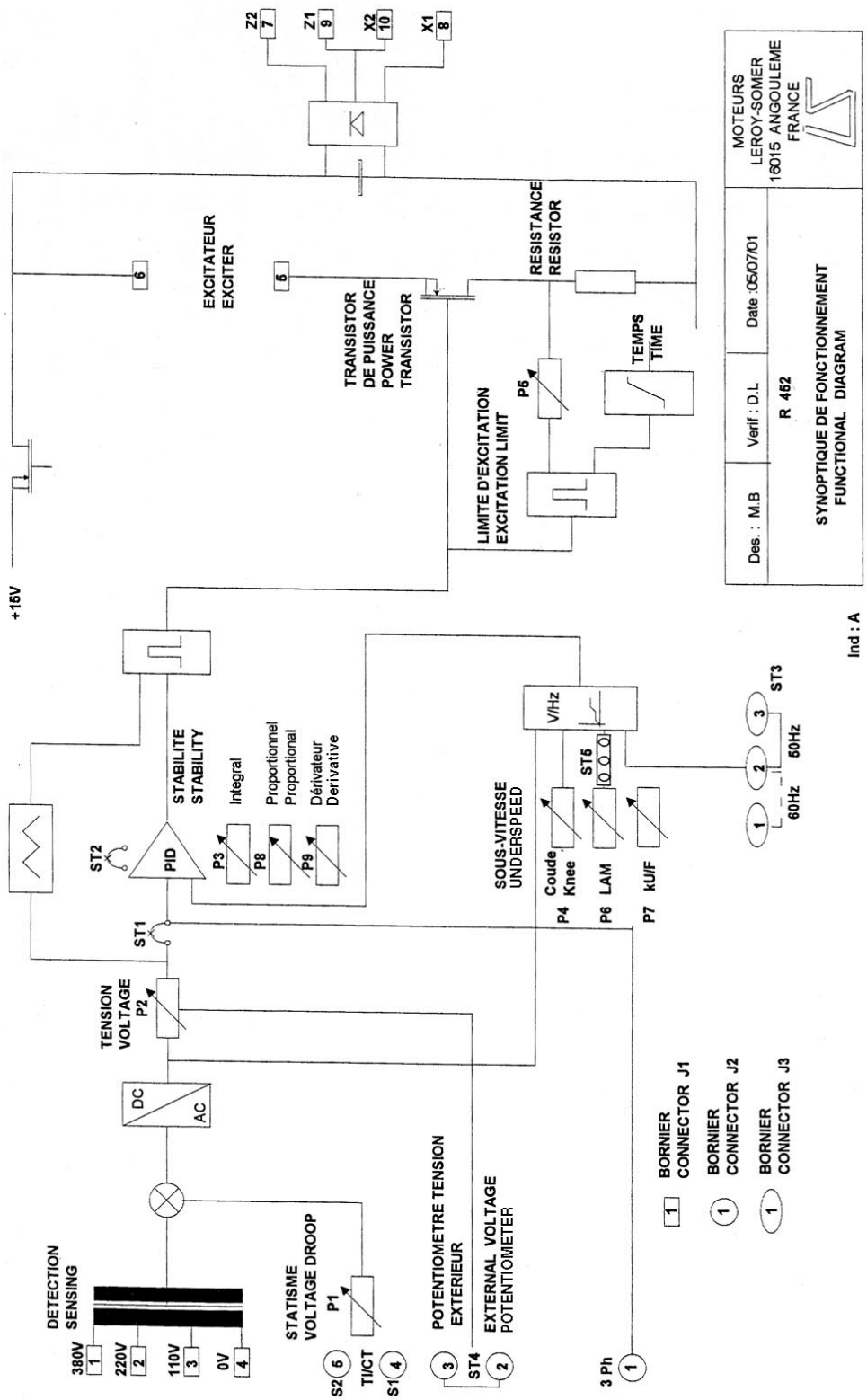
To adjust the potentiometer, check the actual position of the potentiometer stop.





1.3 - electrical characteristics

1.3.1 - operating diagram



VOLTAGE REGULATOR R452

PRESENTATION OF THE R 452

1.3.2 - sensing

The sensing is single-phase and is isolated using an internal transformer.
Sensing VA: 5VA
J1 connector, input voltages:
Terminals 0-110V voltage range from 85 to 130V
Terminals 0-220V voltage range from 170 to 260V
Terminals 0-380V voltage range from 340 to 520V

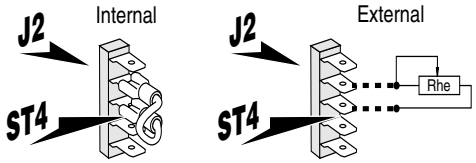
1.3.3 - voltage accuracy

The voltage accuracy is +/- 0,5%Un, steady state, linear load.

1.3.4 - voltage adjustment

The voltage is adjusted either using an internal potentiometer P2, with a voltage range of +/- 10%Un, or using an external potentiometer (as an option).
The voltage is minimum when internal potentiometer P2 has been rotated fully anti-clockwise.

Connecting the external potentiometer:
External potentiometer 470W 3W: Voltage range +/- 5 %Un
External potentiometer 1kW 3W: Voltage range +/-10 %Un
Remove the ST4 jumper and connect the external potentiometer as shown in the diagram below. If a regulator is built into the terminal box, remove the ST10 jumper from terminal block C and connect the external potentiometer.



Voltage setting : ST4

1.3.5 - power supply

The power can be supplied:
using 2 independent auxiliary windings integrated in the alternator stator (AREP excitation) or using a single or 3-phase power VT or using a single or 3-phase PMG.
The single or 3-phase voltage must not exceed 240V AC.

1.3.6 - output power

The output power is 7A 63V under normal conditions and 15A for 10s under overload conditions.

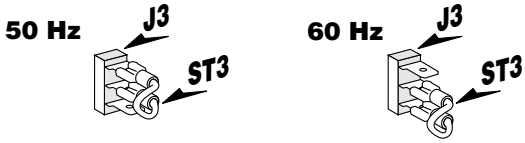
1.3.7 - quadrature droop (1F)

Quadrature droop is achieved using a parallel operation CT (In/1A, 10VA Cl1). The voltage dip can be adjusted using potentiometer P1. The voltage range is 5%Un for Pn PF 0.8.
The quadrature droop is at 0 when potentiometer P1 has been rotated fully anti-clockwise.

1.3.8 - frequency/underspeed

Definition of underspeed potentiometers:
- P4: setting the knee-point - P6: setting the LAM - P7: setting the kU/F

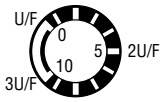
Selection of underfrequency threshold using the ST3 jumper



U/F: Action threshold adjustable using potentiometer P4

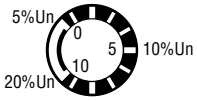
To avoid voltage oscillations, the trip threshold of the "LAM" function should be set approximately 2 Hz below the lowest frequency in normal operation.
(Adjustable using potentiometer P4).

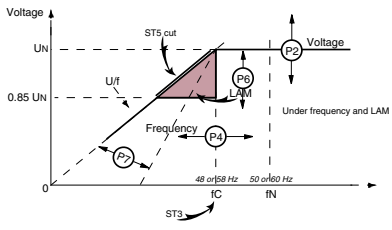
- Setting the kU/F: Potentiometer P7 is used for this purpose.
It can be used to adjust the underspeed slope from U/F to 3U/F.



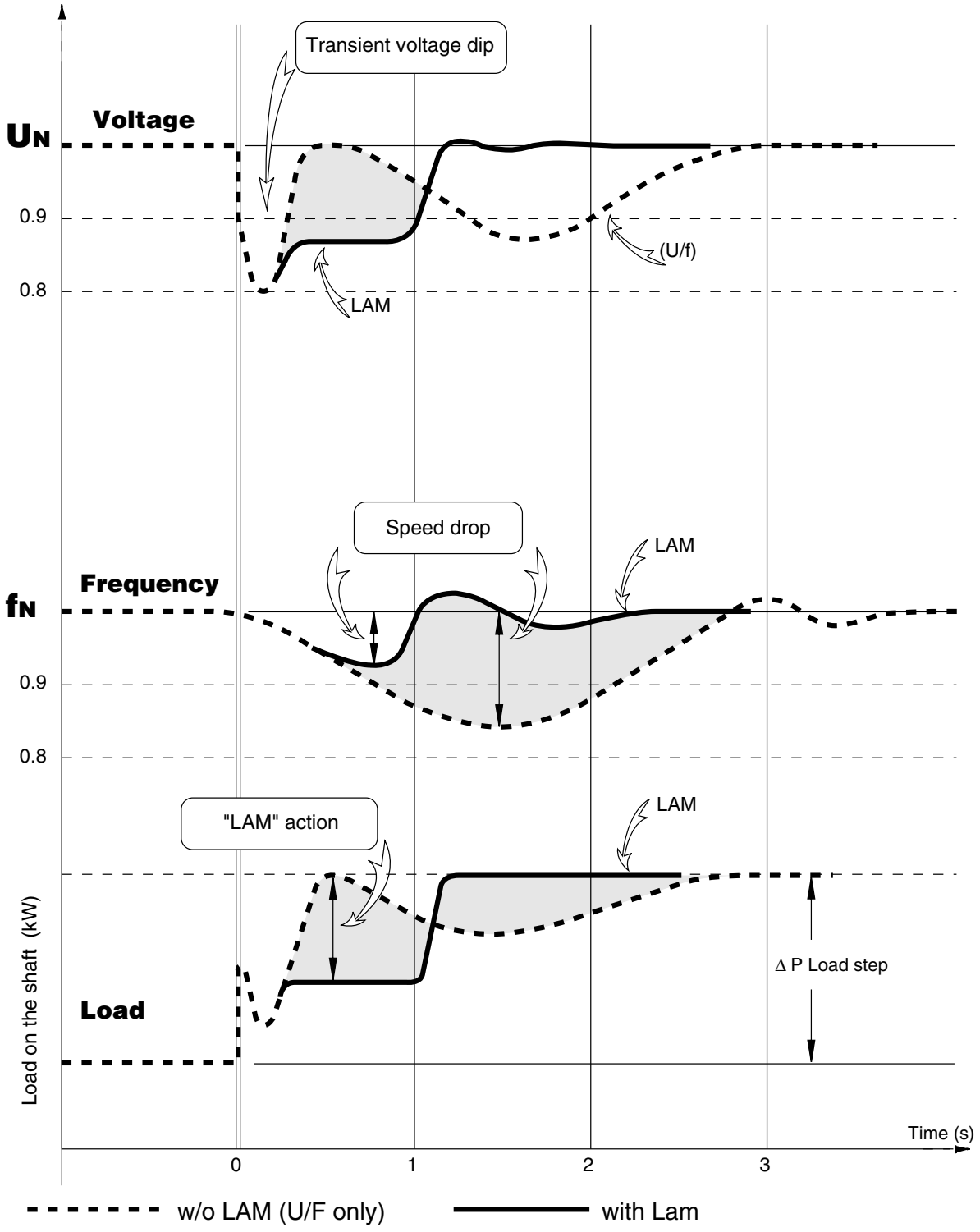
LAM: When it leaves the factory, the regulator is configured with the LAM activated.
It is disabled by disconnecting the ST5 jumper, and operation is then the standard U/F.
- Role of the "LAM" (load adjustment module).
When a load is applied, the speed of rotation of the generator set decreases. When it falls below the preset frequency threshold, the "LAM" causes the voltage to drop by approximately 15 %. This in turn reduces the active load scale applied by approximately 25 %, until the speed returns to its rated value.
The LAM can therefore either be used to reduce the speed variation (frequency) and its duration for a given applied load, or to increase the possible applied load for one speed variation (turbo-charged engines).
Pour régler le LAM procéder comme indiqué ci-dessous :
- P6 (LAM) : position médiane (LAM # 10%)
- P7 (kU/F) : position médiane (2U/F)
Appliquer la charge, enregistrer la vitesse et la tension.
En fonction des résultats, agir d'abord sur :
- P7 (kU/F) : position système horaire (34/F)
Refaire l'essai d'application de la charge, si nécessaire, agir ensuite sur :
- P6 (LAM) : 3/4 horaire (LAM = 15%)
Puis si nécessaire à nouveau sur :
- P6 (LAM) : position extrême horaire (LAM = 20%)

- Setting the LAM:
Potentiometer P6 is used for this purpose.
It can be used to adjust the LAM from 5 to 20 %Un.





- Typical effects of a "LAM" with a diesel engine.



VOLTAGE REGULATOR R452

PRESENTATION OF THE R 452

1.3.9 - stability

Definition of stability potentiometers:
- P3: integrator
- P8: proportional
- P9: derivative
- Standard position potentiometer positions: 5

Setting the stability:
The stability is initially set on voltage build-up, with the alternator at rated speed, de-energised.
At the start of the test, set all 3 potentiometers to 5.

Find the best position for P3:
Close the de-energisation contact and monitor the voltage making (overvoltage and oscillation) on build-up.
De-energise the alternator (open the de-energisation contact).
Set P3 to a different position from 5 and repeat voltage build-up.
Repeat this test several times and select the position of P3 which produces the best voltage build-up, ie. without overvoltage and without oscillations.
Retain this position for subsequent tests.

Find the best position for P8:
Perform the same tests as before.
Select the position of P8 which produces the best voltage build-up.
Retain this position for subsequent tests.

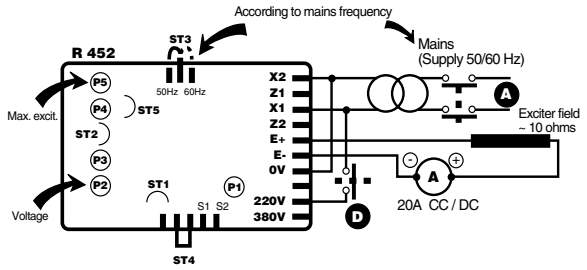
Find the best position for P9:
Perform the same tests as before.
Select the position of P9 which produces the best voltage build-up.

Then do a test with load impact (or load shedding) and fine-tune the settings.

1.3.10 - limiting the excitation current iex

- Potentiometer P5 is used to adjust Iex limitation. Limitation of the excitation current is active for 10s. After this period of time, the excitation current is limited to 2A.
The maximum limitation is 15A.
The minimum limitation is when the potentiometer has been rotated fully anti-clockwise.
In the absence of specification to the contrary, P5 is positioned at the clockwise limit.
- Static adjustment of the max. excitation current.
For this value, the static adjustment is possible when the alternator is stopped, which will not endanger the alternator or the installation.
Disconnect power supply wires X1,X2 and Z1,Z2, and the voltage reference from the alternator (terminal block J1).
Connect the mains power supply, 200 to 240V, as indicated (X1 and X2): 0-220V). Install a 20A D.C. ammeter in series with the exciter field.
Turn P5 fully anti-clockwise, switch on the power supply (switch A).
If there is no output current from the AVR, turn potentiometer P2 (voltage) clockwise until the ammeter indicates a stabilised current.
Switch the power supply off and then on again, turn P5 clockwise until the required excitation current is reached (limited to 15A), (for precise adjustment contact Leroy-Somer).
Checking the internal protection:
Open switch (D): the excitation current should increase to its preset ceiling, remain at that level for 10s and then fall back automatically to a value less than 2A.

To reset, switch off the power supply by opening switch (A).
Note: After setting the excitation ceiling using this procedure, re-adjust the voltage.

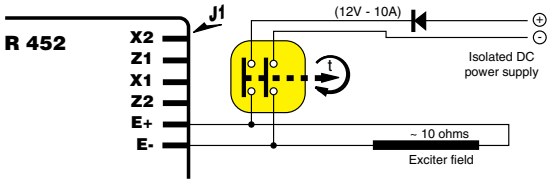


1.3.11 - protection

There are two fuses in the power section. They are fitted externally to the AVR but inside the alternator terminal box.
Rating: gG 10/38 16A 500V

1.3.12 - voltage build-up

The voltage build-up is automatic (no overvoltage) from the residual magnetism.
If there is no voltage build-up, a short pulse of continuous isolated voltage (12VDC), will usually remedy this. Otherwise, proceed in accordance with the diagram below to re-establish the residual magnetism:

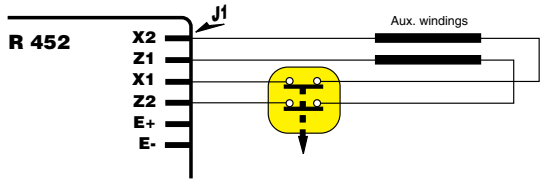


1.3.13 - power usage

The power used by the R 449 is 30W, when the alternator is at rated power.

1.3.14 - de-energising

The regulator is de-energised by switching off its power supply.
Contact rating: 15A, 250V AC



1.4 - environment

- Operating temperature: -20 ˚C to +70 ˚C
- Storage temperature: -55 ˚C to +85 ˚C
- Shocks on the base: 9g for the 3 right-angled directions
- Vibrations: Less than 10Hz: 2mm half-peak amplitude
10Hz to 100Hz: 100mm/s
Above 100Hz: 8g

VOLTAGE REGULATOR R452

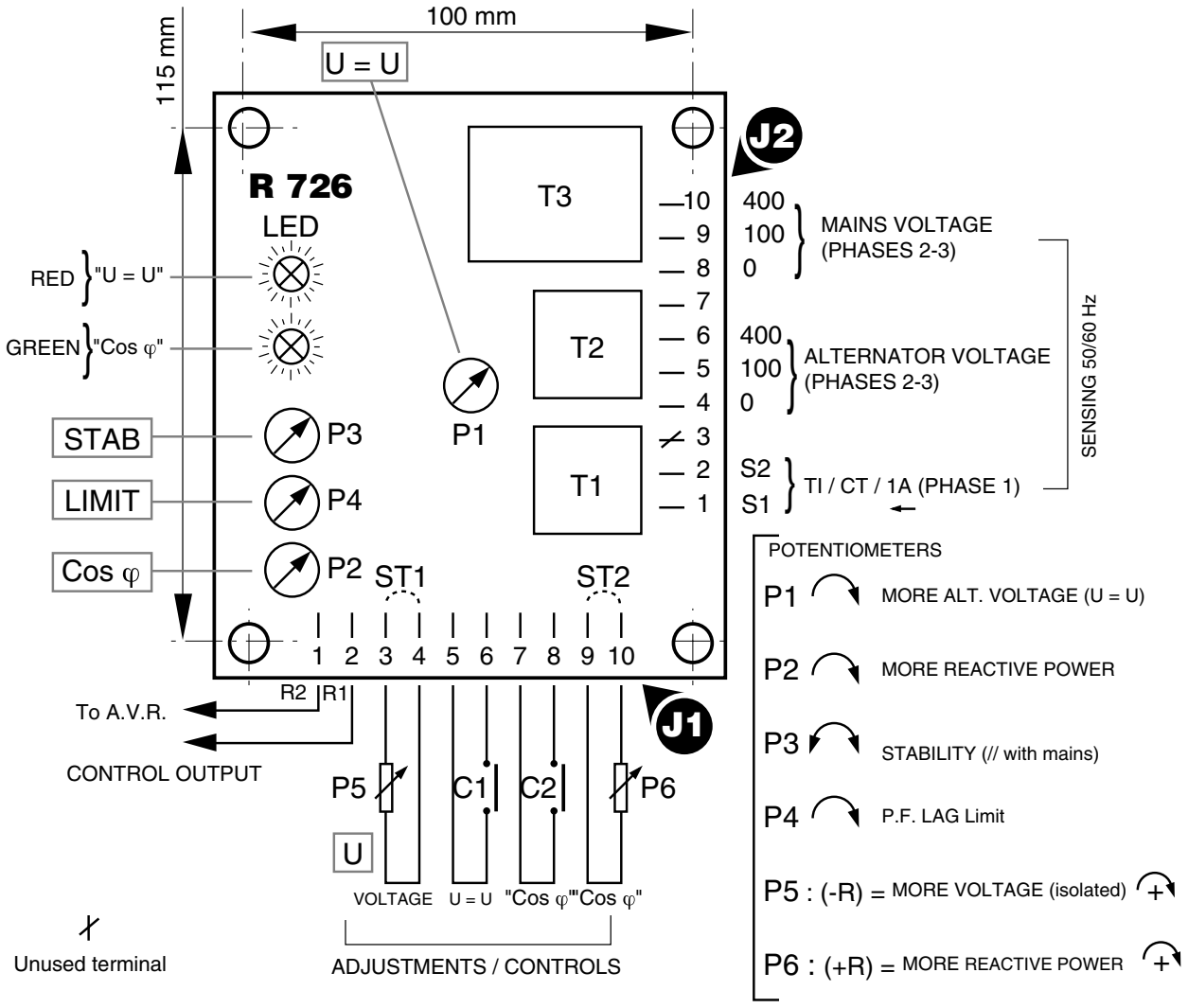
R 726 : REGULATION OF POWER FACTOR (2F) AND MAINS VOLTAGE SENSING (3F)

2 - R 726 : REGULATION OF POWER FACTOR (2F) AND MAINS VOLTAGE SENSING (3F)

The power factor and mains voltage sensing are regulated by the R726 module. See the specific manual.

2.1 - potentiometers

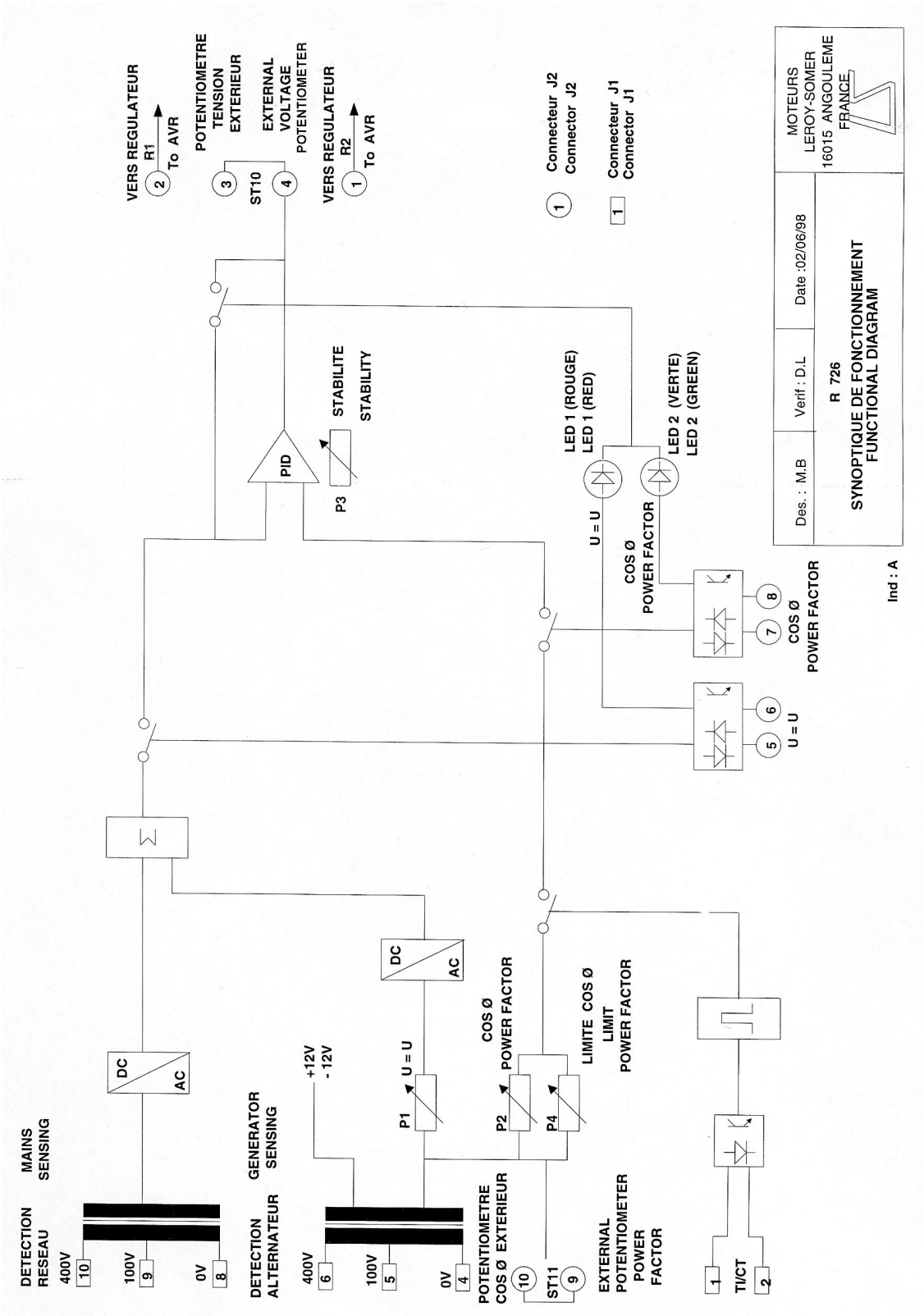
P1: Potentiometer for adjusting the alternator voltage to the mains voltage (operating mode 3F).
P2: Adjustment of the power factor
P3: Stability
P4: Limitation of the power factor



VOLTAGE REGULATOR R452

R 726 : REGULATION OF POWER FACTOR (2F) AND MAINS VOLTAGE SENSING (3F)

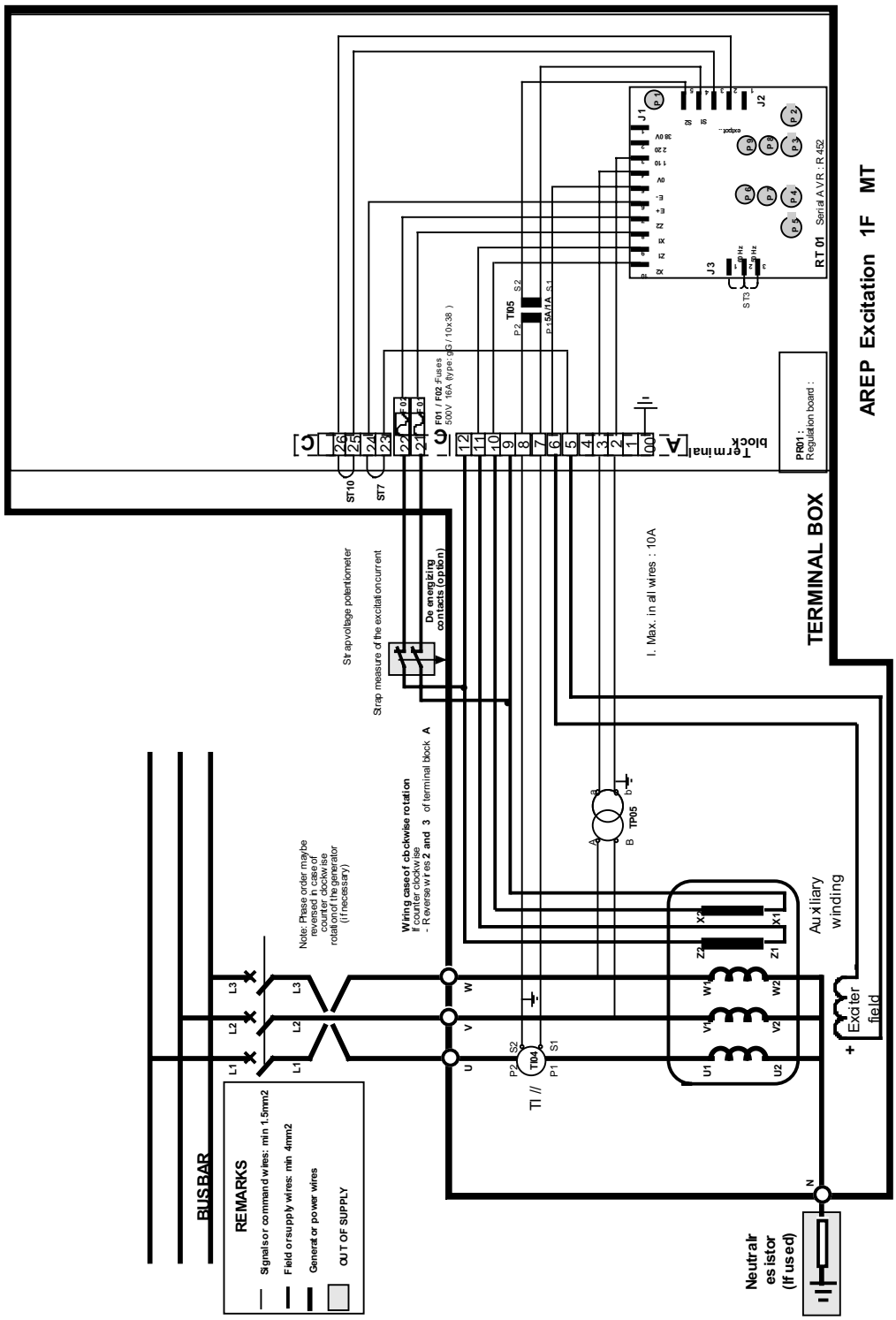
2.2 - operating diagram



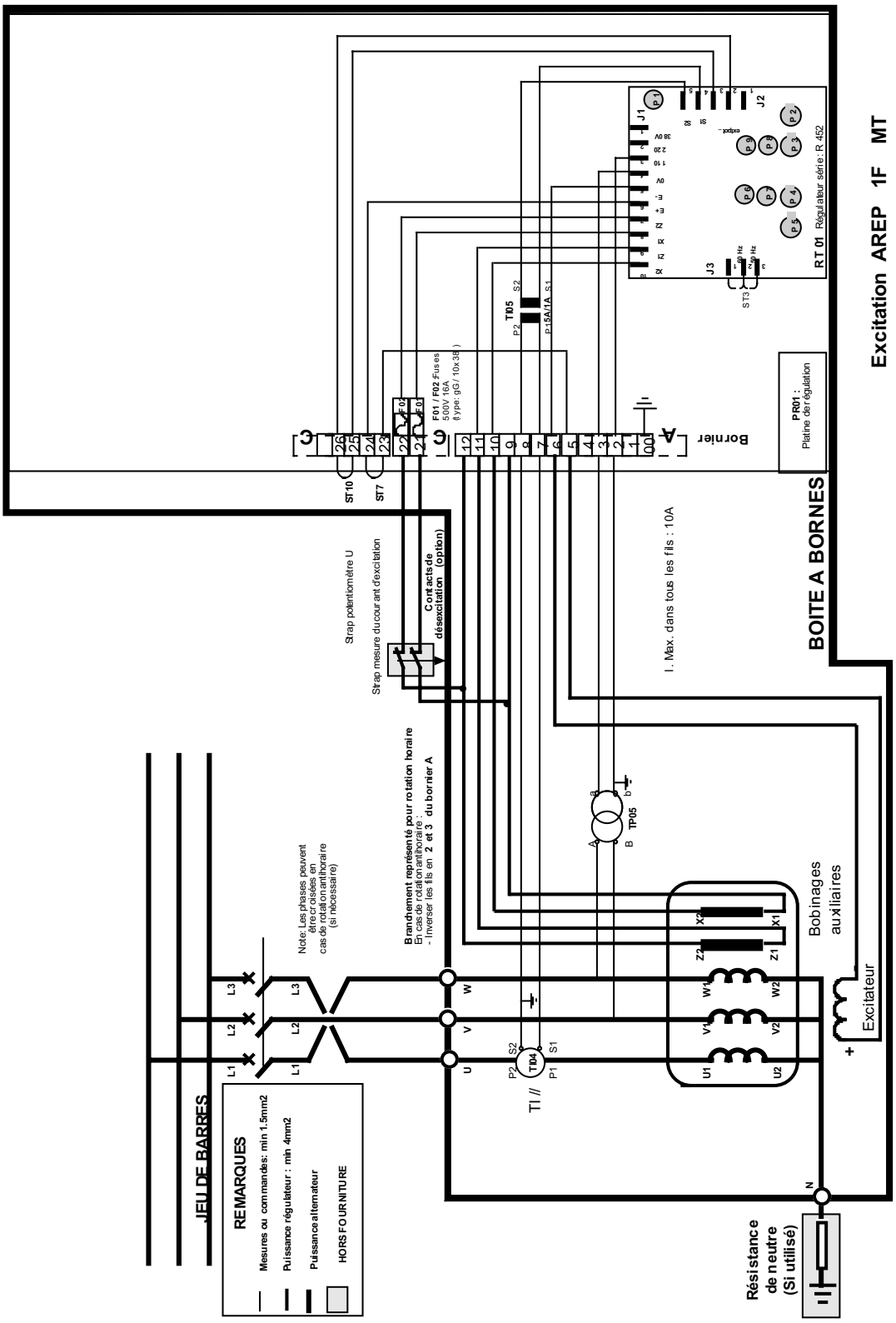
3 - TYPICAL DIAGRAMS

The following diagrams are supplied for information only and are not to be used in place of the actual alternator diagrams.

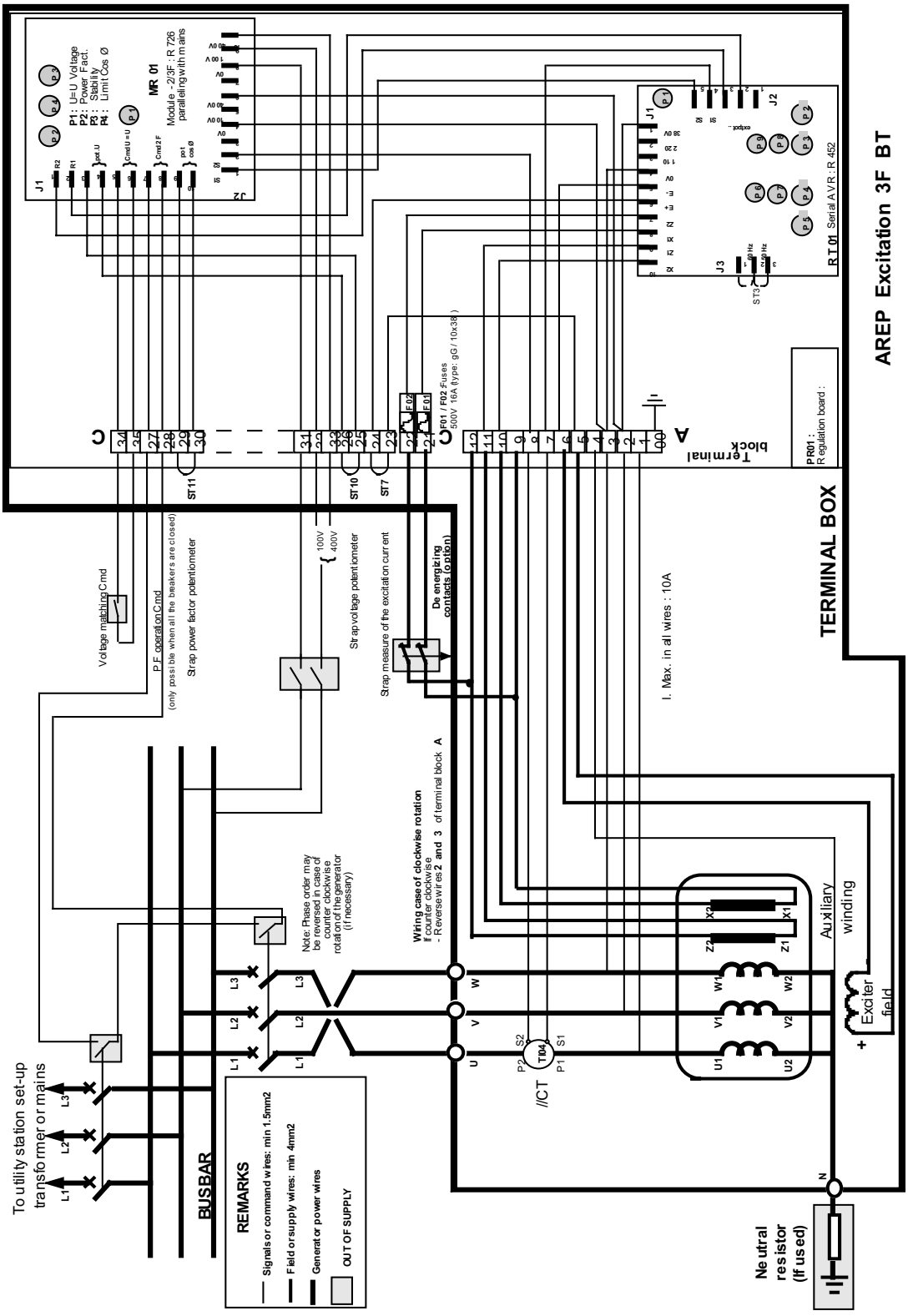
3.1 - AREP 1F LV excitation



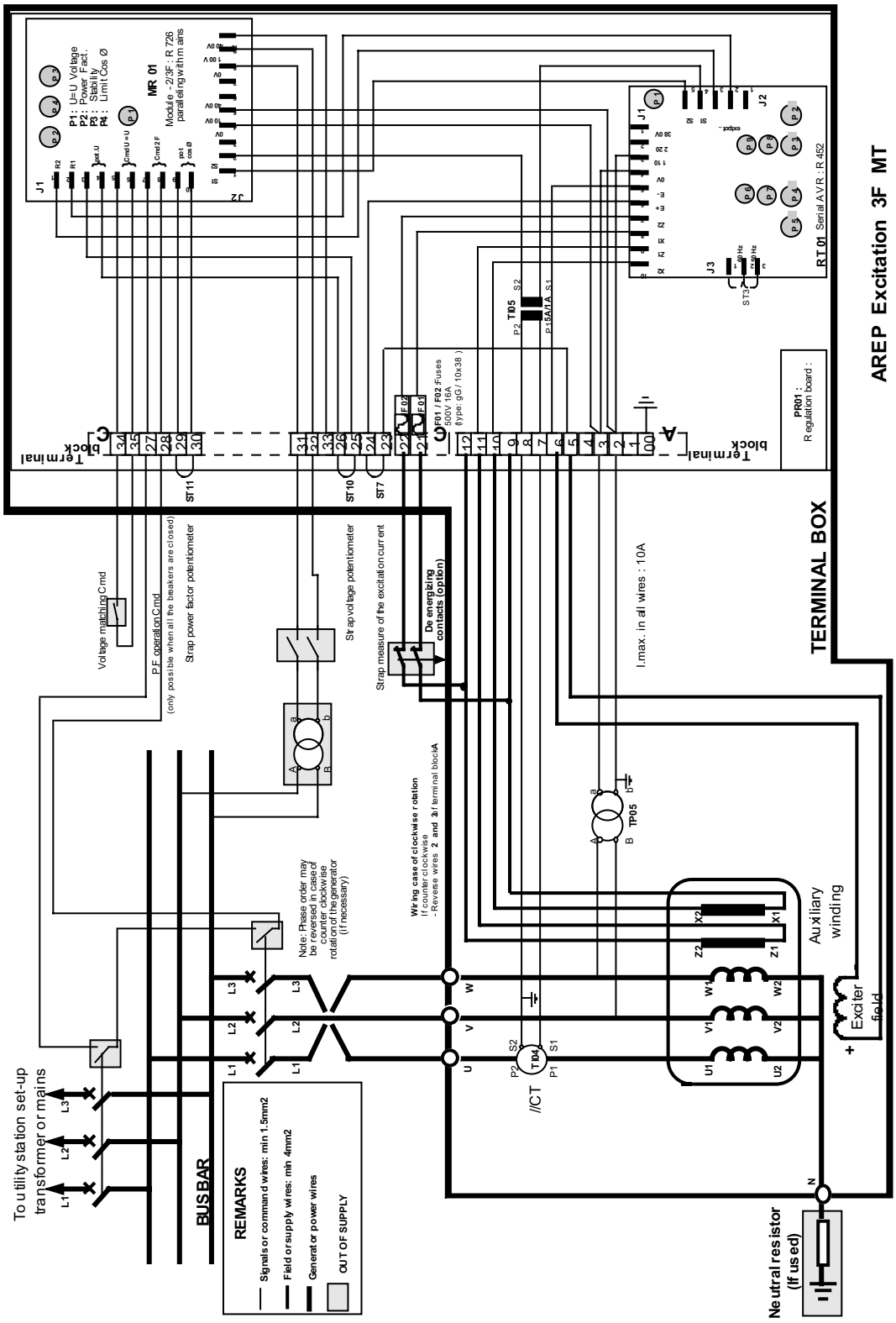
3.2 - AREP 1F MV excitation



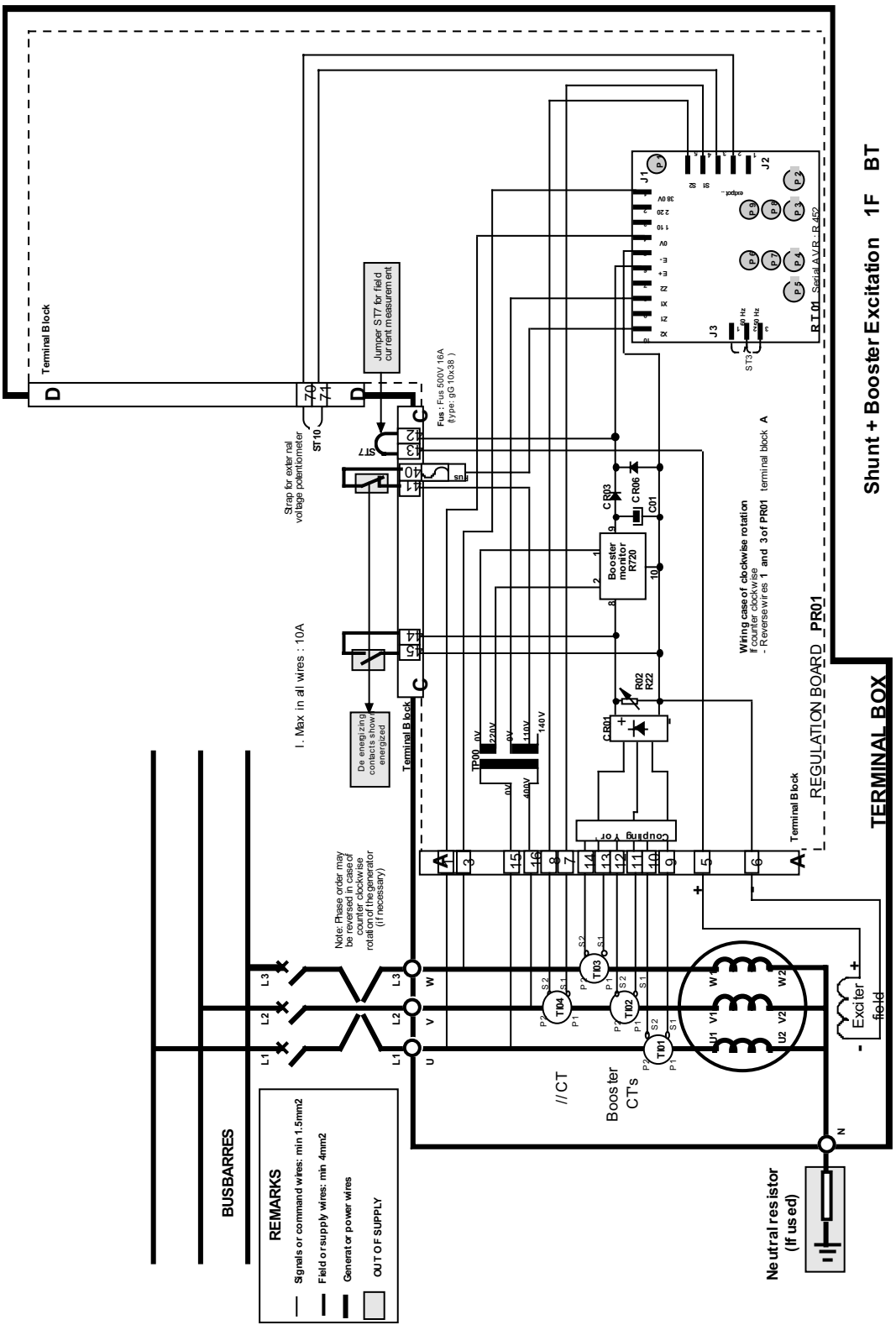
3.3 - AREP 3F LV excitation



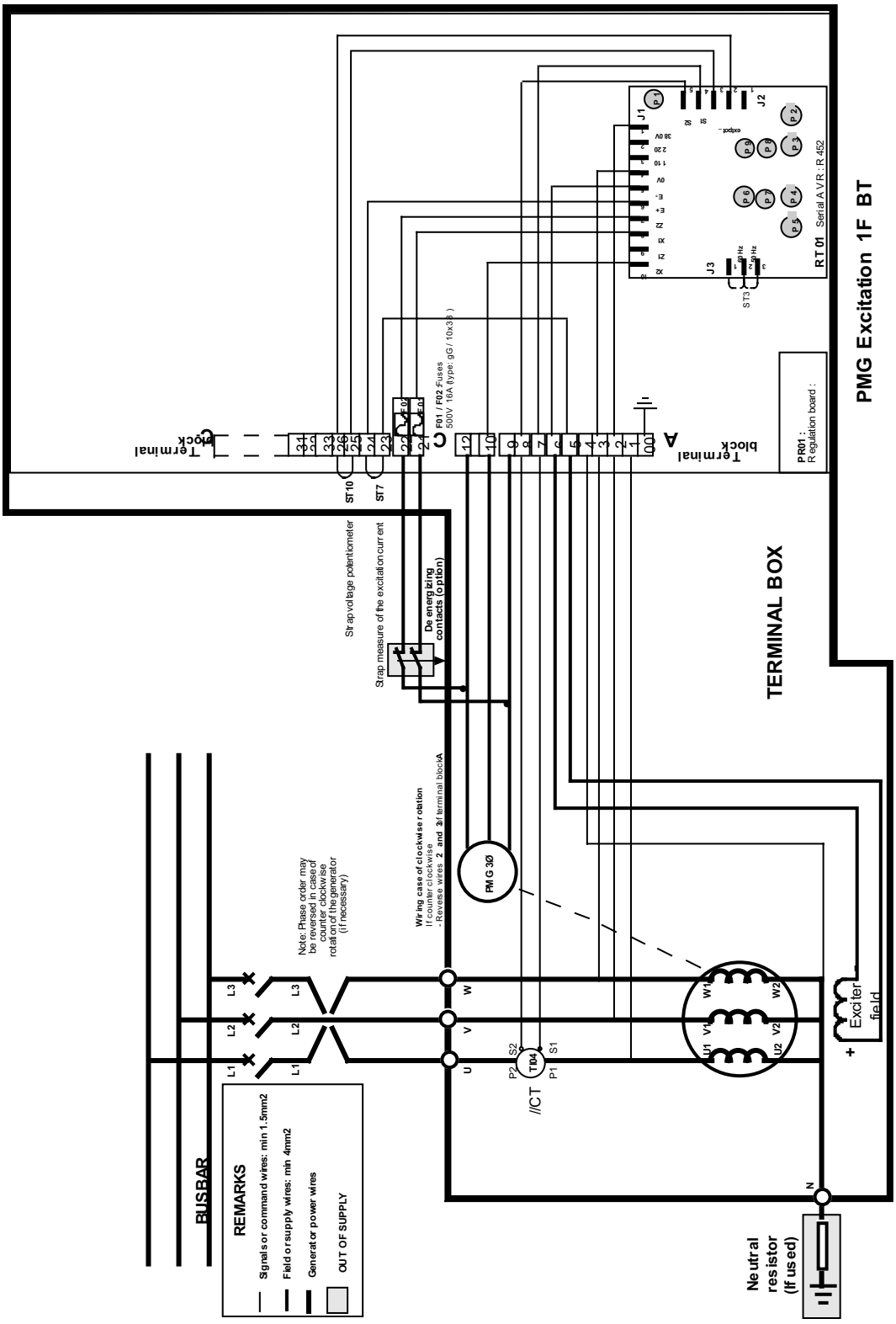
3.4 - AREP 3F MV excitation



3.5 - 1F LV Shunt + Booster excitation



3.6 - PMG 1F LV excitation



4 - COMMISSIONING

The commissioning principle is the same regardless of the type of excitation.

4.1 - for standalone regulation

- Check fuses F1 and F2 which are situated on terminal block C in the alternator.

- Check the regulator:

- Check the position of the ST3 jumper (select the frequency, 50 or 60Hz).

- If an external voltage potentiometer is being used, disconnect it from the regulator and install the ST4 jumper (regulator terminal block J2) or the ST10 jumper (terminal block C) in the alternator terminal box.

- Turn the internal voltage potentiometer P2 on the regulator fully anti-clockwise.

- Set the alternator to its rated speed using the drive system.

- The alternator voltage should rise to a value of 85 to 90%Un.

- Adjust the voltage to the required value using potentiometer P2.

- Turn potentiometer P1 fully anti-clockwise.

- Perform an on-load test with power factor = 0.8 or power factor = 1. The voltage should remain constant within the limits of the regulator. If it is not stable, see section 13-9.

- Stop the alternator and reconnect the external potentiometer, setting it to the centre position.

- Set the alternator to its rated speed then, using the external potentiometer, set the alternator to its rated voltage.

- The regulator set-up phase is now complete.

4.2 - for 1F regulation (parallel operation between alternators)

- The previous settings should be made on each alternator.

- Set the droop potentiometer to the centre position and perform an on-load test.

- With a load at power factor = 1, the voltage does not drop or only drops slightly; with an inductive load, the voltage drops. This voltage dip is set using the droop potentiometer P1. The no-load voltage is always higher than the on-load voltage; if the voltage rises, invert the parallel operation CT. The voltage quadrature droop is generally 2 to 3% of the rated voltage.

- The no-load voltages should be identical on all the alternators intended to run in parallel.

- Connect the alternators in parallel at no load.

- By adjusting the voltage setting P2 or the external voltage potentiometer on one of the machines, try to eliminate (or minimise) the circulating stator current between the machines.

From now on, do not touch the voltage settings.

- Match the kW rating with a minimum of 30% of the load by adjusting the drive system speed.

- By adjusting the droop potentiometer P1 on one of the machines, match or divide the stator currents.

- If several alternators are running in parallel, take one as a reference.

4.3 - for 2F regulation (regulation of power factor and 3F regulation (voltage match circuit) (consult R726 manual ref. 2440)

- Check the wiring between the R 452 and the R 726. (See the connection diagram).

- Check the information given for the R 726: Mains voltage, 2F contact, 3F contact.

- If an external voltage potentiometer is being used, disconnect it from the R 726 and add the ST1 jumper (terminals 3 and 4 of J1) or disconnect it from terminals 25 and 26 of terminal block C of the alternator and add the ST10 jumper.

- If an external PF potentiometer is being used, disconnect it from the R 726 and add the ST2 jumper (terminals 9 and 10 of J1) or disconnect it from terminals 29 and 30 of terminal block C of the alternator and add the ST11 jumper.

- Perform a 1F test.
The test principle is the same as in the case of 1F regulation.

- Matching the alternator and mains voltages prior to synchronisation (3F):
If this function is not used, match the voltages by adjusting the voltage potentiometer.
The following settings are for the R 726.
Close the 3F contact (terminals 5 and 6 of J1 of the R 726 or terminals 34 and 35 of terminal block C of the alternator). The red LED lights up. Adjust potentiometer P1 to match the alternator voltage to the mains voltage.

- Power factor regulation with the alternator synchronised to the mains voltage (2F):

- The following settings are for the R 726.

When the alternator is in phase with the mains and the mains and alternator voltages are equal, proceed with synchronisation. Contact 2F closes when the circuit breaker is closed. The green LED on the R 726 lights up. Open contact 3F and remove the mains voltage reference.

Preset PF potentiometer P2 to 5 and limit potentiometer P4 to 3.5.

Without supplying kW power to the mains, the reactive current of the alternator should be at or around 0.

Increase the kW power. When it reaches 50% of the rated power, adjust potentiometer P4 to obtain a PF of 0.9 LAG (inductive) on the alternator. The PF range is then 0.7 LAG (inductive) (P2 turned fully clockwise) to 0.95 LEADING (capacitive) (P2 turned fully anti-clockwise).

Adjust P2 to obtain the required power factor value.

Increase the kW power until it reaches the rated power. The PF should remain constant.

If it becomes unstable, adjust potentiometer P3 on the R 726 or potentiometer P3 on the R 452.

- Stop the alternator and reconnect the external potentiometers.

5 - TROUBLESHOOTING

5.1 - checking the windings and rotating diodes using a separate excitation

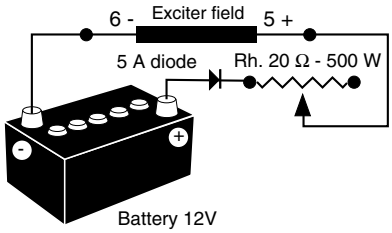
During this procedure, make sure that the alternator is disconnected from any external load and inspect the terminal box to check that the connections are fully tightened.

- Stop the generator, disconnect and isolate the regulator wires.

- There are two ways of creating an assembly with separate excitation: see the diagrams below.

- Assembly A: Connect the DC supply (2 batteries in series) in series with a rheostat of approximately 20 ohms 500W and a diode on both exciter field wires (5+) and (6-).

ASSEMBLY A



- Assembly B: Connect a "variac" variable power supply and a diode bridge to both exciter field wires (5+) and (6-).

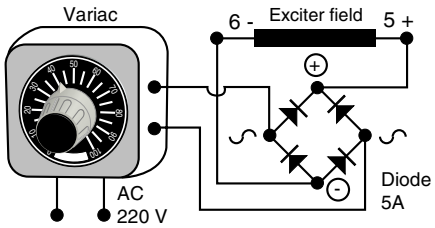
Both these systems must be compatible with the excitation rating of the machine (see the nameplate).

- Run the generator set at its rated speed.

- Gradually increase the exciter field power supply current by adjusting the rheostat or the variac and measure the output voltages L1 - L2 - L3, monitoring the no-load excitation voltages and currents. (See the alternator nameplate or ask Leroy-Somer for the test log).

- If the output voltages are at their rated values and matched to within < 1% for the given excitation value, the machine is operating correctly and the fault is due to the regulation part (regulator, wiring, sensing, auxiliary windings).

ASSEMBLY B



5.2 - static checking of the regulator

If the regulator operates correctly during a static test, this does not necessarily mean that it will operate correctly under real conditions.
If the regulator fails the static test, it can be concluded without doubt that the regulator is faulty.
Connect a test bulb in accordance with the diagram.
The power supply voltage must be between 200 and 240V.
The bulb voltage is 220V. The bulb power rating must be less than 100W.

- Turn potentiometer P1 fully anti-clockwise.

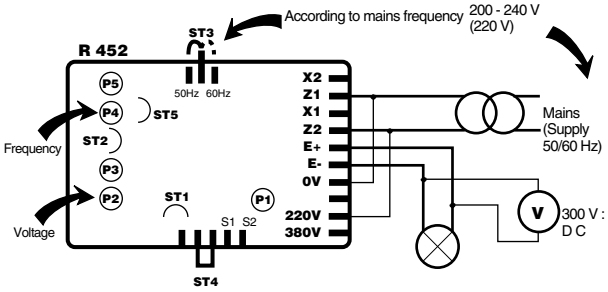
- Switch on the regulator; the bulb should light up briefly and then go out.

- Slowly turn the voltage potentiometer clockwise, to the right.

- When turned fully to the right, the bulb lights up continuously.

- At the regulation point, turning the voltage adjustment potentiometer slightly in one director or the other should make the bulb light up or go out. If the bulb is either lit continuously or does not light up at all, the regulator is faulty.

- Perform one test supplying the regulator via terminals X1, X2 then another supplying it via terminals Z1, Z2.
Static checking of the LAM:
P2 should be positioned at the point where the bulb lights up. Turn the P4 potentiometer slowly to the left. The bulb should dim suddenly and the voltage drops to approximately 85% of the power supply voltage. Return to the P4 starting position. The bulb should light up as brightly as before.



5.3 - troubleshooting table

- Before any intervention on the R 452 or the R 726, carefully note the potentiometer and jumper positions.

5.3.1 - for 1F, parallel operation between alternators

Symptoms	Probable causes	Solutions
Absence of voltage on start-up, at no load.	- No residual magnetism or polarity inversion between the excitation output and the excitation input.	- Voltage build-up is required.
	- De-energising contacts open.	- Close this contact.
	- The speed is less than the rated speed.	- Adjust the speed.
	- Connection lost between the regulator and the exciter.	- Check the wiring.
	- Alternator loaded or short-circuited.	- Remove the load from the alternator.
	- External potentiometer connected incorrectly.	- Check the wiring.
	- Faulty regulator.	- Test it or change it.
	- Faulty exciter or rotating diode bridge.	- Check the exciter and the diodes.
	- Fuses blown.	- Replace the fuses.
Voltage too high and adjustment potentiometer has no effect.	- Incorrect voltage at the sensing terminals.	- Check the wiring of the 0, 110V, 220V and 380V terminals on terminal block J1.
	- Loss of sensing.	- Check the wiring.
	- The external potentiometer has an incorrect value.	- Set a potentiometer with the correct value.
	- Faulty regulator.	- Test it or change it.
Voltage too high, but adjustable by the adjustment potentiometer.	- Voltage potentiometer set too high.	- Adjust voltage potentiometer P2 or the external potentiometer.
	- Regulator sensing incorrect.	- Check the wiring and the sensing value at the 0V, 110V, 220V and 380V terminals.
	- Faulty regulator.	- Test it or change it.
Voltage too low, but adjustable by the voltage potentiometer.	- ST3 and ST4 jumpers.	- Check the presence of the ST3 and ST4 jumpers.
	- The speed is too low.	- Set to the correct speed.
	- Exciter and rotating diodes.	- Check the exciter and the rotating diodes.

VOLTAGE REGULATOR R452

TROUBLESHOOTING

Symptoms	Probable causes	Solutions
Incorrect regulation.	- Distortion of the waveform, non-linear load. - Unbalanced load. - The speed is not at the correct value. - Faulty exciter or rotating diodes. - Faulty regulator.	- Contact ACEO. - Balance the load or change the sensing points. - Adjust the speed. - Check the exciter and the rotating diodes. - Test it or change it.
Response time too long.	- Stability adjustment. - Speed regulator response too slow.	- Adjust stability potentiometer P3 and the ST2 jumper. - Adjust the stability of the speed.
Considerable drop in voltage, on-load.	- Vectorial composition fault between the voltage and the current. - The parallel operation CT ratio is incorrect.	- Check the sensing wiring and the parallel operation CT wiring. - Correct the CT ratio.
kVAR not stable between alternators (reactive current circulation).	- Droop potentiometer needs adjusting. - The no-load voltages are not identical. - Phases not connected to the sensing correctly. - The CT is not on the correct phase.	- Adjust the droop potentiometer. - Check that all the alternators have the same no-load voltage value. - Check the sensing wiring. - Check the position of the parallel operation CT.
Voltage unstable.	- Frequency unstable. - Detection at the secondary of a transformer supplying other devices. - Faulty regulator. - The stability potentiometers are incorrectly set.	- Check the stability of the drive system speed. - Install an isolated sensing for the alternator. - Test it or change it. - Reset the stability.
Voltage drop on load impact.	- Potentiometer P6 is incorrectly set. - Potentiometer P7 is incorrectly set.	- Turn potentiometer P6 fully anti-clockwise. - Turn potentiometer P7 fully anti-clockwise.
Overvoltage on voltage build-up.	- The stability potentiometers are incorrectly set.	- Reset the stability.

5.3.2 - for the 2F and 3F

Symptoms	Probable causes	Solutions
Incorrect PF regulation, PF potentiometer has no effect.	- Vectorial composition fault between the sensing voltage and the stator current. - Faulty R 726. - R 726 ST2 jumper missing. - Wiring fault between the R 452 and the R 726.	- Check the sensing wiring and the parallel operation CT wiring. - Change the module. - Check the wiring, in particular the wires between 1 and 2 of terminal block J1 on the R 726.
PF range incorrect.	- Incorrect setting of P2 and P4 potentiometers.	- Reset the range as shown above.
The LEDs will not light up.	- Contacts 2F and 3F missing.	- Check the wiring.
Cannot adjust the voltage match circuit.	- The sensing voltage is incorrect or incorrectly connected.	- Check the wiring and the voltage value.

5.3.3 - checking the alternator using a separate excitation

- The alternator is tested at no load.
- Disconnect the R 452, R 726 and the entire alternator excitation system.
- Connect a 24V 5A variable DC supply to the exciter field wires.
Apply a direct current to the exciter to obtain the rated voltage.
- Check all the alternator parameters:
Stator voltage, exciter field voltage, AREP or regulator power transformer voltages, sensing voltage at the regulator terminal block.
- All these parameters should be checked against the alternator characteristics.

5.4 - replacing the regulator with a spare voltage regulator

- Set the potentiometers and the jumpers in the same way as the original regulator.

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