MX341 AUTOMATIC VOLTAGE REGULATOR (AVR)

SPECIFICATION, INSTALLATION AND ADJUSTMENTS

GENERAL DESCRIPTION

The MX341 is a two phase sensed Automatic Voltage Regulator (AVR) and forms part of the excitation system for a brushless generator.

In addition to regulating the generator voltage, the AVR circuitry includes protective features to ensure safe reliable control of the generator. Excitation power is derived from a permanent magnet generator (PMG) to guarantee low Radio Frequency Interference (RFI) and immunity from thyristor type loads.

The AVR is linked with the main stator windings and controls the power fed to the exciter stator and hence the main rotor to maintain the machine output voltage within the specified limits, compensating for load, speed, temperature and power factor of the generator.

Soft start circuitry is included to provide a smooth controlled build up of generator output voltage.

A frequency measuring circuit continually monitors the shaft speed of the generator and provides underspeed protection of the excitation system by reducing the generator output voltage proportionally with speed below a presettable threshold. A further enhancement of this feature is an adjustable volts/Hz slope to improve frequency recovery time on turbo charged engines.

Uncontrolled over excitation is limited to a safe period by internal shutdown of the AVR output device. This condition remains latched until the generator has been stopped.

Provision is made for the connection of a remote voltage trimmer allowing the user fine control of the generator's output.

Accessories are available for this AVR. Please refer to factory for further details.

TECHNICAL SPECIFICATION

SENSING INPUT

Voltage	170-250 V ac max
Frequency	50-60 Hz nominal
Phase	2
Wire	2

POWER INPUT (PMG)

Voltage	140-220 V ac
Current	3 A/phase
Frequency	100-120 Hz nominal
Phase	3
Wire	3

OUTPUT

Voltage	max 120 V dc
Current	continuous 2.7 A Transient 6 A for 10 seconds
Field Resistance	15 Ω minimum

REGULATION (See Note 1) +/- 1%

THERMAL DRIFT

(after 10 min)
1% for 40°C change in AVR ambient

SOFT START RAMP TIME

3 seconds

TYPICAL SYSTEM RESPONSE

Field current to 90% 80ms
Machine Volts to 97% 300ms

EXTERNAL VOLTAGE ADJUSTMENT

+/- 6% with 1 K Ω trimmer

UNDER FREQUENCY PROTECTION

Set Point	(see note 2) 95% Hz
Slope	100-300% down to 30 Hz

UNIT POWER DISSIPATION

12 watts maximum

ACCESSORY INPUT

+/- 1 V = +/- 5% change in output volts

QUADRATURE DROOP

Maximum sensitivity (10 Ω Burden)
0.07A for 5% droop @ 0p.f.

OVER EXCITATION PROTECTION

Set Point	75 V dc
Time Delay (fixed)	10 seconds

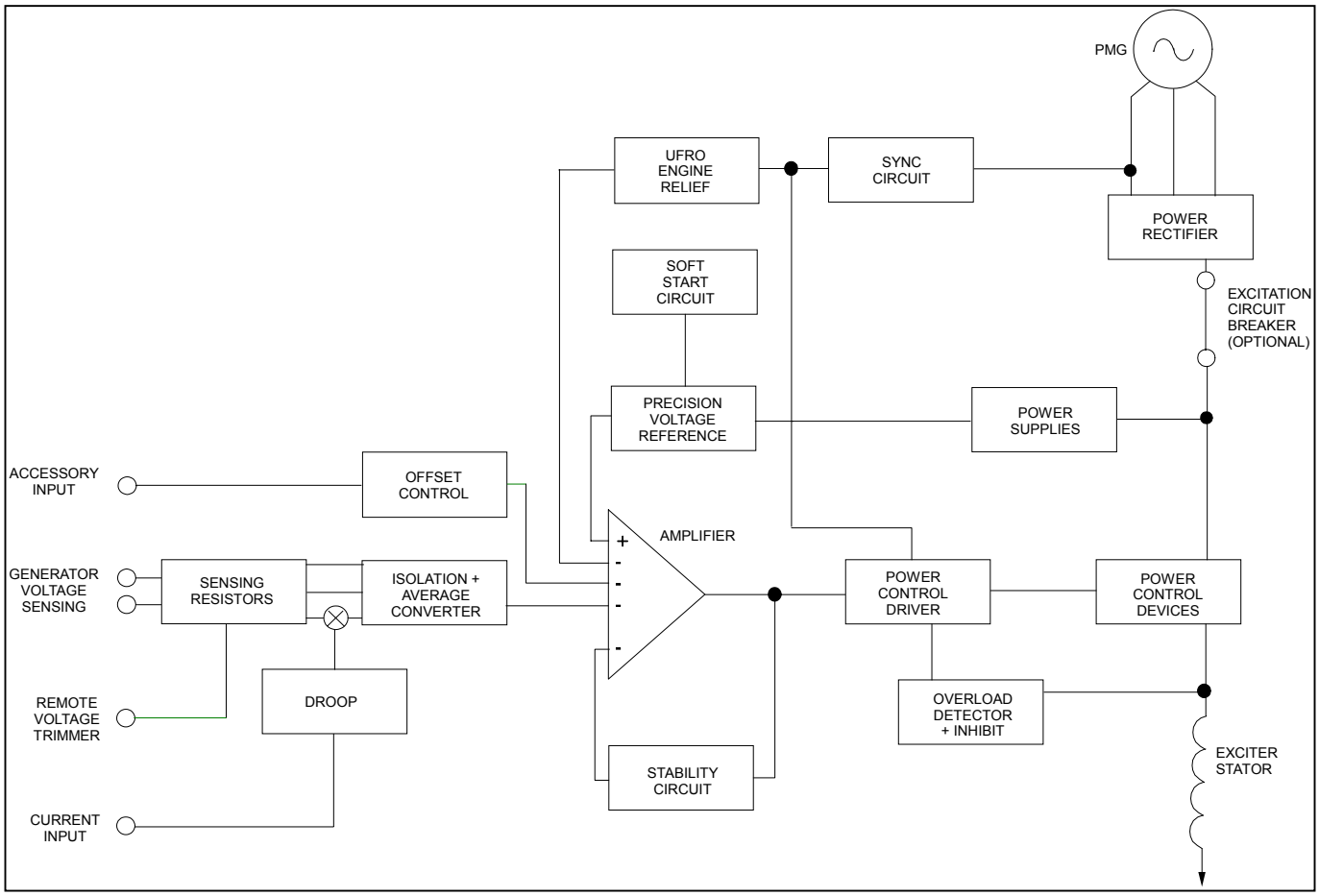
ENVIRONMENTAL

Vibration	20-100Hz 50mm/sec 100Hz-2 kHz 3.3g
Relative Humidity	0-60°C 95%
Operating Temperature	-40°C to + 70°C
Storage Temperature	-55°C + 80°C

NOTES

1. With 4% engine governing
2. Factory set, semi-sealed, jumper selectable.

DESIGN DETAILS



The main functions of the AVR are:

Sensing Resistors take a proportion of the generator output voltage and attenuate it. This input chain of resistors includes the range potentiometer and hand trimmer which adjust the generator voltage. An isolating transformer is included to allow connection to windings of different polarity and phase. An operational precision rectifier converts the ac sensing voltage into dc for further processing.

Quadrature droop circuit converts the current input into a voltage which is phase mixed with the sensing voltage. The result is a net increase in the output from the sensing network as the power factor lags, causing the reduction in excitation needed for reactive load sharing of paralleled generators.

A trimmer allows control over the amount of droop signal.

Offset Control provides an interface between the AVR and accessories.

Power Supply components consist of zener diodes, dropper resistors and smoothing to provide the required voltages for the integrated circuits.

Precision voltage reference is a highly stable temperature compensated zener diode for dc comparison.

Soft Start circuit overrides the precision voltage reference during run-up to provide a linear rising voltage.

Main Comparator/Amplifier compares the sensing voltage to the reference voltage and amplifies the difference (error) to provide a controlling signal for the power device.

Stability circuit provides adjustable negative ac feedback to ensure good steady state and transient performance of the control system.

Power Control Driver controls the conduction period of the output device. This is achieved by pedestal and ramp control followed by a level detector and driver stage.

Power Control devices and rectifier vary the amount of exciter field current in response to the error signals produced by the main comparator.

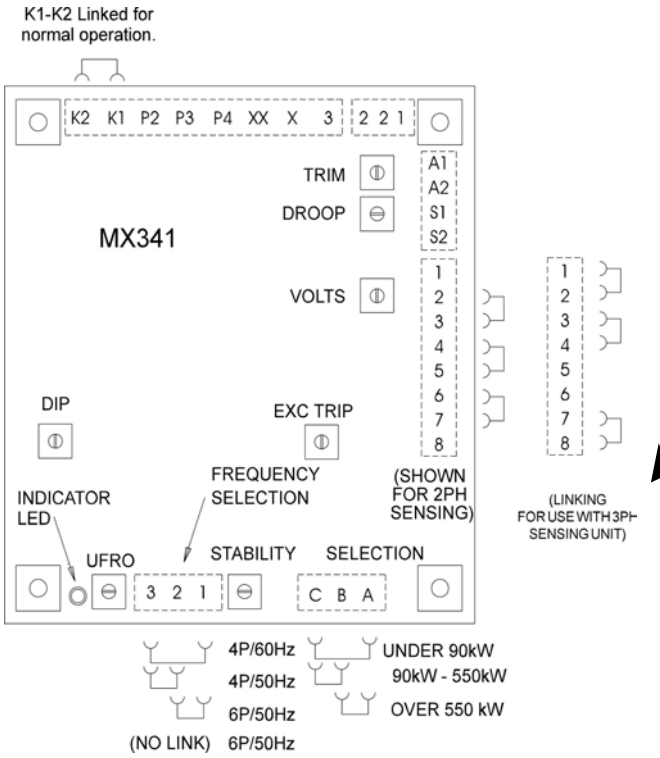
Synchronising circuit provides a short pulse near the zero point of one of the phases on the PMG and is used to synchronise the Under Frequency Roll Off (UFRO) and power control circuits to the generator cycle period.

UFRO circuit measures the period of each electrical cycle and reduces the reference voltage linearly with speed below a presettable threshold. A light emitting diode (LED) gives indication of underspeed.

Engine Relief (load acceptance) circuit causes greater voltage roll off (makes the volts/Hz slope steeper) to aid engine speed recovery after application of a "block" load.

Overload detector continuously monitors the level of excitation and provides signals to shut down the output device if overloads last more than ten seconds. An overload condition produces a latched fault requiring the generator to be stopped for reset.

FITTING AND OPERATING



Warning ! **A separate 3 Phase Sensing unit is needed. Do not connect as shown unless a 3 Phase Sensing unit is fitted. (See sheet 5515)**

SUMMARY OF AVR CONTROLS		
CONTROL	**FUNCTION**	**DIRECTION**
VOLTS	TO ADJUST GENERATOR OUTPUT VOLTAGE	CLOCKWISE INCREASES OUTPUT VOLTAGE
STABILITY	TO PREVENT VOLTAGE HUNTING	CLOCKWISE INCREASES STABILITY OR DAMPING EFFECT
UFRO	TO SET UNDER FREQUENCY ROLL OFF KNEE POINT	CLOCKWISE REDUCES THE KNEEPOINT FREQUENCY
DROOP	TO SET GENERATOR OR DROOP TO 5% AT FULL LOAD 0 PF	CLOCKWISE INCREASES THE DROOP
V/TRIM	TO MATCH AVR INPUT TO ACCESSORY OUTPUT	CW. ALLOWS THE ACCESSORY MORE CONTROL OVER AVR
EXC TRIP	TO SET THE OVEREXCITATION CUT OFF LEVEL	CLOCKWISE INCREASES THE CUT OFF LEVEL
DIP	TO SET THE INITIAL FREQUENCY RELATED VOLTAGE DIP	CLOCKWISE INCREASES THE VOLTAGE DIP

The AVR is fully encapsulated to ensure long trouble-free operation. It is usually fitted on a panel of the terminal box. It can also be separately fitted in a switchboard.

ADJUSTMENT OF AVR CONTROLS

VOLTAGE ADJUSTMENT

The generator output voltage is set at the factory, but can be altered by careful adjustment of the volts control on the AVR board, or by the external hand trimmer if fitted. Terminals 1 & 2 on the auxiliary terminal block in the generator terminal box will be fitted with a shorting link if no hand trimmer is required.

Warning ! **Do not increase the voltage above the rated generator voltage. If in doubt, refer to the rating plate mounted on the generator case.**

If a replacement AVR has been fitted or re-setting of the VOLTS adjustment is required, proceed as follows:-

1) Before running generator, turn VOLTS control fully anti-clockwise.
2) Turn remote volts trimmer (if fitted) to midway position.
3) Turn STABILITY control to midway position.
4) Connect a suitable voltmeter (0-300V ac) across line to neutral of the generator.
5) Start generator set, and run on no load at nominal frequency e.g. 50-53Hz or 60-63Hz.
6) If the red Light Emitting Diode (LED) is illuminated, refer to the Under Frequency Roll Off (UFRO) adjustment.
7) Carefully turn VOLTS control clockwise until rated voltage is reached.
8) If instability is present at rated voltage, refer to stability adjustment, then re-adjust voltage if necessary.
9) Voltage adjustment is now completed.

STABILITY ADJUSTMENT

The AVR includes a stability or damping circuit to provide good steady state and transient performance of the generator.

The correct setting can be found by running the generator at no load and slowly turning the stability control anti-clockwise until the generator voltage starts to become unstable.

The optimum or critically damped position is slightly clockwise from this point (i.e. where the machine volts are stable but close to the unstable region).

OPTIMUM RESPONSE SELECTION

The "jumper" selector lead should be correctly linked (A,B,C at the bottom of the board) for the frame size of the generator (See diagram).

UNDER FREQUENCY ROLL OFF (UFRO) ADJUSTMENT

The AVR incorporates an underspeed protection circuit which gives a volts/Hz characteristic when the generator speed falls below a presettable threshold known as the "knee" point.

The correct linking must first be set with "jumper" lead for 4 or 6 pole, 50 or 60Hz operation (see diagram).

The red Light Emitting Diode (LED) gives indication that the UFRO circuit is operating.

The UFRO adjustment is preset and sealed at the works and only requires the selection of 50/60Hz using the jumper link.

Adjustment of the UFRO control will be necessary if the unit is used on a 6 pole machine to replace an earlier AVR type.

For optimum setting, the LED should illuminate as the frequency falls just below nominal, i.e. 47Hz on a 50Hz system or 57Hz on a 60Hz system.

If the red LED is illuminated and no output voltage is present, refer to Over Excitation adjustment.

DIP ADJUSTMENT

The 'DIP' adjustment allows some control over the generator voltage dip upon the application of load.

This feature is mostly used when the generator is coupled to turbo-charged engines with limited block load acceptance, and operates only when the speed is below the UFRO knee point (LED illuminated).

With the 'DIP' control fully anti-clockwise the generator voltage characteristics will follow the normal V/Hz line as the frequency falls below nominal.

With a more clockwise setting, the slope of the V/Hz line will be increased until the rate of engine falling speed recovers.

Turning the 'DIP' control clockwise provides greater voltage dip allowing easier engine recovery.

DROOP ADJUSTMENT

Generators intended for parallel operation are fitted with a quadrature droop C.T. which provides a power factor dependent signal for the AVR. The C.T. is connected to S1, S2 on the AVR.

The DROOP adjustment is normally preset in the works to give 5% voltage droop at full load zero power factor (cos Ø).

Clockwise increases the amount of C.T. signal injected into the AVR and increases the droop with lagging power factor.

If a three phase sensing unit is fitted, droop adjustment is made on this seperate unit.

With the control fully anti-clockwise there is no droop.

TRIM ADJUSTMENT (V/TRIM)

An auxiliary input is provided to connect to the VPF controller, (A1,A2). It is designed to accept dc signals up to +/- 5 volts.

The dc signal on this input adds to or subtracts from the AVR sensing circuit, depending on polarity.

The V/Trim control allows the user to adjust the sensitivity of the VPF controller.

With V/Trim fully anti-clockwise the VPF controller has no effect. Clockwise it has maximum effect. Normal setting is fully clockwise.

OVER EXCITATION (EXC TRIP) ADJUSTMENT

The adjustment is set and sealed in the works and should not be altered.

An over excitation condition is indicated on the common red LED which also indicates underspeed running.

The generator must be stopped to reset an over excitation trip.

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