STAMFORD®

AS540 Automatic Voltage Regulator (AVR)

SPECIFICATION, CONTROLS AND ACCESSORIES

English
Original Instructions

A054N491 (Issue 1)

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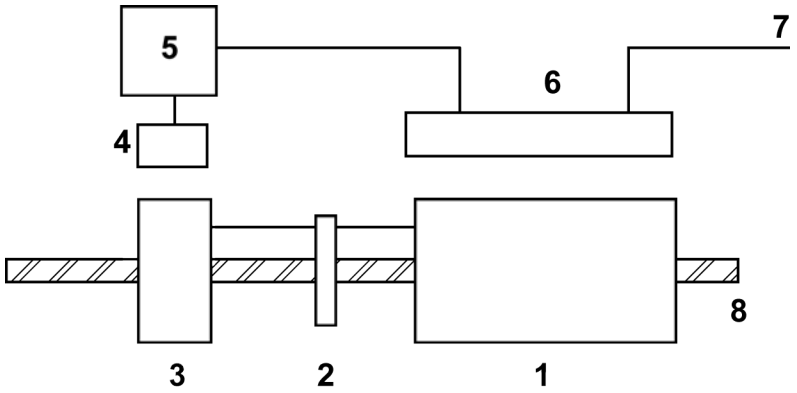
1 Description

1.1 Self-Excited AVR Controlled Alternators

1.1.1 Main Stator Powered AVR

The AVR provides closed loop control by sensing the alternator output voltage at the main stator windings and adjusting the exciter stator field strength. Voltage induced in the exciter rotor, rectified by the rotating diodes, magnetises the rotating main field which induces voltage in the main stator windings. A self-excited AVR receives power from the alternator output terminals or a special auxiliary winding in the main stator winding.



No.	Description	No.	Description
1	Main field (rotor)	5	AVR
2	Rotating diodes	6	Main armature (stator) or auxiliary winding (if fitted)
3	Exciter armature (rotor)	7	Output
4	Exciter field (stator)	8	Rotor shaft

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2 Specification

2.1 AS540 Technical Specification

- **Sensing Input**
  - Voltage: 95 VAC to 130 VAC 1 phase or 190 VAC to 265 VAC 1 phase[1]
  - Frequency: 50 Hz to 60 Hz nominal
- **Power Input**
  - Voltage: 95 VAC to 265 VAC 1 phase only
  - Frequency: 50 Hz to 60 Hz nominal
- **Power Output**
  - Voltage: maximum 82 VDC at 200 VAC input
  - Current
    - continuous 4 A
    - transient 7.5 A for 10 seconds
  - Resistance: 15 Ω minimum (10 Ω minimum when power input less than 175 VAC)
- **Regulation**
  - +/- 1.0% RMS[2]
- **Thermal Drift**
  - 0.03% per 1 °C change in AVR ambient temperature[3]
- **Typical Response**
  - AVR response in 20 ms
  - Field current to 90% in 80 ms
  - Machine Volts to 97% in 300 ms
- **External Voltage Adjustment**
  - +/-10% with 1 kΩ, 1 W trimmer[4]
- **Under-Frequency Protection**
  - Set point 94% to 98% Hz [5]
- **Unit Power Dissipation**
  - 12 W maximum
- **Build-up Voltage**
  - 5 VAC at AVR terminals
- **Over-Voltage Detection**
  - Set point: 65 VDC[6]

[1] selected by jumper
[2] With 4% engine governing
[3] After 2 minutes.
[4] Alternator de-rate may apply. Check with factory.
[5] Factory set, semi-sealed, slide switch selectable.
[6] Factory set, semi-sealed.

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- Time delay: 10 s to 15 s (fixed)

- **Environmental**
  - Vibration
    - 20 Hz to 100 Hz: 50 mm/sec
    - 100 Hz to 2 kHz: 3.3 g
  - Operating temperature: -40 °C to +70 °C[7]
  - Relative Humidity 0 °C to 70 °C: 95%[8]
  - Storage temperature: -55 °C to +80 °C

[7] De-rate output current by 5% per 1 °C above 60 °C
[8] Non condensing.

3 Controls

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns.

To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ DANGER

Live Electrical Conductors

Live electrical conductors at output, AVR and AVR accessory terminals, and AVR heat sink can cause serious injury or death by electric shock and burns.

To prevent injury, take suitable precautions to prevent contact with live conductors including personal protective equipment, insulation, barriers and insulated tools.

NOTICE

Refer to alternator wiring diagram for connection details.

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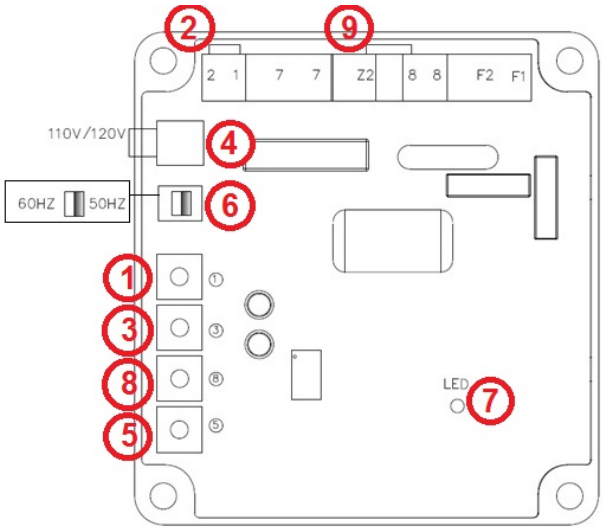


Ref.	Control	Function	Turn potentiometer CLOCKWISE to
1	AVR [VOLTS]	Adjust alternator output voltage	increase voltage
2	**Link : Hand trimmer** 1-2 : No trimmer None : Trimmer fitted	Adjust alternator output voltage	increase voltage by AVR voltage adjustment pot (1)
3	AVR [STAB]	Adjust stability to prevent voltage hunting	increase damping effect
4	**Link : Supply** Link : 110 V/120 V None: 240 V	Select AVR supply voltage	N/A
5	AVR [UFRO]	Adjust under-frequency roll-off knee point	reduce UFRO frequency
6	**Switch : UFRO frequency** Switch Left : 60 Hz Switch Right : 50 Hz	Select alternator frequency for UFRO	N/A
7	Light Emitting Diode	LED lights in UFRO or O/EXC condition	N/A
8	AVR [O/EXC]	Adjust over-excitation trip	increase trip voltage
9	**Link : Supply** 8-Z2 : Main stator None: Auxiliary winding	Select AVR supply source	N/A

FIGURE 1. AS540 AVR CONTROLS

3.2 Initial AVR Setup

NOTICE
The AVR must be setup only by authorised, trained service engineers. Do not exceed the designed safe operating voltage, shown on the alternator rating plate.

The AVR controls are set at the factory for initial running tests. Check that the AVR settings are compatible with your required output. Do not adjust controls that have been sealed. To set up a replacement AVR, follow these steps:

1. Stop and isolate the generator set.
2. Install and connect the AVR.
3. Turn the **AVR [VOLTS]** volts control Section 3.3 on page 7 fully counter-clockwise.
4. Turn the hand trimmer (if fitted) to 50%, the midway position.
5. Turn the **AVR [STAB]** stability control Section 3.4 on page 8 to 50%, the midway position.
6. Connect a suitable voltmeter (0 to 300 VAC range) between one output phase and neutral.
7. Start the generator set with no load.
8. Adjust speed to nominal frequency (50 to 53 Hz or 60 to 63 Hz).
9. If the LDE is lit, adjust the **AVR [UFRO]** control Section 3.5 on page 9.
10. Carefully turn **AVR [VOLTS]** control clockwise until the voltmeter shows rated voltage.
11. If voltage is unstable, adjust the **AVR [STAB]** stability control.
12. Re-adjust the **AVR [VOLTS]** control, as needed.

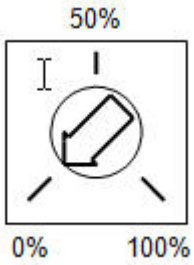
3.3 Adjust the AVR [VOLTS] Voltage Control

NOTICE
Do not exceed the designed safe operating voltage, shown on the alternator rating plate.

NOTICE
Hand trimmer terminals may be above earth potential. Do not ground any of the hand trimmer terminals. Grounding hand trimmer terminals could cause equipment damage.

To set the output voltage AVR [VOLTS] control on the AVR:

1. Check the alternator nameplate to confirm the designed safe operating voltage.
2. Set the **AVR [VOLTS]** control to 0%, the fully counter-clockwise position.



3. Check that the remote hand trimmer is fitted or terminals 1 and 2 are linked.

NOTICE
If a remote hand trimmer is connected, set it to 50%, the midway position.

4. Turn the **AVR [STAB]** control to 50%, the midway position.
5. Start the alternator and set at the correct operating speed.
6. If the red Light Emitting Diode (LED) is illuminated, refer to the Under Frequency Roll Off **AVR [UFRO]** adjustment.
7. Adjust the **AVR [VOLTS]** control slowly clockwise to increase the output voltage.

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NOTICE
If the voltage is unstable set the AVR stability before proceeding Section 3.4 on page 8.

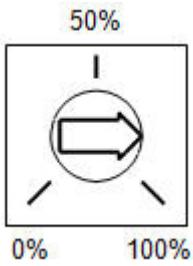
8. Adjust the output voltage to the desired nominal value (VAC).
9. If instability is present at rated voltage, refer to the **AVR [STAB]** adjustment, then adjust **AVR [VOLTS]** again, if necessary.
10. If a remote hand trimmer is connected, check its operation.

NOTICE
0% to 100% rotation corresponds to 90% to 110% VAC

The **AVR [VOLTS]** control is now set.

3.4 Adjust the AVR [STAB] Stability Control

1. Check the nameplate to confirm the power rating of the alternator.
2. Check that the jumper link or rotary switch selection (depending on AVR type) matches the alternator power rating for optimal stability response.
3. Set the **AVR [STAB]** control to approximately 75% position.



4. Start the alternator and set at the correct operating speed.
5. Verify that the alternator voltage is within safe limits.

NOTICE
If the voltage is unstable go immediately to step 5.

6. Adjust the **AVR [STAB]** control slowly counter-clockwise until the output voltage becomes unstable.
7. Adjust the **AVR [STAB]** control slowly clockwise until the voltage is stable.
8. Adjust the **AVR [STAB]** control a further 5% clockwise.

NOTICE
Readjust the voltage level if necessary (see Section 3.3 on page 7).

The **AVR [STAB]** control is now set.

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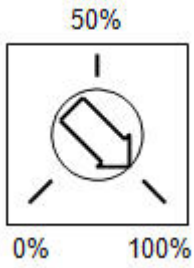
3.5 Adjust the AVR [UFRO] Under-Frequency Roll-Off Control

Below an adjustable frequency threshold ('knee' point), the AVR under-speed protection operates to reduce ('roll-off') the excitation voltage in proportion to alternator frequency. The AVR LED lights when UFRO operates.

1. Check the nameplate to confirm the frequency of the alternator.

NOTICE
Power off the AVR before adjusting the slide switch.

2. Check that the slide switch matches the alternator frequency.
3. Set the **AVR [UFRO]** control to 100%, the fully clockwise position.



4. Start the alternator and set at the correct operating speed.
5. Verify that the alternator voltage is correct and stable.

NOTICE
If the voltage is high / low / unstable, use method Section 3.3 on page 7 or Section 3.4 on page 8 before proceeding.

6. Reduce the alternator speed to approximately 95% of correct operating speed. i.e. 47.5 Hz for 50 Hz operation, 57.0 Hz for 60 Hz operation.
7. Adjust the **AVR [UFRO]** control slowly counter-clockwise until the AVR LED lights.

8. Adjust the **AVR [UFRO]** control slowly clockwise until the AVR LED is just OFF.

NOTICE
Do not go past the point at which the LED is just OFF.

9. Adjust the alternator speed back to 100% nominal. The LED should be off.

The **AVR [UFRO]** control is now set.

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3.6 Adjust the AVR [EXC] Over-Excitation Control

NOTICE
The AVR [EXC] control is set and sealed at the factory to protect the alternator from over-excitation, usually caused by overload. Incorrect AVR [EXC] control setting could damage the alternator rotor components.

The AVR protects the alternator by removing excitation if it senses that the excitation voltage exceeds a threshold set by the **AVR [EXC]** control.

1. If the excitation voltage exceeds the over-excitation trip setting, the red LED on the AVR turns on.
2. After a short time, the AVR removes the excitation voltage and the red LED flashes (which can also indicate an over-voltage trip or UFRO operation).
3. Stop the alternator to reset the over-excitation condition.

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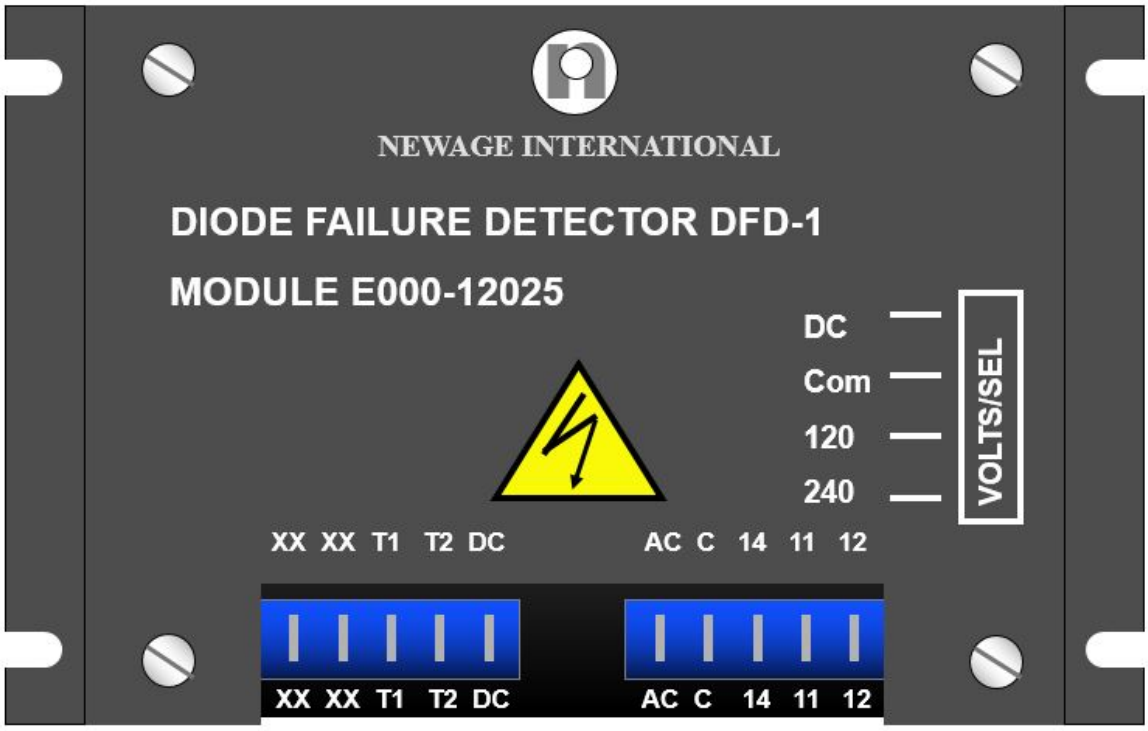
4 Accessories

4.1 Diode Failure Detector



4.1.2 Description

The STAMFORD Diode Failure Detector (DFD) senses ripple current in the exciter output caused by diode failure in short or open circuit, and switches an internal relay if it persists for 7 seconds.

The changeover contacts of the relay can be wired to provide a warning indication of diode failure or initiate an automatic shutdown.

Where the DFD triggers a warning, monitor the exciter field current or voltage and reduce load as necessary, so that the generator set can continue to run until a planned controlled shutdown to replace the diode.

Key features include:

- Robust and reliable solid-state electronics
- Built-in test function
- Selectable power supply
- Simple connection to the alternator.

4.1.3 Specification

- **Sensing Input**
  - Voltage: 0 VDC to 150 VDC

    Input resistance: 100 kΩ

    Sensitivity: 50 V peak
- **Power Supply**
  - Voltage: 12 VDC to 28 VDC

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- Voltage: 100 VAC to 140 VAC
- Voltage: 200 VAC to 280 VAC
- Current: 0.2 A maximum

- **Output**
  - Single pole changeover relay rating: 5 A @ 30 VDC, 5 A @ 240 VAC
  - Isolation: 2 kV
  - Volt-free contacts
- **Time Delays**
  - Response time: 7 s (approximately)
- **Environmental**
  - Vibration: 30 mm/s @ 20 Hz to 100 Hz, 2 g @ 100 Hz to 2 kHz
  - Relative humidity: 95%[9]
  - Storage temperature: -55 °C to +80 °C
  - Operating temperature: -40 °C to +70 °C.

4.1.4 Controls

⚠ DANGER

Live Electrical Conductors

Live electrical conductors can cause serious injury or death by electric shock and burns.

To prevent injury and before removing covers over electrical conductors, isolate the generator set from all energy sources, remove stored energy and use lock out/tag out safety procedures.

⚠ DANGER

Live Electrical Conductors

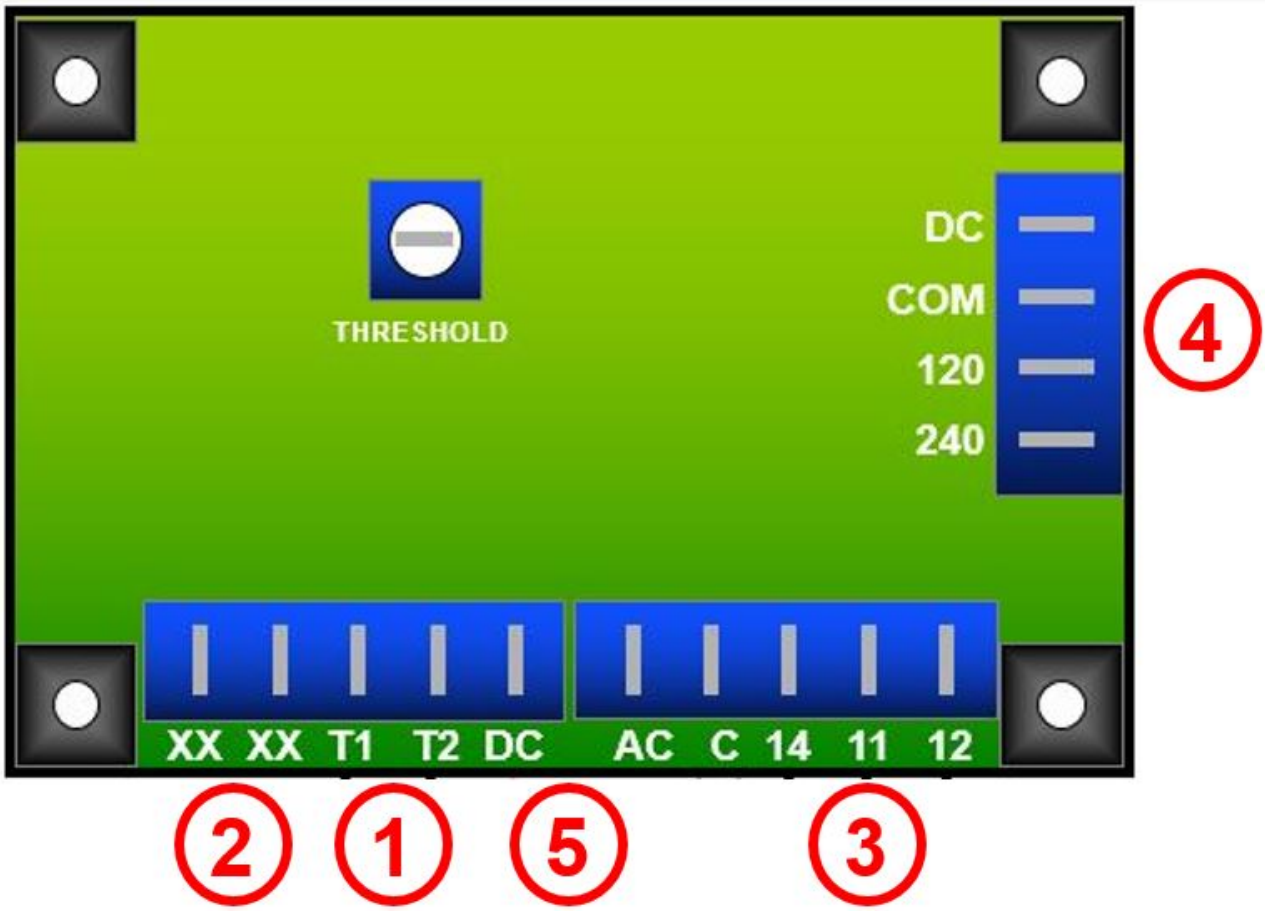
Live electrical conductors at output, AVR and AVR accessory terminals, and AVR heat sink can cause serious injury or death by electric shock and burns.

To prevent injury, take suitable precautions to prevent contact with live conductors including personal protective equipment, insulation, barriers and insulated tools.

NOTICE

Refer to alternator wiring diagram for connection details. Mount the DFD on a switchboard or bedplate, not in the alternator terminal box.

[9] Non-condensing



Ref.	Control	Function
1	**Link : Test** T1-T2	Test DFD function
2	**Sensing Input** XX, XX	Connect F2 in series between exciter stator and AVR
3	**Output relay contacts** 11-14 : Normally-open 11-12 : Normally-closed	Connect to external warning or shutdown system
4	**Link : Supply voltage** COM-DC : 12 VDC to 28 VDC COM-120 : 100 VAC to 140 VAC COM-240 : 200 VAC to 280 VAC	Select VDC or VAC supply voltage
5	**Power Supply** DC : VDC positive (VDC supply)[10] C : VDC negative (VDC supply) AC : P2 from PMG (VAC supply) C : P3 from PMG (VAC supply)	Connect VDC **or** VAC power supply

FIGURE 2. DIODE FAILURE DETECTOR CONTROLS

[10] disconnect to reset DFD

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4.2 Hand Trimmer (for remote voltage adjustment)

A hand trimmer can be fitted in a convenient position (typically in the generator set control panel) and connected to the AVR to provide fine adjustment of the alternator voltage. The hand trimmer value and the adjustment range obtained is as defined in the Technical Specification. Refer to wiring diagram before removing the shorting link and connecting the hand trimmer.