STAMFORD®

Stamford Alternators

FAULT FINDING

English
Original Instructions

A054E988 (Issue 1)

Table of Contents

This page is intentionally blank.

1 Safety Precautions

1.1 Safety Information and Notices used in this manual

Danger, Warning and Caution panels are used in this manual to describe the sources of hazards, their consequences and how to avoid injury. Notice panels emphasize important or critical instructions.

⚠ DANGER
Danger indicates a hazardous situation which, if not avoided, WILL result in death or serious injury.

⚠ WARNING
Warning indicates a hazardous situation which, if not avoided, COULD result in death or serious injury.

⚠ CAUTION
Caution indicates a hazardous situation which, if not avoided, COULD result in minor or moderate injury.

NOTICE
Notice refers to a method or practice which can result in product damage, or to draw attention to additional information or explanations.

1.2 General Guidance

NOTICE
These safety precautions are for general guidance and supplement your own safety procedures and all applicable laws and standards.

1.3 Skill Requirements of Personnel

Service and maintenance procedures must only be carried out by experienced and qualified engineers, who are familiar with the procedures and the equipment.

1.4 Risk Assessment

A risk assessment has been performed on this product by Cummins, however a separate risk assessment must be performed by the user/operating company to establish all personnel-related risks. All affected users must be trained on the identified risks. Access to the Power Plant/Generator Set during operation must be restricted to persons who have been trained on these risks.

1.5 Personal Protective Equipment (PPE)

All persons operating, servicing, maintaining or working in or with a power plant or a generator set must wear appropriate Personal Protective Equipment (PPE)

Recommended PPE includes:

- Ear and Eye Protection
- Head and face protection
- Safety footwear
- Overalls that protect the lower arms and legs

Ensure that all persons are fully aware of the emergency procedures in case of accidents.

1.6 Noise

⚠ WARNING

Noise

Noise from a running alternator can cause serious injury by permanent hearing damage.

To prevent injury, wear appropriate personal protection equipment (PPE).

Maximum A-weighted noise emissions may reach 97 dB(A). Contact the supplier for application-specific details.

1.7 Electrical Equipment

⚠ 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.

All electrical equipment can be dangerous if not operated correctly. Always install, service and maintain the alternator in accordance with this manual. Work that requires access to electrical conductors must comply with all applicable local and national electrical safety procedures for the voltages involved and any site specific rules. Always use genuine branded replacement parts.

1.8 Lock Out/Tag Out

⚠ WARNING

Reconnected Energy Source

Accidental reconnection of energy sources during service and maintenance work can cause serious injury or death by electric shock, burns, crushing, severing or trapping.

To prevent injury and before starting service and maintenance work, use appropriate lock out/tag out safety procedures to keep the generator set isolated from energy sources. Do not defeat or bypass the lock out/tag out safety procedures.

1.9 Lifting

⚠ DANGER

Falling Mechanical Parts

Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping.

To prevent injury and before lifting:

- **Check the capacity, condition and attachment of lifting equipment (crane, hoists and jacks, including attachments to anchor, fix or support the equipment).**
- **Check the capacity, condition and attachment of accessories for lifting (hooks, slings, shackles and eye bolts for attaching loads to lifting equipment).**
- **Check the capacity, condition and attachment of lifting fixtures on the load.**
- **Check the mass, integrity and stability (e.g. unbalanced or shifting center of gravity) of the load.**

⚠ WARNING

Falling Mechanical Parts

Falling mechanical parts can cause serious injury or death by impact, crushing, severing or trapping.

To prevent injury and before lifting the alternator:

- **Do not lift the complete generator set by the alternator lifting fixtures.**
- **Keep the alternator horizontal when lifting.**
- **Fit drive end and non-drive end transit fittings to single bearing alternators to keep the main rotor in the frame.**

Do not remove the lifting label attached to one of the lifting points.

1.10 Alternator Operating Areas

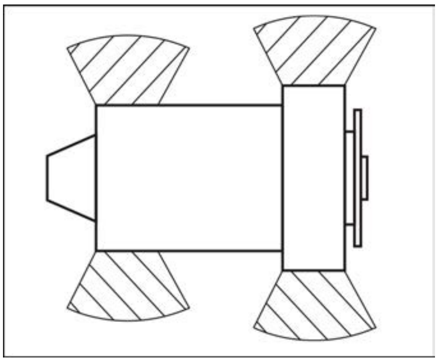
⚠ WARNING

Ejected Debris

Debris ejected during catastrophic failure can cause serious injury or death by impact, severing or stabbing.

To prevent injury:

- **Keep away from the air inlet and air outlet when the alternator is running.**
- **Do not put operator controls near the air inlet and air outlet.**
- **Do not cause overheating by running the alternator outside rating plate parameters.**
- **Do not overload the alternator.**
- **Do not run an alternator with excessive vibration.**
- **Do not synchronize parallel alternators outside the specified parameters.**



Always wear suitable PPE when working in the hatched areas shown in the diagram or directly in-line with any air inlet/outlet.

Make sure this consideration is captured in your risk assessment.

1.11 Hazard Warning Labels

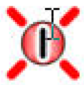
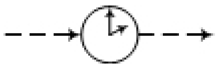
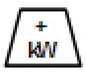
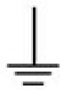
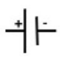
⚠ WARNING
Safety Cover Removed **A hazard exposed when a safety cover is removed can cause serious injury or death.** **To prevent injury:** • **Fit the safety labels at the locations shown on the back of the label sheet supplied.** • **Observe the safety labels.** • **Refer to the service manual before removing covers.**

The generator set manufacturer is responsible for fitting the self-adhesive hazard warning labels supplied with the alternator.

Replace labels that are missing, damaged or painted over.

2 Fault Finding

2.1 Key to Symbols

Symbol	Description
	Red light emitting diode (LED) of automatic voltage regulator (AVR) is OFF
	Red light emitting diode (LED) of automatic voltage regulator (AVR) is ON
	Time delay
	No output load applied (off-load)
	Output load applied (on-load)
	Diode
	Fuse
	Switch
	Earth
	Battery (observe polarity)

2.2 Safety

⚠ DANGER

Live Electrical Conductors

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

To prevent injury and before testing on or near live electrical conductors:

- **Assess risk and test on or near live conductors only if absolutely necessary.**
- **Only trained, competent persons may test on or near live electrical conductors.**
- **Do not test on or near live electrical conductors alone; another competent person must be present, trained to isolate energy sources and take action in an emergency.**
- **Place warnings and prevent access by unauthorized persons.**
- **Make sure that tools, test instruments, leads and attachments are designed, inspected and maintained for use on the maximum voltages likely under normal and fault conditions.**
- **Test medium and high voltage (3.3 kV to 13.6 kV) alternators only with specialized instruments and probes.**
- **Take suitable precautions to prevent contact with live conductors including personal protective equipment, insulation, barriers and insulated tools.**

⚠ 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.

2.3 Introduction

This fault finding guide concerns the alternator - the synchronous a.c. alternator connected to the prime-mover (engine) by a mechanical coupling and connected to an electrical system by two, three or four power cables at an integral terminal block. This guide excludes:

- the prime-mover and its controls
- the generator set, its controls and wiring, and
- panel instruments, circuit breakers and switchgear.

Fault finding relies on collecting information about symptoms, thinking of the most probable cause, then testing for it. This systematic method is progressed until the fault is isolated and eliminated, and minimizes the possibility of false diagnosis and unnecessary expense. Once you are sure that the problem lies with the a.c. alternator, follow this guide to diagnose and correct the fault.

Before attempting to find and repair a fault, check for:

- physical symptoms, for example unusual noise, smoke or burning smell;
- verbal or written reports that may indicate the source of the fault;
- problems external to the alternator; and
- faulty instrumentation, blown fuses or tripped circuit breakers.

Run the alternator only for the shortest time required to confirm the symptoms.

With the alternator stopped, make a general inspection.

- Check for any debris in the body of the alternator.
- Look for any obvious restrictions to rotation.
- Check the main terminals and control wiring for corroded or loose connections.

To find the fault, you may need to:

- Make a general inspection.
- Confirm the symptoms.
- Run the alternator unexcited.
- Run the alternator off-load, on-load or in parallel with other alternator(s).
- Disconnect and measure the resistance of windings and insulation.
- Test components from the rotating rectifier system.
- Disconnect the AVR and make adjustments to the AVR controls.

Do NOT assume that the AVR or control system is faulty until confirmed by test results.

If you are not qualified or competent to carry out these tasks then stop and seek further guidance.

Also note:

- Remove protective covers as needed for testing. Remember to replace the covers afterwards.
- Disable power to anti-condensation heaters (if fitted). Remember to reconnect the heaters afterwards.
- Disable features within the engine control protection systems (e.g. under-voltage protection) as needed to allow the engine to run during these tests. Enable the features afterwards.
- Always use a single independent instrument to make measurements. Do not rely on panel meters.

2.4 Recommended Fault Finding Equipment

2.4.1 Multimeter

The Multimeter is a comprehensive test instrument for measuring voltage, current and resistance. It should be capable of measuring the following ranges:-

- 0 to 250, 0 to 500, 0 to 1000 Volts (VAC)
- 0 to 25, 0 to 100, 0 to 250 Volts (VDC)
- 0 to 10 Amps (DC)
- 0 to 10 kiloOhms (kΩ) or 0 to 2 kiloOhms (kΩ)
- 0 to 100 kiloOhms (kΩ) or 0 to 20 kiloOhms (kΩ)
- 0 to 1 megaOhms (MΩ) or 0 to 200 kiloOhms (kΩ)

2.4.2 Tachometer or Frequency Meter

A tachometer is used to measure the shaft speed of the alternator and should be capable of measuring speeds between 0 and 5000 revolutions per minute, (r/min).

An alternative to the tachometer is the frequency meter. The alternator must be operating at its normal output voltage for a tachometer to be accurate.

2.4.3 Insulation Tester (Megger)

The insulation tester generates a voltage of 500V or 1000V, and is used to measure the resistance value of the insulation to earth (ground). It may be an electronic push button type, or a hand-cranked generator type.

2.4.4 Clamp-On Ammeter (clampmeter)

The clamp-on ammeter uses the transformer effect to measure current flowing in a conductor. A split magnetic core, in the form of pair of jaws, is clamped to surround the conductor (single primary turn) Current flowing in secondary turns within the meter is measured. Useful ranges are

- 0 to 10, 0 to 50, 0 to 100, 0 to 250, 0 to 500 and 0 to 1000 Amps (AC).

2.4.5 Micro Ohmmeter

A micro ohmmeter is used to measure resistance values below 1.0 ohm. It is the only means of accurately measuring very low resistances, such as main stator and exciter rotor windings.

2.4.6 Tools and Spares

For efficient fault finding and to minimise downtime, anticipate likely problems and prepare tools and spares to fix the worst-case fault. Include:

- comprehensive toolkit to remove/refit fasteners
- torque wrench (of appropriate torque range to tighten fasteners)
- spare replacement AVR, of appropriate type
- electrical, flat-bladed screwdriver to adjust AVR controls
- full set of rectifier diodes
- torque wrench and accessories (of appropriate torque range and mechanical configuration to access and tighten diodes)
- full set of rectifier varistors
- remote hand trimmer
- current transformer, if appropriate
- voltage transformer, if appropriate
- exciter rotor and stator, if appropriate
- PMG rotor and stator, if appropriate
- Rectifier diode, 5 A fuse, switch and battery to restore the residual voltage

3 Fault Finding: Low Voltage (LV)

Before starting any fault finding procedure, examine all wiring for broken or loose connections. If in doubt, refer to the wiring diagram supplied with the alternator. Compare measurements with the test report supplied with the alternator.

The following list is to aid in troubleshooting and is not exhaustive. If in doubt, consult Cummins service department.

3.1 Preparation

Record details of the alternator (model, serial number, running time, voltage, AVR and main stator configuration), symptoms and observations[1] in a copy of the fault finding record **Chapter 6 on page 51**.

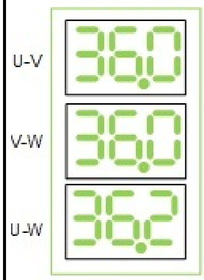
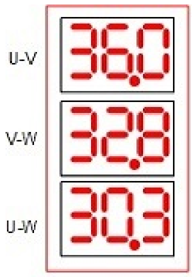
From what you know, does the alternator work NORMALLY when OFF-LOAD (no output load)?	**YES**	Check alternator on-Load **Section 3.4 on page 18**.
	NO	Check Un-excited phase and AVR voltages **Section 3.2 on page 9**.

3.2 Check Un-excited Phase and AVR Voltages

Check the alternator is safe to run:

- Disconnect and isolate the power output cables from the alternator main terminals.
- Disconnect the exciter field wires (F1 and F2) from the AVR and make them safe.
- Start the alternator without output load, ‘Off-Load‘. Be prepared to STOP!
- Verify that the alternator speed is correct.
- Measure the alternator output voltage (phase to phase):[2] This is the residual voltage. Record your measurements on the fault finding record **Chapter 6 on page 51**.

[1] The output voltage, stator configuration and AVR may be different from that shown on the nameplate. Record your **own** observations and measurements.
[2] Three-wire, single-phase alternators should be checked as two separate windings.

<table>
<tr>
<td colspan="2">Are the phase voltages UNBALANCED by more than 1%? (see example below)</td>
<td rowspan="2">YES</td>
<td>
Unbalanced residual voltage could indicate that there is a problem with the main stator winding and it is therefore unsafe to run the alternator under normal excitation:
Unbalanced residual voltage would not be caused by faulty AVR or faulty rotating rectifier components.
</td>
</tr>
<tr>
<td rowspan="3">Balanced

</td>
<td rowspan="3">Unbalanced

</td>
<td>
ACTIONS:

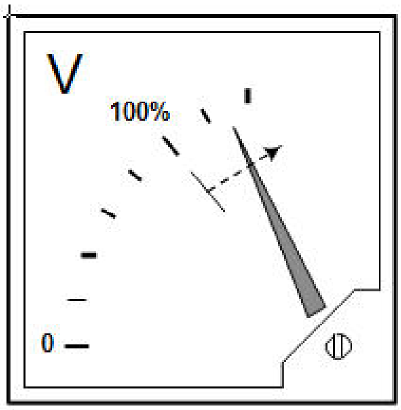

STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Measure and verify the main stator insulation resistance
Section 5.15 on page 48.
2. Measure and verify the main stator resistance
Section 5.11.4 on page 46.
</td>
</tr>
<tr>
<td rowspan="2">NO</td>
<td>
The correct input voltage is essential for the AVR to operate.
For ‘SX’ and ‘AS‘ types, where the residual voltage starts the AVR, if the residual voltage is below the minimum level required then the alternator will fail to excite.
For ‘MX‘ AVRs and machines equipped with a permanent magnet generator (PMG) the residual voltage requirements do not apply.
The AVR Sensing Voltage is a fixed proportion of the main output voltage of the alternator which is used by the AVR for voltage control. If the sensing voltage is not a good and stable representation of the output then the AVR will not control the output correctly.
</td>
</tr>
<tr>
<td>
ACTIONS:
KEEP THE ALTERNATOR RUNNING
Measure the AVR Power Input and Sensing Voltages.
Record your measurements on the fault finding record
Chapter 6 on page 51.
Continue to the next question.
</td>
</tr>
</table>

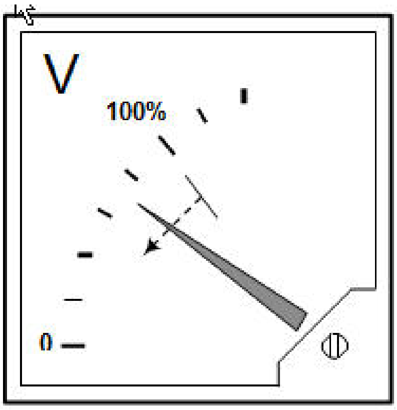
Question		Actions
Does the AVR Power Input Voltage reading (from the fault finding record) fail the requirement?	**YES**	**ACTIONS:**  **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check the main stator output connections. 2. Restore the residual voltage **Section 5.17 on page 49**.
	NO	Calculate V_a, V_b and V_{sen} and record your measurements on the fault finding record **Chapter 6 on page 51**. Continue to the next question.

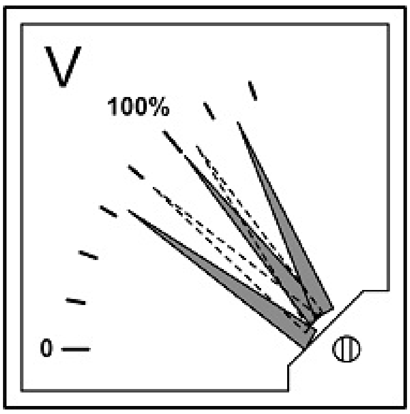
Question		Actions
Does the calculated AVR Sensing Voltage (from the fault finding record) fail the requirement?	**YES**	**ACTIONS:**  **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check the main stator output connections. 2. Check AVR sensing transformer(s). 3. Check other AVR accessories.
	NO	The alternator should be safe to operate off-load.
		ACTIONS:  **STOP THE ALTERNATOR** 1. Reconnect the main output cables to the alternator main terminals. 2. Reconnect the exciter field wires (F1 and F2) to the AVR. 3. Continue to off-load checks **Section 3.3 on page 11**.

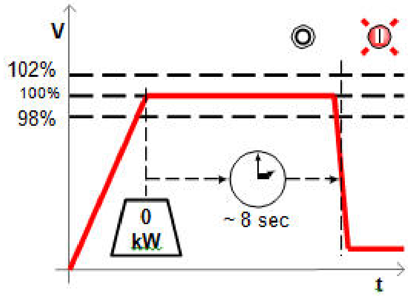
3.3 Check Alternator Off-Load

1. Make sure the main output cables and exciter field wires are securely connected.
2. Start the alternator without output load, 'Off-Load ‘. Be prepared to STOP!
3. Verify that the alternator speed is correct.
4. Measure the main terminal output voltage.

Is the voltage HIGH by more than +2%?  	**YES**	**ACTION:** **KEEP THE ALTERNATOR RUNNING** **High voltage** failure is indicated by: • High voltage **continuously** by more than +2%, or • High voltage for a short time then shuts down. Continue to Section 3.3.1 on page 13.
	NO	Continue to the next question.

Is the voltage LOW by more than -2%?  	**YES**	**ACTION:** **KEEP THE ALTERNATOR RUNNING** **Low voltage** or **no voltage** failure is indicated by: • Low voltage **continuously** by more than -2%, or • Low voltage for a short time then shuts down. Continue to Section 3.3.2 on page 14.
	NO	Continue to the next question.

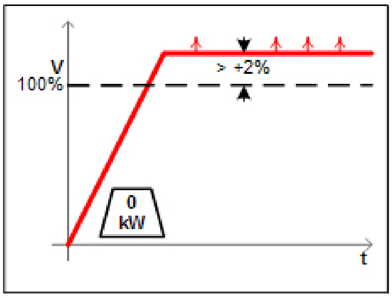
Is the voltage UNSTABLE?  	**YES**	**ACTION:** **KEEP THE ALTERNATOR RUNNING** **Unstable voltage** failure is indicated by: • Rhythmic instability • Erratic instability with the AVR LED flickering • Erratic instability with the AVR LED OFF, or • Voltage drifting. Continue to Section 3.3.3 on page 16.
	NO	Continue to the next question.

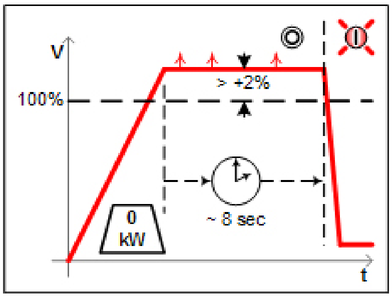
<table>
<tr><td rowspan="3">Is the voltage NORMAL for a short time, then shuts down?

</td><td rowspan="2">YES</td><td>The AVR has shut down in response to a fault within the alternator windings or rotating rectifier components.</td></tr>
<tr><td>ACTION:
STOP
STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check rotating rectifier components Section 5.10.1 on page 43, Section 5.10.2 on page 45.
2. Measure and verify the resistance of exciter windings Section 5.11.1 on page 45, Section 5.11.2 on page 45.
3. Measure and verify the resistance of main rotor Section 5.11.3 on page 45.</td></tr>
<tr><td>NO</td><td>Continue to check alternator on-load Section 3.4 on page 18.</td></tr>
</table>

3.3.1 Higher than Expected Voltage Off-Load

The alternator produces higher than expected voltage:

1. Start the alternator without output load, 'Off-Load ‘. Be prepared to STOP!
2. Verify that the alternator speed is correct.
3. Measure the main terminal output voltage.

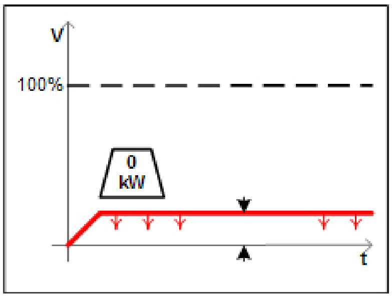
<table>
<tr><td rowspan="3">Is the voltage CONTINUOUSLY HIGH by more than +2%?

</td><td rowspan="2">YES</td><td>It is unlikely to be a fault with the alternator windings or rotating rectifier components.</td></tr>
<tr><td>ACTION:
STOP
STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check and adjust remote hand trimmer (if fitted) Section 5.6 on page 42.
2. Check and adjust AVR VOLTS setting Section 5.2 on page 39.
3. Measure and verify AVR sensing voltage input Section 5.8 on page 42.
4. Replace the AVR.</td></tr>
<tr><td>NO</td><td>Continue to the next question.</td></tr>
</table>

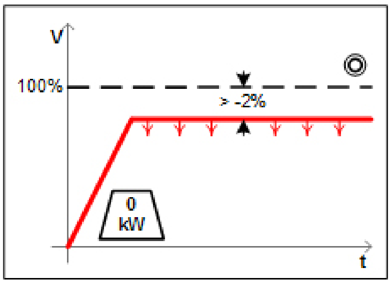
<table>
<tr><td rowspan="3">Is the voltage HIGH for a short time, then shuts down and the AVR LED is ON?

</td><td rowspan="2">YES</td><td>The AVR has shut down in response to a problem but it is unlikely to be a fault with the alternator windings or rotating rectifier components.</td></tr>
<tr><td>ACTION:
STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check and adjust remote hand trimmer (if fitted)
Section 5.6 on page 42.
2. Check and adjust AVR VOLTS setting
Section 5.2 on page 39.
3. Measure and verify AVR sensing voltage input
Section 5.8 on page 42.
4. Replace the AVR.</td></tr>
<tr><td>NO</td><td>ACTION:
STOP THE ALTERNATOR
Seek guidance from CGT Customer Support.</td></tr>
</table>

3.3.2 Lower than Expected Voltage Off-Load

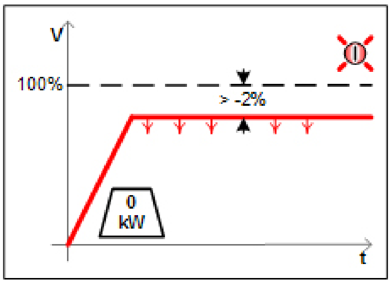
The alternator produces lower than expected voltage:

1. Start the alternator without output load, 'Off-Load ‘. Be prepared to STOP!
2. Verify that the alternator speed is correct.
3. Measure the main terminal output voltage.

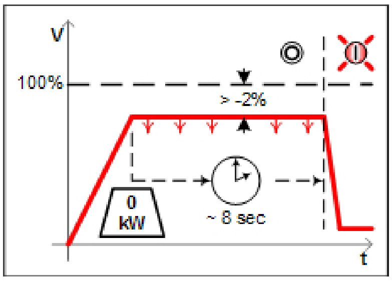
<table>
<tr><td rowspan="2">Is the voltage ZERO or VERY LOW?

</td><td>YES</td><td>ACTION:
STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check the main stator output connections.
2. Restore residual voltage (NOT applicable to machines with a PMG)
Section 5.17 on page 49.</td></tr>
<tr><td>NO</td><td>Continue to the next question.</td></tr>
</table>

<table>
<tr>
<td rowspan="3">Is the voltage CONTINUOUSLY LOW by more than -2% and the AVR LED is OFF?
</td>
<td rowspan="2">YES</td>
<td>It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.</td>
</tr>
<tr>
<td>ACTION:

STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check and adjust remote hand trimmer (if fitted)
Section 5.6 on page 42.
2. Check and adjust AVR VOLTS setting
Section 5.2 on page 39.
3. Check the rotating rectifier components
Section 5.10.1 on page 43, Section 5.10.2 on page 45.
4. Measure and verify the condition of the PMG stator winding (if fitted)
Section 5.11.5 on page 46, Section 5.16 on page 48.
5. Replace the AVR.</td>
</tr>
<tr>
<td>NO</td>
<td>Continue to the next question.</td>
</tr>
</table>

<table>
<tr>
<td rowspan="3">Is the voltage CONTINUOUSLY LOW by more than -2% and the AVR LED is ON?
</td>
<td rowspan="2">YES</td>
<td>It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.</td>
</tr>
<tr>
<td>ACTION:

STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Adjust AVR UFRO setting
Section 5.3 on page 40.
2. Check alternator (prime mover) rotational speed.
3. Replace the AVR.</td>
</tr>
<tr>
<td>NO</td>
<td>Continue to the next question.</td>
</tr>
</table>

<table>
<tr><td rowspan="3">Is the voltage LOW for a short time, then shuts down and the AVR LED is ON?

</td><td rowspan="2">YES</td><td>It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.</td></tr>
<tr><td>ACTION:

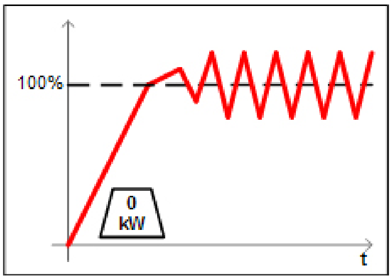

STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check rotating rectifier components Section 5.10.1 on page 43, Section 5.10.2 on page 45.
2. Replace the AVR.</td></tr>
<tr><td>NO</td><td>ACTION:


STOP THE ALTERNATOR
Seek guidance from CGT Customer Support.</td></tr>
</table>

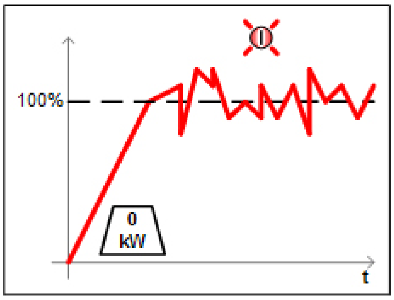
3.3.3 Unstable Voltage Off-Load

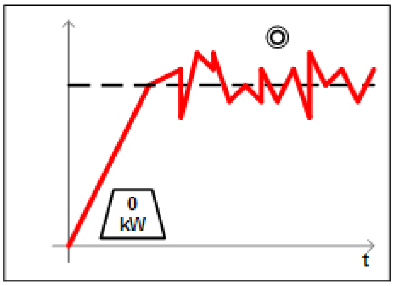
The alternator produces an unstable voltage output:

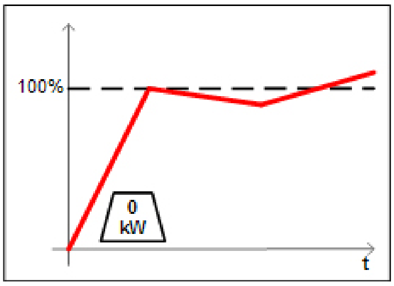
1. Start the alternator without output load, 'Off-Load‘. Be prepared to STOP!
2. Verify that the alternator speed is correct.
3. Measure the main terminal output voltage.

<table>
<tr><td rowspan="3">Is the voltage varying in a regular RHYTHMIC way?

</td><td rowspan="2">YES</td><td>It is unlikely to be a fault with the alternator windings or rotating rectifier components.</td></tr>
<tr><td>ACTION:


STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Verify that the prime mover speed is stable.
2. Check if the alternator is operating below its design voltage.
3. Check and adjust the AVR STAB setting Section 5.4 on page 41.</td></tr>
<tr><td>NO</td><td>Continue to the next question.</td></tr>
</table>

<table>
<tr><td rowspan="2">Is the voltage varying in an irregular ERRATIC way and the AVR LED is flickering?

</td><td rowspan="2">YES</td><td>It is most likely to be a poorly adjusted AVR UFRO setting. It is unlikely to be a fault with the alternator windings or rotating rectifier components.</td></tr>
<tr><td>ACTION:
STOP
STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check prime mover speed governing.
2. Check and adjust AVR UFRO setting
Section 5.3 on page 40.</td></tr>
<tr><td></td><td>NO</td><td>Continue to the next question.</td></tr>
</table>

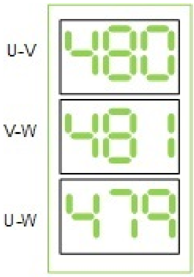
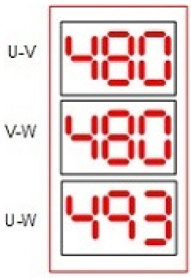
<table>
<tr><td rowspan="2">Is the voltage varying in an irregular ERRATIC way and the AVR LED is OFF?

</td><td rowspan="2">YES</td><td>It is unlikely to be a fault with the rotating rectifier components.</td></tr>
<tr><td>ACTION:
STOP
STOP THE ALTERNATOR
Erratic instability and AVR LED OFF is corrected by taking the following steps, in order:
1. Check prime mover speed governing.
2. Check and adjust AVR STAB setting
Section 5.4 on page 41.
3. Measure and verify the insulation resistance of the exciter stator
Section 5.12 on page 46.
4. Measure and verify the insulation resistance of the PMG (if fitted) and/or auxiliary winding (if fitted)
Section 5.16 on page 48.</td></tr>
<tr><td></td><td>NO</td><td>Continue to the next question.</td></tr>
</table>

<table>
<tr><td rowspan="2">Is the voltage DRIFTING, varying slowly over a long time?

</td><td>YES</td><td>ACTION:
STOP
STOP THE ALTERNATOR
Voltage drifting is corrected by taking the following steps, in order:
1. Check and adjust the remote hand trimmer
Section 5.6 on page 42.
2. Replace the faulty AVR.</td></tr>
<tr><td>NO</td><td>ACTION:
STOP
STOP THE ALTERNATOR
Seek guidance from CGT Customer Support.</td></tr>
</table>

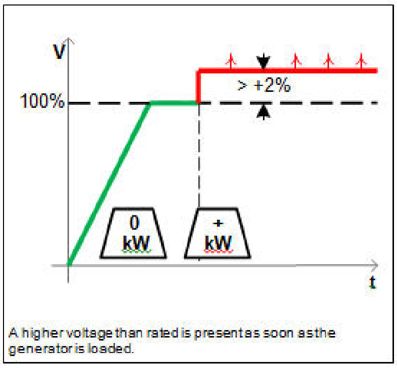
3.4 Check Alternator On-Load

Check the alternator with the output load applied, 'On-Load'.

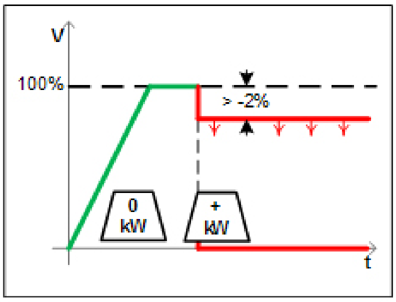
1. Start the alternator and apply the output load. Be prepared to STOP!
2. Make sure that the alternator speed is correct.
3. Measure the main terminal output voltage.

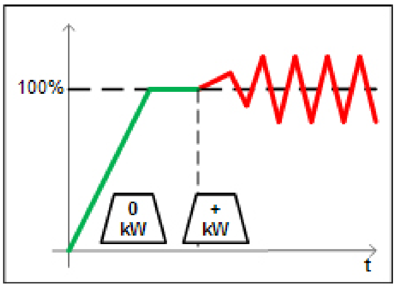
<table>
<tr><td colspan="2">Are the phase voltages UNBALANCED by more than 1%? (see example below)</td><td rowspan="2">YES</td><td>Unbalanced voltage would not be caused by a faulty AVR or faulty rotating rectifier components.</td></tr>
<tr><td rowspan="2">Balanced

</td><td rowspan="2">Unbalanced

</td><td>ACTIONS:


STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check and correct the three-phase load balance.
2. Check and correct the distribution of single-phase loads.
3. Check main stator output connections for loose leads.
4. Measure and verify the main stator resistance Section 5.11.4 on page 46.</td></tr>
<tr><td>NO</td><td>Continue to the next question.</td></tr>
</table>

<table>
<tr><td rowspan="2">Is the voltage HIGH by more than +2% when load applied?

</td><td>YES</td><td>ACTION:


STOP THE ALTERNATOR
Take these recommended steps in order, until the cause is found.
1. Check and correct the leading (capacitive) power-factor load.</td></tr>
<tr><td>NO</td><td>Continue to the next question.</td></tr>
</table>

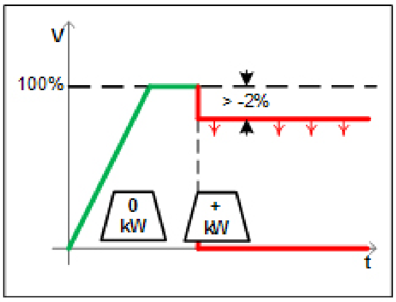
Is the voltage LOW by more than -2% when load applied?  	**YES**	**ACTION:** **STOP THE ALTERNATOR** **Low voltage** or **no voltage when applying load** is indicated by: • Low voltage by more than -2% **continuously** after applying load; • Low voltage by more than -2% **continuously** after applying load and AVR LED is ON; • Low voltage by more than -2% **for a short time** after applying load, then shuts down and AVR LED is ON; or • Normal voltage for a short time after applying load, then shuts down and AVR LED is ON. Continue to **Section 3.4.1 on page 19**.
	NO	Continue to the next question.

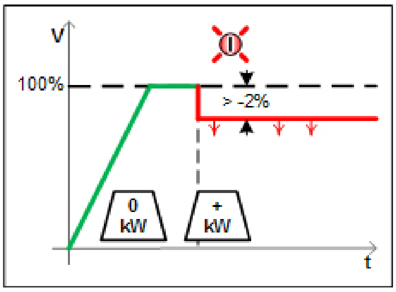
Is the voltage UNSTABLE when load applied?  	**YES**	**ACTION:** **STOP THE ALTERNATOR** **Unstable voltage when applying load** is indicated by: • Interaction between AVR, governor and/or load; or • Waveform distortion caused by load.
	NO	**ACTION:** **STOP THE ALTERNATOR** Seek guidance from CGT Customer Support.

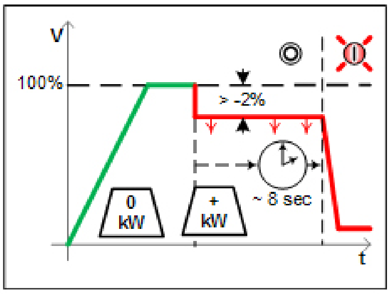
3.4.1 Lower than Expected Voltage On-Load

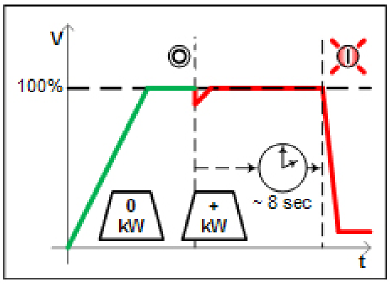
The alternator produces lower than expected voltage:

1. Start the alternator and apply the output load, 'On-Load ‘. Be prepared to STOP!
2. Verify that the alternator speed is correct.
3. Measure the main terminal output voltage.

Is the voltage CONTINUOUSLY LOW by more than -2% when load applied?  	**YES**	It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.
		ACTION:  **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check prime-mover load/speed response. 2. Check and adjust AVR VOLTS setting **Section 5.2 on page 39**. 3. Check rotating rectifier components **Section 5.10.1 on page 43** , **Section 5.10.2 on page 45**. 4. Check and adjust an AVR accessory **Section 5.5 on page 41**, **Section 5.6 on page 42**. 5. Check load for fault.
	NO	Continue to the next question.

Is the voltage CONTINUOUSLY LOW by more than -2% when load applied and the AVR LED is ON?  	**YES**	**ACTION:**  **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check prime-mover load/speed response. 2. Check and adjust AVR UFRO setting **Section 5.3 on page 40**.
	NO	Continue to the next question.

Is the voltage LOW by more than -2% for a short time, then shuts down and the AVR LED is ON? 	**YES**	It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.
		ACTION: **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check prime-mover load/speed response. 2. Check rotating rectifier components Section 5.10.1 on page 43 , Section 5.10.2 on page 45. 3. Check for excessive load.
	NO	Continue to the next question.

Is the voltage NORMAL for a short time, then shuts down and the AVR LED is ON? 	**YES**	It is unlikely to be a fault with the alternator main stator winding unless the phase voltages are unbalanced.
		ACTION: **STOP THE ALTERNATOR** Take these recommended steps in order, until the cause is found. 1. Check rotating rectifier components Section 5.10.1 on page 43, Section 5.10.2 on page 45. 2. Check for excessive load.
	NO	**ACTION:** **STOP THE ALTERNATOR** Seek guidance from CGT Customer Support.

This page is intentionally blank.

4 Fault Finding: Medium Voltage, High Voltage

Before starting any fault finding procedure, examine all wiring for broken or loose connections. If in doubt, refer to the wiring diagram supplied with the alternator. Compare measurements with the test report supplied with the alternator.

The following list is to aid in troubleshooting and is not exhaustive. If in doubt, consult Cummins service department.

4.1 Without AVR

NOTICE
Do tests in order, unless stated otherwise. Do method steps in order. Achieve result before doing the next step, unless action (in bold) states otherwise.

TABLE 1. FAULTFINDING: WITHOUT AVR

TEST	METHOD		RESULT and ACTION
1 External Excitation	1	Test the exciter stator resistance (see **Section 5.11.1 on page 45**)	Resistance of exciter stator winding within tolerance (see **Chapter 7 on page 55**)
	2	Disconnect the AVR. Connect an external 24 V variable DC source to the exciter stator leads, positive to positive, negative to negative. Test the voltage.	Measured excitation is 12 VDC ±10% error.
	3	Run the alternator with no load connected. Test the speed.	Measured speed is within 4% of rated speed.
	4	Test the phase-to-phase and phase-to-neutral voltage at output terminals. Adjust variable DC source.	Measured output equal to rated voltage (with same error as excitation), balanced across phases within 1%. Main & exciter stators, main & exciter rotors, and rectifier diodes are functioning correctly. **Go to test 7 AVR Sensing and Power Supply** If unbalanced by more than 1%, **Go to test 2 Main Stator** If balanced within 1%, but output voltage is more than 10% below rated voltage, and test 3 **not** yet done, **Go to test 3 Rectifier** If balanced within 1%, but output voltage is more than 10% below rated voltage, and test 3 already done, **Go to test 4 Exciter Rotor**

TEST		METHOD	RESULT and ACTION
2 **Main Stator**	A fault in the main stator will produce short circuit currents between turns in the windings. Test for symptoms to confirm diagnosis.		
	1	Test main stator resistance (see Section 5.11.4 on page 46).	Resistances of main stator windings dissimilar, and/or less than minimum values (see Chapter 7 on page 55).
	2	Run up the alternator within 4% of nominal speed, no load or excitation. Connect variable DC source to exciter stator (see test 1).	If short circuit fault causes heat and burning smell or engine sound changes with extra slight loading, **Repair or replace faulty main stator winding**
	3	-	**Go to test 1 External Excitation**
3 **Rectifier**	1	Test the rectifier varistors (see Section 5.10.2 on page 45)	Varistors functioning correctly.
	2	Test the rectifier diodes (see Section 5.10.1 on page 43)	Diodes functioning correctly.
	3	-	**Go to test 1 External Excitation**
4 **Exciter Rotor**	1	Inspect windings and insulation	Windings are not burnt or damaged.
	2	Test the exciter rotor resistance (see Section 5.11.2 on page 45)	Resistance of exciter rotor within tolerance (see Chapter 7 on page 55)
	3	-	**Go to test 5 Main Rotor**
5 **Main Rotor**	1	Test the main rotor resistance (see Section 5.11.3 on page 45)	Resistance of main rotor within tolerance (see Chapter 7 on page 55)
	2	-	**Go to test 6 Exciter Stator Insulation**
6 **Exciter Stator Insulation**	Poor insulation of the exciter stator winding can affect AVR performance.		
	1	Test the electrical insulation of the exciter stator winding (see Section 5.12 on page 46)	Insulation resistance of exciter stator within tolerance
	2	-	**Go to test 7 AVR Sensing and Power Supply**

<table>
<tr><th>TEST</th><th colspan="2">METHOD</th><th>RESULT and ACTION</th></tr>
<tr><td rowspan="5">7
AVR
Sensing
And Power
Supply</td><td colspan="3">Output voltage is sensed at the AVR for closed loop control of the excitation voltage. The alternator wiring diagram shows how sensing leads 6, 7 & 8 (E1, E2, E3) at the output terminals are connected to the AVR, via transformers (as required). AVR power is also taken from the sensing leads or from a permanent magnet generator (PMG).</td></tr>
<tr><td>1</td><td>Disconnect the sensing and power supply(ies) from the AVR</td><td>-</td></tr>
<tr><td>2</td><td>Follow the method of Test 1 to run the alternator with excitation from a variable DC source.</td><td>Alternator runs within 4% of rated speed, 10% of rated output voltage, balanced within 1% across phases.</td></tr>
<tr><td>3</td><td>Test the sensing voltage feedback at the AVR terminals. Check circuit between output terminals and AVR.</td><td>Measured voltage within tolerance (see Chapter 7 on page 55), balanced across phases. No wiring or transformer faults.</td></tr>
<tr><td>4</td><td>Disconnect variable DC source, re-connect AVR and run alternator.</td><td>See Faultfinding: self-excited AVR or
Faultfinding: separately-excited AVR.</td></tr>
</table>

-

4.2 Separately-Excited AVR - OFF load

TABLE 2. FAULTFINDING: SEPARATELY-EXCITED AVR - OFF LOAD

SYMPTOM	CAUSE	ACTION
NO VOLTAGE (NO LOAD)	Faulty permanent magnet generator (PMG), stator or rotor .	Disconnect the PMG leads from AVR terminals P2, P3, P4. Run the alternator at rated speed. Test the phase-to-phase voltage at P2, P3 & P4 leads of the PMG with an r.m.s. measuring instrument. Measured voltage 170 to 195 VAC (at 50 Hz), 204 to 234 VAC (at 60 Hz), balanced within 5% across phases. (Refer to factory for latest voltage ranges in design data specification DD-15590) Test the phase-to-phase resistance of the PMG stator windings with a multimeter. Resistance to be within 10% of expected value (see **Section 7.6 on page 61**), balanced across phases. Replace or re-test according to PMG Fault Diagnosis table below.
	Insulation failure to earth (ground) on PMG stator.	Test the insulation resistance of PMG stator windings. (see **Section 5.11 on page 45**)
	Panel voltmeter faulty.	Test voltage at alternator terminals with a multimeter.
	Connections loose, broken or corroded.	Inspect AVR push-on terminals. Repair or renew where necessary.
	AVR high excitation protection circuit activated, collapsing output voltage. AVR protection circuit is factory set to trip (refer to AVR data sheet for voltage set point) across AVR output X+ (F1), & XX- (F2), after pre-set time delay.	Check AVR LED. If lit, protection circuit is activated. Shut down engine, and re-start. If the voltage builds up normally but collapses again, the protection circuit has operated, & AVR LED will be lit. Run again & check the excitation voltage across AVR X+ (F1) and XX- (F2). If greater than voltage set point, the protection circuit is operating correctly. Follow Faultfinding without AVR see (**Section 4.1**) to find cause of high excitation volts.
	Short circuit of varistor on rotating rectifier	Test varistors. (see **Section 5.10 on page 43**)
	Short circuit of diode(s) on rotating rectifier.	Test diodes. (see **Section 5.10 on page 43**)
	Open circuit in exciter stator windings	Faultfinding without AVR (see **Section 4.1 on page 23**

SYMPTOM	CAUSE	ACTION
NO VOLTAGE (NO LOAD)	AVR fault	Replace AVR and re-test.
	Winding fault. Open circuit or short circuit on any winding in the machine	Faultfinding without AVR (see **Section 4.1 on page 23**)

SYMPTOM	CAUSE	ACTION
LOW VOLTAGE (NO LOAD)	Engine speed low	Test speed with tachometer. Adjust governor control to nominal speed.
	Under frequency protection (UFRO) circuit activated	Inspect UFRO LED at AVR. If lit, UFRO is activated, indicating low speed. Adjust engine speed to within –1% to +4% of nominal.
	AVR volts control or external hand trimmer incorrectly set	1. Test engine speed is correct with tachometer, and UFRO is OFF. 2. Adjust voltage by AVR volts control, or remote trimmer.
	Panel voltmeter faulty or 'sticking'	Test voltage at alternator terminals with a multimeter.
	AVR fault.	Replace AVR and re-test.
HIGH VOLTAGE (NO LOAD)	AVR volts control or external trimmer incorrectly set.	1. Test engine speed is correct with tachometer, and UFRO is OFF. 2. Adjust voltage by AVR volts control, or remote trimmer.
	Voltage sensing input to AVR is open circuit or too low.	Test the AVR sensing supply feedback in Faultfinding without AVR (see **Section 4.1 on page 23**)
	Faulty AVR.	Replace AVR and retest.
UNSTABLE VOLTAGE (NO LOAD)	Engine speed hunting (unstable).	Test engine speed stability with a frequency meter or tachometer. Sometimes this problem will clear when load is applied.
	AVR stability control incorrectly adjusted.	Inspect AVR stability links or selection, adjust stability potentiometer. Check again on load.
	Connections loose or corroded.	Inspect all auxiliary board terminals. Inspect AVR push-on terminals. Repair or renew where necessary.
	Intermittent earth (ground) (low resistance of windings insulation).	Test the insulation resistance of all windings in Faultfinding without AVR (see **Section 4.1 on page 23**)
UNBALANCED VOLTAGE (NO LOAD)	Fault in main stator winding.	Test the main stator windings in Faultfinding without AVR (see **Section 4.1**)

TABLE 3. PMG FAULT DIAGNOSIS

PMG stator voltage		PMG stator phase-to-phase resistance: In range & balanced	PMG stator phase-to-phase resistance: Out of range or unbalanced
In range	Balanced	No fault	Re-test resistance
	Unbalanced	Check connector	Replace PMG stator
Out of range	Balanced	Replace PMG rotor	Replace PMG stator
	Unbalanced	Check connector	Replace PMG stator

4.3 Separately-Excited AVR - ON load

TABLE 4. FAULTFINDING: SEPARATELY-EXCITED AVR - ON LOAD

SYMPTOM	CAUSE	ACTION
LOW VOLTAGE (ON LOAD)	Engine speed low.	Test speed with tachometer. Adjust governor control to nominal speed.
	Under frequency protection (UFRO) circuit activated .	Inspect UFRO LED at AVR. If lit, UFRO is activated, indicating low speed. Adjust engine speed, to within -1% to +4% of nominal.
	Faulty permanent magnet generator (PMG) stator or rotor.	Disconnect the PMG leads from AVR terminals P2, P3, P4. Check voltage across leads with a Multimeter, with the set running at correct speed. For 50Hz, Voltage across P2, P3 and P4 should be approx. 160 VAC – 180 VAC. For 60Hz, Voltage is approx. 190 VAC – 210 VAC.
	AVR fault.	Replace AVR and re-test.
	Fault on winding or rotating diodes.	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). See Faultfinding without AVR (see Section 4.1 on page 23)
	Voltage drop between alternator and load, due to I^2R losses in the cable. This will be worse during current surges (e.g. motor starting).	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
HIGH VOLTAGE (ON LOAD)	Unbalanced load.	Test voltages on all phases. If unbalanced, re-distribute loading between phases.
	Leading Power Factor Load.	Test excitation volts across X+, (F1) and XX- (F2). A leading power factor will give an abnormally LOW DC excitation. Remove power factor correction capacitors from system at low load.
	Parallel droop transformer reversed.	Check for droop reversal. See Faultfinding Parallel Operation (Section 4.4 on page 34)

-

SYMPTOM	CAUSE	ACTION
UNSTABLE VOLTAGE (ON LOAD)	Engine governing unstable (hunting)	Test engine speed stability with a frequency meter or tachometer for governor hunting, or cyclic irregularities in the engine.
	Leading power factor load created by power factor correction capacitors.	Isolate the power factor correction capacitors until sufficient motor load has been applied.
	Non linear loads, causing interaction between dynamic closed loop control systems.	Interaction of closed loop systems controlling the load, the alternator and the engine. Instability is caused by oversensitive control settings. Try different settings of AVR stability, including changing the link to a smaller of larger kW range. Involve designers of the non-linear load to modify their control loop settings. Increase engine speed 'droop' to stabilize engine. Contact factory for further advice regarding non-linear loads.
	Fluctuations in load current, (motor starting, or reciprocating loads).	Test the load current on a stable supply, i.e. mains, or see Faultfinding without AVR using a variable DC supply (Section 4.1 on page 23)
	AVR stability control incorrectly adjusted.	Adjust AVR stability control, until voltage is stable.
UNBALANCED VOLTAGE (ON LOAD)	Single-phase loads (phase - neutral) unevenly distributed over the three phases.	Test current in each phase with clamp ammeter. The full load rated current must NOT be exceeded on any individual phase. Re-distribute load if necessary.

SYMPTOM	CAUSE	ACTION
POOR VOLTAGE REGULATION (ON LOAD)	Large speed droop on engine. AVR UFRO protection activated.	Test the speed droop from no load to full load is no greater than 4%. Inspect AVR LED. If lit, increase engine speed.
	Unbalanced load.	Check voltage and load current on all phases. If unbalanced, redistribute the load more evenly across the phases.
	Parallel droop circuit incorrectly adjusted, or requires shorting switch for single running.	The droop circuit will give additional voltage droop of -3% at full load 0.8 power factor. For single running machines this can be improved by fitting a shorting switch across the droop CT input, (S1 – S2), on the AVR.
	Voltage drop between alternator and load, caused by losses in supply cable, (I^2R losses).	Test the voltage at both ends of the cable run at full load. In severe cases, a larger diameter cable is required.
	AVR stability control incorrectly adjusted.	Adjust AVR control, until voltage is stable.
	Fault on rectifier or excitation winding.	Test the no load excitation volts across AVR X+ (F1) and XX- (F2). If higher than 12 VDC, see Faultfinding without AVR (**Section 4.1**)
	Under frequency protection (UFRO) activated.	Inspect UFRO LED at AVR. If lit, UFRO is activated, indicating low speed. Test speed with tachometer and adjust to correct nominal speed, (or frequency).

SYMPTOM	CAUSE	ACTION
POOR VOLTAGE RESPONSE TO LOAD SURGES OR MOTOR STARTING	Engine governor sticking or slow to respond.	Check performance of engine during application of load. Check if AVR LED is lit during motor starting. Check if AVR ‘DIP’ or ‘DWELL’ circuits are activated. Adjust as necessary. (See AVR instruction sheet).
	AVR ‘UFRO’ protection activated.	Test the speed droop from no load to full load is no greater than 4%. Inspect AVR LED. If lit, increase engine speed.
	Parallel droop circuit incorrectly set.	Too much droop will increase voltage dips when motor starting. Fit shorting switch for single running alternators. See Faultfinding Parallel Operation (**Section 4.4 on page 34**)
	Load surges cause current to exceed 2.5 times the full load current.	Test current with a clamp ammeter. Voltage dip may be excessive if the current exceeds 2.5 times full load. Refer to factory for motor starting calculations.
	Voltage drop between alternator and load, caused by I^2R losses in supply cable. This will be worse during current surges (e.g. motor starting).	Test the voltage at both ends of the cable at full load. In severe cases, a larger diameter cable is required.
	Motor contactors dropping out during starting, (large current surges, voltage dips greater than 30%).	All causes and actions in this section may apply to this problem. Refer to factory for typical voltage dips.
	AVR stability control incorrectly adjusted.	Set AVR stability control for optimum performance. Adjust anticlockwise until voltage is unstable, then slightly clockwise until stable.
	Fault on windings or rotating rectifier.	Any fault in this area will appear as high excitation voltage across X+ (F1) and XX- (F2). If higher than 12V d.c., see Faultfinding without AVR (**Section 4.1 on page 23**)
	Engine relief circuit activated during motor starting.	Check if AVR ‘DIP’ or ‘DWELL’ engine relief circuits are activated. Adjust as necessary. See AVR instructions for details.
	AVR fault.	Replace and re-test on load.

SYMPTOM	CAUSE	ACTION
VOLTAGE COLLAPSES (ON LOAD)	Protection circuit in AVR activated, due to high excitation condition across AVR output, (X+ (F1) and XX- (F2).	Excitation volts higher than 70 VDC Test voltage across X+ (F1) and XX- (F2) on load. Ensure engine speed is correct at full load. Check output voltage, ensure it does not exceed the rated voltage. Check load current for overload.
	Protection circuit in AVR operated, due to fault in alternator windings or diodes.	Check AVR LED. if lit, protection circuit is activated. Shut down engine, and re- start. If voltage returns as normal, but collapses again on load, protection circuit is activated, due to high excitation. Follow Faultfinding without AVR to find cause of high excitation volts.
	AVR fault.	Replace AVR and re-test on load.
	Severe overload or short circuit across phases.	Check load current with clamp ammeter.

-

4.4 Parallel Operation

TABLE 5. FAULTFINDING: PARALLEL OPERATION

SYMPTOM	CAUSE	ACTION
CIRCUIT BREAKER WILL NOT CLOSE WHEN ATTEMPTING PARALLEL OPERATION	Circuit breaker fitted with ‘Check Synchronizing’ protection, which prevents out of phase synchronizing.	Ensure that the synchroscope is indicating that machines are IN PHASE, or close to the eleven o'clock position, (when rotating in a clockwise direction). Ensure that the speed difference between the incoming set and the busbar is small enough to prevent rapid rotation of the synchroscope, (or rapid fluctuations of the lights), before closing circuit breaker.
	Phase rotation of alternators differs.	DO NOT ATTEMPT TO PARALLEL until the phase rotation of all alternators are identical. Check the phase rotation of each alternator. Exchange the connections of two of the phases to reverse the phase rotation of an alternator.
	Voltage difference too high between the incoming alternator and the busbar.	The voltage on the incoming set can be up to 4% higher than the bus bar voltage. THIS IS NORMAL. Do not adjust original no-load Voltage settings. If difference is greater than 4%, check for excessive droop on the loaded alternator(s).
UNSTABLE IN-PHASE CONDITION, BEFORE SYNCHRONIZING	Governor drift on one or more of the engines.	Let engines warm up and stabilize before paralleling. If speed is still drifting check governors and engine condition.
	Load variation on the busbar causing speed/ frequency changes on the loaded alternator when synchronizing.	Disconnect any rapidly varying load. Check that there is no likelihood of a motor or automatic load starting when attempting to synchronize. DO NOT attempt to parallel if the load current is unstable.
UNSTABLE FREQUENCY IN PARALLEL WHEN ON LOAD	Engine speed droop too ‘tight’ or cyclic irregularities (instability) between the engines. (Check kW meters for rapid shifting of kW power between sets).	Increase the engine governor speed droop to 4% (no load to full load). Check for "sticky" governors on a new engine. Check engines for cyclic problems, (firing, out of balance, etc),

SYMPTOM	CAUSE	ACTION
STABLE VOLTAGE BEFORE AND AFTER BUT UNSTABLE WHILE SYNCHRONIZING	Usually results from 'pick- up' through the synchronizing panel and/or earth leakage protection circuits that can form a temporary 'closed loop' link between the alternators during synchronisation.	The fluctuation will decay when the alternators approach synchronizm, (almost identical speeds), and will disappear completely when the circuit breaker is closed. The synchronizing equipment, earth leakage protection, and/or wiring circuits in the switchboard can produce temporary pickup problems.
CURRENT UNCONTROLLED, RISES FAST WHEN CIRCUIT BREAKER CLOSED	Parallel droop equipment reversed on one of the alternators.	Check the droop CTs for reversal. Reverse lead S1-S2 on the droop CT. Test excitation volts - the alternator with reversed droop will have highest excitation volts.
STABLE CIRCULATING CURRENT ON ALL ALTERNATORS, NOT REDUCED BY VOLTAGE ADJUSTMENT	Parallel droop reversed on ALL alternators.	Check droops for reversal. Reverse leads S1–S2 to correct. This repeated wiring error will result in a stable circulating current which cannot be adjusted out by normal means.
STABLE CIRCULATING CURRENT ON BOTH ALTERNATORS AT NO LOAD	Voltage difference (excitation level) between the alternators.	Check Voltages at no load, (identical frequencies), and ensure all alternators have identical voltages. Do not adjust when load sharing.
	Parallel droop equipment reversed on BOTH alternators. (Unlike ONE droop reversal, which is a highly UNSTABLE condition).	Check ALL droop CTs for reversal.
	Incorrect setting of parallel droop equipment.	Check settings of droop trimmers. Check droop CTs are in correct phase. Check CT output to AVR S1-S2 is correct.
UNBALANCED POWER ON KILOWATT METERS	Engines not sharing the power (kW) equally.	Adjust the governor droop of the engines to equalize the kilowatt sharing.
UNBALANCED CURRENT ON AMMETERS AFTER EQUILIZING KILOWATTS	Voltage difference (excitation levels) between the machines.	Test the machines individually for exact voltage at no load.
	Parallel droop equipment incorrectly adjusted.	Adjust as stated in previous text.

SYMPTOM	CAUSE	ACTION
UNBALANCED POWER AS LOAD INCREASED OR DECREASED	Engine governors are incompatible, or new governors 'sticking', causing unequal kW sharing over load range variations.	The engine governors must be adjusted to give similar no load to full load characteristics. Check for 'sticky' governors on new or repainted engines. Electronic governors should be set with a minimum 2% speed droop to ensure satisfactory kilowatt load sharing. If tighter speed regulation is required, an Isochronous Load Sharing system should be installed.
INCREASING UNBALANCED CURRENT AS LOAD INCREASED	Difference in parallel droop level settings. Difference in no load to full load voltage regulation of AVRs. These settings are the major contributing factors to the load/voltage characteristics of the machine, and therefore must be set to give equal characteristics to the machines with which it is paralleled.	Run each alternator individually, and apply load at approximately 25%, 50% & 100% of full load. Test voltage at each load and compare values with the other alternators. Adjust control systems to remove regulation differences. Repeat method with as much inductive load as possible i.e. motors, transformers etc. Adjust the parallel droop trimmers, to achieve equal inductive load sharing.
POOR VOLTAGE REGULATION WHEN MACHINE RUNNING ALONE	Excess amount of parallel droop in circuit.	For normal voltage regulation as a single running machine, a shorting switch should be fitted across the parallel droop transformer. (S1-S2). This should be clearly marked 'Single' and 'Parallel' operation on the panel.
UNBALANCED POWER, ENGINES 'ROCK' ON MOUNTS	Electronic engine governor speed 'droop' characteristics are set too tight.	At least 2% engine droop is essential for kW (Active current) sharing. If 1% or less speed regulation is required, an electronic governing and Isochronous Load Sharing system should be installed.

4.5 AVR Fault Finding

This section has general advice to diagnose faults on AVRs. Further troubleshooting guidance is given in the Specification, Installation and Adjustments instructions or the Instruction Manual specific to the AVR model. The AVR has a protection circuit which operates under fault conditions after about 8 seconds (exact delay depends on AVR type). The circuit removes the alternator excitation, causing output voltage to collapse, and latches until the alternator is stopped and restarted. The system designer must make sure that this feature is compatible with the overall system protection.

Symptom	Action
VOLTAGE DOES NOT INCREASE WHEN STARTING	Check link K1:K2 on AVR or auxiliary terminals. Replace if necessary and restart.
VOLTAGE INCREASES WHEN STARTING TO WRONG VALUE	Check AVR volts control potentiometer setting. Correct if necessary. Check 'Hand Trimmer' if fitted. Adjust if necessary. Check alternator speed. Correct if necessary and restart. Check AVR 'UFRO' indicator. If illuminated, see UFRO Setting Procedure.
VOLTAGE INCREASES VERY SLOWLY WHEN STARTING	Check alternator accelerates as expected. Correct if necessary and restart. Check setting of adjustable ramp. Correct if necessary and restart.
VOLTAGE INCREASES TO HIGH VALUE WHEN STARTING	Check AVR wiring with wiring diagram.
VOLTAGE INCREASES TO HIGH VALUE THEN FALLS TO LOW VALUE WHEN STARTING	Check AVR wiring with wiring diagram.
VOLTAGE NORMAL THEN FALLS TO LOW VALUE WHEN RUNNING	Check alternator loading Check rectifier system (see Service and Maintenance chapter)
VOLTAGE UNSTABLE EITHER WHEN RUNNING NO-LOAD OR ON-LOAD	Check that the alternator speed is stable. Correct if necessary and restart. Check AVR wiring with wiring diagram. Adjust the AVR stability control slowly clockwise until steady.
VOLTAGE FALLS TO LOW VALUE WHEN LOAD APPLIED	Check alternator speed is not dropping as load is applied. Correct if necessary and restart. Check AVR 'UFRO' indicator. If it illuminates as load is applied, see UFRO Setting Procedure.

If all the tests and checks listed above fail to locate the alternator fault then it must be assumed that the AVR is faulty. There are no serviceable items in the AVR.

The AVR should be replaced only by a genuine Cummins part.

This page is intentionally blank.

5 Procedures

⚠ WARNING

Ejected Debris

Debris ejected during catastrophic failure can cause serious injury or death by impact, severing or stabbing.

To prevent injury:

- **Keep away from the air inlet and air outlet when the alternator is running.**
- **Do not put operator controls near the air inlet and air outlet.**
- **Do not cause overheating by running the alternator outside rating plate parameters.**
- **Do not overload the alternator.**
- **Do not run an alternator with excessive vibration.**
- **Do not sychronize parallel alternators outside the specified parameters.**

5.2 Adjust the AVR [VOLTS] Voltage Control

NOTICE

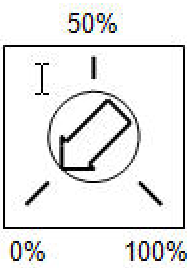
Do not exceed the designed safe operating voltage, shown on the alternator rating plate.

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.

NOTICE

If the voltage is unstable set the AVR stability before proceeding Section 5.4 on page 41.

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

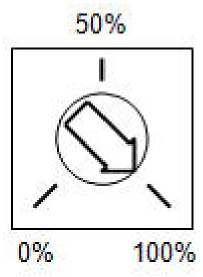
0% to 100% rotation corresponds to 90% to 110% VAC

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

5.3 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.
2. Check that the jumper link or rotary switch selection (depending on AVR type) matches the alternator frequency.
3. Set the **AVR [UFRO]** control to 100%, the fully clockwise position.

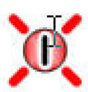


4. Start the alternator and set at the correct operating speed.
5. Verify that the alternator voltage is correct and stable.

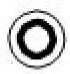
NOTICE

If the voltage is high / low / unstable, use method Section 5.2 on page 39 or Section 5.4 on page 41 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

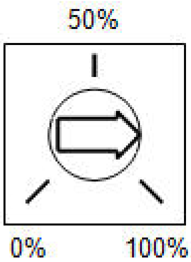
Do not go past the point at which the LED is just OFF.

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

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

5.4 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 5.2 on page 39).

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

5.5 Adjust the AVR [DROOP] Voltage Droop Control for Parallel Operation

A correctly fitted and adjusted droop current transformer (CT) allows the alternator to share reactive current for stable parallel operation.

1. Mount the Droop CT to the correct phase lead of the main output windings of the alternator.
2. Connect the two secondary leads marked S1 and S2 from the CT to the terminals S1 and S2 of the AVR.
3. Turn the **AVR [DROOP]** control to the midway position.
4. Start the alternator(s) and set at the correct operating speed and voltage.

5. Parallel the alternator(s) according to installation rules and procedures.
6. Set the **AVR [DROOP]** control to produce the required balance between individual alternator output currents. Set the AVR droop off-load and then check the currents when the output load is applied, on-load.
7. If the individual alternator output currents rise (or fall) in an uncontrolled way, isolate and stop the alternators then check that:
   - The droop transformer is fitted to the correct phase and in the correct polarity (see the machine wiring diagrams).
   - The droop transformer secondary S1 and S2 leads are connected to the AVR terminals S1 and S2.
   - The droop transformer is the correct rating.

5.6 Connect and Set the Remote Hand Trimmer

A remote hand trimmer is fitted to provide a convenient means of fine voltage adjustment (typically +/- 10% voltage) and can be useful in installations where multiple alternators are operated in parallel.

1. Mount the remote hand trimmer in the required physical location on the generator set.
2. Connect the remote hand trimmer as shown on the alternator wiring diagram (usually to AVR terminals 1 and 2). Check that clockwise rotation results in a reduction of the resistance across terminals 1 and 2.
3. Set the remote hand trimmer to the midway position.
4. Start the alternator(s) and set at the correct operating speed and voltage on the AVR voltage control.
5. Rotate the remote hand trimmer slowly counterclockwise and clockwise to check the alternator output range.
6. If the operation of the trimmer is reversed then correct the wiring on the rear of the hand trimmer. Do not reverse the wiring to AVR terminals 1 and 2 (see step 2 above).

5.7 Measure and Verify the Residual Voltage (self-excited machines only)

Residual, or remanence, voltage is the small voltage produced by the alternator when the exciter field current is zero and the alternator is running at rated speed (while disconnected from any external load or supply).

1. Disconnect the exciter field leads F1 and F2 from the AVR and make them safe.
2. Make sure there are no loads or external supplies connected to the alternator terminals.
3. Start the alternator and set at the correct operating speed.
4. Measure the voltage appearing at AVR input terminals 7 and 8 (or P2 and P3, or 7 and Z2 for AS540). For AVRs SX460*, AS540* AS480*, AS440* and SX421, this voltage should be 6 VAC minimum.[3]
5. If the measured voltage is below the minimum value, restore the residual voltage **Section 5.17 on page 49**.

5.8 Measure and Verify the AVR Sensing Voltage

The AVR sensing voltage is a fixed proportion of the main output voltage of the alternator and is used by the AVR for voltage control. If the sensing voltage is not a good, stable representation of the output then the AVR will not control the output correctly.

[3] * Includes Underwriter's Laboratories (UL) derivatives i.e. SX460UL, AS480UL and AS440UL.

The sensing voltage appearing at AVR terminals 6 (MX321 only), 7 and 8 and can be measured safely at residual voltage levels.

1. Disconnect the exciter field leads F1 and F2 from the AVR and make them safe.
2. Make sure there are no loads or external supplies connected to the alternator terminals.
3. Start the alternator and set at the correct operating speed.
4. Measure the voltage between pairs of AVR input terminals 6,7 and 8 (V_{r67}, V_{r78}, V_{r86}).

NOTICE
The subscript 'r' indicates that the reading is measured with the alternator running without excitation, i.e. residual levels.

5.9 Measure and Verify the PMG Output Voltage

For correct AVR operation, the output of the PMG must be within specified voltage limits. If the PMG voltage is too low or too high, then the AVR may not control the alternator output correctly.

1. Disconnect the three PMG output leads (P2, P3 and P4) from the AVR input connections.
2. Connect a multimeter safely to the PMG output leads.
3. Start the alternator and run at the correct operating speed.
4. Measure the voltage between pairs of PMG output leads P2, P3 & P4 (V_{P2P3}, V_{P3P4}, V_{P4P2}).

For correct operation, the PMG output voltages should all be within these limits:

$170 < V_{p2p3} < 185$ @ 50 Hz,

$170 < V_{p3p4} < 185$ @ 50 Hz,

$170 < V_{p4p2} < 185$ @ 50 Hz, or

$200 < V_{p2p3} < 220$ @ 60 Hz,

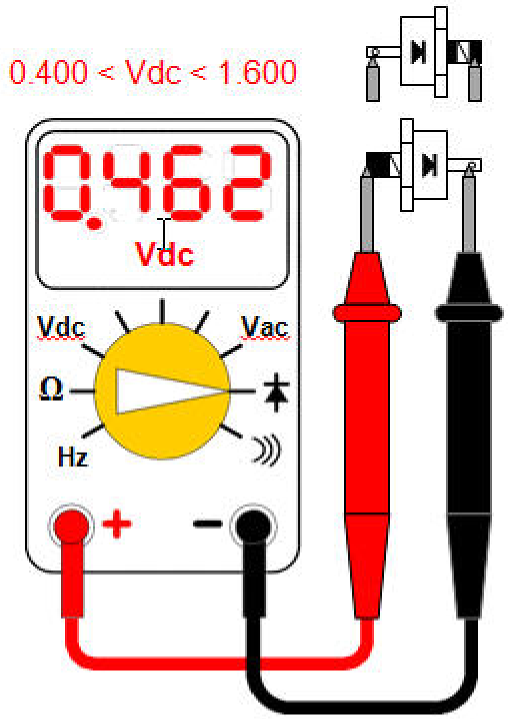
$200 < V_{p3p4} < 220$ @ 60 Hz,

$200 < V_{p4p2} < 220$ @ 60 Hz.

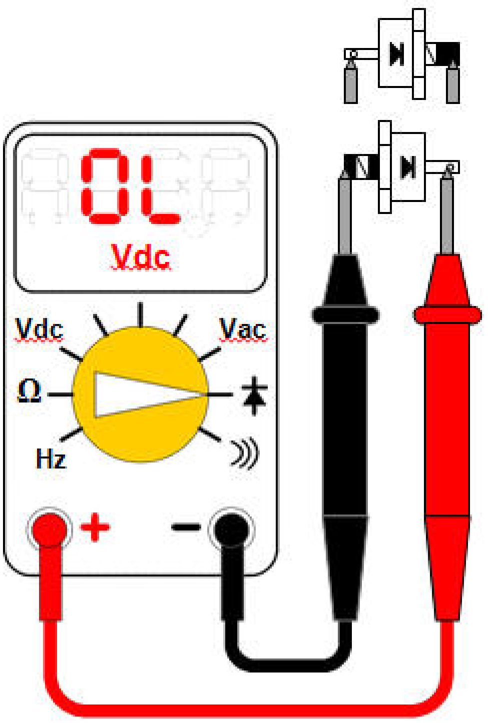
5.10 Rectifier System

5.10.1 Check the Rotating Rectifier Diodes

1. Disconnect the lead of one diode where it joins the windings at the insulated terminal post. Store fastener and washers.
2. Measure the voltage drop across the diode in the forward direction, using the diode test function of a multimeter.



3. Measure the resistance across the diode in the reverse direction, using the diode test function of a multimeter.



4. The diode is faulty if the voltage drop in the forward direction is outside the range 0.4 to 1.6 V, or if the resistance is below 20 MΩ in the reverse direction.
5. Repeat the previous steps for the five remaining diodes.
6. If any diode is faulty, replace the full set of six diodes (same type, same manufacturer) as follows:
   a. Remove the original diodes.
   b. Apply a small amount of heat sink compound **only** to the base of the replacement diodes, not the threads.

c. Check polarity of the replacement diodes.

d. Screw each replacement diode into a threaded hole in the rectifier plate.

e. Tighten each diode to the torque specified in the alternator manual, to give good mechanical, electrical and thermal contact.

f. Replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F)

7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

5.10.2 Check the Rotating Rectifier Varistors

1. Inspect both varistors.
2. A varistor is faulty if there are signs of overheating (discolouration, blisters, melting) or disintegration.
3. Disconnect one varistor lead. Store fastener and washers.
4. Measure the resistance across each varistor. Good varistors have a resistance greater than 100 MΩ.
5. A varistor is faulty if the resistance is short circuit or open circuit in either direction.
6. If a varistor is faulty, replace both varistors with a matched pair (same type, same manufacturer and same voltage grading: A, B, C, D, E, F) and replace all diodes.
7. Reconnect and check that all leads are secure, washers fitted and fasteners tight.

5.11 Windings

5.11.1 Measure and Verify the Exciter Stator Resistance

1. Stop the alternator.
2. Disconnect the exciter field leads F1 (X+) and F2 (XX-) from the AVR.
3. Measure the electrical resistance between F1 and F2 leads with a multimeter.
4. The resistance should be between approximately 15 Ω and 20 Ω at 20 °C. Refer to the Technical Data **Chapter 7 on page 55** for specific values.
5. Reconnect the exciter field leads F1 and F2.
6. Record your measurement in a copy of the fault finding record **Chapter 6 on page 51**.

5.11.2 Measure and Verify the Exciter Rotor Resistance

1. Stop the alternator.
2. Mark the leads attached to diodes on one of the two rectifier plates.
3. Disconnect all exciter rotor leads from all diodes at the rectifier.
4. Measure the electrical resistance between pairs of marked leads (between phase windings). A specialist micro ohmmeter must be used.
5. The resistance phase-to-phase should be between approximately 0.07 Ω and 0.20 Ω at 20 °C. Refer to Technical Data **Chapter 7 on page 55** for specific values.
6. Reconnect all exciter rotor leads to the diodes.
7. Record your measurements in a copy of the fault finding record **Chapter 6 on page 51**.

5.11.3 Measure and Verify the Main Rotor Resistance

1. Stop the alternator.
2. Disconnect the two main rotor DC leads from the rectifier plates.

3. Measure the electrical resistance between the main rotor leads. A specialist micro ohmmeter must be used.
4. The resistance should be between approximately 0.4 Ω and 2.80 Ω at 20 °C. Refer to Technical Data **Chapter 7 on page 55** for specific values.
5. Reconnect the two main rotor DC leads to the rectifier plates.
6. Make sure the fasteners are secure.
7. Record your measurement in a copy of the fault finding record **Chapter 6 on page 51**.

5.11.4 Measure and Verify the Main Stator Resistance

1. Stop the alternator.
2. Disconnect the leads of the main stator from the output terminals.
3. Measure and record the electrical resistance between U1 and U2 leads and between U5 and U6 (if present). A specialist micro ohmmeter must be used.
4. Measure and record the electrical resistance between V1 and V2 leads and between V5 and V6 (if present). A specialist micro ohmmeter must be used.
5. Measure and record the electrical resistance between W1 and W2 leads and between W5 and W6 (if present). A specialist micro ohmmeter must be used
6. The measured resistances should be between approximately 0.25 mΩ and 2.0 Ω at 20 °C. Refer to Technical Data **Chapter 7 on page 55** for specific values.
7. Reconnect the leads to the output terminals, as before.
8. Make sure the fasteners are secure
9. Record your measurements in a copy of the fault finding record **Chapter 6 on page 51**.

5.11.5 Measure and Verify the PMG Stator Resistance

1. Stop the alternator.
2. Disconnect the three PMG output leads P2, P3 and P4 from the AVR.
3. Measure the electrical resistance between pairs of the PMG output leads, with a multimeter.
4. The resistance phase-to-phase should be between approximately 2.5 Ω and 6 Ω at 20 °C. Refer to Technical Data **Chapter 7 on page 55** for specific values.
5. Reconnect the three PMG output leads P2, P3 and P4 to the AVR.
6. Make sure the fasteners are secure.
7. Record your measurements in a copy of the fault finding record **Chapter 6 on page 51**.

5.12 Measure and Verify the Exciter Stator Insulation Resistance

TABLE 6. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	**Minimum Insulation Resistance at 1 minute (MΩ)**	
		New	**In-service**
Exciter stator	500	10	5

1. Inspect the windings for mechanical damage or discolouration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. Connect together both ends of the winding (if possible).

3. Apply the test voltage from the table between the winding and earth.
4. Measure the insulation resistance after 1 minute (IR_{1min}).
5. Discharge the test voltage to earth for five minutes.
6. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
7. Repeat the method for each winding.
8. Remove the connections made for testing.
9. Record your measurements in a copy of the fault finding record Chapter 6 on page 51.

5.13 Measure and Verify the Exciter Rotor Insulation Resistance

TABLE 7. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service
Exciter rotor	500	10	5

1. Inspect the windings for mechanical damage or discolouration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. Connect together the three leads of all phase windings (if possible).
3. Apply the test voltage from the table between the winding and earth.
4. Measure the insulation resistance after 1 minute (IR_{1min}).
5. Discharge the test voltage to earth for five minutes.
6. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
7. Remove the connections made for testing.
8. Record your measurement in a copy of the fault finding record Chapter 6 on page 51.

5.14 Measure and Verify the Main Rotor Insulation Resistance

TABLE 8. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service
Exciter rotor, rectifier & main rotor combined	500	10	5

1. Inspect the windings for mechanical damage or discolouration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. Connect together both ends of the winding (if possible).
3. Apply the test voltage from the table between the winding and earth.

4. Measure the insulation resistance after 1 minute (IR_{1min}).
5. Discharge the test voltage to earth for five minutes.
6. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
7. Remove the connections made for testing.
8. Record your measurement in a copy of the fault finding record **Chapter 6 on page 51**.

5.15 Measure and Verify the Main Stator Insulation Resistance

TABLE 9. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service
Main stator	500	10	5

1. Inspect the windings for mechanical damage or discolouration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. Disconnect the neutral to earth conductor (if fitted).
3. Connect together the three leads of all phase windings (if possible).
4. Apply the test voltage from the table between any phase lead and earth.
5. Measure the insulation resistance after 1 minute (IR_{1min}).
6. Discharge the test voltage to earth for five minutes.
7. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
8. Reconnect neutral to earth conductor (if fitted).
9. Record your measurement in a copy of the fault finding record **Chapter 6 on page 51**.

5.16 Measure and Verify the PMG Stator Insulation Resistance

TABLE 10. TEST VOLTAGE AND MINIMUM ACCEPTABLE INSULATION RESISTANCE FOR NEW AND IN-SERVICE ALTERNATORS

	Test Voltage (V)	Minimum Insulation Resistance at 1 minute (MΩ)	
		New	In-service
PMG stator	500	5	3

1. Inspect the windings for mechanical damage or discolouration from overheating. Clean the insulation if there is hygroscopic dust and dirt contamination.
2. Connect together the three leads of all phase windings (if possible).
3. Apply the test voltage from the table between the winding and earth.
4. Measure the insulation resistance after 1 minute (IR_{1min}).
5. Discharge the test voltage to earth for five minutes.

6. If the measured insulation resistance is less than the minimum acceptable value, dry the insulation, then repeat the method.
7. Repeat the method for each winding.
8. Remove the connections made for testing.
9. Record your measurement in a copy of the fault finding record Chapter 6 on page 51.

5.17 Restore the Residual Voltage

⚠ 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.

⚠ DANGER
Battery Short Circuit
Sudden discharge of battery energy by short circuit can cause serious injury or death by electric shock and burns.
To prevent injury, fit a 5 A fuse in circuit and use insulated leads and tools.

⚠ WARNING
Battery Acid
Contact with battery acid can cause serious injury by chemical burns to eyes and skin.
To prevent injury, wear appropriate personal protection equipment (PPE). Put battery securely on a flat surface to avoid acid spills.

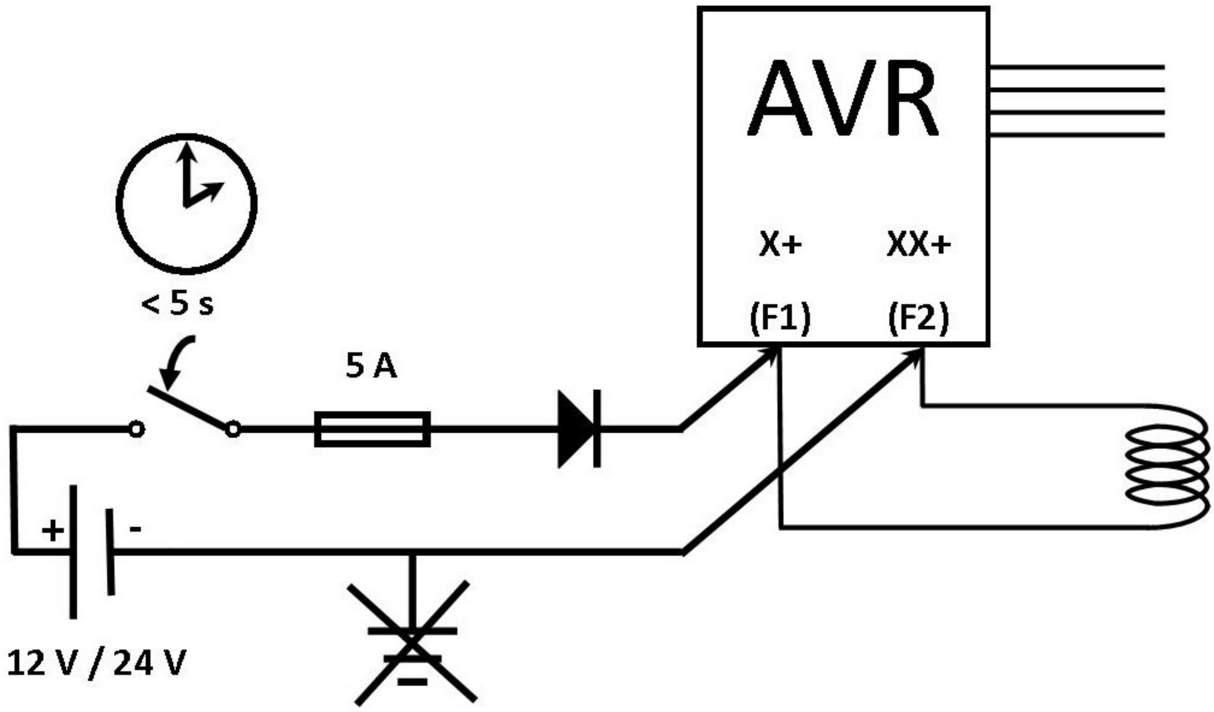
NOTICE
Risk of permanent damage to the AVR. AVR will be destroyed if a battery is connected with incorrect polarity or without a diode of correct polarity in the circuit. Follow the sequence below carefully and check battery polarity before connecting to the AVR.

The laminated steel core of the exciter stator retains a residual, or remanence, magnetism. Residual voltage, generated by the exciter rotor turning in this magnetic field, powers the AVR during alternator start-up. A minimum level of residual voltage is necessary for correct operation of an AVR without a PMG. Residual magnetism can be lost if

- the laminated core sustains a mechanical shock
- the exciter stator winding is replaced (rewound)
- magnetism has decayed during storage for many years
- the residual magnetism is reversed by incorrect use of this procedure.

Restore lost, or weak, residual magnetism as follows:

FIGURE 1. TEMPORARY CIRCUIT TO RESTORE RESIDUAL VOLTAGE



1. Securely place a fully-charged 12 VDC or 24 VDC lead-acid vehicle battery, near the alternator. The generator set starter battery can be used **only** if it is **completely** disconnected (including earth connection) after the engine is started.
2. Connect the temporary circuit shown in the figure above. A spare rectifier diode can be used but must be of the correct polarity. Use the diode test function of a multi meter (see **Section 5.10.1 on page 43**) to identify the polarity of a diode.
3. Disconnect the output load from the alternator.
4. Run the alternator at rated speed off-load.
5. Close the switch for 5 seconds maximum to restore the residual magnetism.
6. Stop the alternator and remove the complete temporary circuit.
7. Run the alternator at rated speed off-load.
8. Measure the main terminal output voltage:
   - if alternator output builds to the rated voltage, the residual voltage has been restored.
   - if the alternator **does not** build to rated voltage, replace the faulty AVR. Repeat this procedure from step 1.
9. If this procedure has not restored the residual voltage, seek guidance from CGT Customer Support.

6 Fault Finding Record

Fault Finding Record						
Alternator Model		**Serial Number**		**Running Time**	hours	
Alternator Voltage, V_G (VAC)	208	220	230	240	380	400
	415	440	480	600	690	Other
AVR Model	SX460	SX440	SX421	AS440		
	AS480	MX341	MX321	MA330	Other	
Stator Connection	Series-Star	Parallel-Star	Series-Delta	Single-Phase	Other	
Fault Symptoms and Observations						

<table>
<tr><th colspan="11">Fault Finding Record</th></tr>
<tr><td rowspan="11">Measurements</td><td colspan="2">Residual Voltage, V_A (VAC)</td><td colspan="2">V_{rUV} =</td><td>V_{rVW} =</td><td>V_{rWU} =</td><td colspan="4">$V_A = (V_{rUV} + V_{rVW} + V_{rWU})/3$ =</td></tr>
<tr><td colspan="6">AVR Power Input</td><td colspan="4">AVR Sensing</td></tr>
<tr><td>AVR Model</td><td>Terminals</td><td colspan="3">Power Input Voltage (VAC)</td><td>Requirement (VAC)</td><td>Terminals</td><td colspan="3">Sensing Voltage (VAC)</td></tr>
<tr><td>SX460
AS440
AS480</td><td>7
8*</td><td colspan="3">V_{r78} =</td><td>$V_{r78} > 6$</td><td>7
8*</td><td colspan="3">$V_B = V_{r78}$ =</td></tr>
<tr><td>SX440</td><td>P2
P3</td><td colspan="3">V_{rP2P3} =</td><td>$V_{rP2P3} > 6$</td><td>2
3</td><td colspan="3">$V_B = V_{r23}$ =</td></tr>
<tr><td rowspan="2">SX421</td><td rowspan="2">P2
P3
P4</td><td rowspan="2">V_{rP2P3} =</td><td rowspan="2">V_{rP3P4} =</td><td rowspan="2">V_{rP4P2} =</td><td rowspan="2">$V_{rP2P3} > 6$
$V_{rP3P4} > 6$
$V_{rP4P2} > 6$</td><td rowspan="2">6
7
8</td><td>V_{r67} =</td><td>V_{r78} =</td><td>V_{r86} =</td></tr>
<tr><td colspan="3">$V_B = (V_{r67} + V_{r78} + V_{r86})/3$ =</td></tr>
<tr><td>MX341</td><td>P2
P3
P4</td><td>V_{P2P3} =</td><td>V_{P3P4} =</td><td>V_{P4P2} =</td><td>$170 < V_{P2P3} < 220$
$170 < V_{P3P4} < 220$
$170 < V_{P4P2} < 220$</td><td>2
3</td><td colspan="3">$V_B = V_{r23}$ =</td></tr>
<tr><td rowspan="2">MX321</td><td rowspan="2">P2
P3
P4</td><td rowspan="2">V_{P2P3} =</td><td rowspan="2">V_{P3P4} =</td><td rowspan="2">V_{P4P2} =</td><td rowspan="2">$170 < V_{P2P3} < 220$
$170 < V_{P3P4} < 220$
$170 < V_{P4P2} < 220$</td><td rowspan="2">6
7
8</td><td>V_{r67} =</td><td>V_{r78} =</td><td>V_{r86} =</td></tr>
<tr><td colspan="3">$V_B = (V_{r67} + V_{r78} + V_{r86})/3$ =</td></tr>
<tr><td colspan="10">Other AVRs: Refer to CGT</td></tr>
<tr><td rowspan="2">Calculations</td><td colspan="7">AVR Sensing Voltage, V_{Sen} from measurements taken (VAC)</td><td colspan="3">Requirement (VAC)</td></tr>
<tr><td colspan="7">$V_{Sen} = V_G \times V_B / V_A$ =
Alternator voltage (V_G) x Sensing voltage (V_B) / Residual Voltage (V_A) =</td><td colspan="3">$190 < V_{Sen} < 240$</td></tr>
</table>

<table>
<tr><td></td><td>Exciter Stator</td><td colspan="3">Exciter Rotor</td><td>Main Rotor</td><td colspan="3">Main Stator</td><td colspan="3">PMG Stator</td></tr>
<tr><td>Resistance (mΩ)</td><td>R =</td><td>R_{UV} =</td><td>R_{VW} =</td><td>R_{UW} =</td><td>R =</td><td>R_{U1U2} =
R_{U5U6} =</td><td>R_{V1V2} =
R_{V5V6} =</td><td>R_{W1W2} =
R_{W5W6} =</td><td>R_{P2P3} =</td><td>R_{P3P4} =</td><td>R_{P2P4} =</td></tr>
</table>

<table>
<tr><th colspan="6">Fault Finding Record</th></tr>
<tr><td>Insulation Resistance (MΩ)</td><td>IR =</td><td>IR_{UVW} =</td><td>IR =</td><td>IR_{UVW} =</td><td>IR_{P2P3P4} =</td></tr>
<tr><td>Engineer's Notes</td><td colspan="5"></td></tr>
<tr><td colspan="6">This is an accurate record of observations and measurements completed according to the fault finding method</td></tr>
<tr><td>Service Engineer</td><td>signature</td><td>Name</td><td>print</td><td>Date</td><td>dd/MMM/yy</td></tr>
<tr><td>Owner/ Approver</td><td>signature</td><td>Name</td><td>print</td><td>Date</td><td>dd/MMM/yy</td></tr>
</table>

[4]

[4] * Power input and voltage sensing share terminals 7 and 8.

This page is intentionally blank.

7 Technical Data

NOTICE

Compare measurements with the technical data sheet and the test certificate supplied with the alternator.

7.1 P0/P1 Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	EBS (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	05 (U1-U2) (U5-U6)	06 (U1-U2) (U5-U6)				
PI044D	1.050	0.660	1.571	0.536	0.412	17.5	0.2110	0.437	12.9
PI044E	0.664	0.425	0.972	0.375	0.275	17.5	0.2110	0.415	12.9
PI044F	0.476	0.325	0.671	0.232	0.179	18.5	0.2280	0.465	12.9
PI044G	0.351	0.230	0.476	0.173	0.134	18.5	0.2280	0.551	12.9
PI044H	0.253	0.195	0.380	0.142	0.097	18.5	0.2280	0.545	12.9
PI144D	0.189	0.132	0.292	0.100	0.066	18.5	0.2280	0.657	12.9
PI144E	0.148	0.102	0.227	0.085	0.060	19.4	0.2150	0.670	12.9
PI144F	0.133	0.097	0.190	0.069	0.047	20.3	0.2010	0.708	12.9
PI144G	0.111	0.071	0.153	0.054	0.036	20.3	0.2010	0.857	12.9
PI144H	0.090	0.065	0.125	0.042	0.030	22.9	0.2100	0.890	12.9
PI144J	0.077	0.055	0.115	0.035	0.025	22.9	0.2100	0.990	12.9
PI144K	0.077	0.049	0.096	0.035	0.026	22.9	0.2100	0.983	12.9
PI042D	0.642	n/a	n/a	0.277	0.197	13.5	0.0479	0.798	12.9
PI042E	0.403	n/a	n/a	0.198	0.131	13.5	0.0479	0.895	12.9
PI042F	0.357	n/a	n/a	0.156	0.096	13.5	0.0479	0.931	12.9
PI042G	0.268	n/a	n/a	0.107	0.085	13.5	0.0479	0.993	12.9
PI142D	0.189	n/a	n/a	0.077	0.060	18.0	0.1280	1.125	12.9
PI142E	0.153	n/a	n/a	0.064	0.046	19.0	0.1340	1.214	12.9
PI142F	0.125	n/a	n/a	0.057	0.037	20.0	0.1050	1.280	12.9
PI142G	0.089	n/a	n/a	0.043	0.025	20.0	0.1050	1.479	12.9
PI142H	0.077	n/a	n/a	0.036	0.025	20.0	0.1050	1.590	12.9

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	EBS (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	05 (U1-U2) (U5-U6)	06 (U1-U2) (U5-U6)				
PI142J	0.070	n/a	n/a	0.030	0.023	20.0	0.1050	1.709	12.9

7.2 UC Winding Resistances

TABLE 11. AVR-CONTROLLED ALTERNATORS

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)										
	Main Stator (lead - lead) (Ohms)							Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	05 (U1-U2) (U5-U6)	06 (U1-U2) (U5-U6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)				
UC22C	0.090	0.045	0.030	0.059	0.140	0.308	n/a	21	0.142	0.59	2.6
UC22D	0.065	0.033	0.025	0.045	0.100	0.180	n/a	21	0.142	0.64	2.6
UC22E	0.050	0.028	0.020	0.035	0.075	n/a	n/a	20	0.156	0.69	2.6
UC22F	0.033	0.018	0.012	0.024	0.051	0.111	n/a	20	0.156	0.83	2.6
UC22G	0.028	0.014	0.010	0.018	0.043	0.090	n/a	20	0.156	0.94	2.6
UC27C	0.030	0.016	0.011	0.022	0.044	0.082	n/a	20	0.156	1.12	2.6
UC27D	0.019	0.010	0.007	0.014	0.026	0.053	n/a	20	0.156	1.26	2.6
UC27E	0.016	0.009	0.008	0.011	0.003	0.040	0.038	20	0.182	1.34	2.6
UC27F	0.012	0.007	0.005	0.010	0.019	0.037	n/a	20	0.182	1.52	2.6
UC27G	0.010	0.006	0.004	0.008	0.013	0.028	n/a	20	0.182	1.69	2.6

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)										
	Main Stator (lead - lead) (Ohms)							Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	05 (U1-U2) (U5-U6)	06 (U1-U2) (U5-U6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)				
UC27H	0.008	0.004	0.004	0.007	0.014	0.021	0.015	20	0.182	1.82	2.6
UCD27J	0.006	n/a	n/a	0.004	0.009	n/a	n/a	20	0.182	2.08	2.6
UCD27K	0.006	n/a	n/a	n/a	0.009	n/a	n/a	20	0.182	2.08	2.6

TABLE 12. TRANSFORMER-CONTROLLED ALTERNATORS

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator 3 Phase Windings, L-N (Ohms)					Exciter Stator (Ohms)		Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)
	380 V 50 Hz	400 V 50 Hz	415 V 50 Hz	416 V 60 Hz	460 V 60 Hz	1 phase transformer, 1 or 3 phase generator	3 phase transformer, 3 phase generator		
UC22C	0.059	0.078	0.082	0.055	0.059	28	138	0.142	0.59
UC22D	0.054	0.056	0.057	0.049	0.054	28	138	0.142	0.64
UC22E	0.041	0.05	0.053	0.038	0.041	30	155	0.156	0.69
UC22F	0.031	0.032	0.033	0.025	0.031	30	155	0.156	0.83
UC22G	0.022	0.026	0.028	0.021	0.022	30	155	0.156	0.94

7.3 HC Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	17 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	14 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	25 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	27 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)				
HC434C	0.0083	0.0115	0.0055	0.0020	0.0154	18	0.136	0.92	2.6
HC434D	0.0062	0.0100	0.0045	0.0160	0.0130	18	0.136	1.05	2.6
HC434E	0.0045	0.0075	n/a	0.0140	0.0100	18	0.136	1.19	2.6
HC434F	0.0037	0.0055	n/a	0.0105	0.0075	18	0.136	1.37	2.6
HC444C	0.0083	0.0115	0.0055	0.0020	0.0154	18	0.136	0.92	n/a
HC444D	0.0062	0.0100	0.0045	0.0160	0.0130	18	0.136	1.05	n/a
HC444E	0.0045	0.0075	n/a	0.0140	0.0100	18	0.136	1.19	n/a
HC444F	0.0037	0.0055	n/a	0.0105	0.0075	18	0.136	1.37	n/a
HC534C	0.0033	0.0053	0.0026	0.0100	0.0065	17	0.184	1.55	2.6
HC534D	0.0025	0.0040	0.0021	0.0075	0.0005	17	0.184	1.77	2.6
HC534E	0.0022	0.0034	0.0013	n/a	0.0044	17	0.184	1.96	2.6
HC534F	0.0019	0.0025	0.0013	0.0050	0.0041	17	0.184	2.46	2.6
HC544C	0.0033	0.0053	0.0026	0.0100	0.0065	17	0.184	1.55	n/a
HC544D	0.0025	0.0040	0.0021	0.0075	0.0005	17	0.184	1.77	n/a
HC544E	0.0022	0.0034	0.0013	n/a	0.0044	17	0.184	1.96	n/a
HC544F	0.0019	0.0025	0.0013	0.0050	0.0041	17	0.184	2.46	n/a
HC634G	0.0017	n/a	n/a	n/a	n/a	17	0.158	1.75	5.6
HC634H	0.0013	n/a	n/a	n/a	n/a	17	0.158	1.88	5.6
HC634J	0.0011	n/a	n/a	n/a	n/a	17	0.158	2.09	5.6
HC634K	0.0009	n/a	n/a	n/a	n/a	17	0.158	2.36	5.6

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator (lead - lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	312 (U1-U2) (V1-V2) (W1-W2)	07 (U1-U2) (V1-V2) (W1-W2)	13 (U1-U2) (V1-V2) (W1-W2)	26 (U1-U2) (V1-V2) (W1-W2)	28 (U1-U2) (V1-V2) (W1-W2)				
HC434F	n/a	n/a	0.0060	n/a	n/a	18	0.136	1.37	2.6
HC444F	n/a	n/a	0.0060	n/a	n/a	18	0.136	1.37	n/a
HC534E	n/a	n/a	n/a	0.0130	n/a	17	0.184	1.96	2.6
HC544E	n/a	n/a	n/a	0.0130	n/a	17	0.184	1.96	n/a
HC634G	0.0034	0.0055	0.0002	0.0090	0.0075	17	0.158	1.75	5.6
HC634H	0.0025	0.0036	0.0019	0.0080	n/a	17	0.158	1.88	5.6
HC634J	0.0022	0.0030	0.0015	0.0060	n/a	17	0.158	2.09	5.6
HC634K	0.0017	0.0026	0.0010	0.0045	0.0030	17	0.158	2.36	5.6
HC636G	0.0090	0.0102	n/a	n/a	n/a	17	0.200	1.12	5.6
HC636H	0.0063	0.0102	n/a	n/a	n/a	17	0.200	1.33	5.6
HC636J	0.0049	0.0070	n/a	n/a	n/a	17	0.200	1.50	5.6
HC636K	0.0039	0.0060	n/a	n/a	n/a	17	0.200	1.75	5.6

7.4 HCG Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)					
	Main Stator (lead-lead) (ohms)		Exciter Stator (ohms)	Exciter Rotor, L-L (ohms)	Main Rotor (ohms)	PMG Stator, L-L (ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	312 (U1-U2) (V1-V2) (W1-W2)				
HCG434C	0.0083	n/a	18	0.136	0.92	2.6
HCG434D	0.0062	n/a	18	0.136	1.05	2.6
HCG434E	0.0045	n/a	18	0.136	1.19	2.6
HCG434F	0.0037	n/a	18	0.136	1.37	2.6
HCG534C	0.0033	n/a	17	0.184	1.55	2.6
HCG534D	0.0025	n/a	17	0.184	1.77	2.6

-

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)					
	Main Stator (lead-lead) (ohms)		Exciter Stator (ohms)	Exciter Rotor, L-L (ohms)	Main Rotor (ohms)	PMG Stator, L-L (ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	312 (U1-U2) (V1-V2) (W1-W2)				
HCG534E	0.0022	n/a	17	0.184	1.96	2.6
HCG534F	0.0019	n/a	17	0.184	2.46	2.6
HCG634G	0.0017	0.0034	17	0.158	1.75	5.6
HCG634H	0.0013	0.0025	17	0.158	1.88	5.6
HCG634J	0.0011	0.0022	17	0.158	2.09	5.6
HCG634K	0.0009	0.0017	17	0.158	2.36	5.6

7.5 P6 Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)					
	Main Stator (lead-lead) (ohms)		Exciter Stator (ohms)	Exciter Rotor, L-L (ohms)	Main Rotor (ohms)	PMG Stator, L-L (ohms)
	311 (U1-U2) (V1-V2) (W1-W2) (U5-U6) (V5-V6) (W5-W6)	312 (U1-U2) (V1-V2) (W1-W2)				
P6-LVI634B	0.0021	0.00354	17.5	0.096	1.60	5.6
P6-LVI634C	n/a	0.00313	17.5	0.096	1.66	5.6
P6-LVI634D	0.0015	0.00278	17.5	0.096	1.74	5.6
P6-LVI634E	0.0012	0.00220	17.5	0.096	1.92	5.6
P6-LVI634F	0.0009	0.00168	17.5	0.096	2.14	5.6
P6-LVI634G	0.0008	0.00136	17.5	0.096	2.45	5.6

7.6 P7 Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)								
	Main Stator (lead-lead) (Ohms)					Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	PMG Stator, L-L (Ohms)
	312 (U1-U2) (V1-V2) (W1-W2)	07 (U1-U2) (V1-V2) (W1-W2)	13 (U1-U2) (V1-V2) (W1-W2)	26 (U1-U2) (V1-V2) (W1-W2)	28 (U1-U2) (V1-V2) (W1-W2)				
P734A	0.0016	0.0026	0.0013	0.0048	0.0031	17.5	0.126	1.67	2.6
P734B	0.0016	0.0026	0.0013	0.0048	0.0031	17.5	0.126	1.67	2.6
P734C	0.0013	0.0020	0.0009	0.0034	0.0027	17.5	0.126	1.85	2.6
P734D	0.0011	0.0020	0.0009	0.0031	0.0019	17.5	0.126	1.98	2.6
P734E	0.0009	0.0015	n/a	0.0030	0.0020	17.5	0.126	2.17	2.6
P734F	0.0008	0.0011	0.0005	0.0022	0.0016	17.5	0.126	2.31	2.6
P734G	0.0008	0.0011	n/a	0.0022	n/a	16.0	0.112	2.42	2.6
P736B	0.0027	0.0042	n/a	n/a	n/a	17.0	0.200	2.33	5.6
P736D	0.0018	0.0032	n/a	n/a	n/a	17.0	0.200	2.69	5.6
P736F	0.0014	0.0020	n/a	n/a	n/a	20.0	0.280	3.25	5.6

7.7 PG7 Winding Resistances

Alternator	Resistance of windings at 20 °C (measured values should be within 10%)				
	Main Stator (lead-lead) (ohms)	Exciter Stator (ohms)	Exciter Rotor, L-L (ohms)	Main Rotor (ohms)	PMG Stator, L-L (ohms)
	312 (U1-U2) (V1-V2) (W1-W2)				
PG7 S	0.00093	17.5	0.126	2.17	2.6
PG7 T	0.00076	17.5	0.126	2.31	2.6

7.8 MV734 Parameters

Alternator	Frequency (Hz)	Voltage at terminals: Phase to phase, L-L (kV)	Typical Residual: 6,7,8 (V)	Typical Residual: Main, L-L (V)	Normal: 6,7,8 (V)	Resistance of windings at 20 °C: Exciter Stator (Ohms)	Exciter Rotor L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (Ohms)	PMG Stator, L-L (Ohms)
MV734E	50	3.3	60	500	165-190	17	0.096	1.20	0.125	3.8
	60	4.16	75	650	208-240	17	0.096	1.20	0.125	3.8
MV734F	50	3.3	60	500	165-190	17	0.096	1.34	0.089	3.8
	60	4.16	75	650	208-240	17	0.096	1.34	0.089	3.8
MV734G	50	3.3	60	500	165-190	17	0.096	1.58	0.068	3.8
	60	4.16	75	650	208-240	17	0.096	1.58	0.068	3.8
MV734H	50	3.3	60	500	165-190	17	0.096	1.75	0.056	3.8
	60	4.16	75	650	208-240	17	0.096	1.75	0.056	3.8

7.9 LV804 Parameters

Alternator	Frequency (Hz)	Voltage at terminals (V)					Resistance of windings at 20 °C				
		Phase to phase, L-L	Typical Residual		Normal		Exciter Stator (Ohms)	Exciter Rotor L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (milliOhms)	PMG Stator, L-L (Ohms)
			6,7,8 (E1, E2, E3)	Main, L-L	6,7,8	E1, E2, E3					
LV804R	50	400	35/60	60	190-250	400	17.5	0.076	1.32	0.67	3.8
	50	690	35	100	190-250	190-250	17.5	0.076	1.32	1.58	3.8
	60	480	35/70	70	190-250	480	17.5	0.076	1.32	0.67	3.8
	60	600	35/90	90	190-250	600	17.5	0.076	1.32	0.97	3.8
LV804S	50	400	35/60	60	190-250	400	17.5	0.076	1.40	0.54	3.8
	50	690	35	100	190-250	190-250	17.5	0.076	1.40	1.45	3.8
	60	480	35/70	70	190-250	480	17.5	0.076	1.40	0.54	3.8
	60	600	35/90	90	190-250	600	17.5	0.076	1.40	0.76	3.8
LV804T	50	400	35/60	60	190-250	400	17.5	0.076	1.50	0.44	3.8
	50	690	35	100	190-250	190-250	17.5	0.076	1.50	1.15	3.8
	60	480	35	70	190-250	480	17.5	0.076	1.50	0.44	3.8
	60	600	35/90	90	190-250	600	17.5	0.076	1.50	0.71	3.8
LV804W	50	400	35/60	60	190-250	400	16	0.092	1.47	0.33	3.8
	50	690	35	100	190-250	190-250	16	0.092	1.47	0.88	3.8
	60	480	35/70	70	190-250	480	16	0.092	1.47	0.33	3.8
	60	600	35/90	90	190-250	600	16	0.092	1.47	0.48	3.8

Alternator	Frequency (Hz)	Voltage at terminals (V)					Resistance of windings at 20 °C				
		Phase to phase, L-L	Typical Residual		Normal		Exciter Stator (Ohms)	Exciter Rotor L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (milliOhms)	PMG Stator, L-L (Ohms)
			6,7,8 (E1, E2, E3)	Main, L-L	6,7,8	E1, E2, E3					
LV804X	50	400	35/60	60	190-250	400	16	0.092	1.63	0.26	3.8
	60	480	35/70	70	190-250	480	16	0.092	1.63	0.26	3.8
	60	600	35/90	90	190-250	600	16	0.092	1.63	0.37	3.8
LV804Y	50	690	35	100	190-250	190-250	16	0.092	1.69	0.66	3.8

7.10 MV804 Parameters

Alternator	Frequency (Hz)	Voltage at terminals				Resistance of windings at 20 °C				
		Phase to phase, L-L (kV)	Typical Residual		Normal	Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (Ohms)	PMG Stator, L-L (Ohms)
			6,7,8 (E1, E2, E3) (V)	Main, L-L (V)	6,7,8 (E1,E2,E3) (V)					
MV804R	50	3.3	35	500	190-250	17.5	0.076	1.32	0.0343	3.8
	60	4.16	35	650	190-250	17.5	0.076	1.32	0.0343	3.8
MV804S	50	3.3	35	500	190-250	17.5	0.076	1.40	0.0339	3.8
	60	4.16	35	650	190-250	17.5	0.076	1.40	0.0339	3.8
MV804T	50	3.3	35	500	190-250	17.5	0.076	1.50	0.0286	3.8
	60	4.16	35	650	190-250	17.5	0.076	1.50	0.0286	3.8

Alternator	Frequency (Hz)	Voltage at terminals				Resistance of windings at 20 °C				
		Phase to phase, L-L (kV)	Typical Residual		Normal	Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (Ohms)	PMG Stator, L-L (Ohms)
			6,7,8 (E1, E2, E3) (V)	Main, L-L (V)	6,7,8 (E1,E2,E3) (V)					
MV804W	50	3.3	35	500	190-250	16	0.092	1.47	0.0194	3.8
	60	4.16	35	650	190-250	16	0.092	1.47	0.0194	3.8
MV804X	50	3.3	35	500	190-250	16	0.092	1.63	0.0154	3.8
	60	4.16	35	650	190-250	16	0.092	1.63	0.0154	3.8

7.11 HV804 Parameters

Alternator	Frequency (Hz)	Voltage at terminals: Phase to phase, L-L (kV)	Typical Residual: 6,7,8 (E1, E2, E3) (V)	Typical Residual: Main, L-L (V)	Normal: 6,7,8 (E1,E2,E3) (V)	Resistance of windings at 20 °C: Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (Ohms)	PMG Stator, L-L (Ohms)
HV804R	50	6.0	35	900	190-250	17.5	0.076	1.32	0.1489	3.8
	50	6.6	35	1000	190-250	17.5	0.076	1.32	0.1636	3.8
	50	10.0	35	1500	190-250	17.5	0.076	1.32	0.4716	3.8
	50	11.0	35	1650	190-250	17.5	0.076	1.32	0.6007	3.8
	60	7.2	35	1100	190-250	17.5	0.076	1.32	0.1489	3.8
	60	13.8	35	2100	190-250	17.5	0.076	1.32	0.6736	3.8
HV804S	50	6.0	35	900	190-250	17.5	0.076	1.40	0.1243	3.8
	50	6.6	35	1000	190-250	17.5	0.076	1.40	0.1549	3.8
	50	10.0	35	1500	190-250	17.5	0.076	1.40	0.3833	3.8
	50	11.0	35	1650	190-250	17.5	0.076	1.40	0.4903	3.8
	60	7.2	35	1100	190-250	17.5	0.076	1.40	0.1243	3.8
	60	13.8	35	2100	190-250	17.5	0.076	1.40	0.5554	3.8

Alternator	Frequency (Hz)	Voltage at terminals				Resistance of windings at 20 °C				
		Phase to phase, L-L (kV)	Typical Residual		Normal	Exciter Stator (Ohms)	Exciter Rotor, L-L (Ohms)	Main Rotor (Ohms)	Main Stator Phase to Neutral, L-N (Ohms)	PMG Stator, L-L (Ohms)
			6,7,8 (E1, E2, E3) (V)	Main, L-L (V)	6,7,8 (E1,E2,E3) (V)					
HV804T	50	6.0	35	900	190-250	17.5	0.076	1.50	0.1068	3.8
	50	6.6	35	1000	190-250	17.5	0.076	1.50	0.1305	3.8
	50	10.0	35	1500	190-250	17.5	0.076	1.50	0.2981	3.8
	50	11.0	35	1650	190-250	17.5	0.076	1.50	0.4022	3.8
	60	7.2	35	1100	190-250	17.5	0.076	1.50	0.1068	3.8
	60	13.8	35	2100	190-250	17.5	0.076	1.50	0.4484	3.8
HV804W	50	6.0	35	900	190-250	16	0.092	1.47	0.0668	3.8
	50	6.6	35	1000	190-250	16	0.092	1.47	0.0888	3.8
	50	10.0	35	1500	190-250	16	0.092	1.47	0.2368	3.8
	50	11.0	35	1650	190-250	16	0.092	1.47	0.3294	3.8
	60	7.2	35	1100	190-250	16	0.092	1.47	0.0668	3.8
	60	13.8	35	2100	190-250	16	0.092	1.47	0.3724	3.8
HV804X	50	6.0	35	900	190-250	16	0.092	1.63	0.0526	3.8
	50	6.6	35	1000	190-250	16	0.092	1.63	0.0717	3.8
	50	10.0	35	1500	190-250	16	0.092	1.63	0.1943	3.8
	50	11.0	35	1650	190-250	16	0.092	1.63	0.2540	3.8
	60	7.2	35	1100	190-250	16	0.092	1.63	0.0526	3.8
	60	13.8	35	2100	190-250	16	0.092	1.63	0.2868	3.8

This page is intentionally blank.

www.stamford-avk.com