

AIRCRAFT ALTERNATOR OWNER'S MANUAL

P/N PP2001

ALTERNATOR MODELS

ES-6012-()

ES-6024-()

ES-7012-()

ES-7024-()

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Thank you for purchasing a Hartzell Engine Technologies alternator. We encourage you to read this manual thoroughly. It contains a wealth of information about how to properly install and maintain your alternator so that it may give you many years of safe and reliable service.

Should you have a question regarding your alternator that is not covered in the manual, Hartzell Engine Technologies Product Support is ready to assist you. We may be reached at the following contact information:

Phone: +1.334.386.5400, option 2
E-mail: techsupport@Hartzell.aero
Fax: +1.334.386.5450
Web: www.Hartzell.aero/

WARNING:

People who fly should recognize that there are various types of risks are involved in this activity; and they should take all precautions to minimize them, since they cannot be eliminated entirely. The alternator is an important component of the aircraft. An alternator failure could result in an unplanned landing or even more severe consequences creating an unsafe condition that may result in death, serious bodily injury, and/or substantial property damage. It is, therefore, essential that the alternator is properly maintained according to the recommended service procedures and monitored to detect impending problems before they become serious. Any unusual operation should be investigated and corrected, as it may be a warning of impending failure.

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Record of Revisions

Revision Letter	Issue Date	Page Revised	Description	Inserted Date	By
New	02/03/20	N/A	Original		

Record of Revisions

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AIRWORTHINESS LIMITATIONS

A.0 General Information

CAUTION: THE AIRWORTHINESS LIMITATIONS HEREIN ARE THOSE MANDATED BY HARTZELL ENGINE TECHNOLOGIES. THESE LIMITATIONS ARE THE MINIMUM REQUIRED TO MEET CONTINUED AIRWORTHINESS BUT MAY BE SUPERSEDED BY MORE STRINGENT REQUIREMENTS AS PUBLISHED BY THE FAA, AIRCRAFT, ROTORCRAFT OR OTHER MANUFACTURERS THAT USE THESE COMPONENTS IN THEIR APPLICATIONS. FAILURE TO OBSERVE THESE LIMITATIONS MAY COMPROMISE THE COMPONENT OR THE APPLICATION IT IS USED IN.

A.1 Airworthiness Limitation Statement

- A. The Airworthiness Limitations section is FAA approved and specifies maintenance required under Secs. 43.16 and 91.403 of the Federal Aviation Regulations unless an alternative program has been FAA approved.

Airworthiness Limitation Revisions Log

Revision Number	Description of Revision

**Airworthiness
Limitations**

A.2 Life Limits

- A. The FAA establishes specific life limits for certain component parts as well as the complete alternator. Such limits require replacement of the identified parts after a specified number of cycles or hours of use.
- B. Additions of, or changes to, any life limit for the alternator or its components, will be noted in the Airworthiness Limitation Revision Log.
- C. Life Limits
 - (1) Alternator models and their component parts affected by this manual currently do not have any life limited parts.
 - (2) There are no new (or additional) Airworthiness Limitations associated with this equipment.

INTRODUCTION

1.1 General Information

WARNING:

IMPROPER OR UNAUTHORIZED APPLICATIONS OF THE INFORMATION CONTAINED IN THE MANUAL MAY RENDER THE AIRCRAFT OR THE COMPONENT UNAIRWORTHY AND RESULT IN LOSSES, DAMAGES, OR INJURY TO THE USER.

DO NOT USE OBSOLETE OR OUTDATED INFORMATION. PERFORM ALL INSPECTIONS OR WORK IN ACCORDANCE WITH THE MOST RECENT REVISION OF THE APPLICABLE AIRCRAFT/ENGINE SERVICE OR MAINTENANCE MANUAL. INFORMATION CONTAINED IN THESE MANUALS MAY BE SIGNIFICANTLY CHANGED FROM EARLIER REVISIONS. USE OF OBSOLETE INFORMATION MAY CREATE AN UNSAFE CONDITION THAT MAY RESULT IN DEATH, SERIOUS BODILY INJURY, AND/OR SUBSTANTIAL PROPERTY DAMAGE.

The accuracy and applicability of this manual has not been verified for any assembly, component or part not manufactured by Hartzell Engine Technologies LLC (HET). Any use of the manual for other than its intended or implied purpose is prohibited. The use of the manual for the purpose of performing any installation, maintenance, replacement, adjustment, or inspection of any assembly, component or part not manufactured by HET is not approved, endorsed, or sanctioned by HET.

This manual has been approved by Hartzell Engine Technologies LLC as the proper methods and procedures that FAA or other airworthiness authority Certificated Repair Stations and A/P Mechanics should use in the inspection and maintenance of Hartzell Engine Technologies LLC alternators.

No liability will be assumed by Hartzell Engine Technologies LLC for actual, consequential, incidental or other types of damages directly or indirectly resulting from the unauthorized use of this manual for other than its stated purposes.

The liability for use of the authorized data herein for the maintenance, or return to service is limited to the specific terms and conditions stated under the applicable Limited Warranty in effect for each piece part, component, assembly or whole unit sold by HET.

Because of the numerous modifications, Supplemental Type Certificates (STC), Parts Manufacturing Approvals (PMA), or Form 337 Field Approvals that may apply, it is the responsibility of the repairman, mechanic or maintenance facility to determine the proper engine or aircraft application of this alternator assembly. Please refer to the appropriate aircraft Type Certificate (TC), Supplemental Type Certificate (STC), aircraft equipment list, maintenance manuals, and/or Log Book entries for determination.

When performing installation, maintenance, replacement, adjustment, or inspection of any HET assembly, component or part, it is imperative that the latest revision of this HET manual or other product support document be referenced. Reference the HET website to be sure you have the latest revision before performing any work. (<http://www.hartzell.aero/maintenance-manuals/>)

All reasonable attempts were made to make this manual as complete and accurate as possible. If you have any questions, comments, corrections or require clarification of any information contained herein, please write to Hartzell Engine Technologies LLC, 2900 Selma Highway, Montgomery, Alabama, 36108 USA. TEL +1.334.386.5400, FAX +1.334.386.5410, or <http://hartzell.aero/contact/>.

1.2 General Specification (manual)

- A. This manual follows unique HET formatting using ATA 100 identification as required. Principle units of measure in the manual are U.S. units with International System of Units (SI) in parentheses.
- B. The ES-6012-(), ES-6024-(), ES-7012-(), and ES-7024-(), series alternator models are considered herein. Variations of these alternators may be noted as applicable.
- C. All aircraft, rotorcraft, or engine applications are limited to the holder of the TC, STC, PMA or TSO and only at the date of that document publication or revision.
- D. Only approved, competent persons with the necessary skills may do maintenance tasks described in the manual. This may include a certified pilot doing “preventative maintenance” as defined in FAR 43, Appendix A, paragraph C with guidance from AC 43.12A of latest change.
- E. The manual describes maintenance on components as they are installed on aircraft and tasks that should be accomplished in a properly equipped service facility.
- F. Maintenance tasks and subtasks are referenced in the manual but will have no specific identification numbers.
- G. The manual contains: Description and operation, Troubleshooting, Instruction for Continued Airworthiness (ICA) and Maintenance information along with part numbers required for basic maintenance tasks.

1.3 How to use the manual:

- A. Make sure the manual contains information applicable to your aircraft, engine, or replacement alternator. Look for the model number on the Title Page and if applicable, the part number of the replacement or superseded component.
- B. It is imperative that you read, understand, and observe all the applicable **WARNINGS** and **CAUTIONS** before you do any work on this component.
- C. Use only the sections needed. Use the check section to determine what actions may be needed periodically and the maintenance sections for servicing the alternator.
- D. If you need to identify a part or find a part number, refer to illustrations or reference in this manual or in the applicable aircraft or engine service or maintenance manual.
- E. Refer to the troubleshooting section to assure that the observed or reported condition lies with the alternator.
- F. Fully test the alternator per the instructions in this manual when running the aircraft. Utilize the aircraft and/or engine manufacturer's service manuals and publications before returning the aircraft to service. Use the AFM or POH for aircraft operations.

1.4 Measurements

- A. The measurements given in the manual are taken from original manufacturing drawings.
- B. Measurements are given in U.S. Units followed by SI Units in parentheses.

1.5 Units of Measure

A. SI Units

A	Ampere
Ah	Ampere hours
g	Gram
min	Minute
N	Newton
Nm	Newton meter
VDC	Volt direct current
°C	Degree Celsius
%	Percent
Ω	Ohm
W	Watt
Hz	Hertz

B. U.S. Units (SI units)

ft (m)	Foot (meter)
in (c)	Inch (centimeter)
lb (kg)	Pound (kilogram)
lb-in (Nm)	Pound inch (Newton meter) torque
lb-ft (Nm)	Pound foot (Newton meter) torque
°F (°C)	Degree Fahrenheit (centigrade)

C. Multiplying Prefixes

μ	Micro
m	Milli
k	Kilo
M	Mega
p	Pico

1.6 Abbreviations

- A. The abbreviations given below are used in the manual: (upper or lower case)

ACU	Alternator Control Unit
ALT	Alternator
ATA	Air Transport Association of America
CMI	Continental Motors, Inc.
DE	Drive End (housing)
DIA	Diameter
FAA	Federal Aviation Administration (USA)
FIG.	Figure
GAMA	General Aviation Manufacturers Association
IPC	Illustrated Parts Catalog
ID	Inside Diameter
HET	Hartzell Engine Technologies LLC
MAX	Maximum
MFR	Manufacturer
MIN	Minimum
NO.	Number
N/A	Not Applicable
OD	Outside Diameter
PCB	Printed Circuit Board
P/N	Part Number
PARA.	Paragraph
REF.	Refer To
S/A	Subassembly
S/N	Serial Number
SRE	Slip Ring End (housing)
TBD	To Be Defined
TOL	Tolerance

1.7 Definitions

- A. This paragraph defines the warnings and notifications used in this manual. **WARNINGS** place critical attention to use of tools, materials, procedures, or limitations, which must be followed without deviation to avoid injury to the technician or other persons. **CAUTIONS** place immediate attention to use of tools and procedures which must be followed to avoid injury, damage to equipment and/or facilities. **Notes** call attention to procedures which make the job easier.

- B. The following are basic definitions of the terms used herein: (as related to this manual)

ALTERNATOR: The complete unit which transforms rotational energy from a powerplant into electrical energy . At a given voltage, produces alternating current (AC) which is converted to direct current (DC).

ALTERNATOR CONTROL UNIT: Device which controls alternator functions on, off, regulation of high/low voltage, field current and output current.

AMMETER: The device for measuring current in amperes.

BRUSH: Device for conducting current to the slip rings of the rotor. It is a composite carbon block which includes a spring, lead and contact.

BRUSH HOLDER: Device that retains multiple brush assemblies and is comprised of a holder, contacts, and terminals.

CARBON PILE: Device used in testing. The carbon pile regulator is basically a large resistor that may be adjusted. It is formed of carbon granules, and its resistance is dependent on the pressure applied across the granules. Mechanical adjustment controls the pressure across the granules in such a way as to increase or decrease voltage (basic regulator).

CONTINUITY: The continuous path for the flow of current in an electrical circuit.

COOLING COVER: Device attached to the alternator to provide cooling air from an external source. May be provided with alternator or required by the airframe manufacturer. (Also known as the "Blast Tube", referring to ram air cooling source.)

EMI: Electro Magnetic Interference. A disturbance in the radio-frequency spectrum that is generated by an external source that affects electrical devices or circuits by electromagnetic induction, electrostatic coupling, or conduction.

FRONT HOUSING: Part of the external housing which contains the components of the alternator. This end has structure typically used for mounting. It may also be referred to as the Drive End Housing or D.E.

INSULATOR: Component that does not allow electricity to flow through it easily. Insulators do not allow electricity to flow through them easily because the electrons in their atoms do not move easily from atom to atom.

MULTIMETER: Device for the measurement of voltage, current, or resistance.

LEAKAGE: Dissipation of voltage or current from a component or connection.

OPEN: Electrical term for a complete disruption of a conductive path in an electrical circuit. Will read infinite resistance.

PEAK INVERSE VOLTAGE: (PIV) The maximum rated value of a AC voltage acting in the direction opposite to that in which a device is designed to pass current.

PHASE: The position of a point in time (instant) on a waveform cycle. A complete cycle is defined as 360 degrees of phase. Phase can also be an expression of relative displacement between or among waves having the same frequency. In our case the alternator is three phase or 120 degrees separation.

POLARIZE: To induce polarization i.e., the partial or complete polar separation of positive and negative electric charge in an electrical system.

REAR HOUSING: Part of the external housing which contains the components of the alternator. It may also be referred to as the Slip Ring End or S.R.E.

RECTIFIER: An electrical circuit used to convert AC into DC current. The rectifier is an arrangement of diodes that causes the current to flow in only one direction.

RFI: Radio Frequency Interference. Electromagnetic energy in the radio-frequency spectrum. Electrical interference may be created by poor slip ring/brush connection, defective rectifiers, or other poor connections. This is a normal by-product of electrical generators.

ROTOR: Rotating electro magnet used to create a magnetic field.

SLIP RING: Device which provides a sliding contact surface for the brush assemblies. The slip rings are smooth surface copper "rings" pressed onto the rotor shaft.

SHORT: Common term for a connection which has no or very little resistance as seen on an Ohmmeter in an electrical circuit. Typically an undesirable condition with respect to grounded elements.

STATOR: A stationary set of conductors wound in coils on an iron core.

TEST BENCH: Device so constructed as to allow testing of the alternator or component parts.

TERMINALS: Studs, screws or other devices that provide connections for electrical power.

THROUGH BOLT: Special bolts which connect front and rear alternator housings.

VOLT/OHM METER: Device for the measurement of voltage or resistance.

WOODRUFF KEY: Device used to capture the pulley or other drive device and aid in coupling torque from the power plant source to the alternator's rotating shaft. Normally half moon in shape.

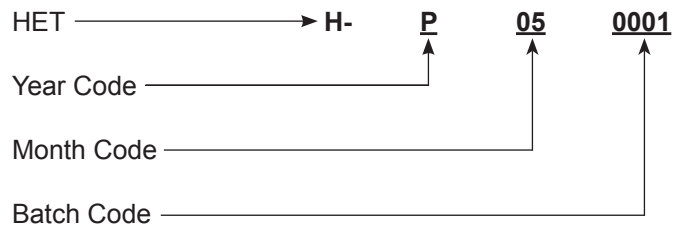
1.8 Disposal

- A. HET alternator assemblies are designed to allow for overhaul and re-use of many of the sub-assemblies and components.
 - (1) Disposal of unairworthy parts and assemblies as well as required replacement parts should be as follows:
 - a. Rejected parts should be tagged and scrapped per FAA requirements and parts deemed unairworthy must be rendered unusable prior to discard.
 - b. Rectifiers and PCB components may be considered hazardous waste and should be discarded whole through your local hazardous waste management system.

1.9 Model Identification

ES-6012-() Belt Driven (12 Volt) all
ES-6024-() Belt Driven (24 Volt) all
ES-7012-() Belt Driven (12 Volt) all
ES-7024-() Belt Driven (24 Volt) all

1.10 Serial number Identification



Example above: HET, 2015, May, first unit of the month (batch)
Year Code: O = 2014, P = 2015, Q = 2016, etc.

1.11 Warranties

- A. Hartzell Engine Technologies LLC (HET) offers a Limited warranty with each new alternator assembly or component (part) it sells through its distribution system. NO expressed or implied warranty exists when repairing, or replacing any assembly or component using this manual except as it may apply to a new HET replacement part purchased. If you suspect that any warranty applies to the alternator assembly, it must be returned through an authorized HET distributor in a manner prescribed by that specific distributor. The affected alternator must be received by the factory fully assembled and not altered in any way for disposition by HET warranty department. ***(Warranty shall be denied for any alternator received altered, modified, or disassembled.)***
- B. The HET Limited warranty policy in affect for your alternator is determined at the time of purchase. (As the Warranty policy is revised from time to time, you must download the policy in affect for your unit for specific terms and conditions should a warranty condition occur. Only the terms and conditions stated in the warranty at the time of purchase will apply. For warranty information, visit our website at <http://www.hartzell.aero/warranty>.

DESCRIPTION OF OPERATION

2.0 GENERAL

- A. Hartzell Engine Technologies (HET) belt driven and gear driven alternators have been designed and constructed to provide extended periods of trouble-free operation with a minimum amount of maintenance. They are designed to provide a large electrical load variation and are intended to withstand normal vibration and temperature changes encountered in aircraft applications.

2.1 BASIC COMPONENT DESCRIPTION

- A. The principle components of the aircraft alternators described herein are the slip ring end housing assembly with bearing, the rectifier assembly, the stator, the rotor, the drive end housing assembly with bearing and the brush holder assembly with spring and brushes.
- B. A simplified electrical diagram is shown in Figure 2.1 which shows the basic electrical operating points and connections.

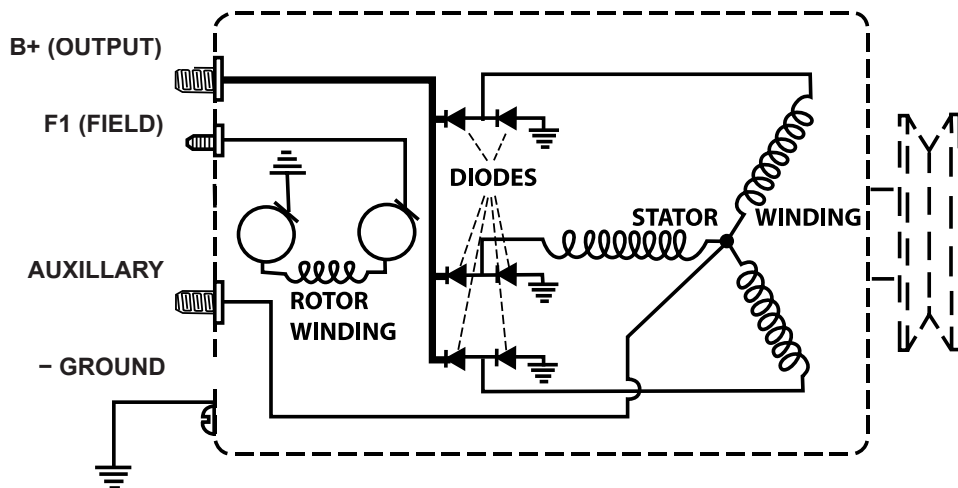


Figure 2.1
Alternator Simplified Electrical Diagram, Wye Connected Stator

2.2 TECHNICAL PURPOSE

- A. The purpose of the alternator is to produce electrical energy. This energy is used to maintain the proper state of charge in the battery and supply current to the electrically powered equipment and accessories in the aircraft. It performs this function by converting mechanical energy derived from its rotating parts into electricity.
- (1) The BATTERY is the source of electrical power whenever the BAT Master Switch is ON and is the source of power for starting the aircraft. Once started, the alternator becomes the electrical power source whenever the engine is running and the ALT Switch is turned ON. (Control systems may vary with each aircraft/rotorcraft.)

2.3 PHYSICAL DETAIL

- A. The brush holder assembly consists of a brush holder housing and two brush assemblies. The brush assemblies are made from a carbon-graphite brush having a flexible braided copper wire lead fitted to a coil spring. Each brush is electrically connected to a separate terminal stud mounted in the brush holder housing. These studs are the F1 and F2 terminals. The brush holder assembly is mounted in the SRE housing in a position and manner that allows one brush to ride on each ring providing for a continuous sliding electrical connection while the rotor spins.
- B. The rotor assembly is composed of a shaft, two pole-shoes, a coil assembly and a slip ring assembly. The coil assembly is a simple enameled-wire coil wound on a bobbin form. The coil is fitted between two iron pole-shoes which serve as magnetic flux guides. The rotor shaft is pressed through the pole-shoes forming a heavy interference fit making a permanent assembly fixing the poles in place on the shaft. The slip ring assembly is composed of two copper rings mounted on a non-metallic, insulating hub. The hub is fixed to the rotor shaft with one ring electrically connected to each end of the coil assembly winding.

- C. The stator assembly is formed by winding three separate coils of enameled copper wire on a common laminated iron core. The coils are symmetrically spaced around the core and overlap one another. Slot insulators are used to protect the windings from abrasion damage due to contact with the core. For Wye-connected stators, one end of each coil is joined in a common connection. The opposite ends of each coil remain free, resulting in four coil leads emanating from the stator assembly. These leads are electrically connected to the bridge rectifier network.

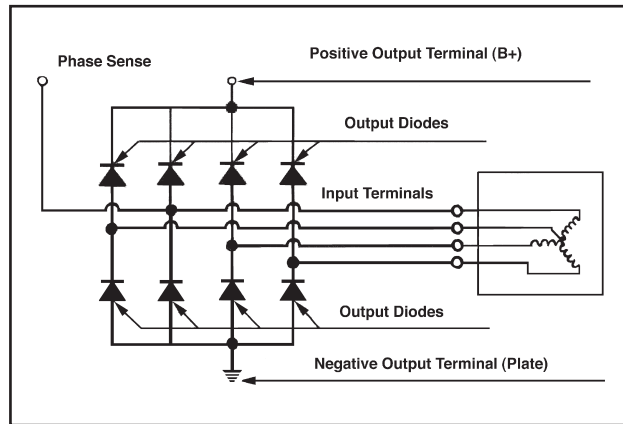


Figure 2.2 Stator Wiring Diagram (Typical).

- D. The auxiliary terminal is electrically isolated from but mechanically mounted to the heat sink and SRE housing. It is electrically connected to one end of one stator winding and provides an electrical voltage signal that varies in a sinusoidal manner with frequency changing directly with speed.
- E. A full-wave bridge rectifier is formed from discrete positive and negative diodes mounted within the alternator. The positive rectifiers are installed in a crescent-shaped aluminum heat sink. The mechanical connection between the rectifier casings and the heat sink forms the positive electrical connection for the bridge leaving the heat-sink electrically energized. As such, the heat sink is mounted in a manner that keeps it electrically isolated from the alternator housings. The alternator's battery terminal (B+) is mechanically and electrically connected to the heat sink. The negative rectifiers are installed in the SRE housing, which also acts as a heat sink. The mechanical connection between the rectifier casings and the housing forms the ground electrical connection for the bridge. The alternator's ground terminal is mechanically and electrically connected to the SRE housing.

2.3 PHYSICAL DETAIL (cont'd)

- F. The rotor assembly is supported by bearings at either end allowing the rotor to spin freely. The bearings are mounted in the DE and SRE housings. The stator assembly is so arranged within the DE and SRE housings as to align concentrically with the rotor assembly. The laminated iron core of the stator assembly surrounds the pole-shoes of the rotor assembly. The slip rings align with the brushes so as to allow one brush to contact one ring. See Figure 2.3.
- G. Most models feature an electrical filter designed to minimize EMI and RFI noise. This filter is a conventional metal case capacitor with an integrated mounting tab.

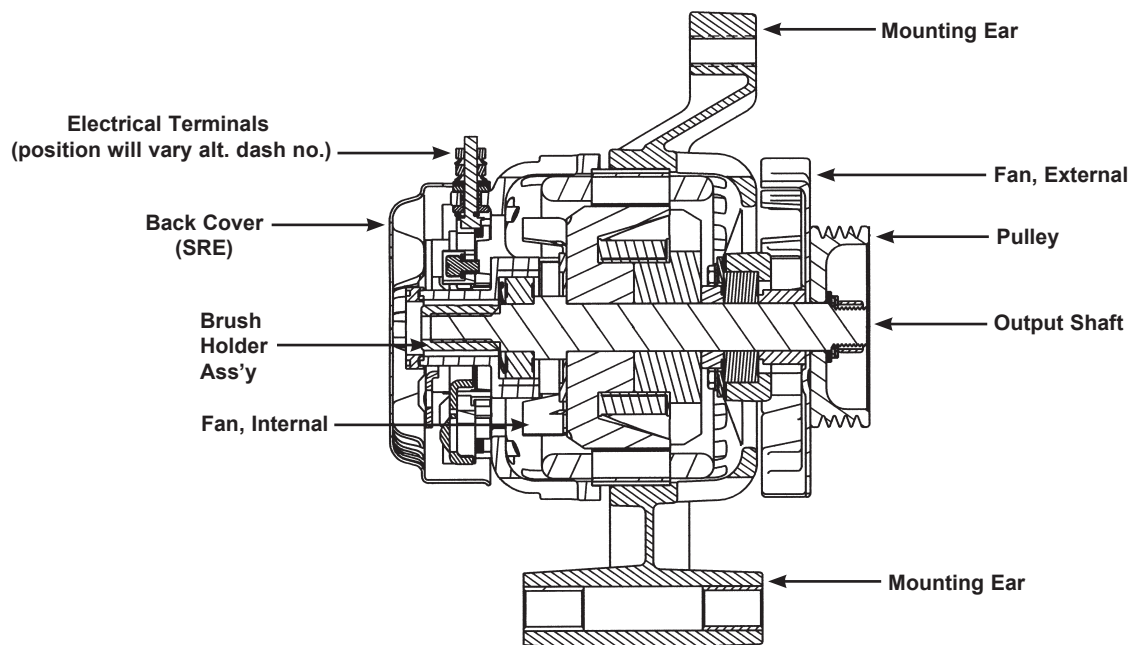


Fig. 2.3 - Typical Alternator Cutaway (Basic Components)

2.4 THEORY OF OPERATION

- A. Power to drive the alternator is derived from the aircraft powerplant by means of a belt for belt-driven type alternators and by means of a gear for direct-driven type alternators. Torque is transmitted through the drive to the alternator rotor shaft resulting in rotor rotation.
- B. During operation, the F1 terminal is electrically excited by an external voltage regulator (customer supplied). The F2 terminal is either electrically connected to the SRE housing (ground) internal to the alternator, externally at the alternator, or remotely by means of the aircraft electrical system. As current flows through the rotor coil a magnetic field is created with lines of flux being concentrated between the pole-shoe fingers. As the rotor turns these lines of flux are swept over the stationary stator coil windings inducing an alternating current flow within them. This three-phase alternating current is conducted to the bridge rectifier circuit which converts the alternating current to direct current. This rectified, DC current is made available to external loads via the B+ terminal.

2.5 Self Excitation Description

A. The HET alternator models referred to in this manual do not incorporate self-excitation.

2.6 OPERATIONAL DATA

Alternator Model	ES-6012	ES-6024	ES-7012	ES-7024
Drive Type	Belt	Belt	Belt	Belt
Cooling	Fan, Internal/Ext.	Fan, Internal/Ext.	Fan, Internal/Ext.	Fan, Internal/Ext.
Temp Range (F)	up to +240° F	up to +240° F	up to +240° F	up to +240° F
Temp Range (C)	up to + 116° C	up to + 116° C	up to + 116° C	up to + 116° C
Min Regulation Speed	1,500 RPM	2,800 RPM	1,500 RPM	2,800 RPM
Max Continuous Speed	10,000 RPM	10,000 RPM	10,000 RPM	10,000 RPM
Voltage, Bus	12 volt	24 volt	12 volt	24 volt
Voltage, Rated	14 volt	28 volt	14 volt	28 volt
Current, Rated	60 Amp	60 Amp	70 Amp	70 Amp
Rated Altitude (feet)	35,000 feet MSL	35,000 feet MSL	35,000 feet MSL	35,000 feet MSL
Rated Altitude (meter)	10,668 meters MSL	10,668 meters MSL	10,668 meters MSL	10,668 meters MS
Weight (lbs / kgs)	7.6 lbs (3.72 kgs) ea.	7.6 lbs (3.72 kgs) ea.	7.75 lbs (3.78 kgs) ea.	7.5 lbs (3.22 kgs) ea.
Field Type	(F1)	(F1)	(F1)	(F1)
Filter Type	Capacitor; 10 µF	Capacitor; 10 µF	Capacitor; 10 µF	Capacitor; 10 µF
Field Resistance	2.8-2.9 ohm 25° C	5.9-6.4 ohm 25° C	2.8-2.9 ohm 25° C	5.9-6.4 ohm 25° C
Belt Tension, Max	See Table 6.2	See Table 6.2	See Table 6.2	See Table 6.2

Table 2.1 - Operational Specifications

2.7 APPEARANCE

A. Features - ES-6012- () & ES-6024- ()

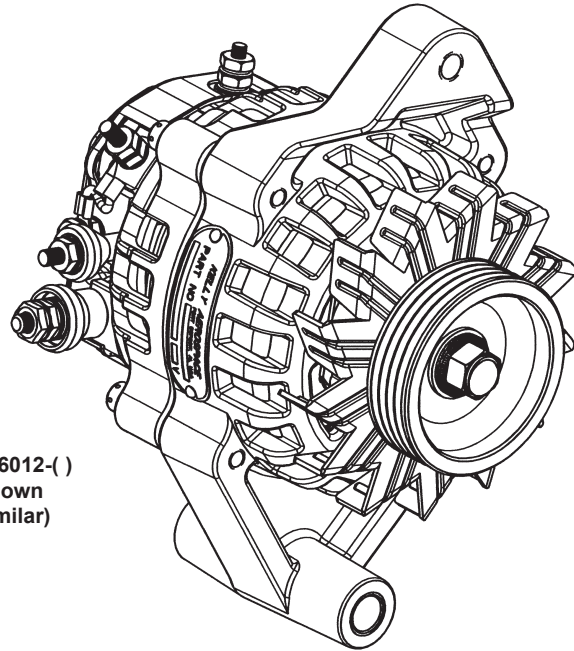


Figure 2.4a - ES-6012-()
Front View Shown
(ES-6024-() similar)

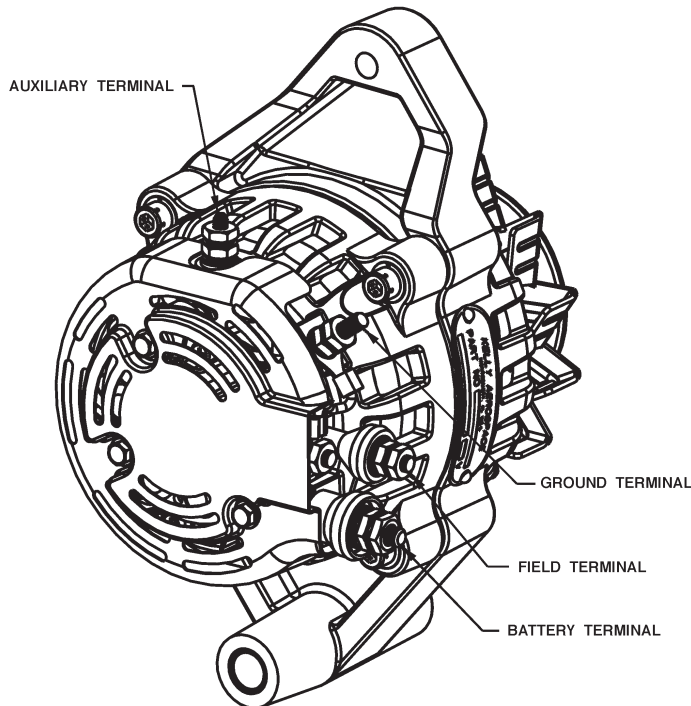


Figure 2.4b - ES-6012-()
Rear View Shown
(ES-6024-() similar)

B. Features - ES-7012- () & ES-7024- ()

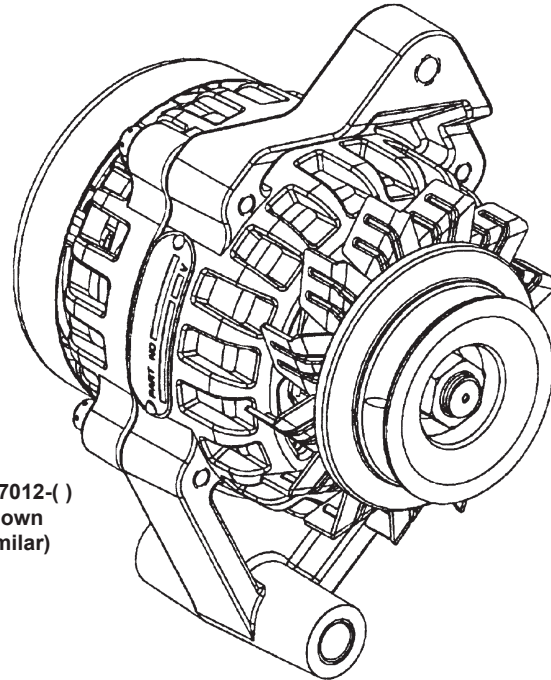


Figure 2.5a - ES-7012- ()
Front View Shown
(ES-7024- () similar)

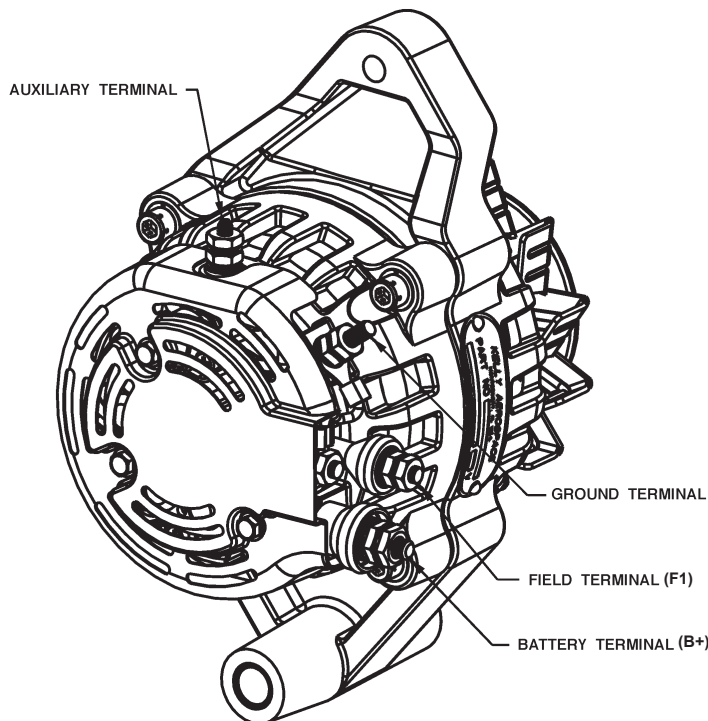


Figure 2.5b - ES-7012- ()
Rear View Shown
(ES-7024- () similar)

TROUBLESHOOTING

3.0 General

- A. In the event of malfunction in electrical power, it should not be assumed to be an alternator fault before employing proper troubleshooting procedures. The overall objective of troubleshooting is to find the cause of trouble and take corrective action to prevent a recurrence. Even perfectly operational alternators cannot compensate for improper adjustments, corroded or worn parts, and improper installation or lack of maintenance.
- B. This section provides general troubleshooting procedures for the alternator assembly for unscheduled maintenance and for possible fault detection prior to maintenance activity. It gives procedures to follow to determine the best course of action prior to disassembly. Block type troubleshooting charts are also provided. Upon determination of fault(s), refer to the TESTING (section 6) for applicable test procedure(s).

3.1 Procedure

WARNING:

WHEN SERVICING, REPAIRING, OR OVERHAULING THE ALTERNATOR, GREAT CARE AND CAUTION MUST BE TAKEN TO AVOID HAZARDOUS SITUATIONS. THE ALTERNATOR WHEN MOUNTED ON AN AIRCRAFT OR ROTORCRAFT, PRESENT A PHYSICAL HAZARD FROM PROPELLERS, ROTORS AND OTHER ROTATING DEVICES. THE ALTERNATOR PRODUCES A HIGH ELECTRICAL CURRENT OUTPUT AND ALSO PRESENTS AN ELECTRICAL SHOCK HAZARD, THAT CAN RESULT IN SERIOUS INJURY IF PROCEDURES IN THIS MANUAL OR THE AIRCRAFT/ROTORCRAFT SERVICE MANUALS ARE NOT FOLLOWED.

Note:

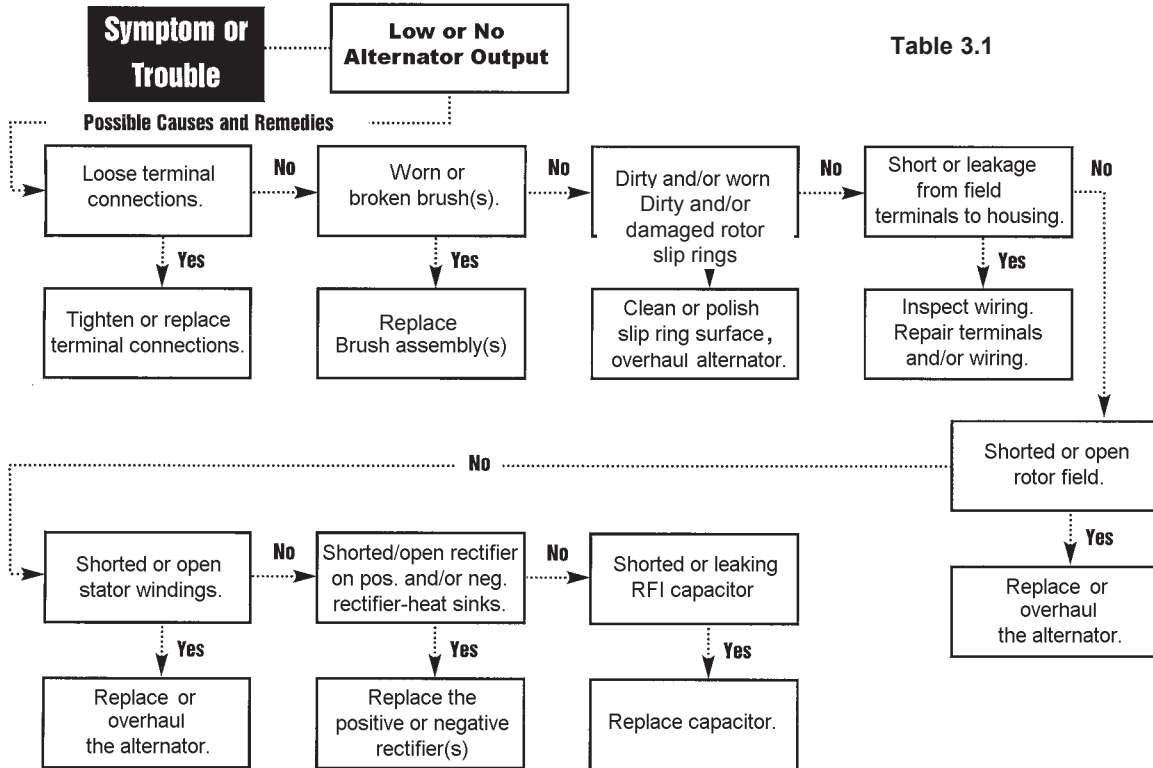
It is required to reference the aircraft or rotorcraft AFM or POH as well as the applicable service or maintenance manual as required.

- A. The Charts on the following pages represent six main areas of trouble in an alternator. Choose the applicable symptom and follow the trouble shooting flow-chart. Below each chart is a discussion of each point.

- 3.1. Low or No Output.
- 3.2. Battery is Discharged.
- 3.3. Battery is Overcharged.
- 3.4. Noisy in Operation (acoustic).
- 3.5. Noisy in Operation (electrical).
- 3.6. Ammeter or Lights Flicker.

3.2 Troubleshooting Charts

Troubleshooting - Low/No Alternator Output



Loose terminal connections: Inspect the terminals, if they will tighten, do so, if not the alternator may need to be disassembled to replace studs or receptacles. Also observe the wire terminal ends to assure they are crimped properly on the wire with no corrosion or burns present. If disassembly is required, replace or overhaul alternator.

Worn or broken brushes: Remove and examine brush material, spring, and leads. If spring is broken or the lead is coming out of brush, or if brush is chipped or worn past 50% replace brush.

Dirty or damaged rotor slip rings: Slip rings may be contaminated with oil or grease. **Note:** it is normal for a dark layer of brush material to be present on the slip rings. Clean slip rings only if contaminated with substance other than brush material. In the event of contamination, also replace the brushes. Take care not to scratch the surface. If the slip rings are damaged, replace or overhaul alternator (see section 6).

Short or leakage from field terminals to housing: Unless it is determined the wire terminal is shorting to the housing, replace the field terminals and insulators. If disassembly is required, replace or overhaul alternator.

Shorted or open rotor field: Perform the tests for rotors as found in section 6. Rotor removal may be required to verify the symptom. Replace or overhaul alternator (no repairs allowed on rotors).

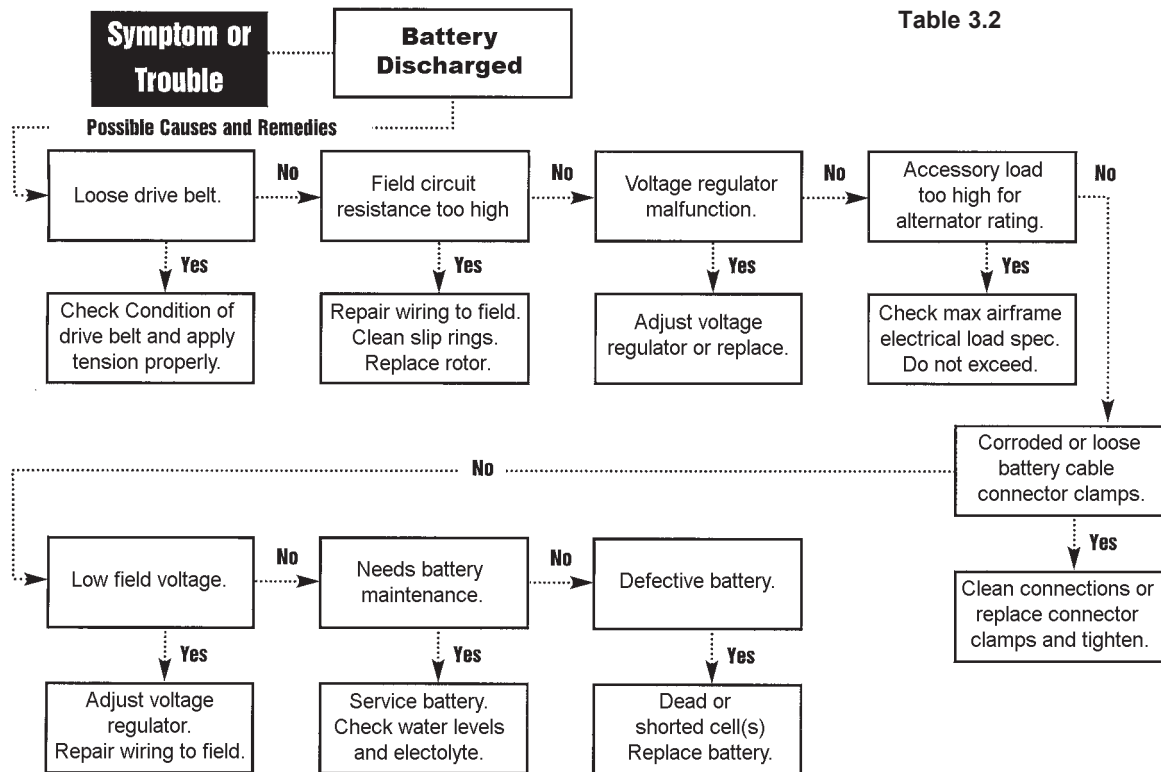
Shorted or open stator windings: Perform the alternator tests found in section 6. Stator removal may be required to verify the symptom. Replace or overhaul alternator if failed (no repairs allowed on stators).

Shorted or open rectifier on heat sinks: Perform the tests for rectifiers (positive and negative) as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

Shorted or leaking RFI capacitor (airframe, engine, HET external filter): Remove capacitor and perform capacitance check and wire lead to case resistance check. Replace filter capacitor if failed (external filter only). If an internal PCB type filter, replace or overhaul alternator if failed.

3.2 Troubleshooting Charts (cont'd)

Troubleshooting - Battery Discharged



Drive Belt slipping: Inspect the condition of the pulley belt. (as applicable) The belt is supplied by the engine manufacturer. Improper tension supplied on the belt may allow slippage during high alternator output.

Field circuit resistance too high: Check wiring and terminal ends and repair as necessary. Check condition of the slip rings and clean. Check rotors as found in section 6 and if failed, replace or overhaul alternator.

Voltage regulator malfunction: Check the voltage regulator per the aircraft service manual and adjust if necessary. If adjustment is not possible, check wiring and replace voltage regulator.

Accessory load too high for alternator rating: Refer to the AFM or POH (and aircraft service manual) for the maximum allowable load specification. Reduce electrical load to meet these limitations.

Corroded or loose battery cable connector clamps: If connections to the battery are corroded, disconnect and clean. Clean battery posts or terminals. If aluminum cable is installed, make sure that corrosion has not spread under the insulation. If severe, replace cables or clamps. Tighten battery connections.

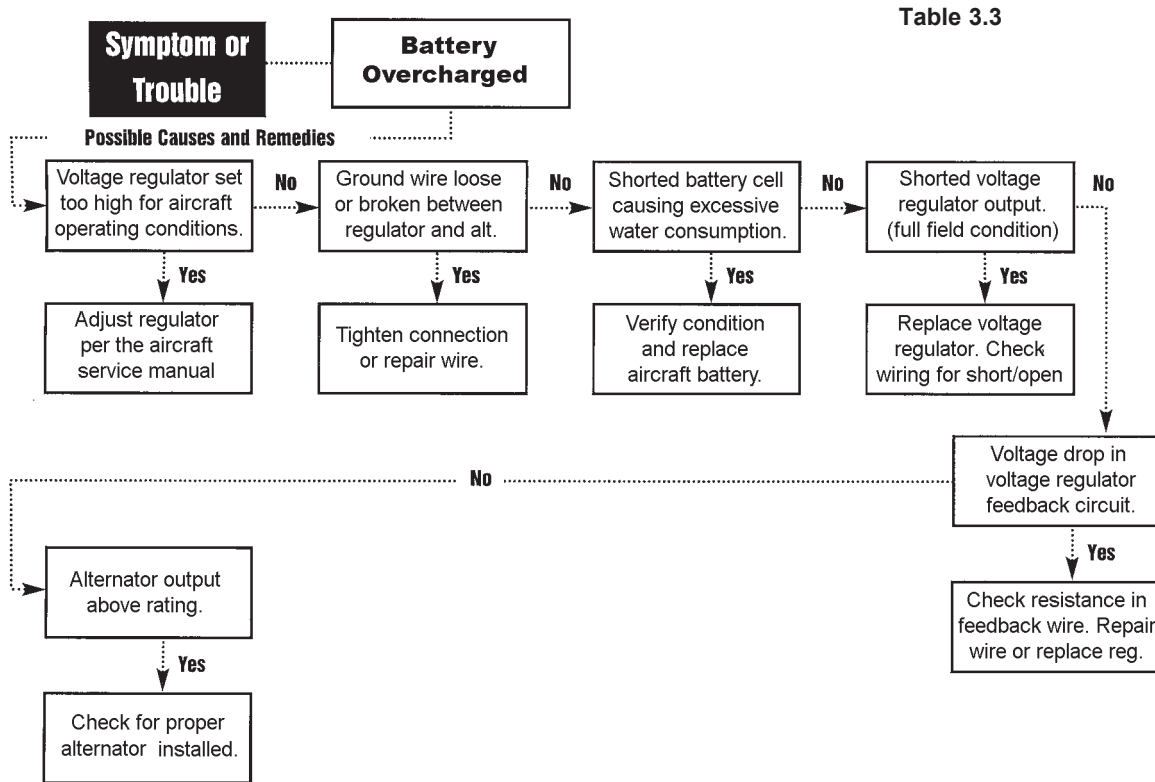
Low field voltage: Check the voltage regulator per the aircraft service manual and adjust if necessary. If adjustment is not possible, check wiring and replace voltage regulator.

Needs battery maintenance: Perform normal battery maintenance. Check water level and electrolyte condition, service per the aircraft service manual.

Failed battery: Determine battery age and check for expected life. If near or beyond normal life, replace battery. If battery discharges frequently, check for dead or shorted cells, if found replace battery.

3.2 Troubleshooting Charts (cont'd)

Troubleshooting - Battery Overcharged



Voltage regulator set too high for aircraft operating conditions: Check the voltage regulator setting per the aircraft service manual. Adjust if necessary. If adjustment is not possible, check the wiring harness before replacing the voltage regulator.

Ground wire loose or broken between regulator and alternator: If wire is broken, make sure there is adequate strain relief and clear chaffing areas. Repair or replace wire. If loose, tighten connection.

Shorted cell in battery causing other cells to use water excessively: Remove and place battery on battery tester to verify the condition. Replace failed battery.

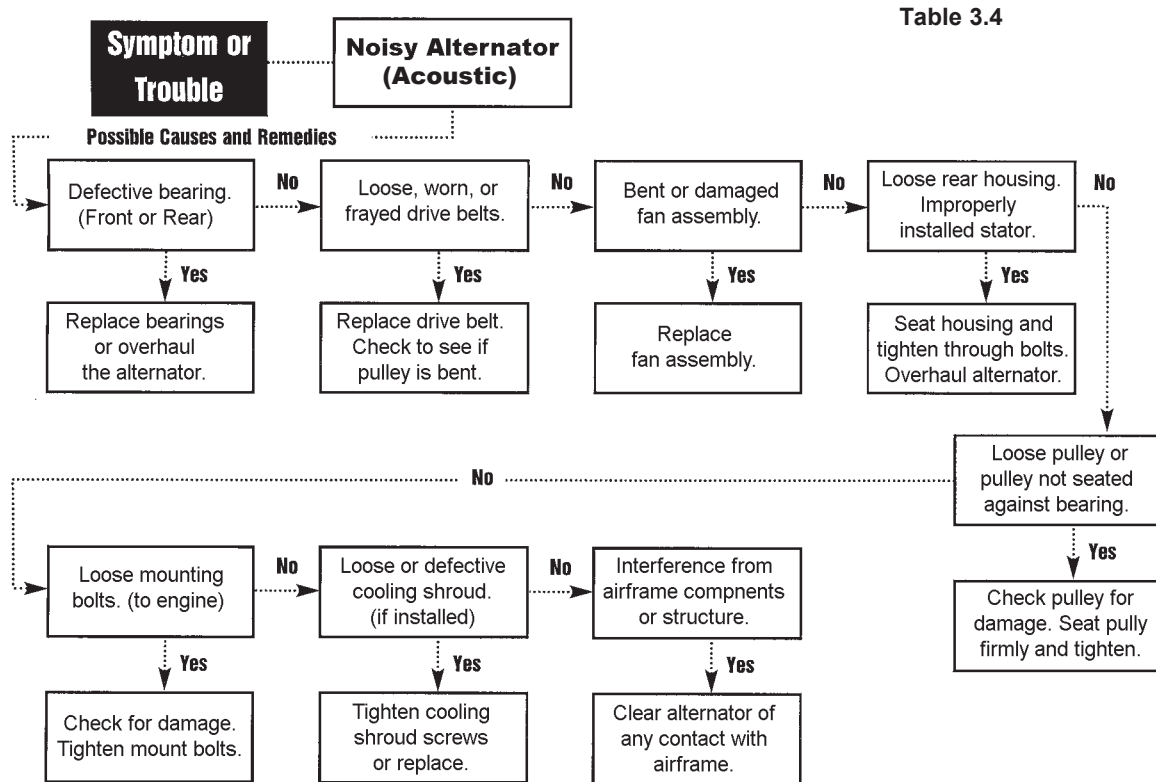
Shorted voltage regulator output - full field condition: Before replacing the voltage regulator, check wiring harness for shorts or open conditions. If harness is burnt or shows signs of overheating, replace harness. If wiring is good, replace voltage regulator.

Voltage drop in voltage regulator feedback circuit: The “feedback” line is commonly known as the sense line. Before replacing the voltage regulator, check sense line wire for resistive or short conditions. Check terminal connections, replace or repair wire if bad. If, wiring is good replace voltage regulator.

Alternator output above rating: As output is related to alternator speed, check that the proper alternator has been installed. Check airplane records to determine that the proper alternator model and rating is installed per the aircraft TC or STC.

3.2 Troubleshooting Charts (cont'd)

Troubleshooting - Noisy Alternator



Failed bearing: To perform a test for failed bearings, hold the alternator in one hand and snap-spin the shaft with the other. A failed bearing will be heard or felt. Replace the bearing by overhaul or replacement of the alternator.

Drive Belt slippage: Inspect the condition of the pulley belt. (as applicable) The belt is supplied by the engine manufacturer. Improper tension supplied on the belt may allow slippage during high alternator output.

Foreign object in cooling duct: Check the duct length and the inlet of the alternator to see if debris have entered the alternator and are rubbing internally or vibrating in the duct.

Loose rear housing or improperly installed stator: Examine through bolts, if loose and distorted or severe “smoking” or black areas appear at the head of the bolt, the alternator should be overhauled or replaced.

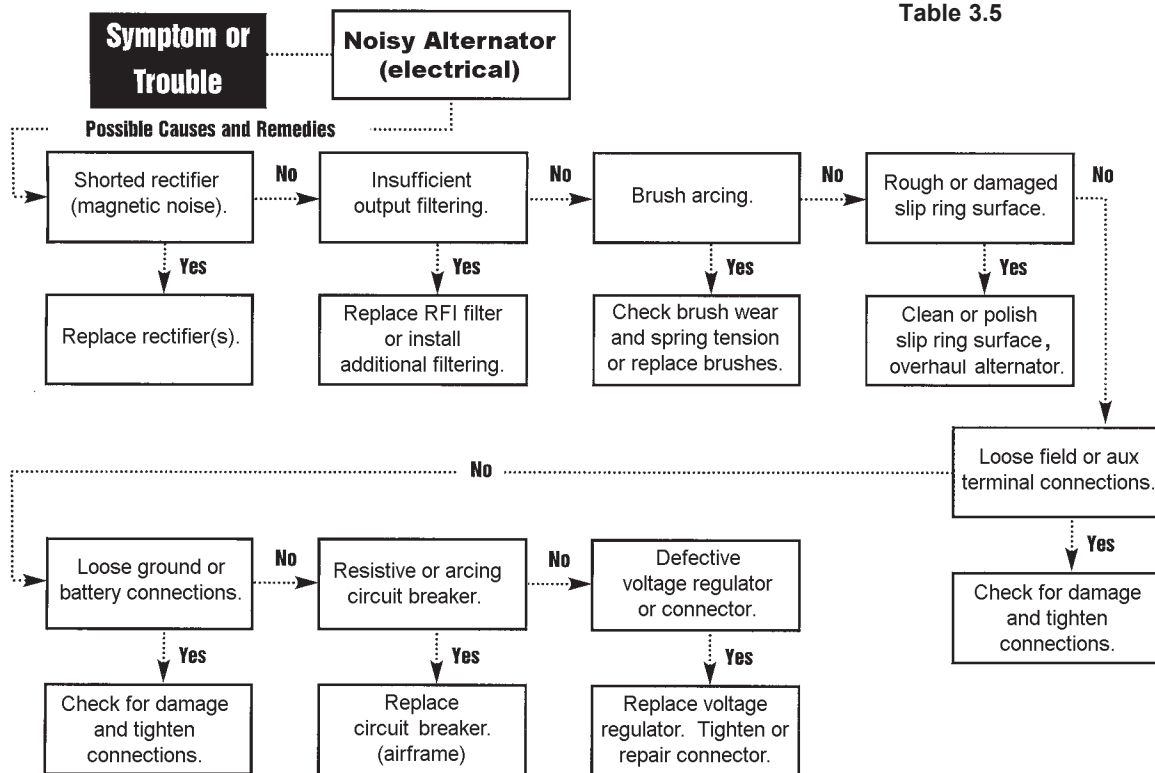
Loose mounting bolts: Inspect mount points for damage and if found overhaul the alternator. If not, re-torque mounting bolts per the engine or aircraft service manual.

Loose cooling duct connection: If cooling duct is installed improperly (normally an airframe component), adjust and tighten the mounting connection (as applicable). Check and clear any interference with the airframe structure.

Interference from airframe components or structure: Examine the alternator and large electrical cables for contact or chaffing on airframe structure. Check and clear any interference areas.

3.2 Troubleshooting Charts (cont'd)

Troubleshooting - Noisy Alternator



Shorted rectifier (magnetic noise): Perform the tests for rectifiers as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

Insufficient output filtering: Remove brush holder and inspect brush holder capacitor for damage and capacitance.

Brush arcing: Remove and examine brush material, spring, and leads. If spring is broken or the lead is coming out of brush, or if brush is chipped or worn past 50% replace brush. Examine slip ring surface for condition.

Rough or damaged slip ring surface: Inspect slip rings for damage either out of round or surface scratches and/or pitting. If found, replace alternator (see section 6).

Loose field or aux terminal connections: Check terminal connections for damage. Provide adequate strain relief to the wiring and tighten terminals properly.

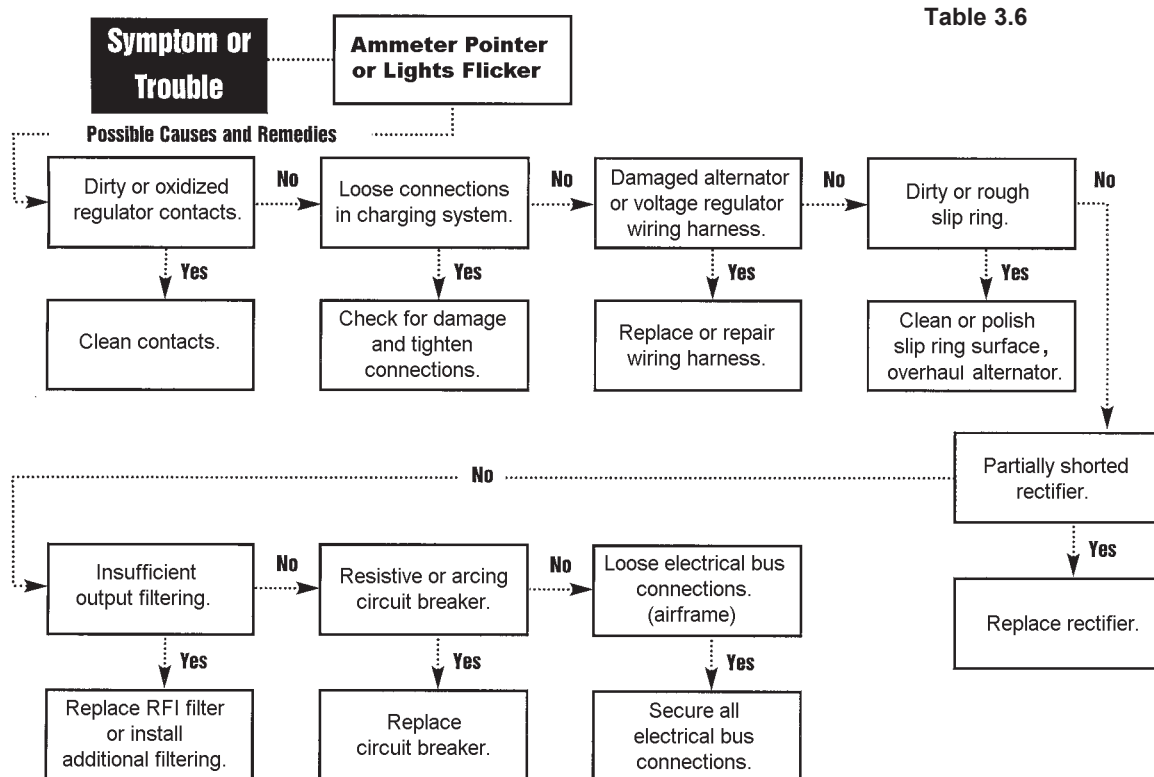
Loose ground or battery connections: Check ground and battery connections for damage. Provide adequate strain relief to the cables and tighten properly. (See engine or aircraft service manuals.)

Resistive or arcing circuit breaker: Make a resistance check of the circuit breaker, essentially, there should be no resistance. Check breaker function. Old circuit breakers should be replaced.

Failed voltage regulator or connector: Check to see if the regulator connector is attached properly. Remove and examine connector. Look for arcing or overheating. Check wiring harness and replace the voltage regulator if failed.

3.2 Troubleshooting Charts (cont'd)

Troubleshooting - Ammeter Pointer or Lights Flicker



Dirty or oxidized regulator contacts: Inspect both the male and female connector contacts. Clean using an aviation quality contact cleaner. For circuit board edge contacts, first use a pencil eraser on the edge followed by contact spray cleaner.

Loose connections in charging system or damaged wiring harness: Inspect the terminals, if they will tighten, do so. Also observe the wire terminal ends to assure they are crimped properly on the wire and no corrosion or burns are present. Check harness from end to end and repair any damaged wiring.

Damaged alternator or voltage regulator wiring harness: Check wiring harness for damage and repair. If damage is found, check voltage regulator for function and replace if necessary.

Dirty or rough rotor slip rings: If dirty, the slip rings may be cleaned. Take care not to scratch the surface. If the slip rings are worn beyond limits, replace or overhaul alternator (see section 6).

Partially shorted rectifier: Perform the tests for rectifiers as found in section 6. Disassembly may be required to verify symptom. Replace or overhaul alternator.

Insufficient output filtering: Remove brush holder and inspect brush holder capacitor for damage and capacitance.

Resistive or arcing circuit breaker: Make a resistance check of the circuit breaker, essentially, there should be no resistance. Check breaker function. Old circuit breakers should be replaced.

Loose electrical bus connections: Check aircraft electrical bus for loose wire connections. Tighten or repair as required.

3.3 Alternator Belt Troubleshooting

- A. Although the alternator belt is provided by the airframe or engine manufacturer and those manufacturers normally issue manuals or instructions regarding their maintenance, the belt is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the belt is offered here to prevent mis-diagnosis of what may seem to be an alternator fault.
- B. Hartzell Engine Technologies new or overhauled alternators using belt drives are designed for two basic types of belts via custom pulley installations. The most common type is the single smooth V belt (large and small width) and the Poly-V belt type which has multi-V grooves but is nearly flat. The basic function of these belts (either type) is to transfer rotational energy produced by the engine to various accessories that are needed for the aircraft.
- C. The belt system or “drive” may be simple, running from the engine drive sheave to an alternator or it might be complex picking up alternator, A/C compressor, hydraulic pump, or idler pulleys. Belt drives are efficient and safe; however, the more complex the configuration, the more difficult it is to align the “drive”. This troubleshooting will provide insight into both sound and visual inspection practices to identify a belt condition before moving on to the alternator or other component.
- D. If an alternator is determined to be at fault, note that HET sells alternators with or without a pulley due to the desire of engine and airframe manufacturers to use their own custom pulley and belt arrangements. The HET alternator designated as delivered without a pulley may have an “LS” suffix. Other HET series alternators are delivered with varied size and type pulleys and are designated with a unique dash number suffix.
- E. Unusual belt condition, low belt tension, belt contamination, and belt vibration are other sources of belt noise. A screech or squeal that occurs when starting or increasing engine RPM rapidly typically indicates a lack of tension so check belt tension. A tapping or grinding sound caused by debris imbedded in the drive side of the belt can be the cause and should be checked. Grinding noise can result from worn or damaged bearings which must be replaced (overhaul or replace alternator). This will eliminate the bearing noise and possible damage to the alternator. Acoustic noise from vibration can develop over time as drive components such as pulleys and spring tensioners (if used) wear beyond tolerance, as bearings wear, or as belts wear and stretch allowing brackets and attachments to loosen.
- F. Specific belt noises may give clues to misalignment conditions. Noises can occur in both single V type and Poly-V type belts. The belt is less likely to generate misalignment noise when in new condition. As a belt wears, it will develop a smooth, glossy surface which will increase the possibility of noise. A wear condition will be accelerated if misalignment exists between any of the pulleys in the drive system.
- G. A drive misalignment will make a “Chirp” noise in both the common V belt and the flat Poly-V belt. This is caused by entry of the belt contact surface into the pulley as the V(s) seat into the pulley groove there still be a chirp that is not repeated as the belt exits. The angle between belt surface and pulley is the critical factor responsible for causing the “chirp” from a misalignment. Misalignment angle can result from many different combinations of pulley positions. An in or out “positioning” error and/or an angular “tilting” error are two typical examples.

3.3 Alternator Belt Troubleshooting (cont'd)

- H. Misalignment noise is most likely to occur on the shortest span in a drive system, such as between two adjacent accessory pulleys. Proper pulley alignment is particularly critical in these locations. The common V belt pulley has a generally large groove while the nearly flat multi-groove pulley has very small grooves guiding the belt both can have considerable misalignment and create the same noises.
- I. Misalignment noise is generally loudest at idle speed and diminishes with increasing engine rpm, often vanishing higher RPM's. The presence of high humidity (or a wet belt) often increases the likelihood for misalignment noise to occur.
- J. Whenever the pilot witnesses belt noise, it is important to determine the type of noise and under what circumstances it occurs. Repairing a drive misalignment (chirp) is not likely to resolve a slip noise (squeal) that may be caused by insufficient tension.
 - (1) Check if the problem is more noticeable when starting and while the engine is cool (cool wet belt).
 - (2) Is the noise loudest at idle speed, or when accelerating the engine RPM (rapid changes in RPM speed can cause a belt to slip).
 - (3) Try to recreate the problem in the maintenance run area. If the noise is heard, use a spray bottle or other source of misting water and mist the belt lightly. If the noise level recedes or goes away for several seconds, then returns, the problem is most likely misalignment.
 - (4) If the noise immediately increases after the belt is sprayed, slipping is likely.
 - (5) If the water spray test is inconclusive and the noise remains unchanged, the problem is not likely related to drive alignment.

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CHECK

4.0 General

- A. This section defines the various checks and inspections to assure reliable and safe operation of the alternator while in service. They are listed in hours time in service (TIS) or in calendar time, whichever is applicable and are the first to occur when offered a choice. Some maintenance is one time initial and others are recurring.
- B. HET recommended maintenance and checks including TIS may be superseded by the aircraft or engine manufacturer's established time limits and schedules based on experience and/or unique requirements under engine or airframe Type Certificate.

4.1 Inspection Checks

- A. 100 Hours TIS and each 100 hours thereafter. (or each annual/event, the first to occur)**
 - (1) Perform a check of the alternator assembly. Note through bolt security and proper safety wire application and re-torque bolts if found loose.
 - (2) Check the alternator to engine mounting bolts for proper torque per aircraft, rotorcraft and/or engine service instructions or maintenance manual.
 - (3) Inspect area around the brush holder for soot. If a large amount of soot appears, remove brush holder and check for wear or damaged brushes.
 - (4) If wear has occurred, check slip rings for gouges or scratches.
 - (5) Check electrical terminal hardware for tightness and insulators for condition.
- B. 500 Hours TIS and each 500 hours thereafter. (or each two years, the first to occur)**
 - (1) Remove brush holder and check each brush for wear or damage. If brush shows more than 50% wear or has chips or damage, replace brushes (brushes must be replaced as a set only). New brushes are 0.50 inch (12.7 mm) long.
 - (2) With the alternator removed, inspect belt and belt drive line components. Adjust belt tension to proper values per engine/aircraft service instructions or maintenance manual.
 - (3) Examine the alternator terminal insulators and replace if cracked, deformed, or indications of thermal distress are observed.
 - (4) Inspect the aluminum housings for surface corrosion, clean as necessary.
 - (5) Inspect the housings for cracks around the through bolt holes and ears. Replace the housings if necessary.
- C. TBO concurrent with engine TBO**
 - (1) Overhaul or replacement is based on the condition of the alternator but shall not exceed 12 (twelve) calendar years regardless of operating time in service. (Calendar time is based on original manufacture date indicated by serial number or if overhauled, calendar time is based from documented overhaul certification date.)
Overhaul time may vary based on cooling, electrical load, and general service. When published, the aircraft OEM TBO shall supersede this HET recommendation.

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INSPECTION AND TESTING

5.0 General

- A. This chapter outlines the tests and inspections required to determine the condition of the alternator removed for scheduled and unscheduled maintenance. Refer to the procedures given in the TROUBLESHOOTING Section prior to applying any test for maintenance.
- B. Where applicable, components called out this section will correspond to the item number listed in MAINTENANCE Section 6.

5.1 Testing

A. Equipment

(1) Standard tools

- Standard mechanic's handtools.
- Torque wrench ounce-inch (gram-centimeter).
- Torque wrench pound-foot (newton-meter).
- Safety gloves.
- Protective goggles (eye protection).
- Ear Plugs (hearing protection).
- Safety shoes.
- Protective cotton apron.
- Air compressor (shop air).

(2) Special tools

Standard and special tools used in this chapter are limited.

- Voltmeter (0 to 30 VDC)
- Ammeter, 0 to 100 Amp.
- Carbon Pile (or equivalent).
- Alternator test bench (12/24 volt, 0 - 100 A). (if removed to test)

(3) Instruments

- A multimeter, (Simpson 260 or Fluke 87) or equivalent (accuracy 1%).
- Optical tachometer.

B. Test conditions

- (1) Ambient temperature: 70 to 80 ° F (21 to 27 ° C).

5.1 Testing (cont'd)**C. Precautions**

Regular maintenance must be accomplished per this manual and per the applicable aircraft and/or engine service manuals and publications. In addition, observe the following precautions:

- (1) **DISCONNECT THE BATTERY** before connecting or disconnecting test instruments (except voltmeter), or before removing or replacing any unit or wiring. Accidental grounding or shorting at the regulator, alternator, ammeter or accessories, will cause severe damage to the units and/or wiring.
- (2) **DO NOT REMOVE THE OUTPUT LEAD.** The output lead must not be removed from the alternator while the rotor winding is energized and the alternator is operating.
- (4) **DO NOT GROUND THE OUTPUT TERMINAL.** Grounding of the alternator output terminal may damage the alternator and/or aircraft electrical circuit.
- (5) **DO NOT REVERSE BATTERY CONNECTIONS.** Reversed battery connections may damage the rectifiers, aircraft wiring or other components of the charging system. Battery polarity should be checked with a voltmeter before connecting the battery.
- (6) **ASSURE PROPER CONNECTIONS TO THE BATTERY.** If a booster-battery or fast-charger is used, its polarity must be connected correctly to prevent damage to the electrical system components.

5.2 Testing & Inspection

A. Arc Marks on Terminals (Visual Inspection):

- (1) Before removing the alternator, the threads and each terminal stud should be inspected for signs of arcing.
- (2) Arc marks are usually caused by a loose wire terminal connection resulting from failure to tighten the attaching nut.
- (3) Arc marks can also be caused by improper service techniques that permit wires to be connected and disconnected while current is flowing. A loose connection at the alternator output (battery) terminal can erode completely through the terminal stud over time.
- (4) Diode damage can occur because of the inductive voltage spikes generated by the make and break of loose terminal connections. The positive and negative rectifiers must be replaced at next alternator overhaul.
- (5) Voltage regulator and mechanical field relay damage can also be expected due to the chattering contacts each time the loose connection makes or breaks. Chattering contacts that are excessive will result in rapid contact erosion.
- (6) Solid state field relays will not be damaged, however they may generate electrical noise.

B. Bearing Inspection (For Troubleshooting Purposes):

- (1) A simple bearing test should be performed regardless of the reason for alternator removal from the engine. This may be done on or off the engine. The purpose of the test is to determine if either of the bearings are a potential for noise or failure.
- (2) To perform a test for worn bearings, disengage the belt or hold the alternator in one hand and snap-spin the shaft/pulley with the other. A worn bearing will be heard or felt. Snap-spin the shaft/pulley a few times to verify.
- (3) Grasp the drive component (pulley or coupling) and push-pull the shaft in a direction parallel to the axis. Movement should be small, less than .0062 inch (.1575 mm).
- (4) Grasp the drive component (pulley or coupling) and push-pull the shaft in a direction perpendicular to the axis. Movement should be small, less than .001 inch (.025 mm).
- (5) If either bearing sounds noisy, movement is not smooth, or excessive movement (axial or radial) is observed, the alternator should be sent for repair, overhaul, or replacement.

C. Field Circuit Open or Ground Test Procedure:

- (1) Using a multimeter on low range scale (0 to 25 ohm), connect one lead of ohmmeter to the Field terminal (orange insulator) and the other lead to ground terminal.
- (2) Spin the output shaft and note ohmmeter reading. Meter should read between 5.8 and 20 ohms (24v) or between 2.8 and 20 ohms (12v) while rotor is turning.
- (3) A reading lower than the above range indicates either a grounded field terminal or a failed rotor. Repair field or send alternator for repair, overhaul, or replacement.
- (4) A reading higher than 20 ohms indicates: either worn out or hung brushes, an open brush lead or a failed rotor.
- (5) Items (2) and (3) reading may be addressed by replacement of the brushes or the brush holder assembly. Refer to section 6.7 (Maintenance) for brushes.
- (6) Item (3 & 4) failed rotor requires overhaul or replacement of the alternator.

5.2 Testing & Inspection (cont'd)**D. Mounting Hardware:**

- (1) Inspect and replace any removed metallic hardware, i.e., screws, flat washers, nuts, shaft spacer, shaft woodruff key, etc., exhibiting damage, wear, corrosion, or distortion.
- (2) Hardware that will be reused shall be cleaned as required, using a non-corrosive chemical degreaser. Air-dry parts with filtered dry low pressure compressed air or wipe dry with clean, lint free cloth.

E. Insulators (Washers and Spacers):

- (1) Inspect parts for cracks, deformation, and burn marks.
- (2) Parts that are suitable for reuse shall be cleaned as required using isopropyl alcohol. Any other cleaner may damage insulators. Air-dry parts with filtered dry low pressure compressed air or wipe dry with clean, lint free cloth.
- (3) Cracked or faulty insulators require replacement or overhaul of the alternator as it must be disassembled to replace damaged parts.

F. Brush holder, Brushes and Springs:

- (1) Inspect orange flexible brush holder dust cover for condition.
- (2) Inspect brush holder for cracks or breaks and brushes for condition.
- (3) If (1) or (2) are damaged, discard and replace with new.
- (4) If brushes are worn or damaged in any way, replace brushes in pairs with new. Never attempt to replace a single brush.
- (5) New brushes are 0.50 inch (12.7 mm) long and must be replaced at 50% wear.

G. Pulley Run Out Check:**NOTE:**

A pulley runout check must be done with the pulley installed on the alternator. Consult the aircraft and/or engine maintenance manuals for procedures to perform the pulley runout check while on the aircraft engine. V-belt pulley assemblies for alternators in this manual must not exceed a runout of 0.008 inch on either axis. Do Not install alternator belt prior to checking pulley runout.

- (1) Place the alternator in a secure fixture but take care not to damage the alternator body using a vice or similar holding device. (May also be checked while mounted on the aircraft engine with belt removed if space permits.)
- (2) Install a dial indicator set up with the indicator measuring on the face of the installed pulley. Indicator must be capable of measuring 0.0005 inch or better.
- (3) Install a dial indicator set up with the indicator measuring on the edge of the installed pulley. Indicator must be capable of measuring 0.0005 inch or better.
- (4) Zero out the indicator and slowly rotate the pulley for each axis runout check.

5.3 Alternator Bench Testing

CAUTION

BEFORE BEGINNING THESE PROCEDURES, REFER TO AND OBSERVE THE PRECAUTIONS LISTED ON PAGE 5-2 OF THIS SECTION. BENCH TEST PROCEDURES MUST BE PERFORMED BY AN APPROPRIATELY RATED MECHANIC IN AN ADEQUATELY EQUIPPED FACILITY.

A. Alternator Output Test Conditions:

The preferred method of testing the alternator is by use of a commercially available alternator test bench (rated 24 volt, 0 - 100 A), however the procedures below are also considered adequate for testing purposes.

- (1) The alternator is to be at room temperature 70-80 degrees Fahrenheit (21-27 degrees Celsius) before beginning the test.
- (2) The alternator is to be connected so that it is supplying its own field current.
- (3) The output is to be controlled by an adjustable load.
- (4) The alternator is not to be run for longer than thirty (30) seconds for each test point.

B. Test Set Up:

- (1) Fabricate the test set up as shown in Figure 5.1.
- (2) This consists of a battery (24 volt DC, 150 ah min. or 12 volt DC, 40 ah min), common carbon pile, test voltmeter (0-28 VDC), test ammeter (0-100 amp), and an appropriate length of jumper wire.
- (3) Use an Optical tachometer to observe RPM (per manufacturers instruction).
- (4) Battery (-NEG) and the alternator case must share a common ground.

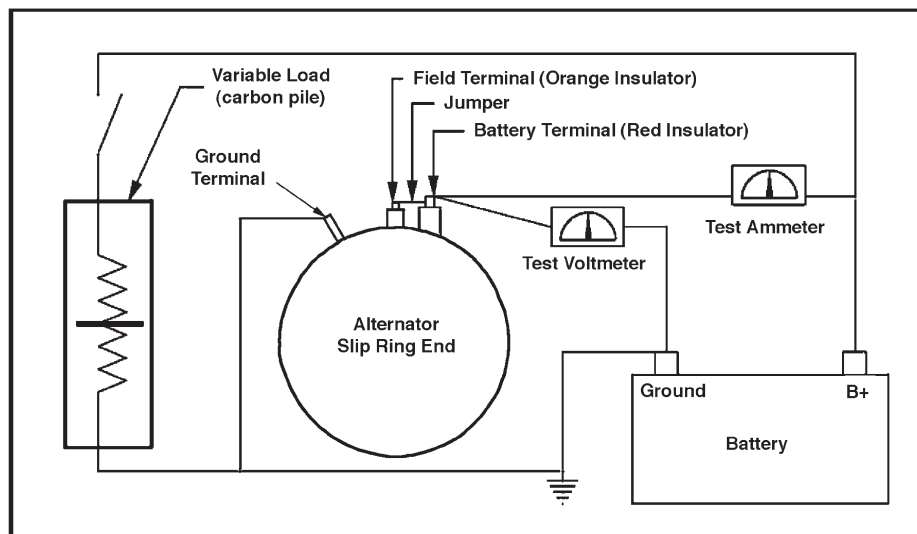


Figure 5.1 - Typical Bench Testing Set Up.

5.3 Alternator Bench Testing (cont'd)**C. Ventilation:****WARNING:**

ALTERNATORS REQUIRE A SOURCE OF VENTILATION. DO NOT TEST ALTERNATORS IN AN ENCLOSED SPACE AT FULLY RATED OUTPUT FOR MORE THAN 30 SECONDS UNLESS A COOLING AIR SOURCE IS SUPPLIED. FAILURE TO VENTILATE MAY CAUSE CATASTROPHIC ALTERNATOR AND EQUIPMENT DAMAGE WHICH MAY RESULT IN INJURY OR DEATH.

CAUTION:

OPERATING AN ALTERNATOR WITH THE FIELD (F1) TERMINAL CONNECTED TO THE B+ TERMINAL CAN RESULT IN VERY HIGH VOLTAGE OUTPUT (>100 VDC) WHICH MAY DAMAGE THE ALTERNATOR AND TEST EQUIPMENT.

NOTE:

Begin testing with the carbon pile adjusted to maximum electrical load which equates to minimum resistance.

D. Test Procedures:

- (1) Adjust the carbon pile, as necessary to obtain the specified voltage shown in Table 5.1, 5.2, 5.3, or 5.4.

CAUTION:

EXCEEDING THE BATTERY VOLTAGE RATING MAY DAMAGE THE BATTERY OR CAUSE AN EXPLOSION. THIS MAY RESULT IN INJURY, BURNS, AND/OR EQUIPMENT DAMAGE.

- (2) Apply power while observing the voltmeter, observe RPM using the optical tachometer and the output amps on the ammeter.
- (3) Vary the RPM while maintaining the specified voltage. Observe the amperage at each RPM. At each RPM, the Min. Output Amps must be achieved as specified in Table 5.1, 5.2, 5.3, or 5.4.
- (4) If alternator is to be reinstalled, refer to section 6.15 or 6.16 (Installation on Aircraft).

5.3 Alternator Bench Testing (cont'd)

E. Alternator Output Test Specifications (Without Regulator)

Table 5.1 - Output Test Specifications

Table 5.2 - Output Test Specifications

Table 5.3 - Output Test Specifications

Table 5.4 - Output Test Specifications

Table 5.1 - Alternator Series: ES-6012

Output Voltage	Min. Output Amps	Max Alternator RPM
12.5 ± .2 Vdc	16	2000 ± 50
12.5 ± .2 Vdc	54	5000 ± 50
12.5 ± .2 Vdc	60	7500 ± 50

Table 5.2 - Alternator Series: ES-6024

Output Voltage	Min. Output Amps	Max Alternator RPM
25.5 ± .2 Vdc	16	2550 ± 50
25.5 ± .2 Vdc	46	5000 ± 50
25.5 ± .2 Vdc	61	7500 ± 50

Table 5.3 - Alternator Series: ES-7012

Output Voltage	Min. Output Amps	Max Alternator RPM
12.5 ± .2 Vdc	15	2500 ± 50
12.5 ± .2 Vdc	65	8000 ± 50
12.5 ± .2 Vdc	70	10000 ± 50

Table 5.4 - Alternator Series: ES-7024

Output Voltage	Min. Output Amps	Max Alternator RPM
25.5 ± .2 Vdc	8	3000 ± 50
25.5 ± .2 Vdc	46	5000 ± 50
25.5 ± .2 Vdc	64	7500 ± 50

MAINTENANCE

6.0 General

- A. This section contains information regarding recommended maintenance for all alternators listed in this manual. These recommendations assure reliable and safe operation of the alternator while in service. Maintenance is listed in hours time-in-service (TIS) or calendar time, whichever is applicable and the first to occur. Some maintenance is one time initial and others are recurring. Refer to Chapter 4, "Check" for required inspections.
- B. HET recommended maintenance, checks and TIS may be superseded by the aircraft or engine manufacturers established time limits and schedules based on experience and/or unique requirements under it's Type Certificate or other certifications.

6.1 Periodic Maintenance

NOTE: The aircraft and/or engine manufacturers periodic or event checks are contained in the respective maintenance manual or service information.

- A. The electrical charging system should be inspected at regular intervals, the frequency of which should be determined by the type of service and the conditions under which the aircraft is operated. Since many airframe maintenance tasks will directly or indirectly affect alternator function, it is recommended that the aircraft manufacturers periodic inspection/maintenance be followed prior to or in conjunction with any HET prescribed alternator maintenance. These include:
 - (1) **Battery** - A battery condition and capacitance check.
 - (2) **Wiring** - An alternator circuit wiring and terminal condition check.
 - (3) **Belt tension** - Check belt tension. Low tension may cause low alternator output as it will slip under load. High tension may cause high bearing wear and mounting installations to fail. In either case the belt may break or come off the pulley.
 - (4) **Operation** - An operational check of the alternator after any maintenance is performed on the aircraft or engine electrical systems. Use the appropriate AFM, POH, service information or maintenance manual as applicable.

6.2 Torque Information

CAUTION: APPLYING TORQUE BEYOND THE VALUES SET IN TABLE 6.1 WILL SEVERELY DAMAGE THE ALTERNATOR. EXCEEDING THESE VALUES MAY REQUIRE OVERHAUL OR REPLACEMENT OF THE ALTERNATOR.

Table 6.1 - Torque Specifications

Reference	Description	Torque Value (US)	Torque Value (SI)
-	Pulley Nut***	55 +/- 5 ft-lbs	74.57 +/- 6.78 Nm
Fig. 6.1 **	Ground Nut*, bottom (top)	25-30 (20-25) in-lbs	2.82-3.39 (2.26-2.82) Nm
Fig. 6.1 **	Battery Nut*, bottom (top)	15-20 (20-25) in-lbs	1.69-2.26 (2.26-2.82) Nm
Fig. 6.1	Aux Nut*, bottom (top)	14-16 (20-30) in-lbs	1.58-1.81 (2.26-3.39) Nm
Fig. 6.2	Cover Bolts	20-25 in-lbs	2.26-2.82 Nm
Fig. 6.2	Brush Holder Screws	12-15 in-lbs	1.36-1.69 Nm
Fig. 6.1	Field bottom (top)	10-15 (20-25) in-lbs	1.13-1.69 (2.26-2.82) Nm

* Bottom Nuts on long stud and ground stud of brush holder assembly.

** Attachment of Ground, Battery, Aux. or Field wires from the engine or airframe may use above torque unless value differs from engine/airframe OEM torque. OEM torque specifications shall supersede HET value. **Always hold the bottom nut while applying torque to top nut to prevent over torque of bottom nut.**

*** Pulley nut torque is provided for reference only, engine or airframe manufacturer specifications supersede Table 6.1

6.3 Maximum Belt Tension

- A. Although the alternator belt is provided by the airframe or engine manufacturer and those manufacturers normally issue manuals or instructions regarding their maintenance, the belt is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the belt is offered here to prevent mis-diagnosis of what may seem to be an alternator fault. Refer to Troubleshooting section 3.3.

Alternator with Pulley	Maximum Tension
ES-6012-()	56 lbs / 25.4 kg
ES-6024-()	56 lbs / 25.4 kg
ES-7012-()	56 lbs / 25.4 kg
ES-7024-()	56 lbs / 25.4 kg

Table 6.2 - Alternator Maximum Belt Tension

6.4 Alternator Belt & Pulley Inspection

- A. Although the alternator belt is provided by the airframe or engine manufacturer and those manufacturers normally issue manuals or instructions regarding their maintenance, the belt is fundamental to the operation of Hartzell Engine Technologies LLC (HET) alternator. As such, some general troubleshooting regarding the belt is offered here to prevent mis-diagnosis of what may seem to be an alternator fault. Refer to Troubleshooting section 3.3.
- B. To aid in the determination if an alternator is at fault, the following may be used:
(Refer to Table 6.3.)
- (1) Check for proper belt tension using a tensionometer.
 - (2) Check for belt wear, flat spots, or fraying on edges.
 - (3) Check for belt alignment (may include multiple units driven by one belt).
 - (4) Check for belt contamination (debris imbedded in belt, fluids on belt or pulley).
 - (5) Listen for belt noise, screeching, squealing, chirping, tapping, or grinding.
 - (6) Listen for acoustic noise, grinding from bearing or popping from electrical arcing.
 - (7) Listen or feel for excessive vibrations (loose drive components and tensioners).
 - (8) Whenever belt is replaced, check that installed pulley runout is within tolerance (refer the engine or airframe manufacturer manuals or instructions regarding this maintenance).
- C. Whenever maintenance is required on a belt driven alternator, the external cooling fan must be visually inspected. The following may be used with engine or airframe guidance in the most current revision of the service instructions or maintenance manual:
- (1) Visually inspect the alternator fan for bent and/or missing blades.
 - (2) Visually inspect each blade of the fan in the radius of the blade for cracks as it appears from the edge of the alternator.

- (3) Visually inspect the fan back plate for cracks appearing from the output shaft area.
 - (4) Spin the alternator pulley and observe the blade and back plate for excessive wobble.
- D. If belt maintenance is required, refer to Table 6.3 and follow the engine or airframe requirements called out in the most current revision of the service instructions or maintenance manual. The following may be used with engine or airframe guidance:
- (1) Adjust to proper belt tension using a tensionometer. Refer to Table 6.2.
 - (2) Replace belt if worn or damaged in any way.
 - (3) Make proper belt alignment (include all pulleys or devices in drive system).
 - (4) If belt remains undamaged remove contamination from belt surface.
 - (5) Determine cause of belt noise(s) and correct. Refer to Table 6.3.
 - (6) Whenever belt is replaced, check that installed pulley runout is within tolerance (refer to section 5.2.G INSPECTION & TESTING).
 - (7) Determine cause of mechanical noise(s) and correct.
 - (8) Determine cause of excessive vibrations. Tighten drive system brackets and/or replace system components showing wear.
 - (9) If a determination is made that a fault exists in the alternator, overhaul, repair, or replace.

6.5 Removal from Aircraft

- A. To remove the belt driven alternator from a specific engine, refer to the aircraft and/or engine service and maintenance manuals for detailed instructions.
- B. General Removal - Belt Driven Alternator
- (1) Make sure any external power has been disconnected. Unless otherwise advised, gain access and disconnect the ground (-) cable from the battery post. Isolate and secure the ground (-) terminal.
 - (2) Disconnect the cable from the positive (+) battery post and isolate the terminal.
 - (3) Disconnect the Field wires, AUX wire, output and ground cables from the alternator.
 - (4) Release the tension from the alternator belt by loosening the retaining bolts. Remove belt from the pulley. Disconnect the retaining hardware and bracketry as required.
 - (5) Remove the alternator from the engine. (Some OEM applications may require the pulley to be removed before the alternator can be removed.)
 - (6) Remove the drive pulley from the output shaft, if required. Use a 1/4 inch hex key to hold the rotor shaft and a 3/4 inch socket or wrench to remove the output shaft nut. (Early model alternators may require a pulley wrench or similar device to hold the pulley for nut removal).

Problem	Possible Cause	Corrective Action
Belt Slippage	Lack of tension Overloaded Drive Worn pulley or V grooves Oily drive conditions	Increase tension Reduce load or check pulley size Replace pulley Clean drive, resolve oil leak
Belt turn over	Misaligned drive Worn pulley or V grooves Heavy impulse loads Excessive vibration Broken cords caused by prying belt over pulley Wrong pulley or belt	Realign shafts and pulleys Replace pulley Check idler pulley (spring or not) Check tension Tension v-belt, if tension is good, inspect belt condition or replace Replace belts Do not pry belt over pulley Check to see if belt rides high or if belt bottoms out in groove
Rapid belt wear	Worn pulley grooves Pulleys misaligned Mismatched belts (multi belts only) Belt slippage Pully diameter too small Overloaded drive	Replace pulley Align the pulleys and brackets Replace with matched belts Increase tension Check P/N and/or replace pulley Pully size on components correct
Belt separated	Foreign materials in drive belt Belt slippage (over much time) Heavy start up loads Belts damaged during installation	Check that pulley is protected Increase tension or replace belt Reduce the load before starting Install new belts properly
Belt stretch	Excessive drive tension Broken cords using multiple belts Large misalignment	Use proper tension Replace belts with matches set Realign brackets and pulleys
Belt Squeal	Belt slippage Insufficient arc of contact Overloaded drive	Increase tension Increase center distance Pulley size on components correct
Belt Chirp	Misaligned drive Belt tilted in pulley groove Belt riding on side of pulley groove	Align the pulleys & brackets Correct angle of belt Adjust bracket in or out to seat belt
Belt-bottom cracks	High surrounding temperature Pulley diameter too small Belt slippage	Provide ventilation Redesign drive Increase tension
Overheated bearings	Continuous belt slippage Excessive drive tension Bearings not lubed or damaged	Increase tension Tension drive properly Replace bearings

Table 6.3 - Alternator Belt System Maintenance

6.6 Exterior Cleaning

NOTE: Prior to cleaning the alternator whether mounted on the aircraft or as removed, observe and note condition. Look for any arcing, wear marks, fretting or other indicators of defect.

CAUTION: DO NOT SPRAY CLEANING FLUIDS INTO THE ALTERNATOR HOUSING OPENINGS. SOLVENTS MAY HAVE A HARMFUL EFFECT ON BRUSHES AND SLIP RINGS. ANY OPENING SHOULD BE TEMPORARILY PLUGGED WITH SHOP TOWELS.

- A. If mounted on an aircraft to engine, initial cleaning may be done using mineral spirits or isopropyl alcohol under pressure. Blow dry using clean shop air.
- B. If removed, initial cleaning should be done using a shop cloth and mineral spirits or isopropyl alcohol. Wipe dry using clean shop cloths.

6.7 Brush Removal and Replacement

- A. Upon achieving each 500 hours time in service or any time the alternator brushes need to be inspected or brush holder assembly replaced, the following instructions apply. Depending upon the reason for inspection or replacement, brush holder removal and installation may be done with alternator on or off the aircraft engine.

- 1. Remove power from aircraft by disconnecting the battery and removing any external aircraft power cables.

CAUTION: TO AVOID THE POSSIBLE ALTERNATOR DAMAGE, LOOSEN THE FIRST AND SECOND NUT OF THE BATTERY TERMINAL (RED INSULATOR) PRIOR TO REMOVING THE BACK COVER SCREWS.

- 2. Disconnect the F1 (field) wire by removing hardware. Refer to Figure 6.1 for terminal identification..
- 3. Remove three screws (1, Figure 6.2) and lock washers (2) and remove the back cover. Discard lock washers (2).
- 4. Remove the first nut from the ground stud at the brush holder assembly. Remove the two screws (3) and lock washers (2) that attach the brush holder assembly (4) to the slip ring end housing. Remove the brush holder assembly from the slip ring end assembly. If replacing the assembly, discard the assembly (4) lock washers (2) and nuts (8). (brushes and hardware are included in new brush holder assembly)

NOTE: If it is determined that the brushes are reusable, inspect the brush holder for cracks or other damage. Never reuse a damaged brush holder even if the brushes are good. Place each brush into the brush holder in the same position and orientation as removed.

- 6. Place the orange rubber seal (6) over the brush holder ensuring proper position and seat (refer to Figure 6.4 & 6.5) .
- 7. Depress each brush (7, Figure 6.3) into it's pocket with a small wood or plastic dowel and slip a length of 22 gage insulated wire into the hole provided in side of the brush holder and seal. The wire will retain the brushes for installation of the holder. (A new brush holder assembly is shipped with retaining wire installed).
- 8. Install the new or refitted brush holder assembly with two retaining screws (3) and two new lock washers (2). Torque screws to 18 to 20 in-lbs. Spin rotor and check for interference between the brush holder and rotor.

9. Remove the brush retaining wire allowing the brushes to snap into place.
10. Reinstall the brush holder ground strap to the ground stud and torque per Table 6.1.
11. Measure the resistance between the field (orange insulator) and ground terminal with an ohmmeter. Spin the pulley and note ohmmeter reading. Meter should read between 5.8 and 20 ohms while rotor is turning for a 24 volt alternator and between 2.8 and 20 ohms for a 12 volt alternator.
12. Install the back cover with three screws (1) and three new lock washers (2) and torque to 20 to 25 in-lbs. Reinstall the alternator if removed per the engine or airframe manufacturer's service or maintenance instructions or manuals.
13. Re-attach F1 (field) wire and re-torque the battery terminal nuts. Refer to torque specification in Table 6.1.

CAUTION: TO PREVENT PERMANENT DAMAGE TO THE ALTERNATOR, HOLD THE BOTTOM NUT OF EACH TERMINAL WITH A WRENCH WHILE TORQUING THE TOP NUT.

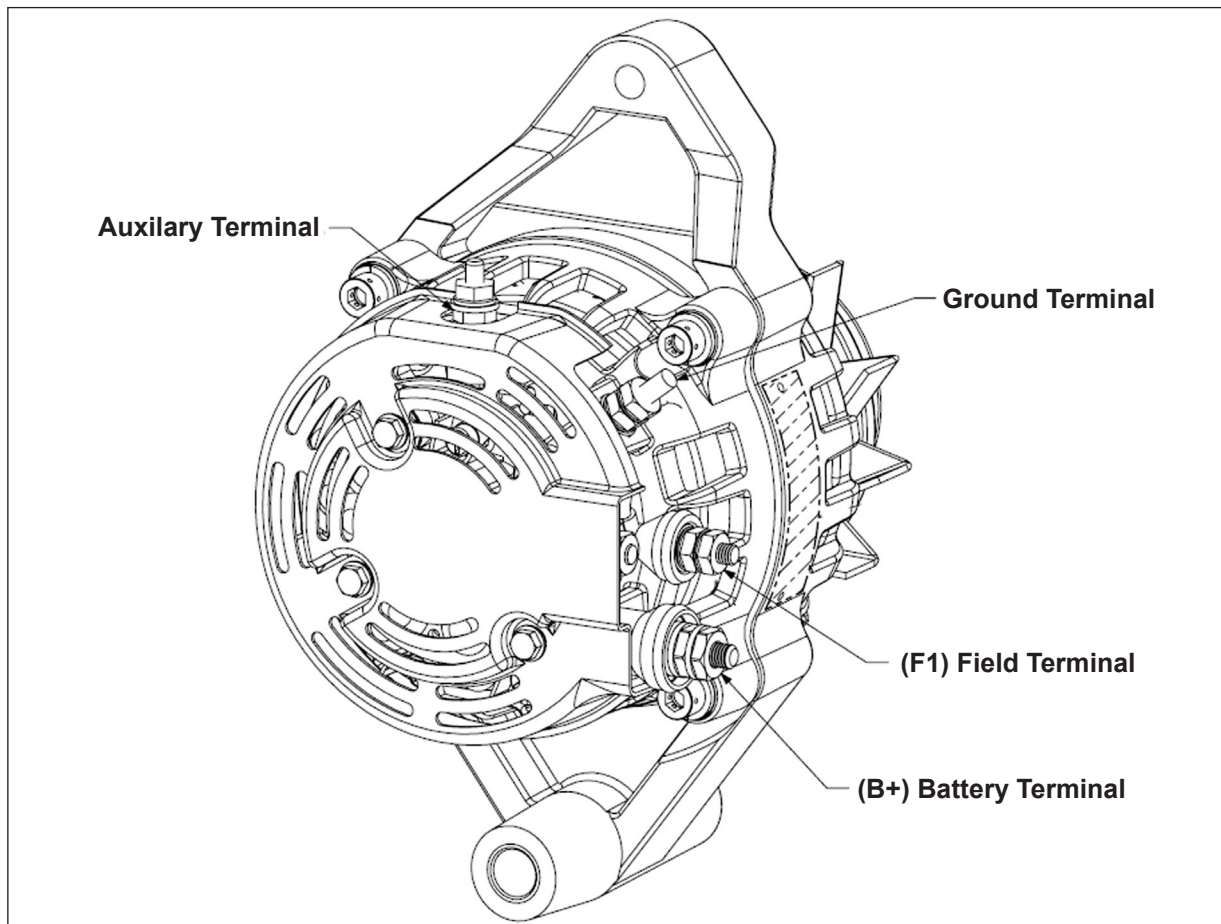


Figure 6.1 - Terminal Identification

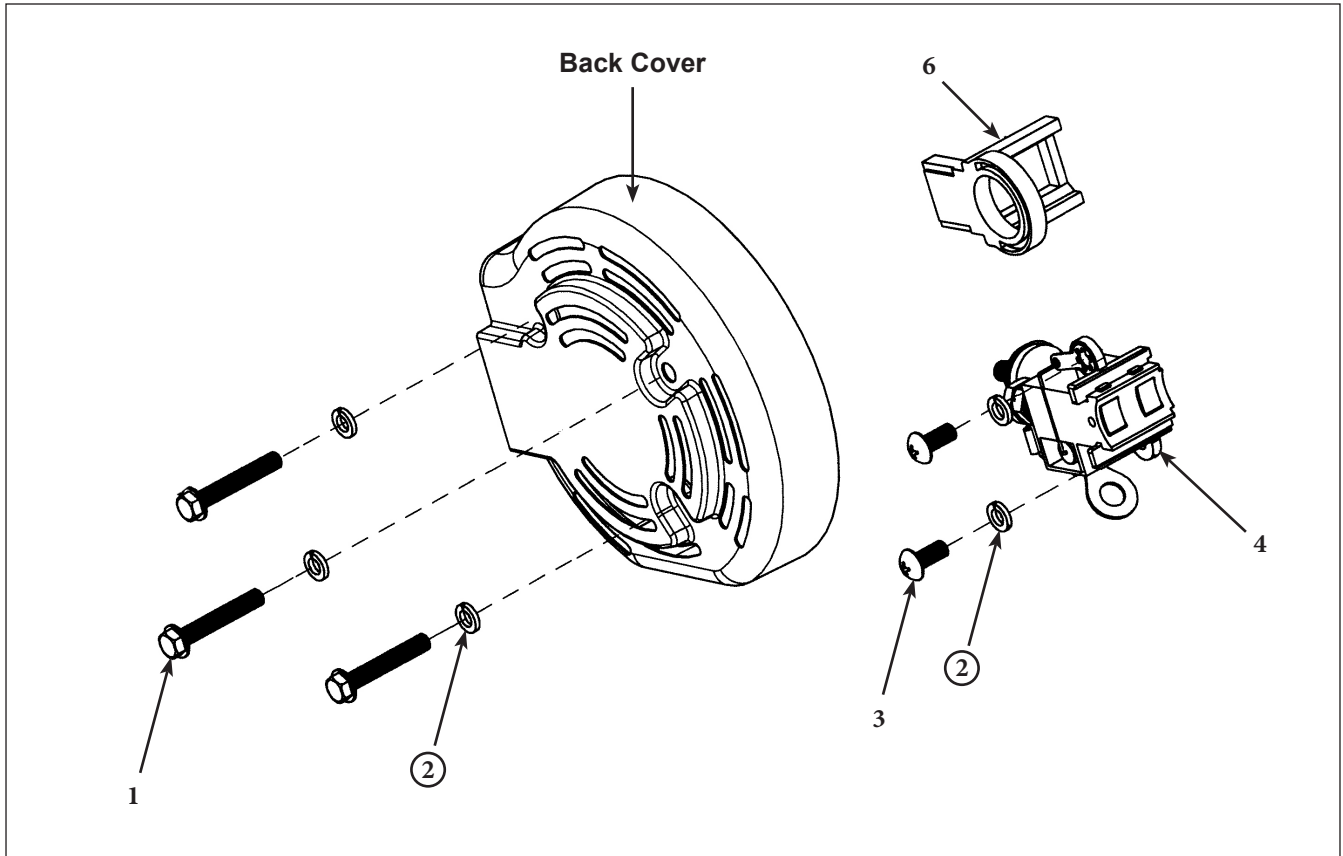


Figure 6.2 - Cover and Brush Assembly

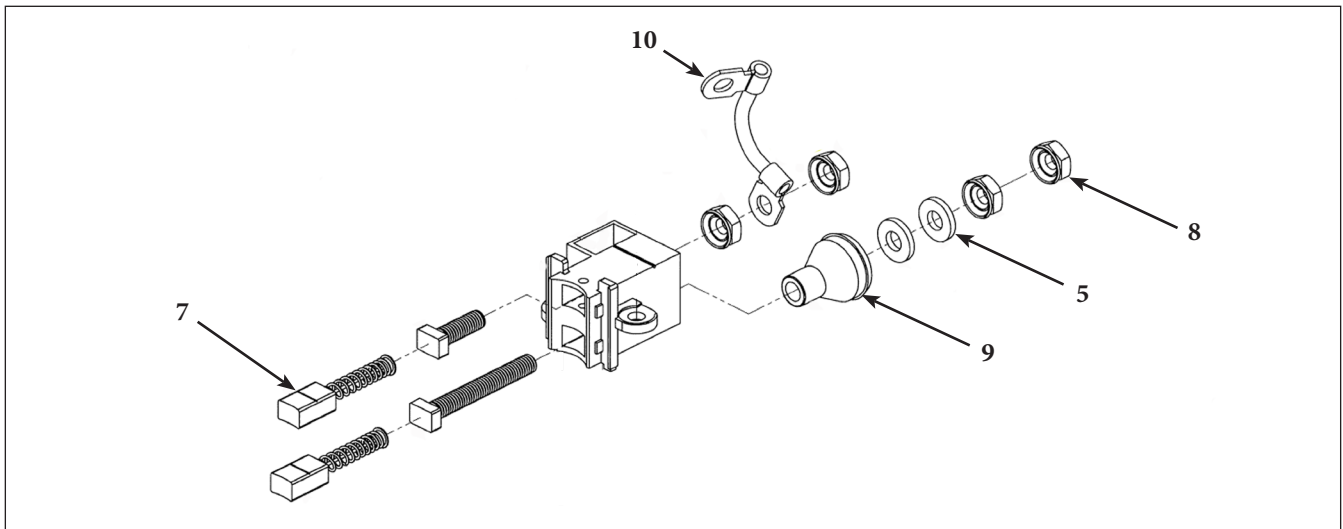


Figure 6.3 - Brush Assembly (4) Exploded View

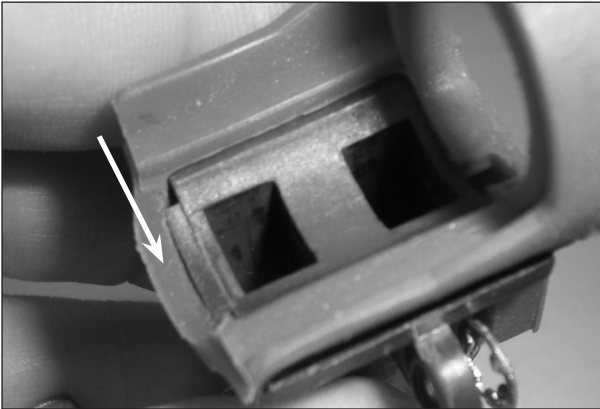


Figure 6.4 - Improper Seat

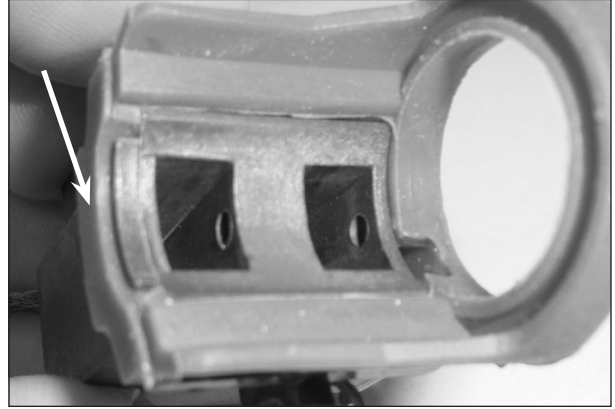


Figure 6.5 - Proper Seat

Materials Required:

The following HET brush assembly parts are available from authorized Hartzell Engine Technologies Distributors: Circled item numbers are required replacement parts any time they are removed from the alternator assembly.

Index No.	Item P/N	Description	Alternator P/N									
			6012(-)	6024(-)	7012(-)	7024(-)						
1	4339-1	Screw, Cover	3	3	3	3						
②	12X-0195	Washer, Lock (Cover & Brush Holder)	5	5	5	5						
3	8X-0055	Screw (Brush Holder)	2	2	2	2						
4	40278	Assembly, Brush *	1	1	1	1						
5	AN960-10	Washer, .203" Flat	2	2	2	2						
6	40288	Seal, Brush Assembly	1	1	1	1						
7	ALE-23A	Brush and Spring	2	2	2	2						
8	40298	Nut, Cupped	4	4	4	4						
9	40297	Insulator, F1 Terminal	1	1	1	1						
10	40316	Ground Strap	1	1	1	1						
		Circled index numbers are mandatory replacement										
		* Includes index numbers 5, 7, 8, 9, & 10										

6.8 Pulley Removal and Installation

A. Removal:

- (1) Using the instructions in the aircraft/engine maintenance manual, release tension from the alternator belt and remove the belt from the pulley.
- (2) Using a pulley wrench or strap wrench on the pulley, remove the output shaft nut. Remove the lockwasher, pulley, plate, and fan.
 - (a) Later models use 1/4 inch hex key to hold the rotor shaft and a 3/4 inch socket or wrench, remove the output shaft nut.

B. Installation:

- (1) Inspect the woodruff key. Distortion, bends, or damage require replacement before the pulley is installed.
- (2) Inspect the spacer, fan, plate, and pulley for damage or defect, replace as required.
- (3) Install the spacer, fan, plate, lockwasher, pulley, and nut. Use a new HET P/N 40523-3 lockwasher. Hold pulley or output shaft and torque the nut per engine manufacturers specifications. If unknown, torque nut to 55 ± 5 ft-lbs (74 ± 7 Nm).
- (4) Check mounted pulley for proper run out. Refer to section 5.2G for details.

6.9 Installation on Aircraft

To install the alternator on the engine, refer to the applicable engine and/or aircraft service and maintenance manuals. Always follow the OEM instructions.

A. Alternator Installation

To install the alternator on the engine, refer to the applicable engine/aircraft maintenance manuals and service instructions. Some OEM require the pulley to be removed prior to the installation of the alternator. Always follow the OEM instructions.

B. General Installation

- (1) Make sure the aircraft battery and any external power has been disconnected.
- (2) Position the alternator and install the retaining hardware and brackets as required.
- (3) Connect the Field wires, Aux wire, and output and ground cables on the proper terminals of the alternator. Refer to Figure 6.1 for locations.

CAUTION: DO NOT EXCEED TENSION LIMITS. EXCESSIVE BELT TENSION CAN LEAD TO PREMATURE WEAR AND BEARING FAILURE.

- (4) Install the alternator belt and properly tension in accordance with the most current revision of the engine/aircraft maintenance manuals and service instructions. A tensionometer should be used to set the specified belt tension.
- (5) Unless otherwise advised by the OEM, connect the positive battery cable to the positive (POS) battery terminal, then connect the aircraft ground cable to the negative (NEG) battery terminal.
- (6) Check the alternator for security and make a running performance test per the AFM or POH and the engine/aircraft service and maintenance manuals.

6.10 Special Conditions:

NOTE: For engine OEM's Special Condition "Sudden Stoppage", refer to the latest revision of Lycoming Engines, Inc. SB 533B or Continental Motors, Inc. SB96-11B.

A. SUDDEN ENGINE STOPPAGE:

- (1) If the aircraft engine has experienced a "sudden stoppage" as defined by the engine manufacturer, the alternator may be impacted critically by this event. Although a belt driven alternator is protected somewhat by the ability of the belt to slip or come off the pulley, the sudden stoppage may cause the seizure of the rotating components inside the alternator. The sudden stop may bend the pulley, damage the bearings, or shift close tolerance parts inside the alternator allowing contact when rotating.
- (2) If "sudden stoppage" as defined by the engine manufacturer has occurred or if a sudden stoppage has caused the belt to twist or come off, the alternator must be inspected. Refer to the appropriate engine or airframe manuals to remove the alternator. Check the following:
 - a. Belt - remove belt and check for flat spots, cuts, or broken fabric.
 - b. Pulley - check for damage such as bending or scarring. Check for pulley groove for damage. Make a run out check on the face of the pulley to check for alteration of the pulley due to bending. Refer to section 5.2(G) for checking pulley run out. Check appropriate engine or airframe manuals for run out spec's as many pulleys ARE NOT supplied by HET.
 - c. Alternator Fan - with belt removed, spin the pulley to check for alternator external fan or back plate wobble. Refer to section 6.4(C) for inspection of the external fan.
 - d. Alternator - with belt removed, snap spin the pulley to check for interference between the rotor and stator and to check for bearing noise.
 - e. Pulley Nut - check for fractures and assure proper torque at the completion of these procedures.
 - f. Brushes - remove brush holder and brushes to check for broken or chipped brush, and other damage. Refer to section 5.2(F) for brush holder and brush checks.
 - g. If you find damage in step (2), b through e, repair, overhaul, or replace the alternator. In addition, all supporting bracketry or mounts associated with the alternator should be inspected in accordance with the appropriate engine or airframe manuals. Assure all steps are taken to properly return the aircraft to service.

B. LIGHTNING STRIKE:

NOTE: For engine OEM's Special Condition "Lightning Strike", refer to the latest revision of Lycoming Engines, Inc. SB 401 or Continental Motors, Inc. Publication M-0.

- (1) Lightning strike is a very unpredictable event both in occurrence and in resultant damage. A lightning bolt entry point may have many exit points or only one. On a well bonded aluminum aircraft, the lightning bolt will stay on the outer surface throughout the aircraft with little damage to components. The path of the electrical current cannot easily be determined in most cases because while the current may surge through well bonded areas without damage, a gap in any metal contact point will result in an arc or flash burn. This is especially true of rotating parts such as gears or shafts.
- (2) If a report of a potential or actual lightning strike is made the first thing to do is to inspect the aircraft for entry and exit points for the lightning bolt. The purpose is to assure that there was indeed a strike. The points of entry or exit are generally on the aircraft extremities such as the wing tip, propeller tips, spinner tip or the tips of tail surfaces. Commonly, the entry point is a single burn mark and the exit several burn marks or burnt static wicks. This discussion is important because if there was a strike it may have coursed through the engine. Cowlings, especially fiberglass or other non-metallic types may not have as good a bond. Many cowlings will not be well bonded due to frequent removal. This will force the electric charge to take a route through the engine components. Lightning will arc at any gap where the path of resistance is less than the surrounding air.
- (3) If a strike has occurred, (especially if arc burns appear on the propeller) remove the alternator and inspect for arc marks. If belt driven, the most likely damage will occur within the alternator or its attachments or mounting brackets. Observe the mounting points and bracketry for arc marks at joints and attachments. Use the appropriate engine and/or aircraft, manufacturers maintenance manuals or service instructions to accomplish this task.
- (4) If evidence of a strike is observed and the alternator is being overhauled or replaced due to this evidence or due to malfunction, it is advised that the entire aircraft/rotorcraft electrical system be inspected. Use the appropriate engine and/or aircraft/rotorcraft manufacturers maintenance manuals or service instructions to accomplish this task.
- (5) If there is no indication of arcing or other damage and a lightning strike cannot be confirmed, reinstall the alternator and check per the applicable airframe and engine manufacturers maintenance or service instructions.
- (6) Upon completion, test run the engine per the POH or AFM prior to returning the aircraft to service. Make an appropriate logbook entry concerning the lightning strike.

6.11 Storage and Shelf Life:**A. STORAGE:**

When storing a new, overhauled or repaired alternator, there are several categories to consider. Short term storage or long term storage on or off the aircraft. Short term storage will be considered as storage up to but not exceeding twenty-four (24) calendar months. Long term storage will be considered as storage up to but not exceeding twelve (12) calendar years. There are different methods for each type of storage.

- (1) Short term, if on the shelf, requires only that the unit be kept inside in the original packaging. If unit is on the aircraft (or unmounted engine) no additional action other than that required for the engine or aircraft is needed.
- (2) Long term, if on the shelf, requires that the alternator be removed from the box and from the plastic bag as originally packaged. Discard the bag. Wipe or lightly spray outside and all openings with electrically friendly preservative oil. Wrap tightly with a waxed type paper (new bags may be used if specifically formulated for the storage of metal products). Place back into original shipping container and store in a cool dry environment.
- (3) If it is anticipated or determined that the aircraft (or unmounted engine) will be in a long term storage situation, as soon as practicable, lightly spray outside and all openings with electrically