220407

ETX400-24-TSO Product Manual

Revision Log

Rev	Description	Date
New	Created New	1/20/2025

ICON KEY

Valuable information

Caution

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Overview

EarthX Lithium batteries are designed as a maintenance free replacement for the 24-volt lead-acid or lithium starter batteries. The Starting Battery (Function) is considered Primary in the electrical system for Part 23 Aircraft. The alternator charging system is considered secondary. Per 14 CFR 23.1309-1E and TSO-C179b, the Failure Condition Classification (FCC) for this TSO Battery is "Major" - unless other installations deem the analysis lessor or greater, dependent on the function in the particular installation Aircraft.

This manual covers the TSO Article (Part) installation aspects for the battery. This manual is an accompanying manual to the Instructions for Continued Airworthiness. For detailed operational information refer to the Aircraft Flight Manual Supplement (AFMS).

Failure to follow all application use, installation, charging, and storage instructions may result in battery damage and or fire! Never disassemble the battery or disable the built-in Battery Management System (BMS).

Technology Inside

Battery Cells

The batteries use cells made of Lithium Iron Phosphate ($LiFePO_4$). This chemistry has great performance and is the safest on the market today.

Lithium batteries have the same charging voltage as a lead acid battery, but there are other differences. The resting voltage (voltage of the battery when not in use) is slightly higher, 26.4 volt versus 25 volt. A lithium battery voltage remains relatively constant while discharging, while voltage for a lead-acid battery decreases more rapidly. As such, a lithium battery's cranking power is stronger, for the voltage while cranking is generally higher.

$LiFePO_4$ cells by the nature of their chemistry are 3.3 volt. 24V lithium batteries are created by using 8 cells in series (technically 26.4 V battery). Another difference is that lithium cells are dry cell technology, where the cells are packaged individually. Individual cell's charge level will diverge with repeated charge/discharge cycles and age. This condition reduces the performance of the battery (reduces capacity) without a Battery Management System to monitor, control and protect the cells.

BMS

EarthX's integrated Battery Management System (BMS) monitors each cell's voltage. If the voltage (charge) of a cell exceeds the others, the BMS circuits will work to reduce that cell's charge level. This ensures that the charge level of all the cells remains equal, even with the high discharge and charge current of your aircraft.

The BMS has the following additional protective features; over-charge protection, over-discharged protection (completely draining the battery), excessive cranking protection, high

temperature protection and short-circuit protection. **The BMS was designed to Design Assurance Level (DAL), C (major).**

The BMS disconnects the battery from the load if 100% of the usable energy is consumed. The usable energy is the rated Ah of the battery (new battery at 25DegC, see the Specification section within). An over-discharged battery typically has a voltage less than 23V. If the BMS disconnects the battery, the voltage reading of the battery will be zero volts. Excessive cranking protection logic includes current, temperature and time monitoring to limit "high current use" (>100 amps) to 1 -30 seconds in any 60 second period. If the battery terminals are "shorted" (or a low impedance load is connected across terminals), which causes the battery volts to instantaneously drop to a very low level, the battery will disconnect from the load to protect the cells and BMS from damage (short circuit protection). If the BMS disconnects due to excessive cranking protection or short circuit protection, the BMS will automatically reconnect after a cooldown period (typically 1-3 minutes). The BMS is designed for short circuit protection > 1000 Amps.

In the event of a charging system failure where the voltage increases above 32V, the charging current is blocked. The time delay for this feature is 3 seconds to allow the aircraft alternators over voltage protection to activate first (typically less than 100ms). This design offers charge voltage protection greater than 100V. The discharge current (current out of battery) is unaffected in this situation. The circuit is like a diode, blocking flow in one direction (charge current into the battery), while allowing current to flow from the battery (discharge current). Once the alternator is shutdown or fails and the voltage returns to < 30 volts, the BMS's over-voltage protection automatically resets (allowing charge current). EarthX requires automatic over-voltage protection (crowbar or other means of shutoff) for alternator type charging systems.

The battery also includes a thermal run-away containment system. The design aligns with the requirements for a FAA approved lithium battery as per RTCA performance specification DO-311A and DO-160.

The battery's microcontroller monitors all failure modes, and reports failures with a built-in LED indicator. The discrete output for external fault monitoring is a single wire connection. The output is a "current sinking" type circuit (see Installation section below) that can handle 100mA (connects the discrete output to battery ground if a fault is present). This output can be connected to an external 24V LED or general-purpose discrete input of an EFIS. The fault output has three states: fast flashing (2 seconds on/ 2 seconds off), slow flashing (5 seconds on/ 5 seconds off) or solid. The fast-flashing fault is an indication of high temperature; temperature exceeding the normal operating or storage limits of the battery (>75C). The slow flashing fault can indicate an improper state of charge or a problem with the cells internal to the battery. The solid fault indicates a BMS hardware failure. See the operating section of this manual for more details.

Charge Limiting

The battery as built-in charge limiting. If the charge current exceeds 12 amp for more than 10 seconds (and voltage above 26.5 volts), the charge limiter circuitry is automatically activated. Once activated it will limit charge current to less than 12-15 amps.

Charge limiting is automatically de-activated once the internal battery voltage reaches 27.5 volt.

Heater

The heater is automatically controlled based on battery use (discharge/charge), temperature and voltage. The below table shows the control logic.

Discharge Amps	Temperature DegC	Voltage	Heater State
>4	<-1	>25.6	On
X	<-1	>26.7	On
X	>1	X	Off
X	X	<25.6	Off
<4	X	X	Off

X indicates, "Don't Care"

The optional RTD provides cell temperature indication. The RTD is a typical 2-wire 100-ohm platinum type.

Installation Requirements

"This article meets the minimum requirements of technical standard order (TSO) C179b. Installation of this article requires separate approval." The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements. Also, refer to AC 20-184 for full Aircraft installation guidance and requirements not the subject of this manual. Below are the installation specific requirements and is not part of the TSO Part (LRU) specific certification under TSO-C179b:

- The maximum voltage output from aircraft charging system shall not exceed 32 volts for greater than 100msec. Thus, an automatic over-voltage protection device (OVPD) is required on the aircraft charging system.
- The battery fault/status monitoring must be installed and tested.
- The battery vent system must be installed (see installation section of this manual).
- The cranking current demand should not exceed those listed in the Specification section below.
- The capacity demand (storage requirement) should not exceed the battery capacity listed in the Specification section below.
- The battery must be installed in such a manner and or location to limit radiant and convection heating. The maximum short term (30 minute) environmental temperature of the battery location shall not exceed the value listed in the specifications section below and the short term ground temperature shall not exceed 85°C. See the specification section for more information.

- The battery should be secured in the existing battery box or battery holder as detailed in this manual or aircraft manufacturer's manual.

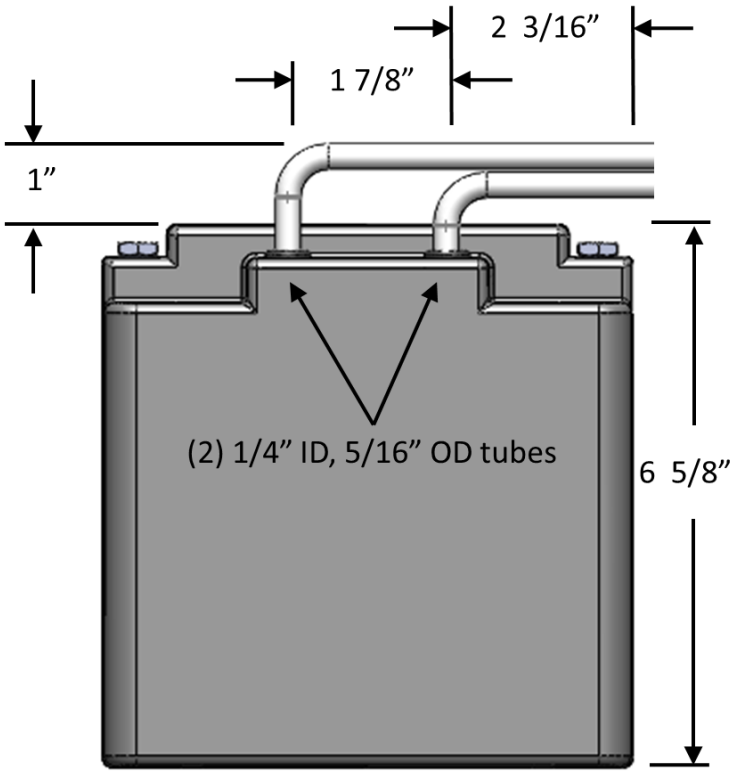
The maintenance must comply with the requirements of the Instructions for Continued Airworthiness (ICA), a separate document.

Specifications

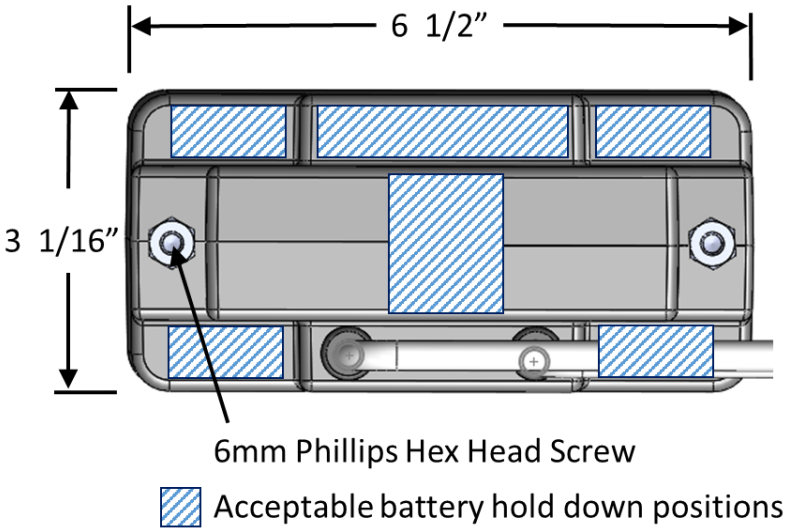
Voltage	26.4 V
Capacity (1C, 1hour rate at 23°C)	7.8Ah @ 1C rate (See below)
Capacity vs Temperature	25 °C = 100% 0°C = 97% -30°C = >95% (7.8Ah at this temperature) -40°C = >92% (7.5Ah at this temperature)
Self-Discharge Rate	<5%/month @ 25°C
Peak Power (Ipp), 23/-18 °C	400 / 290 amps
Rated Power (Ipr), 23/-18 °C	240 / 170 amps
Max Continuous Discharge Amps (Discharging 100% of capacity)	40A
Standard Charge Voltage	27.6 – 28.8 V
Recommended Charger/Maintainer Amps	.8 - 10A
Max Charge Amps	Internally limited to less than 15 amps
Life (Not life limited)	Up to 6 Years
Weight	5.4lb (2.45Kg)
Dimensions	6.5in (L) x 3.0in (W) x 6.6in (H) 166mm(L)x76mm(W)x168mm(H)
Environmental Rating (resistance to water intrusion)	IP 66 (wash down with a high-pressure washer)
Operating Temperature (short term)	-45 °C to +60 °C (+65 °C for 30minutes); Equipped with heater
Storage Temp	-45 °C to +70 °C
Short Term Ground Survival Temp	-45 to 85 °C (30 minutes)
Maximum Altitude	50,000 Ft
Shelf Life	1 year (without charging)
FAA Standard Order	TSO-C179b (TSO version only)
Design Assurance Level (DAL)	C (major)
Flammability Rating (case and vent tube)	14CFR 25.853 (a)

Back View

Back View



Top View

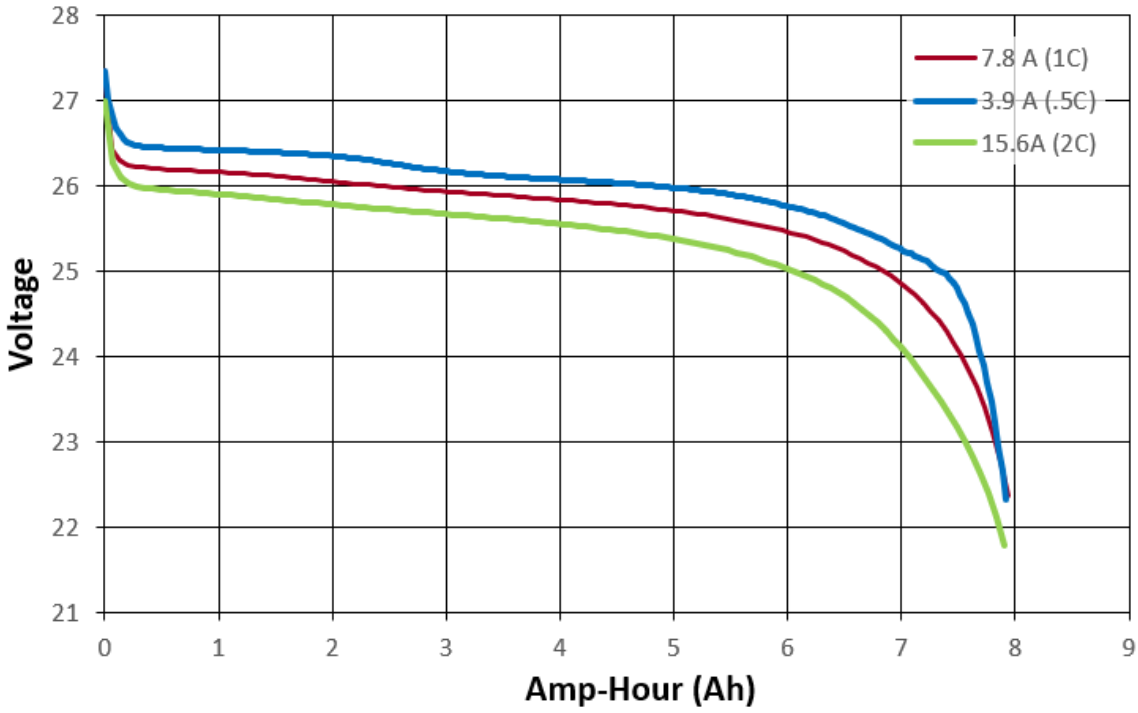


Discharge Curves

The first graph below shows the state-of-charge versus voltage at a 1C discharge rate. Typically, lithium batteries require advanced methods like current counting to track the charge level. As seen from the graph, the voltage only varies .8V for nearly 80% of the discharge cycle at 25°C. 26.8V is a good indication of full charge, while 25.5V is an indication of a discharged battery at 25°C.

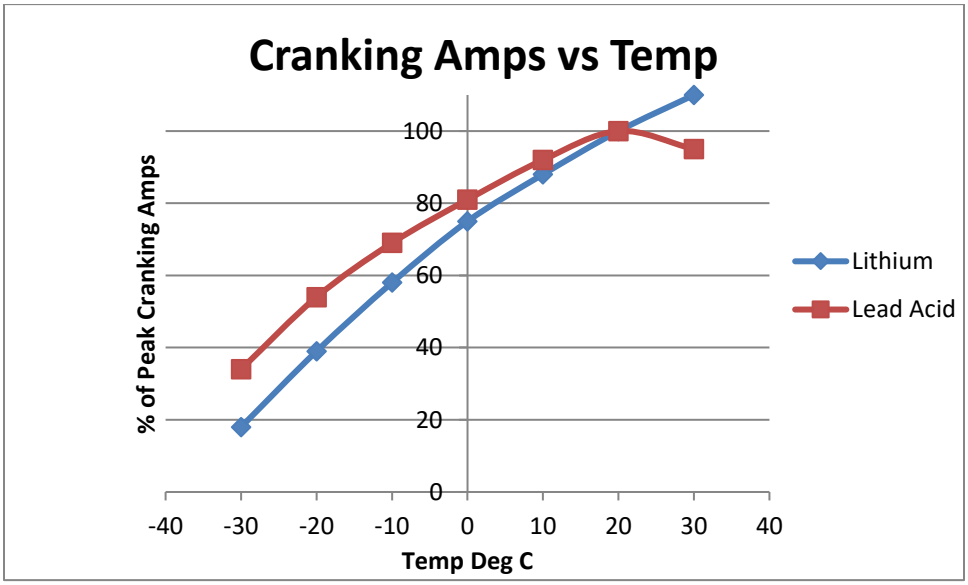
The graph below illustrates that usable Ah is nearly the same regardless of the discharge rate (discharge graph lines are nearly on top of each other), with the voltage remaining above 23V for most of the discharge cycle.

Like lead acid batteries, lithium batteries' discharge performance is lower as the temperature decreases, meaning the voltages and the Ah are lower.



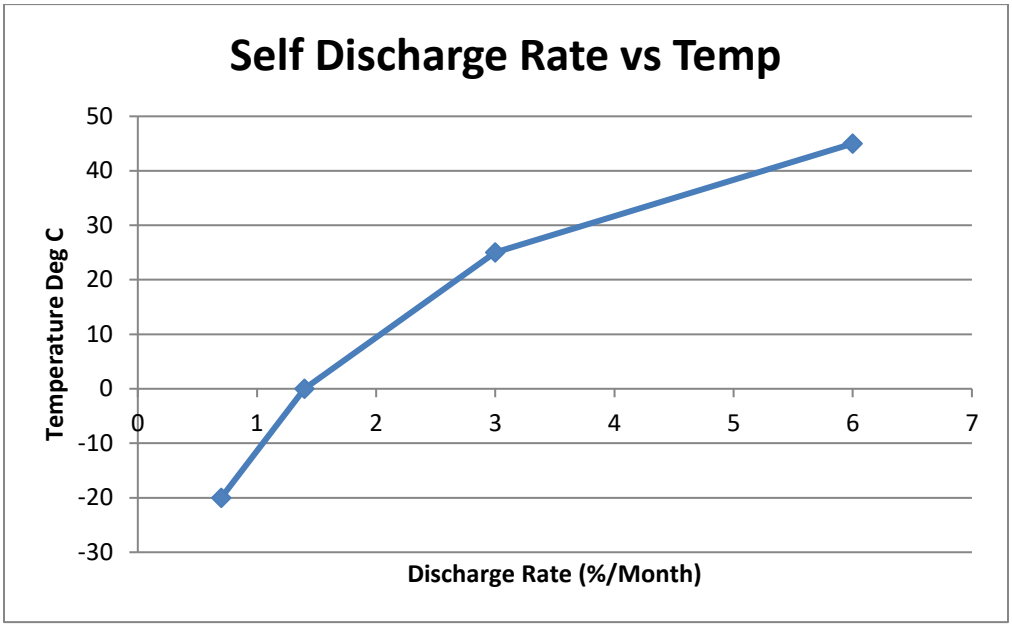
Discharge Versus Temperature

We use a similar Cold Cranking Amp test standard as the lead acid battery manufacturers (DO-311A IPP/IPR test performed at 0°F). As such, our battery with a similar cold cranking rating as a lead acid battery should provide the same cranking performance at 0°F. But, below 0°F an equivalent lead acid battery will outperform a lithium battery (see the graph below).



Self-discharge Rates

The self-discharge rate is dependent on temperature. At high temperatures (>25°C), the cell internal resistance decreases so the self-discharge rate increases. See the graph below for self-discharge rates (in % per month) versus temperature.



Installation

The instruction given here is generic. For a specific aircraft, refer to the installation instructions in the accompanying manual.

Remove all metal objects from your person before handling the battery and use insulated tools for installation.

The power terminals are ALWAYS live. Do not short across the terminals. Use caution when handling the battery inside the aircraft around metallic structures.

Battery Installation Location

The battery is designed to be mounted in a variety of locations within the aircraft including the engine compartment, baggage compartment or cabin as long as the environmental condition in those locations do not exceed the battery's specifications (see the specifications section and environmental qualification section of this manual). The battery can be mounted upright or on its side.

Battery Installation

It is recommended you check the voltage before installing. If the voltage is below 26.4V, charge the battery before installing. Follow these steps to install your new battery properly and safely. Qualified personnel should inspect the box, connections, and venting provisions in accordance with AC 43.13-1B Section 2. STORAGE BATTERIES (refer to 11-19). BATTERY MAINTENANCE (including d. Mechanical Integrity).

1. Remove the old battery, while paying attention to the routing and placement of wires, cables, and protective covers.
2. Check the battery cables and connectors for corrosion or damage. Pay special attention to the positive battery cable (red cable), checking for cuts or wear marks in the insulation. Clean and or replace the battery cables as required.
3. Mount the battery in an approved battery box /hold down, or the existing battery box with the approved spacer.
4. Connect the positive (red) cable first. Make sure the Phillips screw is securely fastened (45in-lbs), but do not over-tighten. Next, connect the negative (black) cable. Do not connect the battery in reverse polarity (positive to negative or negative to positive).
5. Re-install the battery holder or strap and tighten securely. Re-secure all the wires and cables.

Battery Vent Installation

This battery includes a thermal run-away containment system. The containment system includes a vent tube designed to carry vapor or smoke to the exterior of the aircraft in the event of a thermal run-away condition. There are no emissions during normal operation. For specific installation instructions based on the type of aircraft and or battery mounting location, see the Appendix. Plus, follow the below guidelines for properly installing the vent tubes.

- Route the vent tubes to the outside of the aircraft or a compartment sealed-off from the passenger cabin that is vented to the outside. Be sure emitted gases will not be directed to cabin air intakes. Vent tubes should use existing battery drain fittings on exterior of the aircraft if available. Leave at least 1" exposed on the outside of the aircraft. Cut the tube at a 45° angle towards the aft of the aircraft.
- Routing of vent tubes should include a 6" or longer or downward sloping section so condensate drains to the outside of the aircraft.
- Secure the vent tubes within 12" of the battery and or within 12" of the aircraft exit.
- Be careful not to crush or restrict flow through the tubing.
- The minimum bend radius is 3"; tighter bends could cause the tubing to kink.
- The vent tubing should be chemical resistant and rated for 500°F (i.e. EarthX typically supplies Teflon tubing).
- To install tubing to barbed fittings it is helpful to heat the tubing to a couple hundred degrees F.
- Be sure the entire barbed part of the fitting is completely inserted into the tubing.

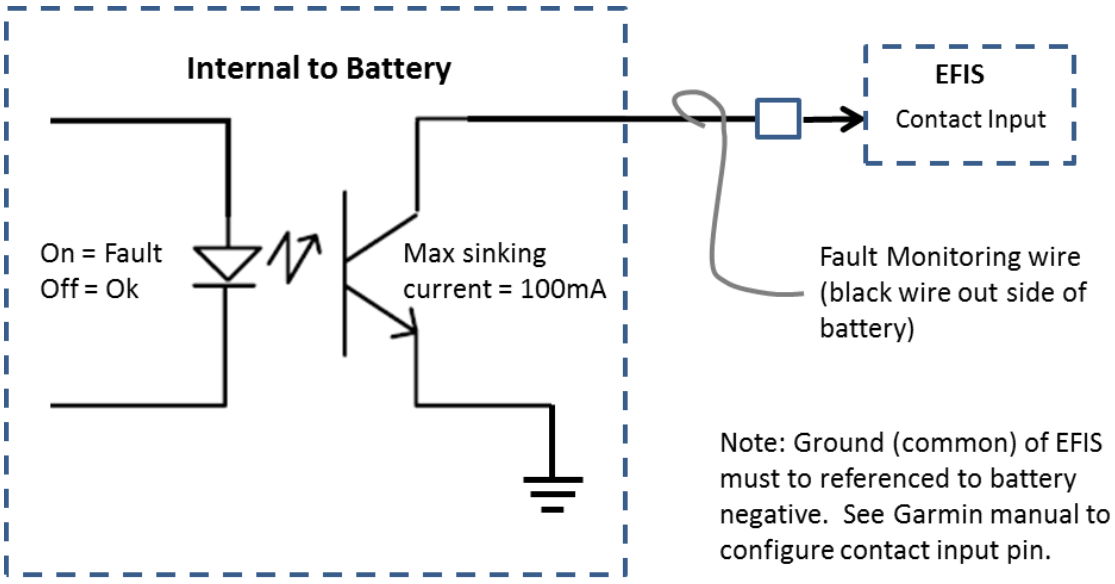
If required 90° elbows may be used to make small radius corners. Fittings must be brass, stainless, Teflon or other material with at least a 400 °F temperature rating (i.e. nylon). Barbed fittings must not restrict flow.

Installation of the battery in the cockpit requires the battery to be properly vented overboard.

Fault Monitoring Installation

The ETX-Hundred Series batteries have a discrete output that can be connected to many aircraft Electronic Flight Instrument System (EFIS) electronics or to a remote mounted LED. If a panel mount LED is used it should be yellow or amber in color. If an EFIS is used, the user defined alerts should also be yellow (caution). Throughout this document the text LED can be used to refer to either a physical battery fault/status LED or the EFIS alert text. The diagrams below detail the required connections for each type of installation.

The discrete output for external fault monitoring is a single wire (see connector pinout below). The following example details how to connect the fault monitoring output to an EFIS general purpose discrete input. The EFIS DC source negative must be referenced to the battery negative (this is the standard configuration).

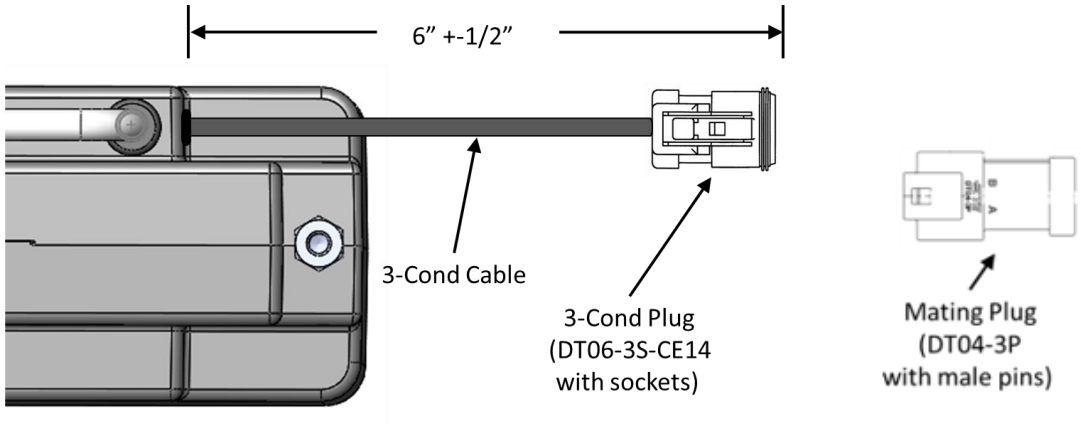


Fault Monitoring Connection to Garmin EFIS

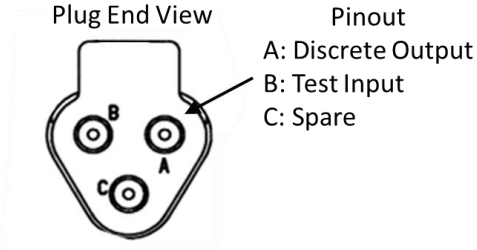
Configure the digital input (contact input) as "active low", "user defined alert" type.

Fault Connection to LED

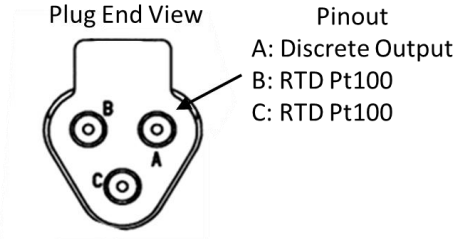
Connect the LED's red wire (positive) to a spare or existing fuse or breaker off the electrical bus. Use any .25 Amp to 2 Amp fuse or breaker. Connect the LED's negative to the battery's fault/status discrete output (Pin A of 3-Pin plug).



Input Option

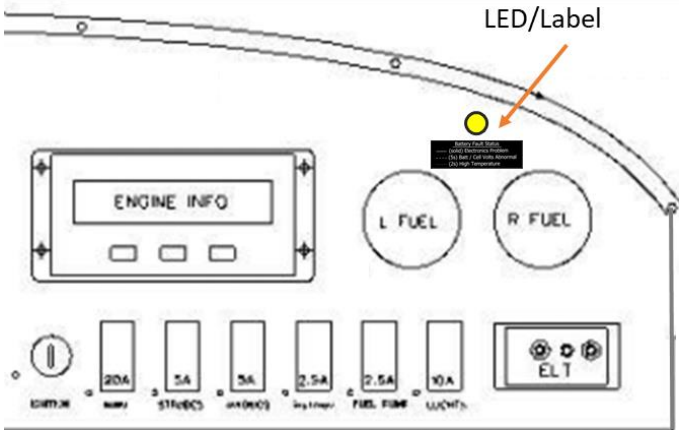


RTD Option



Fault/Status Indicator (LED) Install Procedure (EarthX supplied LED)

A suitable location for the Fault/Status Indicator will be determined by the installer. One example is shown below, but aircraft will vary. Find an open area that will not interfere with other equipment and in plain view of the pilot. LED must be visible in all operating conditions. Follow shop best practice and/or AC 43.13 guidance.



1. Removed trim panel - drill a 7/16" hole in the panel.
2. Remove one panel nut from the LED housing and feed the LED housing through the hole from the back side of the panel.
3. Secure the LED in place with the panel nut removed in the previous step.

4. Secure the LED Placard (1" x 3") to the trim panel in close proximity to the LED.
5. Route the black wire from the LED to the battery box through main wire bundle; secure in place with zip ties. Follow shop best practices and AC 43.13 guidance. **See Appendix for wiring and routing diagrams.**
6. Cut the black signal wire to length leaving a few inches of service loop at the battery.
7. Attach the black wire to the 3-Pin Mating Plug. Then plug it into the battery.
8. Behind the instrument panel, route the red wire (with inline fuse) to the instrument (or lights) circuit breaker (10A Typical); crimp (supplied) #6 ring lug to wire and secure to breaker.
9. Route the white wire to an adequate or available ground stud, crimp on (supplied) #6 ring lug and secure in place.

RTD Temperature Monitoring

The optional RTD provides cell temperature indication to the aircraft. The RTD is a typical 2-wire 100-ohm platinum type. The wiring installation polarity does not matter.

Test Input

The Test Input can be used to test the Fault output; connect the Test Input to battery positive (or aircraft bus), then fault output will turn on (connects the fault output to ground internally).

Return to Service Checks (Tests)

Follow these steps to check the battery operation prior to returning to or putting in service:

1. Verify the vent tube protruding for the aircraft can NOT be pushed up and into the interior of the aircraft with the force of an index finger.
2. Apply power to the aircraft via master switch, observe proper voltage, greater than 26V.
3. Verify the battery Fault/Status LED is off (no faults).
4. Press the LED "push-to-test" and observe the LED illuninates (if equiped).
5. At the battery, jumper the fault/status discrete output to battery negative terminal using a test clip and the panel LED is on.
6. Configure the aircraft for max typical cruise loads and verify it is less than 40 amps. Also, configure aircraft for load shed load and verify it is less than 11.5 amps. If either exceeds these values, conduct a complete Electrical Load and Capacity Analysis as detailed in the Appendix.
7. Verify engine starts as normal (if starter battery installation).

Aircraft Voltage Monitoring Equipment (if applicable)

The table below shows the recommended user alerts based on voltages when in flight. This pertains to existing equipment and is not applicable if existing low or high voltage alerts do not exist or are not adjustable.

The low charge level is very different from a lead acid battery, for a lithium battery is completely drained at approximately 23V.

Note: this table pertains to existing voltage level warning equipment and is NOT associated with the Fault monitoring LED.

Voltage	User Alert
>30V	High voltage warning
<27V	Alternator off-line alert
<25.6V	Low charge level warning

Operating Instruction

While in flight the battery fault/status indicator should be monitored. The indicator can be monitored either by an LED or input to an EFIS where approved. The fault codes are considered cautionary or advisory only.

There are no special requirements for emergency procedures for this battery beyond the airplane PoH or AFM instructions. An in-flight loss of battery functions is indicated by aircraft current and/or voltage meters and is augmented by the battery fault/status light.

Normal Operation

Under normal operating conditions the battery performs as any lead acid battery, storing energy from the charging system and supplying it when the charging system is off. Under normal operation the LED is OFF.

Abnormal Operation

A battery fault in flight indicates the following conditions and recommended actions.

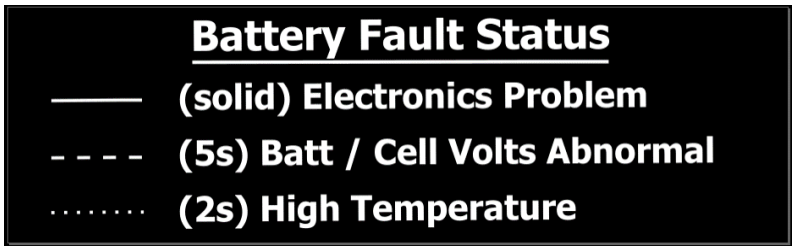
The table below is a summary of the battery's fault codes (discrete output).

LED Light	Airplane Voltage/Current	Battery Possible Cause	Recommended Action
Slow Flashing (5s on/5s off)	25.5-29V or current indicating normal charge or discharge	Cell to cell charge level imbalance. May come on briefly (less than 60 minutes) during or following periods of high current charging	No pilot action is required in flight. The pilot should report a battery problem to maintenance personnel when back on the ground. Do not dispatch aircraft.
Slow Flashing (5s on/5s off)	Less than 25.5V/ amp meter shows discharge / or alternator warning light on	Charging system is not functioning (battery is being discharged or at a low state of charge)	Pilot to follow POH procedure for faulty alternator. Do not dispatch aircraft.
Solid Light	Any voltage or current	BMS electronics problem	No pilot action is required in flight. Continue to monitor aircraft bus voltage and or current. The pilot should report battery problem to maintenance personnel when back

			on the ground. Do not dispatch aircraft.
Short Flashing (2s on/2s off)	Any voltage or current	High battery temperature (> 75°C / 167°F)	No pilot action is required in flight. The pilot should report battery problem to maintenance personnel when back on the ground. Do not dispatch aircraft until battery has cooled and fault cleared.

Placard

A placard (P/N: 200208) should be installed adjacent to the Fault/Status Indicator LED (see image below).



A sustained fault can indicate a serious issue with the battery or aircraft charging system that requires attention. Discontinue use until the issue is resolved and the battery no longer indicates a fault. Continued use of a faulty battery can result in a cell rupture, and the release of flammable vapors, and or smoke (through vent system and to outside the aircraft).

Maintenance

This is a maintenance free battery with no internal replaceable components. Charging is only required as needed (see charging section in this manual).

Inspection and testing is required annually. For more details, see the ICA.

Warranty

EarthX, Inc. (Manufacturer) warrants its lithium batteries (hereafter referred to as Battery or Batteries) to be free of defects in material and workmanship for a period of two years. A dealer is not authorized to issue a replacement battery without prior authorization from EarthX, Inc.

The applicable Warranty period begins from the date of purchase on the original receipt, or, if no receipt is available, from the manufacturing date on the battery. The warranty is non-transferable and for the original purchaser. Batteries determined to meet the conditions of this warranty will be replaced free of charge one time. For warranty replacement consideration, fill out the online warranty submission form located on the EarthX

website. EarthX' s acceptance of any items shipped to EarthX for warranty replacement shall not be deemed an admission that the item(s) are defective. For international warranty returns, the customer will pay the shipping expenses. Batteries replaced under the warranty provisions will carry only the remainder of the original applicable Warranty period.

See our website at https://earthxbatteries.com/ for details.

Appendix I DO-311a and DO-160 Testing

DO-311A Test Summary

Test Description	Section	Reportable Information
Physical Examination	2.4.4.1	Passed functional performance per DO-311A, Section 2.2.1.1
ATP	2.4.4.2	Passed functional performance per DO-311A, Section 2.2.1.2
Insulation Resistance	2.4.4.3	Passed functional performance per DO-311A, Plastic non-conductive lid, no heaters
Handle Strength	2.4.4.4	N/R, no handle on battery
Capacity	2.4.4.5	Passed functional performance per DO-311A, Section 2.2.1.5
Capacity at Low & High Temperatures	2.4.4.6	Passed functional performance per DO-311A, Section 2.2.1.6
Constant Voltage Discharge for High Rate Batteries	2.4.4.7	Passed functional performance per DO-311A, Section 2.2.1.7
Charge Acceptance	2.4.4.8	Passed functional performance per DO-311A, Section 2.2.1.8
Charge Retention	2.4.4.9	Passed functional performance per DO-311A, Section 2.2.1.9
Cycle Test for High Rate Batteries	2.4.4.10	Passed functional performance per DO-311A, Section 2.2.1.10
Rapid Discharge at Short Time Operating High Temperature	2.4.4.11	Passed functional performance per DO-311A, Section 2.2.1.11
Short Circuit with Protection Enabled	2.4.4.12	Passed functional performance per DO-311A, Section 2.2.1.12
Overdischarge	2.4.4.13	Passed functional performance per DO-311A, Section 2.2.1.13
Overcharge	2.4.4.14	Passed functional performance per DO-311A, Section 2.2.1.14
Short Circuit of a Cell	2.4.5.1	Passed functional performance per DO-311A, Section 2.2.2.1
Short Circuit without Protection	2.4.5.2	Passed functional performance per DO-311A, Section 2.2.2.1
Over discharge without Protection	2.4.5.3	Passed functional performance per DO-311A, Section 2.2.2.2
Single Cell Thermal Runaway Containment	2.4.5.4	N/R, this test is not required when thermal runaway containment testing is done with two or more cells in thermal runaway
Battery Thermal Runaway Containment	2.4.5.5	Passed functional performance per DO-311A, Section 2.2.2.4

Explosion Containment	2.4.5.6	Passed functional performance per DO-311A, Section 2.2.2.5
Drop Impact Test	2.4.5.7	N/R, this battery is not for a portable device
Remarks There is no deviation to the test requirements. If test is marked N/R, it is not required due to the battery construction or battery energy category.		

Environmental Qualification Form

Nomenclature: Rechargeable Lithium Battery System
Model: ETX400-24-TSO
Manufacturer: EarthX
Revision & Change Number of DO-160: G, Dec8, 2010
Date Tested: Oct 30, 2020

Conditions	Section	Description of Tests Conducted
Temperature and Altitude	4.0	Equipment tested to Categories:
Low Temperature	4.5.2	B3, -45 DegC
High Temperature	4.5.4	B3, 60 DegC, Short Term 70 DegC
Ground Survival	4.5.1&4.5.3	B, -45 to 85 DegC
Loss of Cooling	-	Equipment Category X, no auxiliary cooling
Altitude	4.6.1	Equipment tested to Cat. C3
Decompression	4.6.2	Equipment tested to Cat. A3, 50,000ft
Overpressure	4.6.3	Equipment tested to Cat. A3, -15,000ft
Temperature Variation	5	Equipment tested to Categories B
Humidity	6	Equipment tested to Categories B
Operational Shock and Crash Safety	7	Equipment tested to Categories B
Vibration	8	Equipment tested to Category R, S, and U aircraft zone 1 and 2 for fixed wing turbojet engine aircraft, fixed wing unducted turbofan engine aircraft, helicopters, and fixed wing reciprocating/turbojet engine aircraft (multi or single engine) less than 5,700kg using vibration test curves B, B1, C, C1, G, G1, L, M, R and F
Explosive Atmosphere	9	Equipment identified as Category X, no test performed
Waterproofness	10	Equipment tested to Categories R
Fluid Susceptibility	11	Equipment tested to Categories F Equipment spray tested
Sand and Dust	12	Equipment identified as Category X, no test performed
Fungus	13	Equipment identified as Category X, no test performed

Salt Fog	14	Equipment tested to Categories X
Magnetic Effect	15	Equipment tested to Categories X, no test performed
Power Input	16	Equipment tested to Categories B(RX), loss of power or low voltage tests not applicable for the equipment is a power source
Voltage Spike	17	Equipment tested to Categories A
Audio Frequency Conducted Susceptibility	18	Equipment tested to Categories B
Induced Signal Susceptibility	19	Equipment tested to Categories B(CX)
Radio Frequency Susceptibility	20	Equipment tested for conducted susceptibility to Categories R and for radiated susceptibility to Category G (100MHz – 1GHz) and D (1GHz -18GHz).
Radio Frequency Emission	21	Equipment tested to Categories P
Lightning Induced Transient Susceptibility	22	Category B4K3L3. Equipment tested to pin test waveform set B, level 4. Cable bundle test waveform K3L3.
Lightning Direct Effects	23	Equipment identified as Category X, no test performed
Icing	24	Equipment identified as Category X, no test performed
Electrostatic Discharge	25	Equipment tested to Categories A
Fire Flammability	26	Equipment identified as Category X, no test performed.
Other Tests: Flammable Material		Fire resistance tests were conducted on battery case and vent tubing in accordance with FAA regulations Part 25, Appendix F
Remarks - No critical frequency was identified. -Fluid susceptibility test was conducted with the following fluids: piston engine fuel, synthetic hydraulic fluid, mineral based lubricating oil, isopropyl alcohol solvent, ethylene glycol, and insecticide.		