Installation Manual and Operating Instructions

TRUE BLUE POWER

TB44 SERIES

ADVANCED LITHIUM-ION BATTERY

Manual Number
9018041

Revision F • May 15, 2020

FOREWORD

This manual provides information intended for use by persons who, in accordance with current regulatory requirements, are qualified to install this equipment. If further information is required, please contact:

True Blue Power
c/o Mid-Continent Instrument Co., Inc.
Attn: Customer Service Dept.
9400 E. 34th St. N.
Wichita, KS 67226 USA
Phone 316-630-0101
Fax 316-630-0723
www.truebluepowerusa.com
www.mcico.com

We welcome your comments concerning this manual. Although every effort has been made to keep it free of errors, some may occur. When reporting a specific problem, please describe it briefly and include the manual part number, the paragraph/figure/table number and the page number. Send your comments to:

True Blue Power
c/o Mid-Continent Instrument Co., Inc.
Attn: Technical Publications
9400 E. 34th St. N.
Wichita, KS 67226 USA
Phone 316-630-0101
Fax 316-630-0723

SCAN QR CODE

Download the current version of this installation manual using your smartphone or tablet.

TABLE OF CONTENTS

REVISION HISTORY

Rev	Date	Detail	Approved
A	04/29/2014	Initial release	BAW
B	10/26/2015	Minor revisions to content	BAW
C	01/14/2016	Correct mating connector number in sec. 5.2.2.B Update weight to 51.7 in sec. 1.4	WVC
D	06/29/2018	Updated to include -3 version and various comments/corrections.	BAW
E	03/25/2019	Updated shipping information and recharge interval to 3 months, EQF to add in helicopter vibration.	WVC
F	05/18/2020	Updated style and brand to meet Marketing and Engineering guidelines.	DLR

SECTION 1 GENERAL DESCRIPTION

1.1 INTRODUCTION

The TB44 series Advanced Lithium-ion Battery, part number 6430044-( ), is designed to provide high current capability to start turbine or piston aircraft engines and subsequently, provide DC power capacity to the primary electrical bus in the event of generator function loss. The TB44 is a sophisticated power system that utilizes state-of-the-art Nanophosphate® lithium-ion battery cell technology which provides improvements to the performance, safety, life and weight when compared to traditional or competing aircraft batteries. Consideration given to key electrical and mechanical design principles provide adherence to regulatory standards and meet or exceed industry expectations. The TB44 is a complete battery solution that provides significant value and benefit to an aircraft designer, owner and operator.

The TB44 requires professional use and maintenance to deliver maximum performance and value as designed. This manual contains information related to the specifications, installation, operation, storage, scheduled maintenance, and other related topics associated with the proper care and use of this product.

1.2 PHYSICAL ATTRIBUTES

The TB44 is a single, integrated component contained in a metal enclosure with multiple interface connections. There is a primary 2-pin, industry standard military-specification power receptacle, an 18-pin circular communications and service connector, a 4-pin circular temperature monitoring connector and a heater enable push-button with LED indicator. The lid of the enclosure includes two hold-down features on either side to support typical aircraft mounting. Handles on each side provide ease of lifting and carrying for installation, removal and transport. There is a 1.50 inch diameter vent port on top of the lid to provide an exhaust connection for directing any released emissions in the rare event of a battery failure.

1.3 UNIT ARCHITECTURE

The unit is comprised of two primary building blocks: the Battery Modules with integrated Module Management System (MMS) and a Central Monitoring System (CMS). Additional components include power and communication interconnects, heaters, temperature sensors, container and hardware.

Each Battery Module consists of eight (8) cells, connected in series, with the MMS electronic protections and battery control logic contained within each module. There are 19 modules arranged in three banks, all connected in parallel through a network of bus bars to provide combined power to the main connector and thus the aircraft. There is an integrated heater in each module as well that improves cold weather performance.

The CMS monitors individual signals provided by each MMS and reports status information to the aircraft. It also employs hardware to manage heater functionality, and software for diagnostic information and storing data that contains operating information.

There are two Resistance-Temperature Devices (RTDs) in the unit that provide analog electrical signals through the 4-pin connector for independent temperature monitoring.

1.4 TECHNICAL SPECIFICATIONS

Electrical Attributes	
Power Input	28.5 volts DC Nominal, 400A Max Charge Current
Power Output	26.4 volts DC Nominal, 750A Continuous Max, 1500A Pulse Max
Rated 1C Battery Capacity	44 amp hours (Ah) @ 23°C

Table 1.1

Physical Attributes	
Weight	51.7 pounds
Dimensions (not including vent, handles and connectors)	10.9 L x 10.5 W x 10.2 H inches (see Figure 1.1) [276 x 266 x 258 mm]
COMM/Service Connector RTD Temperature Connector Quick Disconnect Receptacle	18-pin per MS3114E14-18P 4-pin per MS3114E8-4P 2-pin per Mil-PRF-18148/3 form factor
Mounting	See Section 3.4.2

Table 1.2

Qualifications	
Certification	FAA TSO-C179a
Performance Qualification	RTCA DO-311 Minimum Operational Performance Standard for Rechargeable Lithium Battery Systems
Environmental Qualification	See Appendix 1
Software Qualification	RTCA DO-178B, Design Assurance Level (DAL) C

Table 1.3

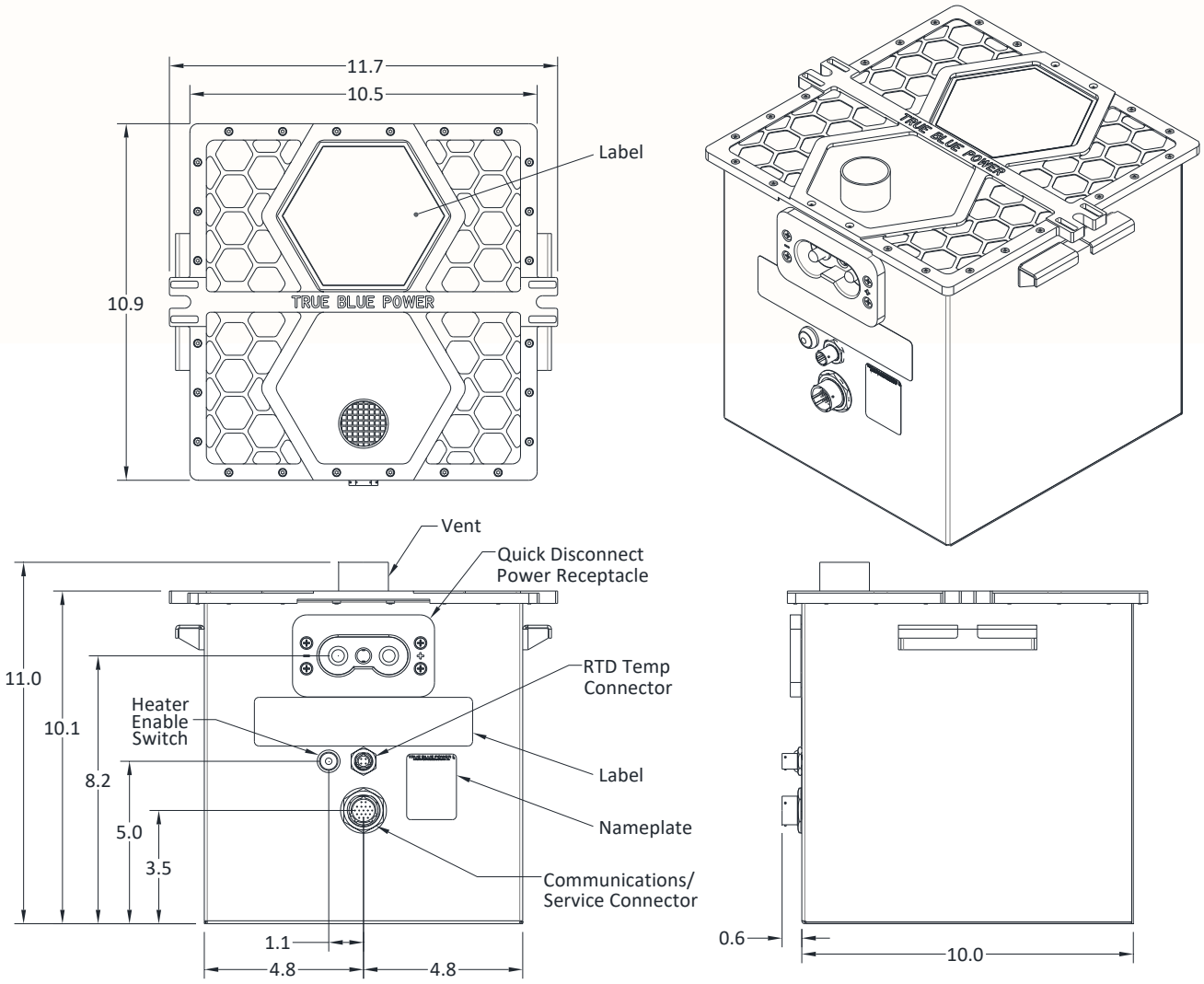

11.7
10.5
10.9
Label
TRUE BLUE POWER
Vent
Quick Disconnect
Power Receptacle
RTD Temp
Connector
Heater
Enable
Switch
Label
Nameplate
Communications/
Service Connector
11.0
10.1
8.2
5.0
3.5
1.1
4.8
4.8
0.6
10.0

Figure 1.1

1.5 IMPORTANT SAFETY INFORMATION

Read this safety information BEFORE maintaining or servicing the battery.

1.5.1 Symbol Definition

This section describes the precautions necessary for safe operations. The following safety symbols have been placed throughout the guide.

Warnings identify conditions or practices that could result in personal injury.

Cautions identify conditions or practices that could result in damage to the equipment.

1.5.2 Handling Precautions

The battery's energy is high enough to sustain an ARC flash. Always wear safety glasses, fire retardant smocks, and use insulated tools when servicing the battery.

- The battery does not include any serviceable internal components. Do not remove the lid or loosen the lid screws. Tampering with the lid could compromise the battery's ability to contain failure events.
- Remove metal items such jewelry and watches when working with batteries. A battery could produce a short circuit current high enough to weld jewelry to metal and cause a severe burn.
- Always use appropriate Electrostatic Discharge (ESD) protection while working with the battery, including grounding of an aircraft to reduce static electricity when working with the battery on-board.
- All connections for battery testing must include appropriate short-circuit protection.
- The battery service area shall be properly ventilated and egress paths shall be unobstructed.
    - Specialized breathing filters are not required under normal service and operation.
- Always use insulated tools.
- Never smoke or allow a spark or flame near the battery.
- Use caution to reduce the risk of dropping a metal tool on the battery. Dropping a tool could spark or short circuit the battery.
- Turn off all attached loads before connecting/disconnecting the battery power harness plug.

- If using a DC power supply or a battery charger, use equipment manufacturer's instructions to prevent the potential for arc discharge during connection. Arc discharge may cause damage to the battery receptacle's pins. Specifically, be aware of whether the power supply or charger should be on or off prior to connecting to the battery.

- Do not stack more than 120 lbs. on top of the battery.

- SDS info can be found on website at truebluepowerusa.com.

1.5.3 Additional Precautions

The following design and operation factors are required for safe use.

- There are no limitations in storing or using this battery in the vicinity of other battery types/chemistries (i.e. lead acid, nickel cadmium (ni-cad), etc.). This battery does not emit or absorb any gas during storage, transportation, or during normal operating conditions.

- Batteries must not be installed with the output terminals reversed. A reversed battery could be charged by other batteries in the circuit during discharge or discharged by the charging system during charge. Verify the correct polarity of any harness or equipment prior to connecting to the battery.

- Battery terminals must be covered with non-conductive protective devices to avoid any possibility of shorting during handling, shipping, or storage.

- Precautions should be applied if the battery is damaged or fails in such a way that produces liquid or gaseous emissions. Consult the Safety Data Sheet and contact the manufacturer for more information.

1.5.4 Shipping

True Blue Power lithium-ion cells and batteries are designed to comply with all applicable shipping regulations as prescribed by industry and regulatory standards. This includes compliance with the UN recommendations on the Transport of Dangerous Goods, IATA Dangerous Goods Regulations, and applicable U.S. DOT regulations for the safe transport of lithium-ion batteries and the International Maritime Dangerous Goods Code. In accordance with IATA and per UN 3480, PI 965, Section 1A and 1B, when shipped by air, the TB44 series Advanced Lithium-ion Battery will be shipped with a state of charge (SOC) not to exceed 30% of rated capacity. This battery is classified as a Class 9 Dangerous Good. If the battery requires shipment, please contact the manufacturer for additional instructions on proper procedures.

The unit may be shipped at approximately 30% state of charge (SOC). Upon receipt, the battery MUST be fully charged using the procedures listed in this manual (prior to storage and again prior to installation/use).

Batteries that are stored or not in use MUST be fully recharged at a minimum every 3 months, following the procedure set forth in Section 5.2.3. For more detailed storage instructions refer to Section 5.4.

SECTION 2 PRE-INSTALLATION CONSIDERATIONS

2.1 COOLING

No internal or external cooling of the unit is required. The unit is designed to operate over a wide temperature range and with internal thermal monitoring and protection circuits. See Section 4 for details.

2.2 EQUIPMENT LOCATION

The TB44 Advanced Lithium-ion Battery is designed to allow for installation without requirements for temperature or pressure control. Although not required, optimum performance and life can be achieved by mounting the TB44 in a section of the aircraft that reduces exposure to high temperatures. In addition to altitude and temperature tolerance, the unit is also designed to withstand high levels of condensing humidity. However, installation locations where the unit could be subject to standing or direct water exposure should be avoided. The unit shall be mounted in the upright position (vent on top).

Failure mode, effects, and criticality analysis of the TB44 has shown that the potential for multiple cells to release toxic or flammable gases as a result of any potential condition is extremely improbable. However, for additional risk mitigation, the unit is designed with a vent which should be connected and diverted overboard in the event of such an occurrence. Details for vent installation are provided in Section 3.

Consideration should be given to how the status and reporting functions of the battery will be displayed within the aircraft. At a minimum, critical parameters determined at time of certification should be available to the pilot and/or crew. Additionally, existing aircraft systems which are designed to work with traditional batteries may need alteration in order to accommodate the slight change in voltage output of this lithium-ion battery and the communication capabilities available.

2.3 ROUTING OF CABLES

The power wires associated with the battery are heavy gauge wire and carry significant power. Be aware of routing cables near other electronics or wire bundles that may be exposed to high energy flow.

Avoid sharp bends in cabling and routing near aircraft control cables. Also avoid proximity and contact with aircraft structures, avionics equipment, or other obstructions that could chafe wires during flight and cause undesirable effects. The interconnect cables should not run adjacent to heaters, engine exhausts, or other heat sources. Interconnect cable wire is recommend to be no smaller than 24 gauge. There are no length restrictions in regard to the interconnect cable wiring.

2.4 LIMITATIONS

The conditions and tests for TSO approval of this article are minimum performance standards. Those installing this article, on or in a specific type or class of aircraft, must determine that the aircraft installation conditions are within the TSO standards. TSO articles must receive additional installation approval prior to being operated on each aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

See Section 4.4 for Performance Specifications and potential limitations and ratings under various environmental and application installations. Also see Section 2.2 for limitations associated with equipment installation location.

2.5 MODIFICATION

This product has a nameplate that identifies the manufacturer, part number, description, certification(s) and technical specifications of the unit. It also includes the "MOD" or modification number representing notable changes in the hardware design of the unit.

Modification (MOD) 0 is the initial release of the product and is identified on the nameplate by the lack of marking on the MOD numbers 1 through 9 (i.e. 1-9 are visible). All subsequent modifications are identified on the nameplate by the marking/blacking out of that particular MOD number (i.e. for MOD 1, the number 1 is not visible and 2-9 are visible - see Figure for examples). MODs do not have to be sequentially inclusive and may be applied independent of each other.

For additional details regarding specific changes associated with each MOD status refer to the product published Service Bulletins at www.truebluepowerusa.com.

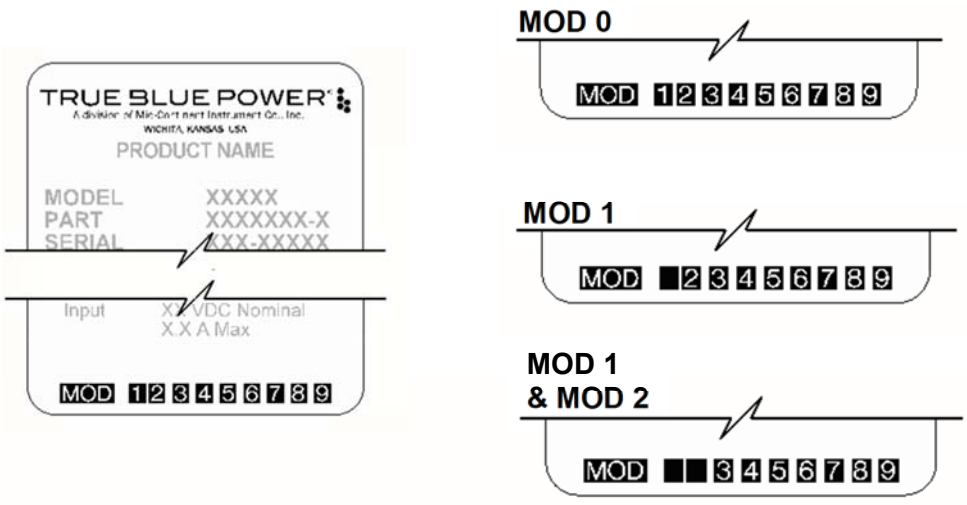


Figure 2.1

Nameplate and MOD Status Example

SECTION 3 INSTALLATION

3.1 GENERAL

This section contains mounting, electrical connections and other information required for installation. These instructions represent a typical installation and are not specific to any aircraft.

3.2 PRE-INSTALLATION INSPECTION

Unpacking: Carefully remove the TB44 battery from the shipping container. The shipping container and packing are designed specifically for the transit of lithium batteries and approved by international transportation agencies. These materials should be retained for use should the unit require future shipment.

Inspect for Damage: Inspect the shipping container and units for any signs of damage sustained in transit. If necessary, return the units to the factory using the original shipping container and packing materials. File any claim for damages with the carrier.

CAUTION

The unit may be shipped at approximately 30% state of charge (SOC). Upon receipt, the battery MUST be fully charged using the procedures listed in this manual (prior to storage and again prior to installation/use).

3.3 PARTS

3.3.1 Included Parts

A. TB44 Battery	MCIA P/N 6430044-( )
B. Installation Manual and Operation Instructions	MCIA P/N 9018041

3.3.2 Available Parts

C. Connector Kit	MCIA P/N 9018042
i. Power Connector Kit	
ii. RTD Temp Connector Kit	
iii. Com/Service Connector Kit	
D. Vent Kit	MCIA P/N 9018043
i. High Temp Vent Hose (48”)	
ii. Vent Clamps (x2)	
E. Service Cable	MCIA P/N 9018044
F. Serial-to-USB Converter Cable	MCIA P/N 9018046
G. MD41-1844 Annunciator Control Unit	MCIA P/N MD41-1844

3.3.3 Installer Supplied Parts

A. Wires
B. Appropriate hold-down hardware

3.4 INSTALLATION

WARNING

The power terminals of the TB44 are always active and energized.
DO NOT SHORT TERMINALS AT ANY TIME!

Extreme care and caution should be used when handling and connecting to the unit. Danger of short circuit and subsequent arc flash, electrical burns or equipment damage can occur if not handled properly.

Install the TB44 according to the aircraft manufacturer's instructions and the following steps:

3.4.1 Harness Preparation

Prepare aircraft wiring with mating connectors in accordance with the proper Wire Size and Type Recommendations (Table 3.1), Wiring Diagram (Figure 3.1), Connector Locations (Figure 3.2) and Pin Identification Diagrams (Figures 3.3, 3.4 and 3.5)

Use of PTFE, ETFE, TFE, PVDF, Teflon or Tefzel insulated wire is recommended for aircraft use. Recommended wire sizes and types are identified in Table 3.1 below. Standard reference for power cables and shielded cables are M22759 and M27500, respectively.

Wire Size and Type			
Wire Gauge	Wire type	Connector	Pins
000 AWG	Stranded Copper	Power	all
20-24 AWG	Stranded Copper	RTD Temp	all
20-24 AWG	Twisted, Shield Pair	Comm/Service	J, K
20-24 AWG	Stranded Copper	Comm/Service	remaining

Table 3.1

Wire Size and Type Recommendations

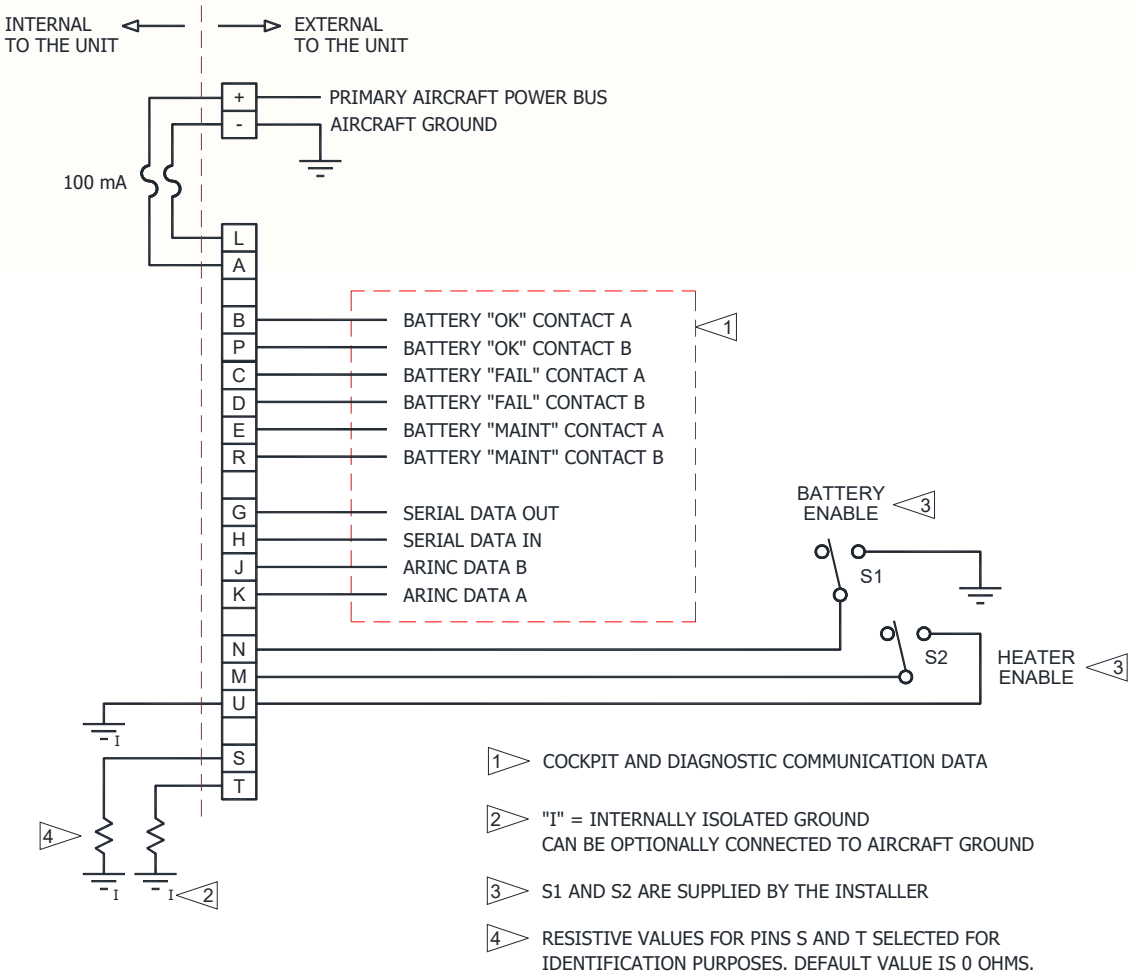


Figure 3.1

Wiring Diagram

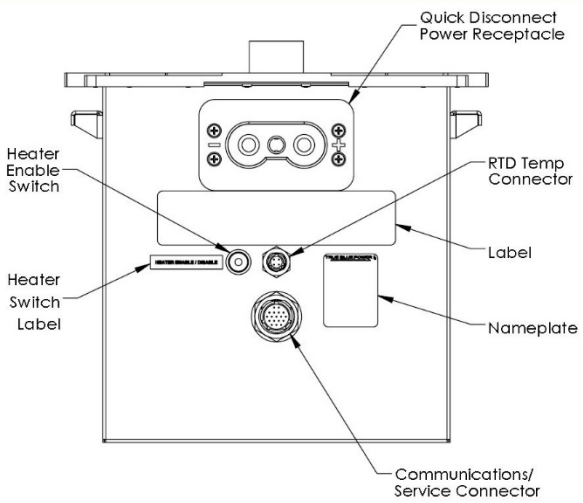
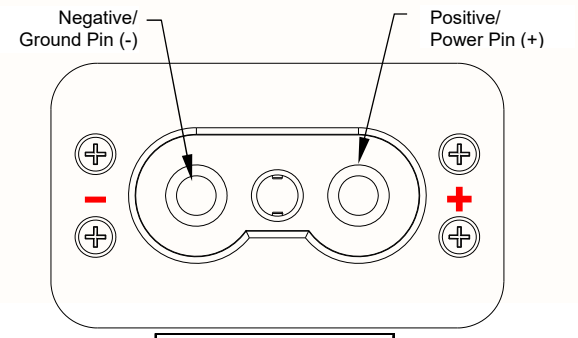


Figure 3.2
Connector Locations



Power Receptacle (2-pin)	
Pin	Pin Function
+	28VDC power in
-	aircraft ground

Figure 3.3
Power Connector

Comm/Service Connector (18-pin)	
Pin	Pin Function
A	Battery Pos (+) Terminal
B	Battery "OK" Contact A
C	Battery "FAIL" Contact A
D	Battery "FAIL" Contact B
E	Battery "MAINT" Contact A
F	Reserved
G	Serial Data Out
H	Serial Data In
J	ARINC Data Out B
K	ARINC Data Out A
L	Battery Neg (-) Terminal
M	Heater Enable
N	Battery Enable
P	Battery "OK" Contact B
R	Battery "MAINT" Contact B
S	Battery Identifier
T	Battery Identifier
U	Ground (Isolated)

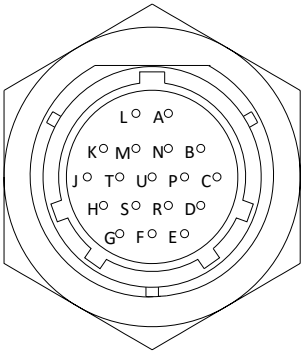


Figure 3.4
Comm/Service Connector

RTD Temp Connector (4-pin)	
Pin	Pin Function
A	Pin 1 of RTD 1
B	Pin 2 of RTD 1
C	Pin 1 of RTD 2
D	Pin 2 of RTD 2

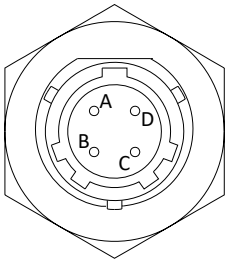


Figure 3.5
RTD Temp Connector

3.4.2 Securing the Unit

The TB44 is designed to be secured in the aircraft using hold-down tie rods. Attachment points are located on either side of the unit case and are detailed in Figure 3.6.

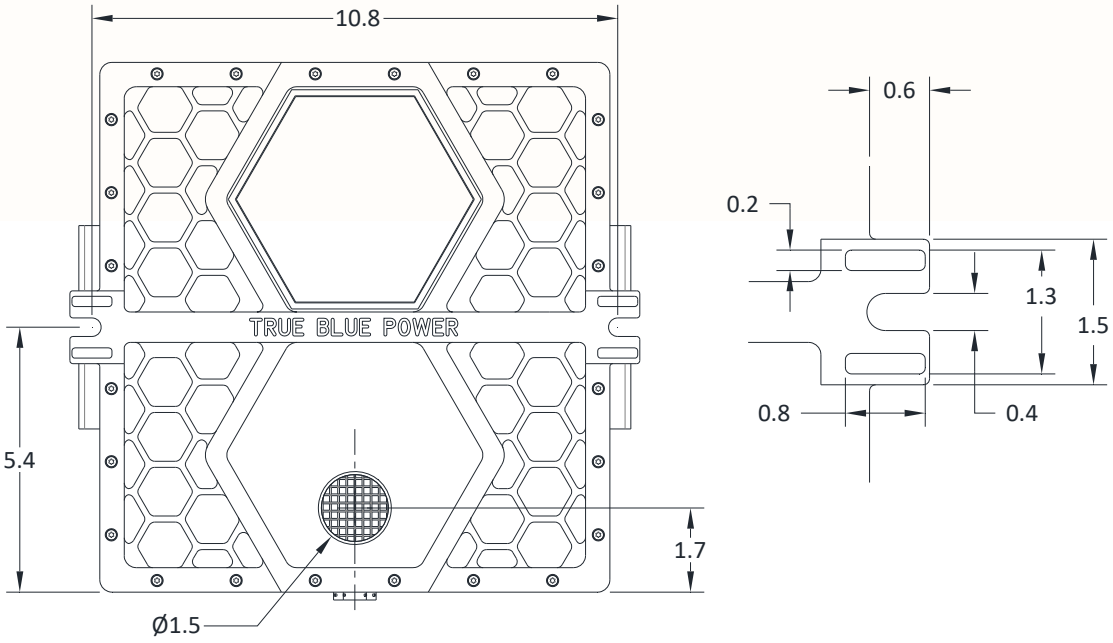


Figure 3.6

Hold Down Attachment Points Detail

3.4.3 Vent Installation

The TB44 is required to be operated with the vent tube in place when installed in the aircraft. The vent is located on the top of the lid of the unit, has an outer diameter of 1.50 inches and is 1.0 inch tall. It is recommended to use the vent tube and attachment hardware as provided in the Vent Kit, MCIA P/N 9018043. (Contact True Blue Power for potential alternatives) The vent tube must be properly and securely attached to an aircraft exit point which would allow any gaseous emissions to be vented overboard. Be sure to locate the vent where emitted gases would not be directed toward any of the aircraft's air intake points.

SECTION 4 OPERATION

4.1 DESCRIPTION

The True Blue Power TB44 Battery is designed to supply power for starting an aircraft engine and provide emergency backup power to aircraft systems in the event of primary power generation loss. It utilizes rechargeable Nanophosphate lithium-ion cells to provide approximately 26 volts DC and 44 Ampere-hours (Ah) of capacity (see Performance 4.4). It has a 2-pin power receptacle and provides battery temperature and communication/service information through a 4-pin and 18-pin circular connector, respectively.

4.2 CONSTRUCTION

4.2.1 Cells

The TB44 Advanced Lithium-ion Battery contains 152 individual cylindrical lithium-ion cells. Lithium-ion battery cells have a very high energy density, producing more power as comparable battery types in a significantly lighter package. The cell's high-performance Nanophosphate lithium-ion chemistry is a proprietary form of lithium iron phosphate ($LiFePO_4$). The lithium iron phosphate chemistry provides safety enhancements over alternative lithium technologies by producing a cell that is more abuse tolerant to external conditions like over-charge or short circuit. It has a very low self-discharge rate and is more stable with significantly less-energetic failure modes. The Nanophosphate advantage enhances typical lithium iron phosphate chemistries by providing exceptional power and energy. The combination of these characteristics makes it an excellent choice for use in aircraft applications.

4.2.2 Battery Modules

The TB44 is comprised of nineteen (19) individual Battery Modules in parallel. Each module contains eight (8) individual lithium-ion cells in series and the Module Management System (MMS) control and protection electronics. Each cell provides a nominal voltage of 3.3VDC, combining to produce a total voltage of 26.4VDC. Each module provides up to 80 amps of current and 2.4 amp-hours of energy/capacity. When combined in parallel, the battery can supply over 1500 amps of current and over 46 amp-hours of capacity at beginning of life (rated at 44 amp-hours). The MMS consists of two circuit boards with analog electronics to control cell balancing, monitoring and protection, and contains an integrated heater. These electronics ensure the health of the module and can stop charging or discharging in the event of a detected fault. The modules communicate status to the Central Monitoring System (CMS) for external reporting of the unit's overall health. There is no software or complex hardware in the battery module's MMS.

The independent design architecture of the modules allows for redundancy, continuing to provide appropriate voltage and only fractionally degraded total capacity or current in the event that a single or multiple modules should be taken offline due to a detected fault.

4.2.3 Central Monitoring System

There is a single Central Monitoring System (CMS) as part of the TB44 design that provides monitoring of the module status and provides communication external to the unit. The CMS contains a microprocessor and software that collects and stores monitored unit characteristics such as voltage, current, temperature and more. These are available and broadcast via the RS 232 (serial) or ARINC 429 communication protocols through the 18-pin communication/service connector. These can be accessed in real-time during operation or as part of maintenance and diagnostic activities. The CMS produces discrete voltage signals to communicate overall dynamic unit status as either “BATT OK”, “BATT MAINT”, or “BATT FAIL” indications. More information on communication capabilities can be found in Section 4.3.5.

4.2.4 Resistance Temperature Detectors

There are two Resistance Temperature Detectors (RTDs) in the unit that supply direct analog resistance through the 4-pin connector for independent temperature monitoring. Each RTD uses two pins of the connector (see Figure 3.5) and are characterized with a resistive (Ohms) output. The RTD has a resistance of 199.9 ohms at 60°C. Resistance will change with temperature; higher resistance for an increase in temperature and lower resistance for a decrease in temperature.

4.2.5 Case and Hardware

The TB44 is constructed with a high degree of intent and specific design. Material selections, component design, assembly process and testing are all part of the total delivery of the product that ensures performance and safety. In addition to the electrical components listed above, the mechanical construction plays a key role as well.

Copper bus bars are used to connect the individual modules and direct power to the 2-pin power connector. Temperature and electrical insulating materials are used between and around each module bank, as well as in the lid and base of the unit. The power connector is a custom design for performance purposes but maintains the same form factor as a standard MS3509 2-pin quick disconnect style connector. The case is constructed to address the unique needs of lithium technology. In particular, it is designed to direct emitted gases overboard, maintain a safe external temperature and pressure, contain any debris or flame, and ultimately to prevent any effect on its surroundings in the aircraft, even in the extremely rare occurrence of a worst-case failure scenario.

4.3 OPERATIONAL MODES

4.3.1 Pre-Heat

The TB44 has the ability to be operational at temperatures as low as -40°C utilizing the internal, self-powered heaters. The TB44 is likely to be able to support an engine start with no special considerations down to approximately -15°C. Below this temperature, the performance of the unit begins to decrease in current and energy delivery as the electrolyte in the cells begins to thicken and the internal impedance increases to retard ion flow. In order to address this, each MMS contains an individual heater which can be powered by the cells themselves,

even at very low temperatures. Pre-heat time will vary depending on temperature. The unit can be pre-heated in one of two ways. The unit's heaters can be enabled by pressing and holding the Heater Enable/Disable switch on the front of the unit for two seconds. The green LED light on the switch will indicate two states: a steady light indicates that the automated heater monitoring circuit is enabled; a blinking light indicates that the heaters are actively heating. When the heater monitoring circuit is enabled, the unit will monitor its own internal temperature and determine if the heater needs to be on or off. The heater comes on below -2°C and turns off at +5°C. The heater monitoring circuit will remain active for approximately two hours after manual activation. The heater function can be de-activated by pressing and quickly releasing the Heater Switch Enable/Disable switch.

The primary method to activate the heater is to use the Battery Enable and Heater Enable signals accessible through the 18-pin Comm/Service connector which is typically connected to a switch in the cockpit. When both are grounded, the heater function will become active. This method will also maintain the heater function in flight after the two-hour limit is reached following manual activation.

4.3.2 Engine Start

The TB44 Battery is rated for up to a 1500 amp discharge peak for the purpose of engine starting. The low internal impedance of the Nanophosphate lithium-ion chemistry allows extremely high current delivery while maintaining higher voltage than traditional battery types. This equates to a higher total power delivery, producing quicker starts, more start attempts as needed and a higher remaining battery capacity following engine start. In some applications this may help reduce wear and tear on electrical starters, hence reducing maintenance.

4.3.3 Maintaining Charge

After engine start, the unit recharges and maintains charge by accepting power from the aircraft power generation system. Depending on the amount of power used during engine start, the unit may draw as much as 400 amps while recharging. However, most typical engine starts will not significantly deplete the battery, thus minimizing the time at this peak recharge current.

4.3.4 Providing Aircraft Power

When the aircraft's power generation systems are offline or fail, the unit will provide immediate power to the equipment/loads on the associated power bus. As the unit's capacity is used, the voltage will begin to drop slightly until the unit is fully depleted. A fully charged unit will initially provide approximately 27 volts. It will provide an average of approximately 24 to 26 volts for the duration of discharge, then decay near end of discharge. When the unit's voltage reaches approximately 19 volts, the unit's under-voltage protection will shut off the unit's output. See Section 4.4 Performance for more details of the unit's behavior.

In order to avoid depleting the unit's power and ensure availability for the next flight, be sure to turn off all aircraft systems, lights and accessories after a flight. A ground power cart that is turned off can act as a resistive load that can completely discharge the battery if it remains electrically connected. If the unit is depleted, see Section 5.2.3 Charging for charging instructions.

4.3.5 Active Monitoring

During ground operations or in flight, the TB44 presents a wide array of information available to the aircraft for display and monitoring on appropriate systems. These are supplied as discrete analog signals and/or ARINC 429 data. The various outputs and their definition are supplied in Table 4.1 and 4.2 on page 18. Connections within the 18-pin Comm/Service connector for each of these outputs are listed in Figure 3.4.

The discrete signals are defined by internal relay contacts (rated for 1A) which are normally closed for the BATT OK signal and normally open for BATT MAINT and BATT FAIL signals.

Contact Name	Normal	Fault	Independent Fault Conditions
BATT OK	Contact closed	Contact open	Battery voltage is below 22V Battery voltage is 30V of greater for 10 seconds Faulted Module code of 4 or more BATT FAIL signal is active Estimated Capacity is 32Ah or less
BATT MAINT	Contact open -3 version: contact is always closed	Contact closed	One or more faulted modules Heater or heater control fault Battery impedance is greater than 15 mOhms BATT OK signal is inactive/open BATT FAIL signal is active
BATT FAIL	Contact open	Contact closed	Battery current has exceeded its limit of 1600A discharge or 1000A charge for 5 seconds

Table 4.1

Discrete Signal Definition

The ARINC 429 data is presented in low speed transmission rate (12.5 kb/sec) with an update sent out once every two seconds. No product ID is sent.

Label	Measurement Description	Units	Significant Bits	Range
275	Number of Failed Modules	count	8	256
277	Battery Voltage	mV	16	65536
301	Battery Current	amp	15	±32768
304	Overall Battery Temperature	°C	15	±256
305	Highest Temperature in the Battery (currently)	°C	15	±256
312	Battery State of Charge	%	7	128
315	Remaining Capacity	Ah	18	262.144

Table 4.2

ARINC 429 Data Label Definition

4.4 PERFORMANCE

4.4.1 Capacity

Capacity is a measurement of the energy stored in the battery and most often is used to determine the length of time a particular electrical load can be operated. A standard measure of rechargeable battery capacity involves both the current-over-time performance (measured in amp-hours) and also the “C” rate.

The C rate is a function of the size of the load in relation to the capability of the battery. A 1C rate corresponds to a constant current load in amps which the battery can supply for one hour. The TB44 has a 1C rating of 44 amp-hours (Ah) and thus can supply 44 amps for one hour. Note that many typical lead acid batteries, and some lithium systems as well, are defined at a 1/20th (0.05) or 1/10th (0.1) C-rate. This is defined as the constant load that can be applied over 20 or 10 hours, respectively. For example, a battery rated at 44 Ah at a 0.1 C-rate can deliver 4.4A for 10 hours (4.4A x 10 hours = 44Ah). However, that same system typically does not perform linearly at higher C-rates. As an example, a 44Ah battery rated at 0.1C may typically only support a 44A load for 45 minutes, not a full hour. The capacity for these types of batteries is generally defined by a logarithmic function of load versus time. So, when doubling the load, the battery will typically last significantly less than half the time.

One of the significant advantages to the Nanophosphate lithium-ion technology is its constant capacity versus load. As the load on the TB44 increases, it maintains its capacity rating proportionately. As an example, if the standard 1C load of 44A is doubled to the 2C load of 88A, the time is proportionally cut in half to 30 minutes. Doubling the load again to 176A would deplete the battery in 15 minutes.

4.4.2 Temperature Performance

The TB44 incorporates cell technology that performs well throughout temperature extremes. It provides full rated current and capacity performance from as low as -15°C (5°F). Cold temperature performance may be extended to as low as -40°C (-40°F) when using the internally powered heater and allowing the appropriate pre-heat time. This feature prevents the need to remove the unit from the aircraft when stored at extremely low temperatures overnight or for longer periods of time. It also exhibits excellent high temperature performance, as high as +70°C (+158°F). However, storage at higher temperatures should be avoided as it may increase the self-discharge rate of the battery. Refer to Section 5.4 for further information.

4.4.3 Life Expectancy

Estimated life for the TB44 Advanced Lithium-ion Battery is expected to exceed six (6) years. The unit has reliably demonstrated over 7000+ engine starts and subsequent charge cycles. The cells are designed for a useful life of up to ten (10) calendar years as well. Actual life will vary depending on application and use and is most often degraded by long-term exposure to elevated temperatures.

SECTION 5 CONFORMANCE

5.1 DISPATCH VERIFICATION AND IN-FLIGHT MONITORING

The TB44 typically serves two primary purposes on an aircraft: engine start and emergency backup power.

- Availability for Engine Start: In order to attempt an engine start, user must verify that the "BATT OK" signal is active and that the "BATT FAIL" signal is not active.
- Dispatch for Emergency Backup Power: If the aircraft has a minimum backup power requirement for loss of aircraft electrical generation in emergency operation, the user may need to verify battery capacity prior to flight. This can be confirmed using the available capacity and state of charge information that are part of the TB44 communication data available to the aircraft. However, if the aircraft is not configured to display this information, the "BATT OK" signal or other means which verify sufficient capacity (such as a regularly scheduled and performed maintenance check) may be sufficient.

During flight, the TB44 is capable of providing a number of status indications and battery health monitoring information to the cockpit or crew through its data communication outputs.

- In-Flight Monitoring: At a minimum, the TB44 shall be installed such that the "BATT OK" signal and "BATT FAIL" signal are available for display to the cockpit. The display of the "BATT MAINT" signal and other data communications are optional. The following are recommended actions based on in-flight annunciation.
  - BATT OK: Active for normal flight conditions
  - Loss of BATT OK: Present the battery for maintenance evaluation upon landing
  - BATT MAINT: Present the battery for maintenance evaluation upon landing (Not applicable for -3 version - Batt MAINT signal is always active during normal operations.)
  - BATT FAIL: Land as soon as possible and present the battery for maintenance evaluation

If using MCIA P/N MD41-1844 ACU, refer to its installation manual for monitoring TB44 annunciations.

5.2 ROUTINE MAINTENANCE

The TB44 requires scheduled maintenance based on calendar life of the battery. Maintenance as described in this section is recommended to be conducted every 24 months from date of original aircraft delivery or subsequent new battery installation. However, this maintenance interval may be extended by the aircraft manufacturer based on engineering test data, field data, or service history. A fully charged battery, if left unused for more than 3 months, whether installed or not, MUST be fully recharged following the procedure set forth in Section 5.2.3.

5.2.1 Visual Inspection

A. With the aircraft's main bus active, verify that proper communication is being presented to the cockpit to validate that the battery is transmitting data appropriately.

CAUTION

It is recommended that the vent port be capped or otherwise covered when the aircraft's vent tube is uninstalled and/or the battery is removed from the aircraft.

Do not remove the lid. Removal of the lid could degrade the battery's containment protection features and will void the battery's warranty.

B. Remove the unit from the aircraft. Visually inspect the exterior of the battery casing for signs of damage or wear. Verify that the lid is secure and not loose. Verify that no damage has occurred which would prevent the battery from maintaining its air-tight seal. If any wear is apparent which has not compromised the case, inspect the battery area of the aircraft for any signs of improper installation.

C. Check the battery for any odors or signs of fluid residue. Reference manufacturer's Safety Data Sheet (SDS) if any is observed.

D. Visually inspect the battery connectors, including the power terminals, RTD Temp connector and Comm/Service connector. Verify that no connectors are loose and there are no signs of damage, excessive wear or corrosion.

E. If any of the above conditions are present, the unit must be evaluated and tested for repair or replacement by an authorized repair facility.

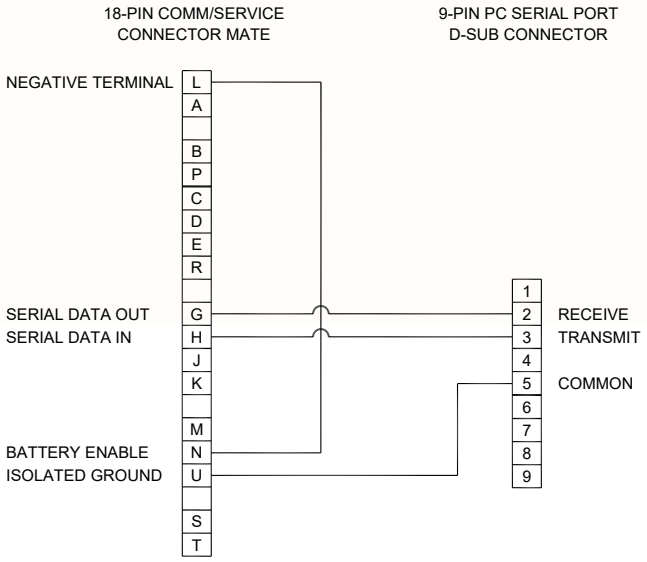
5.2.2 Create a Log File

A. With each scheduled maintenance action, it is required to create a log file of the battery's internal memory and send it to the manufacturer for data collection and analysis. The contents of the log file may help identify any potential performance concerns.

B. Use Service Cable (MCIA P/N 9018044) or create a service cable to interface with the battery.

i. Required materials include:
- 18-pin Comm/Service connector mate
- 9-pin D-Sub connector (female shell/male pins)
- 4-wire cable (20-26 AWG; recommended 48 inches)
- Appropriate crimping and/or soldering tools to construct cable

ii. Construct the cable according to the following diagram:



C. Connect the 9-pin PC Connector of the Service Cable to the Serial Port of a Windows PC, then connect the opposite end to the 18-pin Comm/Service Connector of the unit.

i. If your computer does not have a 9-pin serial connector, use the Serial-to-USB Converter Cable (MCIA P/N 9018046) or procure a generic serial-to-USB converter cable (capable of ±12V).

D. Establish a serial connection between your PC and the unit.

i. Download PuTTY (putty.exe), a serial interface program from the following website:
http://www.putty.org
The program is free and should be saved in a known location on your PC for future use.

ii. Open PuTTY by double-clicking the “putty.exe” file previously downloaded. Select “Run”.

iii. Configure PuTTY using the following steps and parameters:

a. Select “Serial” under the “Connection” items from the navigation list on the left
b. For “Serial line to connect to”, enter: COM1
NOTE: If you are using a USB connection, the serial input may not be COM1. Review the Ports category in the computer’s Device Manager to verify.
c. For “Speed (baud)” rate, enter: 19200
d. For “Data Bits”, enter: 8
e. For “Stop Bits”, enter: 1
f. For “Parity”, select: None
g. For “Flow Control”, select: None
h. Select “Session” from the navigation list on the left
i. Under “Connection Type” on the top right, click on the “Serial” option
j. In the “Saved Sessions” field, enter a name (i.e. “TB44 Interface” or similar) and click Save. This will save your settings for future use.
k. Click “OPEN”.
l. You should now see a terminal window open. Press the ENTER key twice and the TB44 should respond with a prompt for entering serial commands.
m.

E. Capture the log file.

i. In the terminal window previously started in Step D, enter the following commands at the prompt, one at a time, following the results of each:
a. **read sn** (The response should match the battery s/n on the nameplate)
b. **read cms-sn** (The response should match the battery serial number)
c. **read fw-rev**
d. **read capacity** (The response will be the estimated battery capacity reported in mAh.)
e. **read log**

F. Save the log file
   i. Right-click the title bar of the terminal window and select “Copy All to Clipboard”
   ii. Open a blank Microsoft Word or Notebook file.
   iii. Paste the contents of the log file into the new file.
   iv. Save the file to a known location using the following naming format using the current date of download with the appropriate file extension (either .doc, .docx, or .txt):

   “TB44” (unit serial number) (MM-DD-YYYY) “log file”.(extension)
   Example: TB44 B13-00176 06-22-2013 log file.docx

G. Send the log file by submitting electronically to True Blue Power at: TB44Service@mcico.com

5.2.3 Charging

WARNING

The power terminals of the TB44 are always active and energized.
DO NOT SHORT TERMINALS AT ANY TIME!

Extreme care and caution should be used when handling and connecting to the unit. Danger of short circuit and subsequent arc flash, electrical burns or equipment damage can occur if not handled properly.

In order to charge the unit on the ground for capacity checks, recharges or extending storage, follow the steps listed below:

A. If battery voltage is less than 8 VDC, do not charge and contact manufacturer for additional instructions.
B. Press the Heater Enable/Disable switch on the front of the battery (green light should illuminate continuously). If green light does not illuminate, contact manufacturer for additional instructions.
C. Set the power supply to a constant voltage of 28.5 VDC. (avoid charge voltages over 30V)
D. (If using a Christie RF80-K, see Alternate Method at the end of this section).
E. Limit the maximum current of the power supply to 60 amps or less. If the battery is fully discharged, it may accept minimal charge current initially before charging at the maximum rate.
F. Charge the battery until the charge current tapers to less than 1.0 amp.

Alternate Method:

A. With power turned off on the Christie RF80-K, connect the Battery to the RF80-K.
B. Set the Mode Switch to “CHARGE” and the Charge Method Switch to “12 (CONSTANT POTENTIAL / CELLS LEAD ACID)”.

CAUTION

DO NOT use the “CONSTANT CURRENT” or “REFLEX” settings.
This will damage the battery.

C. Make sure CHARGE CURRENT and DISCHAGE CURRENT pots are turned fully CCW
D. Turn on AC power to the RF80-K.
E. Press cycle reset to start the charge.
F. With this method, the voltage will start at approximately 26VDC and a current of 60A. It will rise to approximately 29 VDC as the current drops.
G. Charge the battery until the charge current tapers to less than 1.0 amp.
H. After charging, measure and verify that the voltage on the unit’s power terminals is greater than 25.6 VDC. **If it is less than 25.6V, return unit to an authorized repair facility.**

5.2.4 Capacity Check

A. Ensure that the unit is charged per Section 5.2.3 Charging.
B. Battery and room temperature should be at 23°C ±5°C (64-82°F) for accurate results.
C. Apply a constant current load of 44 amps to discharge the battery.
D. Monitor the time (in minutes) from initially applying the constant current load in Step C until the unit has discharged down to 20.0 VDC on the output.
E. Remove the load from the battery and record the total discharge time.
F. Recharge the battery per 5.2.3 Charging.
G. Calculate the capacity in amp-hours (Ah) and milli-amp-hours (mAh):
    i. Discharge time (in hours) = discharge minutes / 60
    ii. Capacity (Ah) = (amps) x (hours) = (44 amps) x (Discharge time)
    iii. Capacity (mAh) = (Capacity in amp-hours) * 1000
H. The battery must be capable of supporting the aircraft’s emergency electrical load (usually found in the aircraft maintenance manual) for the required amount of time. One typical aviation value for minimum required capacity is 80% of rated capacity (i.e. 44Ah x 80% = 35.2Ah). However, this can vary by application and could require more or less capacity to meet regulatory minimums.

5.2.5 Estimated Capacity Update

With each capacity check, the internal memory of the TB44 Aircraft Battery ***MUST*** be updated with actual measured capacity to avoid erroneous faults and provide more accurate capacity information to the cockpit as part of the unit's communication data. If the Estimated Battery Capacity value falls to 32Ah (32000mAh) or below, a low capacity status will be latched and the BATT OK status will be removed requiring the battery to be returned to the manufacturer for service. The Estimated Battery Capacity value should be checked more frequently as the value approaches 32 Ah,

A. Connect the unit to a PC and establish a serial data connection per Section 5.2.2.C. and 5.2.2.D.
B. Once the terminal window is active on the PC, enter the following command at the prompt:

write capacity XXXXX

(where XXXXX = calculated capacity in milli-amp-hours (mAh) from Step 5.2.4.G.)

CAUTION

All five characters representing capacity must be entered or the unit may latch into a fault state that requires authorized service action.

C. When the unit receives and accepts the write capacity command, the terminal prompt will return "ok". Issue the **read capacity** command to verify that it matches the entered value.

D. Exit the PuTTY terminal window and disconnect the Service Cable from the unit.

5.2.6 Return To Service

A. Recharge the unit per 5.2.3 Charging if not already performed.
B. Re-install the unit in the aircraft, including securing it via proper hold-downs, mating the electrical connections, and verifying proper vent attachment.
C. Record service action in the aircraft maintenance log.

5.3 COMPONENT MAINTENANCE

The cells, electronics, and other components that comprise the TB44 battery are not user replaceable items. Therefore, data is not available from the manufacturer to conduct field repairs. Contact True Blue Power for return to manufacturer for service.

5.4 STORAGE INFORMATION

Although the lithium Nanophosphate cells used in the TB44 maintain an extremely low relative self-discharge rate, all batteries will slowly self-discharge if left unused for long periods. In addition, self-discharge rates are directly related to the storage temperature. Higher storage temperatures will result in faster self-discharge rates. Recommended maximum storage temperature is 30°C (86°F) or less.

Rechargeable lithium-ion batteries must be stored in a dry, well-ventilated area. They should not be kept in the same area as highly flammable materials. The unit can be stored in the same area as other battery types. The TB44 does not emit or absorb any gas during storage, transportation, or during normal operating conditions.

CAUTION

The unit may be shipped at approximately 30% state of charge (SOC). Upon receipt, the battery MUST be fully charged using the procedures listed in this manual (prior to storage and again prior to installation/use).

SHELF LIFE: Batteries that are stored MUST be fully recharged at a minimum every 3 months, following the procedure set forth in Section 5.2.3. If the storage time is unknown, a battery should be recharged prior to reaching 20V. If the battery voltage is less than 8 VDC contact manufacturer for additional instructions before charging.

STORAGE TEMPERATURE: Exposure to temperatures above 30°C (86°F) for sustained periods of time are possible, but may increase the self-discharge rate or result in some permanent loss of capacity. Storage temperatures above 50ºC (122°F) are to be avoided.

5.5 END OF LIFE

Estimated life for the TB44 Advanced Lithium-ion Battery is expected to exceed six (6) years. The unit has reliably demonstrated over 7000+ engine starts and subsequent charge cycles. The cells themselves are designed for a useful life of up to ten (10) calendar years.

The following conditions will help maintain or extend the life and performance of your product:

- Avoid significant exposure to high temperatures (above 38°C/100°F) during operation or storage
- Avoid long periods (greater than 7 days) without charging after a full discharge
- Avoid long periods of storage (greater than 3 months) without recharge

End of life is determined when the unit fails to meet the minimum capacity requirement of the aircraft as tested during the capacity verification per Section 5.2.4. In the event that the unit exhibits failure, insufficient capacity or expired life, contact an authorized True Blue Power maintenance provider for repair, exchange or replacement. Visit www.truebluepowerusa.com for more information.

5.6 DISPOSAL

NOTE: All lithium-ion batteries are classified by the United States government as non-hazardous waste and are safe for disposal as normal municipal waste. However, these batteries do contain recyclable materials and recycling options available in your local area should be considered when disposing of this product. Dispose of in accordance with local and federal laws and regulations. Do not incinerate.

5.7 ENVIRONMENTAL QUALIFICATION STATEMENT

MODEL NUMBER: TB44 Series **PART NUMBER:** 6430044-( )
DESCRIPTION: Advanced lithium-ion Aircraft Battery **CERTIFICATION:** FAA TSO-C179a
MANUFACTURER: True Blue Power, a division of Mid-Continent Instrument Co., Inc.
ADDRESS: 9400 E. 34th St. North, Wichita, KS 67226, USA.
SPECIFICATION: Test Specification (TS) 363 & 364 Test Data Sheet (TDS) 363 & 364
STANDARD: RTCA DO-160, Rev G, dated 12/08/10

CONDITIONS	SECTION	DESCRIPTION OF TEST
Temperature and Altitude	4	Category F2
Temperature Variation	5	Category X
Humidity	6	Category B
Operational Shock and Crash Safety	7	Category B
Vibration	8	Fixed Wing: Category S; Curve C Rotorcraft: Category R; Curve G
Explosion	9	Category H
Waterproofness	10	Category R
Fluids	11	Category F
Sand and Dust	12	Category X
Fungus	13	Category F
Salt Fog	14	Category S
Magnetic Effect	15	Category Z
Power Input	16	Category Z(XX)
Voltage Spike	17	Category A
Audio Frequency Conducted Susceptibility	18	Category Z
Induced Signal Susceptibility	19	Category ZW
Radio Frequency Susceptibility	20	Category RR
Emission of Radio Freq Energy	21	Category L
Lightning Induced Transient Susceptibility	22	Category A3J3L3
Lightning Direct Effects	23	Category X
Icing	24	Category B
ESD	25	Category A
Fire, Flammability	26	Category C

REMARKS:
Section 4: Category F2 with excursions as declared by the manufacturer:

- 4.6.2: Decompression +8,000 feet

Section 5: Temperature Variation was substituted with Section 3.5 of RTCA DO-311, Temperature Shock.

Section 11: Fluid classes include fuels, hydraulic fluids, lubricating oils, solvents/cleaning fluids, de-icing and sullage