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SERVICE MANUAL
AND
INSTRUCTIONS FOR
CONTINUED AIRWORTHINESS
FOR THE
TB60 LITHIUM-ION BATTERY

STC SA02031WI

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LOG OF REVISIONS

Rev	Pages	Description	Date
A	All	Initial Release.	7/12/2024
B	52	Updated Appedix A Wiring Diagram.	8/8/2024

View most current revision of this ICA at www.wipaire.com.

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SECTION 1 INTRODUCTION

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this manual is to describe the unique maintenance procedures related to the installation of the True-Blue Power TB60 Advanced Lithium-ion Battery in the Air Tractor AT-802, AT-802A, or AT-602 aircraft. This manual will present any specific maintenance considerations that are not already addressed by the aircraft maintenance manual (AMM).

Modification of an aircraft with the implementation of this Supplemental Type Certificate (STC) obligates the operator to include the maintenance items identified within this document into their existing maintenance program to retain the aircraft is an airworthy condition as specified by 14 Code of Federal Regulations (14 CFR) §43.16 "Airworthiness Limitations."

It is therefore the responsibility of the owner/operator to ensure the latest revisions of all documents specified are utilized during operation, maintenance, and servicing.

The service products referred to throughout this manual are described by their trade name and may be purchased from the Wipaire Parts Department. For service and repair not covered by this manual, contact Wipaire Customer Service.

To contact Wipaire for technical support or parts sales, call, write or email:

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When a part is significantly changed, or an additional inspection is recommended or required, a service letter and/or kit may be issed. If a warranty is issued, most commonly, it is for an 18 month time period. It is crucial to check for service letters at each periodic inspection to be eligible.

Service manuals and installation documents are revised periodically and need to be kept updated. This service manual is reissued in its entirety. The revision level, page number, and number of pages are marked on each page; revised text is indicated by a vertical black line along the outer margin. The most current revision of service letters, service kits, and service manuals are maintained and distributed online at www.wipaire.com.

NOTE
It is critical to check for manual updates each time an inspection is executed.

1.2 DEFINITIONS AND ACRONYMS

Ah	Amp-Hour
AMM	Aircraft Maintenance Manual
BAT	Battery
CFR	Code of Federal Regulations
CID	Custom Instrument Definition
ESD	Electrostatic Discharge
FAA	Federal Aviation Administration
ICA	Instructions for Continued Airworthiness
IM	Installation and Operation Manual
LED	Light Emitting Diode
SOC	State of Charge
STC	Supplemental Type Certificate
USB	Universal Serial Bus
VDC	Volts Direct Current

1.3 REFERENCE DOCUMENTS

Source	Document	Title
True Blue Power	9019485 Rev C	TB60 Installation Manual, dated June 23, 2022
	9019161	MD23 Installation Manual and Operating Instructions Rev A, dated September 9, 2020
	UG1004	MD23 TBX Battery Monitor Users Guide

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SECTION 2 SYSTEM DESCRIPTION

CONTENTS

2.0 SYSTEM DESCRIPTION

2.1 EQUIPMENT OVERVIEW

The True Blue TB60 Advanced Lithium-Ion Battery is a replacement for the three Gill G-246 batteries located forward of the firewall. The TB60 is a rechargeable, Nanophospahte lithium-ion storage battery. The benefit of using the TB60 is reduced weight (approximately 72 lbs weight savings); no required maintenance; and a life expectancy of at least 6 years. The TB60 Battery is rated for up to a 1445 Amp discharge peak. 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 than a traditional battery.

This STC installed the battery in the location of the center original battery. The TB60 required a redesigned mounting rack. Wiring and connectors for the battery were re-used as practical. A battery status display was added to the flight deck for battery health and information. Because the TB60 is installed in the engine fire zone forward of the firewall, the battery is protected from an engine fire by a fire-resistant battery box.

The existing battery control switch located on the lower right of the instrument panel continues to be used to open and close the battery contactor that removes and attaches the main battery to the aircraft's battery buses. The existing aircraft's battery relay contactor is used to enable the lithium-ion battery's internal processor and heater circuitry. This modification made no change to the Air Tractor AT-602/802/802A electrical distribution system. A general comparison of the existing Gill G-246 batteries and the new TB60 is shown in Table 2-1.

	OEM SLA Battery Gill G-246 (x3 batteries)	**STC Battery Tru Blue TB60**
Chemistry	Sealed Lead Acid Recombinant Gas	Lithium Iron Phosphate
Nominal Voltage	24.0VDC	28.8VDC
Peak Current Output	250A each	1445A
Weight	41.5 lbs each	52.9 lbs
Capacity Check	18 months / 1800 hours initial, 9 months / 900 hours subsequent	On Condition
Rated 1C Capacity (23°C)	19 Ah each	60 Ah
Total Life	3 years	6 years
Dimensions	9.5" x 7.1" x 7.5"	12.1" x 11.6" x 9.2"

TABLE 2-1 - COMPARISON OF THE TB60 AND OEM BATTERY

2.2 SYSTEM COMPONENTS

The TB60 is installed in a battery box on a battery shelf in the same location as the removed center-position lead-acid battery by attachment to exisiting aircraft structure on the forward side of the firewall in the engine equipment bay in Figure 2-1. Access is gained by removing the upper cowl. Table 2-2 identifies the battery and components installed on the Air Tractor.

Component	Qty	Location	Model	Part Number
TB60 Advanced Lithium-ion Battery	1	Forward Firewall Equipment Bay	TB60	6431060-()
Battery Hold Down Assembly	1		N/A	N/A
Battery Shelf Assembly	1		N/A	N/A
Vent Tube Assembly	1		N/A	N/A
Battery Box Assembly	1		N/A	N/A
MD23 Battery Monitor	1	Instrument Panel	MD23	6420023-1

TABLE 2-2 - INSTALLED COMPONENTS

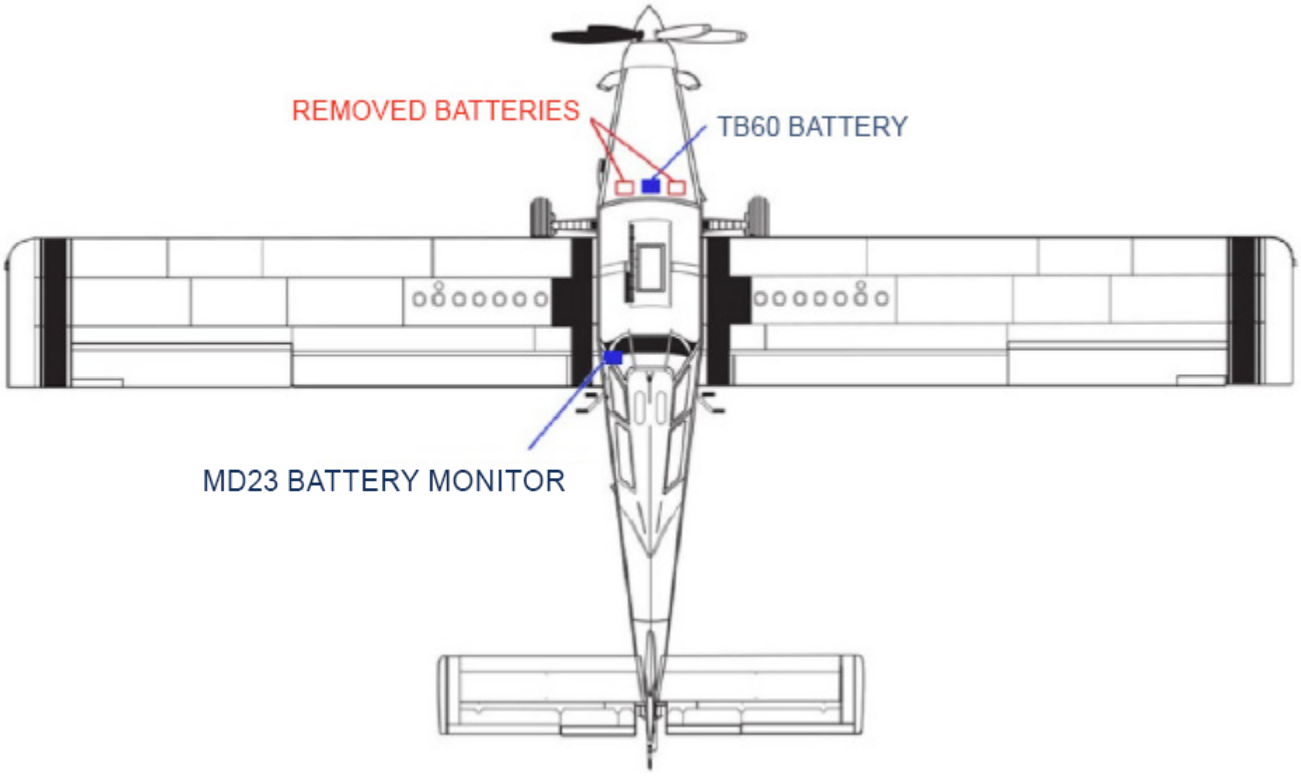

FIGURE 2-1: COMPONENT LOCATIONS

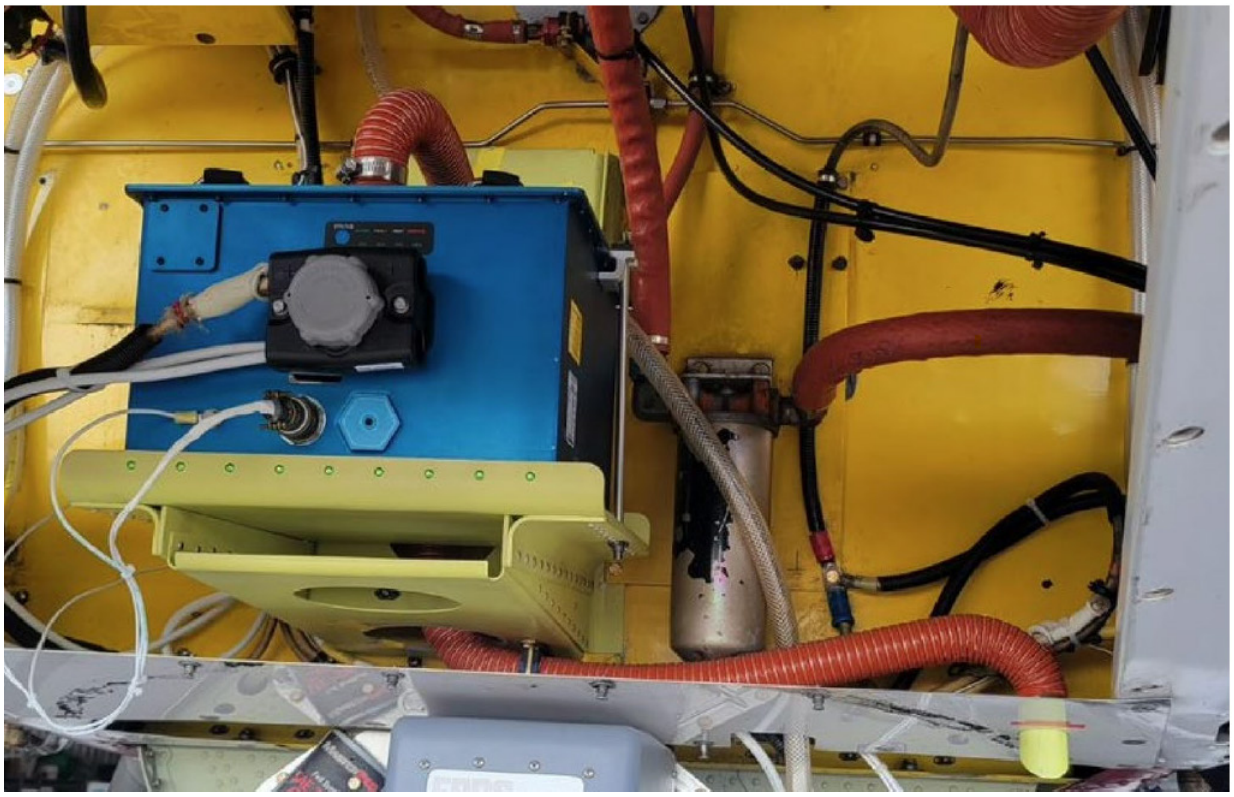

FIGURE 2-2: BATTERY INSTALLATION (SHOWN WITHOUT BATTERY BOX)

2.2.1 VENT TUBE ASSEMBLY

A structural modification to the airframe was made to accommodate the installation of a TB60 battery vent tube. The TB60 battery requires no flow through ventilation and is equipped with a single overboard discharge vent. The lead-acid battery flow-thru vent lines and battery box drain valve (shown in Figure 2-3) are replaced by a 1 1/2" diameter discharge hose and stainless steel vent as shown in Figure 2-4. The TB60 vent is installed in the location vacated by the lead-acid battery drain line valve on the underside of the engine compartment.

The bracket vacated by the existing battery drain line was removed and replaced by a new bracket using the existing holes in the structure. This new bracket secures the flexible duct material and fire sleeve just inside the aircraft skin. No modification to the existing structure of aircraft skin was required to install the duct.

FIGURE 2-3: VENT TUBE LOCATION

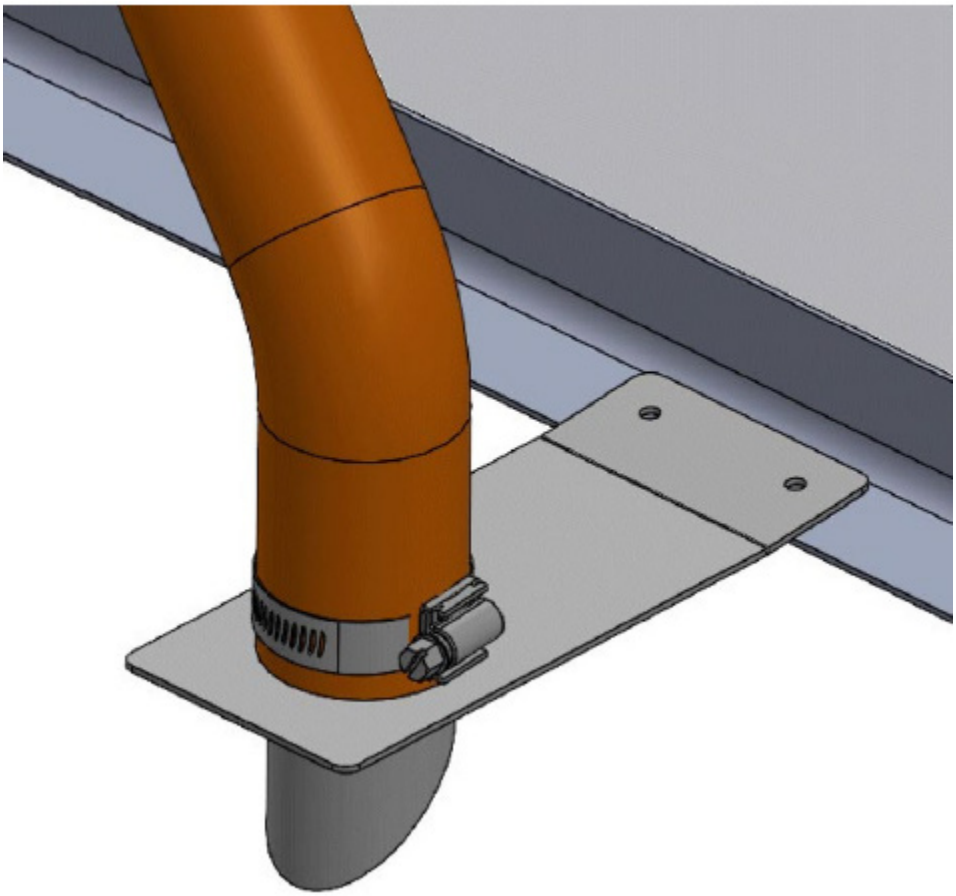

FIGURE 2-4: NEW VENT CONFIGURATION

2.2.2 BATTERY ENCLOSURE

The TB60 battery is installed in the engine accessory compartment of the Air Tractor models, a designated fire zone. A stainless-steel battery box protects the battery in the event of an engine fire. This cover mitigates the risk of damage to the battery or additional fire propagation. The TB60 battery installed within the battery enclosure is shown in Figure 2-5.

The discharge hose for overhead venting is also encased in firesleeve (Eaton Aeroquip Aerospace Firesleeve p/n AE102-24 or equivalent) for fire protection in the engine accessory's compartment.

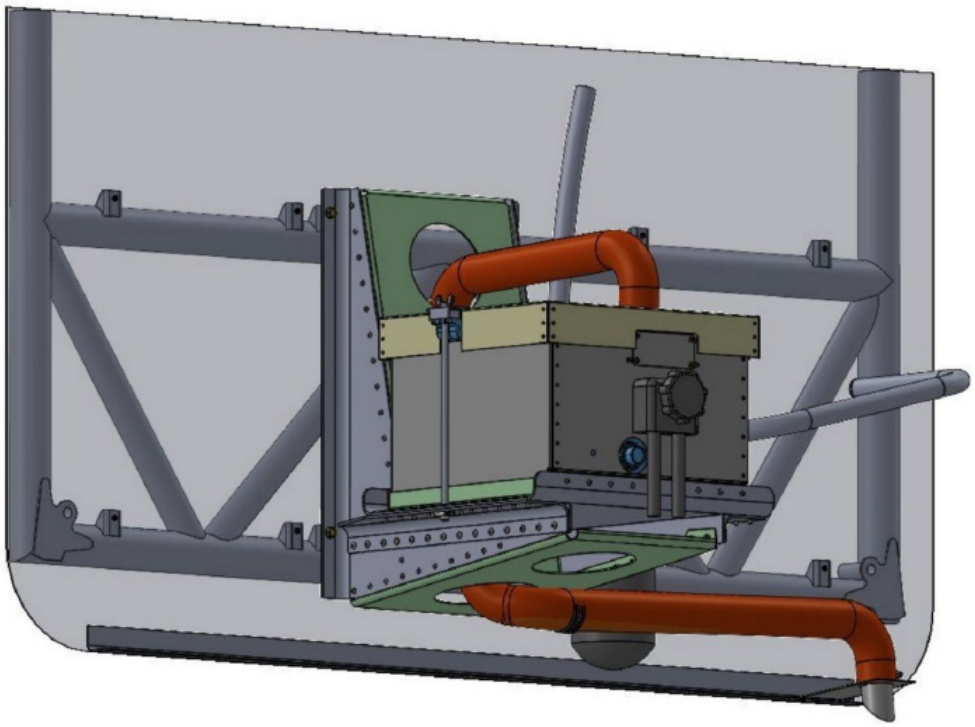

FIGURE 2-5: BATTERY ENCLOSURE INSTALLATION

2.2.3 MD23 BATTERY MONITOR

The MD23 Battery Monitor provides constant monitoring of battery voltage, current temperature, and state of charge. The unit also provides annunciation of battery faults, maintenance advisories, and low state of charge. The unit is mounted in a 2.25" hole in the instrument panel within the primary field of view of the pilot.

FIGURE 2-6: MD23 BATTERY MONITOR

The MD23 is installed in a central location on the instrument panel which is easily visable to the pilot.

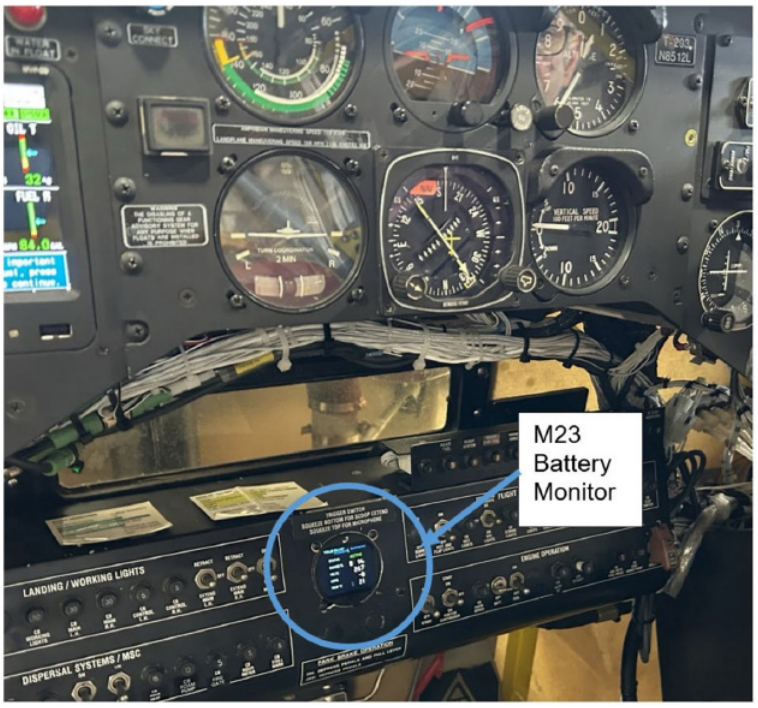

FIGURE 2-7: MD23 INSTALLATION LOCATION

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SECTION 3 SYSTEM OPERATION AND CONTROL

CONTENTS

3.0 SYSTEM OPERATION AND CONTROL

3.1 TB60 BATTERY

A summary of the battery operation is included below. More information about the TB60 operation can be found in the TB60 Installation and Operation Manual (IM).

3.1.1 OPERATIONAL MODES

The TB60 Battery has three basic modes of operation: Sleep, Control, and Active mode. These modes, and associated functionality, are explained in the following sections.

3.1.1.1 SLEEP MODE

Sleep Mode is used to disable the power output of the battery and reduce internal energy consumption to preserve resting state of charge (SOC). When the battery is in Sleep Mode, the battery is not charging or discharging, the internal battery heaters are inactive, all active communications are disabled, and internal energy consumption is reduced by 90% with respect to Active Mode.

In Sleep Mode, up to 30mA of power is available that enables low power devices to operate without causing the battery to transition to Active Mode. The battery is also capable of monitoring the terminals for an external load or charge and the external control discrete inputs (battery disable and heater disable) while in Sleep Mode.

The battery will enter Sleep Mode when the Battery Disable control discrete is engaged (closed), when the battery is inactive or when the STATUS/SOC button is held for 3 seconds. The battery is inactive when all of the following conditions are true:

- Internal battery voltage is less than 27.5VDC (unless STATUS/SOC button is held for 3 seconds while in Active Mode)
- Five minutes after:
    - No charge or discharge (<600 mA)
    - No protections actively being applied.
    - Pre-heat cycle is off.

3.1.1.2 ACTIVE MODE

In Active Mode, the battery is fully functional and available to provide power barring no protections are being enforced and the battery is operating properly. In Active Mode, the battery continuously monitors all cells and battery conditions to manage operation and mitigate exceedances as needed through its various protection methods. Data and status are available through the communication connector and the heater is available in cold conditions while in Active Mode. The major functions available during Active Mode include Heating and Pre-Heat Cycle (Section 3.1.2), Engine Start (Section 3.1.3), Maintaining Charge (Section 3.1.4), Providing Aircraft Power (Section 3.1.5), and all automatic Battery Protection functions (Section 6.1).

3.1.1.3 CONTROL MODE

Control Mode is reserved exclusively for the following interactions with the battery:

- Battery Software Update (IM Section 6.3.1)
- Installing Custom Programmable Parameters (IM Section 6.3.2, 6.3.3)
- Downloading Custom Programmable Parameters (IM Section 3.4.4)
- Downloading Event Log (IM Section 6.3.4)

Control Mode is not available or accessible in flight. In order to enter Control Mode, the battery must not be charging or discharging, the service button must be pressed, and a valid USB flash drive must be present in the USB port.

Additional information regarding the customization of the configuration parameters can be found within the TB60 Installation Manual. This STC requires that the batteries are configured to output a discrete signal that determines when the minimum state of charge is below 80%.

Information regarding software updates, is found in Section 6.3.

3.1.2 BATTERY HEAT

The TB60 modules contain internal heaters to allow for cold weather operation. The TB60 is able to support an engine start with no special considerations down to -5°C. Below this temperature, the performance of the unit begins to decrease in current and energy delivery and pre-heating the battery is required.

The heaters are available at all times when the battery is in Active Mode. The heaters will only provide heat when active and when the battery temperature is sensed below 0°C. The heaters will stop heating when the internal battery temperature is above 5°C. The heaters will automatically turn on and off as needed until the battery enters Sleep Mode.

The battery has the ability to pre-heat itself at temperatures down to -40°C (-40°F) utilizing the internal, self-powered heaters, bringing the battery up to full operational capability. Pre-heat time will vary depending on temperature but can be fully warmed in 15 minutes or less after turning the heaters on.

The battery transitions to Active Mode and the ACTIVE green LED on the Status Indicator blinks once every three seconds when in the Pre-Heat Cycle. The Pre-Heat Cycle can be initiated from Sleep Mode by pressing the STATUS/SOC button on the side of the battery.

The Pre-Heat Cycle will continue to maintain the battery temperature for one hour, and then enter Sleep or Active Mode, unless the following occurs:

- Press and hold the STATUS/SOC button for 3 seconds.

Battery will immediately transition to Sleep Mode if the battery is not charging or discharging.

3.1.3 ENGINE START

The TB60 battery can provide a peak current of 1500A for the purpose of aircraft engine starting. It will provide a maximum of 1680A (280A maximum per module) for up to 15 seconds and below 425A continuously. The low internal impedance of the Nanophosphate lithium-ion chemistry allows high current delivery while maintaining higher voltage than traditional battery types. This higher total power delivery produces quicker starts, lower engine temperatures, more start attempts when needed, and a higher remaining battery capacity following engine start. The higher voltage also means better power to supporting systems during an engine start.

3.1.4 MAINTAINING CHARGE

After engine start, the unit recharges and maintains charge by accepting power from the aircraft power generation system. The unit may draw as much as 600 amps while recharging. A fully depleted battery can be recharged to 95% SOC in less than 15 minutes. In typical applications the unit is likely to be fully recharged from the aircraft power generation system within several minutes following an engine start.

3.1.5 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 until the unit is fully depleted. A fully charged unit will initially provide approximately 28 volts. It will provide an average of approximately 25.5 volts for the duration of discharge, then decay near the end of discharge. When the unit's voltage reaches approximately 16 volts, the unit's under-voltage protection will shut off the unit's output to prevent any potential cell damage due to over-discharge.

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.

3.1.6 TB60 ONBOARD STATUS INDICATOR

The Onboard Status Indicator (Figure 3-1) can provide an on-demand health status and state of charge. It can also be used to manually transition the battery from Sleep Mode to Active Mode by pressing the STATUS button. This can be used to check status, state of charge, or to initiate the heaters to pre-heat the battery (if the battery is cold).

FIGURE 3-1: ONBOARD STATUS INDICATOR

When the battery is in Active Mode, status is continuously displayed. Status is listed as one or more of four states as listed below. For each state, a lighted chevron will appear under the associated label on the Status Indicator. Note that the gray chevrons in Figure 3-1 are not visible (black) on the Status Indicator until a lighted annunciator segment is active.

- Active Solid Green indicator: Battery is active.
- Flashing Green indicator: Battery is in Pre-Heat Cycle.
- Fault Solid Yellow indicator: Battery has a internal fault.
- Heat Flashing White indicator: Battery heaters are currently heating.
- Solid Yellow indicator: Heater is disabled.
- Service Solid Red indicator: Battery has a permanent fault.

The Status Indicator can also provide an on-demand state of charge. By temporarily pressing the STATUS/SOC button, the chevrons will quickly cycle in blue, indicating a change to state of charge indication. The Status Indicator will display nine different state of charge ranges for approximately six seconds as described in Table 3-1.

State of Charge	Indicator 1 "25%"	Indicator 2 "50%"	Indicator 3 "75%"	Indicator 4 "100%"
0 - 10%	Flash Yellow	Off	Off	Off
10 - 15%	Dim Green	Off	Off	Off
15 - 25%	Solid Green	Off	Off	Off
25 - 40%	Solid Green	Dim Green	Off	Off
40 - 50%	Solid Green	Solid Green	Off	Off
50 - 65%	Solid Green	Solid Green	Dim Green	Off
65 - 75%	Solid Green	Solid Green	Solid Green	Off
75 - 90%	Solid Green	Solid Green	Solid Green	Dim Green
90 - 100%	Solid Green	Solid Green	Solid Green	Solid Green

TABLE 3-1 - STATE OF CHARGE INDICATION

3.1.7 STATUS/SOC BUTTON

Pressing the STATUS/SOC Button serves several purposes:

- From Active or Sleep Mode:

  - Cycles the chevrons in blue, followed by the state of charge (SOC) indication, followed by continuous display of the status indication.

  - Initiates a self-test of all battery discrete outputs which are set to active for 10 seconds.

  - If the battery has reached the end of discharge and under-voltage protection is activated, pushing the status button will clear the under-voltage fault (if battery voltages meet under voltage recovery limits as indicated in Table 7-1) and allow further discharge.

- From Sleep Mode (in addition to above):

  - Place the battery into Pre-Heat Cycle.

- From Active Mode, when pressing and holding for three seconds:

  - Transitions to Sleep Mode. If the battery is charging or discharging, it will blink the ACTIVE green LED and then remain Active (not enter Sleep Mode).

3.1.8 BATTERY SYSTEM CONTROLS

The battery monitor is utilitzed to monitor battery status. Under normal conditions the ACTIVE status is illuminated in green and the % Charge, Volts, Amps, and Temp (°C) are white. The BMS provides automatic heating, monitoring, and control of the battery and will disable battery functions when parameters are out of range.

The battery internal heaters are enabled when the battery is in Active Mode (aircraft power on) or if the pre-heat cycle has been enabled with the STATUS/SOC switch during pre-flight while aircraft power is off. The heaters will only activate when the battery temperature is sensed below 0°C. The heaters will stop operating when the internal battery temperature is above 5°C. Manual initiation of the pre-heat cycle can be prompted prior to operations by toggling the battery master switch from OFF to ON to OFF.

3.2 MD23 BATTERY MONITOR

The central Control Knob is located at the bottom-center of the until bezel (see Figure 2-6). This is the only user interface on the unit. The Control Knob has two functions: push and turn.

FIGURE 3-2: BATTERY MONITOR POWER-ON SCREEN

In Flight Mode, the display is presented as shown in the example figures below. Turning the Control Knob right or left changes the display from Page 1 to Page 2.

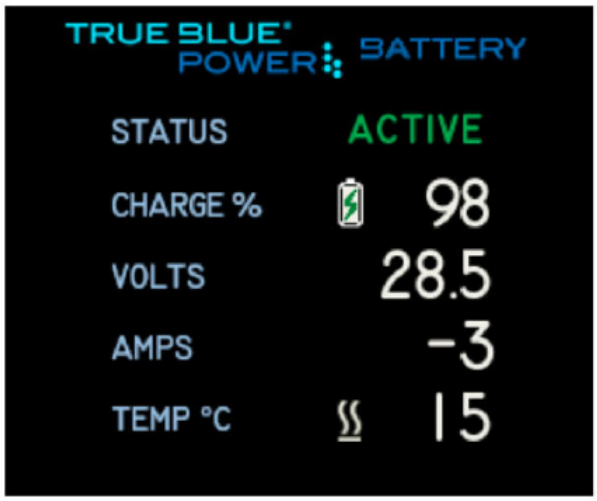

FIGURE 3-3: BATTERY MONITOR PAGE 1 AND PAGE 2

Individual elements are defined as follows:

Page 1

- Status: Displays battery status: Active, Fault, Service, Invalid, or No Start
- Charge %: Displays current state of charge. 0 - 100%
  - The number is amber if the state of charge is below battery programmed minimum.
  - Battery icon represents state of charge and depletes in relation to charge %.
    - Icon is amber if state of charge is below battery-programmed minimum.
    - Icon contains green lightning bolt when battery is charging.
- Volts: Current voltage of the battery
  - Number turns amber when under-voltage or over-voltage.
- Amps: Discharge or current charge (discharge current denoted as negative (-)).
- Temp: Internal temperature of battery, in degrees Celsius.
  - The number is red if the temperature exceeds the upper limit of the battery.
  - The heater icon represents the current state of the battery heater.
    - Icon is a gray horizontal bar if heater is inactive/offline.
    - Icon is a gray bar with squiggles if heater is active/available.
    - Icon is a white bar with squiggles if heater is currently on/heating.

Page 2

- Life: Remaining percentage between original max and battery-programmed end of life capacity. 0 - 100%
- Capacity: Current maximum capacity of the battery. Number is amber if the capacity is below the battery-programmed end of life capacity.
- Faults: Reported battery faults. "(None)," if none.

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SECTION 4 AIRWORTHINESS LIMITATIONS

CONTENTS

4.0 AIRWORTHINESS LIMITATIONS

The Airworthiness Limitations section is Federal Aviation Administration (FAA) approved and specifies maintenance required under §43.16 and §91.403 of Title 14 of the Code of Federal Regulation (14 CFR) unless an alternative program as been FAA approved.

There are no new (or additional) airworthiness limitations with this equipment and/or installation.

SECTION 5 SERVICING INFORMATION

CONTENTS

5.0 SERVICING INFORMATION

Should the TB60 require repair or replacement, contact True Blue Power at www.truebluepowerusa.com.

SECTION 6 MAINTENANCE CONSIDERATIONS

CONTENTS

6.0 MAINTENANCE CONSIDERATIONS

No additional periodic scheduled maintenance, beyond that required by the Air Tractor existing maintenance schedule, is necessary for continued airworthiness of the TB60 Advanced Lithium-ion Batteries. If the battery is stored for more than (6) six months, refer to section 6.1.2 for charging instructions. If the unit fails to perform to specifications, the unit must be removed and serviced by True Blue Power or their authorized designee.

6.1 TB60 MAINTENANCE PROCEDURES

The procedures described in this section are included for verification of battery performance for periodic maintenance and for as-needed, or on-condition basis. Note however, that the battery must be recharged every six (6) months when not in use.

6.1.1 VISUAL INSPECTION

1. Verify that proper communication is available to the cockpit to validate the battery is transmitting data appropriately. To perform this, turn on the battery master switch. Verify batttery operating parameters are displayed appropriately according to the battery monitor (voltage, SOC, capacity, status, etc.).

2. Visually inspect the power terminals and communication connector to make sure they are secure. Inspect the vent connection and make sure the vent hose/tube is secure. Verify that none of the connections are loose and there are no signs of damage, wear, or corrosion.

3. Remove the unit from the aircraft. Visually inspect the exterior of the battery casing for signs or 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. Inspect the battery area of the aircraft for any signs of improper installation or unusual wear.

4. Some wear is expected due to normal use (for instance: scratches on the bottom of the battery or near the hold-down points). However, if there are any anomalous or concerning visual indicators, the unit should be evaluated and tested for repair or replacement by an authorized repair facility.

6.1.2 CHARGING

WARNING!!
The power terminals of the TB60 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.

6.1.3 RECOMMENDED CHARGERS/OPERATION:

1. True Blue Charger Pro TT28-12 - Refer to user manual
2. True Blue Charger Mx TT28-2 - Refer to user manual
3. Benchtop Power Supply: 0-30VDC Range

In order to charge the unit off-aircraft, follow the steps listed below:

1. Set the power supply to a constant voltage of 28.8VDC.
2. Limit the maximum current of the power supply to 60A (or less).
3. Charge the battery until the charge current tapers to less than 3.0A.
4. After charging, measure and verify that the voltage on the unit's power terminals is greater than 27.6VDC. If it is less than 27.6V, return the unit to an authorized repair facility.

6.1.4 CAPACITY CHECK

The battery is designed to dynamically compute its capacity at all times thoughout its life. As the battery ages, the accuracy of its reported capacity can change due to a variety of factors associated with its use, environmental conditions, and the characteristics of the cells. Using the procedures in this section, the battery's reported capacity can be recalibrated or verified. This procedure is recommended for improved performance and accuracy but does not represent required maintenance nor is required for continued airworthiness by the manufacturer.

6.1.5 SELF-LEARNING CAPACITY CALIBRATION

Using the procedure below, the battery can re-calibrate its capacity measurement to improve its accuracy for ongoing use.

A. Ensure that the unit is charged per Section 6.1.2.
B. Apply a constant current load of 60A to discharge the battery pack. (Capacity check should be conducted at 23°C +/- 3°C (68-79°F) for best results.
C. When the battery is nearly depleted, it will turn off its power output and stop discharging.
D. Charge the battery again per Section 6.1.2. The battery's reported capacity will be reset to the actual measured value.

6.1.6 MANUAL CAPACITY CHECK

If there is any reason to suspect the accuracy of the reported capacity, a manually measured capacity check can be performed.

A. Ensure that the unit is charged per Section 6.1.2.
B. Apply a constant current load of 60A to discharge the battery pack. (Capacity check should be conducted at 23°C +/- 3°C (68-79°F) for best results.
C. Monitor the time (in minutes and seconds) from inititally applying the constant current load in Step B until the unit the battery is nearly depleted and turns off the power output/stops discharging.
D. Calculate the capacity in amp-hours (Ah):

- Discharge time (in hours) = discharge minutes / 60
- Capacity (Ah) = (amps) x (hours) = (40 amps) x (discharge time)

6.1.7 STORAGE INFORMATION

In normal use, the battery utilitzes the aircraft power to maintain the proper charge voltage and sustain the battery cells at peak capacity. Although the cells have 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.

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

CAUTION!!
The unit is shipped with approximately 30% state-of-charge (SOC). Upon receipt, the battery shall be fully charged using the procedures listed in this manual (prior to storage and again prior to installation/use).

CAUTION!!
STORED BATTERIES MUST BE FULLY RECHARGED AT A MINIMUM EVERY 6 MONTHS.

SHELF-LIFE: Batteries stored for an extended period of time must be occasionally recharged. Follow the procedure set forth in Section 6.1.2 for charging. If the storage time is unknown, a battery should be recharged prior to reaching 10% state of charge according to the indicator on the front of the battery.

CAUTION!!
If a battery is allowed to self-discharge after it has been depleted (i.e. if it is not recharged within 7 days), the cells can be damaged. If the battery becomes over-discharged due to this condition, it will protect itself by preventing subsequent charging. The battery must then be returned to the factory for assessment.

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

6.1.8 END OF LIFE

Estimated life for the TB60 Advanced Lithium-ion Battery is expected to exceed six (6) years. The unit has reliably demonstrated over 20,000+ simulated 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 30°C / 86°F) during operation or storage.
- Avoid long periods (greater than 7 days) after a full discharge.
- Avoid long periods of storage (greater than 6 months) without recharge.

End of life is represented by the inability of the unit to meet the minimum capacity requirement of the aircraft either as programmed and self-determined by the battery, or upon verification of the manual capacity check and verified against aircraft requirements. In the event that the unit exhibits failure, insufficient capacity, or expired life, contact True Blue Power for repair, exchange, or replacement. Visit www.truebluepowerusa.com for more information.

6.2 MD23 BATTERY MONITOR

No periodic scheduled maintenance or calibration is necessary for continued airworthiness of the battery monitor.

The unit display can be cleaned using a lint-free cloth moistened with water. No chemicals should be used to clean the display.

If the unit fails to perform to specifications, the unit must be removed from the airplane and serviced by Mid-Continent Instruments and Avionics or their authorized designee. Other than software version updates, there are no repairable parts or processes available to be performed in the field.

6.3 SOFTWARE

This STC utilizes software version 1.04 or later approved software version for the TB60.

This STC utilizes software version 1.0.0 or later approved software version for the MD23. The software version can be found on the power up screen of the unit. The Custom Instrument Definition (CID) which defines the specific function of this custom display for this application is also displayed on the power up screen. This STC utilitzes CID 1004A, or later approved version.

True Blue Power may, on occasion, update the software of the TB60 Batteries to improve and/or enhance functionality or performance. This update may be made in the field, the unit does not have to be returned to the factory, and in most cases, may not have to be removed from its installation.

Software updates are typically communicated to the public via Service Bulletins issued by True Blue Power and can be found on the product website www.truebluepowerusa.com.

Consult the TB60 or MD23 Installation Manual for details regarding software updates. Consult with Wipaire for approval status of later software versions with this STC.

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SECTION 7 TROUBLESHOOTING INFORMATION

CONTENTS

7.0 TROUBLESHOOTING INFORMATION

The aircraft main battery system consists of a single TB60 lithium-ion battery, battery monitor, and interconnecting wiring. System wiring details are included in Appendix A. These details can be referenced for standard electrical troubleshooting of the system. Table 7-1 describes the built-in battery protections that may result in automatic disablement of certain functions. Use Table 7-2 to troubleshoot battery system faults.

Should the TB60 battery remain inoperative following the testing, charging, and troubleshooting instructions included herein, it should be returned to the manufacturer for maintenance.

7.1 BATTERY PROTECTIONS

The TB60 battery has built-in automatic protections for conditions that may exceed operating limits:

Protection	Parameters	Action	Recovery
Under voltage (Low current)	If discharge current < 240A and battery voltage < 16VDC or cell string voltage < 1.8VDC	Discharging disabled	Battery voltage > 20VDC and cell string voltage > 2.5VDC (charging will be limited to 4A/Module until module voltage > 20VDC or module cell string voltage > 2.5VDC
Under voltage (High current)	If discharge current > 240A and battery voltage < 12VDC or cell string voltage < 1.0VDC.	Discharging disabled	Battery Voltage > 20VDC and cell string voltage > 2.5VDC (charging will be limited to 4A/Module until module voltage > 20VDC or module cell string voltage > 2.5VDC
Over Discharge	Any model cell string voltage < 1.2VDC and current < 100mA for 10 seconds	Module is disabled	Factory service
Over Voltage	Module voltage > 30.6VDC or any cell string voltage > 3.8VDC	Charging disabled	Module voltage < 29.2VDC and all cell string voltages < 3.6VDC
Over Current	Battery discharges > 1680A (280A per module) for more than 15 seconds	Discharging disabled	External load removed or charging current detected
Short Circuit	Battery detects current > 1500A for > 100ms	Discharging disabled	External load removed or charging current detected
Over Temperature (Discharging)	Any cell temperature > 95°C or discharge control circuitry > 130°C	Discharging disabled	All cell temperatures < 80°C and discharge control circuitry < 90°C
Over Temperature (Charging)	Any cell temperature > 72°C or charge control circuitry > 130°C	Charging disabled	All cell temperatures < 62°C and charge control circuitry < 90°C
Cell Over Temperature Fail	Any cell temperature > 110°C	Module is disabled	Factory service
Module Charge Required	One or more modules have charged/ discharged 50Ah or more without being fully recharged	Battery SOC may not be accurate	Fully charge battery

TABLE 7-1 - BUILT-IN BATTERY PROTECTIONS

System Fault	Probable Cause	Action
Built in battery STATUS and SOC indicators not illuminated.	Battery may be in Control or Sleep Mode.	Press the STATUS / SOC button.
Battery SOC (on TB60 battery) does not display status when the BAT switch in the cockpit is placed to ON.	Battery charge may be too low.	Check battery voltage.
	Battery may be faulty.	< 16VDC Charge battery per Section 6.1.2. < 8VDC Remove and replace battery.
Battery SOC (on TB60 battery) does not display status when the Status Indicator button (on TB60 battery) is depressed.	Battery charge may be too low.	Check battery voltage.
	Battery may be faulty.	< 16VDC Charge battery per Section 6.1.2. < 8VDC Remove and replace battery.
MD23 Battery Display does not turn on.	Check BAT IND Circuit Breaker is closed.	Close circuit breaker.
	Wiring fault between MD23 and power source.	Verify electrical connector is attached to MD23. Verify wiring between battery monitor and battery, reference Appendix A.
MD23 Battery Display status is FAULT.	BAT switch in cockpit may be OFF.	Switch BAT on.
	Battery may be faulty.	Check reported battery fault on Page 2 of MD23. Correct condition or remove and replace battery.
MD23 Battery Display status is NO STRT, and battery heater icon is not illuminated (gray bar or gray bar with squiggles).	Battery is OFF / Inactive, or in Sleep Mode.	Toggle BAT off and on to bring battery out of Sleep Mode.
	Battery was pre-heated more than an hour prior without start.	Toggle BAT off and on to restart preheat cycle.
	Battery heater control has failed.	Remove and replace battery.
MD23 Charge % is Amber.	Battery state of charge is too low.	Charge battery.
MD23 Volts Indicator is Amber.	Battery is under voltage.	Battery will disable discharge. Allow battery to charge to > 20VDC.
	Battery is over voltage.	Battery will disable charging until voltage < 29.2VDC.
MD23 Temp Indicator is Red.	Battery temperature exceeded maximum.	Battery will disable charge and discharge. Allow battery to cool below 72°C.
		If battery temperature exceeded 110°C remove and replace battery.

TABLE 7-2 - TROUBLESHOOTING TB60 BATTERY SYSTEM

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SECTION 8 COMPONENT REMOVAL AND REPLACEMENT

CONTENTS

8.0 COMPONENT REMOVAL AND REPLACEMENT

TB60 battery and equipment are located in accordance with the data included on Wipaire drawing 1012750. The components are removed / installed with basic hand tools (screwdrivers, wrenches, and/or sockets). Access is gained through aircraft manufacturer's procedures defined in the Air Tractor maintenance manual.

8.1 TB60 BATTERY REMOVAL

NOTE
Caution shall be taken to ensure there is no harm to personnel working on the aircraft or aircraft systems.

Ensure all aircraft electrical sources and equipment are powered off (follow specific aircraft AFM). Be cautious of placing hands directly on the electrical connectors (high currents are possible). Follow Electrical Standard Discharge (ESD) practices while working on the TB60.

- Ensure battery switch is in OFF position.
- Remove engine accessory cowling to gain access to battery on the forward side of the firewall.
- Disconnect Battery Connector from battery, install protective cover and position out of the way.
- Disconnect the Communication Connector from battery, install protective cover and position out of the way.
- Loosen the clamp and remove vent line from battery.
- Remove the safety wire from the battery and hold down wing nuts.
- Loosen the wing nuts far enough to disengage the hold down rods.
- Open fire-resistant battery box by breaking or cutting fire sealant.
- Remove battery from aircraft.

8.2 INSTALLATION OF TB60 BATTERY

- Inspect the battery support structure, battery tray and enclosure for corrosion and security.
- Remove the protective covers and inspect the battery electrical connectors.
- Install the battery within the battery enclosure such that all interface points align with their respective apertures. Place the lid of the enclosure such that the notch aligns with the battery status display.
- Install TB60 battery to battery tray using battery shelf assembly and battery hold down assembly.
- Place the hold down rods into position and tighten the wing nuts hand tight and secure with safety wire using AC 43.13-1B as a guide.
- Wiggle the battery and confirm NO movement is present on either the enclosure or the battery within it.
- Connect and secure the SCAT vent line and fire sleeve to battery top vent port using the hose clamp.
- Wiggle the hose and confirm NO movement is present.
- Route, connect and secure vent line and fire sleeve to fuselage vent port with hose clamp.
- Attach hose clamps and ensure vent hose does not touch battery case and hose is not pinched.
- Connect and secure the fire sleeve to the fuselage at the vent outlet.
- Reconnect the Battery Connector, and Communication Connector.
- Seal the seam between the battery box lid and battery box and any other air gaps on the battery box with PR-812 firewall sealant.
- Replace the engine accessory compartment cowling.

Perform an operational test per the system testing instructions in Section 9.

8.3 MD23 REMOVAL AND REPLACEMENT

The MD23 is installed in accordance with Wipaire drawing 1012750. The components are removed / installed with basic hand tools (screwdrivers, wrenches, and/or sockets). Access is gained through the aircraft manufacturer's procedures defined in the applicable maintenance manual.

Removal of the MD23:

- Ensure that the unit is powered off.
- Remove the four mounting screws.
- Remove the unit from the instrument panel.
- Remove the electrical connections.

Installation of the MD23:

- Route the prepared cable harness and pneumatic tubing (if applicable) behind the panel and to the panel cutout.
- VERIFY THAT AIRCRAFT POWER IS TURNED OFF.
- Connect the cable harness and pneumatic fittings (if applicable) to the rear of the unit.
- Insert the unit into the panel cutout and secure with four (4) #6-32 screws provided.

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SECTION 9 RETURN TO SERVICE INSTRUCTIONS

CONTENTS

9.0 RETURN TO SERVICE INSTRUCTIONS

The TB60 battery has an internal central monitoring system that monitors the health of the battery. The battery monitor can all be utilized to test the battery system as well as determining system faults.

- Recharge the unit per Section 5. Measure and verify that the voltage on the unit's power terminals is greater than 27.6VDC. A unit should never be returned to service if the voltage is less than this value after charging.
- Re-install the unit in the aircraft, including securing it via proper hold-downs, mating the electrical connections, and verifying proper vent attachment.

9.1 FROM THE COCKPIT

- Select the BAT switch to ON.
- Verify MD23 (Figure 9-1) indicates ACTIVE, Charge % > 72, VOLTS > 27.6, TEMP > 0 after heat cycle.

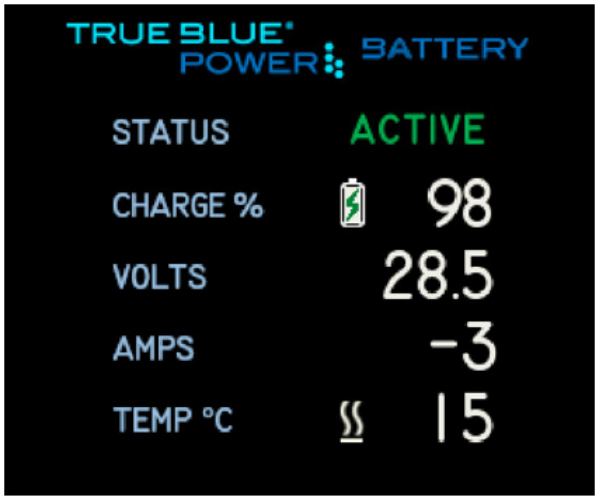

FIGURE 9-1: MD23 ACTIVE INDICATION

- Select the BAT switch to OFF.
- Record service action in aircraft logbook.

9.2 FROM THE ENGINE ACCESSORY COMPARTMENT

- Confirm the BAT switch is OFF.
- Open the engine accessory compartment cowling.
- Remove the battery box display cover, by removing the four (4) #6-32 screws and breaking or cutting the fire sealant to access onboard status indicator.

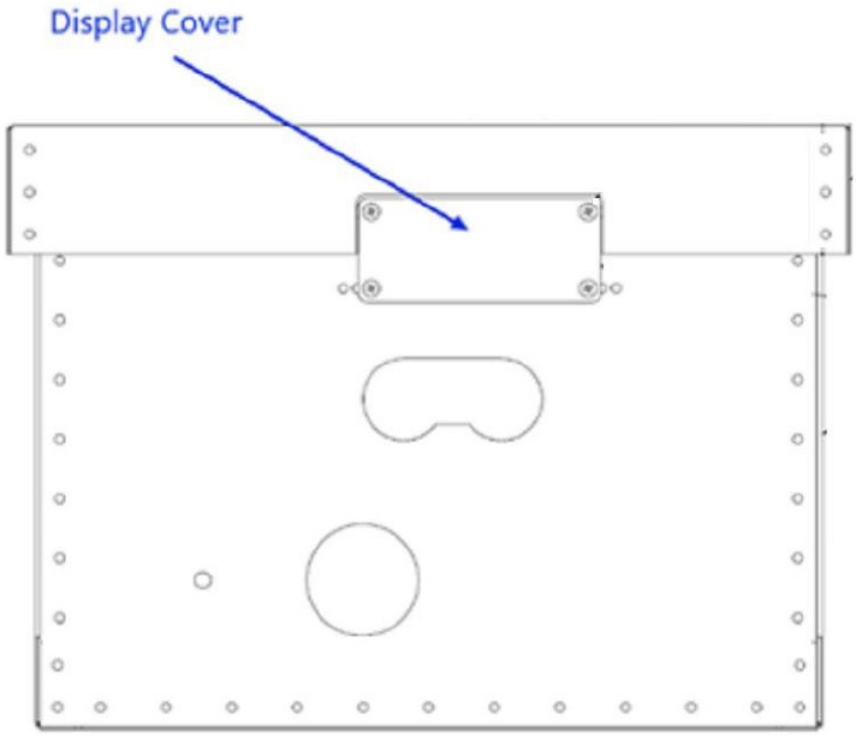

FIGURE 9-2: BATTERY BOX DISPLAY COVER

- With the battery in Active Mode, press the STATUS button (Figure 9-3). Verify the following from Section 3.1.6:

  - The chevron below "Active" is solid green or flashing green.
  - There is no indication below "Fault."
  - The "Heat" indicator reads flashing white or is off.
  - There is no indication below "Service."

FIGURE 9-3: ONBOARD STATUS INDICATOR

- Replace battery box display cover with fire sealant and the four (4) #6-32 screws.
- Close the engine accessory compartment cowling.

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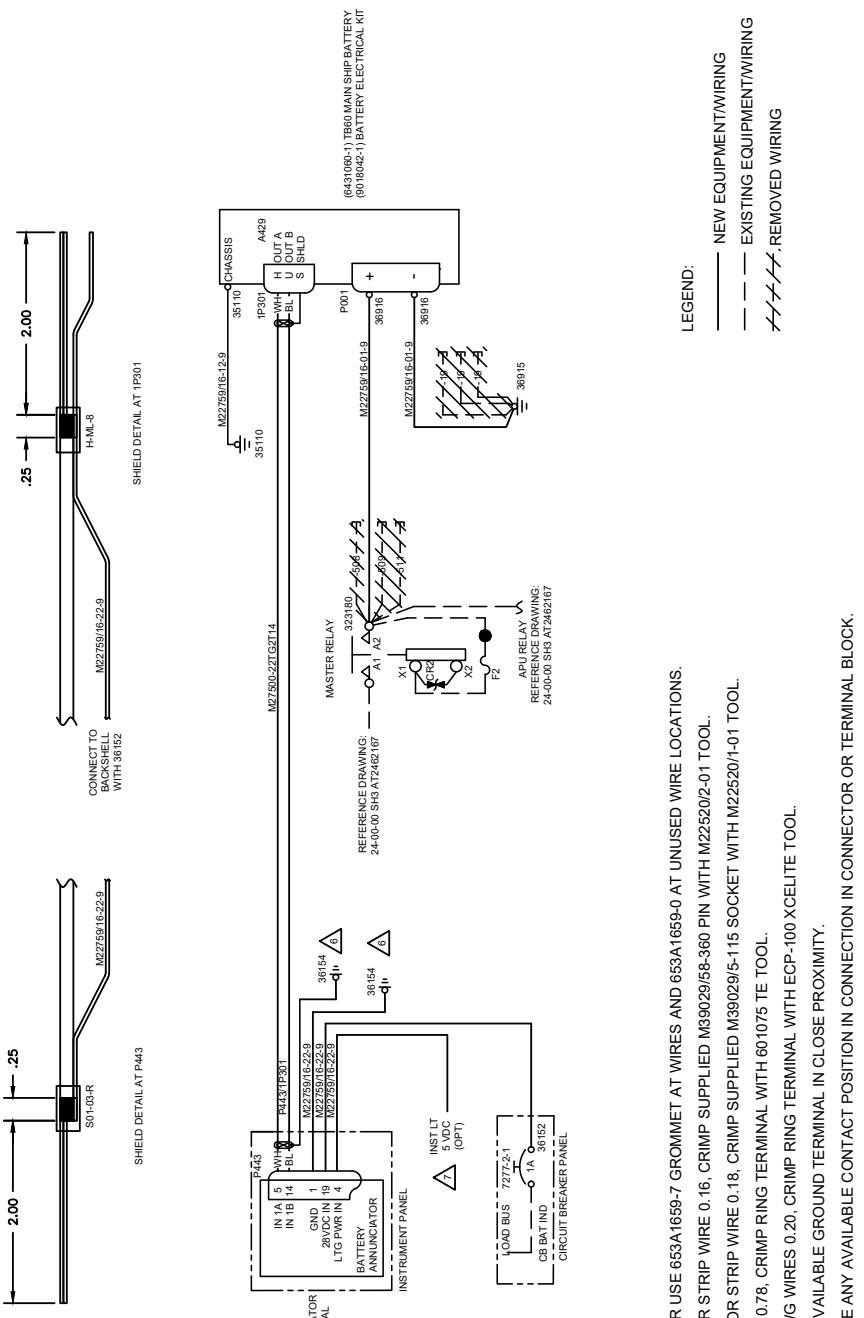
APPENDIX A WIRING DIAGRAM

CONTENTS

APPENDIX A: WIRING DIAGRAM

This appendix identifies the wiring diagram associated with the lithium-ion battery system installation on the Air Tractor AT-802 / AT-802A / AT-602.



NOTES:

1. AT P001 CONNECTOR USE 653A1659-7 GROMMET AT WIRES AND 653A1659-0 AT UNUSED WIRE LOCATIONS.
2. AT P443 CONNECTOR STRIP WIRE 0.16, CRIMP SUPPLIED M39029/58-360 PIN WITH M22520/2-01 TOOL.
3. AT 1P103 CONNECTOR STRIP WIRE 0.18, CRIMP SUPPLIED M39029/5-115 SOCKET WITH M22520/1-01 TOOL.
4. STRIP1/0 AWG WIRE 0.78, CRIMP RING TERMINAL WITH 601075 TE TOOL.
5. STRIP 22 AWG 12 AWG WIRES 0.20, CRIMP RING TERMINAL WITH ECP-100 XCELITE TOOL.

⚠6⚠ USE ANY LOCALLY AVAILABLE GROUND TERMINAL IN CLOSE PROXIMITY.

⚠7⚠ PERMISSIBLE TO USE ANY AVAILABLE CONTACT POSITION IN CONNECTION IN CONNECTOR OR TERMINAL BLOCK.