

## *Integrated Back-up Battery System*

**Model: IBBS-24v-3ah-CRT**



The ***Integrated Back-up Battery System, IBBS***, is an electronic system that combines a Lithium-Iron-Phosphate (Li-Fe-PO<sub>4</sub>) battery pack, a charger and switching logic in one convenient package. The IBBS provides an engineered solution to enable an endurance bus for critical loads found in aircraft. It simplifies the wiring and installation of a source of back-up power by integrating all of the key elements into a single enclosure. The ***IBBS*** system provides back-up power to critical electronic loads such as EFIS, GPS, Autopilots and engine monitor systems.

Integral to the IBBS is a lithium-iron-phosphate battery pack and a matched charging system to ensure the battery is properly charged and maintained. The system also includes switching circuitry to provide a stable source of output power during normal and emergency operations. The IBBS system also provides signals to other equipment such as EFIS systems to communicate the operating state of the main aircraft bus as well as the state of the battery.

The IBBS system connects to the standard aircraft power bus and provides an output to critical equipment that require back-up power. Additionally, the IBBS system provides surge and sag protection for connected equipment, allowing operation of critical equipment during engine starting.

The IBBS system is suitable for use with equipment such as Garmin GNS and GTN series navigators, G3X series of avionics, Grand Rapids Technologies EFIS systems, Advanced Flight Systems EFIS, Dynon EFIS, and MGL EFIS, TruTrak Autopilots and EFIS, Trio Autopilots, SureFly electronic ignitions, Lycoming EIS electronic ignitions, and ElectroAir electronic ignitions.

The IBBS must be installed using the current aircraft standards and practices as detailed in AC 43.13-2A/1B.

IBBS products are protected by US Patent 8,189,305

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## Limitations:

This article meets the minimum requirements of technical standard order (TSO) C179b. Installation of this article requires separate approval.

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 have separate approval for installation in an aircraft. The article may be installed only according to 14 CFR part 43 or the applicable airworthiness requirements.

This article may not be installed as the sole source of power for an instrument or avionic device that has no other redundancy in the aircraft. (i.e., If an aircraft has one and only one vhf radio, it must have an additional source of power beside the IBBS system to qualify for installation.)

See page 14 for Performance Specifications and potential limitations and ratings under various conditions, including environmental and application installations. See Item 3 below for installation location limitations.

## Installation Instructions:

### 1. **IMPORTANT NOTE:**

Consult the attached wiring diagrams to identify wiring connections appropriate to the particular installation. Please note, some equipment such as GPS's and EFIS systems may be provided with multiple power inputs. For these installations the output of the IBBS must be connected to their "back-up" power input. These inputs are often identified as "Aircraft Power 2". For equipment having only a single power input terminal the IBBS pass-thru power function must be utilized. (This is typical of devices such as comm radios, transponders, autopilots, fuel pumps, and electronic ignitions) The IBBS system may be fed from a bus that remains active during engine starting, such as the master bus or it may be fed from an avionics bus that is switched off during engine starting.

2. Check that the total connected load (summed value of all four output wires of the IBBS) is less than the following product ratings:

**IBBS-24v-3ah-CRT: 5 amps maximum continuous current**  
**10 amps peak for radio transmissions and transient loads\***  
\*(30 seconds max duration)

3. Mount the IBBS to structure in a suitable location in the aircraft utilizing the practices identified in AC 43.13-2A/1B. Ensure the mounting points and fasteners are suitable for the weight of the product, consult the specifications for details. The IBBS must be mounted inside the aircraft, do not mount the IBBS in the firewall forward area. Select an area that is accessible to allow for future battery servicing. The preferred operating temperature range of the system is -40 C° to 60 C°, the effective charging temperature range is -40 C° to 40 C°. Select an installation location that takes these temperatures into consideration.

4. Connect the aircraft wiring according to one of the wiring diagrams shown. The IBBS must be powered from properly sized circuit breakers or fuses. Ensure the proper size wire is utilized for the input feed, output supply and ground connection.

**Power Requirements:** The IBBS has multiple power inputs.

Pin 4,5 receives power for charging the internal battery and bus voltage sensing for the switching logic within the IBBS unit. Pins 4,5 must be connected to an aircraft power bus. When the voltage on pins 4,5 falls below about 22 volts the system automatically transfers the load current on the output pins to the internal back-up battery source. Pins 4,5 nominal current draw is 1.9 amps during charging. Pins 4,5 are connected internally and are parallel for redundancy. Additionally, pins 4,5 provides power to an internal battery heater system utilized when the battery temperature is below 0 C°. The nominal current draw is 0.7 amps when the battery temperature is below 0 C°.

Pins 6,7,8 receive power that is passed-thru the IBBS unit to the loads connected to the output pins. These pass-thru power connections are optional and are only required for systems that do not have multiple power inputs. These pins can also be used if it is desired to have redundant power paths feeding the connected loads. These pins are internally wired in parallel; it is recommended to populate all three pins; join the wires together and feed all of these inputs from the pass-thru power breaker. Note: these pins do not individually correspond to any particular output pin (12-15). The pass-thru breaker must be sized for the load that is connected to the IBBS outputs. The maximum combined load is 10 amps peak, 5 amps continuous. If Pins 6,7,8 are used, they must be connected to the same source of power as Pins 4,5.

**Output Power connections:**

The IBBS has four output pins, Pins 12,13,14,15. These pins provide power to the connected load. These four wires may be paralleled together for redundancy and load current sharing. Use 20 awg wire for each pin. The total combined load for all four pins is 5 amps continuous, 10 amps peak. The output wires of the IBBS system are protected with a single 10 amp, Mini fuse. This fuse is accessible on the side of the enclosure.

***IMPORTANT NOTE ON CHANGING FUSE:  
Disconnect the main product connector before changing the fuse!  
Replace fuse with 10 amp, MINI type fuse only***

5. The Back-up Power Master Switch must be utilized to turn the back-up battery system off when not in use. The back-up power master switch gives the pilot the ability to turn the back-up battery system off. In some installations this may be the only means to shut down the connected equipment.

6. The IBBS unit has a low voltage warning output, pin 3. This pin may be used to drive an LED indicator or to provide a digital signal to indicate the main input bus is in a low voltage condition. When the main input bus (connected to pin 5) falls below about 22 volts this output will drive to a low state. Maximum current sourced on this pin is 25 milliamps.

7. The IBBS unit has an internal battery monitor connection, pin 2. This pin allows the voltage state of the internal battery to be monitored with a separate volt meter or analog input of a monitor system. This pin will only report internal battery voltage when the unit is enabled by turning the Back-up Master switch ON. A fully charged battery back will indicate about 26-29.5 volts on this pin. **Important note: the meter utilized to measure pin 2 must have an input impedance >100k ohms otherwise it will load down pin 2 and provide an artificially low voltage reading.**

**When used with the following EFIS systems wire pin 2 to the Volts2 input of the EFIS or engine monitor as follows:**

<b>Manufacturer/model</b>	<b>Volts 2 input location</b>
Garmin G3x system GEA 24	J244, Pin 28
Advanced Flight Systems 5000 series:	Expansion Port Pin 13

8. Complete the installation of the wiring harness and connector prior to attaching the connector to the IBBS product. It is essential to ensure the wires do not inadvertently short together during installation. Remember, the IBBS pack is a back-up source of power and is ready to deliver output power even when the aircraft electrical system is in the off state.

9. When using the IBBS product to provide back-up power to an electronic ignition system it **MUST** be used to back-up one and only one electronic ignition module. Do not use one IBBS to back up both electronic ignition modules in a dual electronic ignition system. Follow the instructions per the electronic ignition manufacture. Do not connect any other loads to the IBBS when using the IBBS to power an electronic ignition module. Do not use the IBBS system to back-up a dual ignition system having only a single power input. Do not use a single IBBS system to back-up two electronic ignition systems.

## **Product Details and General Information:**

### **The Charging System:**

The IBBS automatically maintains its internal battery pack. The internal charging circuit monitors the state of the internal battery and recharges it as necessary when the aircraft is operational. The aircraft's DC supply bus must reach at least 26.4 volts before the IBBS will permit a charge cycle to begin. The input current for battery charging is 1.9 amps. (charging only occurs when the aircraft alternator is running and has available capacity)

If the internal battery is fully discharged for any reason it may require up to 90 minutes of recharge time with the normal aircraft bus on. **NOTE:** Do not attempt to recharge the IBBS product by using an external battery charger directly connected to the input of the IBBS. Do not attempt to utilize battery tender chargers for other types of lead acid battery chargers directly connected to the IBBS inputs. Battery chargers typically provide pulsating voltages that may damage the IBBS product if the system is not connected to a typical primary aircraft battery. Also note, you cannot use a DMM connected to pins 4,5 to measure any meaningful value. Battery voltage may be read on pin 2 or any of the outputs pins 12-15 with the IBBS system enabled via the grounding of pin 1. **Note:** recharging of battery is linear with respect to time. For example, under nominal conditions a recharge period of 1 hour will provide 2/3 of rated product capacity.

Recharge time at normal temperatures: 0C° to 40 C° 90 minutes nominal

Recharge time at low temperatures: -18C° to 0 C° 90 minutes nominal + 30 minutes preheat

-45 C° to -18C° 90 minutes nominal + 60 minutes preheat

### **Back-up Power Master Switch:**

The IBBS has one input switch connection as identified in the wiring diagrams: Back-up Power Master. This switch enables back-up power from the IBBS system to be available on the output wires when power on the normal aircraft bus falls below about 22 volts. Pin 1 is pulled to ground when the back-up master switch is turned on, this enables the IBBS system.

If the back-up power master switch is enabled and normal aircraft power falls below 22 volts, then the internal back-up battery will be connected to the outputs and be utilized to supply back-up power to the connected load.

If the normal aircraft power bus is above 22 volts, then the outputs are energized with normal aircraft power (if the pass thru-power connections are utilized) and the back-up battery remains off-line. This operation occurs regardless of the state of the Back-up Power Master switch. This allows for automatic pass through of power during normal operation.

### **Ground Based Recharging:**

To accomplish ground-based charging, connect an approved battery charger or DC power source (set to 28 volts) to the main aircraft battery and energize the main aircraft power bus by turning on the aircraft master switch, leave all other aircraft loads in their off state. **Note,** the ground base source of power must be capable of supplying the load current of all devices

that can not be turned off in this nominal state, plus the 1.9 amps of IBBS recharge current. Leave the ground-based charging system connected and powered until the IBBS system completes its recharge cycle of its internal battery, see Charging System detail above for battery charging times. If voltage monitoring of pin 2 of the IBBS is available a peak charging voltage of 29-30 volts will be observed as the battery reaches full capacity.

Alternately, a ground-based charger is available from TCW Technologies LLC., model # IBBS-24v-CHARGER-LI-FE. This charger may be used for recharging the IBBS unit as well as keeping it topped off during long term product storage. (9 months or longer)

**Battery Capacity:**

The IBBS provides a capacity of 3 amp-hours at 24 volts for when the system is fully charged and operated at 23 C°. Depending on various conditions including operating and storage temperature and age of the battery pack, the capacity of the system will vary. With a fully charged battery, the following average performance can be expected in terms of operating duration. The operating duration is for output voltage down to 20 volts (end point voltage).

Total connected load	Duration	Capacity
1.5 amps	120 minutes	3 amp-hrs
3.0 amps	60 minutes	3 amp-hrs
5.0 amps	32 minutes	2.6 amp-hrs

Capacity at various temperatures:

- +70 C° 95% of effective nominal capacity
- 18 C° 75% of effective nominal capacity
- 30 C° 70% of effective nominal capacity
- 45 C° 45% of effective nominal capacity

**Servicing:**

The internal battery in the IBBS system is replaceable, however, the IBBS product must be returned to TCW Technologies, LLC. for this service. Battery life depends strongly on many factors including operating and storage temperature, number of discharge cycles and depth of discharge. The battery capacity should be checked at least annually for suitable back-up power operation of the connected equipment. When the battery capacity no longer meets the operating criteria of the aircraft it must be replaced. Contact TCW Technologies, LLC. for battery replacement.

**Storage beyond 9 months:**

If the IBBS unit is stored without connection to an in-service aircraft for a period greater than 9 months, it must be connected to a source of DC power to maintain the battery's charge. Allow for a self-discharge rate of approximately 5% capacity (in amp-hrs) per/month for storage temperatures between 0C°– 50C°. Only connections to the ground terminal and the main power terminal are required. Connect Pin 5 (main power) and Pin 9 (ground) of the IBBS to a source of regulated DC power at 27-29 volts with a current capability of at least 1.9 amps to accomplish full recharging. Charger model IBBS-CHARGER-LiFe-24v is available from TCW Technologies, LLC. to simplify this activity.

**Upon completion of installation:**

The required back-up operating time for the connected equipment should be recorded in the aircraft logbook with follow-up entries confirming the annual testing results that indicate that the required operating time is satisfied.

### **Normal Product Operation:**

For normal operation the following is the recommend operating procedure, the following is the basis for a flight manual supplement. The following is the standard procedures.

### **Start-up Procedure:**

- 1) Prior to turning on the Aircraft Master Switch, turn ON the Back-up Power master switch.
- 2) Turn on any equipment that derives back-up power from the IBBS product.
- 3) Ensure the connected equipment successfully boots-up and is operating properly. (During this period of time the equipment is running off of the back-up battery within the IBBS product. This test ensures the transfer circuit and back-up battery are properly working)
- 4) Turn on the Aircraft Master Switch; ensure the connected equipment remains energized. (If a separate avionics bus is utilized, this may need to be turned ON to continue the operation of equipment connected to the IBBS output.)
- 5) Start and operate the aircraft according to normal operating procedures.

### **Shut-down Procedure:**

- 1) Shut down the aircraft engine using normal procedures.
- 2) Shut down the Aircraft Master Switch
- 3) Verify that the equipment that derives back-up power from the IBBS remains ON
- 4) Turn-off the Back-up Power Master switch, ensure that equipment powers down. (This procedure further ensures the operation of the transfer circuit within the IBBS.)

### **Emergency Procedure for loss of main aircraft electrical power:**

- 1) Operate the Aircraft Master Power Switch per the Emergency Procedure checklist already established for the aircraft.
- 2) Ensure the Back-up Master Switch is in the ON position.
- 3) Land aircraft as soon as practical to resolve the loss of main electrical power.

## **Instructions for Continued Airworthiness:**

On at least an annual basis the endurance capability of the IBBS system shall be confirmed and compared against the back-up endurance required for the connected equipment or 30 mins, whichever is greater.

As an alternate to these tests, the IBBS unit may be returned to TCW Technologies for a loaded endurance test, contact TCW Technologies LLC. for details.

### **Procedure for endurance testing All applications except electronic ignition systems**

- 1) Turn off the Aircraft Master Switch
- 2) Turn on the Back-up Power Master Switch
- 3) Turn on all equipment connected to and supplied with back-up power from the IBBS product.
- 4) Measure and record at least the following information: The time until the first piece of connected equipment no longer functions or the time until the output of back-up power supply voltage drops to 21 volts. Discontinue the test if the back-up battery voltage falls below 21 volts.  
Ensure the connected equipment operates for at least 30 minutes.
- 5) After completing the endurance test, recharge the IBBS product by operating the system with the Aircraft Master Switch in the ON position for up to 1.5 hours. This may be accomplished by operating the aircraft in conditions known to not require back-up power or by powering the aircraft system on a suitable ground power source as described in the section: Ground Base Recharging.
- 6) Record the results of the endurance testing in the aircraft logbook.
- 7) If the IBBS no longer meets the endurance testing requirement, the back-up battery may need replacement or service.

## Instructions for Continued Airworthiness: Electronic Ignition System Back-up

On at least an annual basis the endurance capability of the IBBS system shall be confirmed and compared against the back-up endurance required for the connected equipment or at least 30 minutes, whichever is greater.

As an alternate to these tests the IBBS unit may be returned to TCW Technologies for a loaded endurance test, contact TCW for details.

### **Procedure for endurance testing of system providing back-up power to electronic ignition systems:**

**COMPLETE THESE STEPS IN ORDER!** Perform these tests with the aircraft properly secured on the ground, these are not flight test procedures.

- 1) Start the aircraft using normal starting procedures, including turning ON the Back-up Master switch
- 2) Select engine operation based on the use of only the electronic ignition module provided with back-up battery power.
- 3) PULL the circuit breaker feeding pins 4,5 of the IBBS system, confirm engine continues to run.
- 4) PULL the circuit breaker feeding pins 6,7,8 of the IBBS, confirm the engine continues to run.
- 5) Perform the following; test A or test B:

**Test A:** abbreviated battery test:

Monitor engine operation and voltmeter reading on any of pin 12,13,14,15, the back-up power output. Confirm back-up voltage begins above 26 volts and for a period of 15 minutes remains above 25 volts. If these requirements are met the battery pack is satisfactory.

**Test B:** full endurance test:

Operate the engine on the electronic ignition system for the required minimum run-time requirement (at least 30 minutes), monitor the back-up battery voltage on the voltmeter connected to an output pin, the battery voltage must remain above 22 volts for the duration of the test. If this requirement is met the battery pack is satisfactory.

- 6) Turn off the Back-up Master Switch and confirm that the engine turns off.
- 7) If all these tests pass, the IBBS system is functioning properly, record the results in the aircraft logbook.
- 8) If any of these tests fail, the IBBS system is not functioning properly and corrective action must take place. If the IBBS no longer meets the endurance testing requirement, the back-up battery may need replacement or service.
- 9) Return all pullable breakers to the normal ON position and ensure aircraft engine is properly returned to the off position by following normal run and shut down procedures.
- 10) After completing these tests, recharge the IBBS product by operating the system normally for up to 1.5 hours. This may be accomplished by operating the aircraft in conditions known to not require back-up power or by powering the aircraft system on a suitable ground power source as described in the section: Ground Base Recharging.

**Service Life:**

Expected service life for the internal battery pack is greater than 500 discharge cycles. Operational performance must be checked at least annually per the instructions for continued airworthiness. At the end of 72 months of service installation the internal battery pack must be replaced.

**SPECIFICATIONS: IBBS-24v-3ah-CRT**

<b>Input Voltage*</b>	<b>26.4-32 volts DC for battery charging</b>
<b>Transition Voltage**</b>	<b>21-23 volts</b>
<b>Input Current:</b>	<b>1.9 amps on main input for charging 0.7 amps for battery heating at low temps</b>
<b>Pass-thru Current:</b>	<b>5 amps continuous, 10 amps peak (30 seconds)</b>
<b>Output Voltage:</b>	<b>22-29 volts DC during back-up operation</b>
<b>Output Current:</b>	<b>5 amps continuous 10 amps peak for radio transmissions and transient load (30 second duration max)</b>
<b>Capacity (23 C°):</b>	<b>3 amp-hrs @ 24 volts @ 3 amp load current 2.6 amp-hrs @ 24 volts @ 5 amp load current</b>
<b>Battery:</b>	<b>Internal sealed Li-Fe-PO4</b>
<b>Charger:</b>	<b>Integral high performance fast charger</b>
<b>Surge Protection:</b>	<b>34 volt active clamp, 1500w 10/1000uS waveform</b>
<b>Wiring:</b>	<b>15 pin male D-sub on product.</b>
<b>Enclosure:</b>	<b>Aluminum 7.7" x 2.3" x 2.65"</b>
<b>Weight:</b>	<b>34 oz.</b>
<b>Temperature range:</b>	<b>Operating: -40 C° to 60 C° Charging: -40 C° to 40 C°</b>

**Connector: Standard density 15 pin male D-sub on product**

**Note: Input voltages in excess of 35 volts or reverse polarity may damage unit**

\*minimum input voltage to start a charge cycle is 26.4 volts, this ensures aircraft alternator is running prior to starting a charge cycle.

\*\*transition voltage is the voltage level on the input that causes the system to provide output power via the internal back-up battery

## Functional performance

Certification:	<b>FAA TSO-C179b</b>
Performance Qualification:	RTCA DO-311a Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems
Environmental Qualification:	RTCA DO-160 F,G B2BBB[SCU2F&F1]EYXXFSZB(IX)XXXXAB(ZC)[TT]MA3XXXXXXAX
Power Input	28 volts nominal, 1.9 amps charging, 0.7 amp heating
Power Output	24.0 volts nominal @ 5 amps continuous
Battery Capacity	3.0 amp-hrs @ 1C rate @ 25C°
Maintenance	Perform annual capacity check

# ENVIRONMENTAL QUALIFICATION STATEMENT

**NOMENCLATURE:** Integrated Back-up Battery System

**MODEL/PART NUMBER:** IBBS-24V-3AH-CRT

**MANUFACTURES SPECIFICATIONS:**

**TSO NUMBER:** **C179b-ClassB-3C**

Minimum Performance Specification:  
IBBS product specification per 720.0012

**QUALIFICATION STANDARD:**

RTCA Do-160(f), dated Dec 6, 2007

RTCA Do-160(g), dated Dec 8, 2007 (\*)

CONDITIONS	SECTION	DESCRIPTION OF TEST
Temperature and Altitude	4	Category B2
Low Temperature	4.5.1	Operating Low Temp = -45 C°
High Temperature	4.5.3	Operating High Temp = +70C°
Decompression	4.6.2	Altitude = +55,000ft.
Overpressure	4.6.3	Altitude= -15,000ft.
temp variation	5	Category B
humidity	6	Category B
operational shock*	7	Category B
vibration*	8	Cat S-C, Cat U2-F&F1
explosion	9	Category E
waterproofness	10	Category Y
fluid susceptibility	11	Category X
sand and dust	12	Category X
fungus *	13	Category F
salt fog salt spray *	14	Category S
magnetic effect	15	Category Z
power input	16	Category B(IX)
voltage spike	17	Category A
audio freq susceptibility	18	Category B
induced sig susceptibility	19	Category ZC
Spikes induced into interconnect cables	19.3.4	Category CC
RF susceptibility*	20	Category TT
Emission of RF energy	21	Category M
lightning environment *	22	Category A3XXXX level 3
lightning direct	23	Category X
icing	24	Category X
ESD	25	Category A
flammability	26	Category X

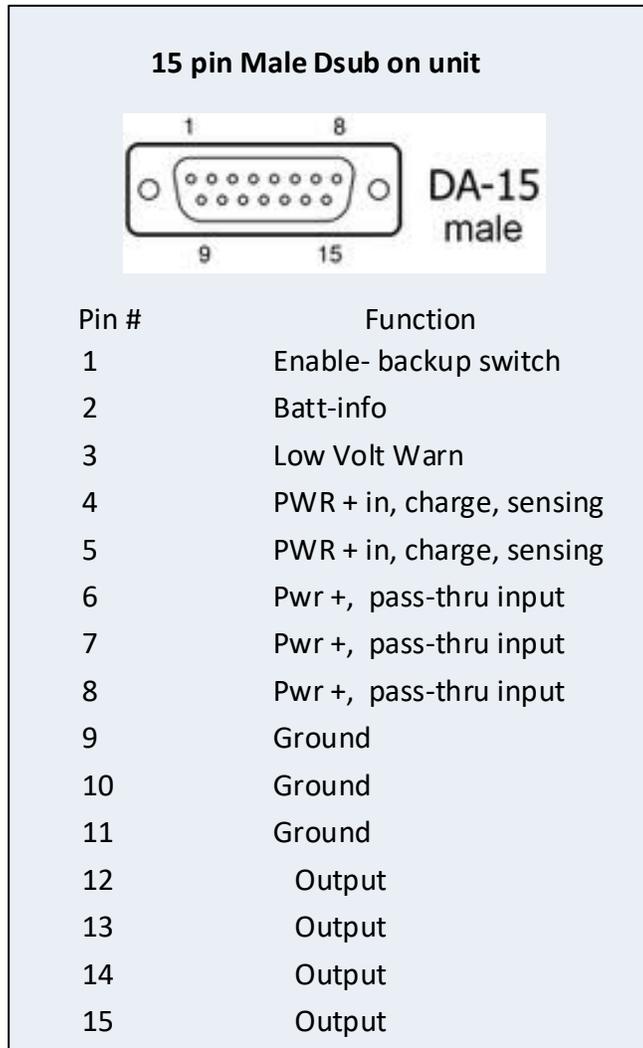
RTCA DO-160 F,G

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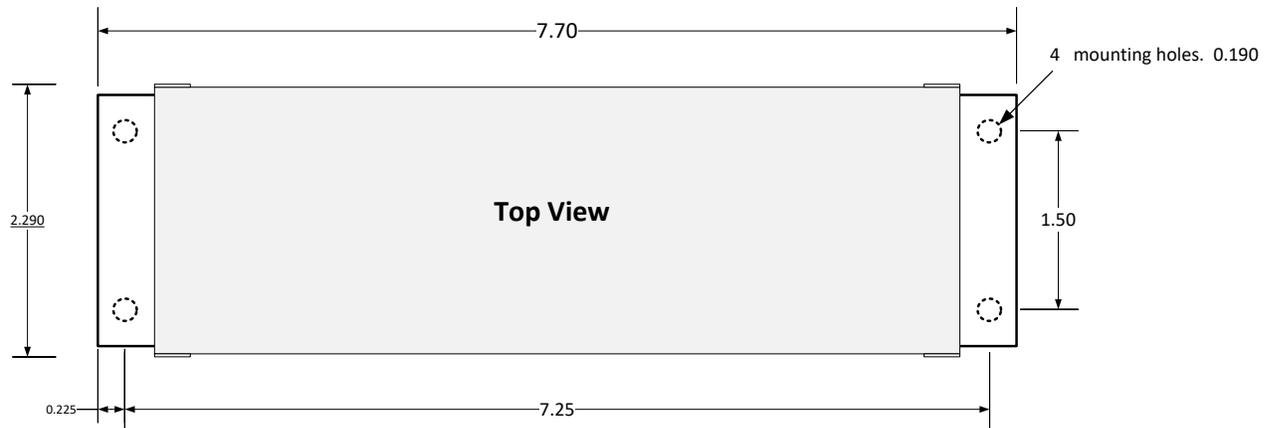
## Wiring connector detail:

Male on IBBS unit  
Female on aircraft wiring harness

View from back of connector on harness



## IBBS mounting footprint

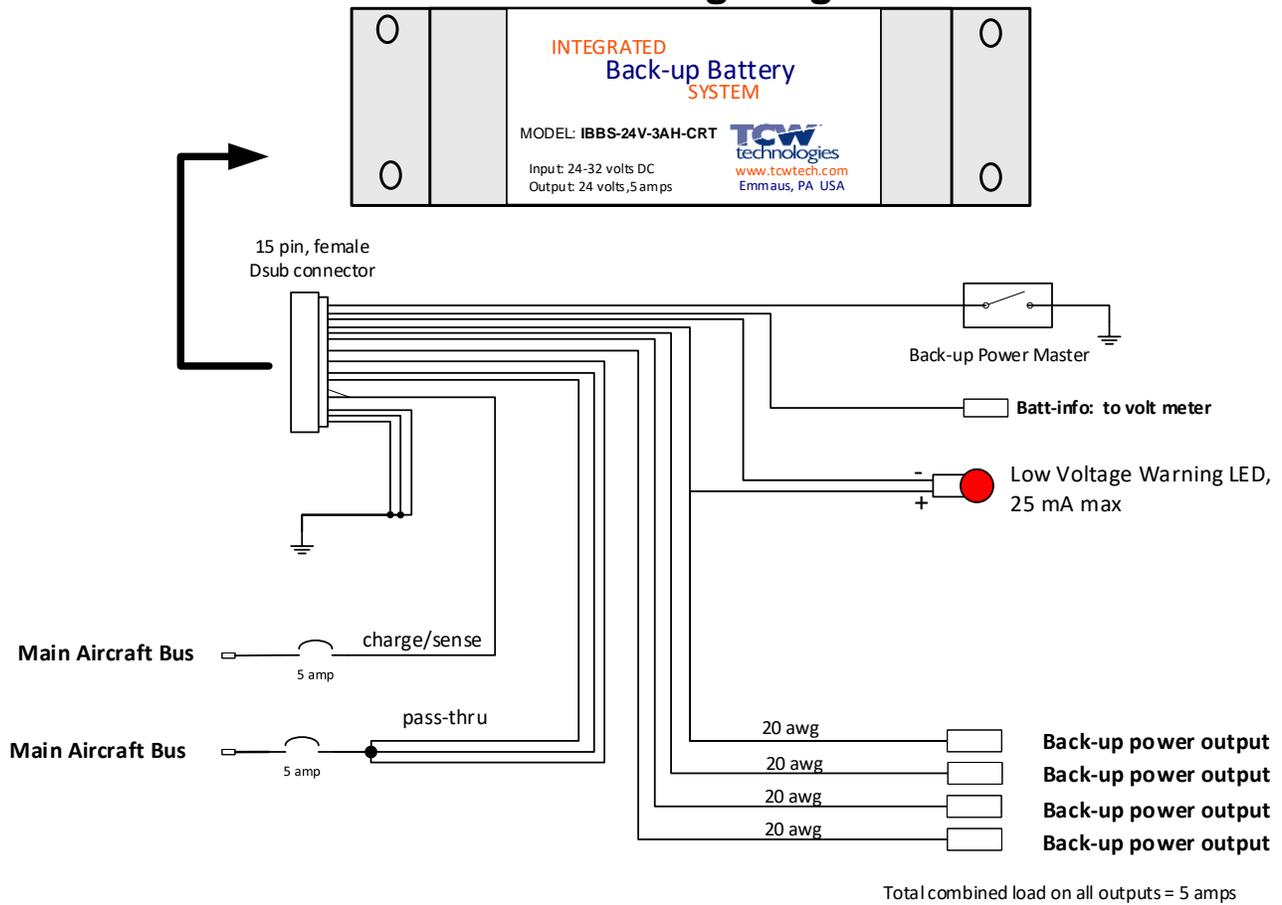


**All dimensions in inches**

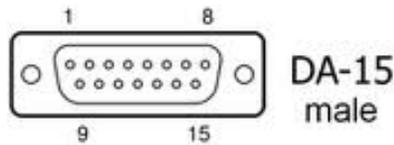
**Product height 2.75"**

**CG located at center of all axis**

# General Wiring Diagram



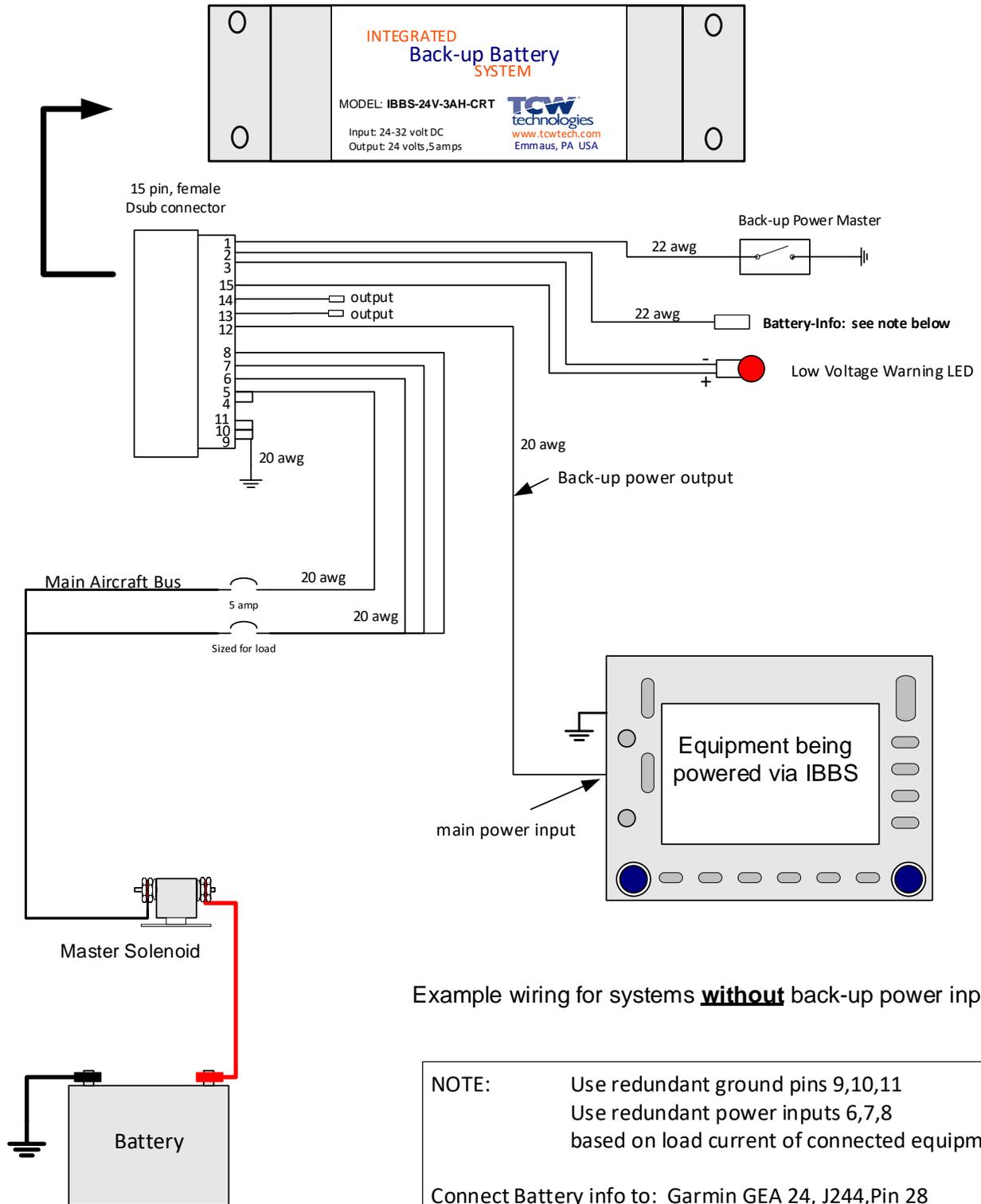
## 15 pin Male Dsub on unit



Pin #	Function	Pin #	Function
1	Back-up master switch	9	Ground
2	Batt-info	10	Ground
3	Low Volt Warn	11	Ground
4	PWR + in, charge, sensing	12	Output
5	PWR + in, charge, sensing	13	Output
6	Pwr +, pass-thru input	14	Output
7	Pwr +, pass-thru input	15	Output
8	Pwr +, pass-thru input		

# Wiring Diagram IBBS-24v-3ah-CRT

Equipment without Back-up Power Input



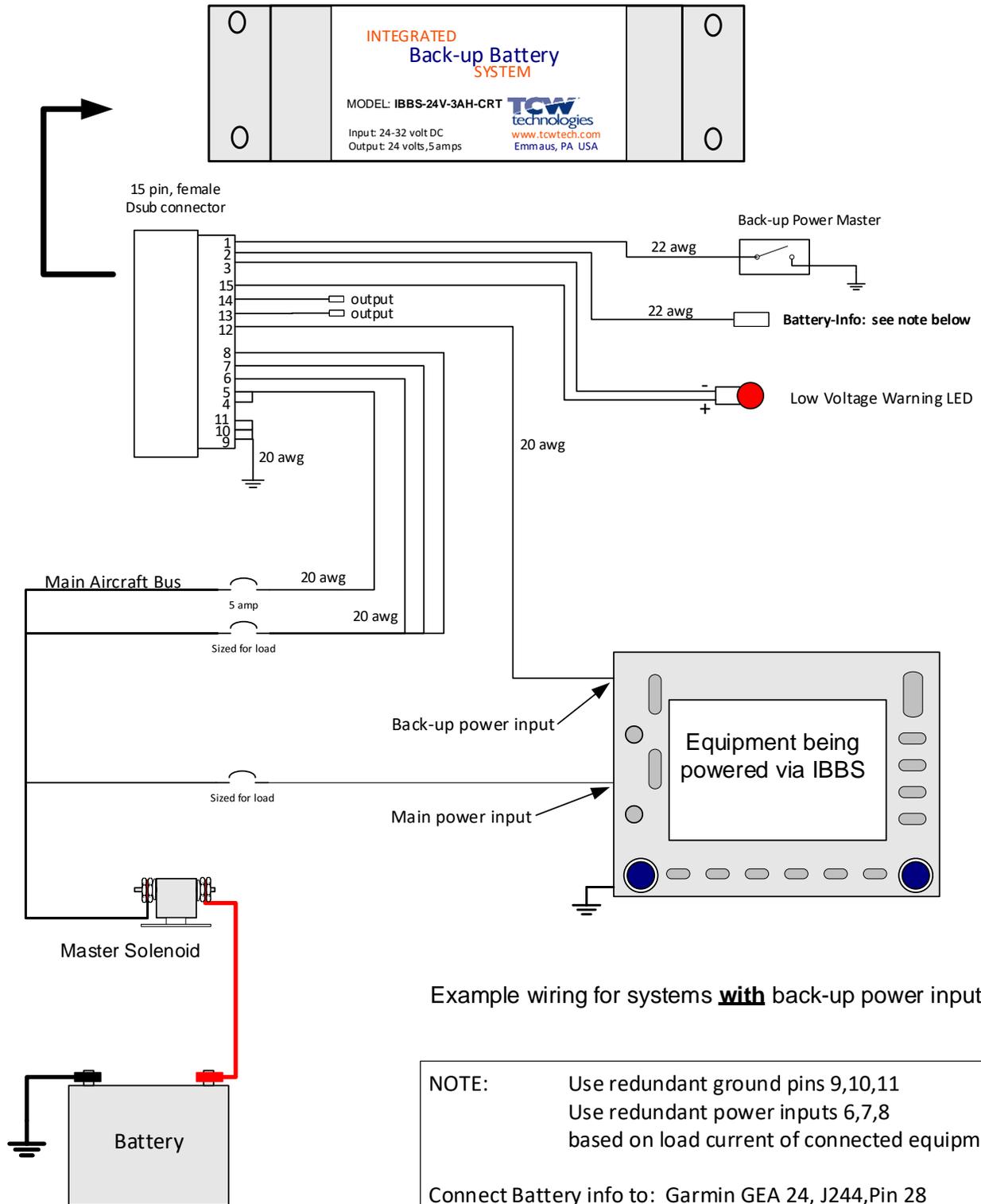
Example wiring for systems **without** back-up power input

**NOTE:** Use redundant ground pins 9,10,11  
Use redundant power inputs 6,7,8  
based on load current of connected equipment

Connect Battery info to: Garmin GEA 24, J244, Pin 28  
AFS EFIS expansion port Pin 13

# Wiring Diagram IBBS-24v-3ah-CRT

Equipment with Back-up Power Input



Example wiring for systems **with** back-up power input

**NOTE:** Use redundant ground pins 9,10,11  
Use redundant power inputs 6,7,8  
based on load current of connected equipment

Connect Battery info to: Garmin GEA 24, J244, Pin 28  
AFS EFIS expansion port Pin 13

## Service and Support information:

610-928-3420  
[www.tcwtech.com](http://www.tcwtech.com)  
email: [support@tcwtech.com](mailto:support@tcwtech.com)

TCW Technologies, LLC.  
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TCW Technologies, LLC.

During the first 12 months from the date of purchase and subject to the conditions hereinafter set forth, TCW Technologies, LLC. (TCW) will repair or replace to the original user or consumer any portion of your new TCW product which proves defective due to defective materials or workmanship of TCW. Contact TCW Technologies for warranty service. TCW shall have and possess the sole right and option to determine whether to repair or replace defective equipment, parts or components. Damage due to equipment, environment or conditions beyond the control of TCW Technologies are NOT COVERED BY THIS WARRANTY.

**LABOR, COSTS:** TCW shall IN NO EVENT be responsible or liable for the cost of field labor or other charges incurred by any customer in removing and/or reaffixing any TCW product, part or component thereof.

**THIS WARRANTY WILL NOT APPLY:** (a) to defects or malfunctions resulting from failure to properly install, operate or maintain the unit in accordance with printed instructions provided; (b) to failures resulting from abuse, accident, or negligence; (c) to normal maintenance services and the parts used in connection with such service; (d) to units which are not installed in accordance good trade practices; or (e) to unit used for purposes other than for what it was designed and manufactured.

**RETURN OR REPLACED COMPONENTS:** any item to be replaced under this Warranty must be returned to TCW Technologies in Emmaus, PA, or such place as TCW may designate, freight prepaid.

**PRODUCT IMPROVEMENTS:** TCW reserves the right to change or improve its products or any portions thereof without being obligated to provide such a change or improvement for units sold and /or shipped prior to such change or improvement.

**WARRANTY EXCLUSIONS:** as to any specific TCW product, after the expiration of the time period of the warranty applicable thereto as set forth above. THERE WILL BE NO WARRANTIES, INCLUDING ANY IMPLIED WARRANTIES OR MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE.

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Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

This Warranty gives you specific legal rights and you may also have other rights which vary from state to state. In the absence of other suitable proof of this installation date, the effective date of this Warranty will be based upon the date of manufacture plus one year. Direct All Notices To: Warranty and Product Service Department, TCW Technologies, 2955 Main Road East. Emmaus, PA 18049