



# **ANALYTIC SYSTEMS**

Power Conversion Solutions

## **INSTALLATION & OPERATION MANUAL**

### **LIAC600-28** **Lithium-Ion AC Charger**



An ISO9001 and AS9100 Registered Company Battery Chargers • Inverters • Power Supplies • Voltage Converters

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**ANALYTIC SYSTEMS**  
Power Conversion Solutions

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## IMPORTANT & SAFETY INSTRUCTIONS

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1. SAVE THESE INSTRUCTIONS - This manual contains important safety and operating instructions for power supply.
2. Do not expose power supply to rain or snow.
3. Use of an attachment not recommended or sold by the power supply manufacturer may result in a risk of fire, electric shock, or injury to persons.
4. Do not disassemble power supply; take it to a qualified serviceman when service or repair is required. Incorrect reassembly may result in a risk of electric shock or fire.
5. To reduce risk of electric shock, unplug power supply from outlet before attempting any maintenance or cleaning. Turning off controls will not reduce this risk.
6. Never place marine power supply directly above battery; gases from battery will corrode and damage power supply.
7. Never allow battery acid to drip on power supply when reading gravity or filling battery.
8. O/P CONNECTION PRECAUTIONS

Connect and disconnect DC output connections only after setting the power supply switch to the off position.

**GROUNDING AND AC POWER CORD CONNECTION INSTRUCTIONS** — The plug must be plugged into an outlet that is properly installed and grounded in accordance with all local codes and ordinances.

**DANGER** — Never alter AC cord or plug provided — if it will not fit outlet, have proper cord installed by a qualified electrician. Improper connection can result in a risk of an electric shock.

Analytic Systems does not recommend the use of the LIAC600 Series Battery Chargers in life support applications where failure or malfunction of this product can be reasonably expected to cause failure of the life support device or to significantly affect its safety or effectiveness. Analytic Systems does not recommend the use of any of its products in direct patient care.

Examples of devices considered to be life support devices are neonatal oxygen analyzers, nerve stimulators (whether used for anesthesia, pain relief, or other purposes), autotransfusion devices, blood pumps, defibrillators, arrhythmia detectors and alarms, pacemakers, hemodialysis systems, peritoneal dialysis systems, neonatal ventilator incubators, ventilators for both adults and infants, anesthesia ventilators, and infusion pumps as well as any other devices designated as “critical” by the U.S. FDA.



## Introduction

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This charger is designed for recharging the SAFT Lithium-Ion Battery (LBB) used by the US Armed Forces and is controlled using a standard Raytheon interface. It can also be used in Bypass Mode as a Stand-Alone power supply. It is designed to deliver 32.0 VDC at up to 22 amps continuous to recharge the battery. The output charges to 28 VDC at up to 22 amps when operating in Bypass Mode.

The LIAC600-28 can be powered from either 110 or 220 VAC (Auto Switching) at frequencies from 47 to 405 Hz. It is supplied with a power cable that has an 110VAC molded plug. To connect the unit to 220VAC, either an adapter must be used, or the 110VAC plug cut off the cable and replaced in the field with a compatible 220VAC plug. Care must be taken to insure that the Hot, Neutral and Ground wires in the cable are correctly connected before connecting to 220VAC (see Table 1 for wire colors).

The unit is tested to MIL461E for both radiated and conducted emissions. It is compliant with MIL810D for shock and vibration and is designed to withstand submersion in 50cm of water for up to 5 minutes.

The unit can be operated over a temperature range of -40 to +60 degrees Celsius, and with an optional pre-heater, will operate at temperatures down to -60 degrees

## Features

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- Built as a COTS Battery Charger for Military Applications
- Military-Grade extrusion ensures a high tolerance for shock and vibration
- Ultra-quiet, low EMI operation
- Can be left permanently connected
- Can function as a power supply
- Optional Carrying Handle available
- Visual indicators for output and charging
- Short circuit protection
- Output over-voltage crowbar
- Inrush Current Limiting with solid state bypass
- Universal Input for 110/220 and 50-405 Hz Operation
- Spark and surge free connection to battery
- 3 year parts and labour warranty (2 yr. Extension available)
- Designed to meet MIL-STD 810F, Method 514-3, Cat-I Proc I for vibration
- Built according to the ISO9001:2008 & AS9100



# Specifications

## Input Voltage

2.1.1 Voltage Range	90 to 140 VAC / 180 to 280 VAC auto-selecting
2.1.2 Frequency Range	47 to 405 Hz.
2.1.3 Electronic Inrush Current Limiting	60A Peak
2.1.4 Circuit Protection	Circuit Breaker, magnetic, 10 Amp
2.1.5 AC Power Connection	3-conductor cord w/ molded NEMA 15-5P plug (3ft) Note: An adapter may be required to connect to 220 VAC

## Output Voltage

2.2.1.1 Voltage (Charging Mode)	32.0 -0.05/+0.0 VDC
2.2.1.2 Voltage (Bypass Mode)	28.0 +/- 0.05 VDC
2.2.3 Current	22A Continuous
2.2.4 Line Regulation	+/- 1.0% or 260mv, max.
2.2.5 Load Regulation	+/- 1.0% or 260mv, max.
2.2.6 Ripple	ripple < 20mV p-p @ 20A Load
2.2.7 Hold-Up Time	20msec., min. @ 24Amps
2.2.8 Dynamic Response	1 sec., max.
2.2.9 Temperature Coefficient	0.02%/°C, max.
2.2.10 Overvoltage Protection	32.25 VDC Latching
2.2.11 Short Circuit Protection	Essentially 0 Amps
2.2.12 DC Power Connection	One D38999/44WG16SN
2.2.13 Battery Load when OFF	25 milli-amps Max

## Output Connections

2.3.1 Output Positive	Pin A, Pin M, Pin P
2.3.2 Output Return	Pin B, Pin N, Pin R
2.3.3 Charger ON	Pin D
2.3.4 LBB Bypass Override	Pin E
2.3.5 LBB Bypass Override Return	Pin F
2.3.6 Status Enable	Pin G
2.3.7 Charger Disable	Pin H
2.3.8 Charger Status	Pin J



### General Specifications

2.4.1 Efficiency	>75%
2.4.2 Isolation	1500 VDC Input-Output 1500 VDC Input-Case w/MOV removed 500 VDC Output-Case
2.4.3 Workmanship	Manufactured in accordance with IPC-A-610
2.4.4 Serviceability	Front Panel is removable to allow replacement of circuit breakers, connectors and switches. No other user serviceable components.
2.4.5 Visual Indicators	Input On, Input Undervolt, Output Undervolt, Overheat

### Physical Specifications

2.5.1 Case Material	Chromated Aluminum – rainproof
2.5.2 Markings	Front panel label (lexan) Serial number stamped
2.5.3 User Controls	Power On/Off Switch Indicator View – Sealed Momentary Pushbutton Charger/Bypass Selector Switch – Sealed Locking Toggle
2.5.3 Dimensions	20 x 10 x 7 Inches including handle
2.5.4 Packaging	Unit has a carrying handle installed that will allow a person wearing cold weather mitts to easily transport unit.
2.5.5 Weight	16 lbs.

### Environmental Specifications

2.6.1 Operating Temperature	-40°C to 60°C
2.6.2 Derating	None
2.6.3 Storage Temperature Range	-50°C to 85°C
2.6.4 Cooling	Convection Cooling via Case
2.6.5 Vibration	Per MIL-STD 810D, Method 514-3, Cat-I Proc I
2.6.6 Shock	Per MIL-STD 810D, Method 516-3, Proc 11, IV, VI
2.6.7 Humidity	0 - 95% Non-Condensing
2.6.8 Water Tightness	Withstand submersion in 50cm of water for 5 minutes.
2.6.9 EMC – conducted emissions	Meet MIL-STD-461E: CE102, figure CE102-1, 10kHz to 10MHz.
2.6.10 EMC – radiated emissions	Meet MIL-STD-461E: RE102, figure RE102-4, 2MHz to 1GHz.

Designed and manufactured by: **ANALYTIC SYSTEMS WARE (1993) LTD.**

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# Operation

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Connect the unit to a source of 110 or 220 AC volts, single phase. If the power plug is not correct for the power source, replace the plug with the appropriate plug that is compatible with the power source. The wire colors for hot, neutral and ground are shown in Table 1.

**Table 1 - Power Cord Wire Colors**

Function	Wire Color
Hot	Brown
Neutral	Blue
Ground	Green

To turn the unit on, flip the combined power switch and input circuit breaker to the ON position.

With the control switch in the NORMAL position, the charger is controlled by the load, which can be any DC device intended for operation from 28 VDC, or a SAFT Lithium Ion 28 Volt battery that is recharged at 32.0 VDC. The unit will turn on and off under control of the load.

If the unit is connected to a battery, a small amount of current (less than 25 milli-amps) will be drawn from the battery to run the interface circuit, and if the battery commands the unit to turn off, it will be completely off.

If the unit is connected to a load that is not a battery, and the load is commanding the unit to be off, the LIAC600-28 will power up the output briefly to energize the interface circuitry every few seconds. A small blip of output voltage at up to 5 VDC will be observed each time this happens. This is normal for this unit, and should not be interpreted as a fault.

With the control switch in the BYPASS position, the charger will simply turn on when the power switch is ON and provide 28 VDC on the output connector (see Table 2 for pin numbers). The output current can vary from no load to 22 amps at any temperature within the operating temperature range, with no derating.

The charger is equipped with an LED display to indicate basic status of the unit. This display is dark unless the pushbutton adjacent to it is depressed. The display includes LEDs to indicate that the unit is powered up (green), the unit is charging (green), low input voltage (red), low output voltage (red) and overheat (red).

## INTERFACE

The output connector is a D38999/44WG16SN, 16 pin bayonet style military connector. A detailed description of each pin is contained in table 2. A more basic description of the interface is presented here.

When a battery is connected and feeding 24V into the power supply, or the power supply is turned on, a 5V regulator circuit is turned on and feeds 5V out to the battery or load control



circuits on pin G. This output has 330 ohms of source impedance. The battery or load has an open collector transistor that switches this line to Vout(-) (Pins B, F, N and R) at a frequency of between 0 and 10 KHz.

The charger feeds this square wave back out on pins D and J. The signal on pin D is in phase with the square wave on pin G when the battery is being charged, and is out of phase when the charge is complete. This output is capable of pulling up to 16 milliamps down to 0.5 VDC or below.

The signal on pin J is in phase with the square wave on pin G when the charger is operating normally, and is out of phase when the charger has a fault. These faults include low input voltage, charger overheat and low output voltage. This output is capable of pulling up to 16 milliamps down to 0.5 VDC or below.

To turn the charger ON, 5V must be applied to pin H. Only 0.4 milliamps of current is required to turn the charger on. Leaving this pin open or connecting the pin to Vout(-) will force the charger to remain OFF.

To force the charger ON in Bypass Mode, connect pin E to pin F. This will force the charger ON regardless of the status of pin H, and will also force the output to 28 VDC. This has the same effect as placing the front panel switch in the BYPASS position.

## LT OPTION

The LT option allows operation of the power supply down to an ambient temperature of -60 degree's celcius. It does this by operating a heater circuit to warm up critical components such as the large aluminum electrolytic capacitors to a suitable temperature before allowing the supply to begin normal operation. There will be no output from the supply while the heater is running.

If the heatsink temperature is below -40 degrees celcius when the supply is turned on, the heater is turned on and the power supply output is disabled. The Dual-Color LED will glow RED and if the pushbutton is pressed the LED will glow ORANGE. The heater will stay on until the heatsink temperature rises above -20 degrees celcius, ensuring that the electrolyte in the capacitors is no longer frozen. Once the heatsink reaches -20 degrees celcius, the heater and the LED will turn off, and the power supply will begin normal operation. If the Pushbutton is pressed now it will display GREEN. There is sufficient self heating within the power supply to keep all internal temperatures at an adequate level during normal operation.

Note that the above two paragraphs assume the unit power switch is ON and refer only to the Dual-Color LED used on the LT model.

## MAINTENANCE

No maintenance is required other than the occasional hosing off to keep the cooling fins clear of debris and dust.



**Table 2 - Output Connector Pin Assignments/Signal Names**

Pin No.	Signal Name	Description
A	LBB_VDC	28VDC power output from Charger to LBB
C	Chassis	Charger Chassis
D	CHARGER_ON	<p>Charger ON signal from Charger to LBB. Signal conditions shall {VMC051, LAC028, LBB082} be as defined below:</p> <p>In Phase indicating charger is providing charge current - Open collector interface with 16 mA maximum current. Charger provides an indication that the charger is ON and charging and that the voltage is valid by switching the signal from a low level signal (&lt; 0.5 V) to a high level (pulled up to 5.25 V max. in the LBB) signal in phase with STATUS_ENABLE.</p> <p>Out of Phase indicating charger is not providing charge current – Open collector interface with 16 mA maximum current. Charger provides an indication that the charger is ON but is not charging and that the voltage is valid by switching the signal from a low level signal (&lt; 0.5 V) to a high level (pulled up to 5.25 V max. in the LBB) signal out of phase with STATUS_ENABLE.</p> <p>Signal low indicates that the charger is in BYPASS/OVERRIDE mode or the charger output is disabled.</p> <p>Signal high indicates charger is disconnected, charger is off, or a broken wire.</p> <p>NOTE: Signal “High” on both CHARGER_ON and CHARGER_STATUS is required to indicate that the charger is not present (disconnected).</p>
E	LBB_BYPASS_OVERRIDE	<p>In the LBB normal mode, the LBB_BYPASS_OVERRIDE signal shall {LBB083} be open.</p> <p>In the LBB override mode, the LBB_BYPASS_OVERRIDE signal shall {LBB084} be connected to LBB_BYPASS_OVERRIDE_RTN (Pin F) with no greater than 51 Ohms.</p>
F	LBB_BYPASS_OVERRIDE_RTN	<p>In the normal LBB configuration, the LBB_BYPASS_OVERRIDE_RTN is open.</p> <p>In the LBB override mode, the LBB_BYPASS_OVERRIDE_RTN signal is connected to LBB_BYPASS_OVERRIDE (Pin E).</p>
G	STATUS_ENABLE	<p>Charger status enable signal from LBB to Charger. Signal conditions shall {VMC065, LAC042, LBB074} be as defined below:</p> <p>Open collector interface with 16 mA maximum current. LBB provides a status enable signal by switching the signal from a low level signal (&lt; 0.5 V) to a high level (pulled up to 5.25 V max. in the charger) pulse with a 5 to 10 Hz frequency and a 10% to 90% duty cycle.</p> <p>STATUS_ENABLE must be present whenever CHARGER_DISABLE is high.</p> <p>STATUS_ENABLE must not be present whenever LBB_BYPASS_OVERRIDE is connected to LBB_BYPASS_OVERRIDE_RTN.</p>
H	CHARGER_DISABLE	<p>Charger enable/disable signal from LBB to Charger. Signal conditions shall {VMC066, LAC043, LBB075} be as defined below:</p> <p>LBB commands a CHARGER_DISABLE by providing a steady state low level signal (&lt; 0.5 V) at the charger.</p> <p>LBB enables charging by providing a pull-up of 475 Ohms +/- 1% to 5 Volts +/- 0.25 Volts. This drives an opto-isolator with 1.2 Volts nominal turn-on voltage.</p> <p>A disconnected cable, broken wire, or the LBB in the OFF position eliminating the CHARGER_DISABLE signal, also disables charging.</p>



Pin No.	Signal Name	Description
J	CHARGER_STATUS	<p>Charger status signal from Charger to LBB. Signal conditions shall {VMC052, LAC029, LBB085} be as defined below:</p> <p>In phase indicating that the charger is on and no charger fault has been detected - Open collector interface with 16 mA maximum current. Charger indicates that it is on and in a no fault condition by switching the signal from a low level signal (&lt; 0.5 V) to a high level (pulled up to 5.25 V max. in the LBB) signal in phase with STATUS_ENABLE.</p> <p>Out of phase indicating that the charger is on and a charger fault has been detected - Open collector interface with 16 mA maximum current. Charger indicates that it is on and in a fault condition by switching the signal from a low level signal (&lt; 0.5 V) to a high level (pulled up to 5.25 V max. in the LBB) signal out of phase with STATUS_ENABLE.</p> <p>Signal low indicates a fault condition or shorted cable, Signal high indicates charger is disconnected, charger is off, or a broken wire.</p> <p>NOTE: Signal "High" on both CHARGER_ON and CHARGER_STATUS is required to indicate that the charger is not present (disconnected).</p>
K	RESERVED	RESERVED (no connection)
L	RESERVED	RESERVED (no connection)
M	LBB_VDC	28VDC power output from Charger to LBB
N	LBB_28VDC_RET	System 28VDC return from Charger to LBB
O	LBB_VDC	28VDC power output from Charger to LBB
P	LBB_28VDC_RET	System 28VDC return from Charger to LBB
Q	RESERVED	RESERVED (no connection)



## Special Services & Options

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<b>Conformal Coating</b>	INCLUDED ON ALL UNITS UNLESS REQUESTED NOT TO as of April 1, 2014
<b>Option "c"</b>	Ruggedization Package (EXTRA Conformal Coating and RTV Compound)
<b>Option "v"</b>	Marine / Industrial Pkg (EXTRA Conformal dipping and RTV Compound)
<b>Option "MS"</b>	Military Pkg (incl. Wide Temp Components, Conformal Dipping and RTV Compound)
<b>Option "w"</b>	Wide Temperature Operation (-40 to +55 C, incl)
<b>Option "SM"</b>	High Voltage Protection on the DC Input Side
<b>Option "d"</b>	Paralleling Diodes
<b>Option "FI"</b>	Forklift Modifications
<b>Option "F"</b>	Open Frame - No chassis just heat sink bars (not for all products)
<b>Special Input</b>	There is no charge for nominal output voltages (ie. 12.0, 24.0, 48.0), but this must be noted at the time of order (Contact Factory for details)
<b>Special Output</b>	
<b>Water tight options</b>	IP66, IPS67, IPS68









## Limited Warranty

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1. The equipment manufactured by Analytic Systems Ware (1993) Ltd. (the "Warrantor") is warranted to be free from defects in workmanship and materials under normal use and service.
2. This warranty is in effect for:
  - a. 3 Years from date of purchase by the end user for standard products offered in our catalog.
  - b. 2 Years from date of manufacture for non-standard or OEM products
  - c. 1 Year from date of manufacture for encapsulated products.
3. Analytic Systems will determine eligibility for warranty from the date of purchase shown on the warranty card when returned within 30 days, or
  - a. The date of shipment by Analytic Systems, or
  - b. The date of manufacture coded in the serial number, or
  - c. From a copy of the original purchase receipt showing the date of purchase by the user.
4. In case any part of the equipment proves to be defective, the Purchaser should do the following:
  - a. Prepare a written statement of the nature of the defect to the best of the Purchasers knowledge, and include the date of purchase, the place of purchase, and the Purchasers name, address and telephone number.
  - b. Call Analytic Systems at 800-668-3884 or 604-946-9981 and request a return material authorization number (RMA).
  - c. Return the defective part or unit along with the statement at the Purchasers expense to the Warrantor; Analytic Systems Ware (1993) Ltd., 8128 River Way, Delta, B.C., V4G 1K5, Canada.
5. If upon the Warrantor's examination the defect proves to be the result of defective material or workmanship, the equipment will be repaired or replaced at the Warrantor's option without charge, and returned to the Purchaser at the Warrantor's expense by the most economical means. Requests for a different method of return or special handling will incur additional charges and are the responsibility of the Purchaser.
6. Analytic Systems reserves the right to void the warranty if:
  - a. Labels, identification marks or serial numbers are removed or altered in any way.
  - b. Our invoice is unpaid.
  - c. The defect is the result of misuse, neglect, improper installation, environmental conditions, non-authorized repair, alteration or accident.
7. No refund of the purchase price will be granted to the Purchaser, unless the Warrantor is unable to remedy the defect after having a reasonable number of opportunities to do so.
8. Only the Warrantor shall perform warranty service. Any attempt to remedy the defect by anyone else shall render this warranty void.
9. There shall be no warranty for defects or damages caused by faulty installation or hook-up, abuse or misuse of the equipment including exposure to excessive heat, salt or fresh water spray, or water immersion except for equipment specifically stated to be waterproof.
10. No other express warranty is hereby given and there are no warranties that extend beyond those described herein. This warranty is expressly in lieu of any other expressed or implied warranties, including any implied warranty of merchantability, fitness for the ordinary purposes for which such goods are used, or fitness for a particular purpose, or any other obligations on the part of the Warrantor or its employees and representatives.
11. There shall be no responsibility or liability whatsoever on the part of the Warrantor or its employees and representatives for injury to any person or persons, or damage to property, or loss of income or profit, or any other consequential or resulting damage which may be claimed to have been incurred through the use or sale of the equipment, including any possible failure of malfunction of the equipment, or part thereof.
12. The Warrantor assumes no liability for incidental or consequential damages of any kind



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