

## PCBA 5010-4 Instruction Manual

### Disclaimer

The PCBA 5010-4 has been designed and manufactured with careful consideration to the issues of safety from electrical shock, thermal hazards and RFI compliance when used according to the requirements of this documentation.

Batteries by their very nature are electrochemical energy storage devices with properties that can become hazardous when abused, misused, or due to simple unforeseen failure. Users working with batteries and battery associated equipment must be knowledgeable of the risks involved due to incorrect equipment configuration, abuse conditions, general hazards and potential for fire, explosion, and emission of fumes due to battery and/or cell level failure during testing and charging operations.

All battery maintenance and testing should be located in an area free from combustible materials. Batteries should be located on a surface that can withstand high temperatures preferably being made of non-flammable or flame resistant material. Battery testing operations should not be left unattended unless careful consideration and attention has been made to minimize the risks of damage in the event of a failure or fire while unattended. When the risk of damage due to fire or explosion is high, a secure and inflammable containment structure should be implemented to contain the battery and its contents in the event of failure.

**In no event will Energy Storage Instruments Inc. or its officers or employees be responsible for any consequential, incidental, or indirect damages including damages for loss of business profits, business interruption, and the like arising out of the use or misuse of the PCBA5010-4 battery analyzer or its documentation.**

### Do Not's

- Do Not – Connect more than one channel to a battery.
- Do Not – Mix the +ve or –ve test leads between channels when connecting to a battery.
- Do Not – Connect two negative or two positive test leads across a battery.
- Do Not – Connect a battery higher in voltage than 36.0 volts nominal rating
- Do Not – Enter incorrect battery parameters in the “Battery : Table”, or connect an incorrect battery to a channel that is not configured correctly for that battery.

### Safety

- Only connect AC line input to a 3-wire earth grounded single phase AC supply.
- Input line to line voltage range is 90–260VAC, 50-60Hz, 3<sup>rd</sup> wire earth ground.
- Only replace AC line fuse with equivalent voltage and current rating 4A/250VAC.
- Do not attempt to charge non-rechargeable primary batteries such as alkaline, carbon-zinc, or non-rechargeable lithium batteries.
- Do not exceed the battery manufacturer's recommended charge current and voltage limits.

- For added safety, use the battery temperature sensing inputs supplied with each channel to halt battery service in the event of a battery over-temperature or under-temperature condition. Batteries are best serviced near room temperature, between 5 and 45 degrees Celsius typical.

## **Grounding**

The PCBA 5010-4 chassis is hard wired to the earth ground for safety. The negative output or common of the analyzer power supply is also connected to earth ground or chassis ground through a 10k resistor such that the output of the supply is essentially floating when the USB cable is not connected. However, it is not uncommon for a USB hub or desktop or laptop computer to hard wire the common of the USB cable to the earth ground essentially short circuiting the analyzer's internal 10k resistor. Therefore, in order to ensure that the output of the analyzer and connections to a battery are floating, it may be required that you disconnect the USB cable from the analyzer.

Floating the output of the analyzer is recommended if an earth grounded oscilloscope or other equipment is connected to the output of the analyzer and battery for measurement of battery voltage and/or current for two reasons:

- 1) If the earth grounded ground connection of the oscilloscope is connected to the battery positive terminal, a dead short circuit will result across the battery.
- 2) If the earth grounded ground connection of the oscilloscope is connected to the battery negative terminal, an unknown amount of current will flow through the oscilloscope ground and return to the analyzer ground/common bypassing the analyzer current sensing and control circuitry, resulting in incorrect current control, analyzer measurement error and possible damage to the analyzer. Therefore, if connecting an earth grounded oscilloscope or any grounded equipment to the output of any channel on the analyzer you should disconnect the USB cable.

## **Isolation**

Other options is to float USB connection and laptop computer

See schematic in Appendix A.

Or use a USB isolator such as the Keterex USB-150 or equivalent

See <http://www.keterex.com/kxusb150.php>

## **Quick Start Operating Procedure**

- 1) From the main window menu click *Database - Battery : Table* and enter the battery chemistry, voltage and capacity for the model of battery you want to analyze. Enter the other battery parameters if desired but are not necessary. Press *Save* and close the *Battery : Table* window.

- 2) From the main window menu click *Database - My Battery : Table* and enter the serial number for each battery of type model entered in step 1. Only the serial number is a required field. Press *Save* and close the *My Battery : Table* window.
- 3) In the main window double click the analyzer channel you want to use to perform a battery analysis. Then click the *Configure* tab and select the battery model entered in step 1 from the top list, and from the next list select the battery serial number entered in step 2. Then choose the function you want to perform on the battery and any required or additional parameters, such as discharge method, discharge rate, current and voltage limits, post charge/discharge pauses etc...
- 4) Once all the configuration parameters are selected and/or typed in. Hit the *Save* button if you want to save your configuration to the database. For future configurations press the *New* button first then set all your configuration parameters and hit *save* to save an additional configuration. Configurations are stored as a function of battery type not serial number. Hit the *Set Configuration* button to send the configuration to the analyzer channel.
- 5) Connect the battery with serial number as per above to the analyzer channel as per above and press the start button.

### **Built in PCBA5010-4.chm Help File**

For more detailed information on how to use the PCBA5010-4 please refer to the built in help file by clicking on the 'Help' buttons anywhere in the PCBA.exe program.

### **Hints**

- To change the name of the analyzer, double click the name in the main window.
- The analyzer time is automatically downloaded from the host computer system clock, so if your system time is not working or if it is inaccurate so will be the analyzer.
- Configuration parameters can be selected from the drop down lists or manually entered for more specific entry values, such as the EODV could be typed in as 9.567 Volts.
- Some configuration parameters can also be manually entered that are outside of what might be considered the normal operating range for a given battery to allow for extreme testing circumstances. Be careful when working outside the norm.
- Use the *Save To File* buttons to save test data to text files for importing into spreadsheet software such as Excel.
- The high speed data logging gives a fairly accurate voltage waveform except for the first 5 to 10 points ( 0.5 to 5ms) after large current changes.
- The actual pulse current load profile is very accurate. For exact battery voltage waveform viewing it is advisable to attach an oscilloscope across the battery. Remember to disconnect the USB cable prior to starting the service or float your oscilloscope with an isolation transformer.

- Zoom and pan features on graphs. Use the left click mouse button to zoom in from top left to the bottom right corners of a box. Use the bottom right to top left action to return to full zoom. Use the right click and hold to pan the graph in any direction.

## **Function Descriptions**

**Charge** - Charges the battery using default, or user defined, voltage and current settings.

**Discharge** - Discharges the battery using user defined EODV - End Of Discharge Voltage and discharge rate. The discharge method can be selected as constant current, constant power, constant resistance or pulsed mode with up to five programmable discharge currents and durations.

**Life Cycle** - Performs repeated discharge-charge cycles according to user defined settings for both charge and discharge operations. Number of cycles selection range is 1-10,000 or can end by 'Discharge Capacity Limit' 'Fade To Target' settings.

The life cycle testing can be continuous or programmed into segments for intermediary test functions throughout the life cycle testing. For example, a 1,000 life cycle test can be broken into 10 x 100 life cycle test segments where after each 100 cycles the ohm test or other function(s) can be performed.

**Ohm Test** - First charges and then discharges the battery while recording voltage and internal resistance in milli-Ohms at each 0.5% rated discharge capacity point. Finishes with a final charge.

The resulting discharge graph shows the battery voltage throughout discharging along with the internal resistance reading for each point as a function of state of charge. As batteries age this curve is likely to shift higher and change shape.

**Prime** - New batteries and batteries from storage are cycled to achieve normal function

**Quick Test** - Determines the approximate condition of a battery within 10-60 minutes. (maximum 2 hours)

This function tries to determine if a battery is good or bad by loading it to see if the voltage can hold-up under load.

If the battery voltage fails to hold-up while under load a series of 1 or 2 charge-discharge cycles are performed to see if the battery is bad or simply needs charging. Analyzer tries to determine battery health overall result based on internal algorithm results FAIL, GOOD, VERY GOOD or EXCELLENT.

**Recondition** - A deep discharge, followed by a charge and overcharge cell balancing initiative is applied to revive nickel cadmium, nickel metal hydride and lead acid type batteries. A very slow rate overcharge has been added for lead acid types as of February 2015 - PCBA.exe software version 1.56 - channel hardware.firmware version 1.56/2.06.

For **NiCd** and **NiMH**, a discharge - Discharge(1), is followed by a deep discharge - Discharge(2), and then a charge - Charge(1), is followed by an overcharge - Charge(2).

Deep discharge is performed by preset internal algorithm using high current pulse discharge method at 1C rate for one second ON, ten seconds OFF.

Overcharge is performed at C/20 rate for 30% over capacity after 6 hours. C/10 rate is used prior to PCBA.exe version 1.56 software - Feb 2015 to give 30% over capacity after 3 hours.

For **Wet Lead Acid** and **SLA**, a discharge - Discharge(1), is followed by a charge - Charge(1), and an overcharge - Charge(2). Applies to FW version 1.56 / 2.06 - Feb 2015 or higher.

Overcharge is performed at C/400 rate for 20% over capacity. (80 hours)

Multiple sequential recondition cycles may be needed to fully restore lead acid type batteries to maximum usable capacity.

For **Lithium Ion** a simple discharge-charge cycle is performed with no deep discharge or overcharge initiatives.

(also applies to wet lead acid and SLA types prior to firmware version 1.56 / 2.06 - Feb 2015)

**Reactivate** - Resets smart batteries to start working again

Analyzer tries to reconnect smart battery internal safety circuit by imitating charger

**Test DC - Battery is Discharged, Charged**

**Test DCD - Battery is Discharged, Charged, Discharged**

**Test DCDC - Battery is Discharged, Charged, Discharged, Charged**

**Test CD - Battery is Charged, Discharged**

**Test CDC - Battery is Charged, Discharged, Charged**

**Test CDCD - Battery is Charged, Discharged, Charged, Discharged**

## Specifications

Volt Meter Resolution	1mV/step, 0 to 51,673mV
<b>Volt Meter Error (typical)</b>	<b>Less than +/- (0.1% + 10mV)</b>
Current Resolution	10mA/step, 0 to 10,000mA, applies to both charge and discharge modes of operation
<b>Current Error (typical)</b>	<b>Less than +/- (0.1% + 2mA)</b>
Battery Voltage Range	NiCd & NiMH 1-30 cells; lead acid 1-18 cells; lithium ion all types 1-11 cells except LiFePO4 1-12 cells
Battery Capacity Range	300mAh to 200Ah; 200Ah capacity de-rated for charge voltage greater than 20 Volts, limited by power and $C/20 = 10A$
Charge Power (continuous)	200 Watts via any single channel or 200 Watts via sum of channels
Discharge Power (continuous)	200 Watts via any single channel or 200 Watts via sum of channels
Chemistries Serviced	Nickel cadmium, nickel metal hydride, lead acid, lithium ion
Lithium Ion Types (cathode)	Cobalt oxide, iron phosphate, manganese oxide, nickel-cobalt-manganese, plus new cathode materials when available
Temperature Range/Resolution	-30 to +96 degrees Celsius with 0.1 degree resolution; Accepts 1-100k nominal thermistor values; Ideal value 10k
Temperature Recording	0-63 degrees Celsius by 1 degree C/step, or -30 to +96 degrees Celsius by 2 degrees C/step
Charge Methods	Nickel batteries - constant current; lead acid and lithium ion batteries - constant voltage with current limit
Discharge Methods	Constant current, constant power, constant resistance, pulsed constant current 2-5 steps
Pulse Discharge Range/Slew	500us-10ms in 500us/step, 10-60,000ms in 1ms/step, discharge current slew rate 15Amps/ms
High Speed Data Logging	500us/point or 2k points/sec, select 1mV or 50mV resolution, log snapshot or continuous(5 min max), digital smoothing
Full Charge Detection	Voltage inflection, negative delta V, input capacity, peak voltage, waning current (lead acid & lithium ion)
Maximum Channels	432 channels via a single USB host controller by connecting 108 analyzers using 19 seven port hubs
Enclosure	Heavy duty aluminum enclosure with powder coat finish. <b>Now available in seven colours; red, green, brown, black, white, yellow and blue</b>
Dimensions	Imperial : LxWxH 10.50x9.30x2.75inches    Metric : LxWxH 267x236x70mm

Weight	11 lbs / 5.0 kg
Input Connection	IEC AC input connector with third wire earth ground connection
Output Connection (Channels)	Analyzer is fitted with four 8 pin Neutricon male receptacles that mate with four female plug and cable sets included
Input Voltage	Universal AC operation from 90-260VAC, 50-60Hz
Input Power	250 Watts maximum at 90VAC
Input Fuse	4 Amps, 250VAC, 5x20mm
System Requirements	Windows 98, 2000, XP, Vista and 7-Seven operating system with USB 2.0 full speed support
Warranty	<b>Lifetime warranty against defective parts, manufacturing and failure due to normal use. (Retroactive for existing customers with version 1 hardware).</b>
Safety Approvals	<b>CE certification now standard with version 2 hardware</b>

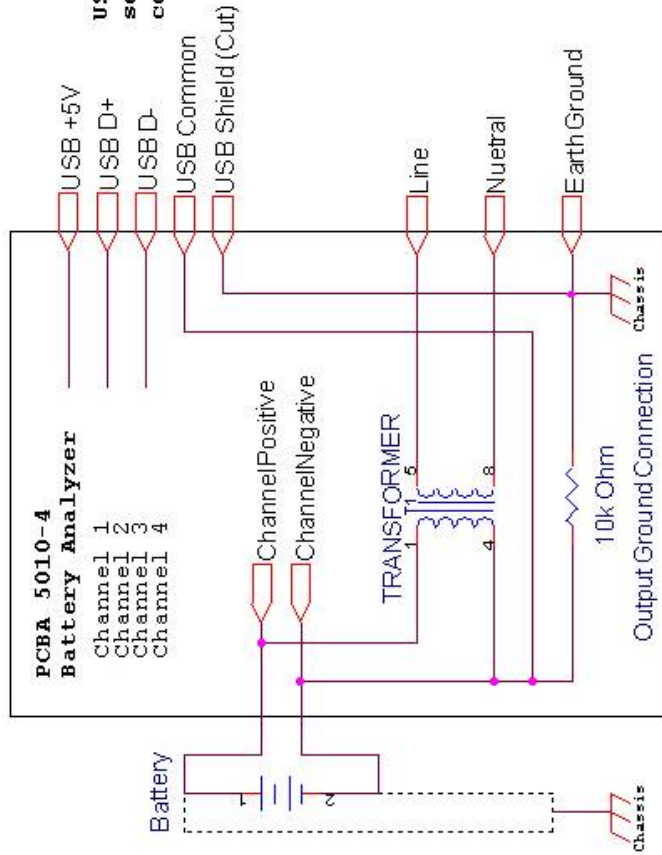
## **Appendix A**

Earth Ground Schematic for PCBA 5010-4 and electrical concerns for floating USB connection from earth ground.

Or use a USB isolator such as the Keterex USB-150 or equivalent  
See <http://www.keterex.com/kxusb150.php>

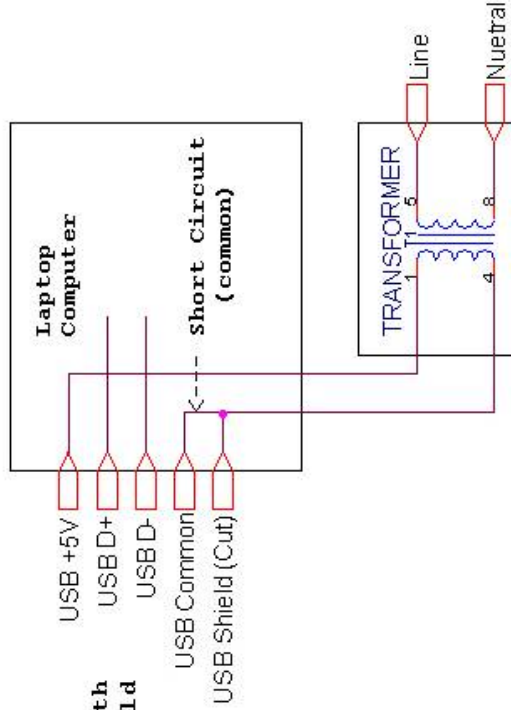
## Floating USB Connection to PCBA 5010-4 Battery Analyzer

All channels share output voltage supply that is earth ground connected on the negative side through an internal 10k resistor



**Floating USB connection allows for +ve or -ve earth ground connection of battery through other equipment or circuits intentional or otherwise.**

Some computers and USB hubs internally connect the USB Shield to the USB Common which in turn short-circuits the PCBA 5010-4 battery analyzer's internal 10k Ohm output ground connection.



**Laptop Computer Power Supply (two-wire earth ground isolated)**

To prevent ground loop errors and/or damaging short circuit currents due to battery analyzer output earth ground connection while having simultaneous control of battery analyzer via computer interface:

- 1) Use a modified USB cable with severed outer shield and foil connection.
- 2) Use a earth ground isolated laptop computer and power supply with mouse and no other equipment or devices connected such as printers or networks.
- 3) Use a single analyzer channel only, disconnect and remove all other channel cables.

Title Floating USB Connection to PCBA 5010-4 Battery Analyzer

Size A Document Number PCBA 5010-4 Battery Analyzer Grounding Rev A

Date: Friday, May 06, 2011 Sheet 1 of 1