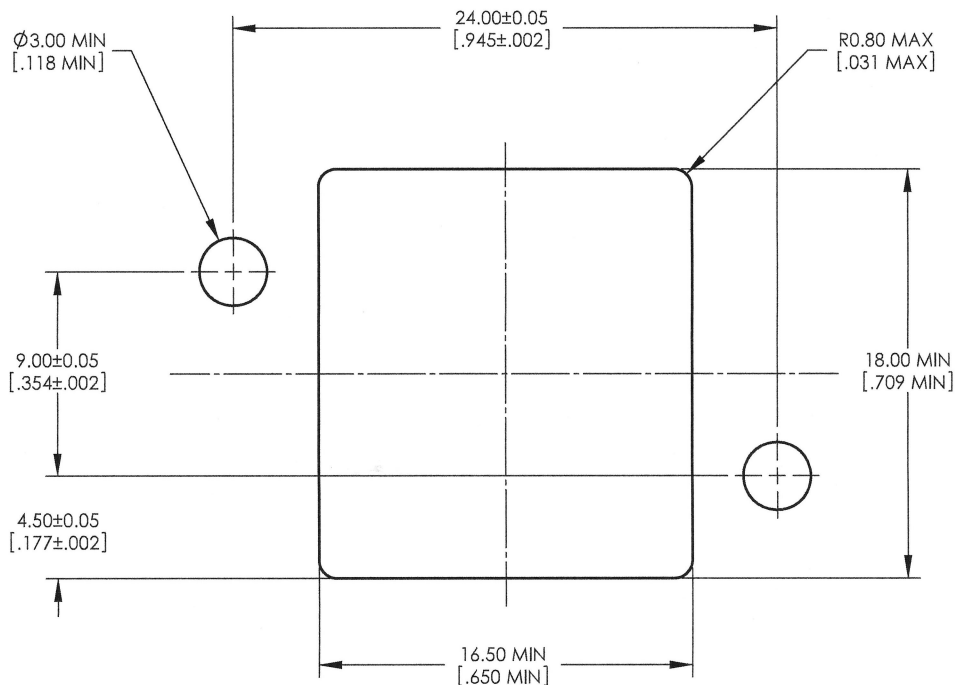# USB Charger Port Installation Instructions
Model CL-USB-IQ

RECOMMENDED PANEL CUTOUT

- Dimensions in the drawing above are in mm., (inches are in parentheses).

- 4 - 40 mounting screws.

- The device is 2 1/4" W x 1 1/8" H x 1 1/2" D (Should probably have 2" behind panel.)

- There must be plenty of room for air to circulate by the diode heat-sink.

- Unit **MUST** be connected to a 2 Amp circuit breaker or fuse, Klixon 7274-11-2 or similar. The unit is a conservative design. The voltage charge pump converter is a 5 A unit but don't push it to its limit. After all, the USB

port itself was never designed to be a 5 A charger, rather it was designed to be a serial port that could provide about a 1/2 amp at 5 volts for some computer peripheral device. In fact the maximum current specification for the pins in the USB connector is 1.5 amps.

- Connect battery negative lead to the pad with the - next to it, connect battery plus lead to the pad with the + next to it.

- The small holes next to the connection pads are for soldering a #18 (minimum) wire for connection to your electrical system, or you can bolt your electrical connections to the board with 6-32 hardware.

- The unit has reverse voltage protection so if you hook it up backwards the regulator will not be damaged but there will be no 5 volt power.

- **<u>Absolute maximum input voltage is 15 volts.</u>** The charge pump converter device has a 15 volt maximum operating voltage and that big diode with the heat sink on it is in there to provide reverse voltage protection and to drop the incoming voltage by about 1 volt giving you some margin if your charge voltage is a bit high, but be aware that you may fry the unit if your charging circuit and bus voltage gets up much over 15 volts. (It shouldn't go much over 14 volts if your voltage regulator is operating properly.)

- The CL-USB-IQ will *Rapid* charge any device plugged into either port. It contains a *Smart Chip* that dynamically senses the device plugged in and configures voltages on the data pins to signal the device that it is plugged into its own OEM wall charger. Because it is electronically sensing the input pins, the circuit is active at all times and draws about 65 ma of current when nothing is plugged into the device.

- Be advised that the sequence of plugging your Apple tablet into the charger is important. It is preferable to use Apple OEM USB cables, not cheap third party cables. Plug your USB cable into the charger first, then plug the cable into your Apple device. The charger and the Apple device do a handshake, and very rarely I have seen the handshake go awry if the cable is plugged in the other way, and the Apple tablet will charge at the 5 watt rate instead of the 10 or 12 watt rate.

- Either port on the charger will charge a device that only needs 5V to charge as long as the total power demand doesn't exceed 25 watts.

If you want to understand USB battery charging, the following Introduction to my out of print book about the subject will give you an idea of the complexity of using a computer serial I/O device for battery charging. Once you understand that the USB port was **<u>NEVER</u>** designed to charge batteries, you will begin to understand the draconian lengths device manufactures have had to go to use the USB standard to safely and reasonably efficiently charge the batteries in your toys. Welcome to bizzaro world.

Introduction

Back in 2010, I had a conversation with a pilot who needed to charge his iPhone and iPad during flight from the 12 volt electrical system in his homebuilt aircraft. The electrical system in small airplanes is no different than in a car. It seemed like a simple request. I knew that smartphones and tablets came with a charger that used the ubiquitous USB cable to connect to their wall charger, and the cable was also used to connect said device to a computer for data exchange. I'd designed numerous electronic devices, and some were even sophisticated computer peripherals. So when I looked at his iPad charger and his iPhone charger, I thought, "Piece of pie. This will be trivial." Was I ever wrong!
In the first prototype, I used a simple linear regulator that was able to supply up to 2.5 amps at 5 volts. However, after he installed it in his airplane, he called and said it did not work. Neither his iPad nor his iPhone indicated they were charging. After I re-tested the device to make sure it worked properly, I began delving into the uncharted world of battery charging using the USB port. The only documentation of this secret realm is supplied by curious minds that have reverse engineered the chargers supplied by manufacturers. References to all of the information I found is in the Acknowledgments section of this booklet. None of this information can be found in any manufacturer's documentation that I am aware of. It is not a trade secret, because they use the common USB connector, not some proprietary connector; it is more like some kind of guild secret.

What I learned was that there are two modes for charging the battery in the iPhone, iPad or Android tablet, *Trickle* charging and *Rapid* charging. In order for the manufacturers to protect the common USB port in a computer from the power demands of battery charging in newer, more power hungry peripheral devices, they added clever charge management circuitry for their devices that limit power draw when the device is plugged into a generic computer USB port. After several design iterations I was able to manufacture chargers suitable for the iPhone, iPad and Android tablets. There are a few companies that make a

single charger unit that will *Rapid* charge both an Apple tablet and an Android tablet simultaneously, although I know of one solar charging device and a plethora of car chargers that claim to be able to do it, but don't. All one has to do is read the negative reviews of the devices to find that out. Luckily there are new *smart* integrated circuits coming to market that can figure out what type of peripheral device is being plugged into the USB port of a third party charger and automatically provided the proper signals on the data pins to inform the device that it is plugged into a charger that can provide *Rapid* charging capability. There are a few chargers on the market that already incorporate this technology but it is not easy to differentiate them from the myriad of devices that claim to be able to charge any device but cannot.

Warning: All computer USB ports have power limits. Plugging a peripheral device into a port that requires more power than the USB standard specifies may cause damage to the port, usually resulting in damage to the motherboard. This document contains information about the USB standards for powering peripheral devices. The documentation for all peripheral devices should clearly state any non-standard power requirements. Please check your documentation carefully before plugging your new toy into a computer USB port, and make sure the USB port on your computer is compatible with your device. There are now three major USB port specifications and several revisions, and they all have different power and data rate capabilities. Make sure you know which version you have in your computer. The most common one is USB 2.0, but USB 3 and 3.1 are being included in most new computers. USB 1.x ports are very obsolete but may be in that old desktop or laptop, so verify before you plug something in, because they are the most prone to damage from excessive power demand. In fact, the newest USB 3.1 ports can negotiate power availability and if the device being connected doesn't negotiate, the USB port limits power to 4.5 watts, or 0.9 amps, which will only *Trickle* charge tablet devices. Readers would be advised to read the Charging Ports section of the Wiki article and also note that many computers, especially laptops, may shut power off to their USB ports when they are turned off.