SCHMIDT CONSULTING

USB
Power Monitor
&
Dummy Load

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I built this simple device to display: volts, amps and to totalize milliamp hours. The display is based on a low cost USB power analyzer. Turned out I ended up using it more than expected so modified it to provide more granular loads. This comes in handy when a device does not meet published specifications.

Overview

With the proliferation of USB devices I wanted to be able to verify voltage and current at the device independent of how it was powered: PC, car adapter or wall wart. In addition I wanted to measure the capacity and overall charge/discharge efficiency of some USB battery packs. To accomplish that task ideally need a display of watthours but an amphour readout is almost as useful.

I picked the Keweisi Charger Doctor it displays: volts, milliamps, milliamp hours and elapse time. It only costs a few dollars. A nice feature is the total is stored in nonvolatile memory so the result is not lost even if power is removed. A reset button clears elapsed time and mAh.

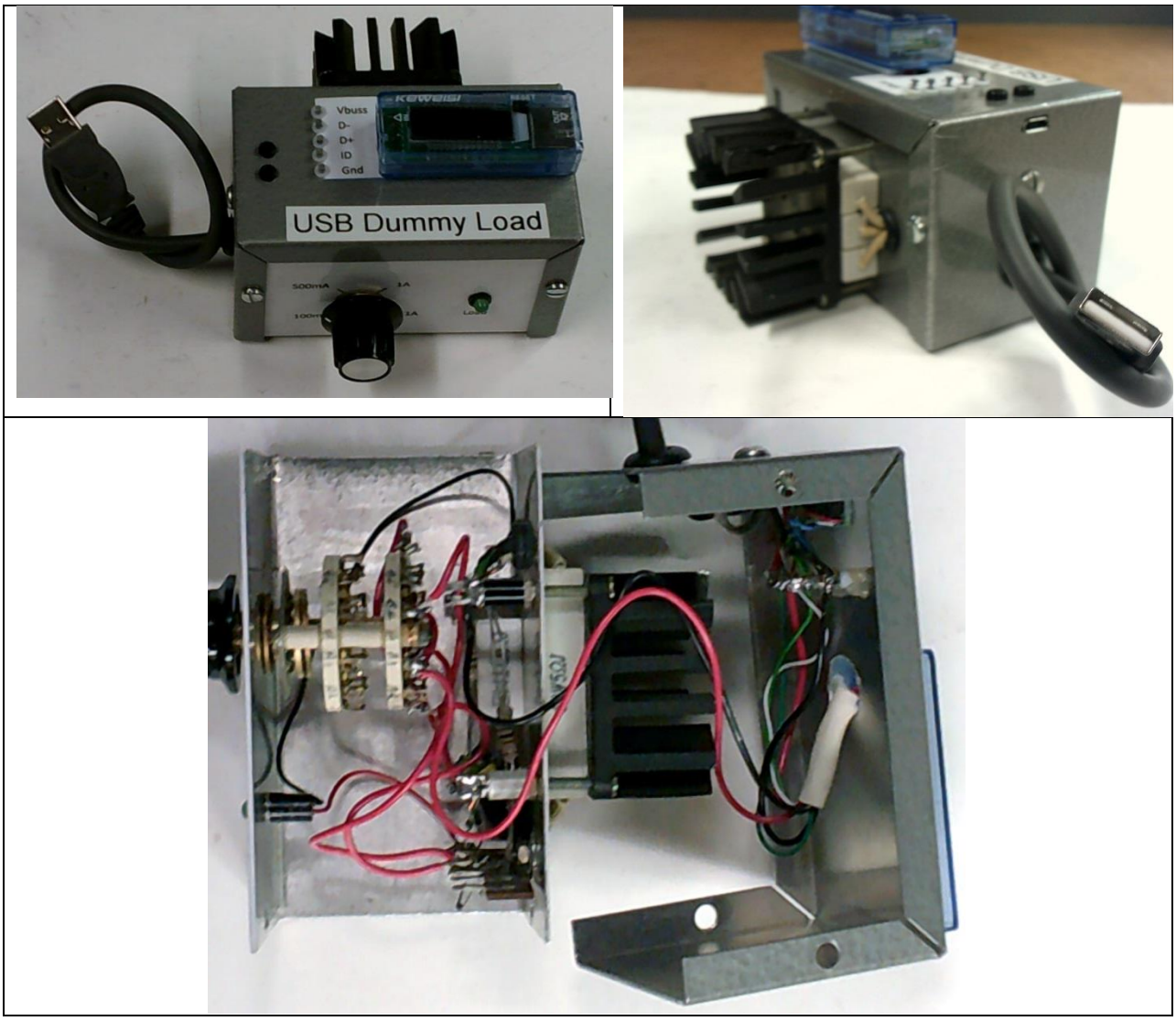
To provide the dummy load function I picked four common USB load values: 100ma, 500ma, 1A and 2.1A. The desired load is selected by a rotary switch and a front panel LED indicates when the load is on. Later I modified the device to provide more granular loads: 100ma, 500ma, 1A, 1.5A, 2.1A and 3.1A.

The most common USB host connector is the type A. Desktops, laptops and many USB car chargers use this connector. In the handheld world most devices have standardized on the USB micro connector. This delivers power and data in a very small form factor and the 5th pin implements USB OTG (on the go) signaling. This pin is used to tell what normally would be a USB slave device to become a host controller allowing USB peripherals to be connected. I wanted the dummy load to be able to accept either connector. For the USB A connector I cut up a USB cable to provide a flying lead. This allows the tester to be connected even when the USB connector is recessed behind a bezel. The Micro A connector is surface mount so I purchased a prototyping version attached to a small PCB with thru hole terminations for the external leads.

To make it easy to probe the various USB signals I mounted 5 test points.

Feature Set:

- Display real time volts and amps and totalize milliamp hours
- Simulate 100ma, 500ma, 1A, 1.5A, 2.1A and 3.A loads
- Connect to either USB A receptacle or Micro B plug
- Provide test points for each USB lead.



Construction

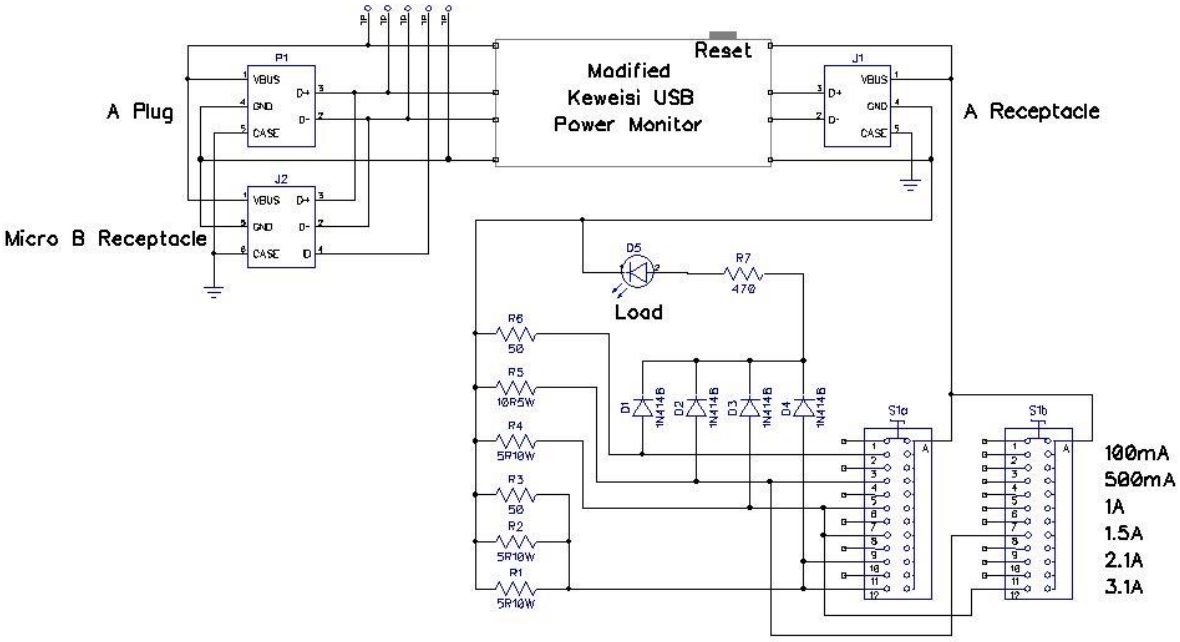
The project fits in a small metal minibox. I modified the Keweisi power monitor by removing the USB A plug and attaching four lead wires out a hole drilled in the bottom of the plastic case. The A receptacle was left in place to allow devices to be attached but load side Vbuss, ground, and cable shield connections were extended. The USB monitor was attached to the box with double sided foam tape.

The 2.1A load dissipates 10.5 watts. To dissipate the heat I used a TO3 transistor heat sink I had laying around. Two 5 ohm 10W resistors are used for the 2.1A load along with a couple of parallel 100 ohm half watt resistors located in the case. The 1A load consists of a single 5 ohm 10W power resistor. The three high wattage resistors are sandwiched between the heat sink and case. The two 2.1A load resistors at the outside and the single 10 watt resistor used for 1A load in the middle to optimize heat

transfer. Steady state temperature at 2.1A is about 125F, warm to the touch but well below danger level.

Diodes connected to each of the four loads provide power to a front panel LED. I used dual deck 12 position rotary switch wired with six active terminations with a no-connect between active positions.

Schematic



USB Power Monitor & Dummy Load

Conclusion

I have been pleased with the result. I've ended up using it a lot to check USB cables and power supplies, both car and mains. It has been interesting seeing the tremendous difference in how closely products meet advertised specifications. Even with a modest load the voltage drop of even a short 1 meter micro USB cable is significant. In addition I doubt most micro B cables twist D+/D-. This severely limits the length of cable that can be used.