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A METHOD TO SIMPLIFY THE USB TYPE-C POWER DELIVERY POWER SUPPLY EFFICIENCY MEASUREMENT AS MEASUREMENT ACCURACY

HP INC

A Method to simplify the USB type-C Power Delivery Power Supply Efficiency measurement as measurement accuracy

I. Object:

Remove an unwanted power draw of USB Power Delivery(PD) control board from the power supply under test to simply the measurements and improve the accuracy of efficiency test especially at low power measurements.

II. Concept:

In order to measure USB type-C Power Delivery power supply efficiency in standalone mode (without system) a Power Delivery control board is required (mandatory) to program the various output voltages. The Power Delivery Integrated Circuit industry is providing these boards but the problems are that:

1) The board itself is also powered by the USB type-C Power Delivery power supply and it's power consumption causes an efficiency measurement error that becomes significant at low power measurements.

2) The Power Delivery control board power consumption is also a function of the set/programmed output voltage on the USB type-C Power Delivery power supply.

3) Power Delivery control board power consumption varies with Power Delivery control board brand.
Consequently, efficiency measurement errors are present and significantly impacting especially low power mode efficiency measurements (Figure 1).

4) The control boards CC signal power consumption is static after output voltage negotiation and very small compared to the Control board power consumption.

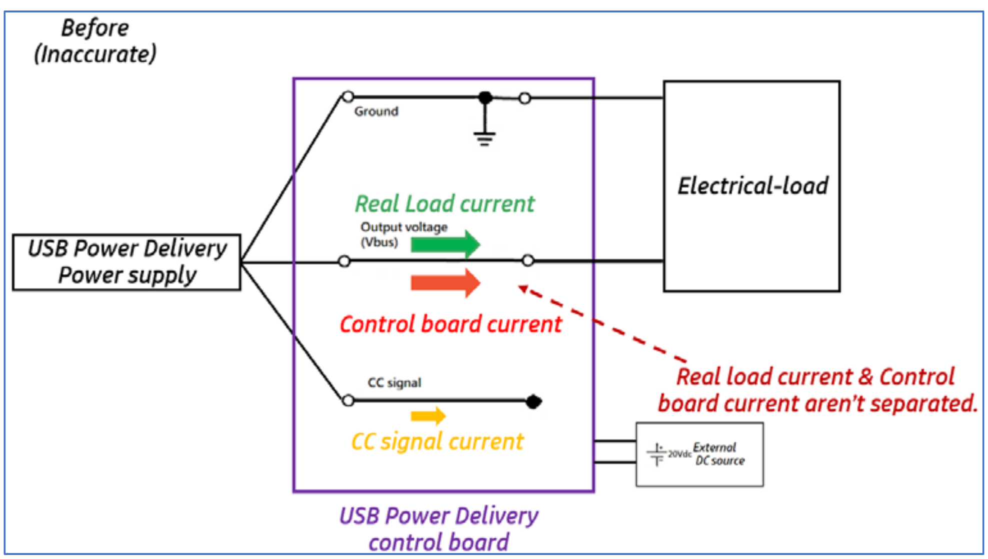
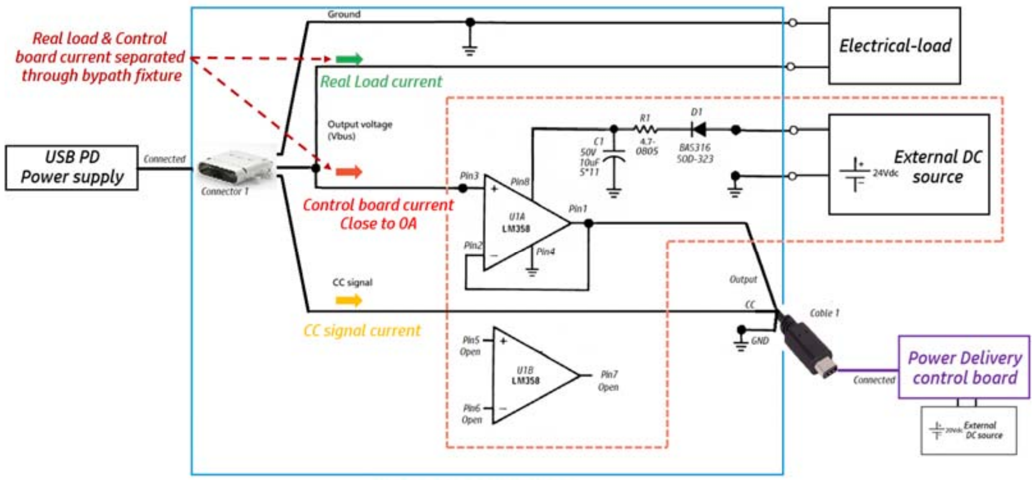


Figure 1



Bypath fixture schematics

Figure 2

To overcome the 1st problem I designed a ‘Bypath fixture’ allowing to separate ‘Real load current’ from ‘Control Board current’ as shown in figure 2. To solve the 2nd and 3rd problem, I interface the Power Delivery control board with a voltage follower circuit powered by an external DC-source as shown in figure 2. There is still some current drawn by the ‘voltage follower circuit’ from the USB type-C Power Delivery power supply output but it’s 1 Million times smaller than before and literally close to zero.

About the 4th problem, CC signal current is specified by USB-IF in USB Power Delivery specification as shown table 1, and CC signal current is static after negotiation. CC signal power loss is very small compared to the Control board power consumption and will be mathematically integrated in the calculations throughout this document.

Table 1: Rp is the pull up resistor inside the USB type-C Power Delivery power supply.

Source CC Termination (Rp) Requirements

Source Advertisement	Current Source to 1.7 – 5.5 V	Resistor pull-up to 4.75 – 5.5 V	Resistor pull-up to 3.3 V ± 5%
Default USB Power	80 μA ± 20%	56 kΩ ± 20% (Note 1)	36 kΩ ± 20%
1.5 A @ 5 V	180 μA ± 8%	22 kΩ ± 5%	12 kΩ ± 5%
3.0 A @ 5 V	330 μA ± 8%	10 kΩ ± 5%	4.7 kΩ ± 5%

Disclosed by Jack Yeh, HP Inc.