# USB Vbus load cable

## A and Type-C™

FS-LS-AP-65
FS-LS-CP-65

Revision 1

# Introduction USB Vbus

- USB Vbus comes from a USB (Embedded) Host, Hub or dedicated charger and is used for powering standard USB devices and/or charging devices.

- In order to guarantee interoperability between USB products it is important that the USB Vbus voltage remains within specification at all times.

- When USB Vbus not stays within the required values it might result in:
  - Device may not function
  - Device may not charge
  - Device may charge slow
  - Permanent destruction of devices

- Products assembled with USB Type-C™ connector implies major changes
  - Device can also provide Vbus to a host
  - Optional power delivery can support up to 100W with different voltages (e.g. Vbus = 20V@5A)

# How to test USB Vbus

- Measure Vbus near to the USB Standard A-Receptacle and/or Type-C™ Receptacle

- USB Vbus Voltage should stay between 4.75V and 5.5V (USB standard requirement)

- Measure Vbus on all ports without load

- Measure Vbus on all ports with highest supported load
    - Load all exposed ports with highest supported load

- Measure for a long period there the voltage may drop over time (≥10 minutes)

- It is recommended to also measure at highest supported environmental operating temperature defined by the product specification/requirements

# Load requirements

- Load USB A-Receptacle standard requirement
  - USB2.0 = 500mA
  - USB3.x = 900mA
  - BC1.2 = 1500mA
- Load USB A-Receptacle vendor specific implementation
  - Depending on the vendor e.g. 1A, 2.1A or 2.4A
- Load USB Type-C™ Receptacle depend on Rp of the source
  - Rp = 56KΩ =  USB2.0 = 500mA; USB3.x = 900mA
  - Rp = 22KΩ = 1.5A
  - Rp = 10KΩ = 3.0A
- If USB Type-C™ Receptacle support Power Delivery load can be up to 5A and different voltages may apply

# Important Notes!

- Using a resistive load will not give the required maximum load. Therefore it's required to use a DC Electronic Load to do proper testing

- Some standards have stricter values set beyond to the USB standard

- Due to the low voltage and high current it's important to take the significant voltage drop into account when making the measurement

- USB cables have a significant resistance that impact the result and vary between different cable manufacturers and models

- The longer the cable the more resistance and voltage drop is introduced

# Cable voltage drop **example**

For example 150mΩ cable resistance on Vbus + GND

Load set to 2.4A

Vbus out 5V



USB Host
Or
USB Hub

Vbus measured on load is
Vbus out – V Cable drop = **4.64V**
Where it should measure 5V in
assumption the voltage not drop
at Host or Hub.

Cable voltage drop = 150mΩ X 2.4A = 0.36V
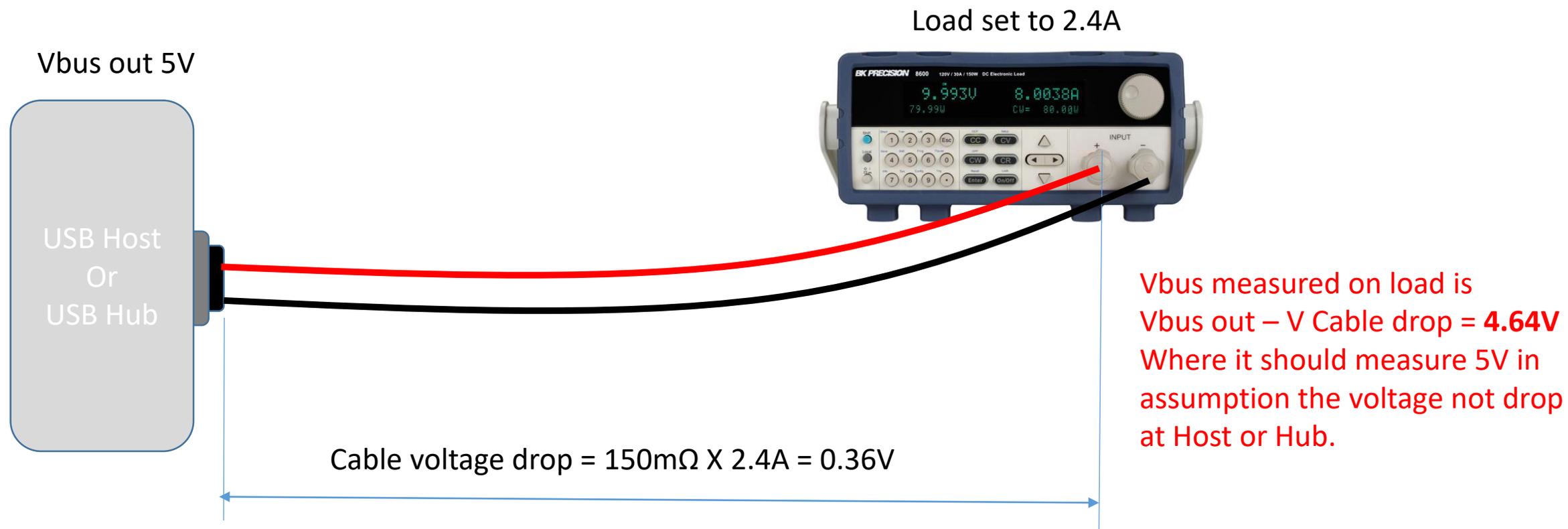
**The cable voltage drop is having too much impact on the measurement resulting in an unexpected failure!**

# Solution

- Use a DC Electronic Load instead of a resistive load

- Use the fixture solution load cables to make an accurate measurement:
    - FS-LS-AP-65
        - 65cm load cable with USB A-plug to connect to load and to measure voltage
    - FS-LS-CP-65
        - 65cm load cable with USB C-plug to connect to load and to measure voltage

# Setup examples

A and Type-C™

FS-LS-AP-65
FS-LS-CP-65

# DC Electronic Load with Voltmeter



(example) can be any voltmeter

Vbus Meas

GND Meas

USB Host
Or
USB Hub
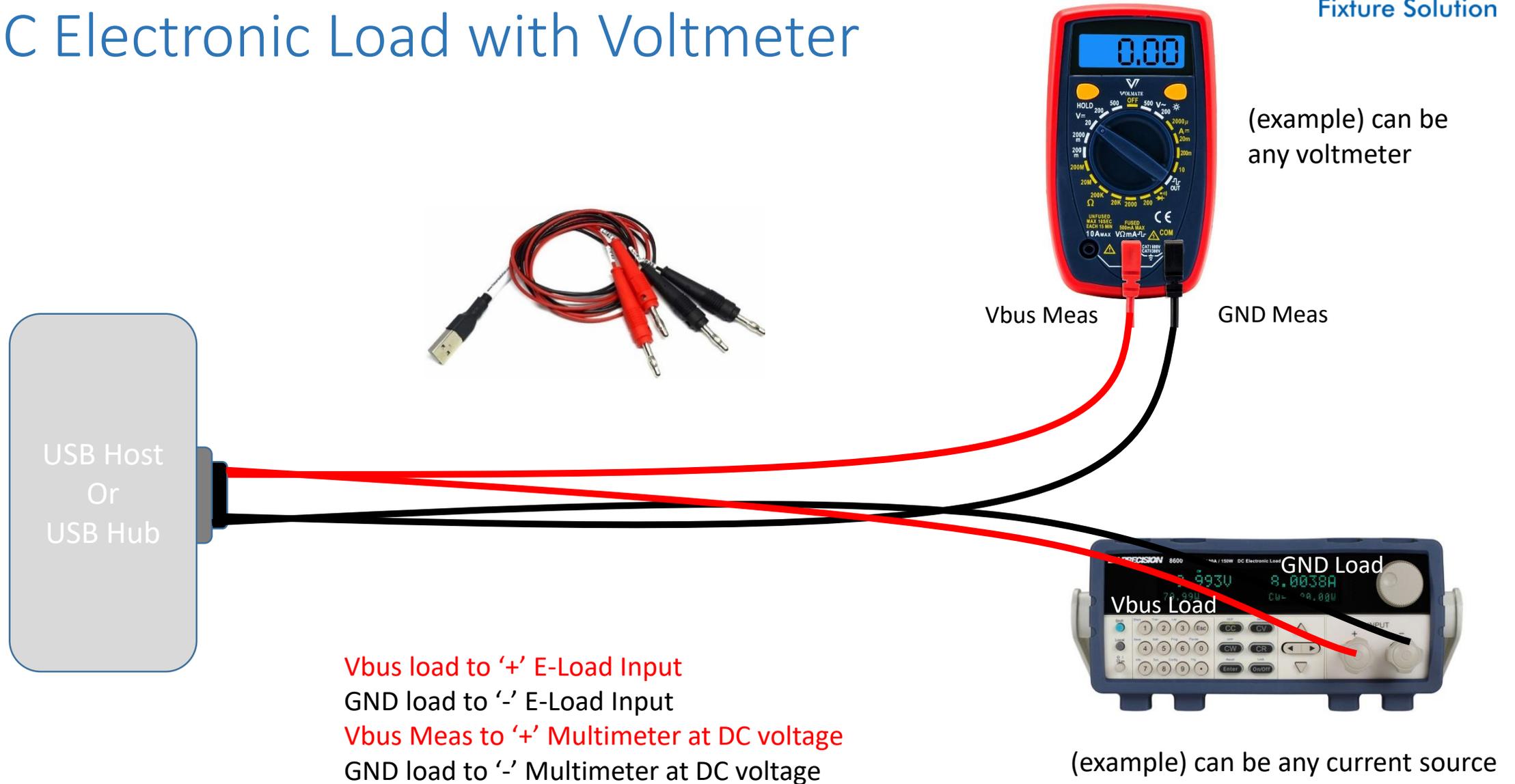
GND Load

Vbus Load

Vbus load to '+' E-Load Input
GND load to '-' E-Load Input
Vbus Meas to '+' Multimeter at DC voltage
GND load to '-' Multimeter at DC voltage

(example) can be any current source

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Fixture Solution

# DC Electronic Load with sense option



Vbus Load

GND Load

Vbus Meas

GND Meas
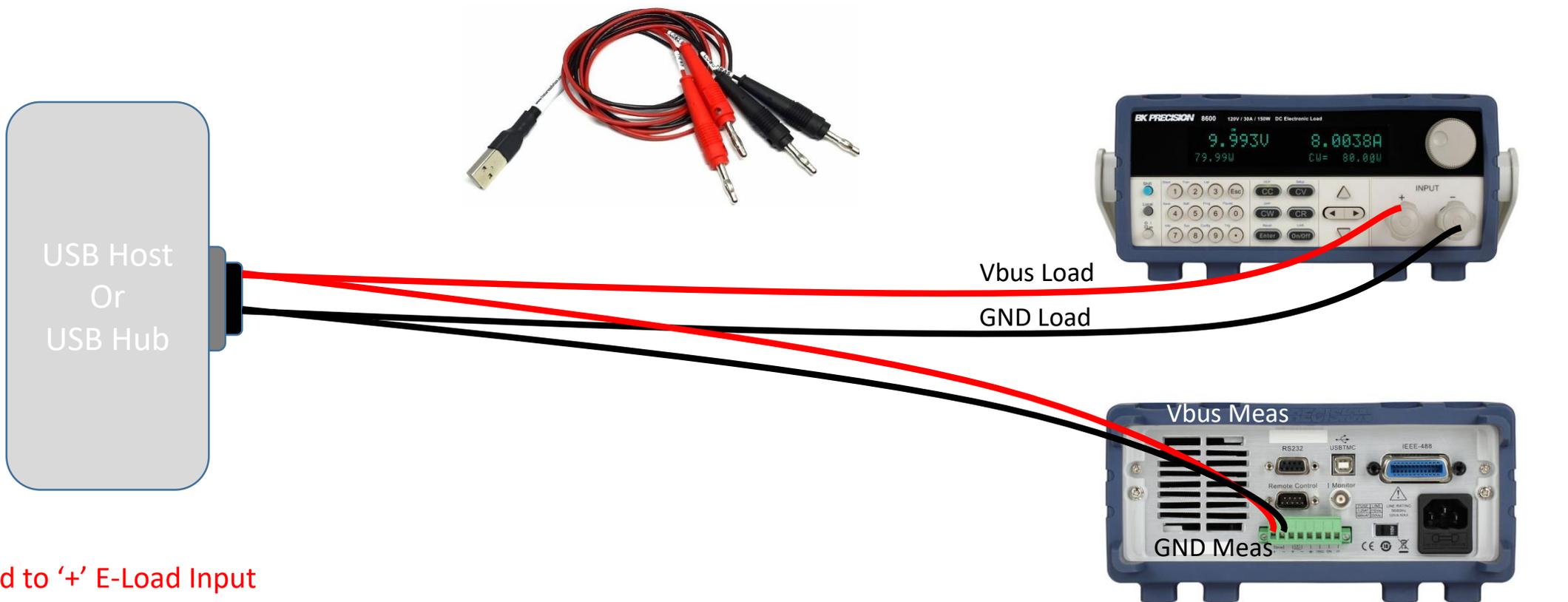
Vbus load to '+' E-Load Input
GND load to '-' E-Load Input
Vbus Meas to '+' sense
GND load to '-' sense
**Make sure to enable sense voltage measurement!**

(example) can be any current source

# Keysight N6705C with sense option



Vbus Meas
GND Meas
Vbus Load
GND Load

USB Host
Or
USB Hub
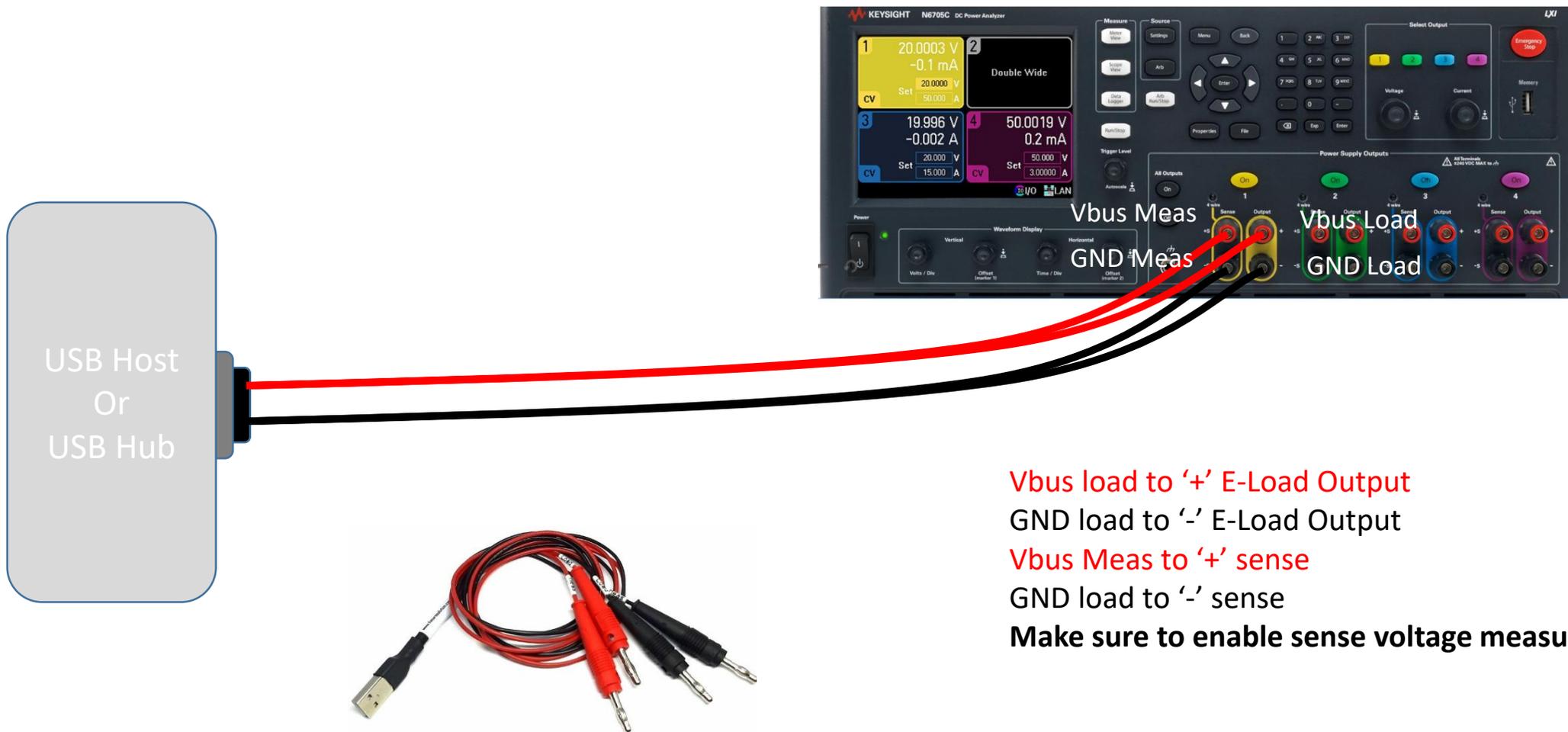
Vbus load to '+' E-Load Output
GND load to '-' E-Load Output
Vbus Meas to '+' sense
GND load to '-' sense
**Make sure to enable sense voltage measurement!**

# 3 port example

Vbus Load

GND Load

Vbus Meas          GND Meas

Do voltage measurement
on all ports while all ports
are loaded.

USB Host
Or
USB Hub

Vbus Load

GND Load

Vbus Load

GND Load
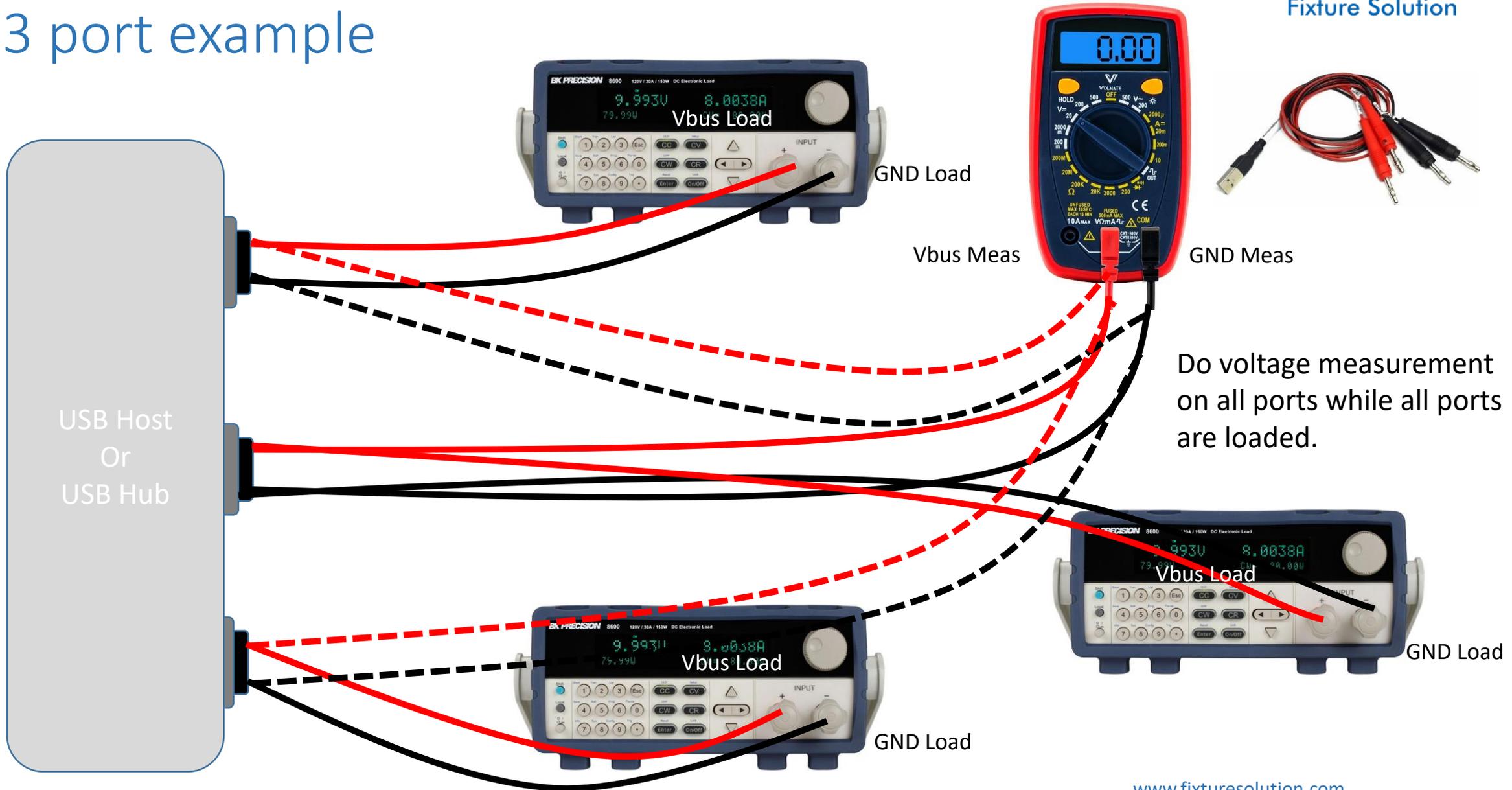
# Test procedure

1) Connect FS-LS-AP-65 and/or FS-LS-CP-65 to all accessible ports
    a) Connect "Meas" Vbus and GND wires to voltmeter or sense port of DC Electronic Load
    b) Connect "Load" Vbus and GND wires to load port
    c) If "sense" port of DC Electronic Load is used for measuring Vbus enable this method (*)
2) Measure voltage on all ports without enabling load and report voltage
3) Enable all load to maximum supported current of each port on the DC Electronic Load
4) Measure voltage on all ports again and report voltage

Result:
Verify that the voltage remain between 4.75V and 5.5V for all values.
Note that some vendors have more strict margin.

Optional test:
- Verify that the voltage remain in range at all different supported loads
- Verify that the voltage remain for 10 minutes within specification
- Place the product under test in temperature chamber at the maximum supported temperature

(*) Check DC Electronic Load manual how to make this setting.

# Setup requirements

- DC Electronic Load that is able to handle the maximum current of the USB port under test.
  - Qty. DC Electronic Load = amount of ports

- If DC Electronic Load sense option is not available or used use one Voltmeter

- A-plug load cable FS-LS-AP-65.
  - Qty. FS-LS-AP-65 = amount of A-receptacle ports

- Type-C™ load cable FS-LS-CP-65.
  - Qty. FS-LS-CP-65 = amount of Type-C™ receptacle ports