

The Sycard USBtest 2000 is a tester for USB ports. It is primarily intended for testing host controllers and hubs in a manufacturing environment. However, its precision testing capabilities and flexible software make the USBtest 2000 quite useful for certain engineering test and verification applications. This application note discusses the use of the USBtest 2000 in verifying self powered hub operation under load.

The USB revision 1.1 specification defines the voltage available at the downstream port of a hub as 4.40V in section 7.2.2. There are many reasons why the supply voltage may be lower than the nominal 5.0V. The unloaded supply voltage may be below 5.0V and/or the addition of a load may cause the voltage to drop. The cable connecting each hub port to the tester has some resistance in both the power and ground connections. The overcurrent protection circuitry in the hub also has some resistance.

If the overcurrent protection is implemented per port, then the cable and overcurrent device resistance will be in series and will have an increasing voltage drop with increasing current load for the individual port. If the overcurrent protection covers more than one port then the voltage drop through the device will depend on the sum of the current through all of the ports that share that overcurrent protection device. The hub power supply also has sources of voltage drop. These depend on the implementation. With a linear regulator, the voltage may drop from nominal at higher loads if the regulator input voltage falls below the regulator's output voltage plus the regulator's dropout voltage. If this happens, the dropout usually first occurs between peaks of the line voltage, if the power supply capacitors cannot keep the voltage high enough. Another cause of voltage drop with a linear regulator is if the regulator starts to go into thermal shutdown and cuts back on the current that it will supply. If the regulator is not rated for the total current draw, then it may also go into current limiting. With a switching regulator, the regulator voltage will drop some with larger loads applied. With an external power supply, there will also be some voltage drop in the cable between the regulator and the hub.

The voltage seen by the tester will drop with increased load due at least to the cable and protection device drops mentioned above. The other reasons listed above may contribute further to the voltage drop. The USBtest 2000 has the ability to load one or more hub ports and then measure the voltage. This capability can be used in both hub manufacturing and hub engineering validation environments.

As a manufacturing test, the USBtest 2000 is primarily used to verify that the correct components are assembled correctly and function together. During the USBtest 2000 hub test, each port in turn has its voltage measured. If the load test is enabled, then after the unload port voltage has been measured a load is placed on the port and the voltage is then measured again. The load amount is selectable. The overcurrent protection device and cable are expected to provide some voltage drop over what is seen with no load. The loaded voltage is checked to

see that it has dropped by a minimum amount from the unloaded voltage but at the same time has not dropped below a lower bound (referred to as the "loaded Vcc lower voltage").

For engineering validation, an additional test is available that loads all the ports at once and then waits for a selectable interval and then checks the voltage on all the ports. Regulator thermal problems may not show up until the load has been applied for a few seconds. The test default is 3 seconds (3000 ms).

The parameters controlling the load tests are given below with the default values shown:

-c0	load current (the value specifies the load: 0 = no load, 1 = 100mA, 2 = 500mA, and 3 = 600mA)
-v1	Display verbosity for each test (the value specifies how much output the test provides: 0 = No test progress displayed, 1 = Display status for each test, and 2 = Display status, voltages and erroneous data values)
-t10	USB Vcc tolerance percent
-l4.15	USB loaded Vcc lower Voltage minimum
-d0.06	USB loaded Vcc protection device minimum Voltage drop (for 500 or 600 mA load, 100 mA drop not checked unless drop is specified)
-x	Disable loaded Vcc drop checking (no default, overridden if a drop is specified)
-m27:0	All-load test enable (0 = disabled, 1 = enabled)
-m28:3000	All-load interval in milliseconds between turning on the loads and measuring the port voltage.
-m32:0	All-load test load (0 = use load test value or 500mA if load test value not explicitly given, 1 = 100mA, 2 = 500mA, and 3 = 600mA)

On hubs with regulator thermal problems, the 3-second interval that all ports are loaded for may not show all problems. By running the all-load test several times in a row, one can see if the voltage is dropping over time. An example command line to run this test is:

```
TESTHUB -m27:1 -v2
```

This test will default to 500 mA loads (which are 10 ohm resistive loads that consume 500 mA at 5.0V) per port. The load can be changed with the "-c" option, note that this will also enable the individual port loaded voltage check. The load can also be changed with the -m32 parameter, in which case the -c value will only be used for the individual load test while the -m32 parameter value will be used for the all-load test. Another way to check for thermal regulator problems is to lengthen the interval between applying the load and measuring the voltage. An example command with a 10 second interval is:

```
TESTHUB -m27:1 -v2 -m28:10000
```

Note that the upper loaded time interval is about one minute (60000).