Proto3 Board #1 In-Office Testing (Matt)

Test results show that despite reverting to original board (same as Proto3 Board #2), the solar charger on Board #1 shows a FAULT condition which seems to indicate that the charger is in TERMINATION (charging suspended) despite having a battery connected that needs charging.

Board #1 worked a previously a week ago in office testing using a both a power supply and solar panel with the modifications to resistors in place. Today's tests included:

- Set up test setup in office with similar conditions to field testing (Voc = 17.4V, Board #1)
- Used power supply used to produce mock solar panel input from previous testing
- Used meters to measure input current from panel (Icc), battery current (Ibat) and battery voltage (Vbat)
- During testing, Icc ≈ 22.3mA and Ibat ≈ 24mA at each checkpoint (0, 5 and 15 minutes). Battery voltage dropped from 12.64V to 12.62V over that same period.
- Test confirmed same issue as experienced out in the field
- The following additional tests were completed with still no change to above result:
  - Removed, retested modified MPPSET resistor
  - Confirmed setting Voc = 16V - 21V had no affect on Icc/Ibat; proved not an MPPSET resistor issue
  - Replaced modified MPPSET resistor with original Proto3 MPPSET resistors
  - Confirmed not in PRECHARGE state (Vbat < Vlowv): 12.64V >> 4.1V
  - Confirmed no change when using really discharged battery (Vbat = 6V-7V)
  - Verified Vmppset > 1.2V (otherwise Icc would be low) V)
  - Replaced all STAT related LEDs and discrete components (resistors, etc) which affect Vbat when fully charged
  - Inserted fresh battery (12.7V)

Out of all the conditions that could cause issues, TERMINATION appears to be the problem:

- Termination occurs when Vfb > Vrech, where Vfb is the feedback voltage from the Vbat output voltage
- Vrech = 2.035V - 2.065V and Vfb = 2.09V on Board #1, meeting TERMINATION condition above
- Using a working Proto2 (old) board with solar charging active, confirmed that Vfb = 1.94V < Vrech, and Proto2 was charging properly as expected.

After fixing the STAT2 resistor setting (needed to move R98 from gate of Q5 to anode of D12), it appeared that neither STAT LED for the solar charger was lit, indicating a FAULT condition occurred. According to TI, a FAULT condition happens under the following conditions:

- Temperature Suspend - **no issue**
  - Vts not within temperature voltage ranges (1.5675V - 2.4255V and 1.485V - 2.4255V)
  - Vts on Board #1 fixed at 1.94V, so confirmed not a problem
- Over Voltage - **no issue**
  - Both input (Vcc > 32V) and battery (Vfb = 2.142V - 2.184V) over voltage conditions were not met by Board #1's Vcc (17.4V) or Vfb (2.09V)
  - Both measurements taken using MAX setting on meter
- Sleep - **no issue**
  - Sleep is entered when Vcc < Vsrn; since Vcc = 17.4V and Vsrn = 12.64V on Board #1, we are not in sleep
- Battery Absent - **possible**

    - Based on Figure 19 in the TI spec, since we are in TERMINATION, it is possible that the battery could be considered absent
    - No issues related to CMAX, as the total output capacitance on the output node is MUCH smaller than calculated value of CMAX ≈ 5000uF

Further testing around the TERMINATION condition specifically yielded the following information:

- Given a battery with Vbat = 12.73V (charged up a bit), we calculate Vfb = 1.895V given resistors on Board #1
- Measured Vfb = 1.90V when solar charger is not active (battery only). This is a valid (i.e. enabled, not terminated) voltage for the charger.
- Once the solar charger is activated (solar panel connected, Vcc > 0V), then Vfb = 2.05V and enters TERMINATION mode; Vbat does not change (remains at 12.73V)
- Checked the thermistor for issues, but still see Vfb jump to 2.05V even if thermistor is removed

Additional testing on 1/30 used the conditions listed in the 'Enable and Disable' charging section of the TI spec (p.14) to confirm if we're hitting a discharge condition:

- Charge disabled (MPPSET < 75mV) - **Nope, Vmppset = 1.22V > 75mV**
- Adapter removed, entering sleep - **Nope, verified yesterday**
- Adapter voltage < 100mV above battery - **Nope, verified yesterday**
- Adapter is over voltage - **Nope, verified yesterday**
- REGN or VREF LDO voltage not valid - **Nope, both in range**
    - Vregn = 5.98V, OK (6V expected)
    - Vref = 3.29V, OK (3.3V expected)
    - **Interesting: STAT2 LED lit up when meter touches VREF**
- TSHUT IC temperature threshold reached - **How can we check this?**
- TS voltage out of range - **Nope, verified yesterday**

THE BIG QUESTION: Why does Vfb increase immediately once the solar charger activates and enters TERMINATION despite no change in Vbat?

Some issues are still outstanding and need to be tested:

- Test disabling termination to see if still have issues
- Individually test all Vfb resistors out-of-circuit to verify resistance