

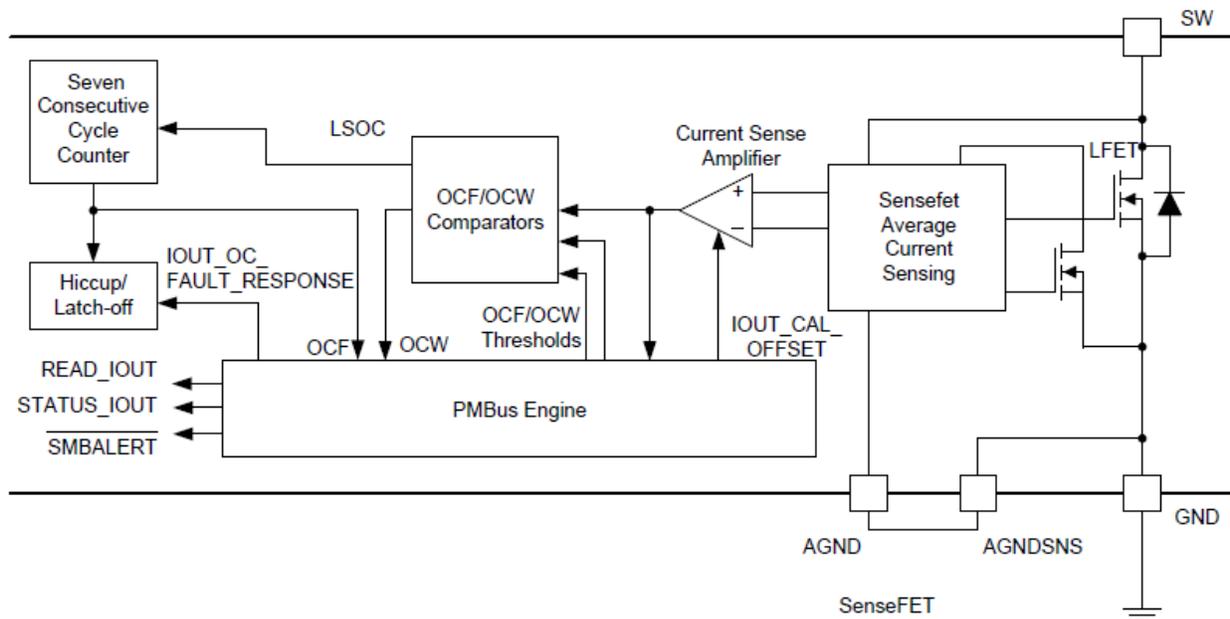
# How to Tighten PMBus Output Current Measurement Accuracy



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Enterprise servers and switches, storage attach networks and base stations are increasingly using power supplies with PMBus to easily configure, control and monitor critical voltage rails such as high-current ASICs, DSPs, FPGAs and DDR memory core without software programming.

Monitoring output voltage, current and temperature is useful for board characterization and real-time, remote monitoring of high-power data centers. DC/DC converters such as TI's 20A [TPS544B20](#) and 30A [TPS544C20](#) provide this capability. These devices are able to sense the average output current using an internal MOSFET sensor. The sensor carries a scaled-down version of the current through the main power MOSFET to enable current monitoring and better overcurrent threshold accuracy compared to inductor DCR current sensing. As well, there is minimal temperature variation and dependence on the inductor power loss thus enabling the end user to select a lower DCR inductor to improve efficiency even further, while reducing cost and size.



**Figure 1. TPS544B20 and TPS544C20 MOSFET Current Sensing**

When the power supply is assembled on the board, there can be layout-related systemic errors that introduce additional variation in the output current sense and measurement accuracy. Fortunately, the [TPS544B20](#) and [TPS544C20](#) include a PMBus command "IOUT\_CAL\_OFFSET" that can be used to improve current sensing and measurement accuracy post assembly.

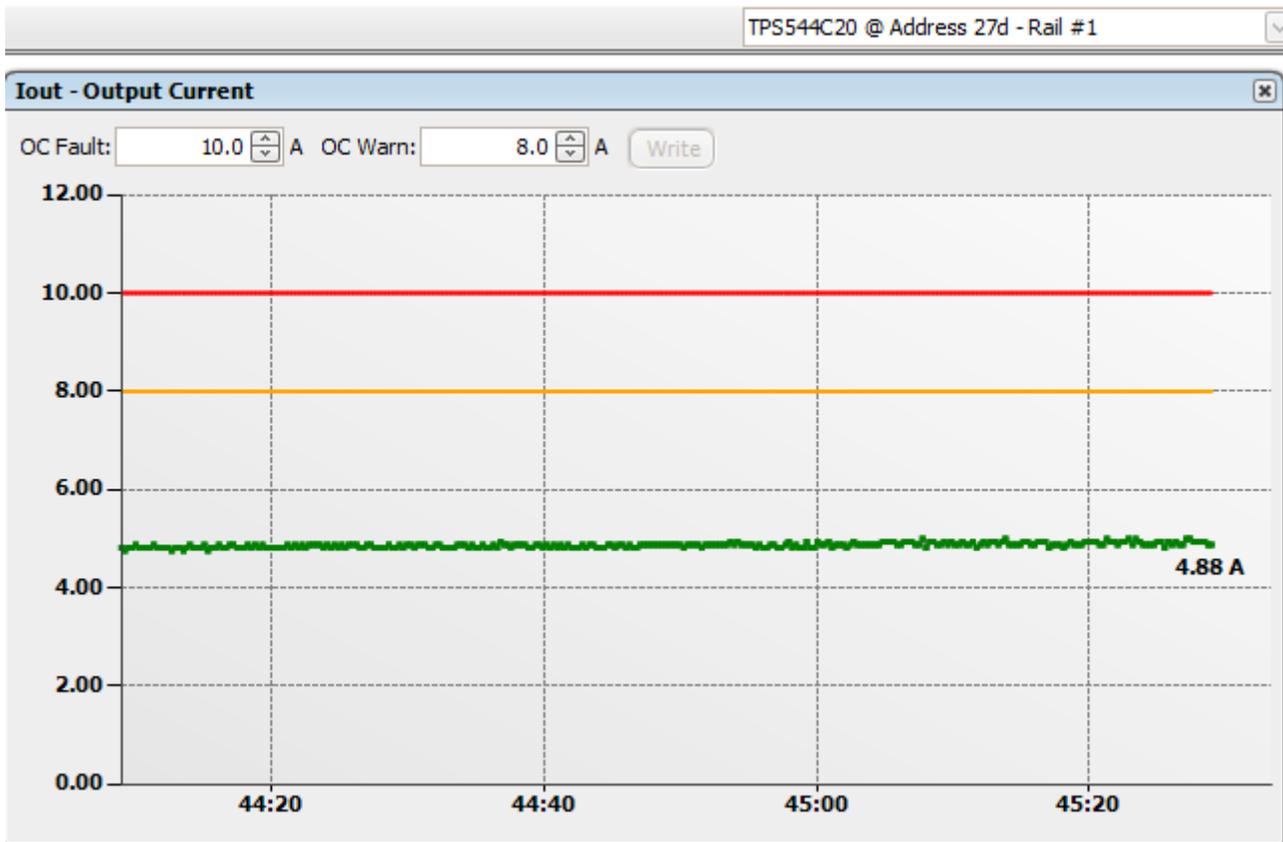


Figure 2. TPS544B20 and TPS544C20 Output Current Monitoring via TI Fusion Digital Power™ Gui

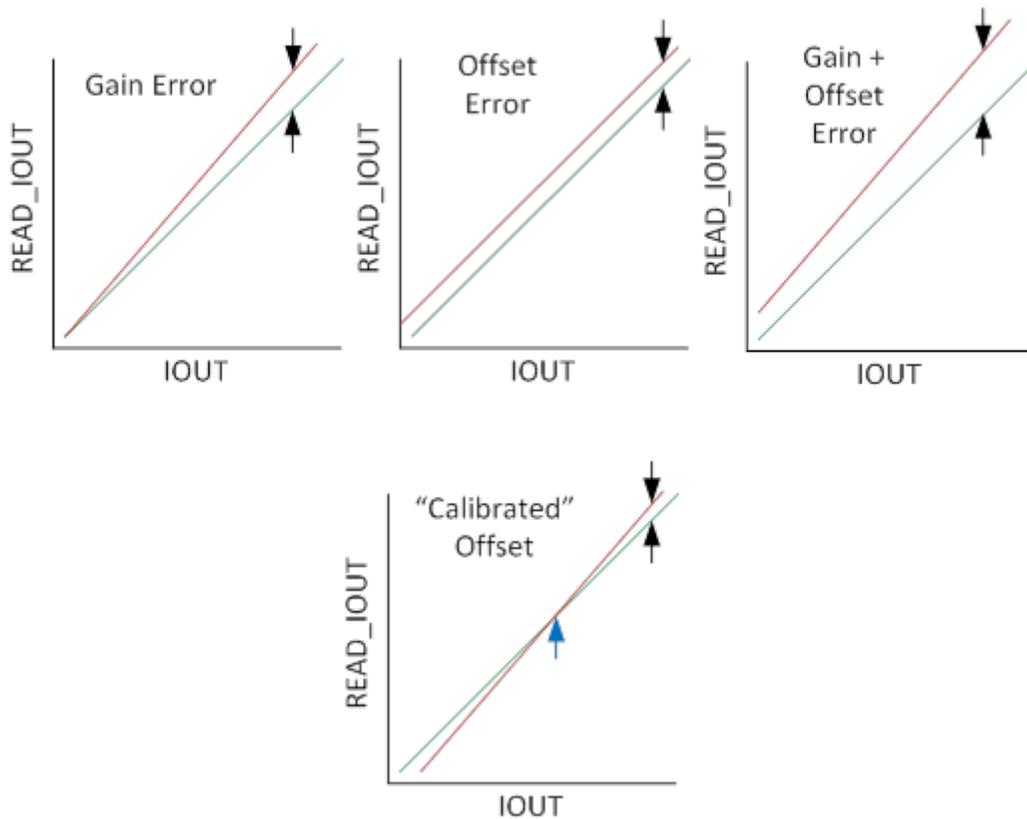
The current sense error has two components: Gain and Offset. Gain is a multiplicative factor (i.e.  $IOUT \times 0.98$  = gain is 2% low). Offset is an additive factor (i.e.  $READ\_IOUT = IOUT + 1A$ ). As the name implies, `IOUT_CAL_OFFSET` adjusts the offset. In reality, the device has both gain and offset error. Using the `IOUT_CAL_OFFSET` command allows the end user to “center” the output current reading at a certain point, which mitigates the cumulative effect of a gain error. The best place to calibrate is in the center of the design’s operating range. The `IOUT_CAL_OFFSET` command is used to compensate for offset errors in the `READ_IOUT` results and the `IOUT_OC_FAULT_LIMIT` and `IOUT_OC_WARN_LIMIT` thresholds. The default setting is 0A (amperes). The resolution of this command is 62.5mA (milliamperes) and the range is +3937.5mA to -4000mA. The contents of this register can be stored to the [TPS544B20](#) or [TPS544C20](#) non-volatile memory using The `STORE_USER_ALL` command.

Command	Code	Value/Edit	Hex/Edit
▼ Calibration			
<code>IOUT_CAL_OFFSET</code>	0x39	0.2000 A	0xE003
<code>MFR_04 (VREF_TRIM)</code>	0xD4	0.039 V	0x0014

Figure 3. TPS544B20 and TPS544C20 `IOUT_CAL_OFFSET` PMBus Command in TI Fusion Digital Power GUI

To “calibrate” the current measurement in ICT using the `IOUT_CAL_OFFSET` command, force a known load current to the output of the [TPS544B20](#) or [TPS544C20](#) and use `IOUT_CAL_OFFSET` to adjust `READ_IOUT` until it matches the known load value. For example, the end user might force a 20A load current with a resistor

or DC load, read READ\_OUT through the Fusion Digital Power GUI and get 22A. They could then apply IOUT\_CAL\_OFFSET = -2A to set the READ\_IOUT to the actual IOUT of 20A.



**Figure 4. READ\_IOUT Gain and Offset Errors before and after Calibrating the READ\_IOUT Offset**

With this PMBus command, the user can tighten the output current measurement accuracy through the [TPS544B20](#) or [TPS544C20](#) PMBus interface eliminating any post-assembly errors.

Download the TI Design, [High density 30W DC/DC buck converter with the inductor mounted over the converter to save space](#) to get started on your design.

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