Technical Article

Save PCB Space and Overcome Point-of-load Design Complexity with PMBus Modules

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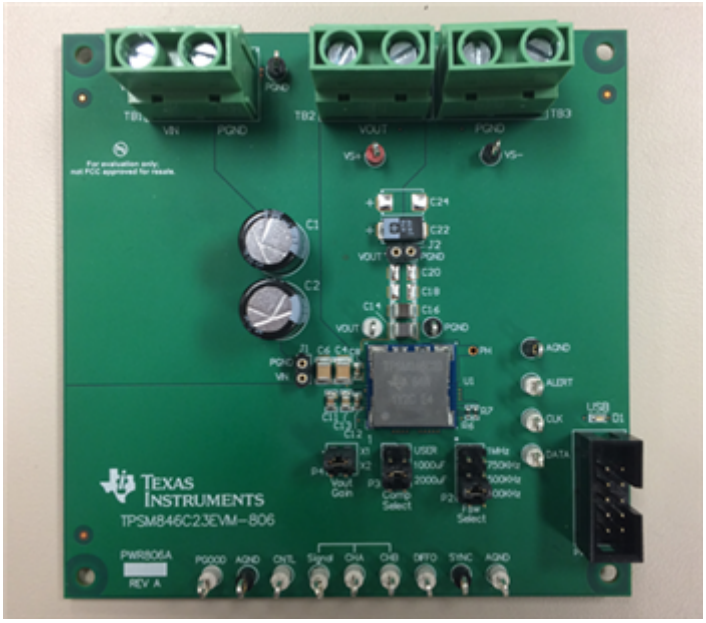


Engineers face many difficult challenges when designing power supplies for industrial and communication systems. A typical system can include one or more field-programmable gate arrays (FPGAs), application-specific integrated circuits (ASICs), systems-on-chip (SoC), networking and communication processors, or other types of processors. Each processor typically requires complex power management of multiple rails (four, 10 or more) for proper operation. The core voltage rail of the processor can often require 20A or more of current. Managing the core rail and all of the auxiliary voltage rails is a huge challenge. In addition, printed circuit board (PCB) space is limited due to shrinking system form factors, so engineers must use high-density solutions.

PMBus-enabled DC/DC converters are becoming a popular option over traditional analog DC/DC to solve these challenges. But because PMBus adds an extra layer of design complexity, many engineers are seeking solutions when implementing PMBus in a system to make things a bit easier.

PMBus is a digital communication standard that enables digital control of a DC/DC converter. PMBus is available in different versions and manufacturers have flexibility in selecting the supported commands. A PMBus-enabled device may offer the ability to set the output voltage to a complete command set that enables margining, output current readings, adaptive voltage scaling (AVS) and adjustable device functionality. PMBus eliminates the external components typically used to program these features which reduce your bill-of-materials. In newer versions of PMBus, AVS can dynamically adjust the output voltage based on processor power demand to boost efficiency.

DC/DC modules with PMBus make designs easier and reduce the power-supply footprint. DC/DC modules help designers get to market faster by simplifying power management; you do not need to be a power expert to design a small solution and meet critical specifications. Traditional PMBus modules solved challenges but were often much more bulky than a custom-designed solution using a DC/DC converter. Some of the new module offerings are smaller than the custom-designed solutions.

Shown in Figure 1, the new TPSM846C23 35A PMBus module reduces the compensation design, eliminates inductor selection, and guarantees performance compared to the TPS546C23 DC/DC converter shown in Figure 2. The TPSM846C23 achieves a smaller footprint by hiding the IC and passives underneath the inductor in a 15mm-by-16mm-by-5.8mm package to deliver an incredible density of 146mA/mm^2. Two of these modules, when sharing current, deliver as much as 70A of output current. The TPSM846C23 is ideal if space and time saving is critical and TPS546C23 is ideal if cost or design optimization is critical.

Figure 1. The 4.5V-15V, 35A TPSM846C23 PMBus Stackable Synchronous Buck Module

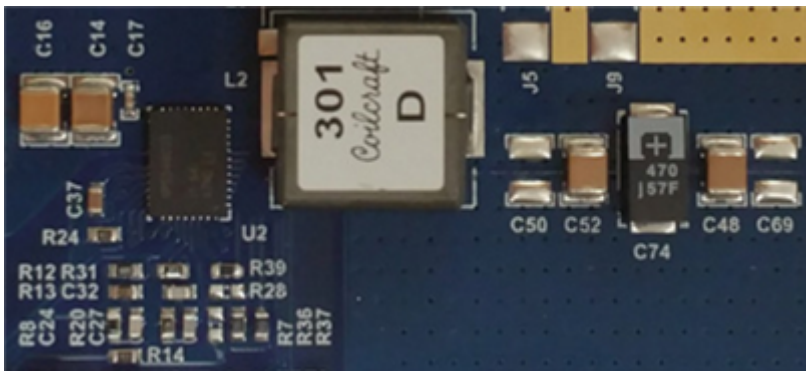
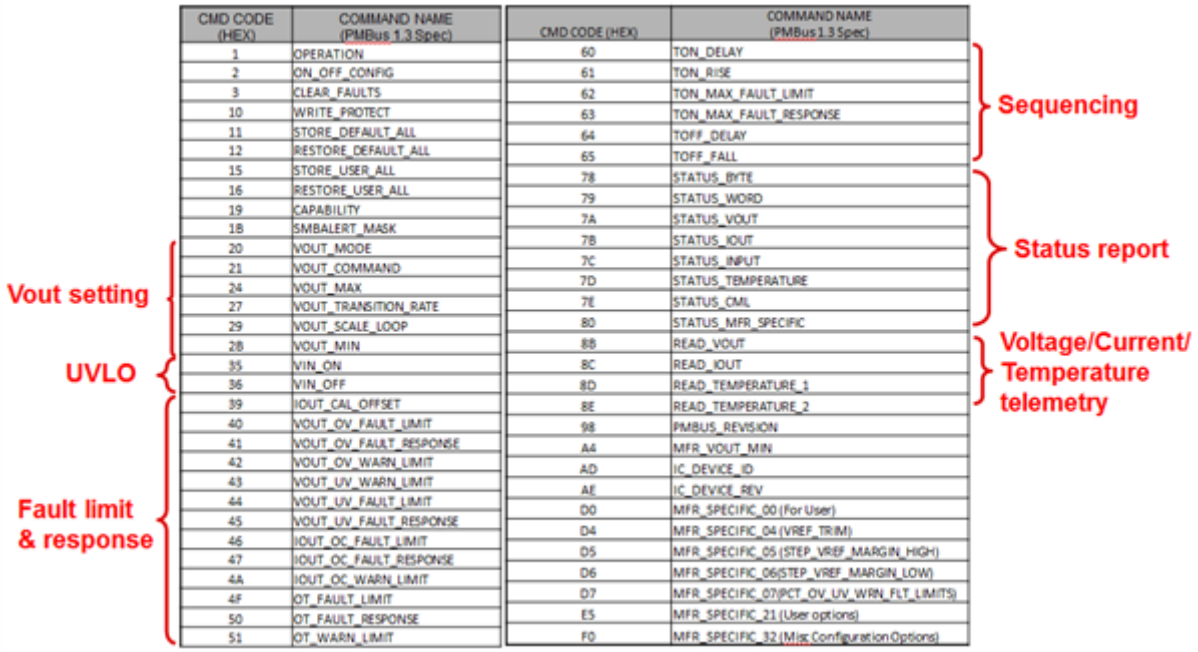


Figure 2. The 4.5V-18V, 35A TPS546C23 PMBus Stackable Synchronous Buck Converter

The TPSM846C23 uses the PMBus v1.3 command set with telemetry features for maximum configurability and design flexibility. With this command set, you can program sequencing, customize device performance and protection, read output current and operating temperature, and implement AVS (Figure 3).



CMD CODE (HEX)	COMMAND NAME (PMBus 1.3 Spec)
1	OPERATION
2	ON_OFF_CONFIG
3	CLEAR_FAULTS
10	WRITE_PROTECT
11	STORE_DEFAULT_ALL
12	RESTORE_DEFAULT_ALL
15	STORE_USER_ALL
16	RESTORE_USER_ALL
19	CAPABILITY
1B	SMBALERT_MASK
20	VOUT_MODE
21	VOUT_COMMAND
24	VOUT_MAX
27	VOUT_TRANSITION_RATE
29	VOUT_SCALE_LOOP
2B	VOUT_MIN
35	VIN_ON
36	VIN_OFF
39	IOUT_CAL_OFFSET
40	VOUT_OV_FAULT_LIMIT
41	VOUT_OV_FAULT_RESPONSE
42	VOUT_OV_WARN_LIMIT
43	VOUT_UV_WARN_LIMIT
44	VOUT_UV_FAULT_LIMIT
45	VOUT_UV_FAULT_RESPONSE
46	IOUT_OC_FAULT_LIMIT
47	IOUT_OC_FAULT_RESPONSE
4A	IOUT_OC_WARN_LIMIT
4F	OT_FAULT_LIMIT
50	OT_FAULT_RESPONSE
51	OT_WARN_LIMIT

CMD CODE (HEX)	COMMAND NAME (PMBus 1.3 Spec)
60	TON_DELAY
61	TON_RISE
62	TON_MAX_FAULT_LIMIT
63	TON_MAX_FAULT_RESPONSE
64	TOFF_DELAY
65	TOFF_FALL
78	STATUS_BYTE
79	STATUS_WORD
7A	STATUS_VOUT
7B	STATUS_IOUT
7C	STATUS_INPUT
7D	STATUS_TEMPERATURE
7E	STATUS_CML
80	STATUS_MFR_SPECIFIC
8B	READ_VOUT
8C	READ_IOUT
8D	READ_TEMPERATURE_1
8E	READ_TEMPERATURE_2
98	PMBUS_REVISION
A4	MFR_VOUT_MIN
AD	IC_DEVICE_ID
AE	IC_DEVICE_REV
D0	MFR_SPECIFIC_00 (For User)
D4	MFR_SPECIFIC_04 (VREF_TRIM)
D5	MFR_SPECIFIC_05 (STEP_VREF_MARGIN_HIGH)
D6	MFR_SPECIFIC_06(STEP_VREF_MARGIN_LOW)
D7	MFR_SPECIFIC_07(PCT_OV_UV_WRN_FLT_LIMITS)
E5	MFR_SPECIFIC_21 (User options)
F0	MFR_SPECIFIC_32 (Misc Configuration Options)

Figure 3. TPSM846C23 PMBus Commands Supported

To ease the design process, TI's implementation of the TPSM846C23 in WEBENCH has support for AVS, output-voltage transition rate, undervoltage lockout and soft start through PMBus. For full prototyping of PMBus, the TPSM846C23 evaluation module is supported by the Fusion graphical user interface (GUI). TI's Fusion GUI configures and monitors the TPSM846C23. Fusion GUI uses the PMBus protocol to communicate with the TPSM846C23 over serial bus by way of a TI USB adapter.

You can see a live demonstration of the TPSM846C23 high-current PMBus power module with telemetry in TI's booth, No. 701, at the Applied Power Electronics Conference (APEC) March 26-30 in Tampa, Florida.

In the demonstration, you'll be able to see how the module's PMBus compatibility enables output voltage, current and junction temperature telemetry, each of which is displayed in real time on the computer interface. The module is controllable through Fusion GUI that allows users to enable or disable the device, and also allows soft start and soft stop. The solution primarily targets enterprise and communication applications.

Additional Resources

- Learn more about TI's presence at APEC.
- For more information on the topic of PMBus, read "A PMBus™ primer: common PMBus questions answered."
- Check out TI's power module product portfolio.

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