10-V TO 24-V INPUT, 5-V OUTPUT, 2.1-A STEP-DOWN VOLTAGE CONVERTER

Check for Samples: TPS5480, TPS5481

FEATURES

- **5-V Synchronous/Asynchronous Hysteretic Switching Regulator**
- **Low Output Ripple and Allows Ceramic Output Capacitor**
- **Fault Conditions Monitored:**
  - **Over- and Under-Voltage**
  - **Over-Temperature**
  - **Over-Current**
- **Wide V_{IN} Input Range: 10 V to 24 V**
- **Pre-Biased and Adjustable Soft Start**
- **Highly Efficient Integrated FETs: < 120 mΩ (High Side only)**
- **Capacitor Based Boost Circuit**
- **Over Current Protection**
- **High Accuracy Internal Bandgap, Oscillator, Reference Current and Margin Voltage**

APPLICATIONS

- **Wide Range of Applications for Low-Voltage, High-Current Systems**
  - **Up to 2.1-A High-Efficiency Step-Down Regulator**
  - **Battery Charger**
  - **High-Efficiency Preregulator (5 V)**

DESCRIPTION

The TPS5480 and TPS5481 are positive, hysteretic, 5-V, 2.1-A, 200-kHz (TPS5480) or 400-kHz (TPS5481) switching regulators with wide input voltage range of 10 V to 24 V. They require either an external, low forward-voltage Schottky diode or a power MOSFET. Internal digital control logic is used to sequence the output of a fast comparator before applying it to the input of the MOSFET gate driver. A pin selectable soft start circuit is present to reduce current draw and overshoot during power up. The EN pin enables the regulator output when forced high (tied to V3P3 pin); an internal pull-down resistor disables the regulator when the EN pin is not connected. The internal 3.3-V linear regulator provides power for the enable pin.

ORDERING INFORMATION(1)

PACKAGE(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING
(QFN) - RGT	TPS5480	TBD
	TPS5481	TBD

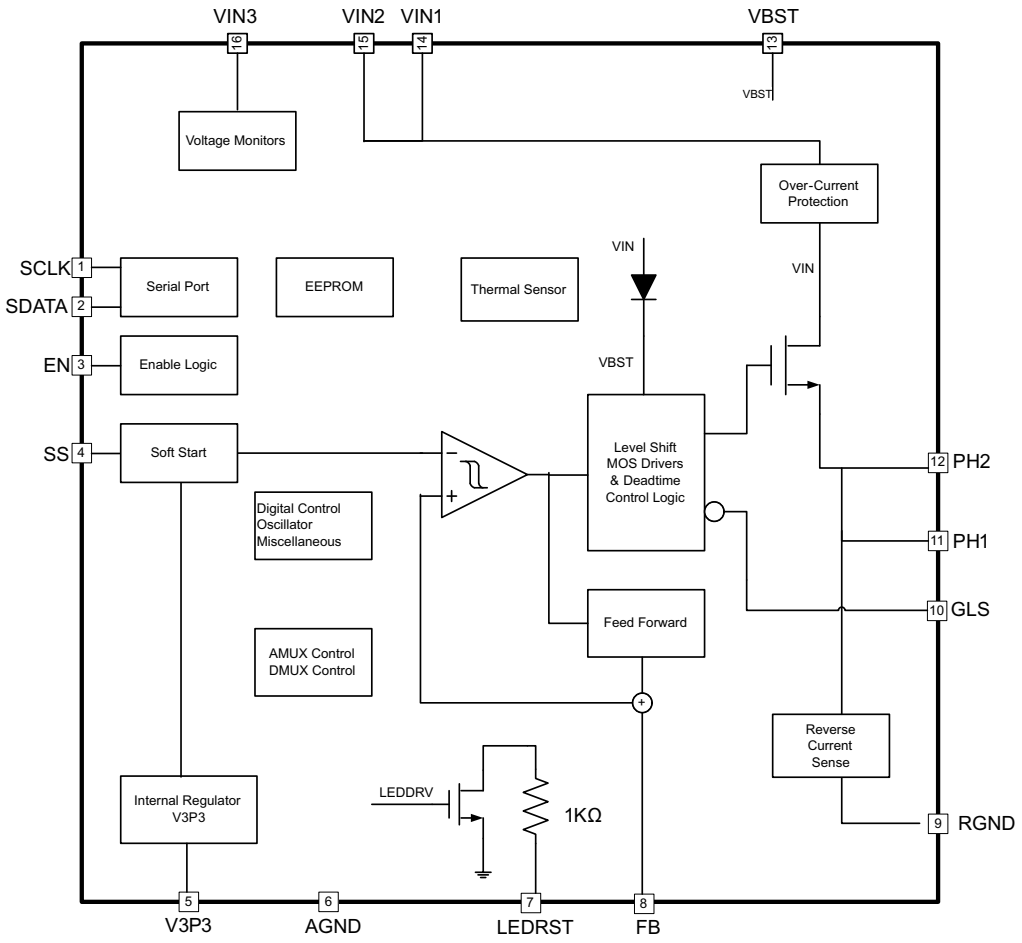
(1) For the most current packaging and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.

(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

PRODUCT PREVIEW

DEVICE INFORMATION

Functional Block Diagram



PRODUCT PREVIEW

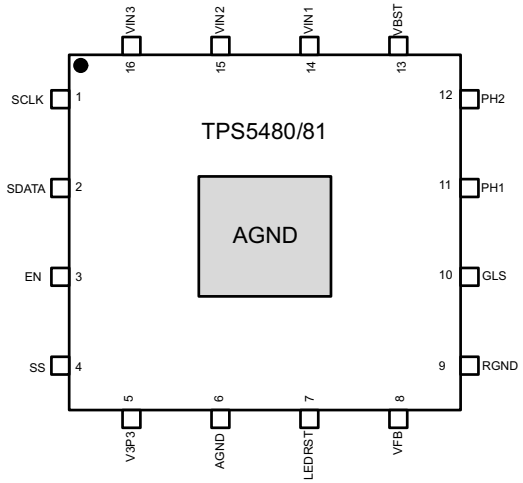
Table 1. TERMINAL FUNCTIONS

NAME	PIN	DESCRIPTION
SCLK	1	Serial port clock
SDATA	2	Serial port data
EN	3	Regulator enable
SS	4	Programmable soft-start
V3P3	5	Linear regulator output used for EN pin
AGND	6	Analog ground
LEDRST	7	Current sink for LED
VFB	8	Converter feedback input. Connect with output of converter.
RGND	9	Ground return for low-side driver and reverse-current sense
GLS	10	Gate voltage for external low-side FET
PH1, PH2	11, 12	Switch node connection between high-side NFET and low-side NFET
VBST	13	Supply input for high-side NFET gate driver (boost terminal)
VIN1, VIN2	14, 15	Power input connected to high-side NFET drain
VIN3	16	Input to over- and under-voltage monitor

Table 2. RECOMMENDED EXTERNAL COMPONENTS

PIN	TO	FUNCTION		VALUE	UNIT
VIN1, VIN2, VIN3	AGND	Noise decoupling capacitor		20	µF
PH1, PH2	VBST	Boost Capacitor		100	nF
PH1, PH2	VOUT	Output filter to Voltage supply	Inductor (ESR < 60mΩ)	> 22	µH
			Capacitor (ESR < 10mΩ)	20	1F
V3P3	AGND	Internal regulator capacitor		100	nF
SS	AGND	Optional for faster soft-start		66	kΩ
	V3P3	Optional for slower soft-start		66	
PH1, PH2	RGND	Schottky diode or		< 0.55	V
PH1, PH2	GLS, RGND	Extenal low-side NFET with GLS pin to gate		< 50	mΩ

RGT PACKAGE
(TOP VIEW)



PRODUCT PREVIEW

ABSOLUTE MAXIMUM RATINGS(1)(2)

		CONDITIONS	VALUE	UNIT
$V_{IN1,2,3}$	Input voltage(1)	T_A = 25°C	-1 to 30	V
$V_{PH1,2}$	Phase voltage	T_A = 25°C	-1 to 30	V
V_{BST}	Boost voltage (wrt $V_{PH1,2}$)	T_A = 25°C	-1 to V_{PH} + 7	V
V_{FB}	Regulator feedback voltage	T_A = 25°C	-0.3 to 7	V
V_{LEDRST}	LED current sink	T_A = 25°C	-0.3 to 7	V
	Voltage on other pins		-0.3 to 3.6	V
T_{FA}	Operating free-air temperature		-10 to 60	°C
T_J	Operating junction temperature		160	°C
θ_{JA}	Junction-to-ambient thermal resistance		47.4	°C/W
T_{stg}	Storage temperature		-55 to 150	°C
P_{DISS}	Total power dissipation with device appropriately mounted(2)	T_A = 25°C	2.7	W
ESD_{HBM}	Human body model		2000	V
ESD_{CDM}	Charged device model		500	V

(1) Stresses beyond those under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability. All voltages are with respect to ground.

(2) This number is listed for reference only based on typical junction-to-ambient thermal resistance (θ_{JA}). The maximum power should be determined by final thermal characteristics for the application in order to maintain a maximum die temperature that is less than 150°C.

PRODUCT PREVIEW

RECOMMENDED OPERATING CONDITIONS

T_A = 25°C (unless otherwise noted)

		MIN	NOM	MAX	UNIT
$V_{IN1,2,3}$	Input voltage	10		24	V
$V_{PH1,2}$	Phase voltage	10		24	V
V_{BST}	Boost voltage	PH		PH+7	V
V_{FB}	Regulator feedback voltage		5		V
V_{LEDRST}	LED current sink		5		V
	Voltage on other pins		3.3		V

ELECTRICAL CHARACTERISTICS

T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
BUCK REGULATOR OUTPUT						
V_{FB}	V_{OUT} output voltage	T_A = 25°C, 10 V < V_{IN} < 24 V, 0 < I_{LOAD} < 2.1 A	4.85	5.15	5.45	V
V_{ripple}	V_{OUT} ripple voltage	T_A = 25°C, 10 V < V_{IN} < 24 V, 0 < I_{LOAD} < 2.1 A, Continuous mode at 200 kHz			100	mV
V_{HYS}	Comparator hysteresis		20	25	30	mV
V_{OS}	V_{OUT} output overshoot		-20%	V_{FB}	20%	V
SUPPLY QUIESCENT CURRENT						
I_Q	Quiescent current (V_{IN})	EN = 1, no load			10	mA
SOFT START						
V_{OUT}	Ramp time	SS = no connect	1.5	2.75	4	ms
		SS = Pullup to V3P3 (66 kΩ)	2.25	4	5.75	
		SS = Pulldown to AGND (66 kΩ)	0.75	1.5	2.25	
MOSFET						
R_{dsONHS}	High side switch resistance	T_A = 125°C			0.12	Ω
OVER-CURRENT SHUTDOWN PROTECTION						
I_{OCS}	Over-current limit (average load current)	T_A = 25°C, L = 22 µH at 200 kHz, 10 V < V_{IN} < 24 V	2.3		2.8	A
THERMAL SHUTDOWN PROTECTION						
T_{EOTW}	Early over temperature warn		170	180	190	°C
T_{OTS}	Over temperature shutdown		180	190	200	°C
VOLTAGE MONITORS						
V_{OVR}	Over-voltage rising trip point		28	28.6	29.2	V
V_{OVF}	Over-voltage falling trip point		27.3	27.9	28.5	
V_{UVR}	Under-voltage rising trip point		8.2	8.5	8.8	
V_{UVF}	Under-voltage falling trip point		7.7	8	8.3	
FEED FORWARD FREQUENCY						
f_{SW}	Switching frequency	TPS5480	120	200	280	kHz
		TPS5481	250	400	550	kHz
LED DRIVER						
I_{LED}	LED sink current				7	mA
V_{LED}	LED voltage				7	V
REGULATOR EFFICIENCY						
Efficiency (Reference only)	f_{SW} = 200 kHz, V_{IN} = 10 V - 24 V (1)	Inductor = 22 µH, 60 mΩ ESR	75			%
		Load capacitor = 20 µF, 10 mΩ ESR				
		V_{IN} capacitor = 20 µF, 10 mΩ ESR				
		VBST capacitor = 100 nF, 10 mΩ ESR				
		V3P3 capacitor = 100 nF, 10 mΩ ESR				
		Load current = 2.1 A				
		V_F, Schottky diode < 0.55 V				
		T_A = 25°C				
LOGIC ENABLE PIN						
V_{ENH}	EN high-level input voltage	T_A = 25°C	2			V
V_{ENL}	EN low-level input voltage	T_A = 25°C			0.8	
R_{in}	Input pulldown resistance		-20%	160	20%	kΩ

(1) Example only, measured with reference to device input and output pins.

PRODUCT PREVIEW

ELECTRICAL CHARACTERISTICS (continued)

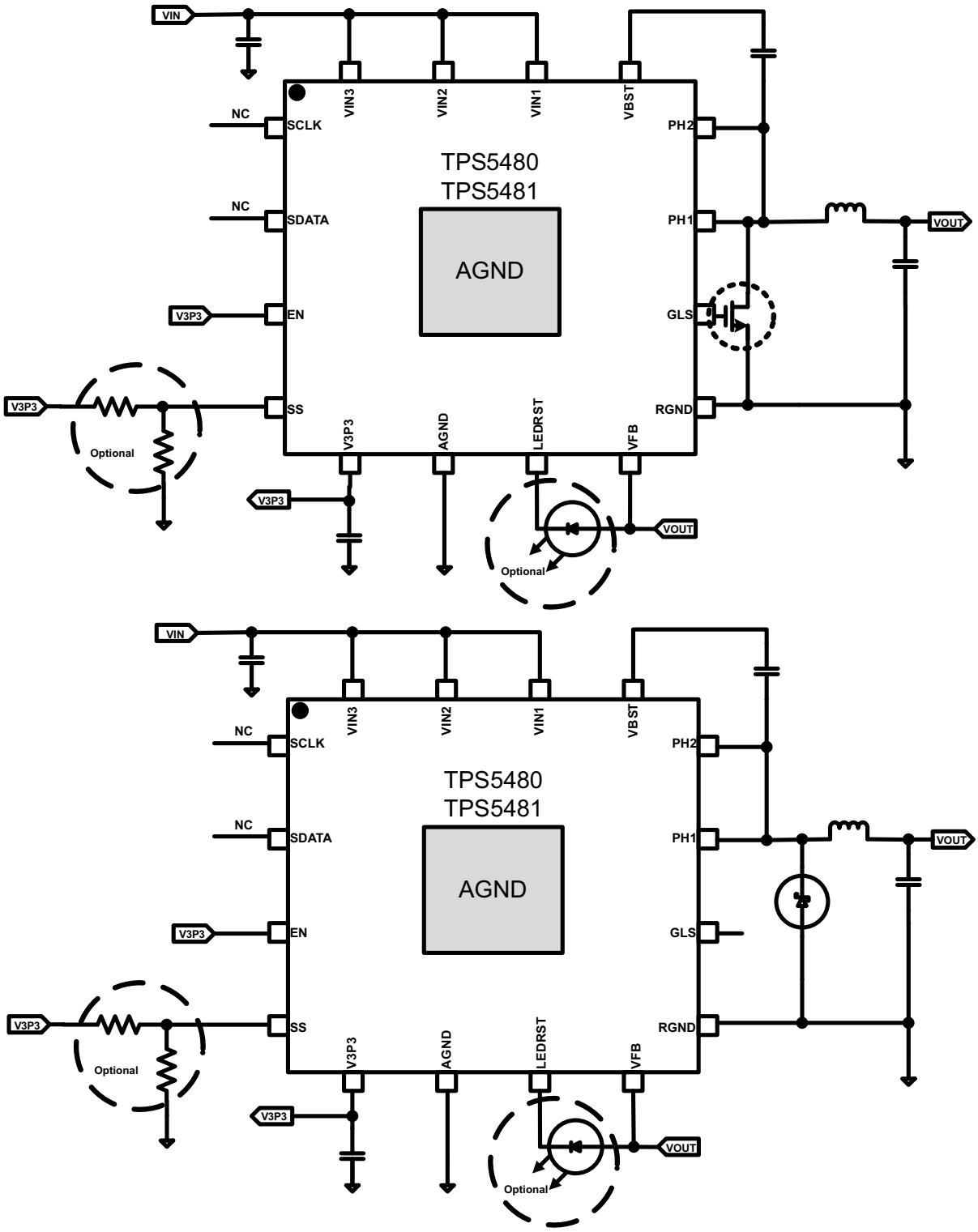
T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
REGULATOR FOLDBACK CURRENT						
$I_{Foldback}$	Foldback current(2)	10 V < V_{IN} < 24 V	0		6	mA
REGULATOR LOAD CURRENT						
I_{Load}	Load current	T_A = 25°C, L = 22 µH at 200 kHz	0		2.1	A
I_{Load}	Load current	T_A = 25°C, L = 22 µH at 400 kHz			2.1	A

(2) Ensured by application board functional test.

PRODUCT PREVIEW

SAMPLE APPLICATION SCHEMATIC



PRODUCT PREVIEW

PACKAGING INFORMATION

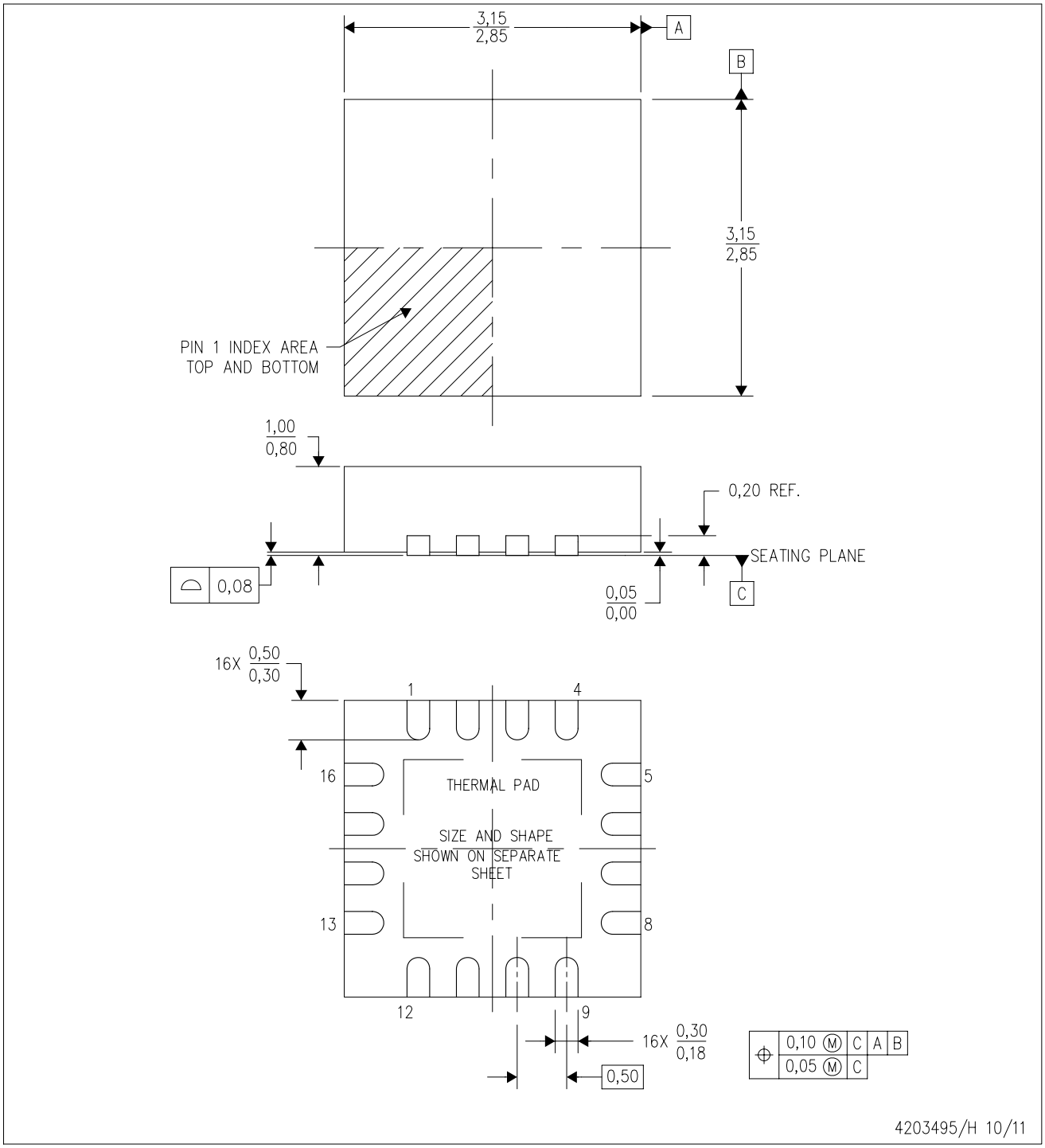
Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/ Ball Finish	MSL Peak Temp (3)	Samples (Requires Login)
TPS5480RGTR	PREVIEW	QFN	RGT	16		TBD	Call TI	Call TI	
TPS5480RGTT	PREVIEW	QFN	RGT	16		TBD	Call TI	Call TI	
TPS5481RGTR	PREVIEW	QFN	RGT	16		TBD	Call TI	Call TI	
TPS5481RGTT	PREVIEW	QFN	RGT	16		TBD	Call TI	Call TI	

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

RGT (S–PVQFN–N16) PLASTIC QUAD FLATPACK NO–LEAD



NOTES:
A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M–1994.
B. This drawing is subject to change without notice.
C. Quad Flatpack, No–leads (QFN) package configuration.
D. The package thermal pad must be soldered to the board for thermal and mechanical performance.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
F. Falls within JEDEC MO–220.

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