200-W 48-V INPUT, 8-V OUTPUT, SEMI-REGULATED, ISOLATED DC-DC BUS CONVERTER

Check for Samples: PTQB425080

FEATURES

- **200-W Output**
- **Input Voltage Range: 36 V to 75 V**
- **Meets 100 V, 100 ms Input Transient**
- **6:1 Input-to-Output DC Conversion Ratio: 36 V to 55 V Input**
- **10.5 V Output Voltage Limit: > 55 V Input**
- **93% Efficiency**
- **1500 V_{DC} Isolation**
- **On/Off Control**
- **Overcurrent Protection**
- **Over-Temperature Shutdown**
- **Undervoltage Lockout**
- **SmartSync External Clock Drive (Optional)**
- **AutoTrack™ Power-Up Sequencing (Optional)**
- **Standard 1/4-Brick Bus Converter Footprint**
- **UL Safety Agency Approval**



DESCRIPTION

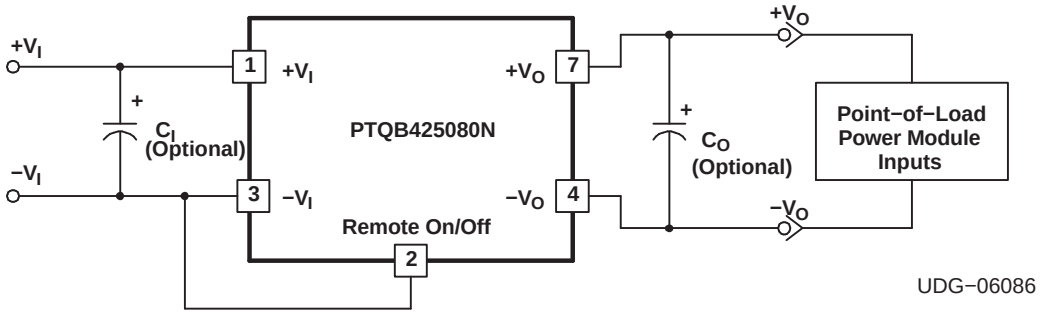
The PTQB425080 power module is single-output isolated DC/DC converter, housed in an industry standard quarter-brick package. The module is nominally rated up to 200 W with a maximum load current of 25 A. It delivers an output voltage of 1/6th the input voltage for an input voltage range of 36 V to 55 V, while limiting the output voltage to 10.5 V for an input voltage greater than 55 V.

The PTQB425080 operates from a standard 48-V telecom central office (CO) supply and occupies only 3.3 in^2 of PCB area. The module offers OEMs a compact and flexible high-output power source in an industry standard footprint. It is suitable for distributed power applications in both telecom and computing environments that utilize an intermediate bus architecture (IBA), and may be used for powering downstream point-of-load (POL) devices such as the second generation PTH series of products (T2).

Features include a remote On/Off control with optional logic polarity, and an undervoltage lockout (UVLO). Protection features include output over-current protection (OCP) and over-temperature protection (OTP). To compliment T2-POL products, optional features include a SmartSync compatible clock drive and a AutoTrack™ power-up sequencing manager

The module is fully integrated for stand-alone operation, and require no additional components.

STANDARD APPLICATION



Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of the Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

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This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

ORDERING INFORMATION

For the most current package and ordering information, see the Package Option Addendum at the end of this datasheet, or see the TI website at www.ti.com.

Table 1. PART NUMBERING SCHEME

	Input Voltage	Output Current	Output Voltage	Enable	Electrical Options		Pin Style
PTQB	**4**	**25**	**080**	**N**	**2**	**A**	**D**
	4 = 48 V	25 = 25A	080 = 8 V	N = Negative P = Positive	2 = Standard 3 = SmartSync Clock Drive and AutoTrack™ Enable		D = Through-hole, Pb-free

ABSOLUTE MAXIMUM RATING

				UNIT
T_A	Operating Temperature Range	Over V_I Range		–40°C to 85°C (1)
$V_{I,MAX}$	Maximum Input Voltage	Continuous voltage		75 V
		Peak voltage for 100 ms duration		100 V
$P_{O,MAX}$	Maximum Output Power	V_I = 48 V		200 W
T_S	Storage Temperature			–40°C to 125°C
	Mechanical Shock	Per Mil-STD-883, Method 2002.3 1 ms, 1/2 Sine, mounted	AD Suffix	250 G
	Mechanical Vibrarion	Per Mil-STD-883, Method 2007.2 20-2000 Hz, PCB mounted	AD Suffix	15 G
	Weight			30 grams
	Flammability	Meets UL 94V-O		

(1) See SOA curves or consult factory for appropriate derating.

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ELECTRICAL CHARACTERISTICS PTQB425080

(Unless otherwise stated, T_A = 25°C, V_I = 48 V, V_O = 8 V, C_O = 10 µF, and I_O = $I_O$max

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_O	Output Current	Over V_I range		0		25	A
V_I	Input Voltage Range	Over I_O range		36	48	75	V
V_O tol	Output Voltage Tolerance	Over V_I and I_O range		5.4		10.5	V
Reg_{line}	Line Regulation	36 ≤ V_I ≤ 55 V			0.17		V/V
		55 < V_I ≤ 75 V, V_O = 9.5 V			10		%
Reg_{load}	Load Regulation	Over I_O range			40		mV/A
η	Efficiency	I_O = $I_O$max			93%		
V_R	V_O Ripple (pk-pk)	20 MHz bandwidth				100	mV_{pp}
I_{TRIP}	Overcurrent Threshold	Shutdown, followed by auto-recovery			35		A
OTP	Over Temperature Protection	Temperature Measurement at thermal sensor. Hysteresis = 10°C nominal.			125		° C
f_s	Switching Frequency	Over V_I range			275		kHz
UVLO	Undervoltage Lockout	V_{OFF}	V_I decreasing, I_O = 10 A		32.5		V
		V_{HYS}	Hysteresis		1.5		
On/Off Input: **Negative Enable**							
V_{IH}	Input High Voltage	Referenced to –V_I		2.4		Open[1]	V
V_{IL}	Input Low Voltage			–0.2		0.8	
I_{IL}	Input Low Current				–0.3		mA
On/Off Input: **Positive Enable**							
V_{IH}	Input High Voltage	Referenced to –V_I		4.5		Open[1]	V
V_{IL}	Input Low Voltage			–0.2		0.8	
I_{IL}	Input Low Current				–0.5		mA
I_{ISB}	Standby Input Current	Output disabled (pin 2 status set to Off)			3		mA
C_I	External Input Capacitance	Between +V_I and –V_I		0	100		µF
C_O	External Output Capacitance	Between +V_O and –V_O		0		3000	µF
	Isolation Voltage	Input-to-output and input-to-case		1500			Vdc
	Isolation Capacitance	Input-to-output			500		pF
	Isolation Resistance	Input-to-output		10			MΩ
f_{ss}	SmartSync Clock Drive (pin 5)	TTL Output signal for synchronizing POL modules	Signal Amplitude		5		V_{pk-pk}
			Signal Frequency		275		kHz

(1) The Remote On/Off input has an internal pull-up and may be controlled with an open collector (drain) interface. An open circuit correlates to a logic high. Consult the application notes for interface considerations.

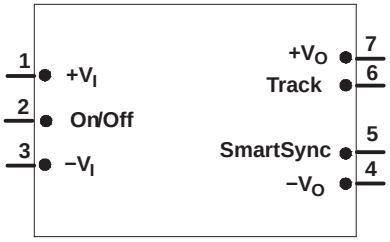
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TERMINAL FUNCTIONS

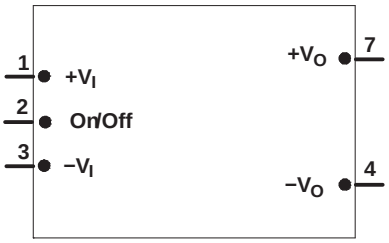
TERMINAL		DESCRIPTION
NAME	NO.	
$+V_I$ (1)	1	The positive input for the module with respect to $-V_I$. When powering the module from a negative input voltage, this input is connected to the input source ground.
$-V_I$ (1)	3	The negative input supply for the module, and the 0-V reference for the enable input. When powering the module from a positive source, this input is connected to the input source return.
Remote On/Off	2	This input controls the On/Off status of the output voltage. It is either driven low ($-V_I$ potential), or left open-circuit. For units identified with the N (negative logic) option, applying a logic low to this pin enables the output. And for units identified with the P (positive logic) option, the output is disabled.
$+V_O$	7	This is the positive power output with respect to $-V_O$. It is isolated from the input power pins and produces a valid output voltage approximately 80 ms before the voltage at the *Track* terminal is allowed to rise. This provides the required standby power source to any *downstream* nonisolated modules in power-up sequencing applications.
$-V_O$	4	This is the output power return for both the $+V_O$ output voltage. This terminal should be connected to the common of the load circuit.
AutoTrack™ Enable (Optional)	6	This terminal may be used in power-up sequencing applications to control the output voltage of Auto-Track compatible modules, powered from the converter $+V_O$ output. The converter *Track* control has an internal, open-collector transistor, which holds the voltage close to $-V_O$ potential for approximately 80 ms after the $+V_O$ output is in regulation. Following this delay, the *Track* voltage rises simultaneously with the output voltages of all other modules controlled by Auto-Track. See Application Information for more details.
SmartSync Clock Drive (Optional)	5	This terminal sources a 275kHz clock signal that can be used to synchronize the switching frequency of multiple downstream point-of-load power modules. Frequency synchronization eliminates beat frequencies and reduces the external filtering requirement. See Application Information for more details.

(1) These functions indicate signals electrically common with the input.

PTQB425080x3



PTQB425080x2



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TYPICAL CHARACTERISTICS

PTQB425080 (1) (2)

EFFICIENCY VS LOAD CURRENT

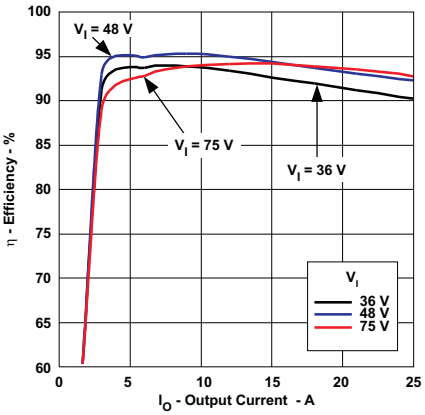


Figure 1.

POWER DISSIPATION VS LOAD CURRENT

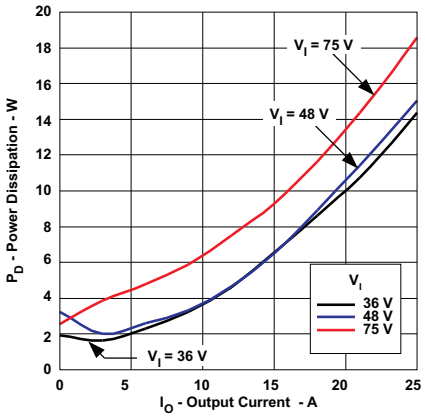


Figure 2.

AMBIENT TEMPERATURE VS LOAD CURRENT

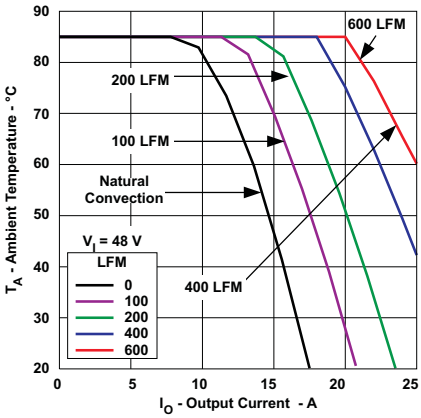


Figure 3.

LINE REGULATION

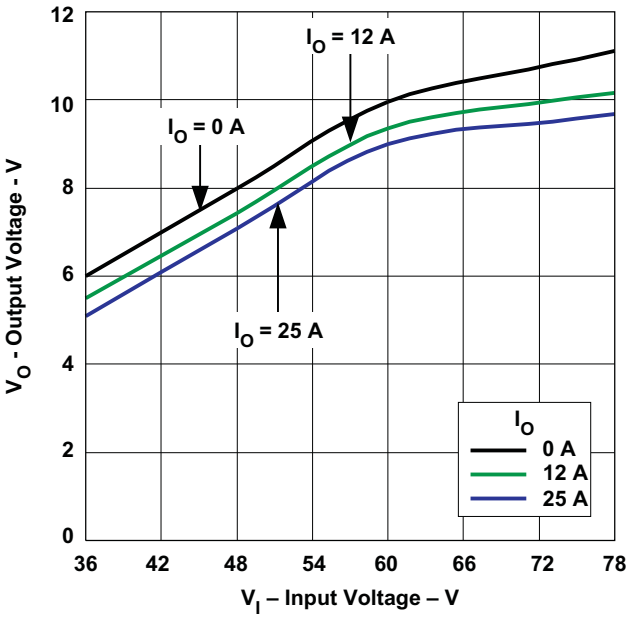


Figure 4.

LOAD REGULATION

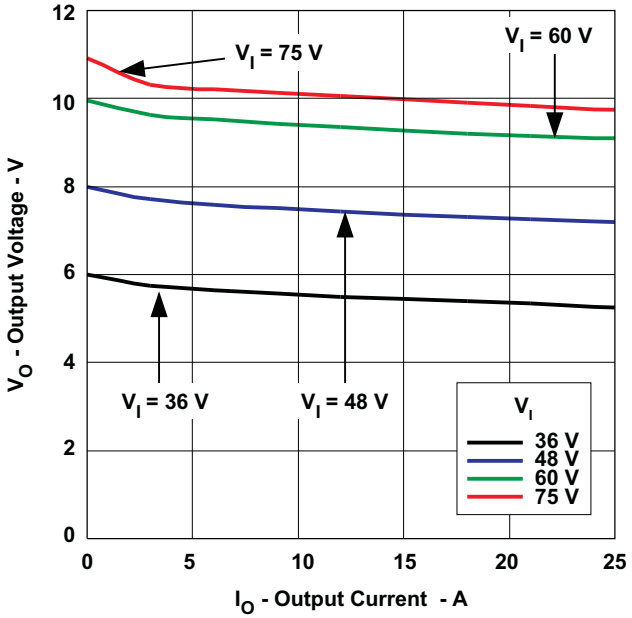


Figure 5.

(1) All data listed in Figure 1, Figure 2, Figure 4, and Figure 5 have been developed from actual products tested at 25°C. This data is considered typical data for the dc-dc converter.

(2) The temperature derating curves represent operating conditions at which internal components are at or below manufacturer's maximum rated operating temperature. Derating limits apply to modules soldered directly to a 100–mm × 100–mm, double-sided PCB with 2 oz. copper. For surface mount packages, multiple vias (plated through holes) are required to add thermal paths around the power pins. Please refer to the mechanical specification for more information. Applies to Figure 3.

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APPLICATION INFORMATION

Operating Features and System Considerations for the PTQB425080 Series of DC/DC Converters

Overcurrent Protection

To protect against load faults, these converters incorporate output overcurrent protection. Applying a load to the output that exceeds the converter's overcurrent threshold (see applicable specification) causes the output voltage to momentarily fold back, and then shut down. Following shutdown the module periodically attempts to automatically recover by initiating a soft-start power-up. This is often described as a *hiccup* mode of operation, whereby the module continues in the cycle of successive shutdown and power up until the load fault is removed. Once the fault is removed, the converter automatically recovers and returns to normal operation.

Overtemperature Protection

Overtemperature protection is provided by an internal temperature sensor, which closely monitors the temperature of the converter's printed circuit board (PCB). If the sensor exceeds a temperature of approximately 125°C, the converter shuts down. The converter then automatically restarts when the sensed temperature drops back to approximately 95°C. When operated outside its recommended thermal derating envelope (see data sheet SOA curves), the converter typcially cycles on and off at intervals from a few seconds to one or two minutes. This is to ensure that the internal components are not permanently damaged from excessive thermal stress.

Undervoltage Lockout

The Undervoltage lockout (UVLO) is designed to prevent the operation of the converter until the input voltage is at the minimum input voltage. This prevents high start-up current during normal power-up of the converter, and minimizes the current drain from the input source during low input voltage conditions. The UVLO circuitry also overrides the operation of the *Remote On/Off* control.

Primary-Secondary Isolation

The converter incorporates electrical isolation between the input terminals (primary) and the output terminals (secondary). All converters are production tested to a withstand voltage of 1500 VDC. This specification complies with UL60950 and EN60950 requirements. This allows the converter to be configured for either a positive or negative input voltage source. The data sheet *Pin Descriptions* section provides guidance as to the correct reference that must be used for the external control signals.

Input Current Limiting

The converter is not internally fused. For safety and overall system protection, the maximum input current to the converter must be limited. Active or passive current limiting can be used. Passive current limiting can be a fast acting fuse. A 125-V fuse, rated no more than 10 A, is recommended. Active current limiting can be implemented with a current limited *Hot-Swap* controller.

Thermal Considerations

Airflow may be necessary to ensure that the module can supply the desired load current in environments with elevated ambient temperatures. The required airflow rate may be determined from the Safe Operating Area (SOA) thermal derating chart (see typical characteristics).

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Using the Remote On/Off Function on the PTQB425080 Series of DC/DC Converters

For applications requiring output voltage On/Off control, the PTQB425080 series of DC/DC converters incorporate a *Remote On/Off* control (pin 2). This feature can be used to switch the module off without removing the applied input source voltage. When placed in the *Off* state, the standby current drawn from the input source is typically reduced to 3 mA.

Negative Output Enable (N Option)

Models using the negative enable option, the *Remote On/Off* (pin 2) control must be driven to a logic low voltage for the converter to produce an output. This is accomplished by either permanently connecting pin 2 to $-V_I$ (pin 3), or driving it low with an external control signal. Table 2 shows the input requirements of pin 2 for those modules with the *NEN* option.

Table 2. On/Off Control Requirements for Negative Enable

	PARAMETER	MIN	TYP	MAX
V_{IH}	Disable	2.4 V		20 V
V_{IL}	Enable	–0.2 V		0.8 V
$V_{o/c}$	Open-Circuit		9 V	15 V
I_I	Pin 2 at $-V_I$			–0.75 mA

Positive Output Enable (P Option)

For those models with the positive enable option, leaving pin 2 open circuit, (or driving it to an equivalent logic high voltage), enables the converter output. This allows the module to produce an output voltage whenever a valid input source voltage is applied to $+V_I$ with respect to $-V_I$. If a logic-low signal is then applied to pin 2 the converter output is disabled. Table 3 gives the input requirements of pin 2 for modules with the *PEN* option.

Table 3. On/Off Control Requirements for Positive Enable

	PARAMETER	MIN	TYP	MAX
V_{IH}	Enable	4.5 V		20 V
V_{IL}	Disable	–0.2 V		0.8 V
$V_{o/c}$	Open-Circuit		5 V	7 V
I_I	Pin 2 at $-V_I$			–0.5 mA

Notes:

1. The *Remote On/Off* control uses $-V_I$ (pin 3) as its ground reference. All voltages are with respect to $-V_I$.
2. An open-collector device (preferably a discrete transistor) is recommended. A pull-up resistor is not required. If one is added the pull-up voltage should not exceed 20 V.

   Caution: *Do not use a pull-resistor to $+V_I$ (pin 1). The remote On/Off control has a maximum input voltage of 20 V. Exceeding this voltage can overstress, and possibly damage, the converter*.
3. The *Remote On/Off* pin may be controlled with devices that have a totem-pole output. This is provided the output high level voltage (V_{OH}) meets the module's minimum V_{IH} specified in Table 2. If a TTL gate is used, a pull-up resistor may be required to the logic supply voltage.
4. The converter incorporates an *undervoltage lockout* (UVLO). The UVLO keeps the converter off until the input voltage is close to the minimum specified operating voltage. This is regardless of the state of the *Remote On/Off* control. Consult the product specification for the UVLO input voltage thresholds.

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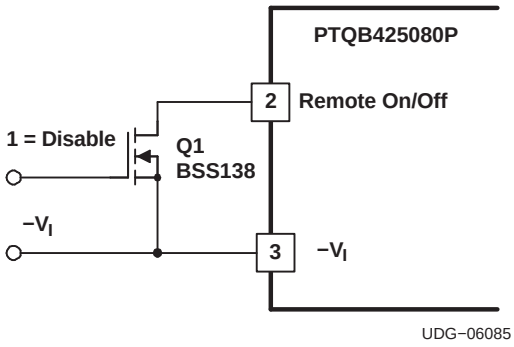


Figure 6. Recommended Control for Remote On/Off Input

Turn-On: With a valid input source voltage applied, the converter produces a regulated output voltage within 75 ms of the output being enabled. Figure 7 shows the output response of the PTQB425080P following the removal of the logic-low signal from the *Remote On/Off* (pin 2); see Figure 6. This corresponds to the drop in Q1 V_{GS} in Figure 7. Although the rise-time of the output voltage is short (<10 ms), the indicated delay time varies depending upon the input voltage and the module's internal timing. The waveforms were measured with 48 VDC input voltage, and a 10-A resistive load.

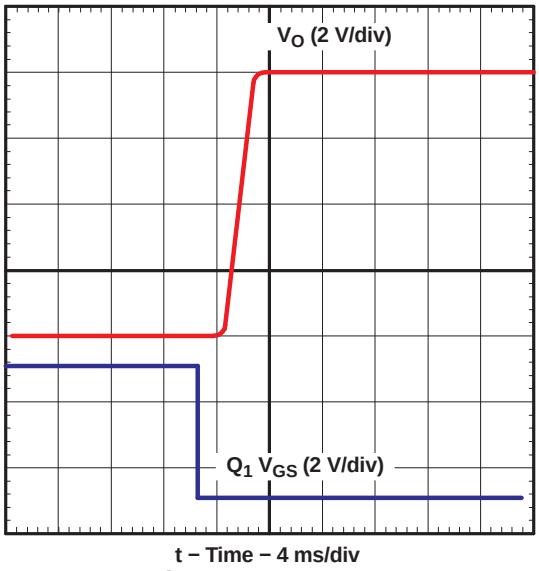


Figure 7. Power Up

Simultaneous Power-Up Sequencing Using AutoTrack™ Control (Optional Feature)

The PTQB425080 bus converter provides the input power and coordinate the power-up sequencing to two or more non-isolated, Auto-Track compliant power modules. Figure 8 shows the PTQB425080 converter (U1) configured to provide both the input source and the power-up sequence timing to two wide-nput non-isolated modules. The example shows a simplified block diagram of two PTH08T220W modules (U2 and U3), each rated for up to 16 A of output current. In this case, the number of downstream modules, and their respective output voltage and load current rating, is only limited by the amount of current available at the $+V_O$ output (25 A maximum). In this example, they are set to 3.3 V (R2 = 1.21 kΩ) and 1.8 V (R3 = 4.78 kΩ), respectively. Figure 9 shows the power-up waveforms from when the Track control of all three modules are simply connected together.

The PTQB425080 converter (U1) provides the required intermediate voltage from the $+V_O$bus output to power the downstream modules, while holding the common Track control at ground potential. After allowing times for U2 and U3 to initialize, U1 removes the ground from the Track control, allowing this voltage to rise. The outputs from the two nonisolated modules then rise simultaneously to their respective set-point voltages.

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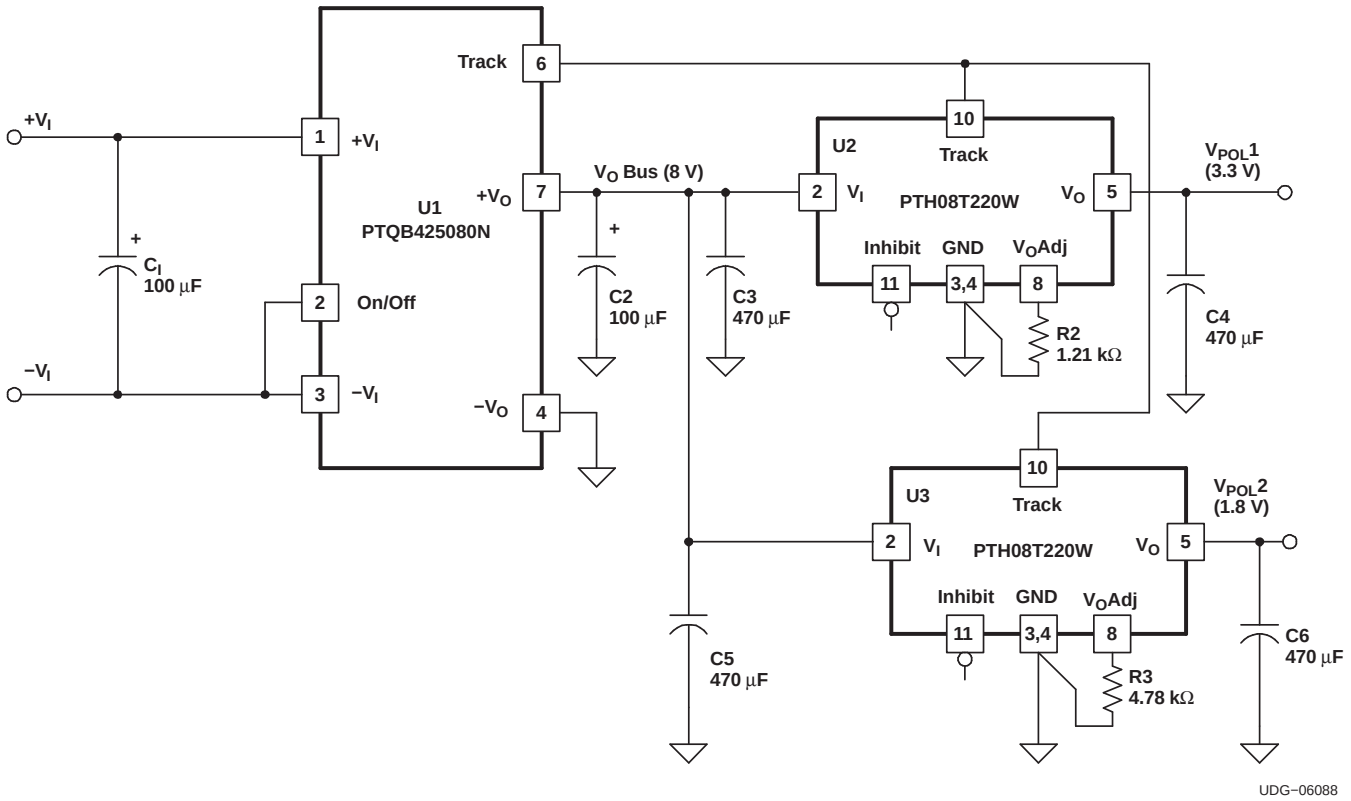
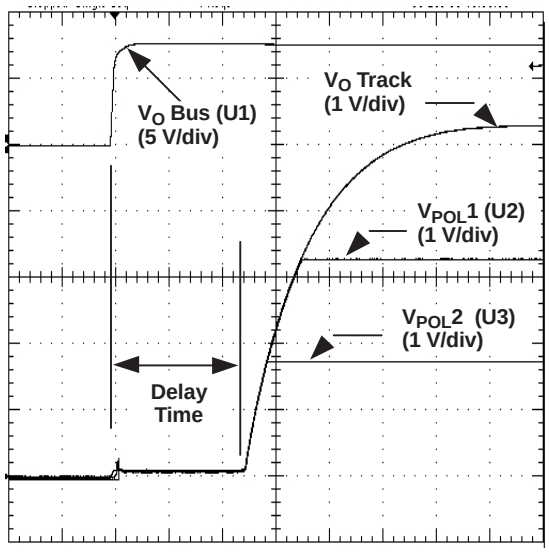


Figure 8. Power-Up Sequencing Using AutoTrack™ Control



t − Time − 40 ms/div

Figure 9. AutoTrack™ Control Waveform

Synchronizing Multiple POL Modules using SmartSync Clock Drive

The PTQB425080 provides a 275 kHz SmartSync clock signal that may be used to synchronize multiple downstream non-isolated modules to a common frequency. Figure 10 shows a simplified block diagram of the PTQB425080 clock signal driving the SmartSync input of two PTH08T220W modules. Synchronizing modules powered from the same bus, eliminates beat frequencies reflected back to the input supply, and also reduces EMI filtering requirements. These are the benefits of Smart Sync. Power modules can also be synchronized out of phase to minimize source current loading and minimize input capacitance requirements. Figure 10 also shows module U2 synchronized 180° out of phase with module U3 using an inverter circuit.

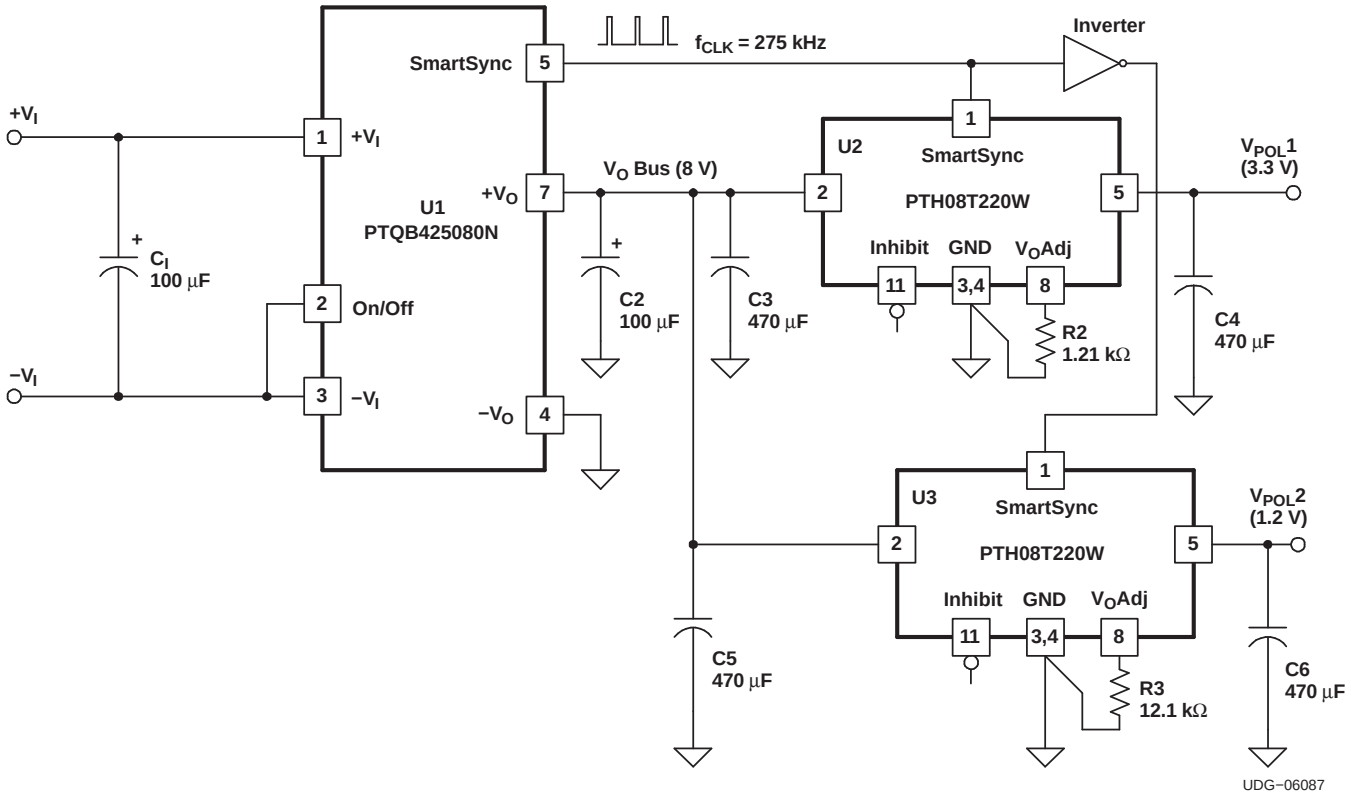


Figure 10. Synchronizing Modules Powered from the Same Bus

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
PTQB425080N2AD	NRND	Through-Hole Module	EBY	5	9	Pb-Free (RoHS)	SN	N / A for Pkg Type	-40 to 85		
PTQB425080N3AD	NRND	Through-Hole Module	EBY	7	9	Pb-Free (RoHS)	SN	N / A for Pkg Type	-40 to 85		

(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.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

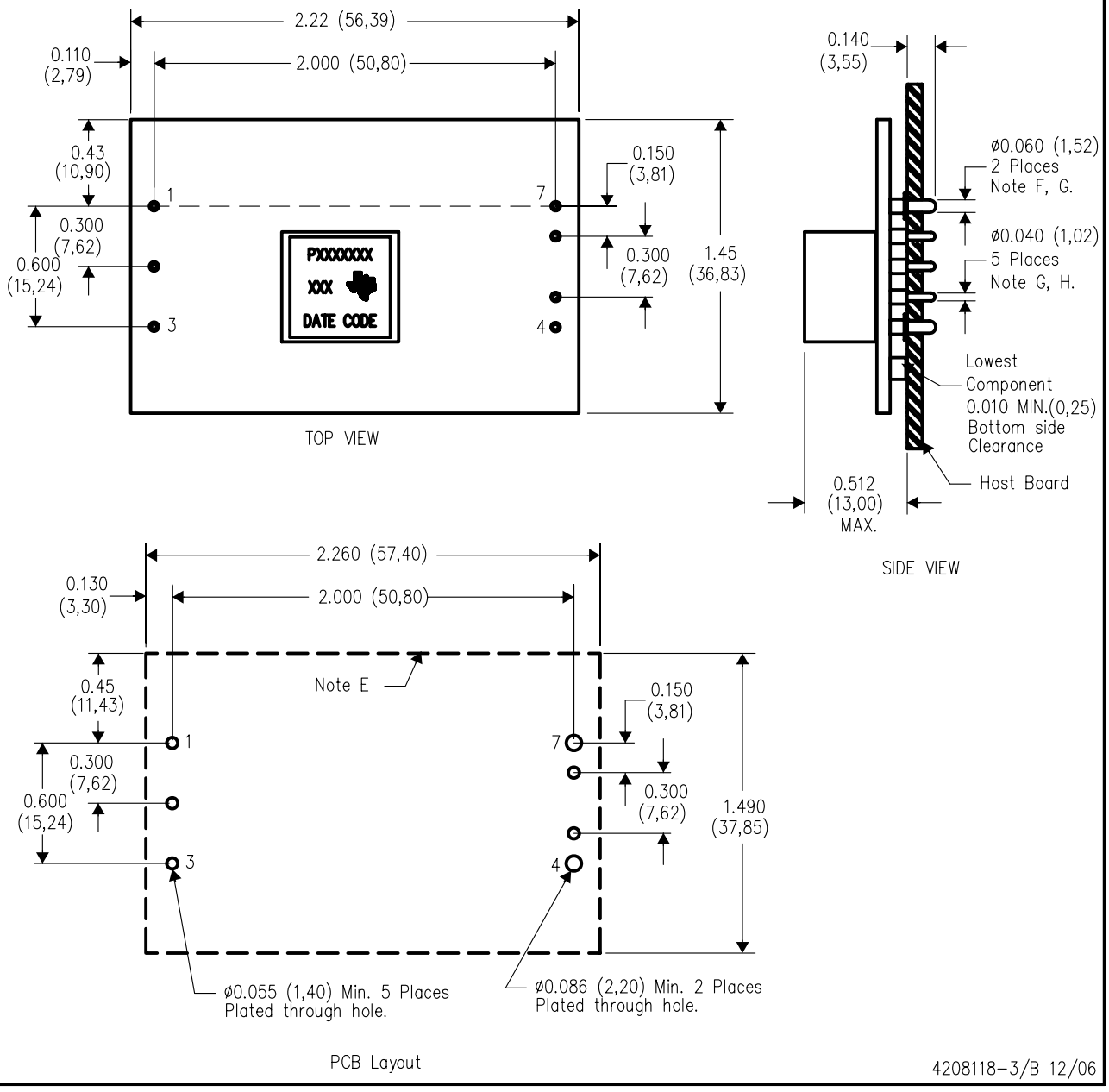
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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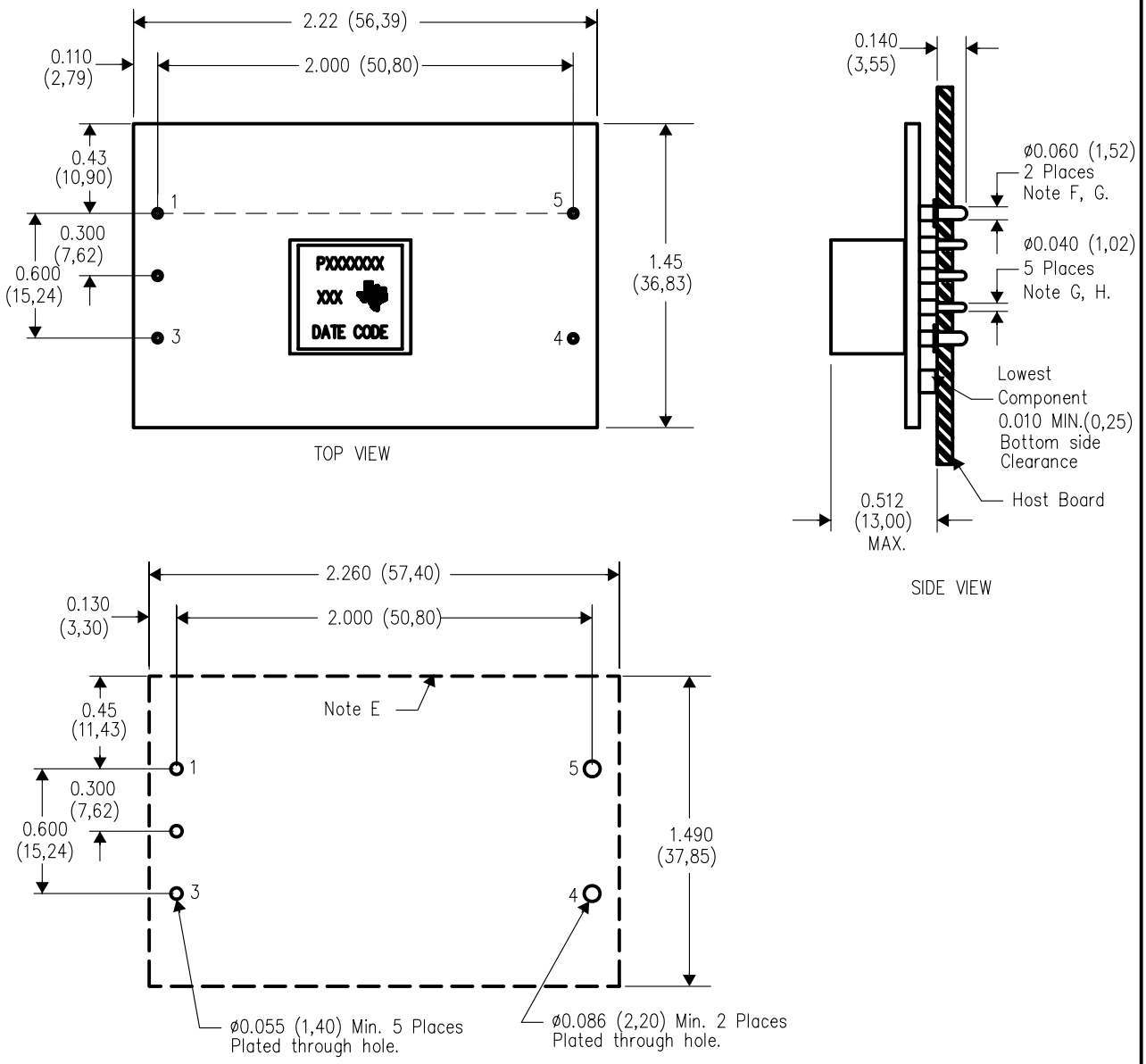
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

EBY (R–PDSS–T7) DOUBLE SIDED MODULE



NOTES:
- A. All linear dimensions are in inches (mm).
- B. This drawing is subject to change without notice.
- C. 2 place decimals are ±0.020 (±0,51mm).
- D. 3 place decimals are ±0.010 (±0,25mm).
- E. Recommended keep out area for user components.
- F. Pins are 0.060" (1,52) diameter with 0.125" (3,20) diameter standoff shoulder.
- G. All pins: Material – Copper Alloy
  Finish – Tin (100%) over Nickel plate
- H. Pins are 0.040" (1,02) diameter with 0.070" (1,78) diameter standoff shoulder.

EBY (R–PDSS–T5) DOUBLE SIDED MODULE



NOTES:
A. All linear dimensions are in inches (mm).
B. This drawing is subject to change without notice.
C. 2 place decimals are ±0.020 (±0,51mm).
D. 3 place decimals are ±0.010 (±0,25mm).
E. Recommended keep out area for user components.
F. Pins are 0.060" (1,52) diameter with 0.125" (3,20) diameter standoff shoulder.
G. All pins: Material – Copper Alloy
Finish – Tin (100%) over Nickel plate
H. Pins are 0.040" (1,02) diameter with 0.070" (1,78) diameter standoff shoulder.

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