VRM10.0 COMPLIANT PROGRAMMABLE FEEDBACK DIVIDER

FEATURES

- **VRM 10.x VID Code Table**
- **14-Pin TSSOP**

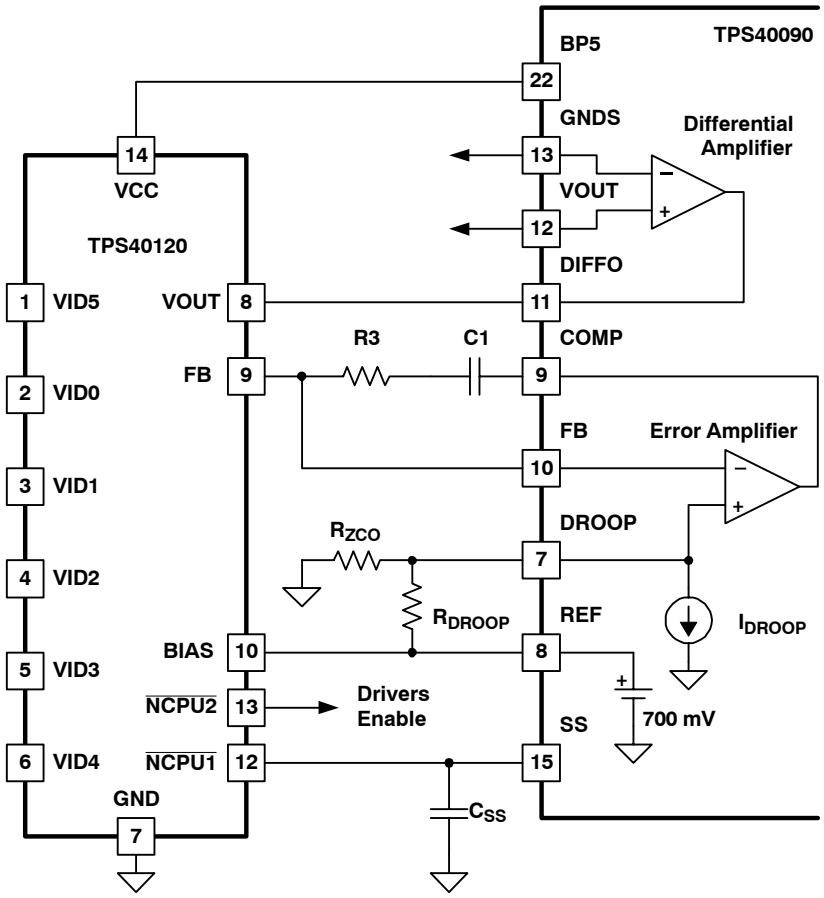
APPLICATIONS

- **Voltage Regulator Modules VRM/EVRD 10.x**
- **Multiphase Processor Power Supplies**

DESCRIPTION

The TPS40120 is a 6-bit digitally programmed feedback divider designed to work with TPS40090 multiphase controller or other controllers having 0.7-V internal reference to support VRM 10.x compliant power supplies. The TPS40120 is designed to support discrete DC/DC converters for Intel® processors using 5-bit (Pentium® 4 or Xeon™) or 6-bit VID codes with 12.5 mV steps.

TYPICAL APPLICATION



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOSFET gates.

ORDERING INFORMATION

T_A	PLASTIC HTTSOP(1)
-40°C to 85°C	TPS40120PW

(1) The PW package is available taped and reeled. Add an R suffix to the device type (i.el TPS40120PWR).

ABSOLUTE MAXIMUM RATING(1)

over operating free-air temperature range unless otherwise noted

			TPS40120	UNITS
V_{IN}	Input voltage range	VID0, VID1, VID2, VID3, VID4, VID5, VOUT	-0.3 to 5.5	V
V_{OUT}	Output voltage range	FB, $\overline{NCPU2}$	-0.3 to 5.5	V
		VCC, $\overline{NCPU1}$	-0.3 to 7.0	
T_A	Operating ambient temperature range		-40 to 85	°C
T_{stg}	Storage temperature		-55 to 150	

(1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device 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 voltage values are with respect to the network ground terminal unless otherwise noted.

RECOMMENDED OPERATING CONDITIONS

		MIN	NOM	MAX	UNIT
Supply voltage, VCC		4.3	5.0	5.5	V
I/O voltage range	VID0, VID1, VID2, VID3, VID4, VID5, VOUT	-0.1		5.5	
Operating free-air temperature, T_A		-40		85	°C

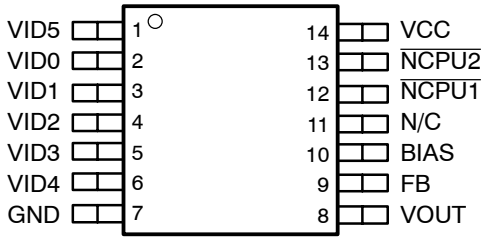
ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{VCC}	Supply voltatge		4.3	5.0	5.5	V
I_{VCC}	Supply current	All VID inputs low			1	mA
R_{FB}	Resistance between FB and OUT		7.5	10	14.5	kΩ
	Divider accuracy		-0.5%		0.5%	
VID_{THD}	VID input logic high		0.85			V
VID_{THD}	VID input logic low				0.3	
I_{BIAS}	BIAS input leakage	V_{BIAS} = 0.7 V			100	μA
	Logic low voltage	I_{PULLUP}= 1 mA			0.8	V
	Logic high leakage current				1	μA
	No CPU output voltage	$I_{L(SNK)}$= 0.5 mA, $I_{L(SRC)}$= 0.5 mA	V_{VSS}+ 0.5		V_{VCC} - 0.5	V

DEVICE INFORMATION

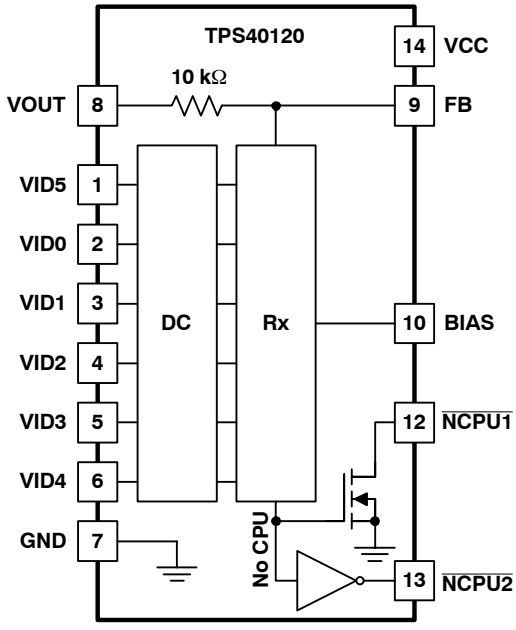
PW PACKAGE
(TOP VIEW)



TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
BIAS	10	I	Provides controller's reference voltage into the divider for improved tolerance.
FB	9	O	Middle point of the feedback divider connected to the inverting input of the controller's error amplifier
GND	7	-	Signal ground pin.
$\overline{\text{NCPU1}}$	12	O	Signals no CPU state. VID = x11111. Open drain output.
$\overline{\text{NCPU2}}$	13	O	Signals no CPU state. VID = x11111. TTL logic output.
VCC	14	I	Power to the device.
VID0	2	I	Voltage identification inputs. V_{REF} voltage is set in accordance with VRM 10.x codes applied to these pins.
VID1	3	I	
VID2	4	I	
VID3	5	I	
VID4	6	I	
VID5	1	I	
VOUT	8	I	This pin is connected to the output of the VR module or to the output of the differential amplifier of the TPS40090 controller.

FUNCTIONAL BLOCK DIAGRAM



DETAILED DESCRIPTION

Operation

The digitally programmed feedback divider TPS40120 substitutes for a discrete output voltage set-divider and allows for multiphase PWM controllers such as the TPS4009x, TPS40130 and with internal reference of 0.7 V to provide voltage identification (VID) feature to power supply designs.

The TPS40120 operates as a resistive divider with constant value of the upper resistor and variable and code determined value of the lower resistor, refer to the functional block diagram. The VID code truth table is presented in Table 1.

Dynamic VID

Most modern processors adjust their core voltage depending on the workload and clock frequency by commanding voltage identification (VID) codes to the power supply.The power supply reads these VID codes and adjusts the output voltage in a control manner per processor requirements. To provide safe transition from one VID code to another (and to ensure that no erroneous output voltage is produced by the power supply), the TPS40120 VID inputs have internal anti-skew circuit with approximately 500 ns of filtering time. With a rate of change of 12.5 mV in 5 μs, nothing else is required to achieve smooth upward and downward core voltage transitions. See Figure 1 and Figure 2.

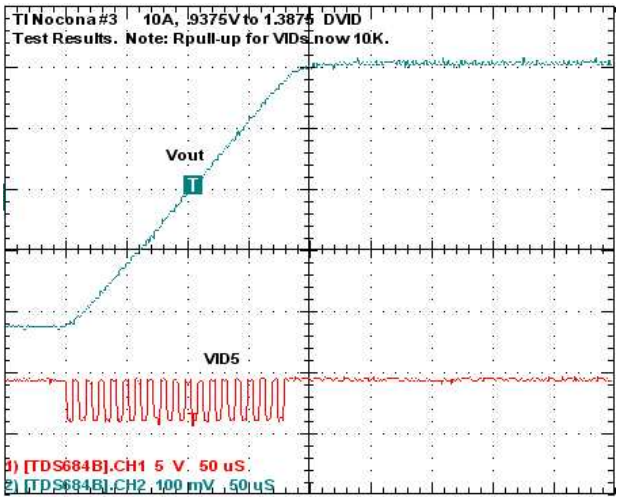


Figure 1. VID Step-Up Transition

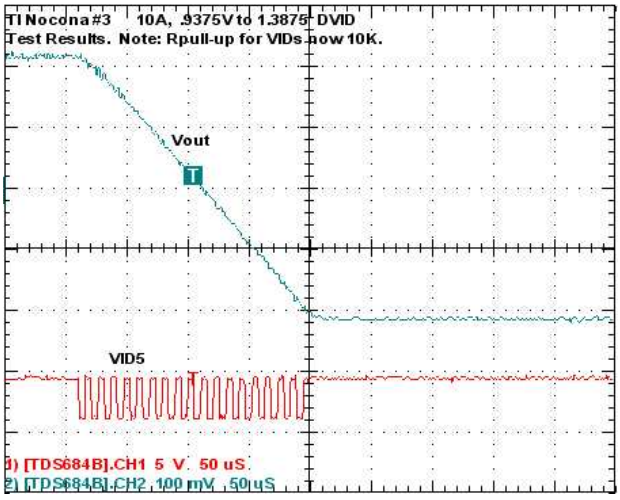


Figure 2. VID Step-Down Transition

DETAILED DESCRIPTION (continued)

Table 1. Voltage Identification (VID)

PROCESSOR PINS (0=LOW, 1=HIGH)						V_{REF} (V)
VID4	VID3	VID2	VID1	VID0	VID5	
0	1	0	1	0	0	0.8375
0	1	0	0	1	1	0.8500
0	1	0	0	1	0	0.8625
0	1	0	0	0	1	0.8750
0	1	0	0	0	0	0.8875
0	0	1	1	1	1	0.9000
0	0	1	1	1	0	0.9125
0	0	1	1	0	1	0.9250
0	0	1	1	0	0	0.9375
0	0	1	0	1	1	0.9500
0	0	1	0	1	0	0.9625
0	0	1	0	0	1	0.9750
0	0	1	0	0	0	0.9875
0	0	0	1	1	1	1.0000
0	0	0	1	1	0	1.0125
0	0	0	1	0	1	1.0250
0	0	0	1	0	0	1.0375
0	0	0	0	1	1	1.0500
0	0	0	0	1	0	1.0625
0	0	0	0	0	1	1.075
0	0	0	0	0	0	1.0875
1	1	1	1	1	1	OFF(1)
1	1	1	1	1	0	OFF(1)
1	1	1	1	0	1	1.1000
1	1	1	1	0	0	1.1125
1	1	1	0	1	1	1.1250
1	1	1	0	1	0	1.1375
1	1	1	0	0	1	1.1500
1	1	1	0	0	0	1.1625
1	1	0	1	1	1	1.1750
1	1	0	1	1	0	1.1875
1	1	0	1	0	1	1.2000
1	1	0	1	0	0	1.2125
1	1	0	0	1	1	1.2250
1	1	0	0	1	0	1.2375
1	1	0	0	0	1	1.2500
1	1	0	0	0	0	1.2625
1	0	1	1	1	1	1.2750
1	0	1	1	1	0	1.2875
1	0	1	1	0	1	1.3000
1	0	1	1	0	0	1.3125
1	0	1	0	1	1	1.3250
1	0	1	0	1	0	1.3375
1	0	1	0	0	1	1.3500

(1) $\overline{\text{NCPU1}}$ and $\overline{\text{NCPU2}}$ outputs go low.

DETAILED DESCRIPTION (continued)

Table 1. Voltage Identification (VID) (continued)

PROCESSOR PINS (0=LOW, 1=HIGH)						V_{REF} (V)
VID4	VID3	VID2	VID1	VID0	VID5	
1	0	1	0	0	0	1.3625
1	0	0	1	1	1	1.3750
1	0	0	1	1	0	1.3875
1	0	0	1	0	1	1.4000
1	0	0	1	0	0	1.4125
1	0	0	0	1	1	1.4250
1	0	0	0	1	0	1.4375
1	0	0	0	0	1	1.4500
1	0	0	0	0	0	1.4625
0	1	1	1	1	1	1.4750
0	1	1	1	1	0	1.4875
0	1	1	1	0	1	1.500
0	1	1	1	0	0	1.5125
0	1	1	0	1	1	1.5250
0	1	1	0	1	0	1.5375
0	1	1	0	0	1	1.5500
0	1	1	0	0	0	1.5625
0	1	0	1	1	1	1.5750
0	1	0	1	1	0	1.5875
0	1	0	1	0	1	1.6000

APPLICATION INFORMATION

Typical application circuit for TPS40120 and TPS40090 combination is presented on the front page. Normally, the TPS40120 accepts power from the BP5 pin of the TPS40090 multiphase controller which simplifies its enable/disable control. The upper resistor of the programmable divider (pin 8) is connected to the output of the differential amplifier DIFFO. The center tap of the divider (pin 9) is connected to the joint point of the FB pin of the multi-phase controller and error amplifier compensation network. TPS40120 has two logic $\overline{\text{NCPUx}}$ outputs that can be used to control output and the gate drivers in a multi-phase power supply when no-CPU code is asserted. The $\overline{\text{NCPU1}}$ output is an open drain that can be useful by discharging the soft-start capacitor and bringing the output voltage down. The push-pull $\overline{\text{NCPU2}}$ output can be used to control gate drivers to provide high impedance of the power supply output in off state.

The application circuit for a four-phase 105-A CPU VRM10.x compliant power supply is shown in Figure 3.

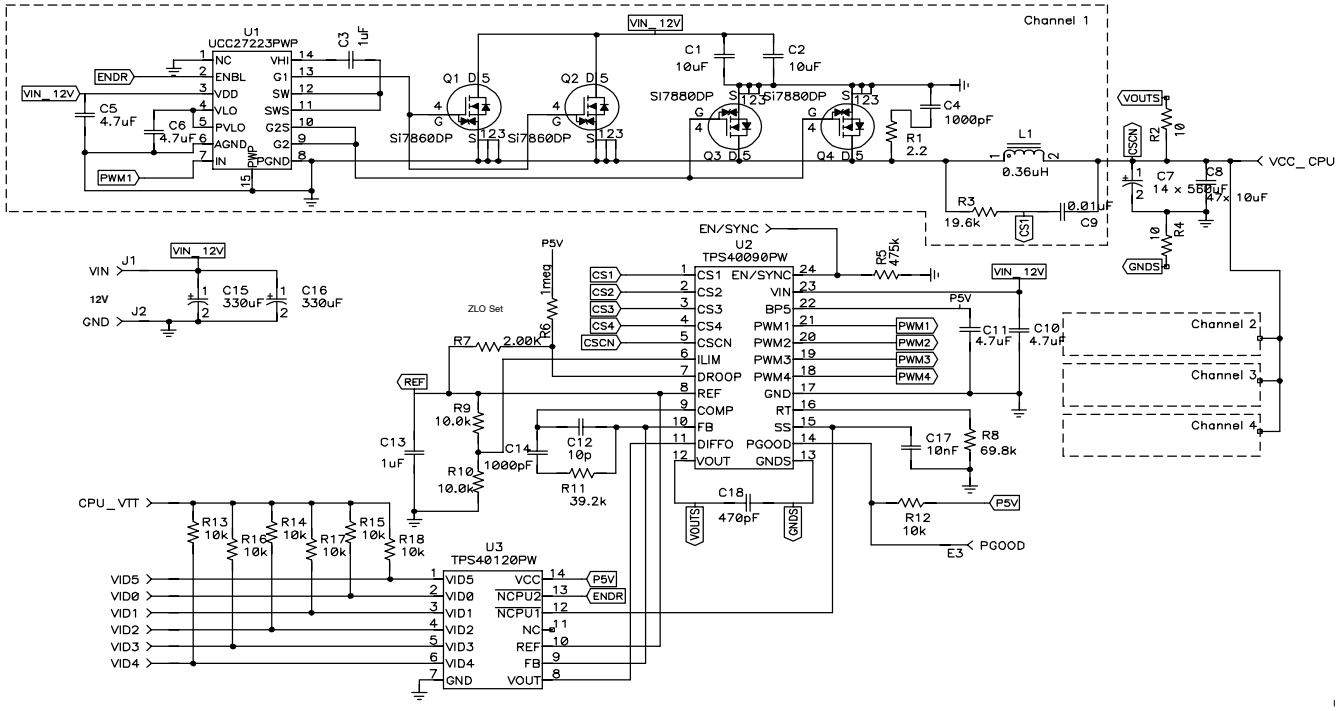


Figure 3. VRM 10.x Compliant CPU Power Supply

For detailed information on TPS40090 multiphase controller and design example request the TPS4009x datasheet (SLUS578) and the user's guide (SLUU026).

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TPS40120PW	Active	Production	TSSOP (PW) | 14	90 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	40120
TPS40120PW.A	Active	Production	TSSOP (PW) | 14	90 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	40120
TPS40120PWR	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	40120
TPS40120PWR.A	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	40120

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

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

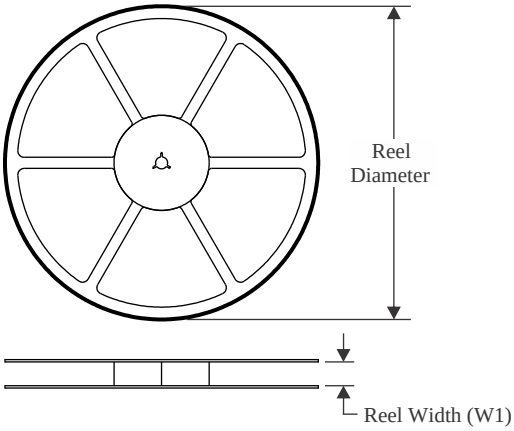
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

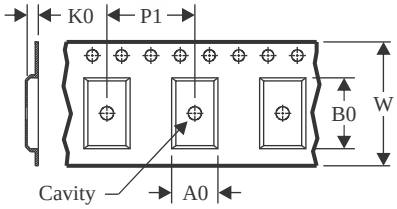
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

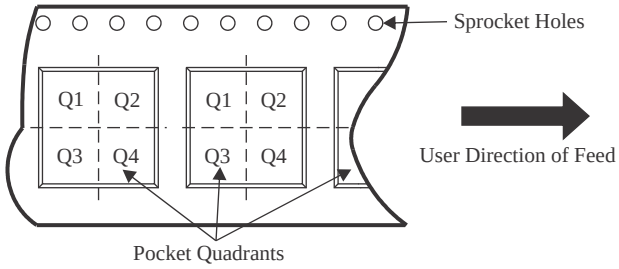


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

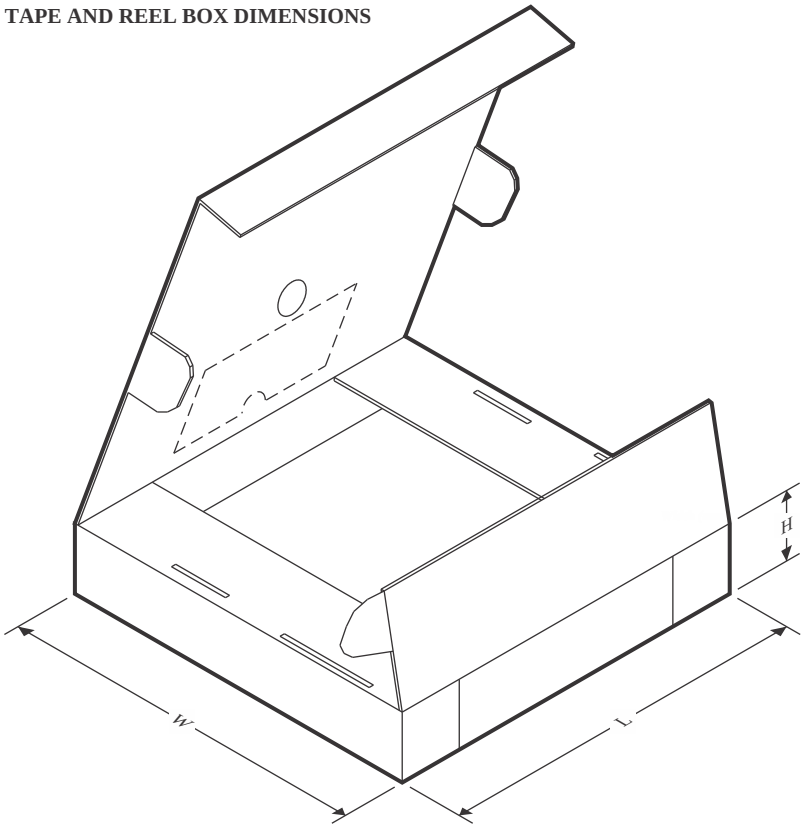
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPS40120PWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

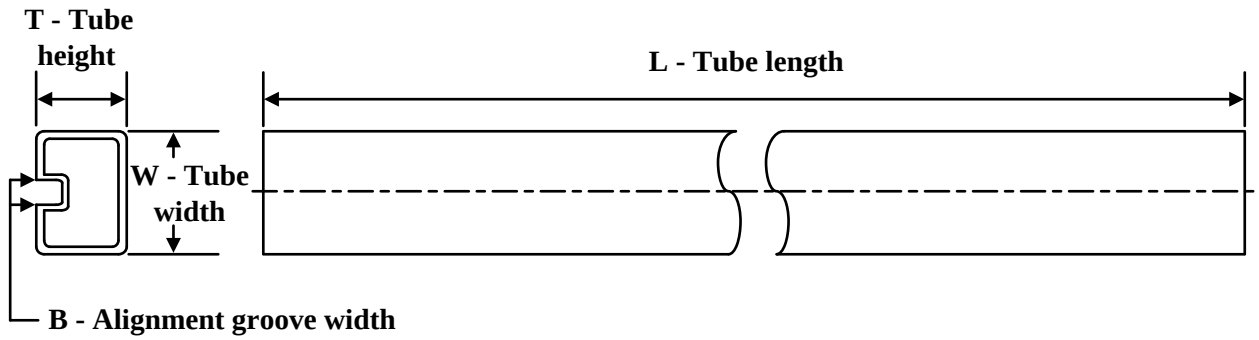
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS40120PWR	TSSOP	PW	14	2000	353.0	353.0	32.0

TUBE



*All dimensions are nominal

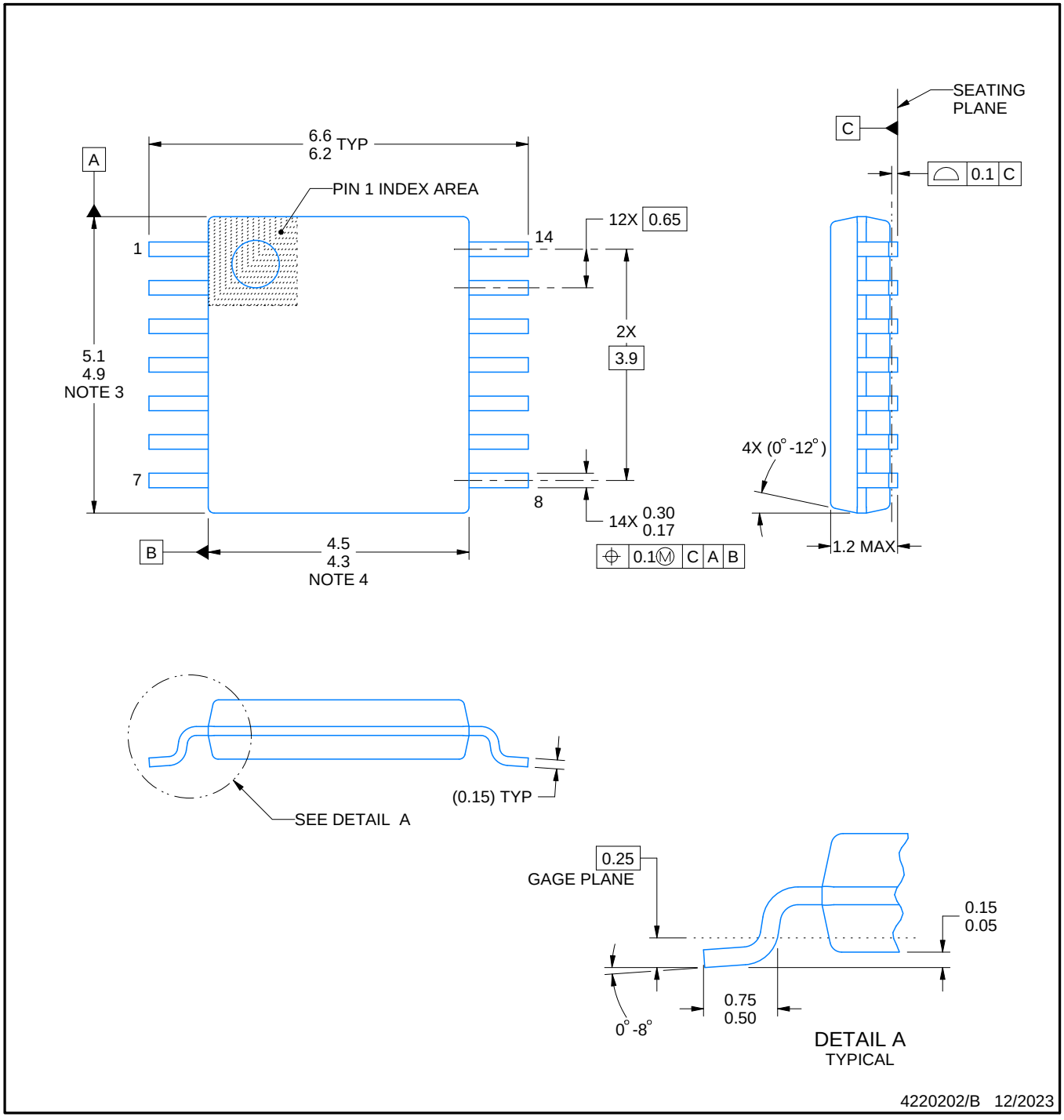
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TPS40120PW	PW	TSSOP	14	90	530	10.2	3600	3.5
TPS40120PW.A	PW	TSSOP	14	90	530	10.2	3600	3.5

PACKAGE OUTLINE

PW0014A

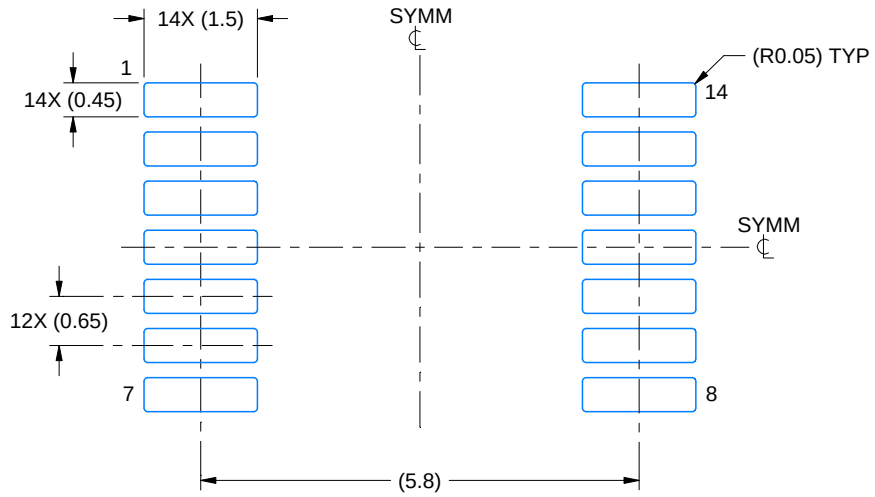
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

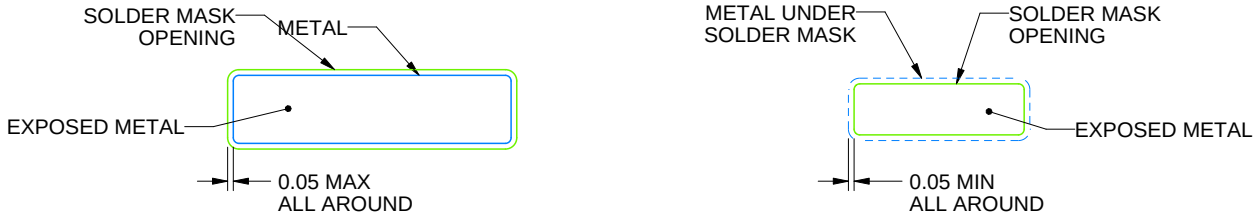


NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

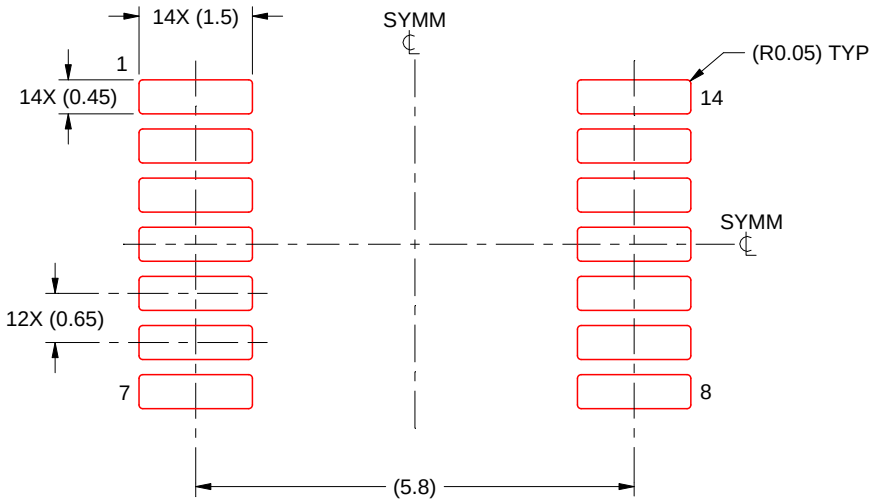


SOLDER MASK DETAILS

4220202/B 12/2023

NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

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NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

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