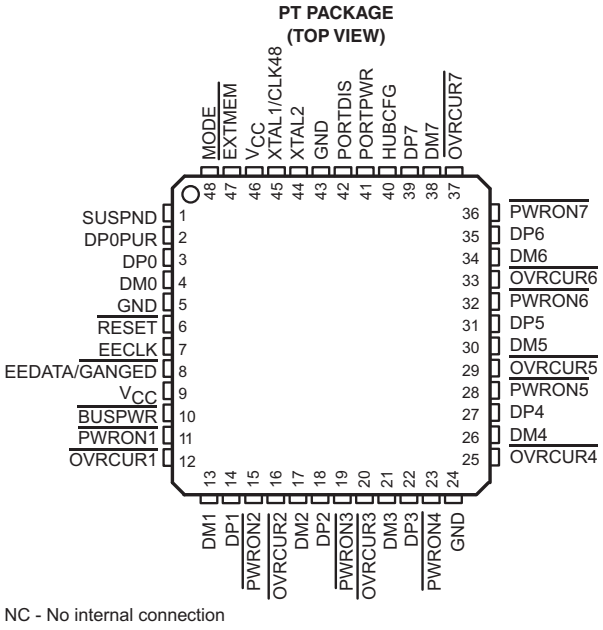
7-PORT HUB FOR THE UNIVERSAL SERIAL BUS WITH OPTIONAL SERIAL EEPROM INTERFACE

Check for Samples: TUSB2077A

FEATURES

- **Fully Compliant With the USB Specification as a Full-Speed Hub: TID #20240226**
- **Integrated USB Transceivers**
- **3.3-V Low Power ASIC Logic**
- **Two Power Source Modes**
  - **Self-Powered Mode Supporting Seven Downstream Ports**
  - **Bus-Powered Mode Supporting Four Downstream Ports**
- **All Downstream Ports Support Full-Speed and Low-Speed Operations**
- **Power Switching and Overcurrent Reporting Is Provided Ganged or Per Port**
- **Supports Suspend and Resume Operations**
- **Suspend Status Terminal Available for External Logic Power Down**
- **Supports Custom Vendor ID and Product ID With External Serial EEPROM**
- **3-State EEPROM Interface Allows EEPROM Sharing**
- **Push-Pull Outputs for $\overline{\text{PWRON}}$ Eliminate the Need for External Pullup Resistors**
- **Noise Filtering on $\overline{\text{OVRCUR}}$ Provides Immunity to Voltage Spikes**
- **Supports 6-MHz Operation Through a Crystal Input or a 48-MHz Input Clock**
- **New Functional Terminals Introduced to Reduce the Board Material Cost**
  - **3 LED Indicator Control Outputs Enable Visualized Monitoring of 6 Different Hub/Port Status (HUBCFG, PORTPWR, PORTDIS)**
  - **Output Terminal Available to Disable External Pullup Resistor on DP0 for 15 ms After Reset or After Change on $\overline{\text{BUSPWR}}$ and Enable Easy Implementation of Onboard Bus/Self- Power Dynamic Switching Circuitry**
- **Available in 48-Terminal LQFP Package** (1)



NC - No internal connection

(1) JEDEC descriptor S−PQFP−G for low-profile quad flatpack (LQFP).

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.

ORDERING INFORMATION[1]

T_A	PACKAGE[2]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 70°C	LQFP – PT	Reel of 250	TUSB2077APT	TUSB2077A
		Reel of 1000	TUSB2077APTR	
			TUSB2077APTRG4	

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.

DESCRIPTION

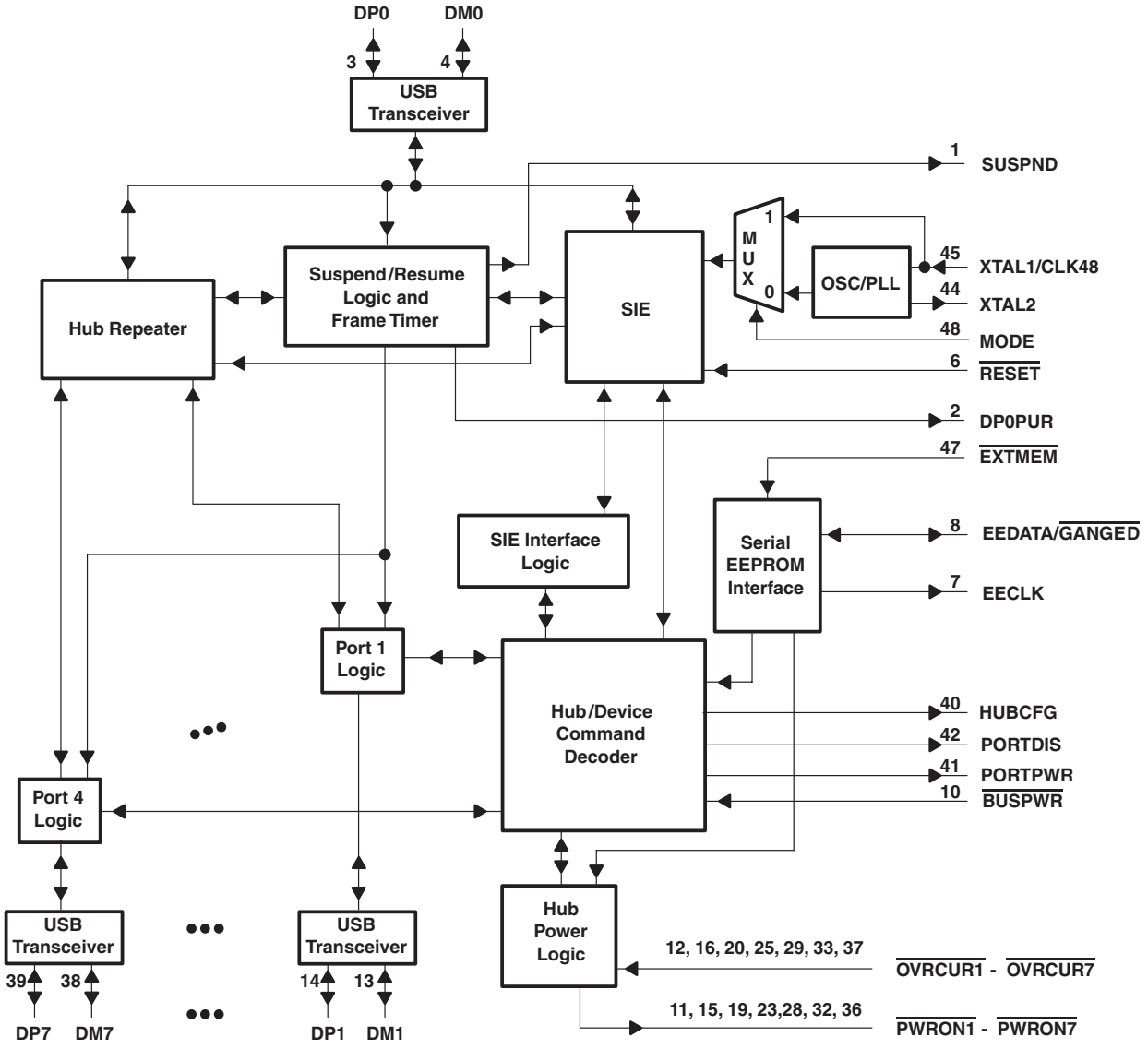
The TUSB2077A hub is a 3.3-V CMOS device that provides up to seven downstream ports in compliance with the USB 2.0 specification. Because this device is implemented with a digital state machine instead of a microcontroller, no software programming is required. Fully-compliant USB transceivers are integrated into the ASIC for all upstream and downstream ports. The downstream ports support both full-speed and low-speed devices by automatically setting the slew rate according to the speed of the device attached to the ports. The configuration of the $\overline{\text{BUSPWR}}$ terminal selects either the bus-powered or self-powered mode. The introduction of the DP0 pullup resistor disable terminal, DP0PUR, makes it much easier to implement an onboard bus/self-power dynamic-switching circuitry. The three LED indicator control output terminals also enable the implementation of visualized status monitoring of the hub and its downstream ports. With these new function terminals, the end equipment vendor can considerably reduce the total board cost while adding additional product value.

The $\overline{\text{EXTMEM}}$ (terminal 47) enables or disables the optional EEPROM interface. When $\overline{\text{EXTMEM}}$ is high, the vendor and product IDs (VID and PID) use defaults, such that the message displayed during enumeration is General Purpose USB Hub. For this configuration, terminal 8 functions as the $\overline{\text{GANGED}}$ input terminal and EECLK (terminal 7) is unused. If custom VID and PID descriptors are desired, the $\overline{\text{EXTMEM}}$ must be tied low ($\overline{\text{EXTMEM}}$ = 0) and a SGS Thompson M93C46 EEPROM, or equivalent, stores the programmable VID, PID, and $\overline{\text{GANGED}}$ values. For this configuration, terminals 7 and 8 function as the EEPROM interface signals with terminal 7 as EECLK and terminal 8 as EEDATA, respectively.

The TUSB2077A supports both bus-powered and self-powered modes. External power-management devices, such as the TPS2044, are required to control the 5-V power source switching (on/off) to the downstream ports and to detect an overcurrent condition from the downstream ports individually or ganged. Outputs from external power devices provide overcurrent inputs to the TUSB2077A $\overline{\text{OVRCUR}}$ terminals in case of an overcurrent condition, the corresponding $\overline{\text{PWRON}}$ terminals are disabled by the TUSB2077A. In the ganged mode, all $\overline{\text{PWRON}}$ signals transition simultaneously, and any $\overline{\text{OVRCUR}}$ input can be used. In the nonganged mode, the $\overline{\text{PWROR}}$ outputs and $\overline{\text{OVRCUR}}$ inputs operate on a per-port basis.

The TUSB2077A provides the flexibility of using either a 6-MHz or a 48-MHz clock. The logic level of the MODE terminal controls the selection of the clock source. When MODE is low, the output of the internal APLL circuitry is selected to drive the internal core of the chip. When MODE is high, the XTAL1 input is selected as the input clock source and the APLL circuitry is powered down and bypassed. The internal oscillator cell is also powered down while MODE is high. For 6-MHz operation, TUSB2077A requires a 6-MHz clock signal on XTAL1 terminal (with XTAL2 for a crystal) from which its internal APLL circuitry generates a 48-MHz internal clock to sample the data from the upstream port. For 48-MHz operation, the clock cannot be generated with a crystal, using the XTAL2 output, since the internal oscillator cell only supports the fundamental frequency. If low-power suspend and resume are desired, a passive crystal or resonator must be used, although the hub supports the flexibility of using any device that generates a 6-MHz clock. Because most oscillators cannot be stopped while power is on, their use prohibits low-power suspend, which depends on disabling the clock. When the oscillator is used, by connecting its output to the XTAL1 terminal and leaving the XTAL2 terminal open, its TTL output level can not exceed 3.6 V. If a 6-MHz oscillator is used, it must be stopped at logic low whenever SUSPND is high. For crystal or resonator implementations, the XTAL1 terminal is the input and the XTAL2 terminal is used as the feedback path. A sample crystal tuning circuit is shown in Figure 7.

FUNCTIONAL BLOCK DIAGRAM



TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
$\overline{\text{BUSPWR}}$	10	I	Power source indicator. $\overline{\text{BUSPWR}}$ is an active-low input that indicates whether the downstream ports source their power from the USB cable or a local power supply. For the bus-power mode, this terminal must be pulled low, and for the self-powered mode, this terminal must be pulled to 3.3 V. Input must not change dynamically during operation.
DM0	4	I/O	Root port USB differential data minus. DM0 paired with DP0 constitutes the upstream USB port.
DM1–DM7	13, 17, 21, 26, 30, 34, 38	I/O	USB differential data minus. DM1–DM7 paired with DP1–DP7 support up to four downstream USB ports.
DP0	3	I/O	Root port USB differential data plus. DP0 paired with DM0 constitutes the upstream USB port.
DP1–DP7	14, 18, 22, 27, 31, 35, 39	I/O	USB differential data plus. DP1–DP7 paired with DM1–DM7 support up to four downstream USB ports.
DP0PUR	2	O	Pullup resistor connection. When a system reset happens ($\overline{\text{RESET}}$ being driven to low, but not USB reset) or any logic level change on $\overline{\text{BUSPWR}}$ terminal, DP0PUR output is inactive (floating) until the internal counter reaches a 15-ms time period. After the counter expires, DP0PUR is driven to the VCC (3.3 V) level thereafter until the next system reset event occurs or there is a $\overline{\text{BUSPWR}}$ logic level change.
EECLK	7	O	EEPROM serial clock. When $\overline{\text{EXTMEM}}$ is high, the EEPROM interface is disabled. The EECLK terminal is disabled and must be left floating (unconnected). When $\overline{\text{EXTMEM}}$ is low, EECLK acts as a 3-state serial clock output to the EEPROM with a 100-µA internal pulldown.
EEDATA/ $\overline{\text{GANGED}}$	8	I/O	EEPROM serial data/power-management mode indicator. When $\overline{\text{EXTMEM}}$ is high, EEDATA/$\overline{\text{GANGED}}$ selects between ganged or per-port power overcurrent detection for the downstream ports. When $\overline{\text{EXTMEM}}$ is low, EEDATA/$\overline{\text{GANGED}}$ acts as a serial data I/O for the EEPROM and is internally pulled down with a 100-µA pulldown. This standard TTL input must not change dynamically during operation.
$\overline{\text{EXTMEM}}$	47	I	When $\overline{\text{EXTMEM}}$ is high, the serial EEPROM interface of the device is disabled. When $\overline{\text{EXTMEM}}$ is low, terminals 7 and 8 are configured as the clock and data terminals of the serial EEPROM interface, respectively.
GND	5, 24, 43		GND terminals must be tied to ground for proper operation.
HUBCFG(1)	40	O	Hub configured. Used to control LED indicator. When the hub is configured, HUBCFG is high, which can be used to turn on a green LED. When the hub is not configured, HUBCFG is low, which can be used to turn on a red LED.
MODE	48	I	Mode select. When MODE is low, the APLL output clock is selected as the clock source to drive the internal core of the chip and 6-MHz crystal or oscillator can used. When MODE is high, the clock on XTAL1/CLK48 is selected as the clock source and 48-MHz oscillator or other onboard clock source can be used.
$\overline{\text{OVRCUR1}}$ – $\overline{\text{OVRCUR7}}$	12, 16, 20, 25, 29, 33, 37	I	Overcurrent input. $\overline{\text{OVRCUR1}}$–$\overline{\text{OVRCUR7}}$ are active low. For per-port overcurrent detection, one overcurrent input is available for each of the seven downstream ports. In the ganged mode, any $\overline{\text{OVRCUR}}$ input may be used and all $\overline{\text{OVRCUR}}$ terminals must be tied together. $\overline{\text{OVRCUR}}$ terminals are active low inputs with noise filtering logic.
PORTPWR(1)	41	O	Any port powered. Used to control LED indicator. When any port is powered on, PORTPWR is high, which can be used to turn on a green LED. When all ports are off, PORTPWR is low, which can be used to turn on a red LED.
PORTDIS(1)	42	O	No ports disabled. PORTDIS is used for LED indicator control. When no port is disabled, PORTDIS is high, which can be used to turn on a green LED. When any port is disabled, PORTDIS is low, which can be used to turn on a red LED.
$\overline{\text{PWRON1}}$ – $\overline{\text{PWRON7}}$	11, 15, 19, 23, 28, 32, 36	O	Power-on/-off control signals. $\overline{\text{PWRON1}}$–$\overline{\text{PWRON7}}$ are active low, push-pull outputs that enables the external power switch device. Push-pull outputs eliminate the pullup resistors which open-drain outputs require. However, the external power switches that connect to these terminals must be able to operate with 3.3-V inputs because these outputs cannot drive 5-V signals.
$\overline{\text{RESET}}$	6	I	$\overline{\text{RESET}}$ is an active low TTL input with hysteresis and must be asserted at power up. When $\overline{\text{RESET}}$ is asserted, all logic is initialized. Generally, a reset with a pulse width between 100 µs and 1 ms is recommended after 3.3-V V_{CC} reaches its 90%. Clock signal has to be active during the last 60 µs of the reset window.
SUSPND	1	O	Suspend status. SUSPND is an active high output available for external logic power-down operations. During the suspend mode, SUSPND is high. SUSPND is low for normal operation.
V_{CC}	9, 46		3.3-V supply voltage
XTAL1/CLK48	45	I	Crystal 1/48-MHz clock input. When MODE is low, XTAL1/CLK48 is a 6-MHz crystal input with 50% duty cycle. An internal APLL generates the 48-MHz and 12-MHz clocks used internally by the ASIC logic. When MODE is high, XTAL1/CLK48 acts as the input of the 48-MHz clock and the internal APLL logic is bypassed.
XTAL2	44	O	Crystal 2. XTAL2 is a 6-MHz crystal output. This terminal must be left open when using an oscillator.

(1) All LED controls are 3-stated during low-power suspend.

ABSOLUTE MAXIMUM RATINGS(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage range(2)		–0.5	3.6	V
V_I	Input voltage range		–0.5	V_{CC} + 0.5	V
V_O	Output voltage range		–0.5	V_{CC} + 0.5	V
I_{IK}	Input clamp current	V_I < 0 V or V_I < V_{CC}		±20	mA
I_{OK}	Output clamp current	V_O < 0 V or V_O < V_{CC}		±20	mA
T_{stg}	Storage temperature range		–65	150	°C
T_A	Operating free-air temperature range		0	70	°C

(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.
(2) All voltage levels are with respect to GND.

RECOMMENDED OPERATING CONDITIONS

	PARAMETER	MIN	NOM	MAX	UNIT
V_{CC}	Supply voltage	3	3.3	3.6	V
V_I	Input voltage, TTL/LVCMOS(1)	0		V_{CC}	V
V_O	Output voltage, TTL/LVCMOS(2)	0		V_{CC}	V
$V_{IH(REC)}$	High-level input voltage, signal-ended receiver	2		V_{CC}	V
$V_{IL(REC)}$	Low-level input voltage, signal-ended receiver			0.8	V
$V_{IH(TTL)}$	High-level input voltage, TTL/LVCMOS(1)	2		V_{CC}	V
$V_{IL(TTL)}$	Low-level input voltage, TTL/LVCMOS(1)	0		0.8	V
T_A	Operating free-air temperature	0		70	°C
$R_{(DRV)}$	External series, differential driver resistor		22		Ω
$f_{(OPRH)}$	Operating (dc differential driver) high speed mode			12	Mb/s
$f_{(OPRL)}$	Operating (dc differential driver) low speed mode			1.5	Mb/s
V_{ICR}	Common mode, input range, differential receiver	0.8		2.5	V
t_t	Input transition times, TTL/LVCMOS(1)	0		25	ns
T_J	Junction temperature range(3)	0		115	°C

(1) Applies for input and bidirectional buffers.
(2) Applies for output and bidirectional buffers.
(3) These junction temperatures reflect simulated conditions. Absolute maximum junction temperature is 150°C. The customer is responsible for verifying junction temperature.

ELECTRICAL CHARACTERISTICS

over recommended ranges of operating free-air temperature and supply voltage (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	MAX	UNIT
V_{OH}	High-level output voltage	TTL/LVCMOS	I_{OH} = –4 mA	V_{CC} – 0.5		V
		USB data lines	$R_{(DRV)}$ = 15 kΩ to GND	2.8		
			I_{OH} = –12 mA (without $R_{(DRV)}$)	V_{CC} – 0.5		
V_{OL}	Low-level output voltage	TTL/LVCMOS	I_{OL} = 4 mA		0.5	V
		USB data lines	$R_{(DRV)}$ = 1.5 kΩ to 3.6 V		0.3	
			I_{OL} = 12 mA (without $R_{(DRV)}$)		0.5	
V_{IT+}	Positive input threshold	TTL/LVCMOS			1.8	V
		Single-ended	0.8 V ≤ V_{ICR} ≤ 2.5 V		1.8	
$V_{IT–}$	Negative-input threshold	TTL/LVCMOS		0.8		V
		Single-ended	0.8 V ≤ V_{ICR} ≤ 2.5 V	1		
V_{hys}	Input hysteresis(1) ($V_{T+} – V_{T–}$)	TTL/LVCMOS		0.3	0.7	mV
		Single-ended	0.8 V ≤ V_{ICR} ≤ 2.5 V	300	500	
I_{OZ}	High-impedance output current	TTL/LVCMOS	V = V_{CC} or GND(2)		±10	µA
		USB data lines	0 V ≤ V_O ≤ V_{CC}		±10	
I_{IL}	Low-level input current	TTL/LVCMOS	V_I = GND		–1	µA
I_{IH}	High-level input current	TTL/LVCMOS	V_I = V_{CC}		1	µA
$z_{0(DRV)}$	Driver output impedance	USB data lines	Static V_{OH} or V_{OL}	7.1	19.9	Ω
V_{ID}	Differential input voltage	USB data lines	0.8 V ≤ V_{ICR} ≤ 2.5 V	0.2		V
I_{CC}	Input supply current		Normal operation		40	mA
			Suspend mode		1	µA

(1) Applies for input buffers with hysteresis.
(2) Applies for open drain buffers.

DIFFERENTIAL DRIVER SWITCHING CHARACTERISTICS Full Speed Mode

over recommended ranges of operating free-air temperature and supply voltage, C_L = 50 pF (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
t_r	Transition rise time for DP or DM	See Figure 1 and Figure 2	4	20	ns
t_f	Transition fall time for DP or DM	See Figure 1 and Figure 2	4	20	ns
$t_{(RFM)}$	Rise/fall time matching(1)	(t_r/t_f) × 100	90	110	%
$V_{O(CRS)}$	Signal crossover output voltage(1)		1.3	2.0	V

(1) Characterized only. Limits are approved by design and are not production tested.

DIFFERENTIAL DRIVER SWITCHING CHARACTERISTICS Low Speed Mode

over recommended ranges of operating free-air temperature and supply voltage, C_L = 50 pF (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	MAX	UNIT
t_r	Transition rise time for DP or DM(1)	C_L = 200 pF to 600 pF, See Figure 1 and Figure 2	75	300	ns
t_f	Transition fall time for DP or DM(1)	C_L = 200 pF to 600 pF, See Figure 1 and Figure 2	75	300	ns
$t_{(RFM)}$	Rise/fall time matching(1)	(t_r/t_f) × 100	80	120	%
$V_{O(CRS)}$	Signal crossover output voltage(1)	C_L = 200 pF to 600 pF	1.3	2.0	V

(1) Characterized only. Limits are approved by design and are not production tested.

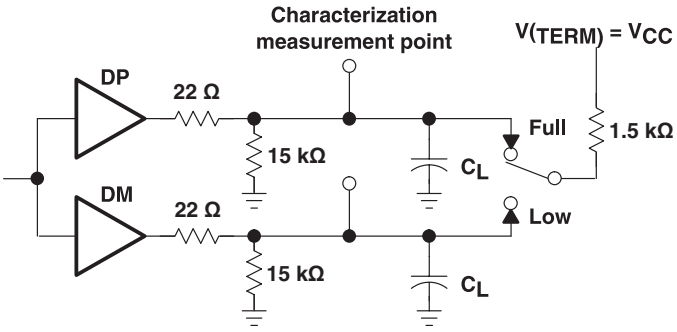
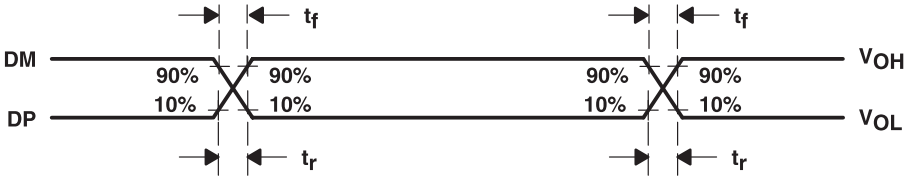


Figure 1. Differential Driver Switching Load



NOTE: The t_r/t_f ratio is measured as $t_{r(DP)}/t_{f(DM)}$ and $t_{r(DM)}/t_{f(DP)}$ at each crossover point.

Figure 2. Differential Driver Timing Waveforms

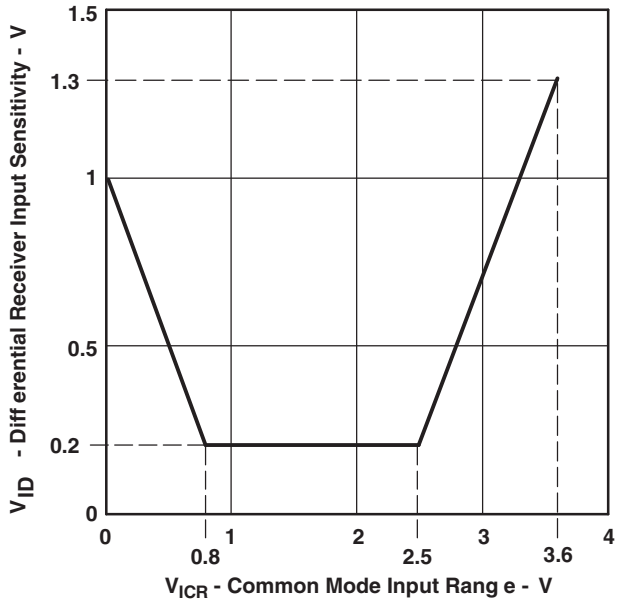


Figure 3. Differential Receiver Input Sensitivity vs Common Mode Input Range

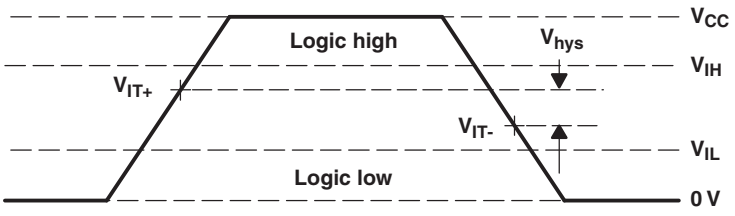


Figure 4. Single-Ended Receiver Input Signal Parameter Definitions

APPLICATION INFORMATION

A major advantage of USB is the ability to connect 127 functions configured in up to 6 logical layers (tiers) to a single personal computer (see Figure 5).

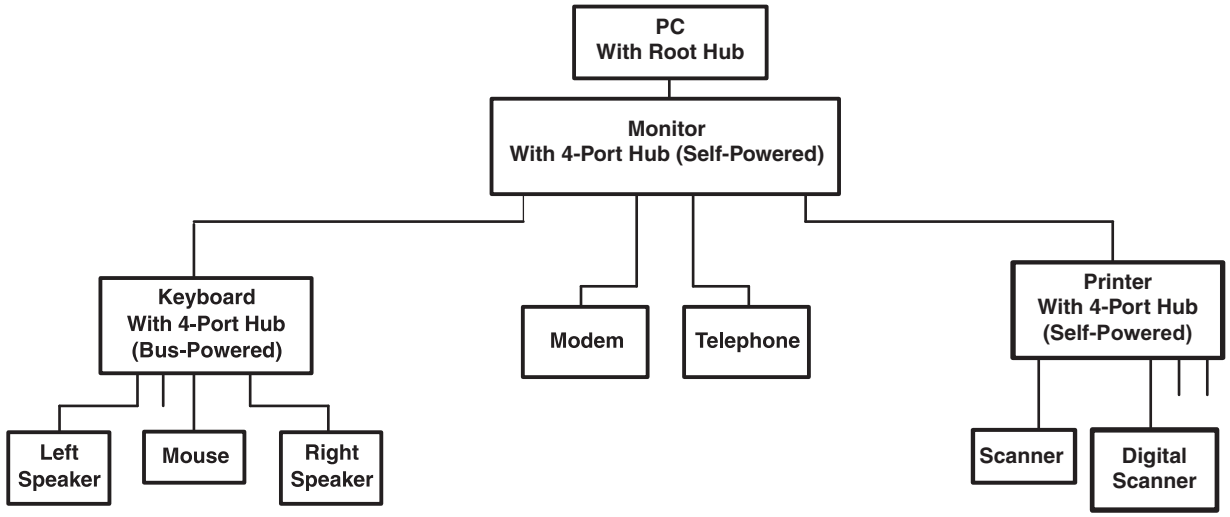


Figure 5. USB-Tiered Configuration Example

Another advantage of USB is that all peripherals are connected using a standardized four-wire cable that provides both communication and power distribution. The power configurations are bus-powered and self-powered modes. The maximum current that may be drawn from the USB 5-V line during power up is 100 mA. For the bus-powered mode, a hub can draw a maximum of 500 mA from the 5-V line of the USB cable. A bus-powered hub must always be connected downstream to a self-powered hub unless it is the only hub connected to the PC and there are no high-powered functions connected downstream. In the self-powered mode, the hub is connected to an external power supply and can supply up to 500 mA to each downstream port. High-powered functions may draw a maximum of 500 mA from each downstream port and may only be connected downstream to self-powered hubs. Per the USB specification, in the bus-powered mode, each downstream port can provide a maximum of 100 mA of current, and in the self-powered mode, each downstream port can provide a maximum of 500 mA of current.

Both bus-powered and self-powered hubs require overcurrent protection for all downstream ports. The two types of protection are individual-port management (individual-port basis) or ganged-port management (multiple-port basis). Individual-port management requires power-management devices for each individual downstream port, but adds robustness to the USB system because, in the event of an overcurrent condition, the USB host only powers down the port that has the condition. The ganged configuration uses fewer power management devices and thus has lower system costs, but in the event of an overcurrent condition on any of the downstream ports, all the ganged ports are disabled by the USB host.

Using a combination of the BUSPWR and EEDATA/GANGED inputs, the TUSB2077A supports four modes of power management: bus-powered hub with either individual-port power management or ganged-port power management, and the self-powered hub with either individual-port power management or ganged-port power management. Texas Instruments supplies the complete hub solution because we offer this TUSB2077A along with the power-management devices needed to implement a fully USB compliant system.

USB Design Notes

The following sections provide block diagram examples of how to implement the TUSB2077A device. Note, even though no resistors are shown, pullup, pulldown, and series resistors must be used to properly implement this device.

Figure 6 is a block diagram example of how to connect the external EEPROM if a custom product ID and vendor ID are desired.

Figure 7 is an example of how to generate the 6-MHz clock signal.

Figure 8 shows the EEPROM read operation timing diagram.

Figure 9, Figure 10, and Figure 11 illustrate how to connect the TUSB2077A device for different power source and port power-management combinations.

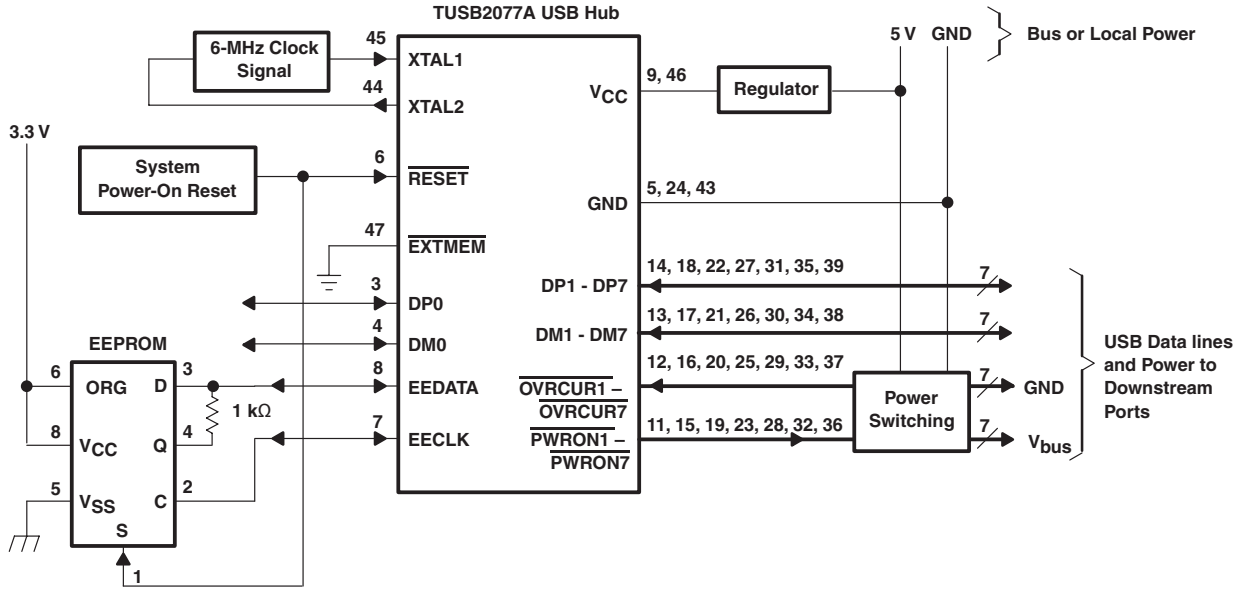
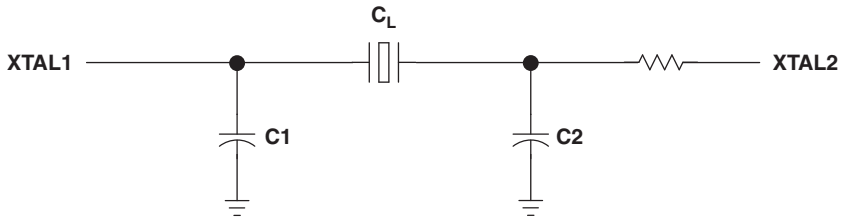


Figure 6. Typical Application of the TUSB2077A USB Hub



NOTE: This figure assumes a 6-MHz fundamental crystal that is parallel loaded. The component values of C1, C2, and R_d are determined using a crystal from Fox Electronics – part number HC49U-6.00MHz 30\50\0±70\20, which means ±30 ppm at 25°C and ±50 ppm from 0°C to 70°C. The characteristics for the crystal include a load capacitance (C_L) of 20 pF, maximum shunt capacitance (C_o) of 7 pF, and the maximum ESR of 50 Ω. In order to insure enough negative resistance, use C1 = C2 = 27 pF. The resistor R_d is used to trim the gain, and R_d = 1.5 kΩ is recommended.

Figure 7. Crystal Tuning Circuit

Programming the EEPROM

An SGS Thompson M93C46 EEPROM, or equivalent, stores the programmable VID and PID. When the EEPROM interface is enabled ($\overline{\text{EXTMEM}}$ = 0), the EECLK and EEDATA are internally pulled down (100 µA) inside the TUSB2077A. The internal pulldowns are disabled when the EEPROM interface is disabled ($\overline{\text{EXTMEM}}$ = 1).

The EEPROM is programmed with the three 16-bit locations as shown in Table 1. Connecting terminal 6 of the EEPROM high (ORG = 1) organizes the EEPROM memory into 64×16-bit words.

Table 1. EEPROM Memory Map

ADDRESS	D15	D14	D13	D12–D8	D7–D0
00000	0	$\overline{\text{GANGED}}$	00000	00000	00000000
00001	VID High-byte				VID Low-byte
00010	PID High-byte				PID Low-byte
	XXXXXXXX				

The D and Q signals of the EEPROM must be tied together using a 1-kΩ resistor with the common I/O operations forming a single-wire bus. After system power-on reset, the TUSB2077A performs a one-time access read operation from the EEPROM if the $\overline{\text{EXTMEM}}$ terminal is pulled low and the chip select(s) of the EEPROM is connected to the system power-on reset. Initially, the EEDATA terminal is driven by the TUSB2077A to send a start bit (1) which is followed by the read instruction (10) and the starting-word address (00000). Once the read instruction is received, the instruction and address are decoded by the EEPROM, which then sends the data to the output shift register. At this point, the hub stops driving the EEDATA terminal and the EEPROM starts driving. A dummy (0) bit is then output and the first three 16-bit words in the EEPROM are output with the most significant bit (MSB) first.

The output data changes are triggered by the rising edge of the clock provided by the TUSB2077A on the EECLK terminal. The SGS-Thompson M936C46 EEPROM is recommended because it advances to the next memory location by automatically incrementing the address internally. Any EEPROM used must have the automatic internal address advance function. After reading the three words of data from the EEPROM, the TUSB2077A puts the EEPROM interface into a high-impedance condition (pulled down internally) to allow other logic to share the EEPROM. The EEPROM read operation is summarized in Figure 8. For more details on EEPROM operation, refer to *SGS-Thompson Microelectronics M93C46 Serial Microwire Bus EEPROM* data sheet.

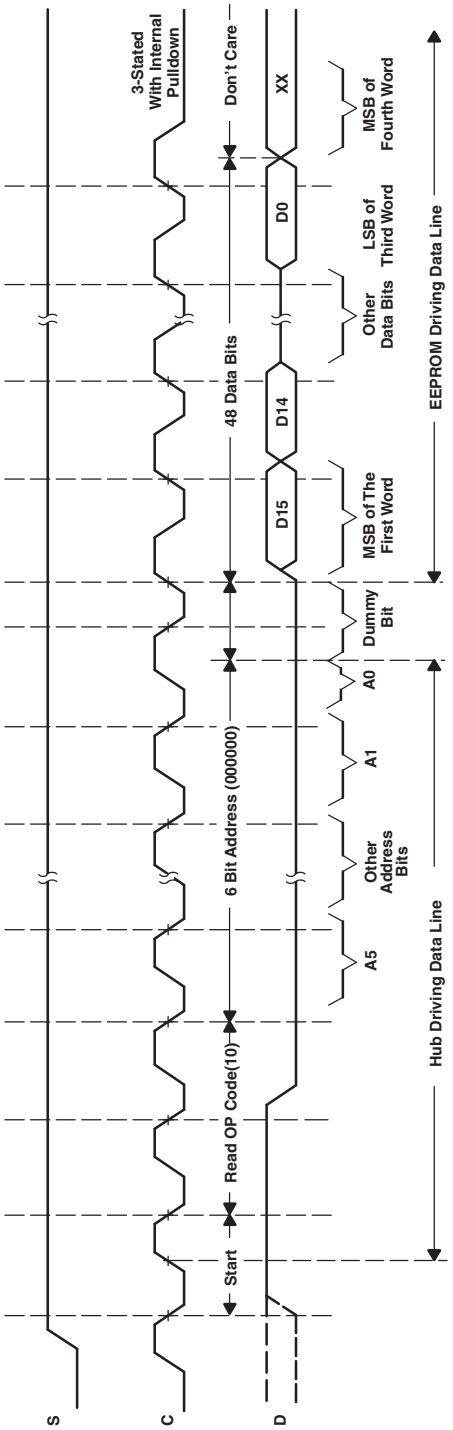
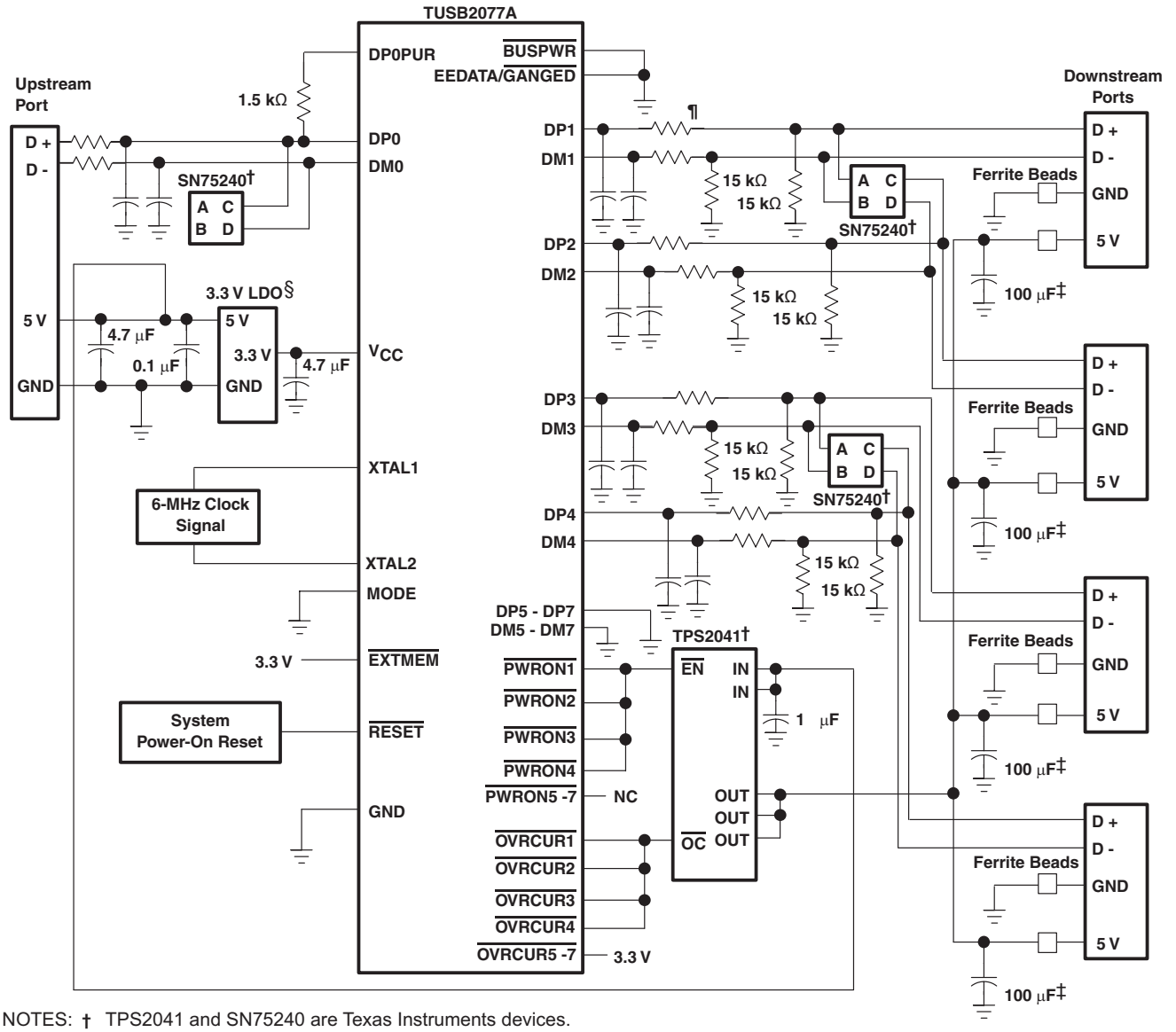


Figure 8. EEPROM Read Operation Timing Diagram

Bus-Powered Hub, Ganged-Port Power Management

When used in bus-powered mode, the TUSB2077A supports up to four downstream ports by controlling a TPS2041 device which is capable of supplying 100 mA of current to each downstream port. Bus-powered hubs must implement power switching to ensure current demand is held below 100 mA when the hub is hot-plugged into the system. Utilizing the TPS2041 for ganged-port power management provides overcurrent protection for the downstream ports. The SN75240 transient suppressors reduce inrush current and voltage spikes on the data lines. The $\overline{\text{OVRCUR}}$ signals must be tied together for a ganged operation.



NOTES: † TPS2041 and SN75240 are Texas Instruments devices.

‡ 120 μF per hub is the minimum required per the USB specification. However, TI recommends a 100-μF, low ESR, tantalum capacitor per port for immunity to voltage droop.

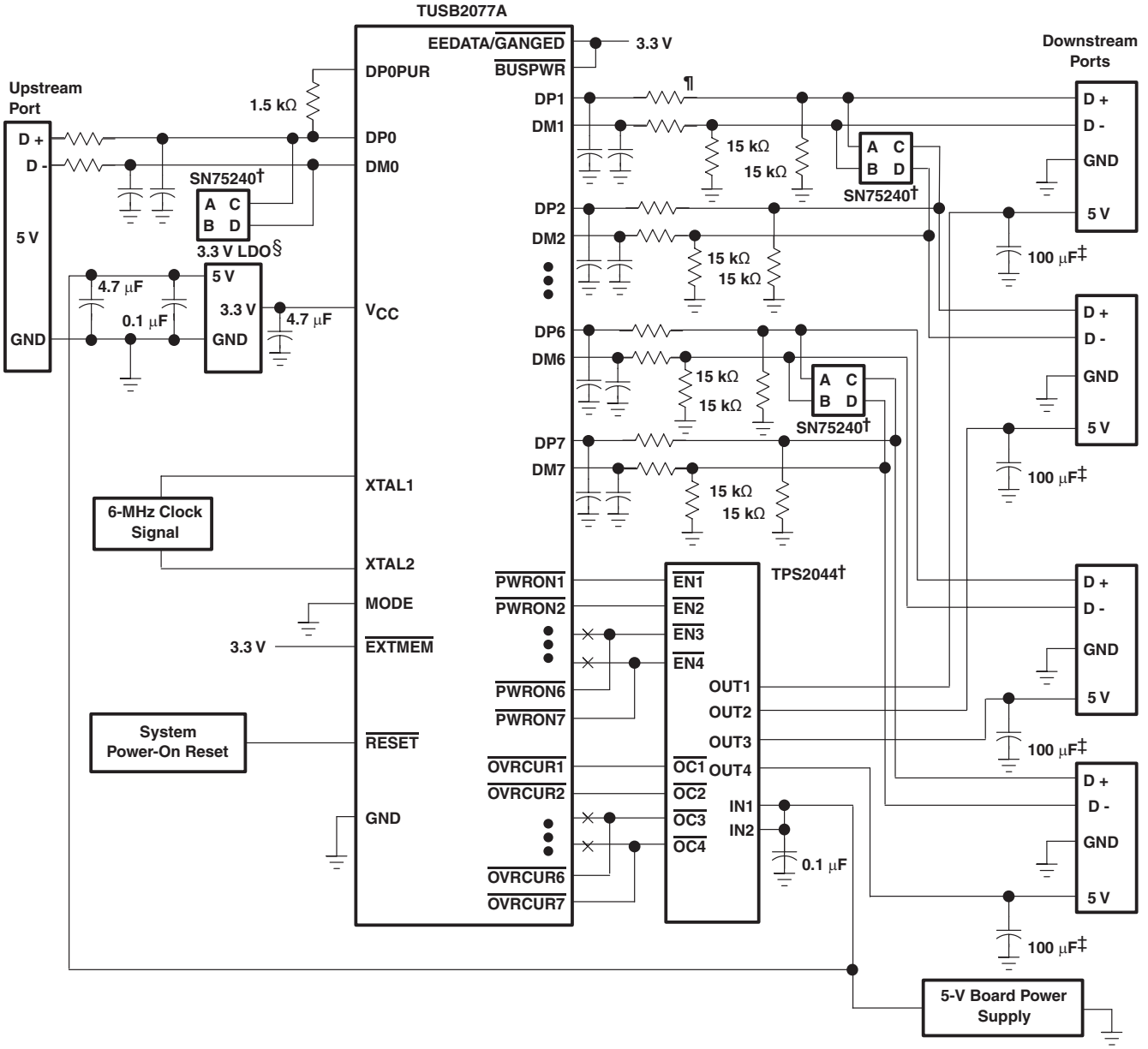
§ LDO is a 5-V-to-3.3-V voltage regulator

¶ All USB DP, DM signal pairs require series resistors of approximately 27Ω to ensure proper termination. An optional filter capacitor of about 22 pF is recommended for EMI suppression. This capacitor, if used, must be placed between the hub terminal and the series resistor, as per section 7.1.6 of the USB specification.

Figure 9. TUSB2077A Bus-Powered Hub, Ganged-Port Power-Management Application

Self-Powered Hub, Individual-Port Power Management

In a self-powered configuration, the TUSB2077A can be implemented for individual-port power management when used with two TPS2044 because it is capable of supplying 500 mA of current to each downstream port and can provide current limiting on a per port basis. When the hub detects a fault on a downstream port, power is removed from only the port with the fault and the remaining ports continue to operate normally. Self-powered hubs are required to implement overcurrent protection and report overcurrent conditions. The SN75240 transient suppressors reduce inrush current and voltage spikes on the data lines.

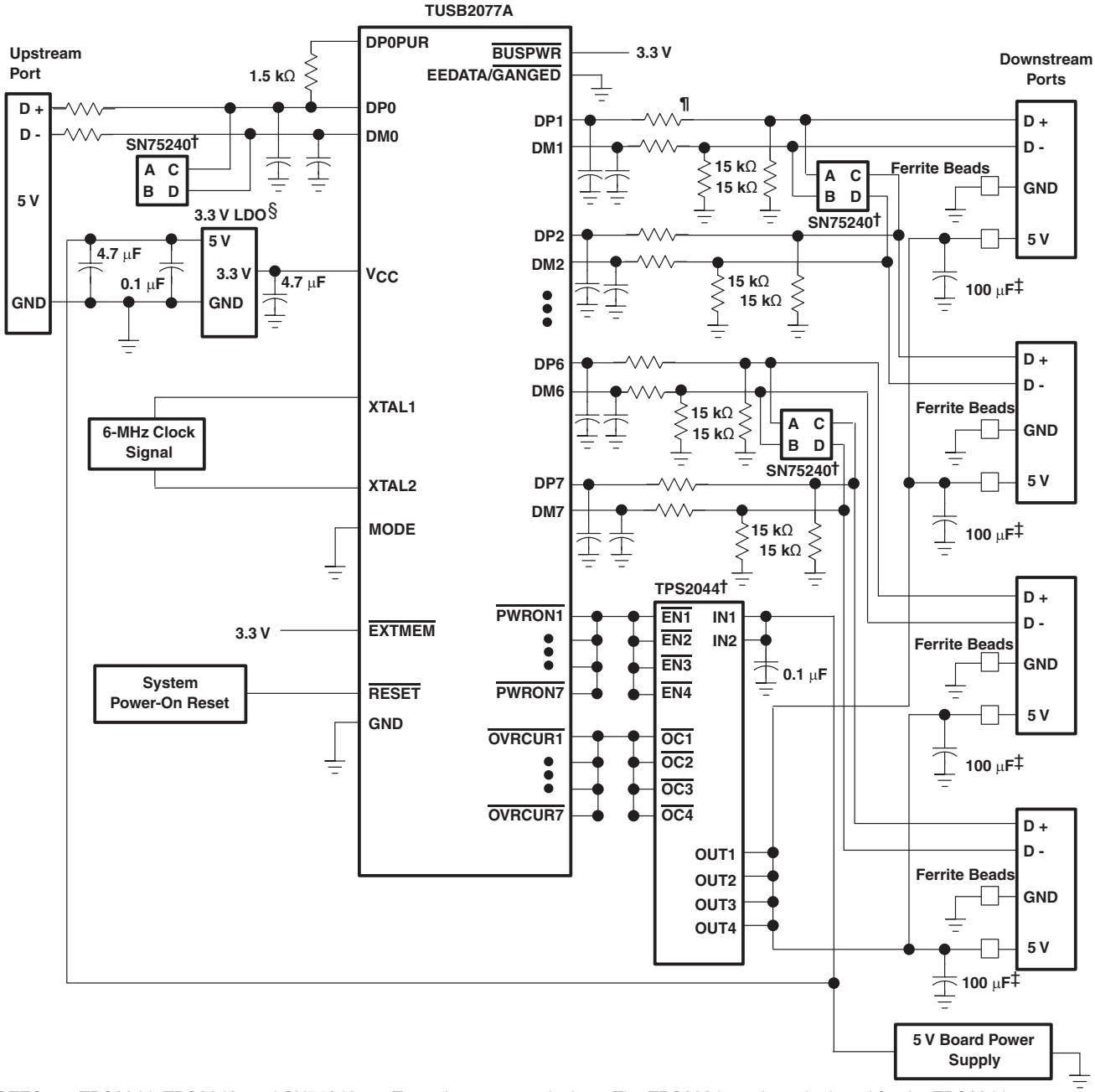


NOTES: † TPS2042 and SN75240 are Texas Instruments devices. Two TPS2042 devices can be substituted for the TPS2044.
‡ 120 µF per hub is the minimum required per the USB specification. However, TI recommends a 100-µF, low ESR, tantalum capacitor per port for immunity to voltage droop.
§ LDO is a 5-V-to-3.3-V voltage regulator. TPS76333 from Texas Instruments can be used.
¶ All USB DP, DM signal pairs require series resistors of approximately 27Ω to ensure proper termination. An optional filter capacitor of about 22 pF is recommended for EMI suppression. This capacitor, if used, must be placed between the hub terminal and the series resistor, as per section 7.1.6 of the USB specification.

Figure 10. TUSB2077A Self-Powered Hub, Individual-Port Power-Management Application

Self-Powered Hub, Ganged-Port Power Management

The TUSB2077A can also be implemented for ganged-port power management in a self-powered configuration. The implementation is very similar to the bus-powered example with the exception that a self-powered port supplies 500 mA of current to each downstream port. The overcurrent protection can be provided by a TPS2044 quad device or a TPS2024 single power switch.



NOTES: † TPS2044, TPS2042, and SN75240 are Texas Instruments devices. The TPS2024 can be substituted for the TPS2044.
‡ 120 µF per hub is the minimum required per the USB specification. However, TI recommends a 100-µF, low ESR, tantalum capacitor per port for immunity to voltage droop.
§ LDO is a 5-V-to-3.3-V voltage regulator. TPS76333 from Texas Instruments can be used.
¶ All USB DP, DM signal pairs require series resistors of approximately 27Ω to ensure proper termination. An optional filter capacitor of about 22 pF is recommended for EMI suppression. This capacitor, if used, must be placed between the hub terminal and the series resistor, as per section 7.1.6 of the USB specification.

Figure 11. TUSB2077A Self-Powered Hub, Ganged-Port Power-Management Application

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)
TUSB2077APT	ACTIVE	LQFP	PT	48	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
TUSB2077APTR	ACTIVE	LQFP	PT	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	
TUSB2077APTRG4	ACTIVE	LQFP	PT	48	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-3-260C-168 HR	

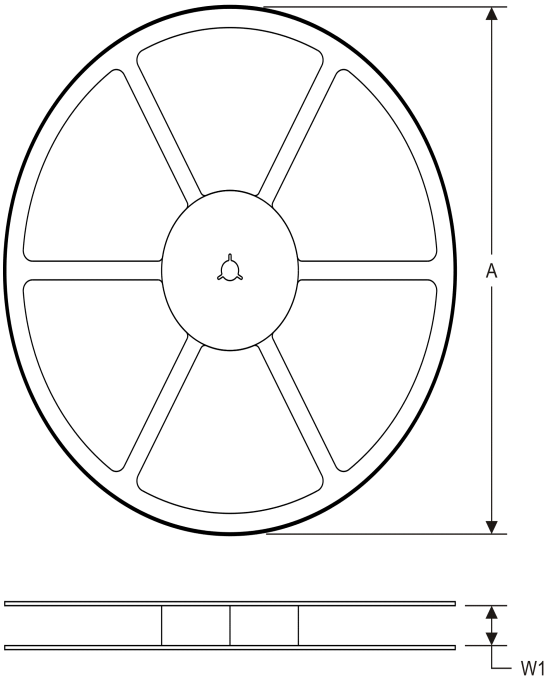
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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)

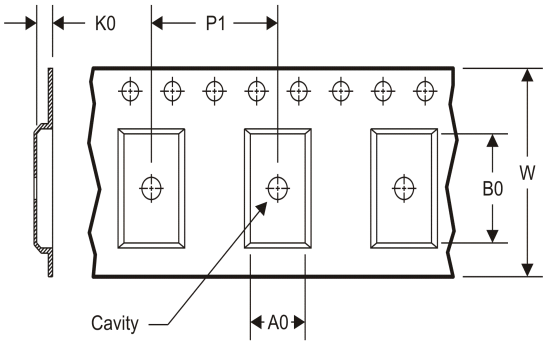
(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



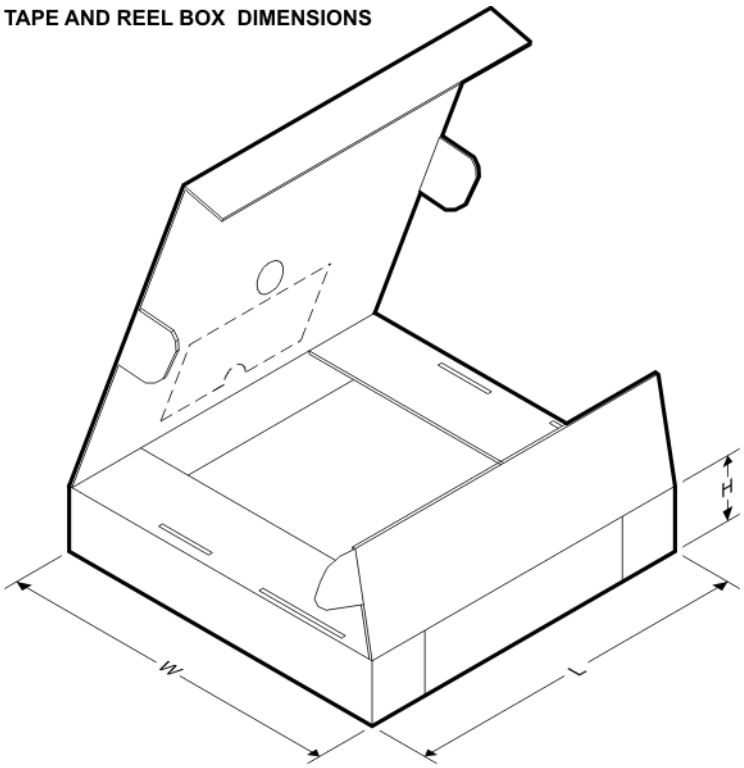
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*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
TUSB2077APTR	LQFP	PT	48	1000	330.0	16.4	9.6	9.6	1.9	12.0	16.0	Q2

TAPE AND REEL BOX DIMENSIONS

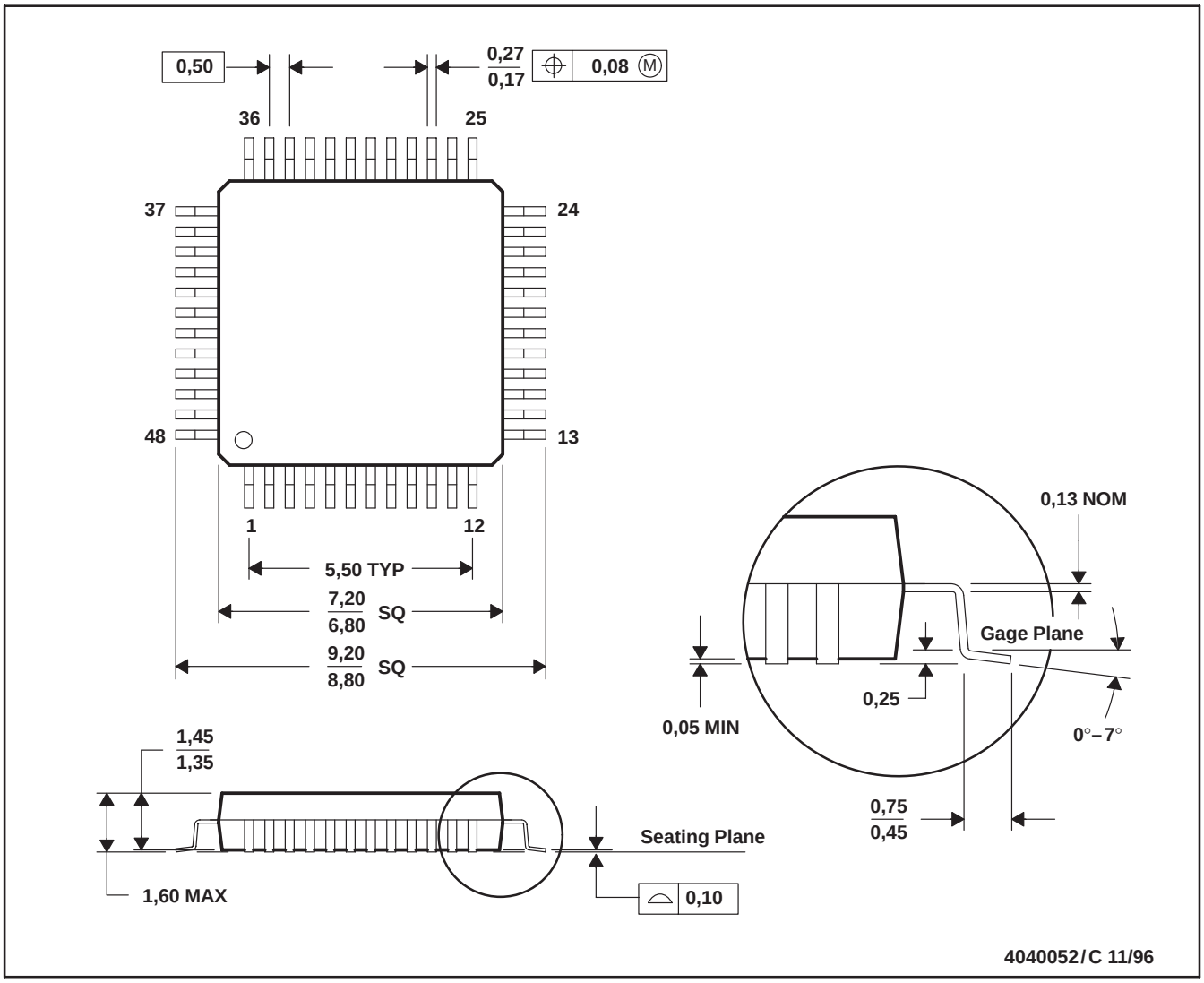


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TUSB2077APTR	LQFP	PT	48	1000	367.0	367.0	38.0

MTQF003A – OCTOBER 1994 – REVISED DECEMBER 1996

PT (S-PQFP-G48) **PLASTIC QUAD FLATPACK**



NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-026
D. This may also be a thermally enhanced plastic package with leads conected to the die pads.

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