

# USB1T11A — Universal Serial Bus Transceiver

## Features

- Complies with Universal Serial Bus Specification 1.1
- Utilizes Digital Inputs and Outputs to Transmit and Receive USB Cable Data
- Supports 12Mbit/s "Full Speed" and 1.5Mbit/s "Low Speed" Serial Data Transmission
- Compatible with the VHDL "Serial Interface Engine" from USB Implementers' Forum
- Supports Single-ended Data Interface
- Single 3.3V Supply
- ESD Performance: Human Body Model  
>9.5kV on D-, D+ pins only  
>4kV on all other pins
- 16-lead, Space-Saving, MLP Package

## Description

The USB1T11A is a one-chip, generic USB transceiver. It is designed to allow 5.0V or 3.3V programmable and standard logic to interface with the physical layer of the Universal Serial Bus. It is capable of transmitting and receiving serial data at both full-speed (12Mbit/s) and low-speed (1.5Mbit/s) data rates.

The input and output signals of the USB1T11A conform with the "Serial Interface Engine." Implementation of the serial interface engine allows designers to make USB-compatible devices with off-the-shelf logic to modify and update the application.

## Ordering Information

| Part Number  | Operating Temperature Range | Package                                                                           | Packing Method |
|--------------|-----------------------------|-----------------------------------------------------------------------------------|----------------|
| USB1T11AM    | -40 to +85°C                | 14-Lead, Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150-Inch Narrow | Tube           |
| USB1T11AMX   | -40 to +85°C                | 14-Lead, Small Outline Integrated Circuit (SOIC), JEDEC MS-012, 0.150-Inch Narrow | Tape and Reel  |
| USB1T11ABQX  | -40 to +85°C                | 16-Terminal, Molded Leadless Package (MLP), JEDEC MO-220, 3mm Square              | Tape and Reel  |
| USB1T11AMTC  | -40 to +85°C                | 14-Lead, Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide      | Tube           |
| USB1T11AMTCX | -40 to +85°C                | 14-Lead, Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide      | Tape and Reel  |

All packages are lead free per JEDEC: J-STD-020B standard.

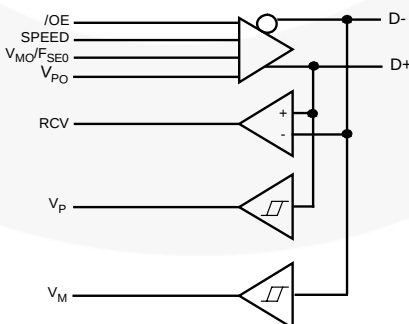


Figure 1. Logic Diagram

## Pin Configuration

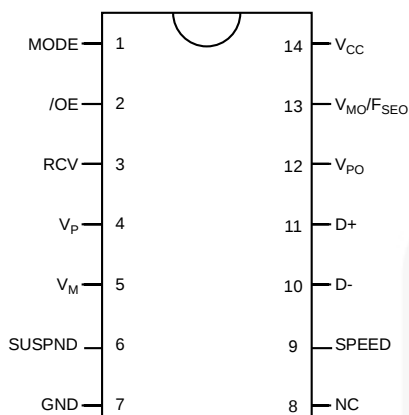


Figure 2. TSSOP and SOIC Pin Assignments

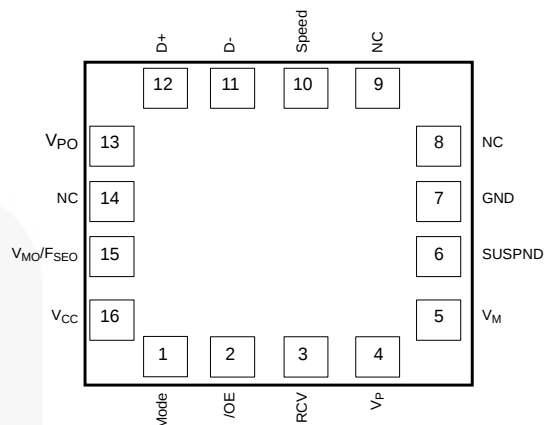


Figure 3. MLP Pin Assignments

## Pin Descriptions

| Pin Names                                          | I/O  | Description                                                                                                                                                                                        |                 |                                   |              |
|----------------------------------------------------|------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-----------------------------------|--------------|
| RVC                                                | O    | Receive Data. CMOS level output for USB differential input.                                                                                                                                        |                 |                                   |              |
| /OE                                                | I    | Output Enable. Active LOW, enables the transceiver to transmit data on the bus. When not active, the transceiver is in receive mode.                                                               |                 |                                   |              |
| Mode                                               | I    | Mode. When left unconnected, a weak pull-up transistor pulls it to V <sub>CC</sub> and, in this GND, the V <sub>MO</sub> /F <sub>SEO</sub> pin takes the function of F <sub>SEO</sub> (force SEO). |                 |                                   |              |
| V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub> | I    | Inputs to differential driver. (Outputs from SIE.)                                                                                                                                                 |                 |                                   |              |
|                                                    |      | Mode                                                                                                                                                                                               | V <sub>PO</sub> | V <sub>MO</sub> /F <sub>SEO</sub> | RESULT       |
|                                                    |      | 0                                                                                                                                                                                                  | 0               |                                   | Logic “0”    |
|                                                    |      |                                                                                                                                                                                                    | 0               |                                   | /SEO         |
|                                                    |      |                                                                                                                                                                                                    | 1               |                                   | Logic “1”    |
|                                                    |      |                                                                                                                                                                                                    | 1               |                                   | /SEO         |
|                                                    |      | 1                                                                                                                                                                                                  | 0               | 0                                 | /SEO         |
|                                                    |      |                                                                                                                                                                                                    | 0               | 1                                 | Logic “0”    |
|                                                    |      |                                                                                                                                                                                                    | 1               | 0                                 | Logic “1”    |
|                                                    |      |                                                                                                                                                                                                    | 1               | 1                                 | Illegal Code |
| V <sub>P</sub> ,V <sub>M</sub>                     | O    | Gated version of D- and D+. Outputs are logic “0” and logic “1.” Used to detect single ended zero (/SEO), error conditions, and interconnected speed. (Input to SIE).                              |                 |                                   |              |
|                                                    |      | V <sub>P</sub>                                                                                                                                                                                     | V <sub>M</sub>  | RESULT                            |              |
|                                                    |      | 0                                                                                                                                                                                                  | 0               | /SEO                              |              |
|                                                    |      | 0                                                                                                                                                                                                  | 1               | Low Speed                         |              |
|                                                    |      | 1                                                                                                                                                                                                  | 0               | Full Speed                        |              |
|                                                    |      | 0                                                                                                                                                                                                  | 1               | Error                             |              |
| D+, D-                                             | AI/O | Data+, Data-. Differential data bus conforming to the Universal Serial Bus standard.                                                                                                               |                 |                                   |              |
| SUSPND                                             | I    | Suspend. Enables a low-power state while the USB bus is inactive. While the suspend pin is active, it drives the RCV pin to a logic “0” state. Both D+ and D- are 3-STATE.                         |                 |                                   |              |
| Speed                                              | I    | Edge Rate Control. Logic “1” operates at edge rates for “full speed.” Logic “0” operates edge rates for “low speed.”                                                                               |                 |                                   |              |
| V <sub>CC</sub>                                    |      | 3.0 to 3.6 power supply.                                                                                                                                                                           |                 |                                   |              |
| GND                                                |      | Ground reference.                                                                                                                                                                                  |                 |                                   |              |

**Functional Truth Table**

| Input      |                 |                                   |     |        | I/O     |         | Outputs         |                 |                 |              |
|------------|-----------------|-----------------------------------|-----|--------|---------|---------|-----------------|-----------------|-----------------|--------------|
| Mode       | V <sub>PO</sub> | V <sub>MO</sub> /F <sub>SEO</sub> | /OE | SUSPND | D+      | D-      | RCV             | V <sub>P</sub>  | V <sub>M</sub>  | Result       |
| 0          | 0               | 0                                 | 0   | 0      | 0       | 1       | 0               | 0               | 1               | Logic "0"    |
| 0          | 0               | 1                                 | 0   | 0      | 0       | 0       | Undefined State | 0               | 0               | /SEO         |
| 0          | 1               | 0                                 | 0   | 0      | 1       | 0       | 1               | 1               | 0               | Logic "1"    |
| 0          | 1               | 1                                 | 0   | 0      | 0       | 0       | Undefined State | 0               | 0               | /SEO         |
| 1          | 0               | 0                                 | 0   | 0      | 0       | 0       | Undefined State | 0               | 0               | /SEO         |
| 1          | 0               | 1                                 | 0   | 0      | 0       | 1       | 0               | 0               | 1               | Logic "0"    |
| 1          | 1               | 0                                 | 0   | 0      | 1       | 0       | 1               | 1               | 0               | Logic "1"    |
| 1          | 1               | 1                                 | 0   | 0      | 1       | 1       | Undefined State | Undefined State | Undefined State | Illegal Code |
| Don't Care | Don't Care      | Don't Care                        | 1   | 0      | 3-State | 3-State | Undefined State | Undefined State | Undefined State | D+/D-Hi-Z    |
| Don't Care | Don't Care      | Don't Care                        | 1   | 1      | 3-State | 3-State | Undefined State | Undefined State | Undefined State | D+/D-Hi-Z    |

## Absolute Maximum Ratings

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only.

| Symbol             | Parameter                                                  | Min. | Max.           | Unit |
|--------------------|------------------------------------------------------------|------|----------------|------|
| $V_{CC}$           | DC Supply Voltage                                          | 0.5  | 7.0            | V    |
| $I_{IK}$           | DC Input Diode Current, $V_{IN} < 0V$                      |      | -50            | mA   |
| $V_{IN}$           | Input Voltage <sup>(1)</sup>                               | 0.5  | 5.5            | V    |
| $V_{I/O}$          | Input Voltage                                              | 0.5  | $V_{CC} + 0.5$ | V    |
| $I_{OK}$           | Output Diode Current, $V_O > V_{CC}$ or $V_O < 0$          |      | $\pm 50$       | mA   |
| $V_O$              | Output Voltage                                             | 0.5  | $V_{CC} + 0.5$ | V    |
| $I_O$              | Output Source or Sink Current<br>( $V_O = 0$ to $V_{CC}$ ) |      | $\pm 15$       | mA   |
|                    |                                                            |      | $\pm 50$       |      |
| $I_{CC} / I_{GND}$ | $V_{CC} / GND$ Current                                     |      | $\pm 100$      | mA   |
| $T_{STG}$          | Storage Temperature Range                                  | -60  | +150           | °C   |

**Note:**

1. The input and output negative voltage ratings may be exceeded if the input and output diode current ratings are observed.

## Recommended Operating Conditions

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to Absolute Maximum Ratings.

| Symbol     | Parameter                               | Min. | Max.     | Unit |
|------------|-----------------------------------------|------|----------|------|
| $V_{CC}$   | Power Supply Operating                  | 3.0  | 3.6      | V    |
| $V_{IN}$   | Input Voltage                           | 0    | 5.5      | V    |
| $V_{AI/O}$ | Input Range for AI/O                    | 0    | $V_{CC}$ | V    |
| $V_O$      | Output Voltage                          | 0    | $V_{CC}$ | V    |
| $T_A$      | Operating Ambient Temperature, Free Air | -40  | +85      | °C   |

**DC Electrical Characteristics Digital Pins**

Over recommended range of supply voltage and operating free air temperature unless otherwise noted.  
 $V_{CC} = 3.0V$  to  $3.6V$ .

| Symbol            | Parameter                  | Conditions                                                              | T <sub>A</sub> = -40 to +85°C |      |      | Units |
|-------------------|----------------------------|-------------------------------------------------------------------------|-------------------------------|------|------|-------|
|                   |                            |                                                                         | Min.                          | Typ. | Max. |       |
| Input Levels      |                            |                                                                         |                               |      |      |       |
| V <sub>IL</sub>   | Low-Level Input Voltage    |                                                                         |                               |      | 0.8  | V     |
| V <sub>IH</sub>   | High-Level Input Voltage   |                                                                         | 2                             |      |      | V     |
| Output Levels     |                            |                                                                         |                               |      |      |       |
| V <sub>OL</sub>   | Low-Level Output Voltage   | I <sub>OL</sub> =4mA                                                    |                               |      | 0.4  | V     |
|                   |                            | I <sub>OL</sub> =20μA                                                   |                               |      | 0.1  |       |
| V <sub>OH</sub>   | High-Level Output Voltage  | I <sub>OH</sub> =4mA                                                    | 2.5                           |      |      | V     |
|                   |                            | I <sub>OH</sub> =20μA                                                   | V <sub>CC</sub> -0.1          |      |      |       |
| Leakage Current   |                            |                                                                         |                               |      |      |       |
| I <sub>IN</sub>   | Input Leakage Current      | V <sub>CC</sub> =3.0 to 3.6                                             |                               |      | ±5   | μA    |
| I <sub>CCFS</sub> | Supply Current, Full Speed | V <sub>CC</sub> =3.0 to 3.6                                             |                               |      | 5    | mA    |
| I <sub>CCLS</sub> | Supply Current, Low Speed  | V <sub>CC</sub> =3.0 to 3.6                                             |                               |      | 5    | mA    |
| I <sub>CCQ</sub>  | Quiescent Supply Current   | V <sub>CC</sub> =3.0 to 3.6,<br>V <sub>IN</sub> =V <sub>CC</sub> or GND |                               |      | 5    | mA    |
| I <sub>CCS</sub>  | Supply Current in Suspend  | V <sub>CC</sub> =3.0 to 3.6<br>Mode=V <sub>CC</sub>                     |                               |      | 10   | μA    |

**DC Electrical Characteristics D+/D- Pins**

Over recommended range of supply voltage and operating free air temperature unless otherwise noted.  
 $V_{CC} = 3.0V$  to  $3.6V$ .

| Symbol                          | Parameter                              | Conditions                      | T <sub>A</sub> = -40 to +85°C |      |      | Units |
|---------------------------------|----------------------------------------|---------------------------------|-------------------------------|------|------|-------|
|                                 |                                        |                                 | Min.                          | Typ. | Max. |       |
| Input Levels                    |                                        |                                 |                               |      |      |       |
| V <sub>DI</sub>                 | Differential Input Sensitivity         | (D+) – (D-)                     | 0.2                           |      |      | V     |
| V <sub>CM</sub>                 | Differential Common-Mode Range         | Includes V <sub>DI</sub> Range  | 0.8                           |      | 2.5  | V     |
| V <sub>SE</sub>                 | Single-Ended Receiver Threshold        |                                 | 0.8                           |      | 2.0  | V     |
| Output Levels                   |                                        |                                 |                               |      |      |       |
| V <sub>OL</sub>                 | Static Output Low-Voltage              |                                 |                               |      | 0.3  | V     |
| V <sub>OH</sub>                 | Static Output High-Voltage             | R <sub>L</sub> of 1.5kΩ to 3.6V | 2.8                           |      | 3.6  | V     |
| V <sub>CR</sub>                 | Differential Crossover                 | R <sub>L</sub> of 1.5kΩ to GND  | 1.3                           |      | 2.0  | V     |
| Leakage Current                 |                                        |                                 |                               |      |      |       |
| I <sub>OZ</sub>                 | High Z-State Data Line Leakage Current | 0V<V <sub>IN</sub> <3.3V        |                               |      | ±5   | μA    |
| Capacitance                     |                                        |                                 |                               |      |      |       |
| C <sub>IN</sub> <sup>(2)</sup>  | Transceiver Capacitance                | Pin to GND                      |                               |      | 10   | pF    |
|                                 | Capacitance Match                      |                                 |                               |      | 10   | %     |
| Output Resistance               |                                        |                                 |                               |      |      |       |
| Z <sub>DRV</sub> <sup>(3)</sup> | Driver Output Resistance               | Steady-State Drive              | 4                             |      | 20   | Ω     |
|                                 | Resistance Match                       |                                 |                               |      | 10   | %     |

**Notes:**

- This specification is guaranteed by design and statistical process distribution.
- Excludes external resistor. To comply with USB specification 1.1, external series resistors of  $24\Omega \pm 1\%$  each on D+ and D- are recommended.

## AC Electrical Characteristics D+/D- Pins, Full Speed

Over recommended range of supply voltage and operating free air temperature unless otherwise noted.  
 $V_{CC} = 3.0V$  to  $3.6V$ ,  $C_L = 50pF$ ;  $R_L = k\Omega$  on D+ to  $V_{CC}$ .

| Symbol                              | Parameter                                                                                  | Conditions                      | T <sub>A</sub> =-40 to +85°C |      |      | Units |
|-------------------------------------|--------------------------------------------------------------------------------------------|---------------------------------|------------------------------|------|------|-------|
|                                     |                                                                                            |                                 | Min.                         | Typ. | Max. |       |
| Driver Characteristics              |                                                                                            |                                 |                              |      |      |       |
| t <sub>R</sub> , t <sub>F</sub>     | Rise and Fall Time                                                                         | 10 and 90%, Figure 4            | 4                            |      | 20   | ns    |
| t <sub>RFM</sub>                    | Rise/Fall Time Matching                                                                    | t <sub>r</sub> / t <sub>f</sub> | 90                           |      | 110  | %     |
| V <sub>CRS</sub>                    | Output Signal Crossover Voltage                                                            |                                 | 1.3                          |      | 2.0  | V     |
| Driver Timings                      |                                                                                            |                                 |                              |      |      |       |
| t <sub>PLH</sub>                    | Driver Propagation Delay<br>(V <sub>PO</sub> , V <sub>MO</sub> /F <sub>SEO</sub> to D+/D-) | Figure 5                        |                              |      | 18   | ns    |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Driver Disable Delay (/OE to D+/D-)                                                        | Figure 7                        |                              |      | 13   | ns    |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Driver Enable Delay (/OE to D+/D-)                                                         | Figure 7                        |                              |      | 17   | ns    |
| Receiver Timings                    |                                                                                            |                                 |                              |      |      |       |
| t <sub>PLH</sub>                    | Receiver Propagation Delay                                                                 | Figure 6                        |                              |      | 16   | ns    |
| t <sub>PHL</sub>                    | D+/D- to RVC                                                                               | Figure 6                        |                              |      | 19   | ns    |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Single-ended Receiver Delay<br>(D+, D- to V <sub>P</sub> , V <sub>M</sub> )                | Figure 6                        |                              |      | 8    | ns    |

## AC Electrical Characteristics D+/D- Pins, Low Speed

Over recommended range of supply voltage and operating free air temperature unless otherwise noted.  
 $V_{CC} = 3.0V$  to  $3.6V$ ,  $C_L = 200pF$  to  $600pF$ ;  $R_L = 1.5k\Omega$  on D- to  $V_{CC}$ .

| Symbol                              | Parameter                                                                              | Conditions                      | T <sub>A</sub> =-40 to +85°C |      |      | Units |
|-------------------------------------|----------------------------------------------------------------------------------------|---------------------------------|------------------------------|------|------|-------|
|                                     |                                                                                        |                                 | Min.                         | Typ. | Max. |       |
| Driver Characteristics              |                                                                                        |                                 |                              |      |      |       |
| t <sub>LR</sub> , t <sub>LF</sub>   | Rise and Fall Time                                                                     | 10 and 90%, Figure 4            | 75                           |      | 300  | ns    |
| t <sub>RFM</sub>                    | Rise/Fall Time Matching                                                                | t <sub>r</sub> / t <sub>f</sub> | 80                           |      | 120  | %     |
| V <sub>CRS</sub>                    | Output Signal Crossover Voltage                                                        |                                 | 1.3                          |      | 2.0  | V     |
| Driver Timings                      |                                                                                        |                                 |                              |      |      |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Driver Propagation Delay (V <sub>PO</sub> , V <sub>MO</sub> /F <sub>SEO</sub> to D+D-) | Figure 5                        |                              |      | 300  | ns    |
| t <sub>PHZ</sub> , t <sub>PLZ</sub> | Driver Disable Delay (/OE to D+/D-)                                                    | Figure 7                        |                              |      | 13   | ns    |
| t <sub>PZH</sub> , t <sub>PZL</sub> | Driver Enable Delay (/OE to D+/D-)                                                     | Figure 7                        |                              |      | 205  | ns    |
| Receiver Timings                    |                                                                                        |                                 |                              |      |      |       |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Receiver Propagation Delay (D+/D- to RVC)                                              | Figure 6                        |                              |      | 18   | ns    |
| t <sub>PLH</sub> , t <sub>PHL</sub> | Single-ended Receiver Delay (D+,D- to V <sub>P</sub> , V <sub>M</sub> )                | Figure 6                        |                              |      | 28   | ns    |

## AC Loadings and Waveforms

$V_{OL}$  and  $V_{OH}$  are the typical output voltage drops that occur with the output load.  $V_{CC}$  never goes below 3.0V.

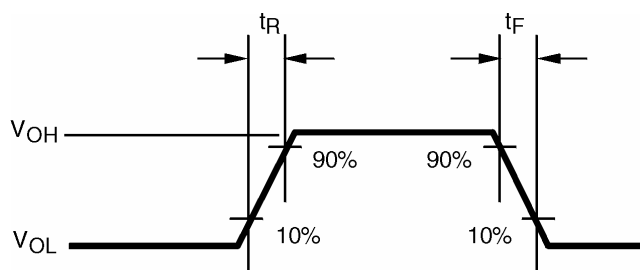


Figure 4. Rise and Fall Times

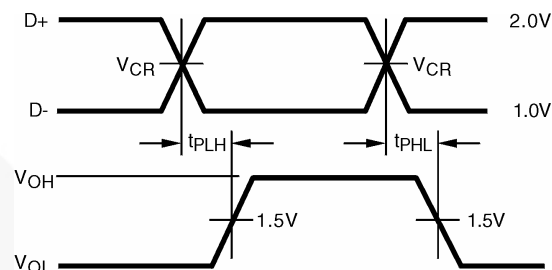


Figure 5.  $V_{PO}$ ,  $V_{MO}/F_{SEO}$  to D+/D-

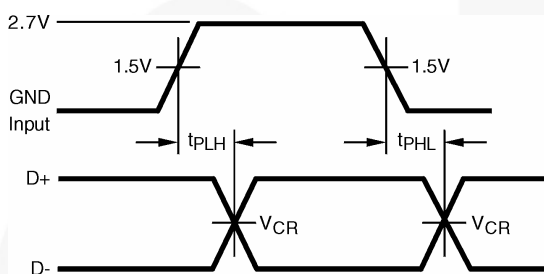


Figure 6. D+/D- to RCV,  $V_P/V_M$

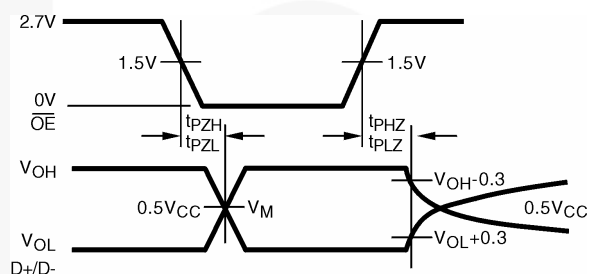


Figure 7. /OE to D+/D-

## Test Circuits and Waveforms

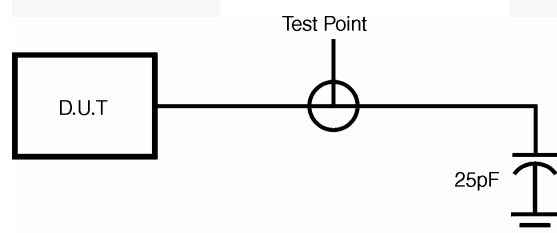


Figure 8. Load for  $V_M/V_P$  and RCV

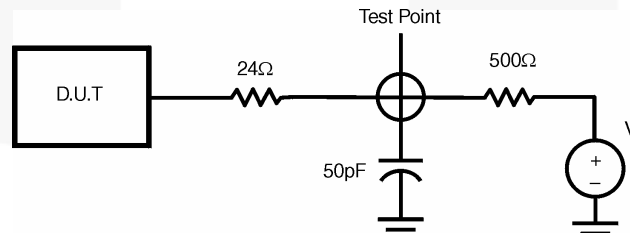
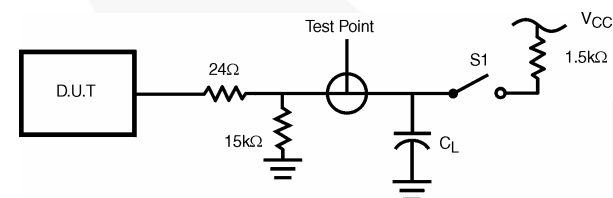


Figure 9. Load for Enable and Disable Times

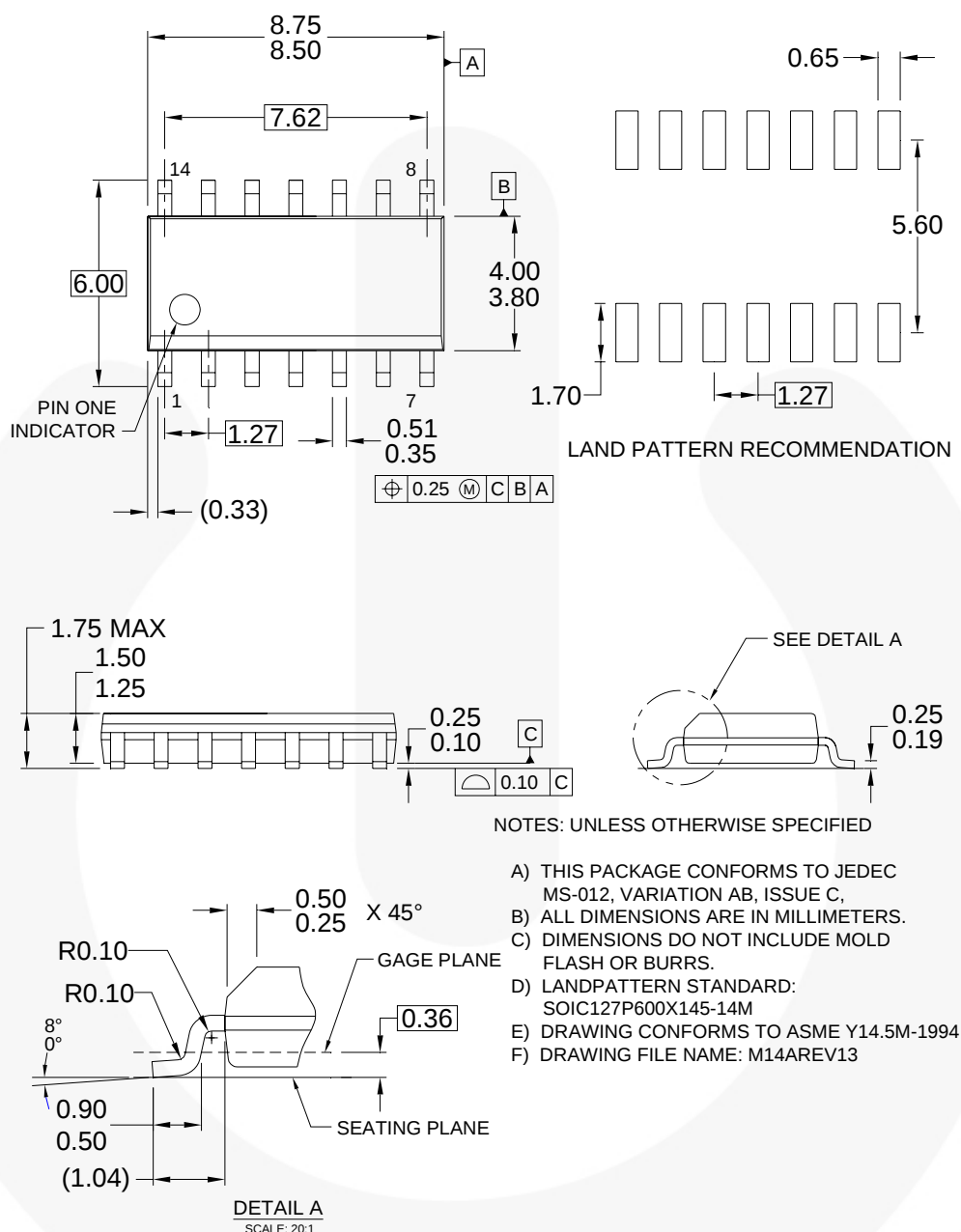


$C_L=50\text{pF}$ , Full Speed  
 $C_L=200\text{pF}$ , Full Speed (Minimum Timing)  
 $C_L=600\text{pF}$ , Full Speed (Maximum Timing)  
 $1.5\text{k}\Omega$  on D-(Low Speed) or D+ (Full Speed) only.

| Test  | S1    |
|-------|-------|
| D-/LS | Close |
| D+/LS | Open  |
| D-/FS | Open  |
| D+/FS | Close |

Figure 10. Load for D+/D-

# Physical Dimensions



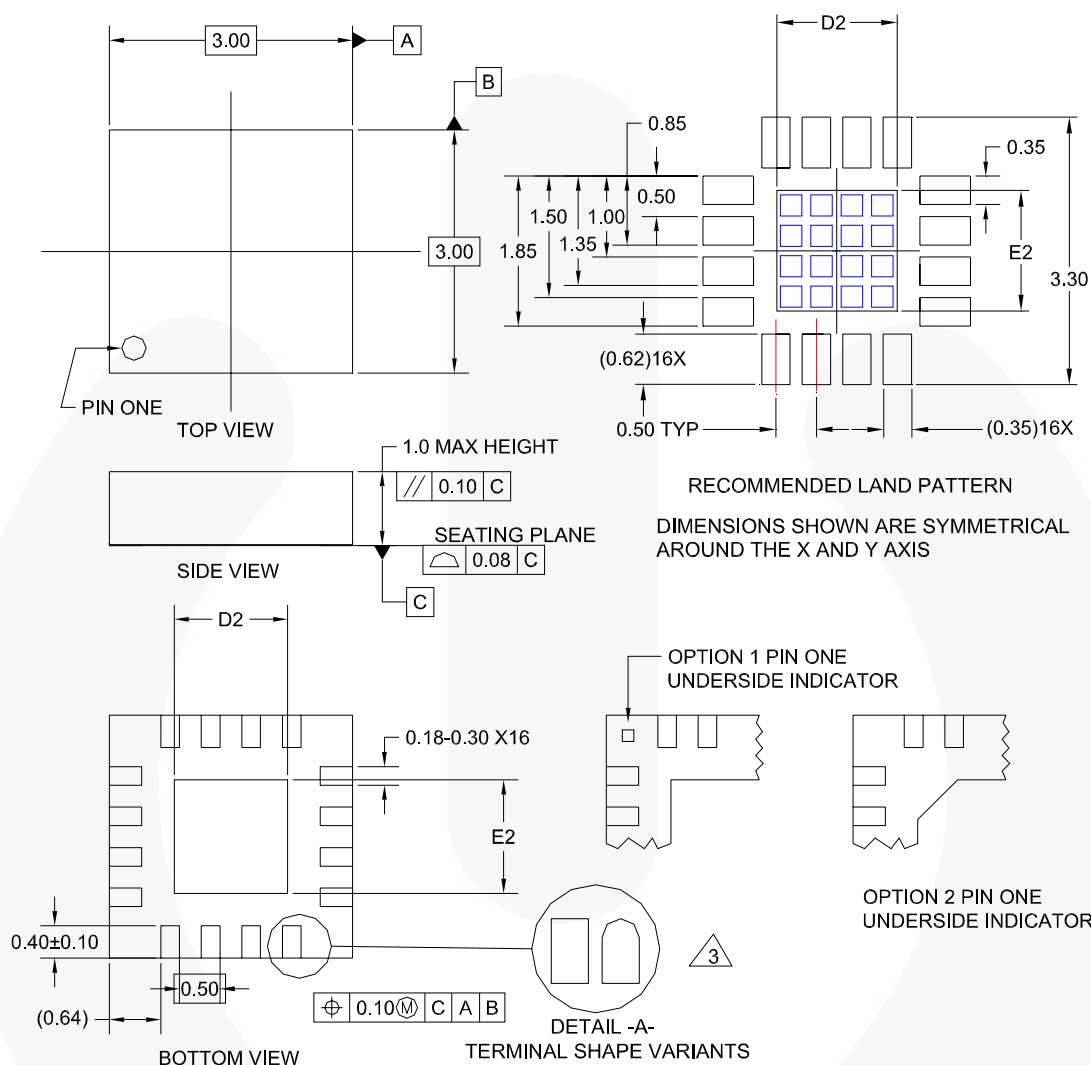
**Figure 11. 14-Lead, Small Outline Integrated Circuit (SOIC) MO-012, 0.150-inch Wide**

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

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<http://www.fairchildsemi.com/packaging/>

# Physical Dimensions



## NOTES

- A. Package conforms to JEDEC MO-220
- B. DIMENSIONS ARE IN MILLIMETERS
- C. TERMINAL SHAPE MAY VARY ACCORDING TO PACKAGE SUPPLIER, SEE DETAIL A

MLP016CrevB

**Figure 12. 16-Terminal, Molded Leadless Package (MLP), JEDEC MO-220, 3mm Square**

[Click here for tape and reel specifications, available at:](#)

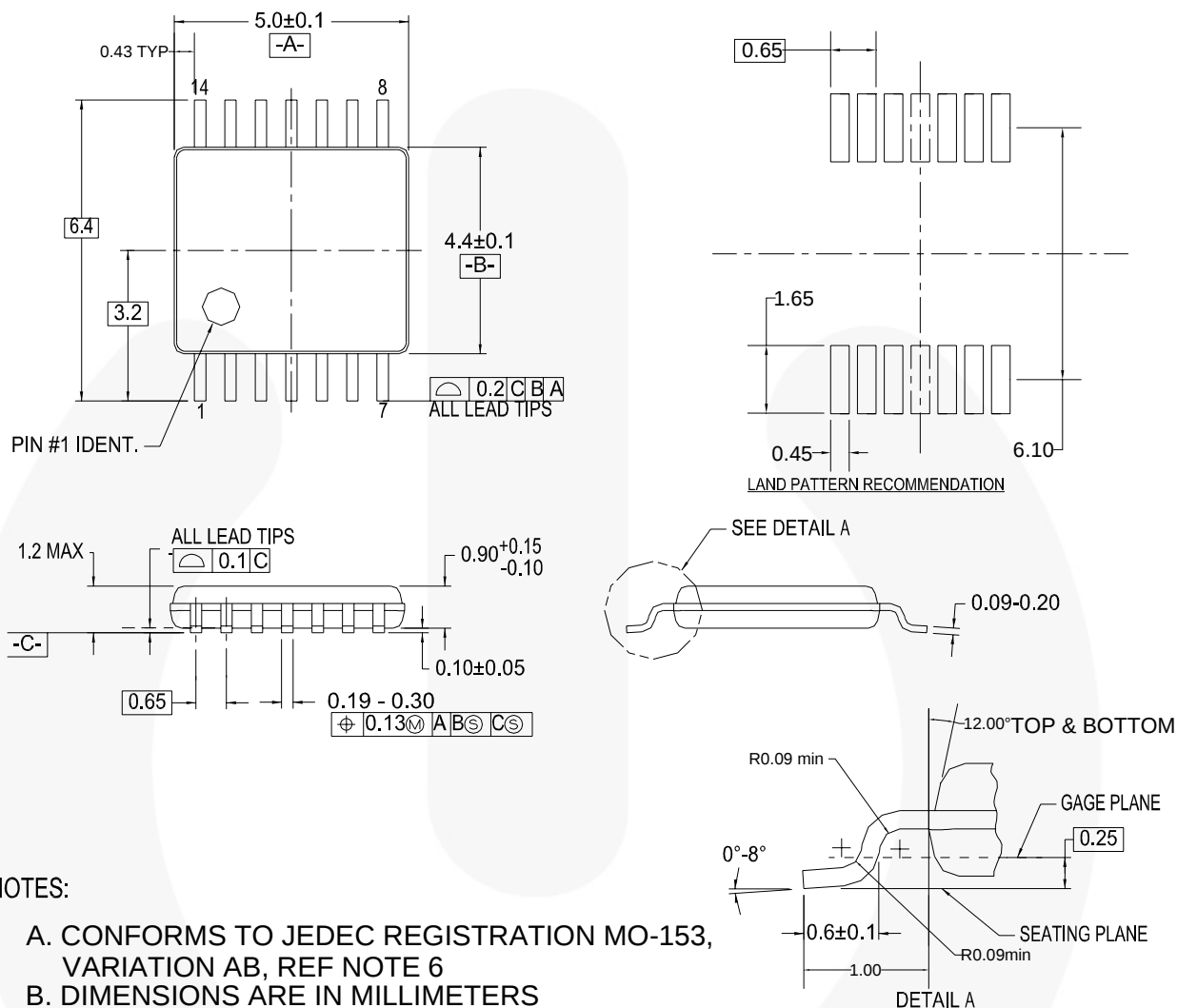
[http://www.fairchildsemi.com/products/analog/pdf/MLP6\\_3x3\\_TNR.pdf](http://www.fairchildsemi.com/products/analog/pdf/MLP6_3x3_TNR.pdf)

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# Physical Dimensions



## NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MO-153, VARIATION AB, REF NOTE 6
- B. DIMENSIONS ARE IN MILLIMETERS
- C. DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSIONS
- D. DIMENSIONING AND TOLERANCES PER ANSI Y14.5M, 1982
- E. LANDPATTERN STANDARD: SOP65P640X110-14M
- F. DRAWING FILE NAME: MTC14REV6

**Figure 13. 14-Lead Thin Shrink Small Outline Package (TSSOP), JEDEC MO-153, 4.4mm Wide**

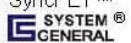
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### Definition of Terms

| Datasheet Identification | Product Status        | Definition                                                                                                                                                                                               |
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