

# 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.

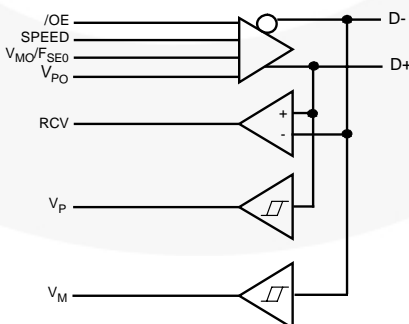


Figure 1. Logic Diagram

## Pin Configuration

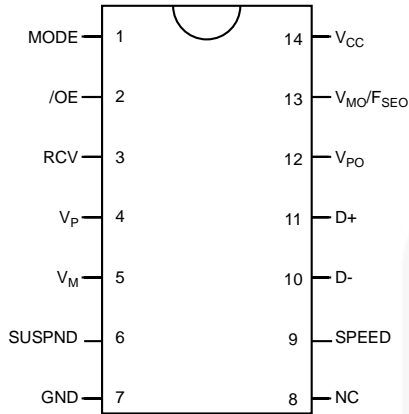


Figure 2. TSSOP and SOIC Pin Assignments

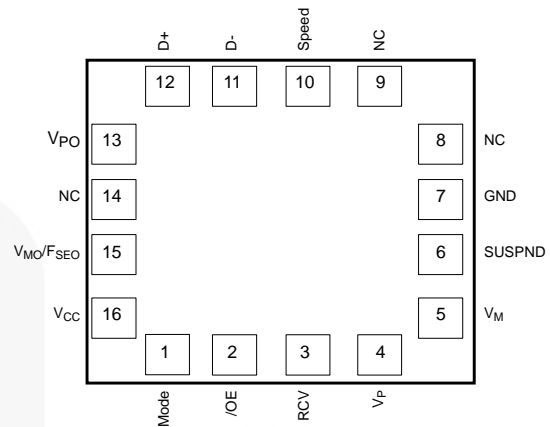


Figure 3. MLP Pin Assignments

## Pin Descriptions

Pin Names	I/O	Description																																				
RVC	O	<b>Receive Data.</b> CMOS level output for USB differential input.																																				
/OE	I	<b>Output Enable.</b> Active LOW, enables the transceiver to transmit data on the bus. When not active, the transceiver is in receive mode.																																				
Mode	I	<b>Mode.</b> When left unconnected, a weak pull-up transistor pulls it to $V_{CC}$ and, in this GND, the $V_{MO}/F_{SEO}$ pin takes the function of $F_{SEO}$ (force SEO).																																				
$V_{PO}, V_{MO}/F_{SEO}$	I	Inputs to differential driver. (Outputs from SIE.)																																				
		<table border="1"> <thead> <tr> <th>Mode</th> <th><math>V_{PO}</math></th> <th><math>V_{MO}/F_{SEO}</math></th> <th>RESULT</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td></td> <td>Logic "0"</td> </tr> <tr> <td></td> <td>0</td> <td></td> <td>/SEO</td> </tr> <tr> <td></td> <td>1</td> <td></td> <td>Logic "1"</td> </tr> <tr> <td></td> <td>1</td> <td></td> <td>/SEO</td> </tr> <tr> <td>1</td> <td>0</td> <td>0</td> <td>/SEO</td> </tr> <tr> <td></td> <td>0</td> <td>1</td> <td>Logic "0"</td> </tr> <tr> <td></td> <td>1</td> <td>0</td> <td>Logic "1"</td> </tr> <tr> <td></td> <td>1</td> <td>1</td> <td>Illegal Code</td> </tr> </tbody> </table>	Mode	$V_{PO}$	$V_{MO}/F_{SEO}$	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
		Mode	$V_{PO}$	$V_{MO}/F_{SEO}$	RESULT																																	
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			0	1	Logic "0"																																	
	1	0	Logic "1"																																			
	1	1	Illegal Code																																			
$V_P, V_M$	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).																																				
		<table border="1"> <thead> <tr> <th><math>V_P</math></th> <th><math>V_M</math></th> <th>RESULT</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> <td>/SEO</td> </tr> <tr> <td>0</td> <td>1</td> <td>Low Speed</td> </tr> <tr> <td>1</td> <td>0</td> <td>Full Speed</td> </tr> <tr> <td>0</td> <td>1</td> <td>Error</td> </tr> </tbody> </table>	$V_P$	$V_M$	RESULT	0	0	/SEO	0	1	Low Speed	1	0	Full Speed	0	1	Error																					
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D+, D-	AI/O	Data+, Data-. Differential data bus conforming to the Universal Serial Bus standard.																																				
SUSPND	I	<b>Suspend.</b> 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	<b>Edge Rate Control.</b> Logic "1" operates at edge rates for "full speed." Logic "0" operates edge rates for "low speed."																																				
$V_{CC}$		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 ( $V_O = 0$ to $V_{CC}$ )	$V_P, V_M, RCV$ Pins		$\pm 15$	mA
		D+/D- Pins		$\pm 50$	
$I_{CC} / I_{GND}$	$V_{CC} / GND$ Current		$\pm 100$	mA	
$T_{STG}$	Storage Temperature Range	-60	+150	°C	

### Note:

- 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	$T_A = -40$ to $+85^\circ C$			Units
			Min.	Typ.	Max.	
<b>Input Levels</b>						
$V_{IL}$	Low-Level Input Voltage				0.8	V
$V_{IH}$	High-Level Input Voltage		2			V
<b>Output Levels</b>						
$V_{OL}$	Low-Level Output Voltage	$I_{OL} = 4mA$			0.4	V
		$I_{OL} = 20\mu A$			0.1	
$V_{OH}$	High-Level Output Voltage	$I_{OH} = 4mA$	2.5			V
		$I_{OH} = 20\mu A$	$V_{CC} - 0.1$			
<b>Leakage Current</b>						
$I_{IN}$	Input Leakage Current	$V_{CC} = 3.0$ to $3.6$			$\pm 5$	$\mu A$
$I_{CCFS}$	Supply Current, Full Speed	$V_{CC} = 3.0$ to $3.6$			5	mA
$I_{CCLS}$	Supply Current, Low Speed	$V_{CC} = 3.0$ to $3.6$			5	mA
$I_{CCQ}$	Quiescent Supply Current	$V_{CC} = 3.0$ to $3.6$ , $V_{IN} = V_{CC}$ or GND			5	mA
$I_{CCS}$	Supply Current in Suspend	$V_{CC} = 3.0$ to $3.6$ Mode = $V_{CC}$			10	$\mu A$

## 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	$T_A = -40$ to $+85^\circ C$			Units
			Min.	Typ.	Max.	
<b>Input Levels</b>						
$V_{DI}$	Differential Input Sensitivity	$ (D+) - (D-) $	0.2			V
$V_{CM}$	Differential Common-Mode Range	Includes $V_{DI}$ Range	0.8		2.5	V
$V_{SE}$	Single-Ended Receiver Threshold		0.8		2.0	V
<b>Output Levels</b>						
$V_{OL}$	Static Output Low-Voltage				0.3	V
$V_{OH}$	Static Output High-Voltage	$R_L$ of $1.5k\Omega$ to $3.6V$	2.8		3.6	V
$V_{CR}$	Differential Crossover	$R_L$ of $1.5k\Omega$ to GND	1.3		2.0	V
<b>Leakage Current</b>						
$I_{OZ}$	High Z-State Data Line Leakage Current	$0V < V_{IN} < 3.3V$			$\pm 5$	$\mu A$
<b>Capacitance</b>						
$C_{IN}^{(2)}$	Transceiver Capacitance	Pin to GND			10	pF
	Capacitance Match				10	%
<b>Output Resistance</b>						
$Z_{DRV}^{(3)}$	Driver Output Resistance	Steady-State Drive	4		20	$\Omega$
	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  $24W \pm 1\%$  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	$T_A = -40$ to $+85^\circ C$			Units
			Min.	Typ.	Max.	
<b>Driver Characteristics</b>						
$t_R, t_F$	Rise and Fall Time	10 and 90%, Figure 4	4		20	ns
$t_{RFM}$	Rise/Fall Time Matching	$t_r / t_f$	90		110	%
$V_{CRS}$	Output Signal Crossover Voltage		1.3		2.0	V
<b>Driver Timings</b>						
$t_{PLH}$	Driver Propagation Delay ( $V_{PO}, V_{MO}/F_{SEO}$ to D+/D-)	Figure 5			18	ns
$t_{PHZ}, t_{PLZ}$	Driver Disable Delay (/OE to D+/D-)	Figure 7			13	ns
$t_{PZH}, t_{PZL}$	Driver Enable Delay (/OE to D+/D-)	Figure 7			17	ns
<b>Receiver Timings</b>						
$t_{PLH}$	Receiver Propagation Delay	Figure 6			16	ns
$t_{PHL}$	D+/D- to RVC	Figure 6			19	ns
$t_{PLH}, t_{PHL}$	Single-ended Receiver Delay (D+,D- to $V_P, V_M$ )	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	$T_A = -40$ to $+85^\circ C$			Units
			Min.	Typ.	Max.	
<b>Driver Characteristics</b>						
$t_{LR}, t_{LF}$	Rise and Fall Time	10 and 90%, Figure 4	75		300	ns
$t_{RFM}$	Rise/Fall Time Matching	$t_r / t_f$	80		120	%
$V_{CRS}$	Output Signal Crossover Voltage		1.3		2.0	V
<b>Driver Timings</b>						
$t_{PLH}, t_{PHL}$	Driver Propagation Delay ( $V_{PO}, V_{MO}/F_{SEO}$ to D+/D-)	Figure 5			300	ns
$t_{PHZ}, t_{PLZ}$	Driver Disable Delay (/OE to D+/D-)	Figure 7			13	ns
$t_{PZH}, t_{PZL}$	Driver Enable Delay (/OE to D+/D-)	Figure 7			205	ns
<b>Receiver Timings</b>						
$t_{PLH}, t_{PHL}$	Receiver Propagation Delay (D+/D- to RVC)	Figure 6			18	ns
$t_{PLH}, t_{PHL}$	Single-ended Receiver Delay (D+,D- to $V_P, V_M$ )	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.

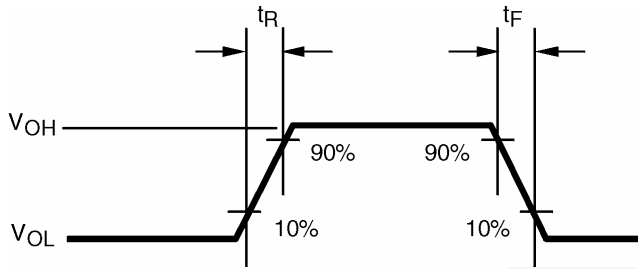


Figure 4. Rise and Fall Times

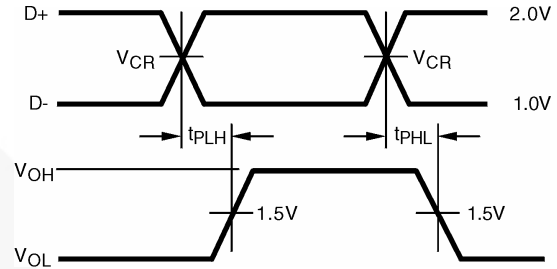


Figure 5.  $V_{PO}$ ,  $V_{MO}/F_{SEO}$  to D+/D-

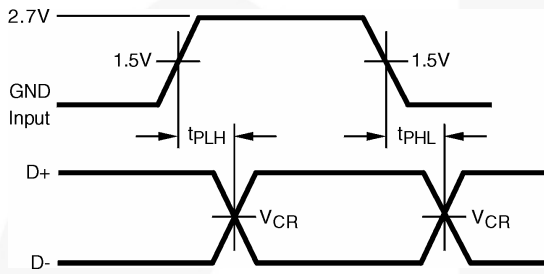


Figure 6. D+/D- to RCV,  $V_P/V_M$

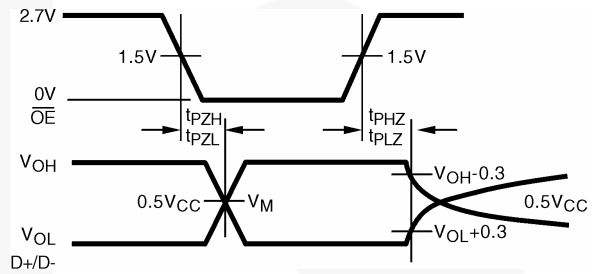


Figure 7. /OE to D+/D-

### Test Circuits and Waveforms

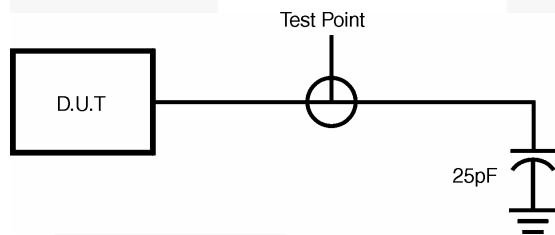


Figure 8. Load for  $V_M/V_P$  and RCV

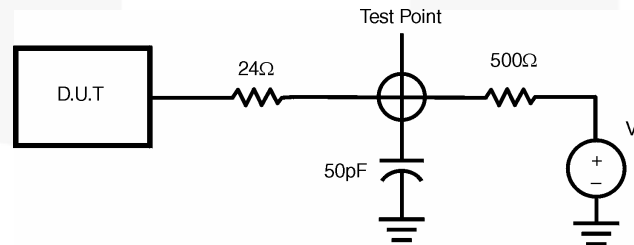
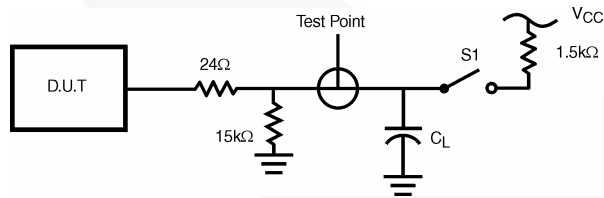


Figure 9. Load for Enable and Disable Times



$C_L=50\text{pF}$ , Full Speed  
 $C_L=200\text{pF}$ , Full Speed (Minimum Timing)  
 $C_L=600\text{pF}$ , Full Speed (Maximum Timing)  
 1.5k $\Omega$  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

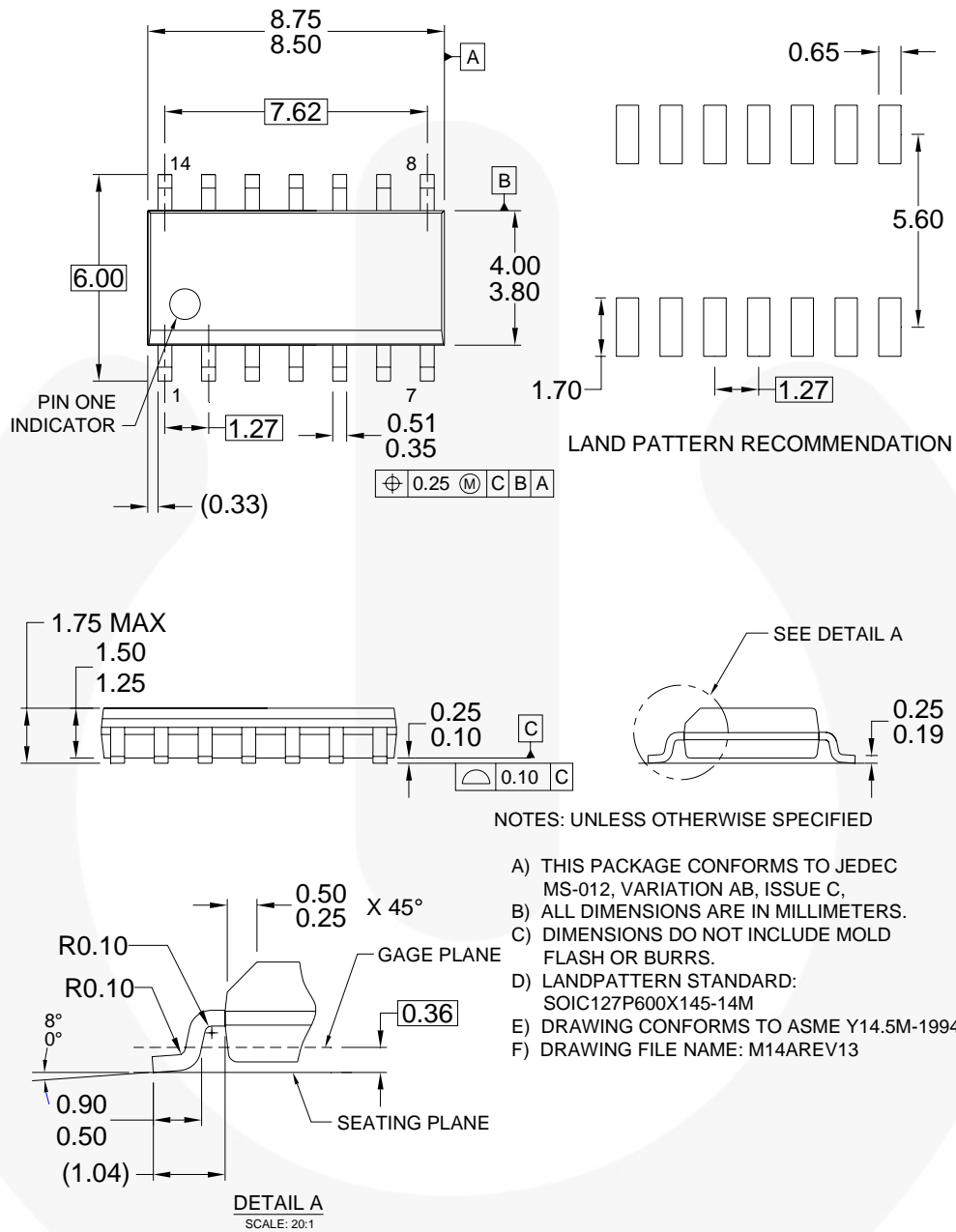


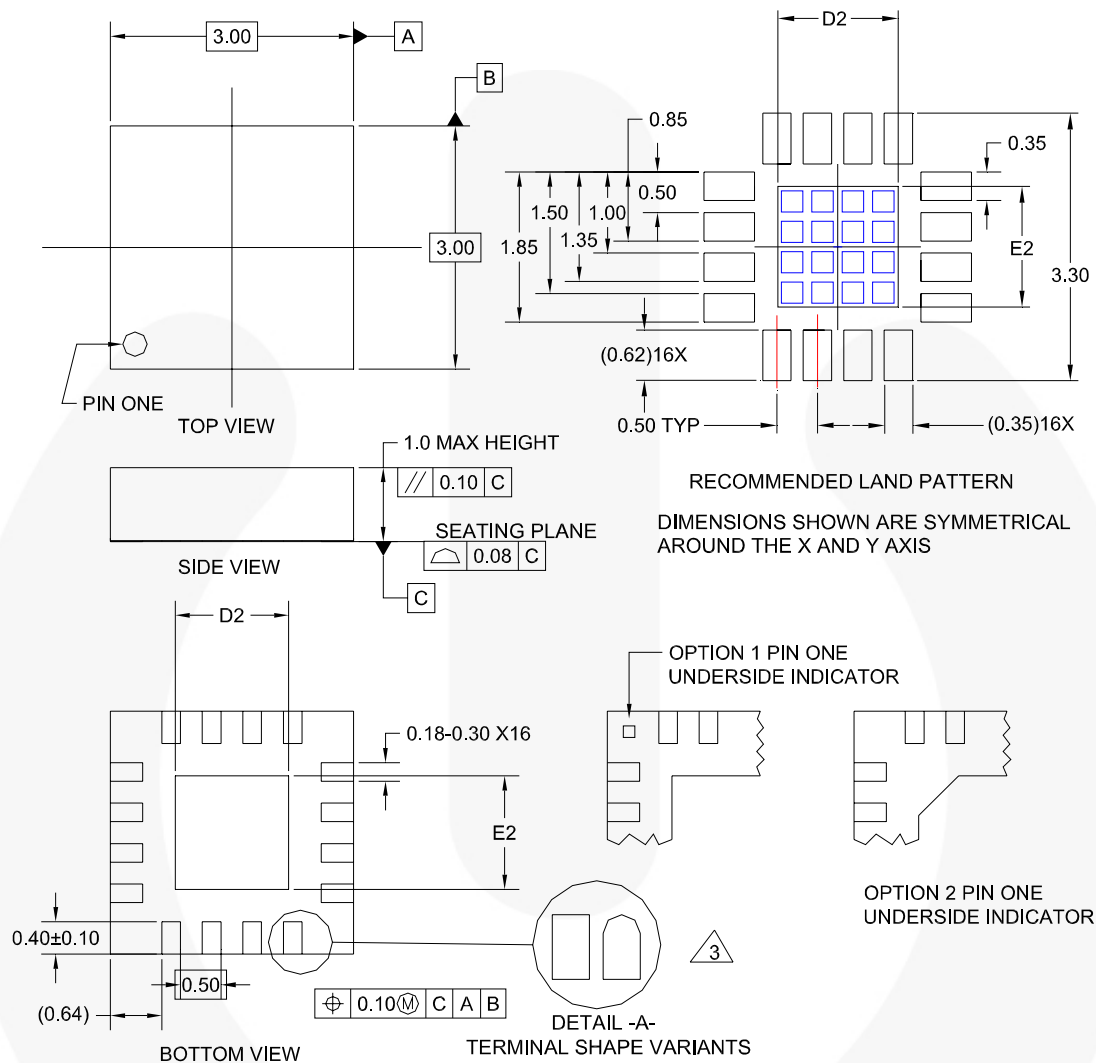
Figure 11. 14-Lead, Small Outline Integrated Circuit (SOIC) MO-012, 0.150-inch Wide

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## Physical Dimensions



MLP016CrevB

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

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

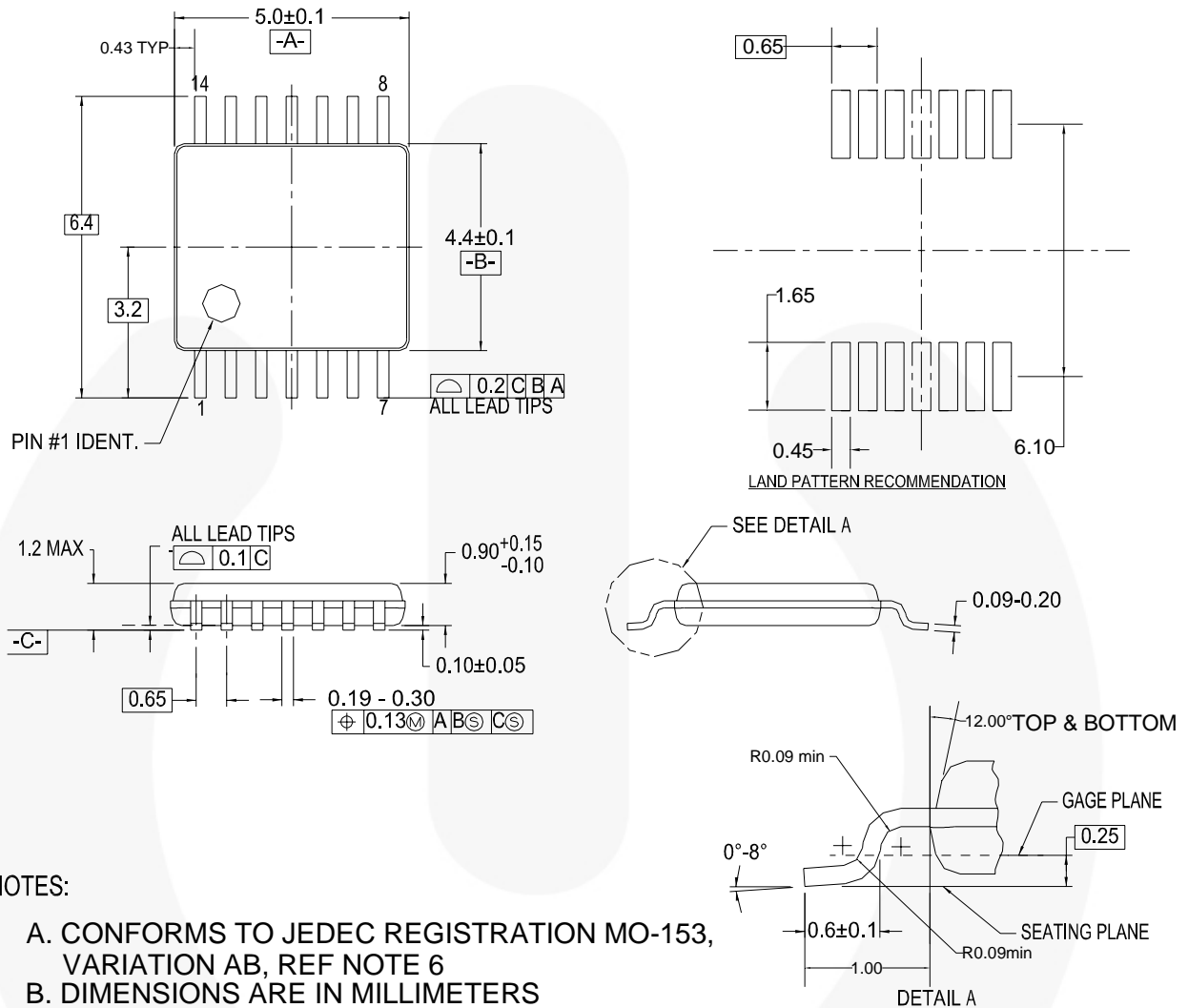
[http://www.fairchildsemi.com/products/analog/pdf/MLP6\\_3x3\\_TNR.pdf](http://www.fairchildsemi.com/products/analog/pdf/MLP6_3x3_TNR.pdf)

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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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| Current Transfer Logic <sup>™</sup>   | GTO <sup>™</sup>                             | Quiet Series <sup>™</sup>   | TinyPower <sup>™</sup>  |
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| EfficientMax <sup>™</sup>   | ISOPLANAR <sup>™</sup>                       | Saving our world, 1mW at a time <sup>™</sup>                                      | TinyWire <sup>™</sup>   |
| EZSWITCH <sup>™</sup> *   | MegaBuck <sup>™</sup>                        | SmartMax <sup>™</sup>   | μSerDes <sup>™</sup>  |
|  | MICROCOUPLER <sup>™</sup>                    | SMART START <sup>™</sup>  |  |
|  | MicroFET <sup>™</sup>                        | SPM <sup>®</sup>  | UHC <sup>®</sup>  |
| Fairchild <sup>®</sup>  | MicroPak <sup>™</sup>                        | STEALTH <sup>™</sup>  | Ultra FRFET <sup>™</sup>  |
| Fairchild Semiconductor <sup>®</sup>  | MillerDrive <sup>™</sup>                     | SuperFET <sup>™</sup>   | UniFET <sup>™</sup>   |
| FACT Quiet Series <sup>™</sup>  | MotionMax <sup>™</sup>                       | SuperSOT <sup>™</sup> -3  | VCX <sup>™</sup>  |
| FACT <sup>®</sup>   | Motion-SPM <sup>™</sup>                      | SuperSOT <sup>™</sup> -6  | VisualMax <sup>™</sup>  |
| FACT <sup>®</sup>   | OPTOLOGIC <sup>®</sup>                       | SuperSOT <sup>™</sup> -8  |   |
| FAST <sup>®</sup>   | OPTOPLANAR <sup>®</sup>                      | SupreMOS <sup>™</sup>   |   |
| FastvCore <sup>™</sup>  |  | SyncFET <sup>™</sup>  |   |
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As used herein:

1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body or (b) support or sustain life, and (c) whose failure to perform when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury of the user.
2. A critical component in any component of a life support, device, or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	This datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	This datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
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