May 2013

USB1T20 — Universal Serial Bus Transceiver

Features

- Complies with Universal Serial Bus Specification 2.0 for FS/LS Applications
- Utilizes Digital Inputs and Outputs to Transmit and Receive USB Cable Data
- Supports 12Mbit/s Full Speed (FS) and 1.5Mbit/s Low Speed (LS) Serial Data Transmission
- Supports Single-ended and Differential Data Interface as Function of MODE
- Single 3.3 V Supply
- ESD Performance: Human Body Model
  - 9.5 kV on D-, D+ Pins Only
  - 4.0 kV on All Other Pins

Description

USB1T20 is a generic USB 2.0 compliant transceiver. Using a single voltage supply, the USB1T20 provides an ideal USB interface solution for any electronic device able to supply 3.0 V to 3.6 V. It is designed to allow 5.0 V or 3.3 V programmable and standard logic to interface with the physical layer of the Universal Serial Bus (USB). It is capable of transmitting and receiving serial data at both full speed (12Mbit/s) and low speed (1.5Mbit/s) data rates.

Packaged in industry-standard TSSOP package. The USB1T20 is ideal for mobile electronics and other space-constrained applications.

Ordering Information

Part Number	Operating Temperature Range	Package	Packing Method
USB1T20MTCX	-40° to +85°C	14-Lead, Thin-Shrink Small-Outline Package (TSSOP) JEDEC MO-153, 4.4mm Wide	Tape and Reel

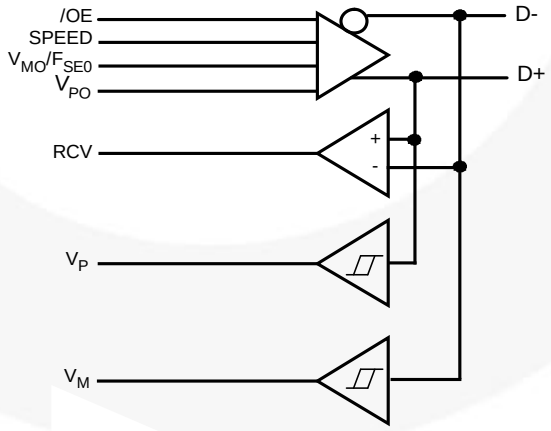


Figure 1. Logic Diagram

Pin Configuration

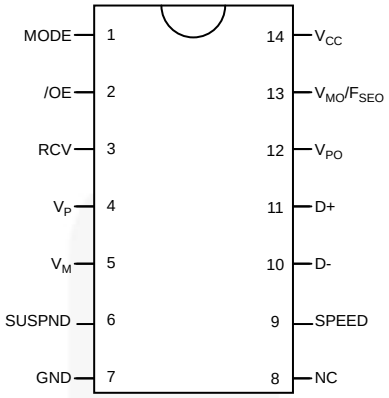


Figure 2. Pin Configuration (Top View)

Pin Definitions

Pin #	Name	I/O	Description
1	MODE	I	**Mode**. When left unconnected, a weak pull-up transistor pulls mode pin to V_{CC} and, in this GND, the V_{MO}/F_{SEO} pin takes the function of F_{SEO} (force SEO).
2	/OE	I	**Output Enable**. Active LOW; enables the transceiver to transmit data on the bus. When not active, the transceiver is in receive mode.
3	RCV	O	**Receive Data**. CMOS-Level output for USB differential input.
4, 5	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).

V_P	V_M	RESULT
0	0	/SEO
0	1	Low Speed
1	0	Full Speed
0	1	Error

6	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.
7	GND		Ground reference.
8	NC		No connect.
9	SPEED	I	**Edge Rate Control**. Logic "1" operates at edge rates for full speed. Logic "0" operates edge rates for low speed.
10, 11	D-, D+	AI/O	Data+, Data-. Differential data bus conforming to the Universal Serial Bus standard.
12, 13	V_{PO},V_{MO}/F_{SEO}	I	Inputs to differential driver. (Outputs from SIE.)

Mode	V_{PO}	V_{MO}/F_{SEO}	RESULT
0	0	0	Logic "0"
	0	1	/SEO
	1	0	Logic "1"
	1	1	/SEO
1	0	0	/SEO
	0	1	Logic "0"
	1	0	Logic "1"
	1	1	Illegal Code

14	V_{CC}		3.0 to 3.6 power supply.

Functional Truth Table

Input					I/O		Outputs			
Mode	V_{PO}	V_{MO}/F_{SEO}	/OE	SUSPND	D+	D-	RCV	V_P	V_M	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, $V_{IN} < 0$ V			-50	mA
V_{IN}	Input Voltage(1)		-0.5	5.5	V
$V_{I/O}$	Input / Output Voltage		-0.5	V_{CC} + 0.5	V
I_{OK}	Output Diode Current, $V_O > V_{CC}$ or $V_O < 0$ V			±50	mA
V_O	Output Voltage(1)		-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		±15	mA
		D+/D- Pins		±50	
I_{CC} / I_{GND}	V_{CC} / GND Current			±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}	Supply Voltage	3.0	3.6	V
V_{IN}	Input Voltage	0	5.5	V
$V_{AI/O}$	Input Range for AI/0	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 the recommended range of supply voltage and operating free air temperature unless otherwise noted. V_{CC} = 3.0 V to 3.6 V.

Symbol	Parameter	Conditions	T_A = -40 to +85°C			Units
			Min.	Typ.	Max.	
Input Levels						
V_{IL}	Low-Level Input Voltage				0.8	V
V_{IH}	High-Level Input Voltage		2			V
Output Levels						
V_{OL}	Low-Level Output Voltage	I_{OL} = 4 mA			0.4	V
		I_{OL} = 20 µA			0.1	
V_{OH}	High-Level Output Voltage	I_{OH} = 4 mA	2.4			V
		I_{OH} = 20 µA	V_{CC}-0.1			
Leakage Current						
I_{IN}	Input Leakage Current	V_{CC} = 3.0 to 3.6 V			±5	µA
I_{CCFS}	Supply Current, Full Speed	V_{CC} = 3.0 to 3.6 V			5	mA
I_{CCLS}	Supply Current, Low Speed	V_{CC} = 3.0 to 3.6 V			5	mA
I_{CCQ}	Quiescent Supply Current	V_{CC} = 3.0 to 3.6 V, V_{IN} = V_{CC} or GND			5	mA
I_{CCS}	Supply Current in Suspend	V_{CC} = 3.0 to 3.6 V, Mode = V_{CC}			10	µA

DC Electrical Characteristics D+/D- Pins

Over the 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°C			Units
			Min.	Typ.	Max.	
Input Levels						
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
Output Levels						
V_{OL}	Static Output Low-Voltage	R_L of 1.5 kΩ to 3.6 V			0.3	V
V_{OH}	Static Output High-Voltage	R_L of 1.5 kΩ to GND	2.8		3.6	V
V_{CR}	Differential Crossover		1.3		2.0	V
Leakage Current						
I_{OZ}	High-Z State Data Line Leakage Current	0 V<V_{IN}<3.3 V			±5	µA
Capacitance						
C_{IN}	Transceiver Capacitance[2]	Pin to GND			10	pF
	Capacitance Match[2]				10	%
Output Resistance						
Z_{DRV}	Driver Output Resistance[3]	Steady-State Drive	4		20	Ω
	Resistance Match[3]				10	%

Notes:

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

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

Over the recommended range of supply voltage and operating free air temperature unless otherwise noted.
V_{CC} = 3.0 V to 3.6 V; C_L = 50 pF; R_L = 1.5 kΩ on D+ to V_{CC}.

Symbol	Parameter	Conditions	T_A=-40 to +85°C			Units
			Min.	Typ.	Max.	
Driver Characteristics						
$t_{R,}$ t_F	Rise and Fall Time	10 and 90%, Figure 3	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
Driver Timings						
t_{PLH}	Driver Propagation Delay (V_{PO},V_{MO}/F_{SEO} to D+D-)	Figure 4			18	ns
$t_{PHZ,}$ t_{PLZ}	Driver Disable Delay (/OE to D+/D-)	Figure 6			13	ns
$t_{PZH,}$ t_{PZL}	Driver Enable Delay (/OE to D+/D-)	Figure 6			17	ns
Receiver Timings						
t_{PLH}	Receiver Propagation Delay D+/D- to RVC	Figure 5			16	ns
t_{PHL}					19	ns
t_{PLH}, t_{PHL}	Single-ended Receiver Delay (D+,D- to V_P, V_M)	Figure 5			8	ns

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

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

Symbol	Parameter	Conditions	T_A=-40 to +85°C			Units
			Min.	Typ.	Max.	
Driver Characteristics						
t_{LR}, t_{LF}	Rise and Fall Time	10 and 90%, Figure 3	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
Driver Timings						
t_{PLH}, t_{PHL}	Driver Propagation Delay (V_{PO},V_{MO}/F_{SEO} to D+D-)	Figure 4			300	ns
$t_{PHZ,}$ t_{PLZ}	Driver Disable Delay (/OE to D+/D-)	Figure 6			13	ns
$t_{PZH,}$ t_{PZL}	Driver Enable Delay (/OE to D+/D-)	Figure 6			205	ns
Receiver Timings						
t_{PLH}, t_{PHL}	Receiver Propagation Delay (D+/D- to RVC)	Figure 5			18	ns
t_{PLH}, t_{PHL}	Single-ended Receiver Delay (D+,D- to V_P, V_M)	Figure 5			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 3.0 V.

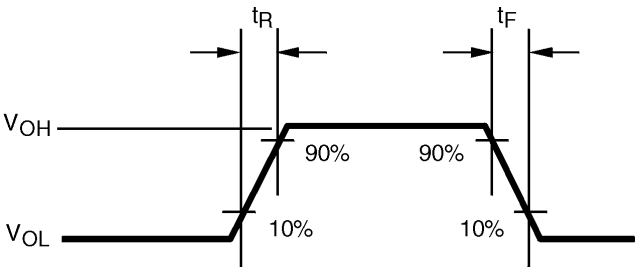


Figure 3. Rise and Fall Times

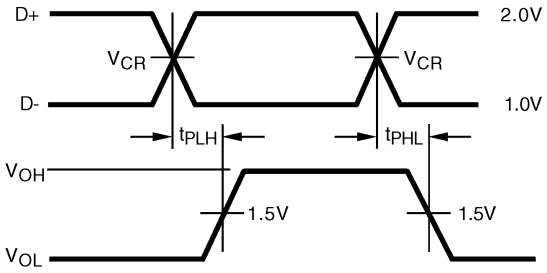


Figure 4. V_{PO}, V_{MO}/F_{SEO} to D+/D-

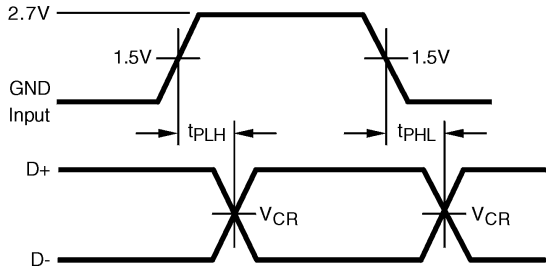


Figure 5. D+/D- to RCV, V_P/V_M

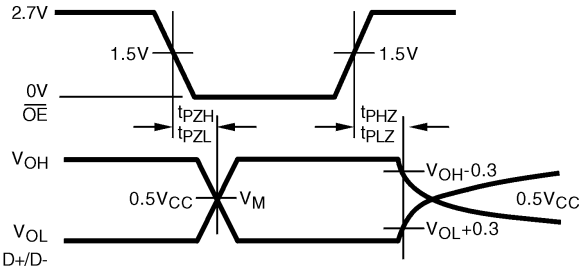


Figure 6. /OE to D+/D-

Test Circuits and Waveforms

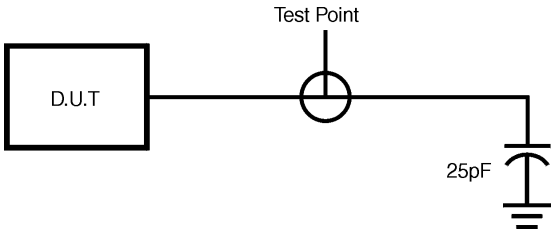


Figure 7. Load for V_M/V_P and RCV

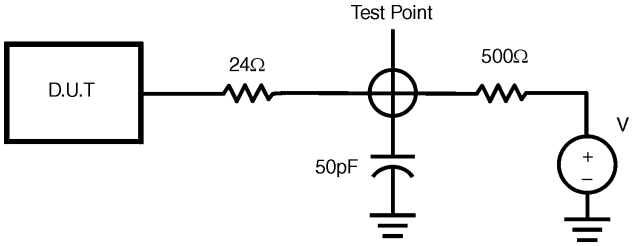
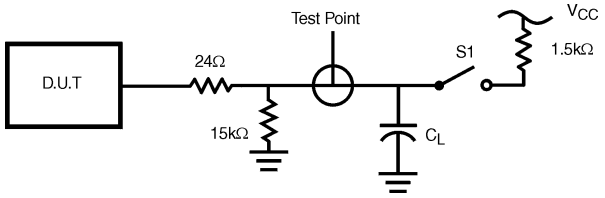


Figure 8. Load for Enable and Disable Times

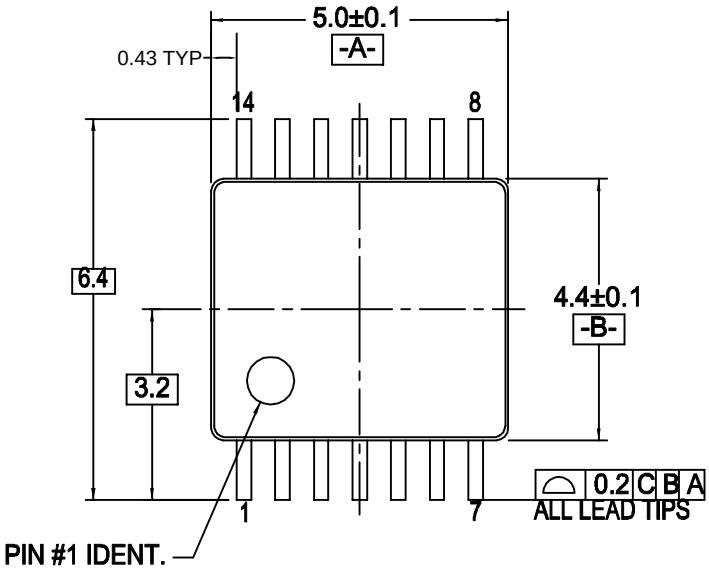


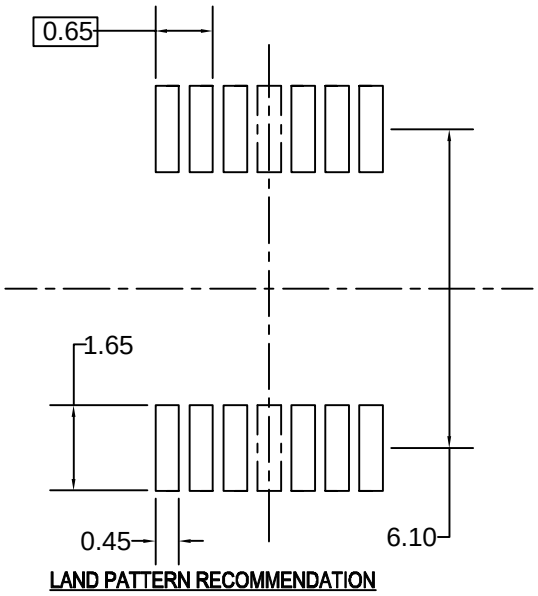
Test	S1
D-/LS	Close
D+/LS	Open
D-/FS	Open
D+/FS	Close

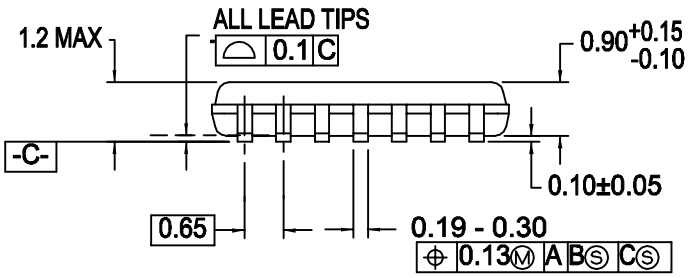
C_L=50pF, Full Speed
C_L=200pF, Low Speed (Minimum Timing)
C_L=600pF, Low Speed (Maximum Timing)
1.5kΩ on D- (Low Speed) or D+ (Full Speed) only

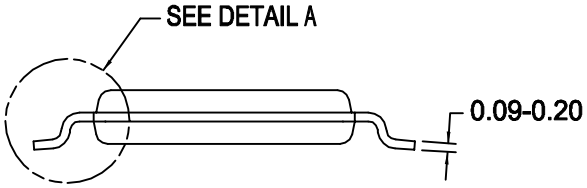
Figure 9. Load for D+/D-

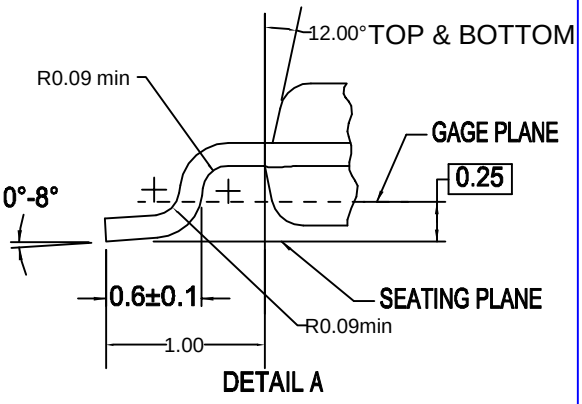
REVISIONS				
LTR	DESCRIPTION	E.C.N.	DATE	BY/APP'D
C	REVISE & REDRAW ON PRO/E PER CURRENT STD; CORRECT DET CALLOUT FROM D TO A	11099	08/21/95	MS/
C1	CHANGE TO (FSPM) DRAWING		4-6-98	FEITAN
C2	ADDED NOTES SECTION, ADDED RADIUS DIMS, MOLDED BODY ANGLE DIMS, AND FILENAME		6-12-98	H.ALLEN
C3	CHANGED TITLE, ADDED TITLE		6-23-98	H.ALLEN
D	CHANGED REVISION LEVEL ONLY		11/12/04	H.ALLEN
6	UPDATED LAND PATTERN		9 JULY 07	L.HUEBENER











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

APPROVALS	DATE
DRAWN L.HUEBENER	9 JULY 07
DFTG. CHK. H.ALLEN	31 JULY 07
ENGR. CHK.	

FAIRCHILD SEMICONDUCTOR™

14LD, TSSOP, JEDEC MO-153, 4.4MM WIDE

PROJECTION INCH (MM)

SCALE	SIZE	DRAWING NUMBER	REV
N/A	C	MKT-MTC14	6

DO NOT SCALE DRAWING | SHEET 1 of 1

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Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	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.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

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