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#### Features

**FAIRCHILD** 

- 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 3.3V Supply
- ESD Performance: Human Body Model
  9.5kV on D-, D+ Pins Only
  - 4.0kV 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 3.0V to 3.6V. 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 (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	Eco  Status  Package		Packing Method
USB1T20MTC	-40° to +85°C	RoHS	IS 14-Lead Thin Shrink Small Outline Package (TSSOP) JEDEC MO-153, 4.4mm Wide	
USB1T20MTCX	-40° to +85°C	RoHS	14-Lead Thin Shrink Small Outline Package (TSSOP) JEDEC MO-153, 4.4mm Wide	Tape and Reel

Ø For Fairchild's definition of "green" Eco Status, please visit: <u>http://www.fairchildsemi.com/company/green/rohs\_green.html</u>.





# **Pin Configuration**



Figure 2. Pin Configuration (Top View)

# **Pin Definitions**

Pin #	Name	I/O		Desc	cription			
1	MODE	I	Mode. When left unce this GND, the $V_{MO}/F_{SH}$			mode pin to V <sub>cc</sub> and, i EO).		
2	/OE	с I		<b>Dutput Enable</b> . Active LOW; enables the transceiver to transmit data on the bus Vhen not active, the transceiver is in receive mode.				
3	RCV	0	Receive Data. CMOS	eceive Data. CMOS-Level output for USB differential input.				
			Gated version of D- a ended zero (/SEO), e			" Used to detect single d. (Input to SIE).		
			VP		V <sub>M</sub>	RESULT		
4, 5	V <sub>P</sub> ,V <sub>M</sub>	0	0		0	/SEO		
			0		1	Low Speed		
			1		0	Full Speed		
			0		1	Error		
6	SUSPND	I	<b>Suspend</b> . Enables a suspend pin is active, state.			ctive. While the Both D+ and D- are 3		
7	GND		Ground reference.	Fround reference.				
8	NC		No connect.	No connect.				
9	SPEED	I	Edge Rate Control. I edge rates for low spe		edge rates for full sp	peed. Logic "0" operate		
10, 11	D-, D+	AI/O	Data+, Data Differer	ntial data bus conform	ming to the Universal			
					ning to the entretea	Serial Bus standard.		
			Inputs to differential d	river. (Outputs from	Ū.	Serial Bus standard.		
			Inputs to differential d Mode	river. (Outputs from VPo	Ū.	Serial Bus standard.		
				•••	SIE.)			
			Mode	V <sub>PO</sub>	SIE.) Vmo/Fseo	RESULT		
10 10				<b>V</b> <sub>РО</sub> 0	SIE.) V <sub>MO</sub> /F <sub>SEO</sub> 0	RESULT Logic "0"		
12, 13	V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub>	I	Mode	<b>V</b> <sub>Ро</sub> 0 0	SIE.) V <sub>MO</sub> /F <sub>SEO</sub> 0 1	RESULT Logic "0" /SEO		
12, 13	V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub>	1	Mode	V <sub>PO</sub> 0 0 1	SIE.) V <sub>M0</sub> /F <sub>SE0</sub> 0 1 0	RESULT Logic "0" /SEO Logic "1"		
12, 13	V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub>	I	Mode 0	V <sub>PO</sub> 0 0 1 1	SIE.) Vmo/Fseo 0 1 0 1 0 1	RESULT Logic "0" /SEO Logic "1" /SEO		
12, 13	V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub>	I	Mode	V <sub>PO</sub> 0 0 1 1 0	SIE.) V <sub>M0</sub> /F <sub>SE0</sub> 0 1 0 1 0 1 0	RESULT Logic "0" /SEO Logic "1" /SEO /SEO		
12, 13	V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub>	I	Mode 0	V <sub>PO</sub> 0 0 1 1 0 0 0	SIE.) Vmo/Fseo 0 1 0 1 0 1 0 1 0 1	RESULT      Logic "0"      /SEO      Logic "1"      /SEO      /SEO      Logic "0"		

Funct	ional T	ruth Tabl	е							
	Input				I/	0	Outputs			
Mode	V <sub>PO</sub>	$V_{MO}/F_{SEO}$	/OE	SUSPND	D+	D-	RCV	VP	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	lllegal 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	Paramete	Min.	Max.	Unit	
V <sub>CC</sub>	DC Supply Voltage		-0.5	7.0	V
l <sub>iK</sub>	DC Input Diode Current, VIN<0V	1		-50	mA
V <sub>IN</sub>	Input Voltage <sup>(1)</sup>		-0.5	5.5	V
V <sub>I/O</sub>	Input / Output Voltage		-0.5	V <sub>CC</sub> + 0.5	V
I <sub>ОК</sub>	Output Diode Current, Vo>Vcc o	or V <sub>O</sub> <0		±50	mA
Vo	Output Voltage <sup>(1)</sup>		-0.5	V <sub>CC</sub> + 0.5	V
	Output Source or Sink Current	V <sub>P</sub> , V <sub>M</sub> , RCV Pins		±15	mA
Io	$(V_{O} = 0 \text{ to } V_{CC})$	D+/D- Pins		±50	ША
I <sub>CC</sub> / I <sub>GND</sub>	V <sub>CC</sub> / GND Current			±100	mA
T <sub>STG</sub>	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
Vcc	Supply Voltage	3.0	3.6	V
V <sub>IN</sub>	Input Voltage	0	5.5	V
V <sub>AI/O</sub>	Input Range for AI/0	0	Vcc	V
Vo	Output Voltage	0	V <sub>CC</sub>	V
T <sub>A</sub>	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.  $V_{CC}$  = 3.0V to 3.6V.

Symbol	Deremeter	Parameter Conditions	T <sub>A</sub> =	Units		
Symbol	Parameter	Conditions	Min.	Тур.	Max.	Units
Input Levels	S					
VIL	Low-Level Input Voltage				0.8	V
VIH	High-Level Input Voltage		2			V
Output Leve	els					
N/	Low-Level Output Voltage	$I_{OL} = 4mA$			0.4	V
V <sub>OL</sub>		I <sub>OL</sub> = 20µA			0.1	V
V	)/	I <sub>OH</sub> = 4mA	2.4			v
V <sub>OH</sub>	High-Level Output Voltage	I <sub>OH</sub> = 20μA	V <sub>cc</sub> -0.1			
Leakage Cu	irrent					
I <sub>IN</sub>	Input Leakage Current	$V_{CC} = 3.0$ to $3.6V$			±5	μA
I <sub>CCFS</sub>	Supply Current, Full Speed	$V_{CC} = 3.0 \text{ to } 3.6 \text{V}$			5	mA
I <sub>CCLS</sub>	Supply Current, Low Speed	$V_{CC} = 3.0 \text{ to } 3.6 \text{V}$			5	mA
Icca	Quiescent Supply Current	$V_{CC} = 3.0 \text{ to } 3.6 \text{V},$ $V_{IN} = V_{CC} \text{ or GND}$			5	mA
I <sub>CCS</sub>	Supply Current in Suspend	$V_{CC} = 3.0$ to 3.6V, 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.

Oursels of	Devementer	O an dition o	T <sub>A</sub> =-				
Symbol	Parameter	Conditions	Min.	Тур.	Max.	Units	
Input Level	s						
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 Lev	els	·				6	
V <sub>OL</sub>	Static Output Low-Voltage	$R_L$ of $1.5 k\Omega$ to $3.6 V$			0.3	V	
V <sub>OH</sub>	Static Output High-Voltage	$R_L$ of 1.5k $\Omega$ to GND	2.8		3.6	V	
V <sub>CR</sub>	Differential Crossover		1.3		2.0	V	
Leakage Cu	urrent						
I <sub>oz</sub>	High Z-State Data Line Leakage Current	0V <v<sub>IN&lt;3.3V</v<sub>			±5	μA	
Capacitanc	e					~	
0	Transceiver Capacitance <sup>(2)</sup>	Pin to GND			10	pF	
CIN	Capacitance Match <sup>(2)</sup>				10	%	
Output Res	istance						
7	Driver Output Resistance <sup>(3)</sup>	Steady-State Drive	4		20	Ω	
Z <sub>DRV</sub>	Resistance Match <sup>(3)</sup>				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  $24\Omega \pm 1\%$  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.  $V_{CC}$  = 3.0V to 3.6V;  $C_L$  = 50pF;  $R_L$  = 1.5k $\Omega$  on D+ to  $V_{CC}$ .

Symbol	Parameter	Conditiono	T <sub>A</sub> =-4	L lucit e		
Symbol	Parameter	Conditions	Min.	Тур.	Max.	Units
Driver Chara	acteristics					
t <sub>R</sub> , t <sub>F</sub>	Rise and Fall Time	10 and 90%, Figure 3	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 Timin	igs					
t <sub>PLH</sub>	Driver Propagation Delay (V <sub>PO</sub> ,V <sub>MO</sub> /F <sub>SEO</sub> to D+D-)	Figure 4			18	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Driver Disable Delay (/OE to D+/D-)	Figure 6			13	ns
t <sub>PZH</sub> , t <sub>PZL</sub>	Driver Enable Delay (/OE to D+/D-)	Figure 6			17	ns
Receiver Tir	nings					
t <sub>PLH</sub>	Receiver Propagation Delay	Figure F			16	ns
t <sub>PHL</sub>	D+/D- to RVC	Figure 5			19	ns
t <sub>PLH</sub> , t <sub>PHL</sub>	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.  $V_{CC}$  = 3.0V 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> =-	Linite		
Symbol	Parameter	Conditions	Min.	Тур.	Max.	Units
Driver Chara	acteristics					
t <sub>LR</sub> , t <sub>LF</sub>	Rise and Fall Time	10 and 90%, Figure 3	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 Timir	ngs	· · · · · ·			1	
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 4			300	ns
t <sub>PHZ</sub> , t <sub>PLZ</sub>	Driver Disable Delay (/OE to D+/D-)	Figure 6			13	ns
t <sub>PZH</sub> , t <sub>PZL</sub>	Driver Enable Delay (/OE to D+/D-)	Figure 6			205	ns
Receiver Ti	nings					
t <sub>PLH</sub> , t <sub>PHL</sub>	Receiver Propagation Delay (D+/D- to RVC)	Figure 5			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 5			28	ns







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		, Rev. 137