

# DATA SHEET

## **PDIUSBP11A**

### Universal Serial Bus Transceiver

Product specification  
Supersedes data of 1997 Jun 17

1997 Aug 01

# Universal Serial Bus Transceiver

# PDIUSBP11A

## FEATURES

- Complies with Universal Serial Bus specification 1.0
- 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
- Available in SO-14, SSOP-14 and TSSOP-14 packages

## DESCRIPTION

The PDIUSBP11A 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.

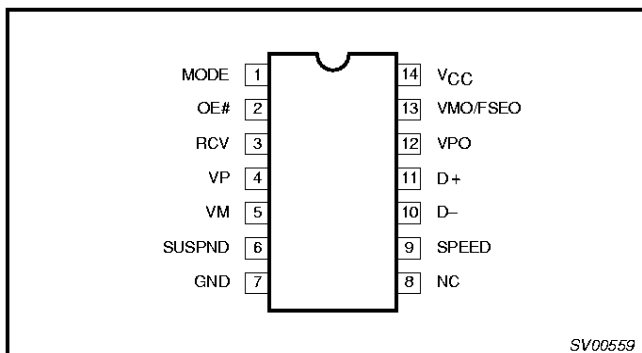
The pinout conforms with the "Serial Interface Engine". Implementation of the Serial Interface Engine along with the USB transceiver allows the designer to make USB compatible devices with off-the-shelf logic and easily modify and update the application.

The PDIUSBP11A is backward compatible to the PDIUSBP11 and allows for single-ended data interfacing.

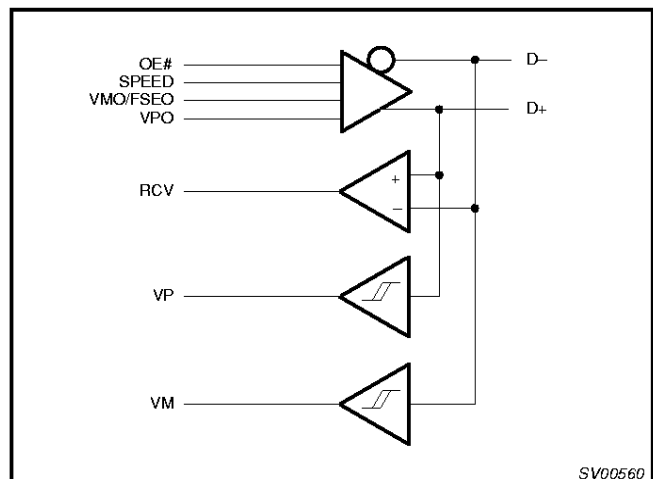
## ORDERING INFORMATION

PACKAGES	TEMPERATURE RANGE	OUTSIDE NORTH AMERICA	NORTH AMERICA	PKG. DWG. #
14-pin plastic SO	-40°C to +85°C	PDIUSBP11A D	PDIUSBP11A D	SOT108-1
14-pin plastic SSOP	-40°C to +85°C	PDIUSBP11A DB	PDIUSBP11A DB	SOT337-1
14-pin plastic TSSOP	-40°C to +85°C	PDIUSBP11APW	PDUSBP11APW DH	SOT402-1

## PIN CONFIGURATION



## FUNCTIONAL DIAGRAM



## Universal Serial Bus Transceiver

## PDIUSBP11A

## PIN DESCRIPTION

PIN No.	PIN SYMBOL	I/O	NAME AND FUNCTION																														
3	RCV	O	Receive data. CMOS level output for USB differential input																														
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																														
1	MODE	I	Mode. When left unconnected, a weak pull-up transistor pulls it to $V_{CC}$ and in this mode, the PDIUSBP11A is backward compatible to PDIUSBP11. When connected to GND, the VMO/FSEO pin takes the function of FSEO (Force SEO).																														
12, 13	$V_{PO}, V_{MO}/F_{SEO}$	I	Inputs to differential driver. (Outputs from SIE).																														
			<table border="1"> <thead> <tr> <th>MODE</th> <th>VPO</th> <th>VMO/FSEO</th> <th>RESULT</th> </tr> </thead> <tbody> <tr> <td rowspan="4">0</td> <td>0</td> <td>0</td> <td>Logic "0"</td> </tr> <tr> <td>0</td> <td>1</td> <td>SEO#</td> </tr> <tr> <td>1</td> <td>0</td> <td>Logic "1"</td> </tr> <tr> <td>1</td> <td>1</td> <td>SEO#</td> </tr> <tr> <td rowspan="4">1</td> <td>0</td> <td>0</td> <td>SEO#</td> </tr> <tr> <td>0</td> <td>1</td> <td>Logic "0"</td> </tr> <tr> <td>1</td> <td>0</td> <td>Logic "1"</td> </tr> <tr> <td>1</td> <td>1</td> <td>Illegal code</td> </tr> </tbody> </table>	MODE	VPO	VMO/FSEO	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
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	1	0	Logic "1"																														
	1	1	Illegal code																														
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 interconnect speed. (Inputs to SIE).																														
			<table border="1"> <thead> <tr> <th>VP</th> <th>VM</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>1</td> <td>1</td> <td>Error</td> </tr> </tbody> </table>	VP	VM	RESULT	0	0	SEO#	0	1	Low Speed	1	0	Full Speed	1	1	Error															
			VP	VM	RESULT																												
			0	0	SEO#																												
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1	1	Error																															
11, 10	D+, D-	AI/O	Data+, Data-. Differential data bus conforming to the Universal Serial Bus standard.																														
			6	SUSPND	I	Suspend. Enables a low power state while the USB bus is inactive. While the suspnd pin is active it will drive the RCV pin to a logic "0" state. Both D+ and D- are tri-stated.																											
						9	SPEED	I	Edge rate control. Logic "1" operates at edge rates for "full speed". Logic "0" operates edge rates for "low speed".																								
									14	$V_{CC}$		3.0V to 3.6V power supply																					
7	GND		Ground reference																														

## RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN.	MAX.	
$V_{CC}$	DC supply voltage		3.0	3.6	V
$V_I$	DC Input voltage range		0	5.5	V
$V_{AI/O}$	DC input range for AI/O's		0	$V_{CC}$	V
$V_O$	DC output voltage range		0	$V_{CC}$	V
$T_{amb}$	Operating ambient temperature range in free air	See DC and AC characteristics per device	-40	+85	°C

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**ABSOLUTE MAXIMUM RATINGS<sup>1</sup>**

In accordance with the Absolute Maximum Rating System (IEC 134) Voltages are referenced to GND (ground = 0V)

SYMBOL	PARAMETER	CONDITIONS	LIMITS		UNIT
			MIN	MAX	
$V_{CC}$	DC supply voltage		-0.5	+6.5	V
$I_{IK}$	DC input diode current	$V_I < 0$	-	-50	mA
$V_I$	DC input voltage	Note 2	-0.5	+5.5	V
$V_{I/O}$	DC input voltage range for I/O's		-0.5	$V_{CC} + 0.5$	V
$I_{OK}$	DC output diode current	$V_O > V_{CC}$ or $V_O < 0$	-	$\pm 50$	mA
$V_O$	DC output voltage	Note 2	-0.5	$V_{CC} + 0.5$	V
$I_O$	DC output source or sink current for VP/VM, RCV pins	$V_O = 0$ to $V_{CC}$	-	$\pm 15$	mA
$I_O$	DC output source or sink current for D+/D- pins	$V_O = 0$ to $V_{CC}$	-	$\pm 50$	mA
$I_{CC}, I_{GND}$	DC $V_{CC}$ or GND current		-	$\pm 100$	mA
$T_{STO}$	Storage temperature range		-60	+150	°C
$P_{TOT}$	Power dissipation per package				mW

**NOTES:**

- Stresses beyond those listed 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.
- The input and output voltage ratings may be exceeded if the input and output clamp current ratings are observed.

**DC CHARACTERISTICS (DIGITAL PINS)**

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			Temp = -40°C to +85°C			
			MIN	TYP	MAX	
	<b>INPUT LEVELS:</b>					
$V_{IL}$	LOW level input voltage				0.8	V
$V_{IH}$	HIGH level input voltage		2.0			V
	<b>OUTPUT LEVELS:</b>					
$V_{OL}$	LOW level output voltage	$I_{OL} = 4\text{mA}$			0.4	V
		$I_{OL} = 20\mu\text{A}$			0.1	
$V_{OH}$	HIGH level output voltage	$I_{OH} = 4\text{mA}$	2.4			V
		$I_{OH} = 20\mu\text{A}$	$V_{CC} - 0.1$			
	<b>LEAKAGE CURRENT:</b>					
$I_L$	Input leakage current				$\pm 5$	$\mu\text{A}$
$I_{CCS}$	Supply current in Suspend			-	5	$\mu\text{A}$

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## DC CHARACTERISTICS (AI/O PINS)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS		UNIT
			Temp = -40°C to +85°C		
			MIN	MAX	
	<b>INPUT LEVELS:</b>				
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
	<b>OUTPUT LEVELS:</b>				
V <sub>OL</sub>	Static output LOW voltage	R <sub>L</sub> of 1.5 kΩ to 3.6V		0.3	V
V <sub>OH</sub>	Static output HIGH voltage	R <sub>L</sub> of 15 kΩ to GND	2.8	3.6	V
	<b>LEAKAGE CURRENT:</b>				
I <sub>LO</sub>	Hi-Z State data line leakage current	0V < V <sub>IN</sub> < 3.3V		±10	μA
	<b>CAPACITANCE:</b>				
C <sub>IN</sub>	Transceiver capacitance	Pin to GND		20	pF
	<b>OUTPUT RESISTANCE:</b>				
Z <sub>DRV</sub> <sup>1</sup>	Driver output resistance	Steady state drive	6	18	Ω

## NOTES:

- Excludes external resistor. In order to comply with USB Specifications 1.0, external series resistors of 24Ω ±1% each on D+ and D- are recommended.

## AC CHARACTERISTICS (AI/O PINS. FULL SPEED)

SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			T <sub>amb</sub> = -40°C to +85°C			
			MIN	TYP	MAX	
	<b>Driver Characteristics:</b>	C <sub>L</sub> = 50pF; R <sub>pu</sub> = 1.5kΩ on D+ to V <sub>CC</sub>				
t <sub>R</sub>	Transition Time: Rise time	Between 10% and 90% Waveform 1	4 <sup>1</sup>		20	ns
t <sub>F</sub>	Fall time	Waveform 1	4 <sup>1</sup>		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
	<b>Driver Timings:</b>					
tp <sub>LH</sub>	Driver propagation delay	Waveform 2			18	ns
tp <sub>HL</sub>	(VPO, VMO/FSEO to D+/D-)	Waveform 2			19	ns
tp <sub>HZ</sub>	Driver disable delay	Waveform 4			13	ns
tp <sub>LZ</sub>	(OE# to D+/D-)	Waveform 4			13	ns
tp <sub>ZH</sub>	Driver enable delay	Waveform 4			17	ns
tp <sub>ZL</sub>	(OE# to D+/D-)	Waveform 4			17	ns
	<b>Receiver Timings:</b>					
tp <sub>LH</sub>	Receiver propagation delay	Waveform 3			16	ns
tp <sub>HL</sub>	(D+, D- to RCV)	Waveform 3			19	ns
tp <sub>LH</sub>	Single-ended receiver delay	Waveform 3			8	ns
tp <sub>HL</sub>	(D+, D- to VP, VM)	Waveform 3			8	ns

## NOTE:

- The 4ns specification is only for 0°C to +85°C.

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## AC CHARACTERISTICS (AI/O PINS. LOW SPEED)

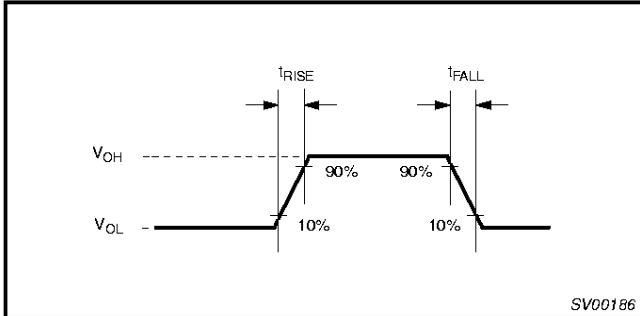
SYMBOL	PARAMETER	TEST CONDITIONS	LIMITS			UNIT
			T <sub>amb</sub> = -40°C to +85°C			
			MIN	TYP	MAX	
	<b>Driver Characteristics:</b>	C <sub>L</sub> = 50pF and 350pF; R <sub>pu</sub> = 1.5kΩ on D- to V <sub>CC</sub>				
t <sub>LR</sub>	Transition Time: Rise time Fall time	Between 10% and 90% C <sub>L</sub> = 50pF. Waveform 1	75		300	ns
t <sub>LF</sub>		C <sub>L</sub> = 350pF. Waveform 1 C <sub>L</sub> = 50pF. Waveform 1 C <sub>L</sub> = 350pF. Waveform 1	75		300	
t <sub>LRFM</sub>	Rise / Fall time matching	(T <sub>LR</sub> /T <sub>LF</sub> )	80		120	%
V <sub>LCRS</sub>	Output signal crossover voltage		1.3		2.0	V
	<b>Driver Timings:</b>					
t <sub>PLH</sub>	Driver propagation delay	Waveform 2			300	ns
t <sub>PHL</sub>	(VPO, VMO/FSEO to D+/D-)	Waveform 2			300	ns
t <sub>PHZ</sub>	Driver disable delay	Waveform 4			13	ns
t <sub>PLZ</sub>	(OE# to D+/D-)	Waveform 4			13	ns
t <sub>PZH</sub>	Driver enable delay	Waveform 4			205	ns
t <sub>PZL</sub>	(OE# to D+/D-)	Waveform 4			205	ns
	<b>Receiver Timings:</b>					
t <sub>PLH</sub>	Receiver propagation delay	Waveform 3			18	ns
t <sub>PHL</sub>	(D+, D- to RCV)	Waveform 3			18	ns
t <sub>PLH</sub>	Single-ended receiver delay	Waveform 3			28	ns
t <sub>PHL</sub>	(D+, D- to VP, VM)	Waveform 3			28	ns

# Universal Serial Bus Transceiver

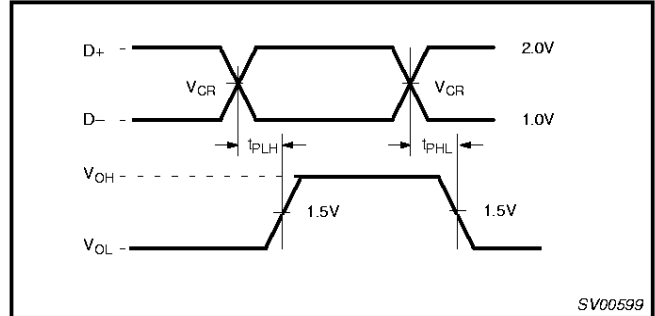
# PDIUSBP11A

## AC WAVEFORMS

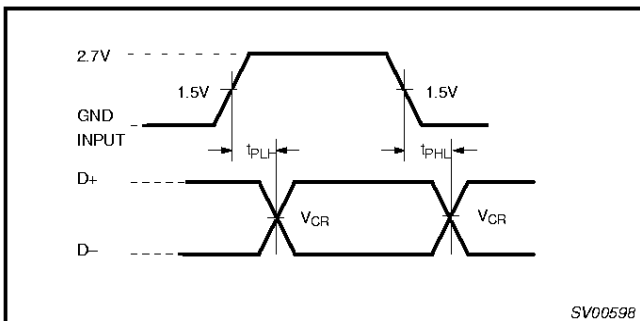
$V_{OL}$  and  $V_{OH}$  are the typical output voltage drops that occur with the output load. ( $V_{CC}$  never goes below 3.0V).



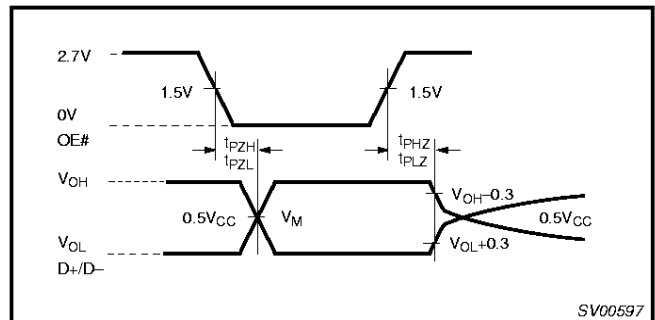
Waveform 1. Rise and Fall Times



Waveform 3. D+/D- to RCV, VP/VM

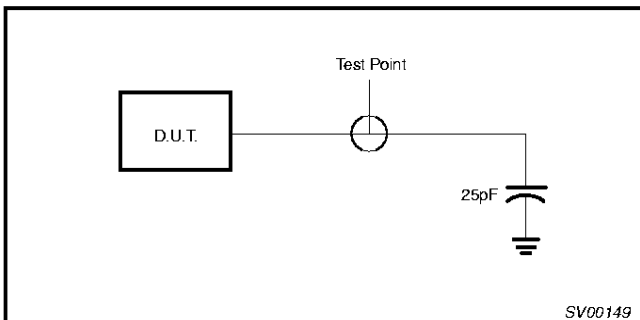


Waveform 2. VPO, VMO/FSEO to D+/D-

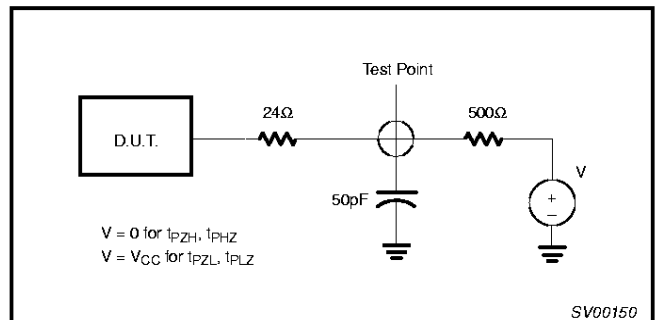


Waveform 4. OE# to D+/D-

## TEST CIRCUITS AND WAVEFORMS

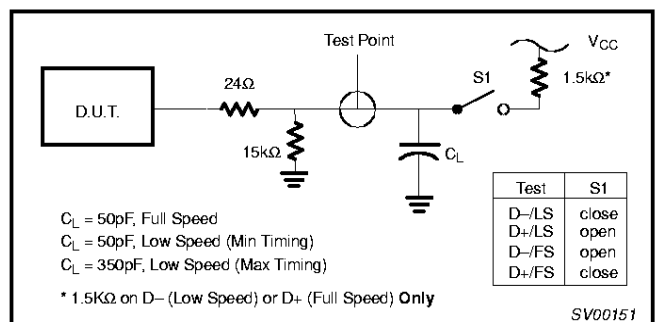


Load for VM/VP and RCV



$V = 0$  for  $t_{PZH}$ ,  $t_{PHZ}$   
 $V = V_{CC}$  for  $t_{PZL}$ ,  $t_{PLZ}$

Load for Enable and Disable Times



$C_L = 50\text{pF}$ , Full Speed  
 $C_L = 50\text{pF}$ , Low Speed (Min Timing)  
 $C_L = 350\text{pF}$ , Low Speed (Max Timing)

\* 1.5kΩ on D- (Low Speed) or D+ (Full Speed) Only

Test	S1
D-/LS	close
D+/LS	open
D-/FS	open
D+/FS	close

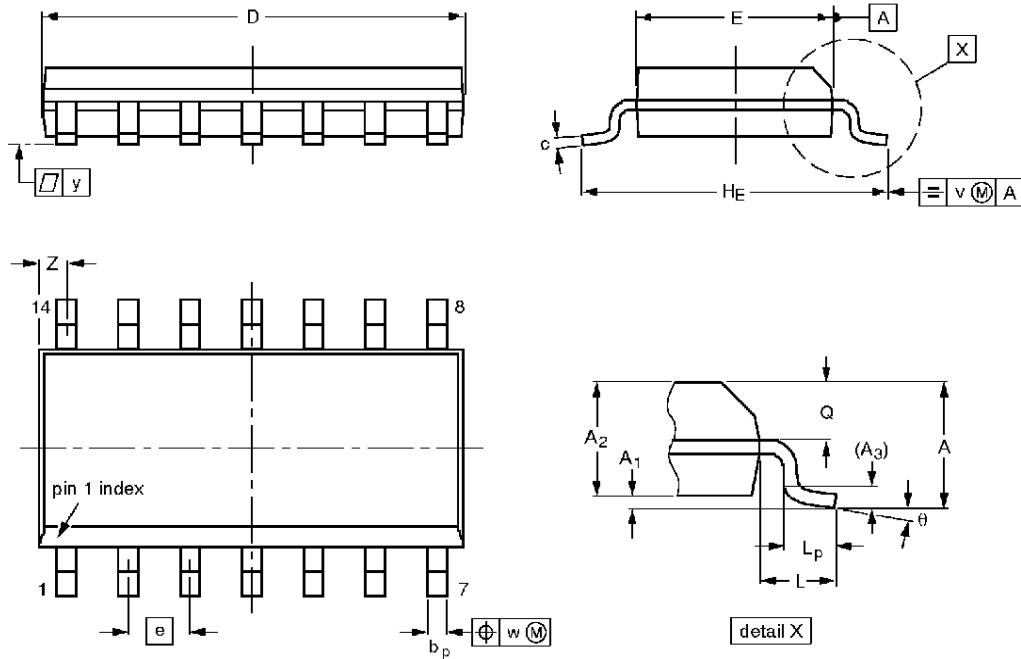
Load for D+/D-

# Universal Serial Bus Transceiver

# PDIUSBP11A

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



**DIMENSIONS** (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	8.75 8.55	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.0098 0.0039	0.057 0.049	0.01	0.019 0.014	0.0098 0.0075	0.35 0.34	0.16 0.15	0.050	0.24 0.23	0.041	0.039 0.016	0.028 0.024	0.01	0.01	0.004	0.028 0.012	

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT108-1	076E06S	MS-012AB				91-08-10 95-01-23

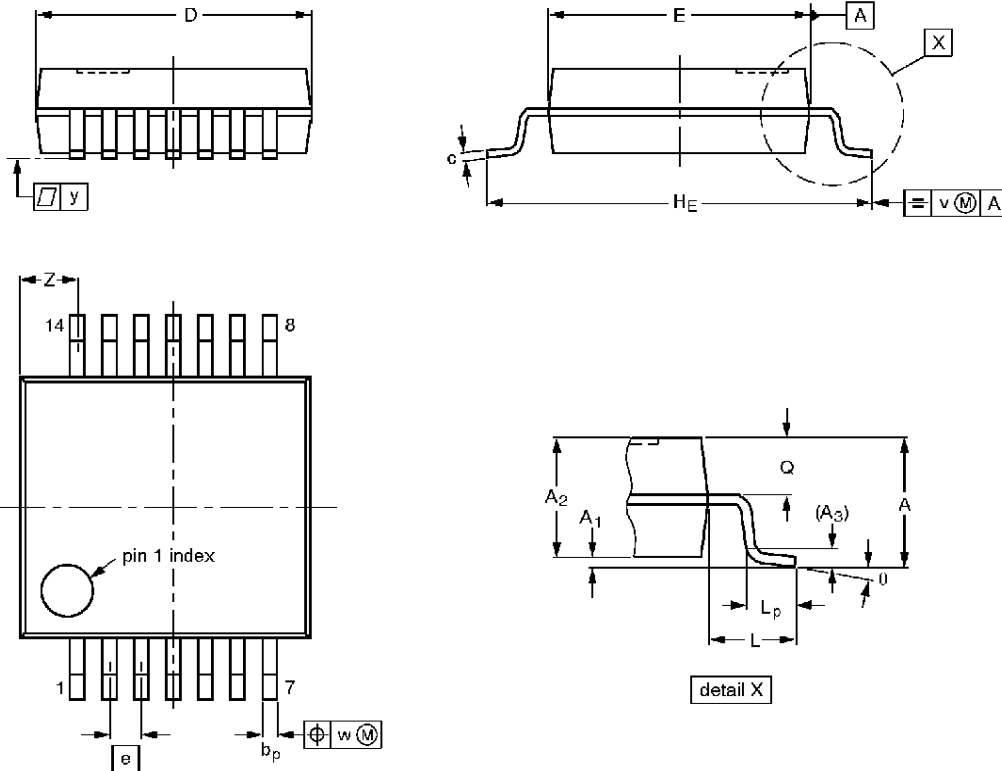


Universal Serial Bus Transceiver

PDIUSBP11A

SSOP14: plastic shrink small outline package; 14 leads; body width 5.3 mm

SOT337-1



**DIMENSIONS** (mm are the original dimensions)

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	2.0	0.21 0.05	1.80 1.65	0.25	0.38 0.25	0.20 0.09	6.4 6.0	5.4 5.2	0.65	7.9 7.6	1.25	1.03 0.63	0.9 0.7	0.2	0.13	0.1	1.4 0.9	8° 0°

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

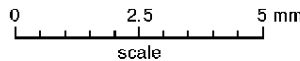
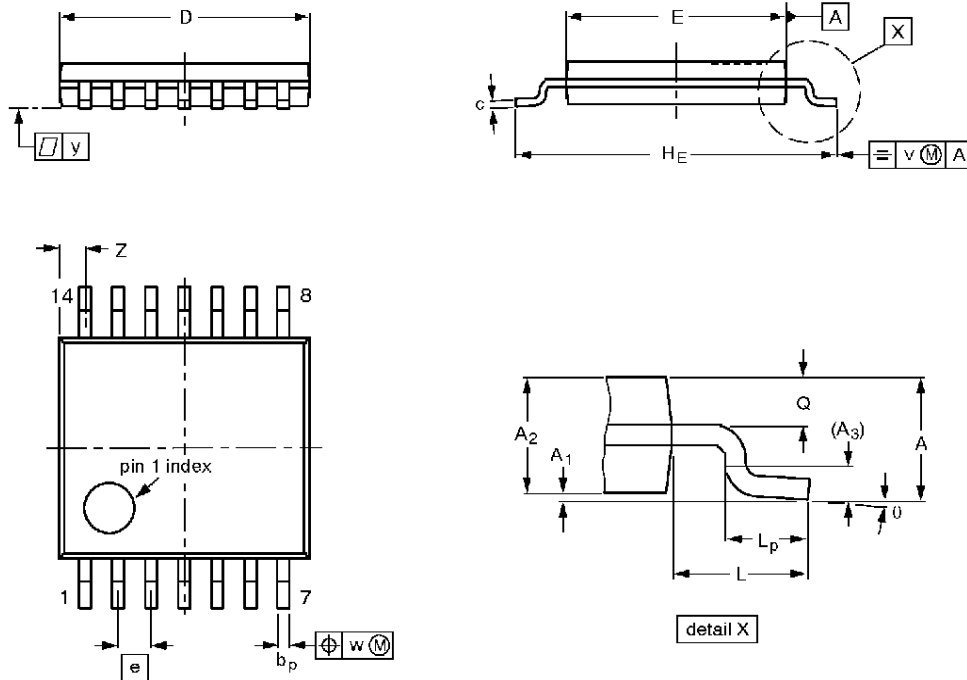
OUTLINE VERSION	REFERENCES			EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ		
SOT337-1		MO-150AB			<del>95-02-04</del> 96-01-18

# Universal Serial Bus Transceiver

# PDIUSBP11A

**TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm**

**SOT402-1**



**DIMENSIONS (mm are the original dimensions)**

UNIT	A max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(2)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	Z <sup>(1)</sup>	θ
mm	1.10	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1.0	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.72 0.38	8° 0°

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT402-1		MO-153				94-07-12 95-04-04

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# Universal Serial Bus Transceiver

# PDIUSBP11A

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## NOTES

# Universal Serial Bus Transceiver

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## DEFINITIONS

Data Sheet Identification	Product Status	Definition
<i>Objective Specification</i>	Formative or in Design	This data sheet contains the design target or goal specifications for product development. Specifications may change in any manner without notice.
<i>Preliminary Specification</i>	Preproduction Product	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
<i>Product Specification</i>	Full Production	This data sheet contains Final Specifications. Philips Semiconductors reserves the right to make changes at any time without notice, in order to improve design and supply the best possible product.

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