

## RS-232 LINE DRIVER/RECEIVER AT 3.3 V/5 V

The  $\mu$ PD4724 is a high breakdown voltage silicon gate CMOS line driver/receiver based on the EIA/TIA-232-E standard. This IC features various functions, such as standby, and incorporates a DC/DC converter that switches boost multiples, enabling operation at both +3.3 V and +5 V single supply voltage.

The  $\mu$ PD4724 incorporates three drivers and five receivers, so an RS-232 interface circuit can be easily constructed by connecting five external capacitors.

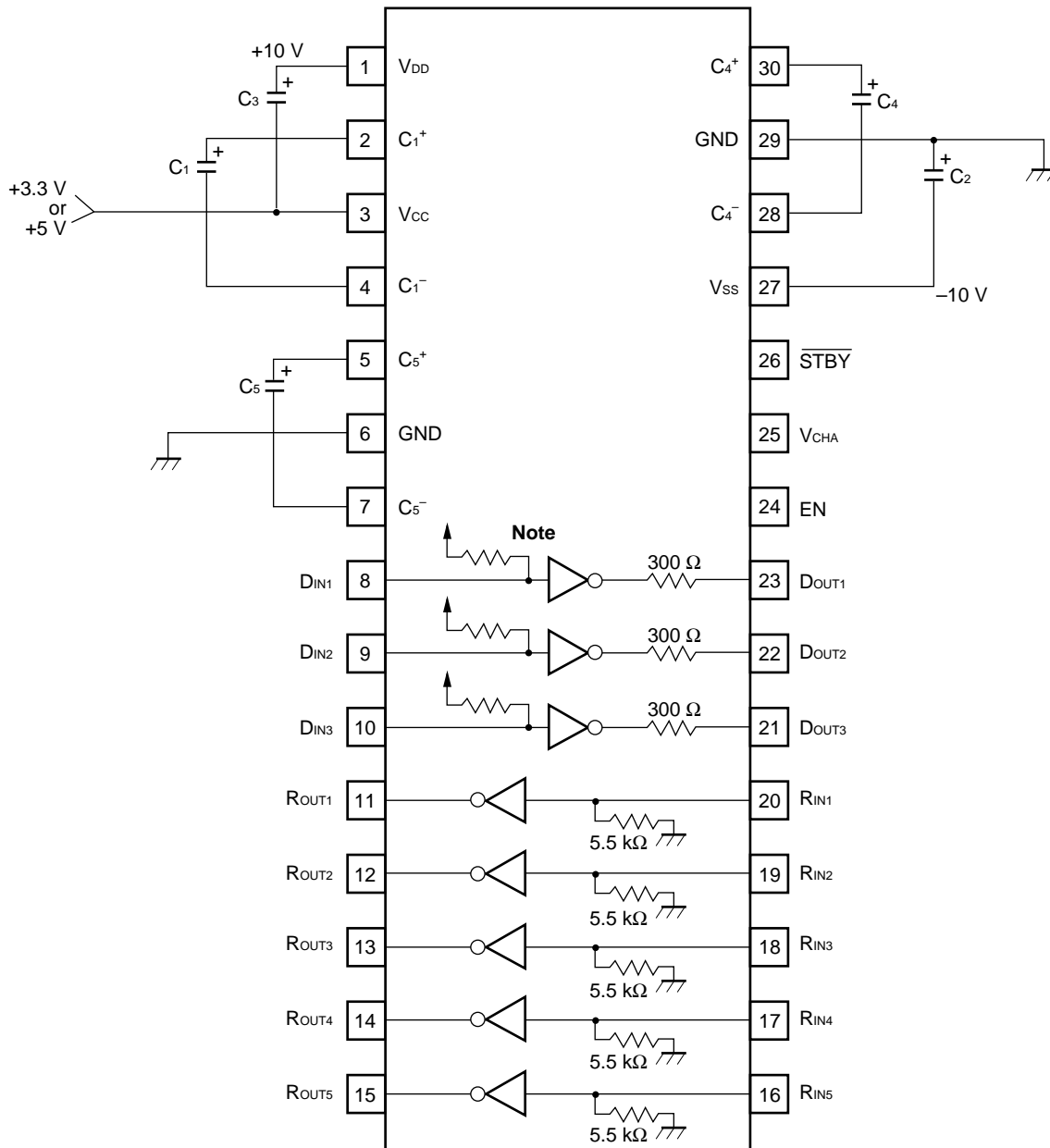
### FEATURES

- Based on EIA/TIA-232-E (RS-232-C) standard.
- Single power supply: +3.3 V or +5 V (selectable with the  $V_{CHA}$  pin)
- Standby mode: Setting the standby pin to low level switches this IC into the standby mode and makes the driver outputs high-impedance.
- Enable mode: When the enable pin is high level during the standby mode, two receivers can operate as inverters without hysteresis width (The other three receivers are fixed to high level).

### ORDERING INFORMATION

Part number	Package
$\mu$ PD4724GS-GJG	30-pin plastic shrink SOP (300 mil)

BLOCK DIAGRAM/PIN CONFIGURATION (TOP VIEW)



**Note** The pull-up resistors of the driver inputs are active resistors.

**Remark 1.** V<sub>DD</sub> and V<sub>SS</sub> are pins that output the voltage boosted internally. Don't connect these pins to the load.

2. Capacitors with a breakdown voltage of 20 V or higher are recommended for C<sub>1</sub> to C<sub>5</sub>. And it is recommended to insert the capacitor that is 0.1 μF to 1 μF between V<sub>CC</sub> and GND.
3. The capacitor C<sub>5</sub> does not have to be connected when the IC is used in 5 V mode (V<sub>CHA</sub> = L).

**TRUTH TABLE**

**Driver**

$\overline{\text{STBY}}$	D <sub>IN</sub>	D <sub>OUT</sub>	Remark
L	×	Z	Standby mode (D/D converter OFF)
H	L	H	Space level output
H	H	L	Mark level output

**Receiver**

$\overline{\text{STBY}}$	EN	R <sub>IN</sub>		R <sub>OUT</sub>		Remark
		R <sub>4</sub> to R <sub>5</sub>	R <sub>1</sub> to R <sub>3</sub>	R <sub>4</sub> to R <sub>5</sub>	R <sub>1</sub> to R <sub>3</sub>	
L	L	×	×	H	H	Standby mode1 (D/D converter OFF)
L	H	L	×	H	H	Standby mode2 (D/D converter OFF, R <sub>4</sub> and R <sub>5</sub> operate)
L	H	H	×	L	H	Standby mode2 (D/D converter OFF, R <sub>4</sub> and R <sub>5</sub> operate)
H	×	L		H		Mark level input
H	×	H		L		Space level input

**3 V and 5 V Switching<sup>Note</sup>**

V <sub>CHA</sub>	Operation mode
L	5 V mode (Double boost)
H	3 V mode (Triple boost)

H: High level, L: Low level, Z: High-impedance, ×: Don't care

**Note** Be sure to switch the V<sub>CHA</sub> pin in standby mode ( $\overline{\text{STBY}} = \text{L}$ ).

**ABSOLUTE MAXIMUM RATINGS (T<sub>A</sub> = +25 °C)**

Parameter	Symbol	Ratings	Unit
Supply Voltage (V <sub>CHA</sub> = L)	V <sub>CC</sub>	-0.5 to +7.0	V
Supply Voltage (V <sub>CHA</sub> = H)	V <sub>CC</sub>	-0.5 to +4.5	V
Driver Input Voltage	D <sub>IN</sub>	-0.5 to V <sub>CC</sub> + 0.5	V
Receiver Input Voltage	R <sub>IN</sub>	-30.0 to +30.0	V
Control Input Voltage ( $\overline{\text{STBY}}$ , V <sub>CHA</sub> , EN)	V <sub>IN</sub>	-0.5 to V <sub>CC</sub> + 0.5	V
Driver Output Voltage	D <sub>OUT</sub>	-25.0 to +25.0 <sup>Note</sup>	V
Receiver Output Voltage	R <sub>OUT</sub>	-0.5 to V <sub>CC</sub> + 0.5	V
Input Current (D <sub>IN</sub> , $\overline{\text{STBY}}$ , V <sub>CHA</sub> , EN)	I <sub>IN</sub>	±20.0	mA
Operating Temperature	T <sub>A</sub>	-40 to +85	°C
Storage Temperature	T <sub>stg</sub>	-55 to +150	°C
Power Dissipation	P <sub>T</sub>	0.5	W

**Note** Pulse width = 1 ms, duty cycle = 10 % MAX.

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage (V <sub>CHA</sub> = L, 5 V mode)	V <sub>CC</sub>	4.5	5.0	5.5	V
Supply Voltage (V <sub>CHA</sub> = H, 3 V mode)	V <sub>CC</sub>	3.0	3.3	3.6	V
High Level Input Voltage (D <sub>IN</sub> )	V <sub>IH</sub>	2.0		V <sub>CC</sub>	V
Low Level Input Voltage (D <sub>IN</sub> )	V <sub>IL</sub>	0		0.8	V
High Level Input Voltage ( $\overline{\text{STBY}}$ , V <sub>CHA</sub> , EN)	V <sub>IH</sub>	2.4		V <sub>CC</sub>	V
Low Level Input Voltage ( $\overline{\text{STBY}}$ , V <sub>CHA</sub> , EN)	V <sub>IL</sub>	0		0.6	V
Receiver Input Voltage	R <sub>IN</sub>	-30		+30	V
Operating Temperature	T <sub>A</sub>	-40		+85	°C
Capacitance of External Capacitor	<b>Note</b>	0.33		4.7	μF

**Note** If the use of an electrolytic capacitor at low temperature is likely, set the capacitance with sufficient margin, because the capacitance of an electrolytic capacitor is smaller at lower temperatures (0 °C or lower). Care must be taken to minimize the wiring length between the capacitor and this IC. Using capacitors of excellent high frequency characteristics (such as tantalum, multi-layer ceramic capacitors, and aluminum electrolytic capacitors for switching power supplies) is highly recommended.

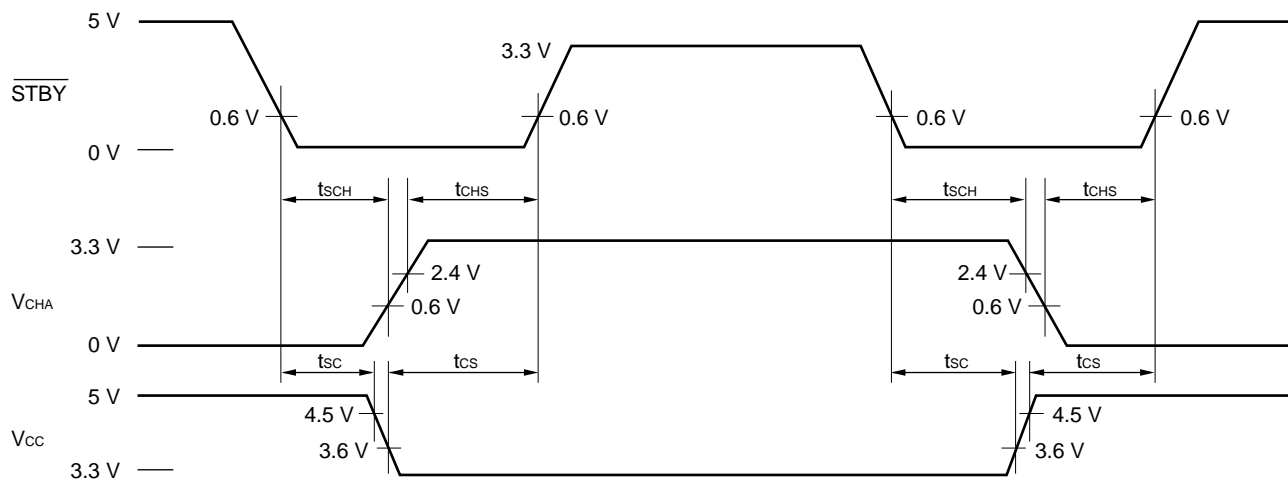
**ELECTRICAL SPECIFICATIONS FOR THE IC AS A WHOLE**

(T<sub>A</sub> = -40 to +85 °C and C<sub>1</sub> to C<sub>5</sub> = 1 μF Unless Otherwise Specified)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I <sub>CC1</sub>	V <sub>CC</sub> = +3.3 V, unloaded, R <sub>IN</sub> pin is open, $\overline{\text{STBY}} = \text{H}$		7.5	15	mA
		V <sub>CC</sub> = +5.0 V, unloaded, R <sub>IN</sub> pin is open, $\overline{\text{STBY}} = \text{H}$		5.5	11	mA
Circuit Current	I <sub>CC2</sub>	V <sub>CC</sub> = +3.3 V, R <sub>L</sub> = 3 kΩ(D <sub>OUT</sub> ), D <sub>IN</sub> = GND, R <sub>IN</sub> and R <sub>OUT</sub> pins are open, $\overline{\text{STBY}} = \text{H}$		25	35	mA
		V <sub>CC</sub> = +5.0 V, R <sub>L</sub> = 3 kΩ(D <sub>OUT</sub> ), D <sub>IN</sub> = GND, R <sub>IN</sub> and R <sub>OUT</sub> pins are open, $\overline{\text{STBY}} = \text{H}$		19	28	mA
Circuit Current at Standby (Standby Mode 1)	I <sub>CC3</sub>	V <sub>CC</sub> = +3.3 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = L, T <sub>A</sub> = 25 °C		1	3	μA
		V <sub>CC</sub> = +3.3 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = L		5		μA
		V <sub>CC</sub> = +5.0 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = L, T <sub>A</sub> = 25 °C		2	5	μA
		V <sub>CC</sub> = +5.0 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = L		10		μA
Circuit Current at Standby (Standby Mode 2)	I <sub>CC4</sub>	V <sub>CC</sub> = +3.3 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = H, T <sub>A</sub> = 25 °C		1	3	μA
		V <sub>CC</sub> = +3.3 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = H		5		μA
		V <sub>CC</sub> = +5.0 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = H, T <sub>A</sub> = 25 °C		2	5	μA
		V <sub>CC</sub> = +5.0 V, No load, D <sub>IN</sub> and R <sub>IN</sub> pins are OPEN, $\overline{\text{STBY}} = \text{L}$ , EN = H		10		μA
High Level Input Voltage	V <sub>IH</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, $\overline{\text{STBY}}$ , V <sub>CHA</sub> , and EN pins	2.4			V
Low Level Input Voltage	V <sub>IL</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, $\overline{\text{STBY}}$ , V <sub>CHA</sub> , and EN pins			0.6	V
High Level Input Current	I <sub>IH</sub>	V <sub>CC</sub> = +5.5 V, V <sub>I</sub> = +5.5 V, $\overline{\text{STBY}}$ , V <sub>CHA</sub> , and EN pins			1	μA
Low Level Input Current	I <sub>IL</sub>	V <sub>CC</sub> = +5.5 V, V <sub>I</sub> = 0 V, $\overline{\text{STBY}}$ , V <sub>CHA</sub> , and EN pins			-1	μA
Input Capacitance	C <sub>IN</sub>	Driver and receiver inputs, V <sub>CC</sub> = +3.3 V, to GND, f = 1 MHz			10	pF
		Driver and receiver inputs, V <sub>CC</sub> = +5.0 V, to GND, f = 1 MHz			10	pF
$\overline{\text{STBY}} - \text{V}_{\text{CHA}}$ Time	t <sub>SCH</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, $\overline{\text{STBY}} \downarrow \rightarrow \text{V}_{\text{CHA}}$ <sup>Note</sup>	1			μs
V <sub>CHA</sub> - $\overline{\text{STBY}}$ Time	t <sub>CHS</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, V <sub>CHA</sub> → $\overline{\text{STBY}} \uparrow$ <sup>Note</sup>	1			μs
$\overline{\text{STBY}} - \text{V}_{\text{CC}}$ Time	t <sub>SC</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, $\overline{\text{STBY}} \downarrow \rightarrow \text{V}_{\text{CC}}$ <sup>Note</sup>	1			μs
V <sub>CC</sub> - $\overline{\text{STBY}}$ Time	t <sub>CS</sub>	V <sub>CC</sub> = +3.0 to +5.5 V, V <sub>CC</sub> → $\overline{\text{STBY}} \uparrow$ <sup>Note</sup>	1			μs

**Remark** TYP. values are valid only at T<sub>A</sub> = 25 °C and should be used for reference only.

**Note** Test points for these parameters



ELECTRICAL SPECIFICATIONS FOR THE DRIVERS ( $T_A = -40$  to  $+85$  °C and  $C_1$  to  $C_5 = 1$  μF)3 V Mode ( $V_{CHA} = H$ ,  $V_{CC} = 3.0$  to  $3.6$  V Unless Otherwise Specified)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Low Level Input Voltage	$V_{IL}$				0.8	V
High Level Input Voltage	$V_{IH}$		2.0			V
Low Level Input Current	$I_{IL}$	$V_{CC} = +3.6$ V, $V_I = 0$ V			-25	μA
High Level Input Current	$I_{IH}$	$V_{CC} = +3.6$ V, $V_I = 3.6$ V			1.0	μA
Output Voltage	$V_{DO}$	$V_{CC} = +3.3$ V, $R_L = \infty$ , $T_A = 25$ °C		±9.5		V
		$V_{CC} = +3.3$ V, $R_L = 3$ kΩ, $T_A = T_{opt.}$	±5.0	±6.0		V
		$V_{CC} = +3.0$ V, $R_L = 3$ kΩ, $T_A = 25$ °C	±5.0			V
Output Short-Circuit Current	$I_{SC}$	$V_{CC} = +3.3$ V, to GND			±40	mA
Slew Rate <sup>Note 1</sup>	SR	$C_L = 10$ pF, $R_L = 3$ to $7$ kΩ	3.0		30	V/μs
		$C_L = 2500$ pF, $R_L = 3$ to $7$ kΩ	3.0		30	V/μs
Propagation Delay Time <sup>Note 1</sup>	$t_{PHL}$	$R_L = 3$ kΩ, $C_L = 2500$ pF		2.5		μs
	$t_{PLH}$					
Output Resistance	$R_O$	$V_{CC} = V_{DD} = V_{SS} = 0$ V $V_{OUT} = \pm 2$ V	300			Ω
Output Transfer Time in Standby State	$t_{DAZ}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 2</sup>		4	10	μs
Output Transfer Time in Standby State	$t_{DZA}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 2</sup>		1	3	ms
Power On Output Transfer Time	$t_{PRA}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 3</sup>		1	3	ms

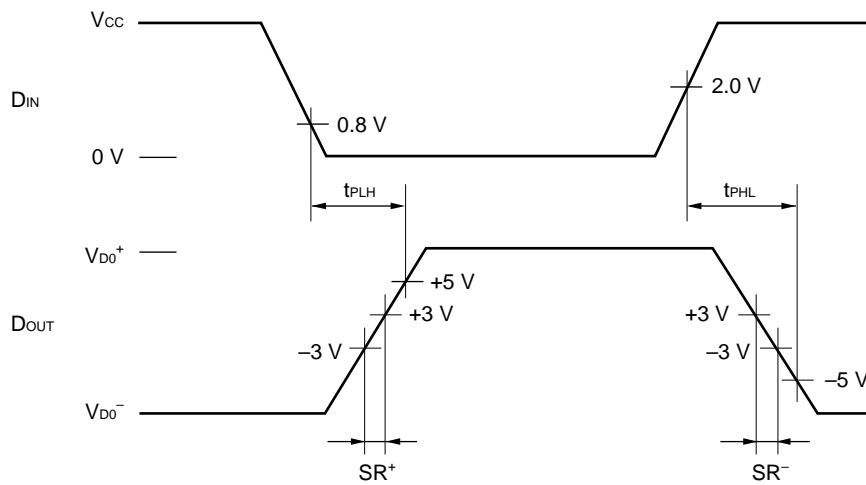
**Remark** TYP. values are valid only at  $T_A = 25$  °C and should be used for reference only.

5 V Mode ( $V_{CHA} = L$ ,  $V_{CC} = 5.0$  V ±10 % Unless Otherwise Specified)

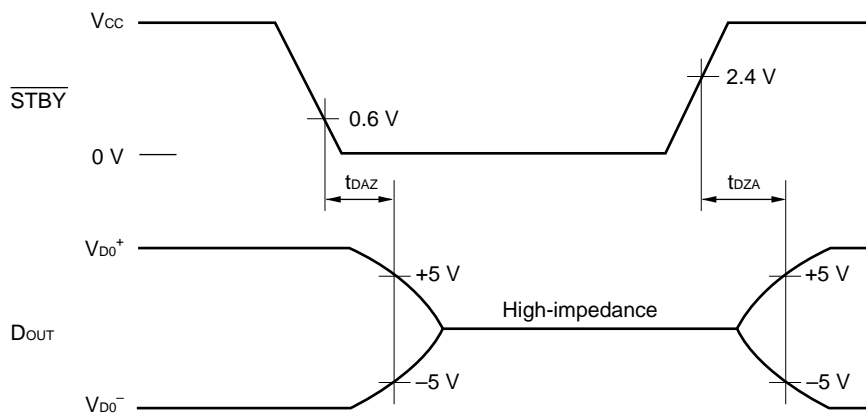
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Low Level Input Voltage	$V_{IL}$				0.8	V
High Level Input Voltage	$V_{IH}$		2.0			V
Low Level Input Current	$I_{IL}$	$V_{CC} = +5.5$ V, $V_I = 0$ V			-40	μA
High Level Input Current	$I_{IH}$	$V_{CC} = +5.5$ V, $V_I = 5.5$ V			1.0	μA
Output Voltage	$V_{DO}$	$V_{CC} = +5.0$ V, $R_L = \infty$ , $T_A = 25$ °C		±9.7		V
		$V_{CC} = +5.0$ V, $R_L = 3$ kΩ, $T_A = T_{opt.}$	±6.0			V
		$V_{CC} = +4.5$ V, $R_L = 3$ kΩ, $T_A = T_{opt.}$	±5.0			V
Output Short-Circuit Current	$I_{SC}$	$V_{CC} = +5.0$ V, to GND			±40	mA
Slew Rate <sup>Note 1</sup>	SR	$C_L = 10$ pF, $R_L = 3$ to $7$ kΩ	4.0		30	V/μs
		$C_L = 2500$ pF, $R_L = 3$ to $7$ kΩ	4.0		30	V/μs
Propagation Delay Time <sup>Note 1</sup>	$t_{PHL}$	$R_L = 3$ kΩ, $C_L = 2500$ pF		2		μs
	$t_{PLH}$					
Output Resistance	$R_O$	$V_{CC} = V_{DD} = V_{SS} = 0$ V $V_{OUT} = \pm 2$ V	300			Ω
Output Transfer Time in Standby State	$t_{DAZ}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 2</sup>		4	10	μs
Output Transfer Time in Standby State	$t_{DZA}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 2</sup>		0.5	1	ms
Power-On Output Transfer Time	$t_{PRA}$	$R_L = 3$ kΩ, $C_L = 2500$ pF, <sup>Note 2</sup>		0.5	1	ms

**Remark** TYP. values are valid only at  $T_A = 25$  °C and should be used for reference only.

**Note 1** Test points for slew rate,  $t_{PLH}$ , and  $t_{PLH}$



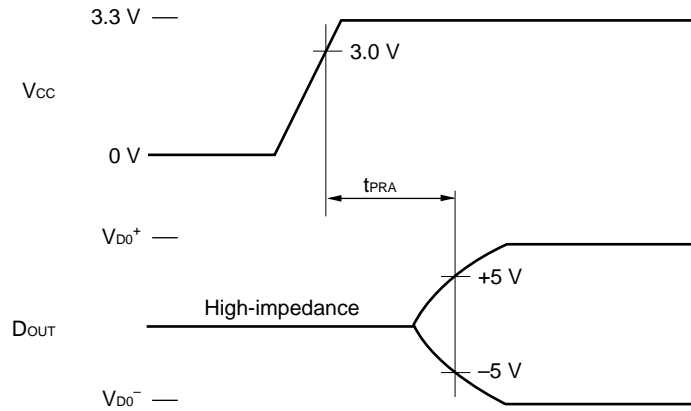
**Note 2** Test points for  $t_{DAZ}$ , and  $t_{DZA}$



Driver outputs are indefinite during transition time ( $t_{DZA}$ ).

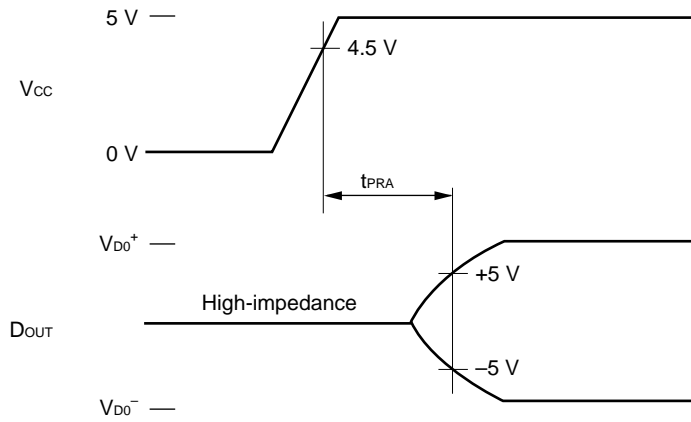


**Note 3** Test points for  $t_{PRA}$  in 3 V mode



Driver outputs are indefinite during transition time ( $t_{PRA}$ ).

**Note 4** Test points for  $t_{PRA}$  in 5 V mode



Driver outputs are indefinite during transition time ( $t_{PRA}$ ).

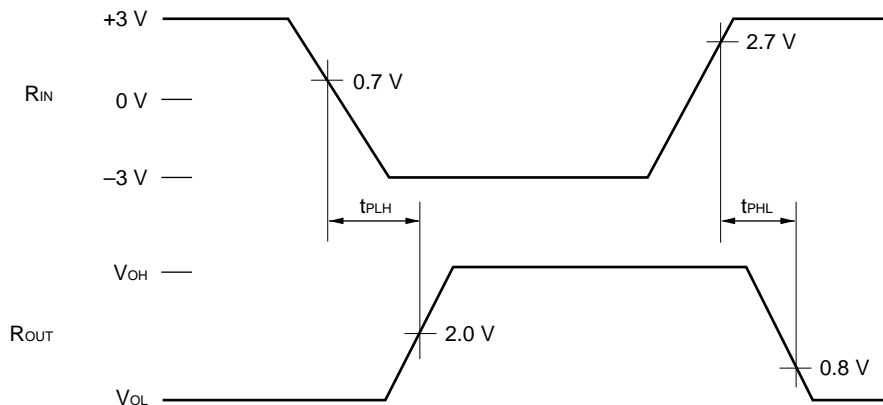
**ELECTRICAL SPECIFICATIONS FOR THE RECEIVERS**

(V<sub>CC</sub> = 3.0 to 5.5 V, T<sub>A</sub> = -40 to +85 °C and C<sub>1</sub> to C<sub>5</sub> = 1 μF Unless Otherwise Specified)

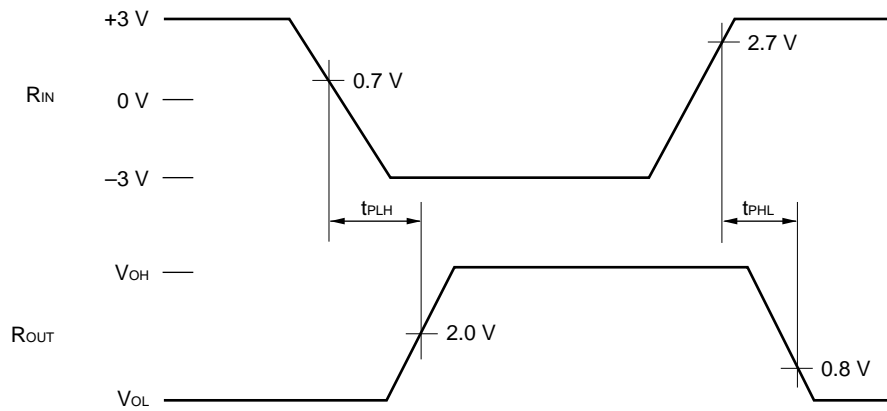
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Low Level Output Voltage	V <sub>OL1</sub>	I <sub>OUT</sub> = 4 mA			0.4	V
High Level Output Voltage	V <sub>OH1</sub>	I <sub>OUT</sub> = -4 mA	V <sub>CC</sub> -0.4			V
Low-Level Output Voltage	V <sub>OL2</sub>	I <sub>OUT</sub> = 4 mA, $\overline{\text{STBY}} = \text{L}$			0.5	V
High Level Output Voltage	V <sub>OH2</sub>	I <sub>OUT</sub> = -4 mA, $\overline{\text{STBY}} = \text{L}$	V <sub>CC</sub> -0.5			V
Propagation Delay Time (STBY = H)	t <sub>PHL</sub> t <sub>PLH</sub>	R <sub>IN</sub> → R <sub>OUT</sub> , C <sub>L</sub> = 150 pF V <sub>CC</sub> = +3.0 V, <b>Note 1</b>		0.2		μs
Propagation Delay Time (STBY = L)	t <sub>PHL</sub> t <sub>PLH</sub>	R <sub>IN</sub> → R <sub>OUT</sub> , C <sub>L</sub> = 150 pF V <sub>CC</sub> = +3.0 V, <b>Note 2</b>		0.1		μs
Propagation Delay Time (STBY = L)	t <sub>PHA</sub> t <sub>PAH</sub>	EN → R <sub>OUT</sub> , C <sub>L</sub> = 150 pF V <sub>CC</sub> = +3.0 V, <b>Note 3</b>		100	300	ns
Input Resistance	R <sub>I</sub>		3	5.5	7	kΩ
Input Terminal Release Voltage	V <sub>IO</sub>				0.5	V
Input Threshold Voltage (STBY = H)	V <sub>IH</sub>	V <sub>CC</sub> = +3.0 to + 5.5 V	1.7	2.3	2.7	V
	V <sub>IL</sub>	V <sub>CC</sub> = +3.0 to + 5.5 V	0.7	1.1	1.7	V
	V <sub>H</sub>	V <sub>CC</sub> = +3.0 to + 5.5 V (Hysteresis width)	0.5	1.2	1.8	V
Input Threshold Voltage (STBY = L, EN = H)	V <sub>IH</sub>	V <sub>CC</sub> = +3.0 to + 5.5 V	2.7	1.5		V
	V <sub>IL</sub>	V <sub>CC</sub> = +3.0 to + 5.5 V		1.5	0.7	V
Output Transition Time in Standby State	t <sub>DAH</sub>	<b>Note 4</b>		0.2	3	μs
Output Transition Time in Standby State	t <sub>DHA</sub>	V <sub>CHA</sub> = H (3 V mode), <b>Note 4</b>		0.6	3	ms
		V <sub>CHA</sub> = L (5 V mode), <b>Note 4</b>		0.3	1	ms
Power-On Reset Release Time	t <sub>PRA</sub>	V <sub>CHA</sub> = H (3 V mode), <b>Note 5</b>		1	3	ms
		V <sub>CHA</sub> = L (5 V mode), <b>Note 6</b>		0.5	1	ms

**Remark** TYP. values are valid only at T<sub>A</sub> = 25 °C and should be used for reference only.

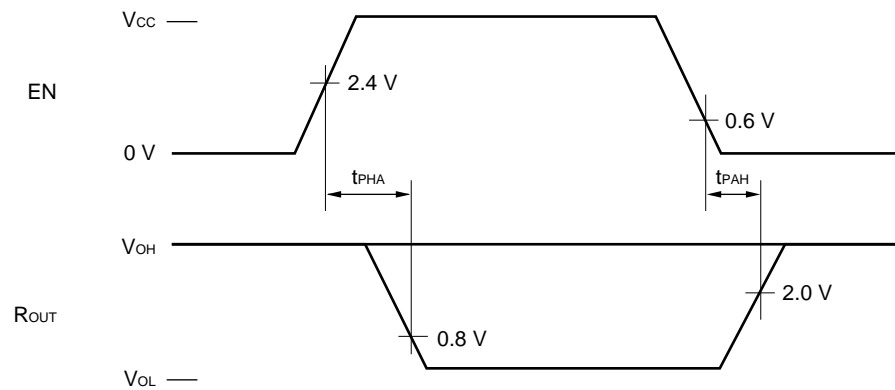
**Note 1** Test points for t<sub>PHL</sub>, t<sub>PLH</sub>



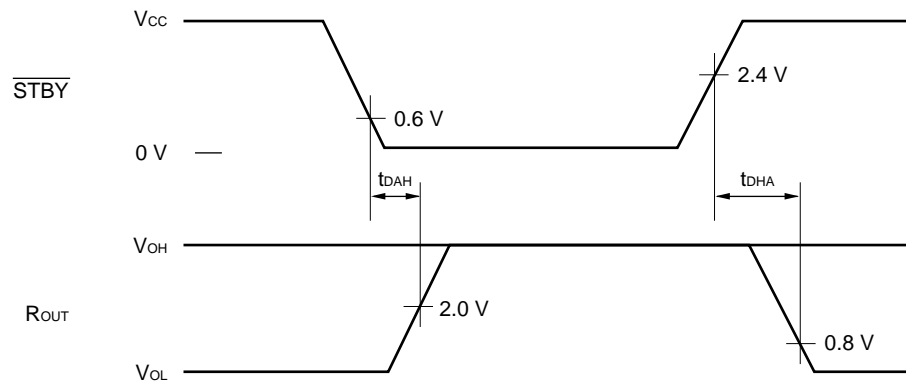
**Note 2** Test points for  $t_{PHL}$ ,  $t_{PLH}$



**Note 3** Test points for  $t_{PHA}$ ,  $t_{PAH}$

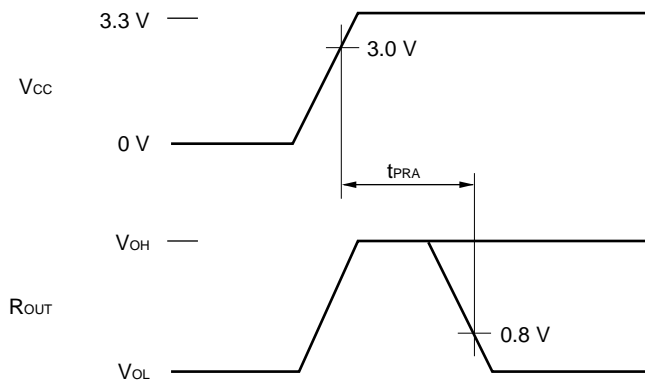


**Note 4** Test points for  $t_{DAH}$ ,  $t_{DHA}$



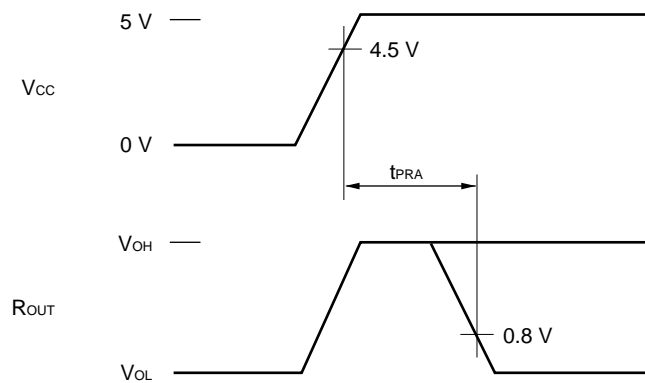
Receiver outputs are indefinite during transition time ( $t_{DHA}$ ).

**Note 5** Test points for  $t_{PRA}$  in 3 V mode



Receiver outputs are indefinite during reset release time ( $t_{PRA}$ ).

**Note 6** Test points for  $t_{PRA}$  in 5 V mode



Receiver outputs are indefinite during reset release time ( $t_{PRA}$ ).

**REFERENCE MATERIAL**

- IC PACKAGE MANUAL (C10943X)
- NEC SEMICONDUCTOR DEVICE RELIABILITY/QUALITY (IEI-1212)

**RECOMMENDED SOLDERING CONDITIONS**

The following conditions (see table below) must be met when soldering this product. Please consult with our sales offices in case other soldering process is used, or in case soldering is done under different conditions.

**TYPES OF SURFACE MOUNT DEVICE**

For more details, refer to our document "SMT MANUAL" (C10535E).

**μPD4724GS-GJG**

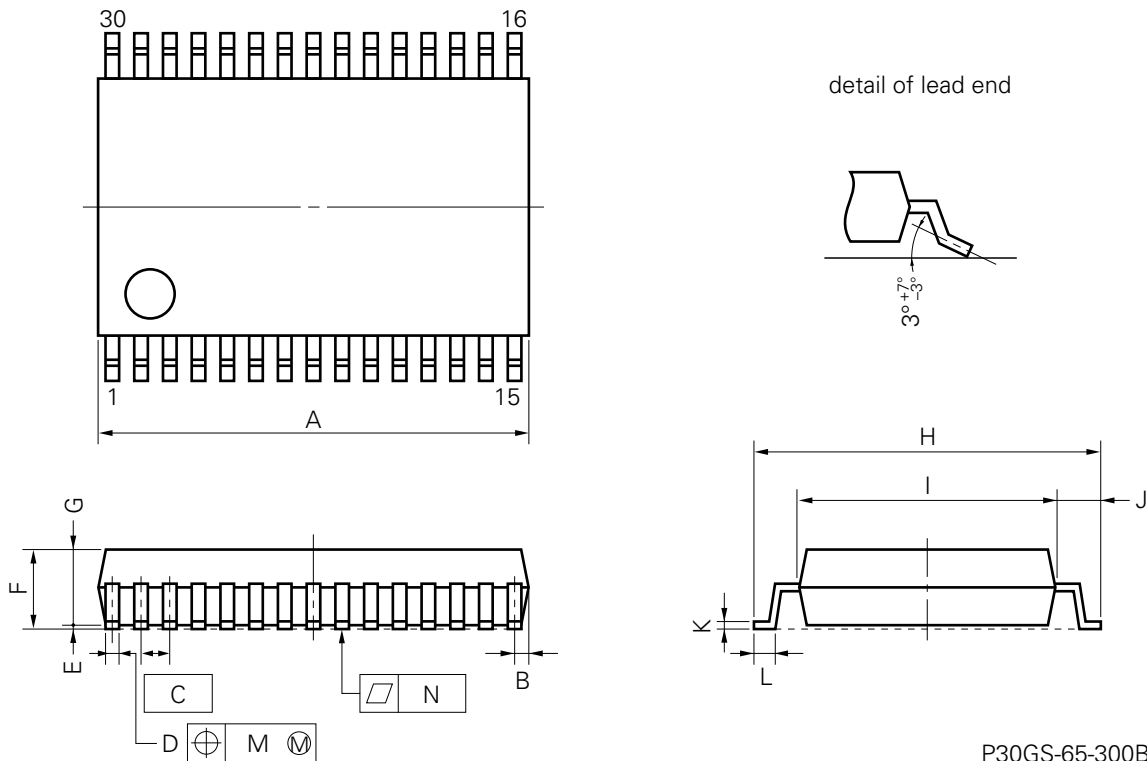
Soldering process	Soldering conditions	Symbol
Infrared ray reflow	Peak package's surface temperature: 230 °C or below, Reflow time: 30 seconds or below (210 °C or higher), Number of reflow process: 2, Exposure limit*: None	IR30-00-2
VPS	Peak package's surface temperature: 215 °C or below, Reflow time: 40 seconds or below (200 °C or higher), Number of reflow process: 2, Exposure limit*: None	VP15-00-2
Wave soldering	Solder temperature: 260 °C or below, Flow time: 10 seconds or below, Number of flow process: 1, Exposure limit*: None	WS60-00-1
Partial heating method	Terminal temperature: 300 °C or below, Flow time: 10 seconds or below, Exposure limit*: None	○

\* Exposure limit before soldering after dry-pack package is opened.

Storage conditions: 25 °C and relative humidity at 65 % or less.

**Note** Do not apply more than a single process at once, except for "Partial heating method".

30 PIN PLASTIC SHRINK SOP (300 mil)



**NOTE**

Each lead centerline is located within 0.10 mm (0.004 inch) of its true position (T.P.) at maximum material condition.

P30GS-65-300B-1

ITEM	MILLIMETERS	INCHES
A	10.11 MAX.	0.398 MAX.
B	0.51 MAX.	0.020 MAX.
C	0.65 (T.P.)	0.026 (T.P.)
D	0.30 <sup>+0.10</sup> <sub>-0.05</sub>	0.012 <sup>+0.004</sup> <sub>-0.003</sub>
E	0.125±0.075	0.005±0.003
F	2.0 MAX.	0.079 MAX.
G	1.7±0.1	0.067±0.004
H	8.1±0.2	0.319±0.008
I	6.1±0.2	0.240±0.008
J	1.0±0.2	0.039 <sup>+0.009</sup> <sub>-0.008</sub>
K	0.15 <sup>+0.10</sup> <sub>-0.05</sub>	0.006 <sup>+0.004</sup> <sub>-0.002</sub>
L	0.5±0.2	0.020 <sup>+0.008</sup> <sub>-0.009</sub>
M	0.10	0.004
N	0.10	0.004

[MEMO]

No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.

NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation or others.

While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.

NEC devices are classified into the following three quality grades:

"Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device before using it in a particular application.

Standard: Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots

Special: Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support)

Specific: Aircrafts, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems or medical equipment for life support, etc.

The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.

Anti-radioactive design is not implemented in this product.