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TANDEM 64-TAP DIGITAL POTENTIOMETER

Check for Samples: TPL8002-25

FEATURES

- Adjustable Gain From 23.25 dB to –24 dB
- 64-Tap Positions With 0.75 dB Per Step
- Supports 8-MHz Analog Bandwidth
- Operating Range up to -4-V V_{EE}/+4-V V_{DD}
- 100-µA Maximum Static Supply Current
- ±30% End-to-End Resistance Tolerance
- Absolute Tolerance of ±0.3 dB
- Operating Temperature Range From _40°C to 85°C
- ESD Performance Tested Per JESD 22
 - 2000-V Human-Body Model (A114-B,Class II)

APPLICATIONS Tandem Adjusta

 Tandem Adjustable Feedback and Gain Resistors for Operational Amplifers

	PW PACKAG (TOP VIEW)	E		
RG1 💷	1	16		GND
RF1 🗆	2	15		А
RSW1 🗆	3	14		В
V _{DD}	4	13		С
V _{EE}	5	12		D
RSW2 🖂	6	11		E
RF2 🗆	7	10		F
RG2 🖂	8	9		GND
	- 49-1		2.4	

DESCRIPTION/ORDERING INFORMATION

The TPL8002-25 is a programmable resistor device implementing two digital potentiometers with 64 wiper positions each that are tandem controlled through a 6-bit parallel interface. The device has fixed wiper resistances at the respective wiper contacts that tap the potentiometer resistors at a point determined by the binary code present at its digital inputs.

The resistive wiper tap terminals, RSW, of the TPL8002-25 are typically connected to the inverting inputs (–) of an external differential path inverting operational amplifier configuration, with the non-inverting inputs (+) connected through to ground. The application's differential input to the configuration is the device's RG terminals. The differential output of the external operational amplifiers is connected to the device's RF terminals, and thus becomes the differential output of the application configuration.

The resistance between the wiper contacts and the end points RG and RF of the TPL8002-25 provides a logarithmic gain/attenuation response of the configuration. With a digital code of decimal 0 (b000000) the configuration has an inverting maximum attenuation of -24 dB. With a digital code of decimal 32 (b100000) the configuration has inverting unity gain of 0.00 dB. With a digital code of decimal 63 (b111111) the configuration has an inverting maximum gain of +23.25 dB. The response of the configuration with respect to the digital code varies in fixed steps of 0.75 dB.

	ORDERING INFORMATION								
T _A PACKAGE ^{(1) (2)}				ORDERABLE PART NUMBER	TOP-SIDE MARKING				
	–40°C to 85°C	TSSOP – PW	Tape and reel	TPL8002-25PWR	PHY03A				

(1) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at www.ti.com.



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TEXAS INSTRUMENTS

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FUNCTION TABLE

DECIMAL **FEDCBA** GAIN/ATTN (dB) R_F (Ω) R_G (Ω) CONTROL 23.25 22.5 21.75 20.25 19.5 18.75 17.25 16.5 15.75 14.25 13.5 12.75 11.25 10.5 9.75 8.25 7.5 6.75 5.25 4.5 3.75 2.25 1.5 0.75 -0.75 -1.5 -2.25 -3 -3.75 -4.5 -5.25 -6 -6.75 -7.5 -8.25 -9

Table 1. Switch Truth Table

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Table 1. Switch Truth Table (continued)

DECIMAL CONTROL	FEDCBA	GAIN/ATTN (dB)	R _G (Ω)	R _F (Ω)
19	010011	-9.75	1886	614
18	010010	-10.5	1925	575
17	010001	-11.25	1963	537
16	010000	-12	1998	502
15	001111	-12.75	2032	468
14	001110	-13.5	2064	436
13	001101	-14.25	2094	406
12	001100	-15	2123	377
11	001011	-15.75	2149	351
10	001010	-16.5	2175	325
9	001001	-17.25	2198	302
8	001000	-18	2220	280
7	000111	-18.75	2241	259
6	000110	-19.5	2261	239
5	000101	-20.25	2279	221
4	000100	-21	2295	205
3	000011	-21.75	2311	189
2	000010	-22.5	2326	174
1	000001	-23.25	2339	161
0	000000	-24	2352	148



SLIS133-NOVEMBER 2009

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ABSOLUTE MAXIMUM RATINGS⁽¹⁾ ⁽²⁾

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
$V_{DD} - V_{EE}$	Power supply delta voltage ⁽³⁾			10	V
V _{DD}	Positive supply voltage range ⁽³⁾	-0.3	5	V	
V _{EE}	Negative supply voltage range ⁽³⁾	0.3	-5	V	
V _{IN}	Control input voltage range ^{(2) (3)}	-0.3	V _{DD} + 0.3	V	
V _{I/O}	Resistor I/O voltage range ^{(2) (3) (4)}		V _{EE} - 0.3	V _{DD} + 0.3	V
I _{IK}	Control input clamp current	$V_{IN} < 0$ and $V_{I/O} < 0$		-18	mA
I _{I/OK}	I/O port clamp current	$V_{IN} < 0$ and $V_{I/O} < 0$		-18	mA
T _{stg}	Storage temperature range		-40	85	°C

(1) Stresses beyond those listed under "absolute maximum ratings" 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.

(2) All voltages are with respect to ground, unless otherwise specified.

(3) The input and output voltage ratings may be exceeded if the input and output clamp-current ratings are observed.

(4) V_1 and V_0 are used to denote specific conditions for $V_{1/0}$.

RECOMMENDED OPERATING CONDITIONS

over operating free-air temperature range (unless otherwise noted)

		MIN	TYP	MAX	UNIT
$V_{DD} - V_{EE}$	Power supply delta voltage			8	V
V _{DD}	Positive supply voltage	2.5	3.6	4	V
V _{EE}	Negative supply voltage	-2.5	-3.6	-4	V
VIH	High-level control input voltage	$V_{DD} \times 0.65$			V
VIL	Low-level control input voltage			$V_{DD} \times 0.35$	V
VI	Control input voltage	GND		V _{DD}	V
V _{I/O}	Resistor inputs/outputs	V _{EE}		V _{DD}	V
T _A	Operating free-air temperature	-40		85	°C



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ELECTRICAL CHARACTERISTICS Dual ±4-V Supply

over operating free-air temperature range (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{IK}	Control inputo	$V_{DD} = 4 V, I_{IN} = -18 mA$			-1.8	V
I _{IN}		$V_{DD} = 4 V, V_{IN} = V_{DD} \text{ or } GND$			±1	μA
I_{DD} + $ I_{EE} $		$V_{DD} = 4 \text{ V}, \text{ V}_{EE} = -4 \text{ V}, \text{ V}_{IN} = V_{DD} \text{ or GND}, \text{ I}_{I/O} = 0$			100	μA
C _{IN}	Control capacitance ⁽¹⁾	$V_{DD} = 4 V, V_{IN} = V_{DD} \text{ or GND}$		3.2		pF
C _{RG}	RG capacitance ⁽¹⁾	V _{IN} = 0 V, frequency = 10 MHz		45		pF
C _{RF}	RF capacitance ⁽¹⁾	V _{IN} = 0 V, frequency = 10 MHz		45		pF
C _W	Wiper capacitance ⁽¹⁾	V _{IN} = 0 V, frequency = 10 MHz		45		pF
R	End-to-end resistance		1.75	2.5	3.25	kΩ
R _W	Wiper resistance				420	Ω
INL	Integral nonlinearity		-0.3		0.3	dB
DNL	Differential nonlinearity		-0.3		0.3	dB

(1) The AC method is a frequency domain measurement. A 10-MHz ac voltage signal of known dc offset and amplitude of 82.5 mV are applied to the pin under test. The imaginary component of the complex current is measured and used in the equation: C = I_{im} / (2 × π × F × V_{IN}) where I_{im} = imaginary component of input current, V_{IN} = magnitude of input voltage, and F = frequency.

SWITCHING CHARACTERISTICS⁽¹⁾

over operating free-air temperature range (unless otherwise noted)

	PARAMETER	TEST CONDITIONS	MIN	TYP MAX	UNIT
t _{PS}	Contol to output step delay			100	ns
BW	Analog signal bandwidth	For a typical example, see Figure 2	8		MHz

(1) Typical bandwidth shown in Figure 2 supports 6 MHz minimum.



TPL8002-25

SLIS133-NOVEMBER 2009

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4 V -4 V V_{DD} V_{EE} Absolute tolerance is used to compare v_{IN} measured gain versus expected gain. $\wedge \wedge \wedge$ R_g R_{sw} Binary Control dB_{CALCULATED} V_{sw} 000000 R_f –24 dB BW : 0.75 dB/step 23.25 dB 111111 ÷ -Absolute tolerance = $dB_{CALCULATED} - dB_{MEASURED}$ Control V_{CTRL} • Л Circuitry Position • Decoder $dB_{MEASURED} = -20*LOG((V_{IN} - V_{SW})/(V_{IN}))$ GND ÷

PARAMETER MEASUREMENT INFORMATION





Figure 2. Bandwidth Setup

PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins F	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
TPL8002-25PWR	ACTIVE	TSSOP	PW	16	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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TAPE AND REEL INFORMATION





QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All	dimensions	are	nominal	
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Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPL8002-25PWR	TSSOP	PW	16	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1



PACKAGE MATERIALS INFORMATION

30-Jul-2010



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPL8002-25PWR	TSSOP	PW	16	2000	346.0	346.0	29.0

MECHANICAL DATA

<u> 查询"TPL8002-25"供应商</u>

MTSS001C - JANUARY 1995 - REVISED FEBRUARY 1999

PLASTIC SMALL-OUTLINE PACKAGE

PW (R-PDSO-G**)

14 PINS SHOWN



NOTES: A. All linear dimensions are in millimeters.

- B. This drawing is subject to change without notice.
- C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
- D. Falls within JEDEC MO-153



LAND PATTERN DATA

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PW (R-PDSO-G16) PLASTIC SMALL OUTLINE Stencil Openings (Note D) Example Board Layout (Note C) 16x0,30 -14x0,65 -14x0,65 16x1,55 5,60 5,60 Example Non Soldermask Defined Pad Example Pad Geometry (See Note C) 0,35 Example 1,60 Solder Mask Opening (See Note E) 0,07 All Around 4211284-3/C 11/10

NOTES: A. All linear dimensions are in millimeters.

- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate designs.
- D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
 E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.



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