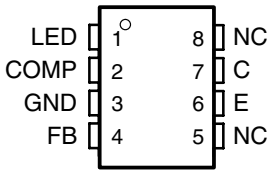
- **TL1431 Precision Programmable Reference (2.5 V) and an Optocoupler in a Single Package**
- **Reference Voltage Tolerance**
  - **TPS5904 0.8%**
  - **TPS5904A 0.4%**
- **Controlled Optocoupler CTRs:**
  - **TPS5904 100% to 400%**
  - **TPS5904A 150% to 300%**
- **High Withstand Voltage (WTV), 7500 V Peak for 1 Minute**
- **Safety Regulatory Approvals**
  - **UL . . . File Number E65085**
  - **FIMKO, SEMKO, NEMKO, DEMKO**
    - **EN60065/IEC 65**
    - **EN60950/IEC 950**
  - **VDE 0884, Level 4 (6000-V Insulation)**

DCS OR P PACKAGE
(TOP VIEW)



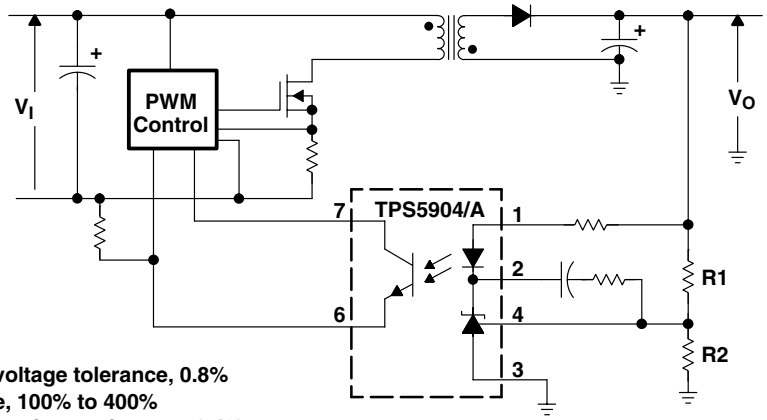
NC – No internal connection

description

The TPS5904 and TPS5904A optoisolated feedback amplifiers consist of the industry standard TL1431 precision programmable reference and an optocoupler. Reference-voltage tolerance for the TPS5904 is 0.8%, and for the TPS5904A, 0.4%. The devices are primarily intended for use as the error-amplifier/reference/isolation-amplifier element in isolated ac-to-dc power supplies and dc/dc converters. The optocoupler is a gallium-arsenide (GaAs) light-emitting diode that emits at a wavelength of 940 nm, combined with a silicon phototransistor. The current transfer ratio (CTR) ranges from 100% to 400% in the standard version. The TPS5904A version with a 150%-to-300% CTR is available for higher-performance applications. When using the TPS5904 or TPS5904A, power-supply designers can reduce component count and save space in tightly packaged designs. The tight-tolerance reference eliminates the need for adjustments in many applications.

The TPS5904 and TPS5904A are characterized for operation from –40°C to 100°C. Each device is supplied in an 8-pin DIP or in an 8-pin gull-wing surface-mount package (DCS).

typical application



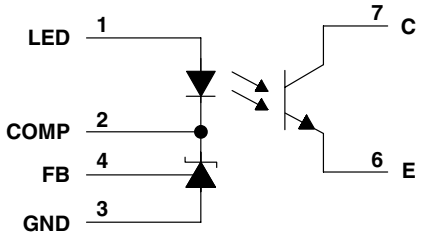
TPS5904: Reference-voltage tolerance, 0.8%
CTR Range, 100% to 400%
TPS5904A: Reference-voltage tolerance, 0.4%
CTR Range, 150% to 300%

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

Copyright © 1998, Texas Instruments Incorporated

functional block diagram



Terminal Functions

TERMINAL NAME	TERMINAL NO.	I/O	DESCRIPTION
C	7		Phototransistor collector
COMP	2	O	Light-emitting diode and TL431 cathodes
E	6		Phototransistor emitter
FB	4	I	Feedback
GND	3		Ground
LED	1	I	Light-emitting diode anode
NC	5, 8		No connection

absolute maximum ratings at 25°C free-air temperature (unless otherwise noted)†

Input power dissipation at (or below) T_A = 25°C (see Note 1) . . . . . 250 mW
Input LED current, $I_{I(LED)}$ . . . . . 50 mA
Input LED voltage, $V_{I(LED)}$ . . . . . 37 V
Input diode reverse voltage . . . . . 6 V
Output power dissipation at (or below) T_A = 25°C (see Note 2) . . . . . 150 mW
Output collector-to-emitter voltage . . . . . 35 V
Output emitter-to-collector voltage . . . . . 7 V
Output collector current . . . . . 50 mA
Total continuous power dissipation at (or below) T_A = 25°C (see Note 3) . . . . . 350 mW
Operating free-air temperature range, T_A . . . . . −40°C to 100°C
Storage temperature range, T_{stg} . . . . . −55°C to 150°C
Total input-to-output voltage . . . . . 7.5 kV peak or dc (5.3 kVrms)
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C
Flammability . . . . . (see Note 4)

† 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.

NOTES: 1. Derate linearly from 25°C at a rate of 2.95 mW/°C.
2. Derate linearly from 25°C at a rate of 1.76 mW/°C.
3. Derate linearly from 25°C at a rate of 4.12 mW/°C.
4. Optocoupler total-package flame retardancy is tested to IEC695-2-2 using a flame application time of 30 seconds. Outer mold compound is verified to meet UL 94V-0.

electrical characteristics, T_A = 25°C (unless otherwise noted)

input

PARAMETER			TEST CONDITIONS		MIN	TYP	MAX	UNIT
V_F	Light-emitting diode forward voltage		$V_{O(COMP)} = V_{I(FB)}$, See Figure 1	$I_{I(LED)}$ = 10 mA,		1.2	1.4	V
I_R	Light-emitting diode reverse current		V_R = 6 V				10	μA
V_{ref}	Reference voltage	TPS5904	$V_{O(COMP)} = V_{I(FB)}$, See Figure 1	$I_{I(LED)}$ = 10 mA,	2.48	2.5	2.52	V
		TPS5904A			2.49	2.5	2.51	
$V_{ref(dev)}$	Deviation of reference voltage over temperature		$V_{O(COMP)} = V_{I(FB)}$, T_A = 25°C to 100°C,	$I_{I(LED)}$ = 10 mA, See Figure 1		25		mV
$\frac{\Delta V_{ref}}{\Delta V_{I(LED)}}$	Ratio of reference voltage change-to-change in input light-emitting-diode voltage		$\Delta V_{I(LED)}$ = 4 V to 37 V, See Figure 2	$I_{I(LED)}$ = 10 mA,		–1.1	–2	mV/V
$I_{I(FB)}$	Feedback input current		$I_{I(LED)}$ = 10 mA, See Figure 3	R3 = 10 kΩ ,		1.5	3	μA
$I_{ref(dev)}$	Deviation of reference input current over temperature		$I_{I(LED)}$ = 10 mA, T_A = 25°C to 100°C,	R3 = 10 kΩ, See Figure 3		0.5		μA
$I_{DRV(min)}$	Minimum drive current		$V_{O(COMP)} = V_{I(FB)}$,	See Figure 1		0.45	1	mA
$I_{I(off)}$	Off-state input light-emitting-diode current		$V_{I(LED)}$ = 37 V, See Figure 4	$V_{I(FB)}$ = 0,		0.18	0.5	μA
$\lvert Z_{ka}\rvert$†	Regulator output impedance		$V_{O(COMP)} = V_{I(FB)}$, $I_{O(COMP)}$ = 1 mA to 50 mA	f ≤ 1 kHz,		0.1		Ω

† This symbol is not currently listed within EIA or JEDEC standards for semiconductor symbology.

output

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
I_{CEO}	Collect dark current	V_{CE} = 35 V,	See Figure 5			100	nA
$V_{(BR)ECO}$	Emitter-collector voltage breakdown	I_E = 100 μA		7			V

coupler

PARAMETER			TEST CONDITIONS		MIN	TYP	MAX	UNIT
CTR	Current transfer ratio	TPS5904	$V_{O(COMP)} = V_{I(FB)}$, V_{CE} = 5 V,	$I_{I(LED)}$ = 5 mA, See Figure 6	100%		400%	
		TPS5904A			150%		300%	
$V_{CE(sat)}$	Collector-emitter saturation voltage		$V_{O(COMP)} = V_{I(FB)}$, I_C = 1 mA,	$I_{I(LED)}$ = 10 mA, See Figure 6		0.1	0.2	V
V_{iso}†	Isolation voltage		I_{IO} = 10 μA,	f = 60 Hz	7500			V
C_{io}	Input to output capacitance		V_{IO} = 0,	f = 1 kHz		0.6		pF

† This symbol is not currently listed within EIA or JEDEC standards for semiconductor symbology.

PARAMETER MEASUREMENT INFORMATION

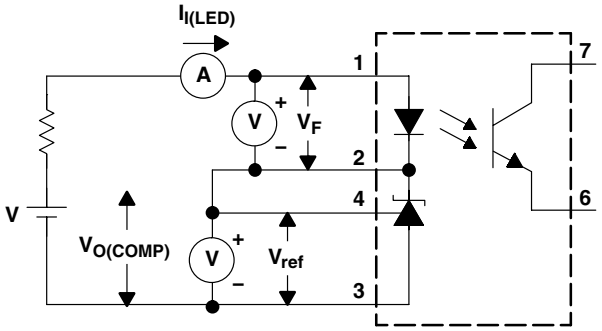


Figure 1. V_{ref}, V_F, I_{min} Test Circuit

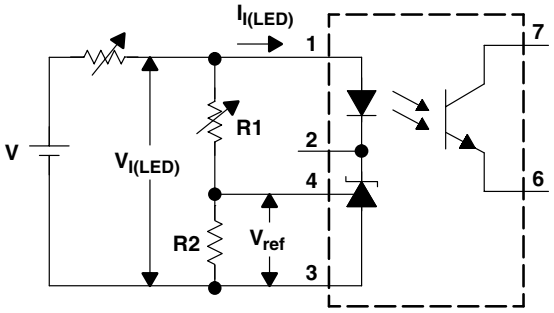


Figure 2. $\Delta V_{ref}/\Delta V_{I(LED)}$ Test Circuit

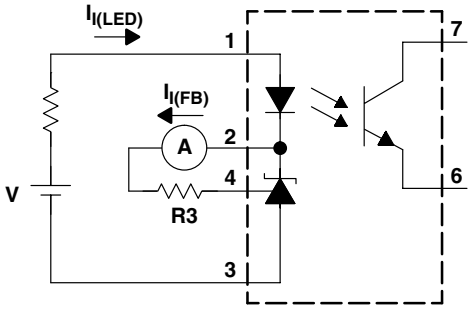


Figure 3. $I_{I(FB)}$ Test Circuit

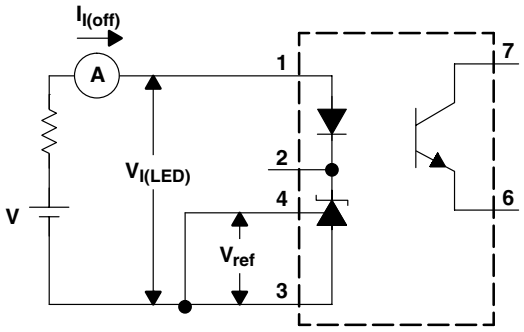


Figure 4. $I_{I(off)}$ Test Circuit

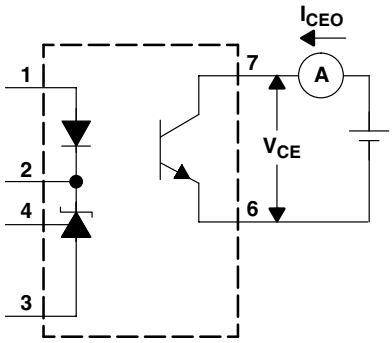


Figure 5. I_{CEO} Test Circuit

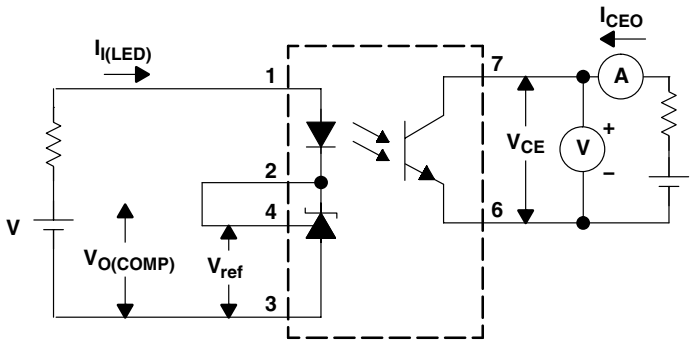


Figure 6. CTR, $V_{CE(sat)}$ Test Circuit

TYPICAL CHARACTERISTICS

INPUT LIGHT-EMITTING-DIODE CURRENT vs REFERENCE VOLTAGE

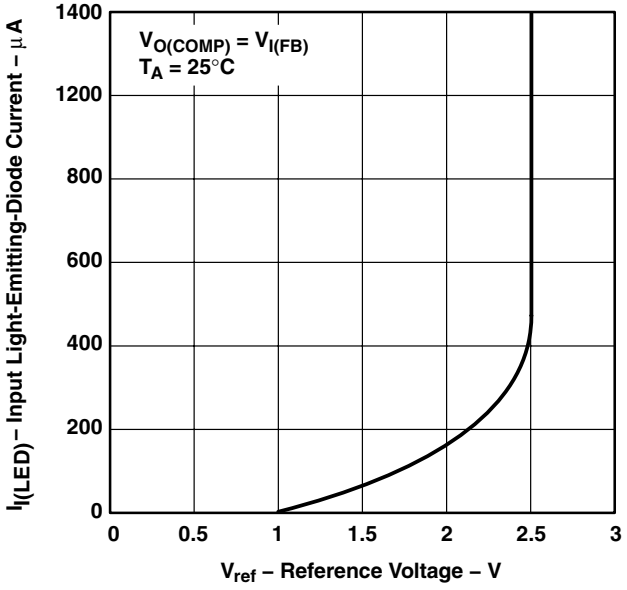


Figure 7

INPUT LIGHT-EMITTING-DIODE CURRENT vs REFERENCE VOLTAGE

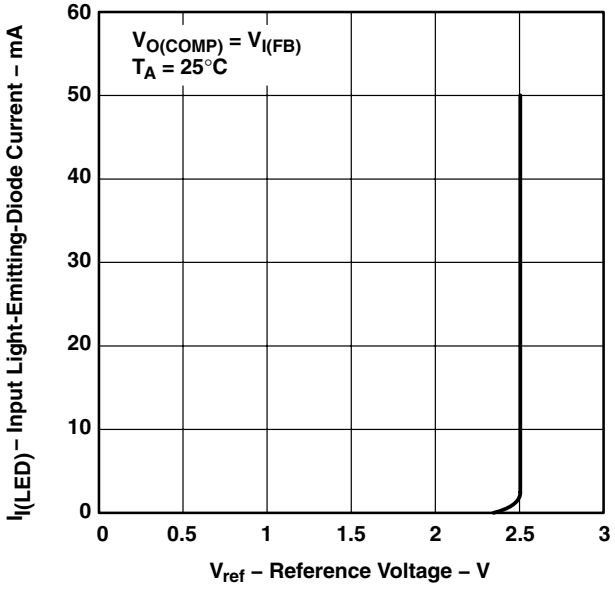


Figure 8

REFERENCE VOLTAGE vs FREE-AIR TEMPERATURE

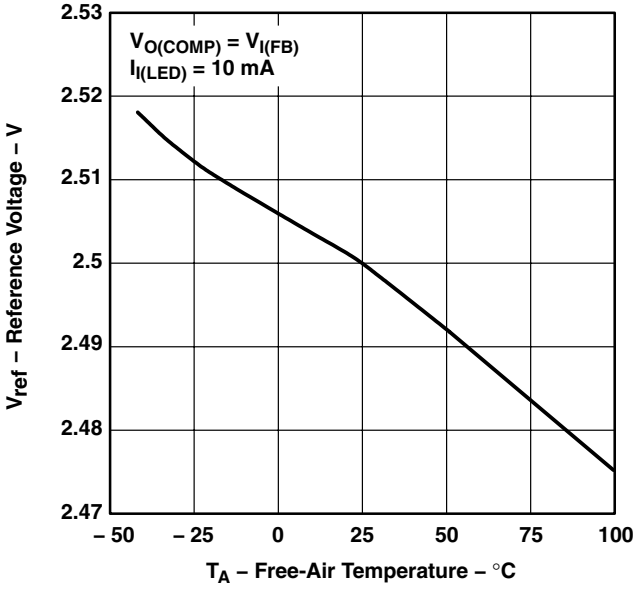


Figure 9

RATIO OF DELTA REFERENCE VOLTAGE TO DELTA LED VOLTAGE vs FREE-AIR TEMPERATURE

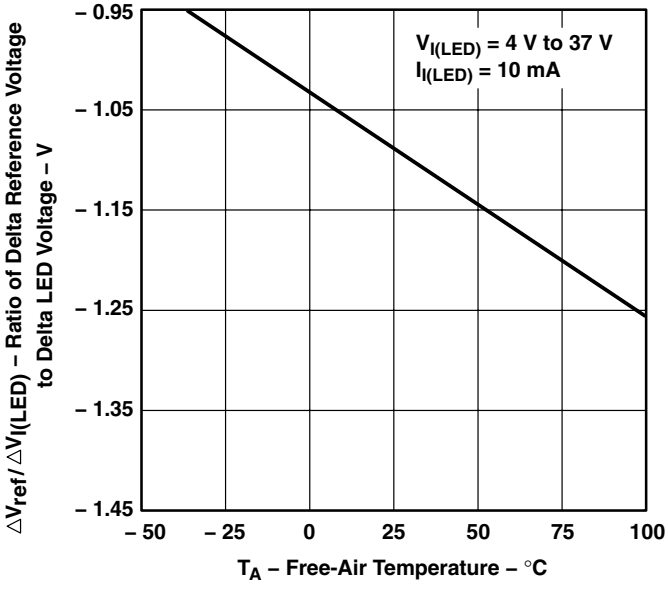


Figure 10

TYPICAL CHARACTERISTICS

REFERENCE CURRENT vs FREE-AIR TEMPERATURE

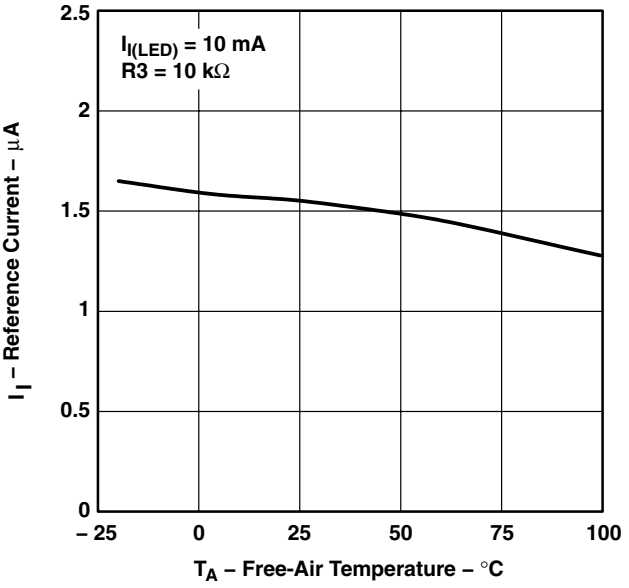


Figure 11

OFF-STATE INPUT LIGHT-EMITTING-DIODE CURRENT vs FREE-AIR TEMPERATURE

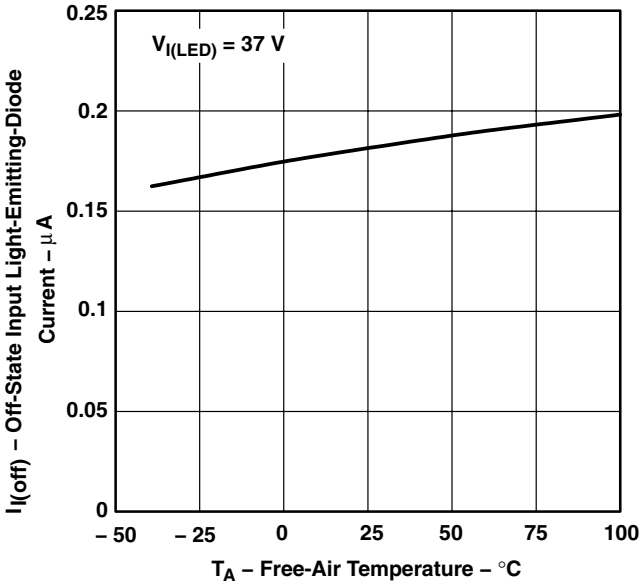


Figure 12

COLLECTOR DARK CURRENT vs FREE-AIR TEMPERATURE

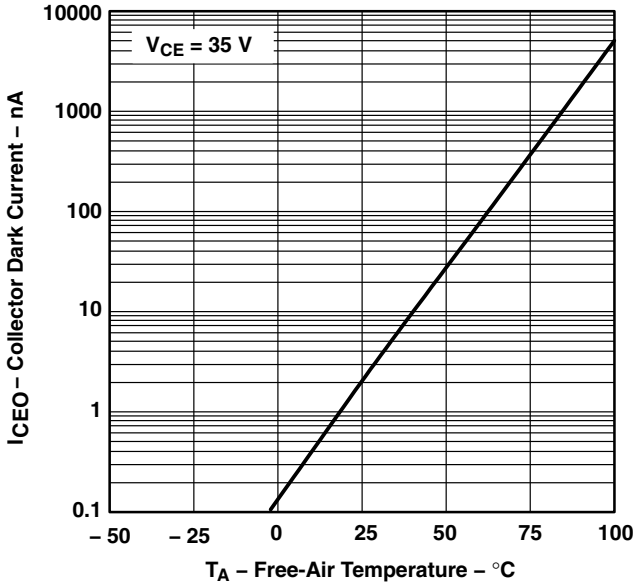


Figure 13

NORMALIZED CURRENT TRANSFER RATIO RELATIVE TO VALUE AT T_A = 25°C vs FREE-AIR TEMPERATURE

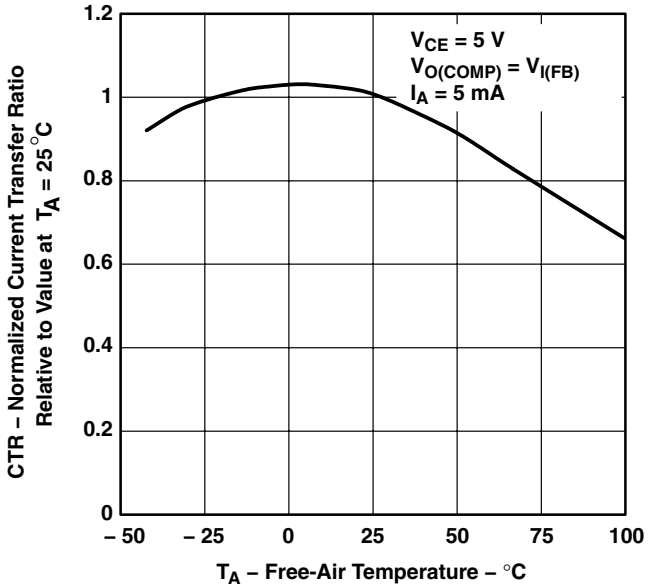


Figure 14

TYPICAL CHARACTERISTICS

CURRENT TRANSFER RATIO vs INPUT LIGHT-EMITTING-DIODE CURRENT

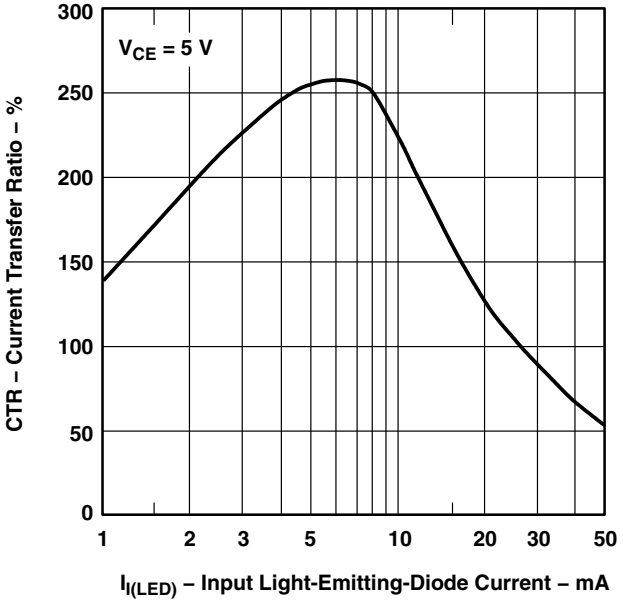


Figure 15

COLLECTOR-TO-EMITTER SATURATION VOLTAGE vs FREE-AIR TEMPERATURE

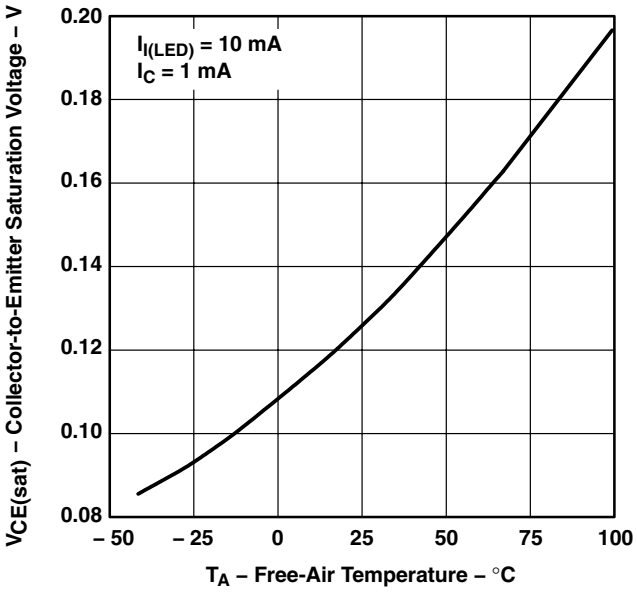


Figure 16

INPUT LIGHT-EMITTING-DIODE FORWARD CURRENT vs LIGHT-EMITTING-DIODE FORWARD VOLTAGE

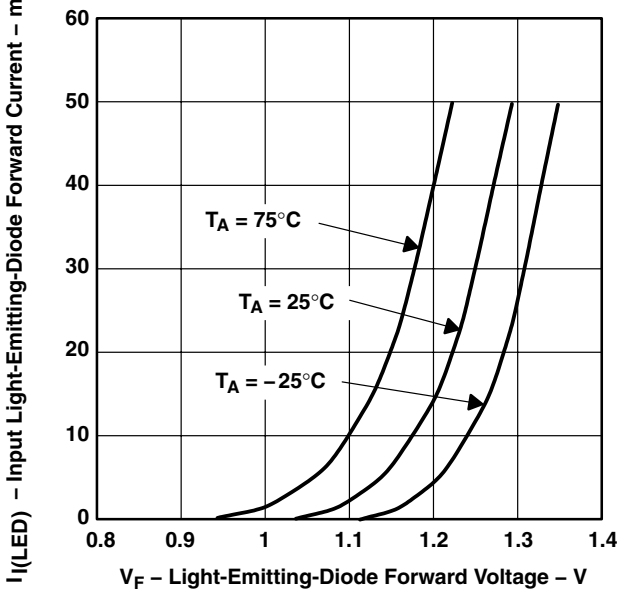
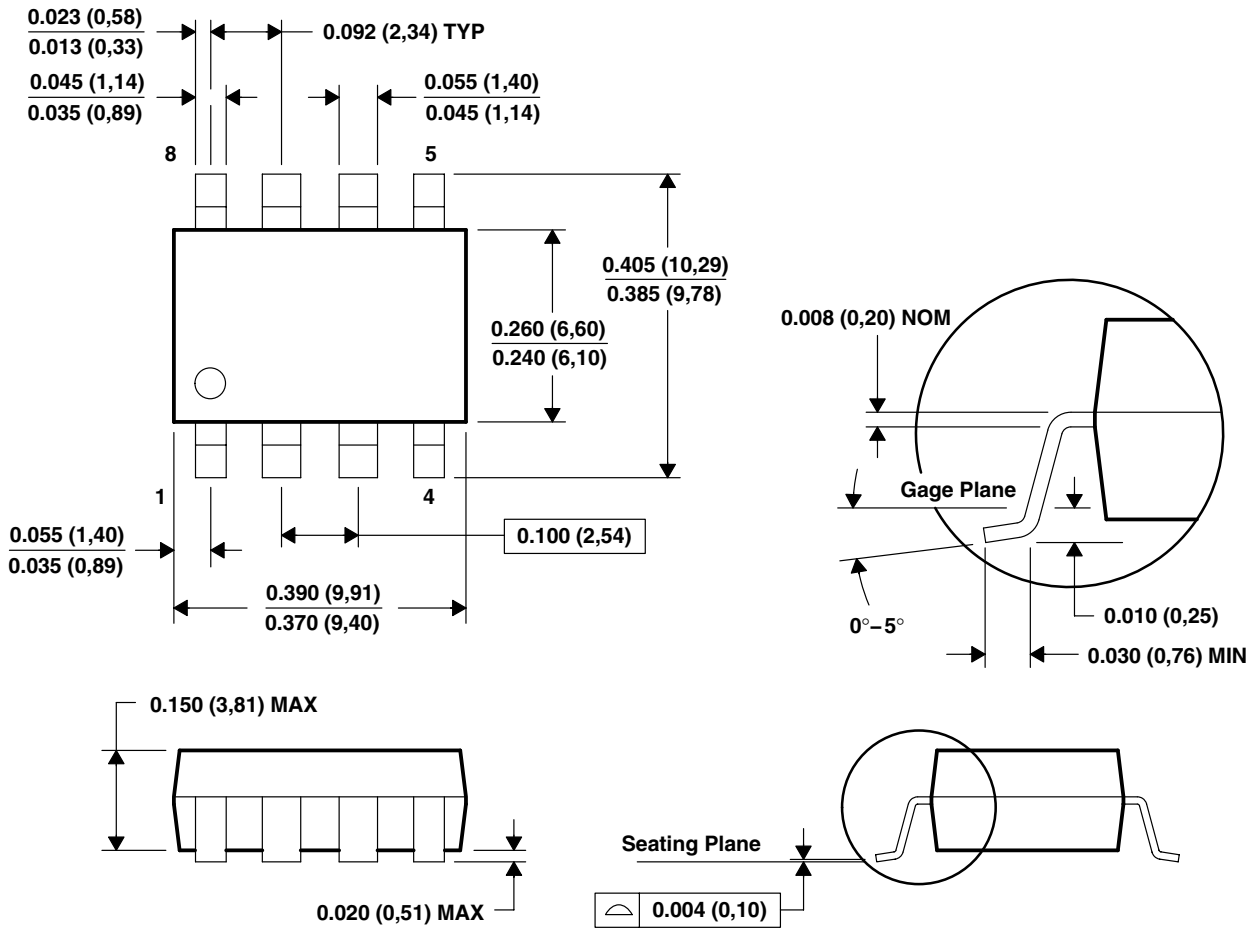


Figure 17

MECHANICAL DATA

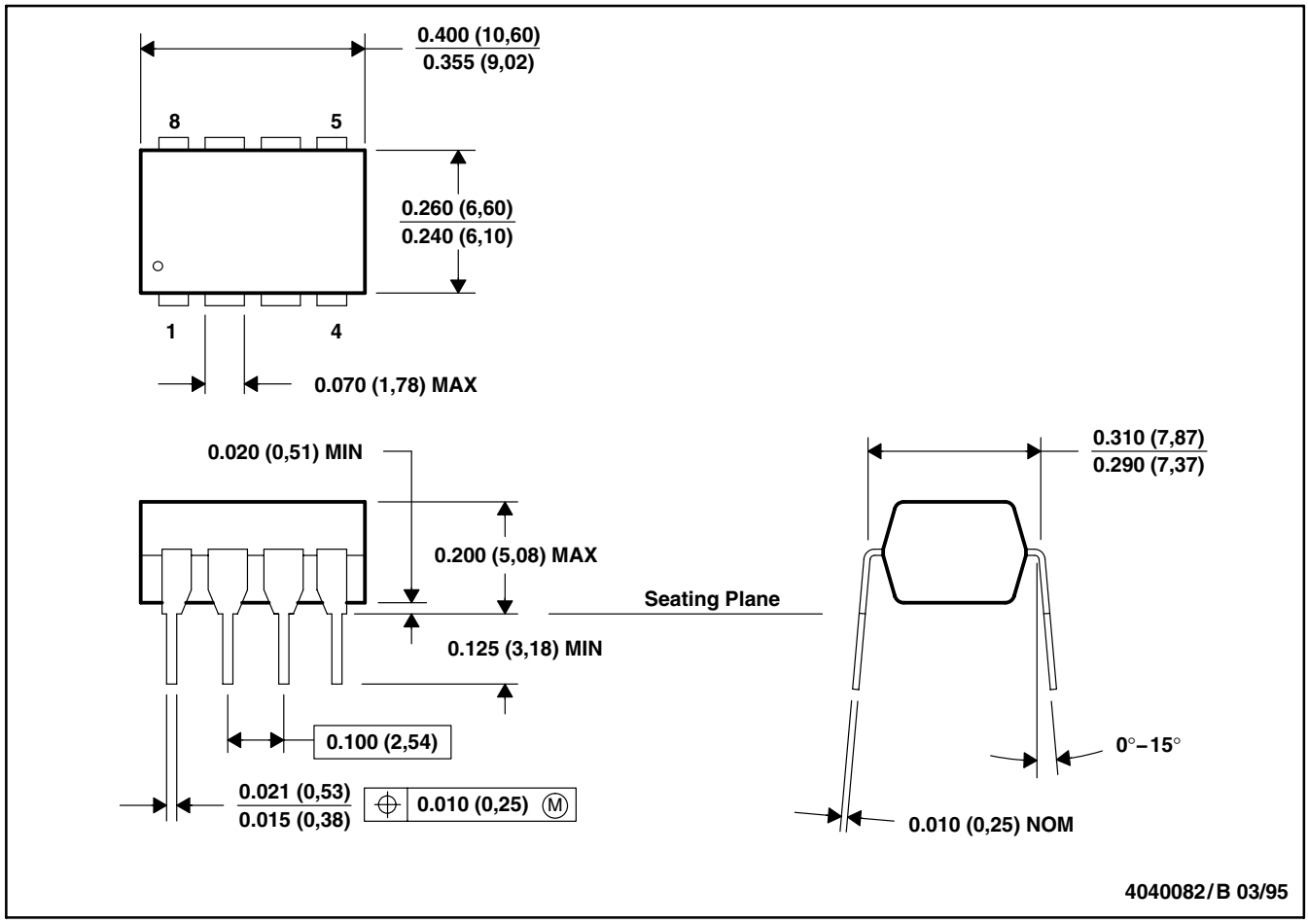
DCS (R-PDSO-G8) **PLASTIC DUAL SMALL-OUTLINE OPTO COUPLER**



NOTES: A. All linear dimensions are in inches(millimeters).
B. This drawing is subject to change without notice.

MECHANICAL DATA

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE PACKAGE**



NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TPS5904	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TPS5904A	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TPS5904ADCS	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI
TPS5904DCS	OBSOLETE	PDIP	P	8		TBD	Call TI	Call TI

(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.

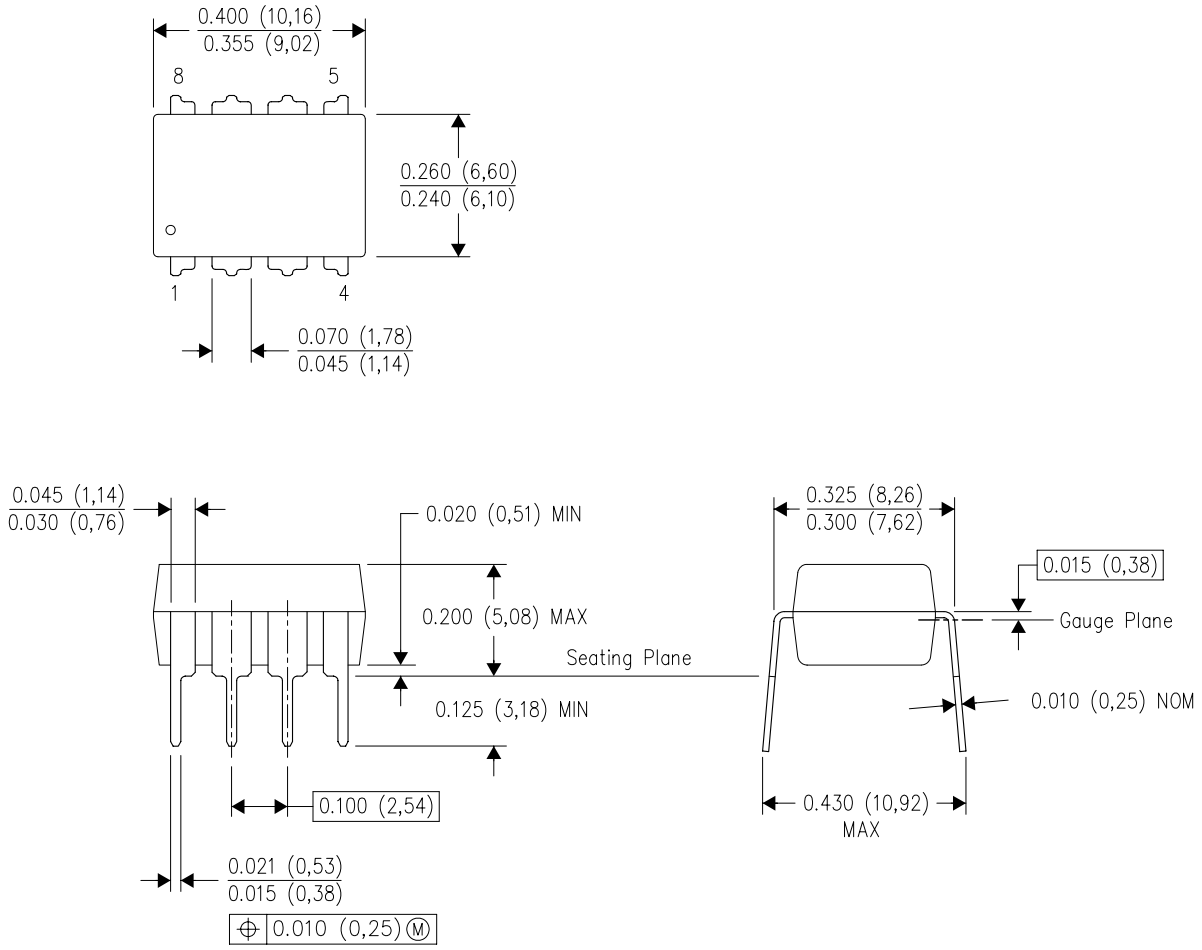
(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been 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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE



NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, modifications, enhancements, improvements, and other changes to its products and services at any time and to discontinue any product or service without notice. Customers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All products are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its hardware products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by government requirements, testing of all parameters of each product is not necessarily performed.

TI assumes no liability for applications assistance or customer product design. Customers are responsible for their products and applications using TI components. To minimize the risks associated with customer products and applications, customers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any TI patent right, copyright, mask work right, or other TI intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information published by TI regarding third-party products or services does not constitute a license from TI to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. Reproduction of this information with alteration is an unfair and deceptive business practice. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

TI products are not authorized for use in safety-critical applications (such as life support) where a failure of the TI product would reasonably be expected to cause severe personal injury or death, unless officers of the parties have executed an agreement specifically governing such use. Buyers represent that they have all necessary expertise in the safety and regulatory ramifications of their applications, and acknowledge and agree that they are solely responsible for all legal, regulatory and safety-related requirements concerning their products and any use of TI products in such safety-critical applications, notwithstanding any applications-related information or support that may be provided by TI. Further, Buyers must fully indemnify TI and its representatives against any damages arising out of the use of TI products in such safety-critical applications.

TI products are neither designed nor intended for use in military/aerospace applications or environments unless the TI products are specifically designated by TI as military-grade or "enhanced plastic." Only products designated by TI as military-grade meet military specifications. Buyers acknowledge and agree that any such use of TI products which TI has not designated as military-grade is solely at the Buyer's risk, and that they are solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI products are neither designed nor intended for use in automotive applications or environments unless the specific TI products are designated by TI as compliant with ISO/TS 16949 requirements. Buyers acknowledge and agree that, if they use any non-designated products in automotive applications, TI will not be responsible for any failure to meet such requirements.

Following are URLs where you can obtain information on other Texas Instruments products and application solutions:

Products		**Applications**	
Amplifiers	amplifier.ti.com	Audio	www.ti.com/audio
Data Converters	dataconverter.ti.com	Automotive	www.ti.com/automotive
DLP® Products	www.dlp.com	Communications and Telecom	www.ti.com/communications
DSP	dsp.ti.com	Computers and Peripherals	www.ti.com/computers
Clocks and Timers	www.ti.com/clocks	Consumer Electronics	www.ti.com/consumer-apps
Interface	interface.ti.com	Energy	www.ti.com/energy
Logic	logic.ti.com	Industrial	www.ti.com/industrial
Power Mgmt	power.ti.com	Medical	www.ti.com/medical
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
RFID	www.ti-rfid.com	Space, Avionics & Defense	www.ti.com/space-avionics-defense
RF/IF and ZigBee® Solutions	www.ti.com/lprf	Video and Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless-apps

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
Copyright © 2010, Texas Instruments Incorporated