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August 2008

FOD2743A, FOD2743B, FOD2743C Optically Isolated Error Amplifier

Features

- Optocoupler, precision reference and error amplifier in a single package
- 2.5V reference
- CTR 50% to 100% at 1mA
- 5,000V RMS isolation
- UL approval E90700, Vol. 2
  CSA approval 1296837
  VDE approval pending
  BSI approval pending
- Low temperature coefficient 50ppm/°C max
- FOD2743A: tolerance 0.5%
  FOD2743B: tolerance 1%
  FOD2743C: tolerance 2%

Applications

- Power supplies regulation
- DC to DC converters

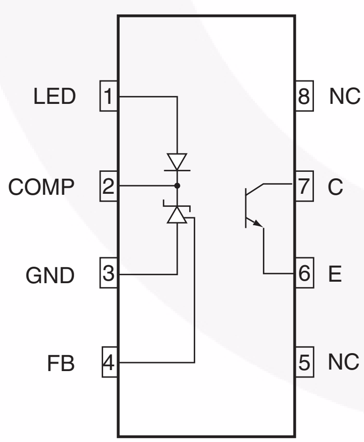
Description

The FOD2743 Optically Isolated Amplifier consists of the popular KA431 precision programmable shunt reference and an optocoupler. The optocoupler is a gallium arsenide (GaAs) light emitting diode optically coupled to a silicon phototransistor. It comes in 3 grades of reference voltage tolerance = 2%, 1%, and 0.5%.

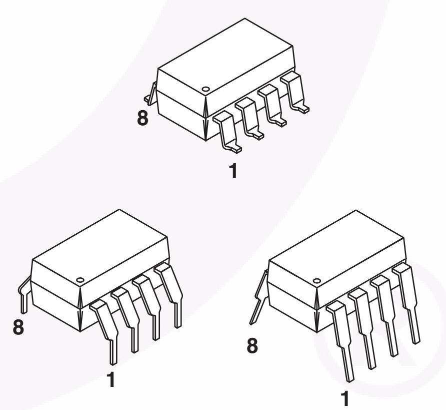
The Current Transfer Ratio (CTR) ranges from 50% to 100%. It also has an outstanding temperature coefficient of 50 ppm/°C. It is primarily intended for use as the error amplifier/reference voltage/optocoupler function in isolated AC to DC power supplies and dc/dc converters.

When using the FOD2743, power supply designers can reduce the component count and save space in tightly packaged designs. The tight tolerance reference eliminates the need for adjustments in many applications. The device comes in an 8-pin dip white package.

Functional Bock Diagram



Package Outlines

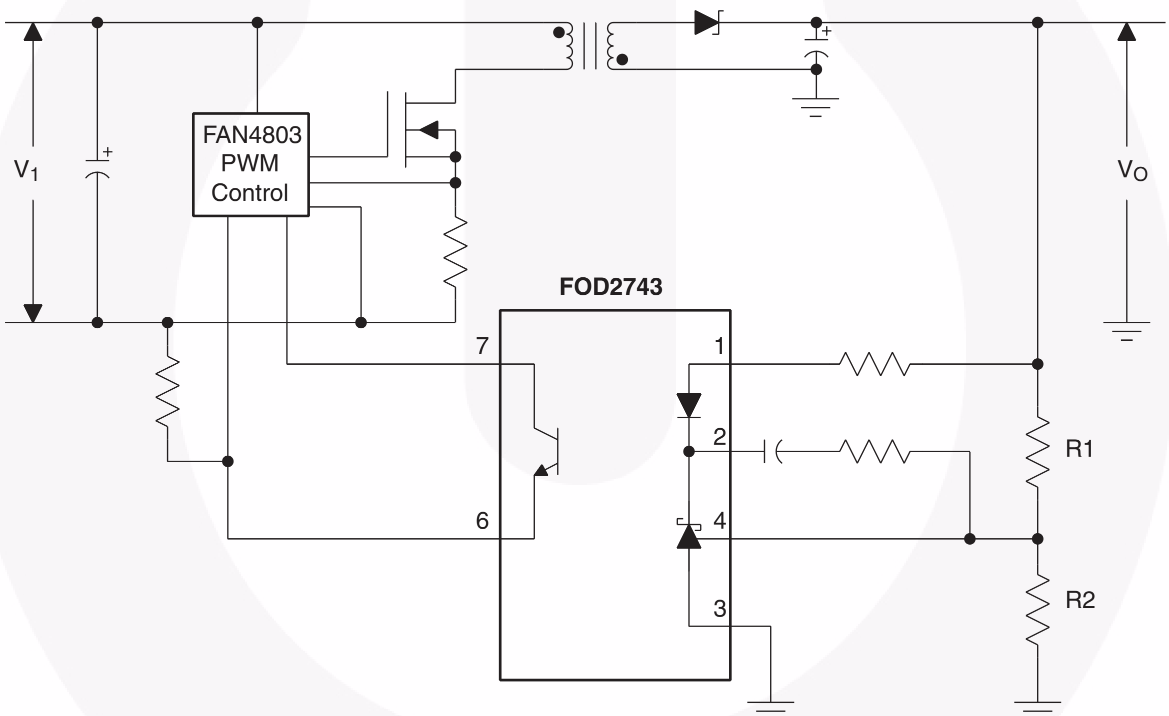


Pin Definitions

Pin Number	Pin Name	Pin Description
1	LED	Anode LED. This pin is the input to the light emitting diode.
2	COMP	Error Amplifier Compensation. This pin is the output of the error amplifier. *
3	GND	Ground
4	FB	Voltage Feedback. This pin is the inverting input to the error amplifier
5	NC	Not connected
6	E	Phototransistor Emitter
7	C	Phototransistor Collector
8	NC	Not connected

*The compensation network must be attached between pins 2 and 4.

Typical Application



Absolute Maximum Ratings (T_A = 25°C unless otherwise specified)

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	Parameter	Value	Units
T_{STG}	Storage Temperature	-40 to +125	°C
T_{OPR}	Operating Temperature	-40 to +85	°C
T_{SOL}	Lead Solder Temperature	260 for 10 sec.	°C
V_{LED}	Input Voltage	37	V
I_{LED}	Input DC Current	20	mA
V_{CEO}	Collector-Emitter Voltage	70	V
V_{ECO}	Emitter-Collector Voltage	7	V
I_C	Collector Current	50	mA
PD1	Input Power Dissipation	145	mW
PD2	Transistor Power Dissipation	85	mW
PD3	Total Power Dissipation(1)	145	mW

Note:
1. See derating graph, Figure 21.

Electrical Characteristics (T_A = 25°C unless otherwise specified)

Input Characteristics

Symbol	Parameter	Test Conditions	Device	Min.	Typ.	Max.	Unit
V_F	LED Forward Voltage	I_{LED} = 1mA, $V_{COMP} = V_{FB}$ (Fig.1)	All		1.07	1.2	V
V_{REF}	Reference Voltage	I_{LED} = 1mA, $V_{COMP} = V_{FB}$	FOD2743A	2.482	2.495	2.508	V
			FOD2743B	2.470	2.495	2.520	V
			FOD2743C	2.450	2.500	2.550	V
$V_{REF\ (DEV)}$ (2)	Deviation of V_{REF} Over Temperature(2)	T_A = -25°C to +85°C	All		4.5	17	mV
ΔV_{REF} / ΔV_{COMP}	Ratio of V_{REF} Variation to the Output of the Error Amplifier	I_{LED} = 1mA, ΔV_{COMP} = 10V to V_{REF}	All		-0.4	-2.7	mV/V
		ΔV_{COMP} = 36V to 10V			-0.3	-2.0	
I_{REF}	Feedback Input Current	I_{LED} = 1mA, R_1 = 10kΩ (Fig. 3)	All		2	4	µA
$I_{REF\ (DEV)}$ (2)	Deviation of I_{REF} Over Temperature	T_A = -25°C to +85°C	All		1	1.2	µA
$I_{LED\ (MIN)}$	Minimum Drive Current	$V_{COMP} = V_{FB}$ (Fig.1)	All		0.45	1.0	mA
$I_{(OFF)}$	Off-State Error Amplifier Current	V_{LED} = 37V, V_{FB} = 0 (Fig. 4)	All		0.001	1.0	µA
$\|Z_{OUT}\|$	Error Amplifier Output Impedance(3)	$V_{COMP} = V_{REF}$, I_{LED} = 1mA to 20mA, f ≥ 1.0 kHz	All		0.15	0.5	Ω

Output Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{CEO}	Collector Dark Current	V_{CE} = 10V (Fig. 5)		1	50	nA
BV_{ECO}	Emitter-Collector Voltage Breakdown	I_E = 100µA	7	10		V
BV_{CEO}	Collector-Emitter Voltage Breakdown	I_C = 1.0mA	70	100		V

Transfer Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
CTR	Current Transfer Ratio	I_{LED} = 1mA, $V_{COMP} = V_{FB}$, V_{CE} = 5V (Fig. 6)	50		100	%
$V_{CE\ (SAT)}$	Collector-Emitter Saturation Voltage	I_{LED} = 1mA, $V_{COMP} = V_{FB}$, I_C = 0.1mA (Fig. 6)			0.4	V

Notes:

2. The deviation parameters $V_{REF(DEV)}$ and $I_{REF(DEV)}$ are defined as the differences between the maximum and minimum values obtained over the rated temperature range. The average full-range temperature coefficient of the reference input voltage, ΔV_{REF}, is defined as:

$$|\Delta V_{REF}|(\text{ppm}/°\text{C}) = \frac{\{V_{REF(DEV)}/V_{REF}(T_A = 25°\text{C})\} \times 10^6}{\Delta T_A}$$

where ΔT_A is the rated operating free-air temperature range of the device.

3. The dynamic impedance is defined as $|Z_{OUT}| = \Delta V_{COMP}/\Delta I_{LED}$. When the device is operating with two external resistors (see Figure 2), the total dynamic impedance of the circuit is given by:

$$|Z_{OUT,\ TOT}| = \frac{\Delta V}{\Delta I} \approx |Z_{OUT}| \times \left[1 + \frac{R1}{R2}\right]$$

Electrical Characteristics (Continued) (T_A = 25°C unless otherwise specified)

Isolation Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
I_{I-O}	Input-Output Insulation Leakage Current	RH = 45%, T_A = 25°C, t = 5s, V_{I-O} = 3000 VDC(4)			1.0	µA
V_{ISO}	Withstand Insulation Voltage	RH ≤ 50%, T_A = 25°C, t = 1 min.(4)	5000			Vrms
R_{I-O}	Resistance (Input to Output)	V_{I-O} = 500 VDC(4)		10^{12}		Ω

Switching Characteristics

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
BW	Bandwidth	(Fig. 7)		50		kHZ
|CMH|	Common Mode Transient Immunity at Output HIGH	I_{LED} = 0mA, |Vcm| = 10 V_{PP}, R_L = 2.2kΩ(5) (Fig. 8)		1.0		kV/µs
|CML|	Common Mode Transient Immunity at Output LOW	(I_{LED} = 1 mA, |Vcm| = 10 V_{PP}, R_L = 2.2 kΩ(5) (Fig. 8)		1.0		kV/µs

Notes:

4. Device is considered as a two terminal device: Pins 1,2, 3 and 4 are shorted together and Pins 5, 6, 7 and 8 are shorted together.
5. Common mode transient immunity at output high is the maximum tolerable (positive) dVcm/dt on the leading edge of the common mode impulse signal, Vcm, to assure that the output will remain high. Common mode transient immunity at output low is the maximum tolerable (negative) dVcm/dt on the trailing edge of the common pulse signal,Vcm, to assure that the output will remain low.

Test Circuits

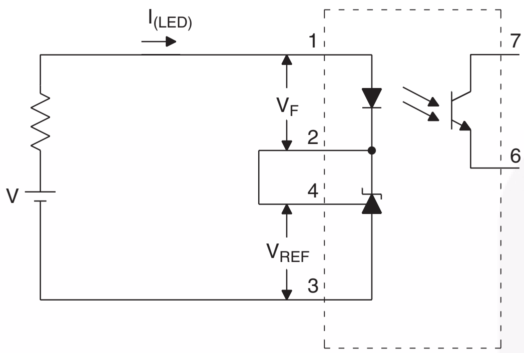


Figure 1. V_{REF}, V_F, I_{LED} (min.) Test Circuit

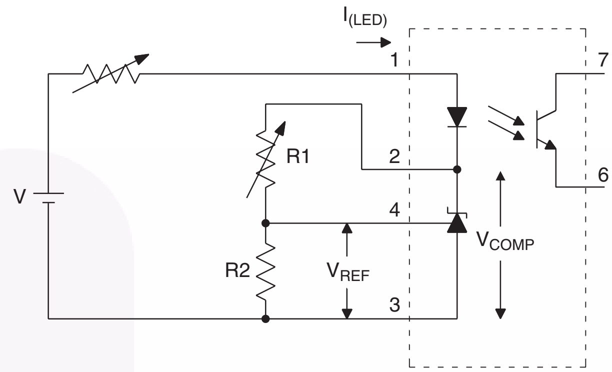


Figure 2. ΔV_{REF} / ΔV_{COMP} Test Circuit

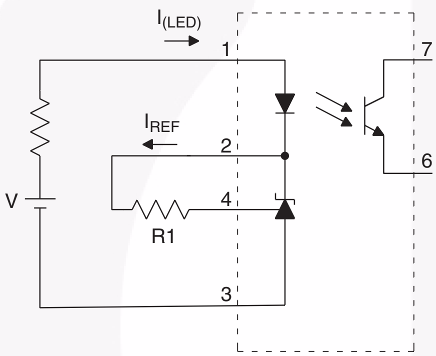


Figure 3. I_{REF} Test Circuit

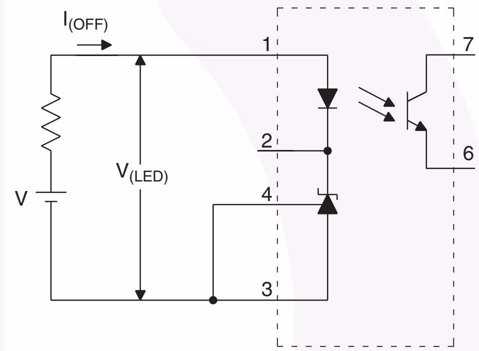


Figure 4. $I_{(OFF)}$ Test Circuit

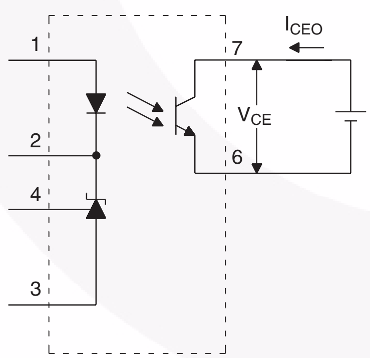


Figure 5. I_{CEO} Test Circuit

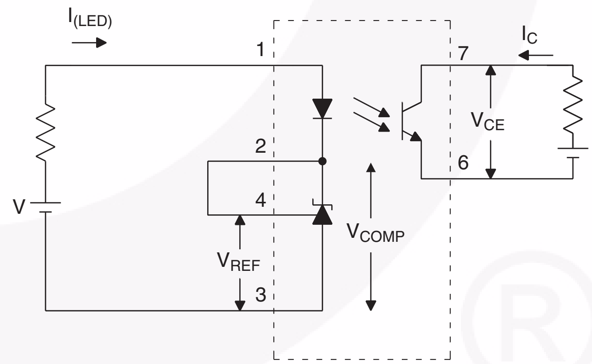


Figure 6. CTR, $V_{CE(sat)}$ Test Circuit

Test Circuits (Continued)

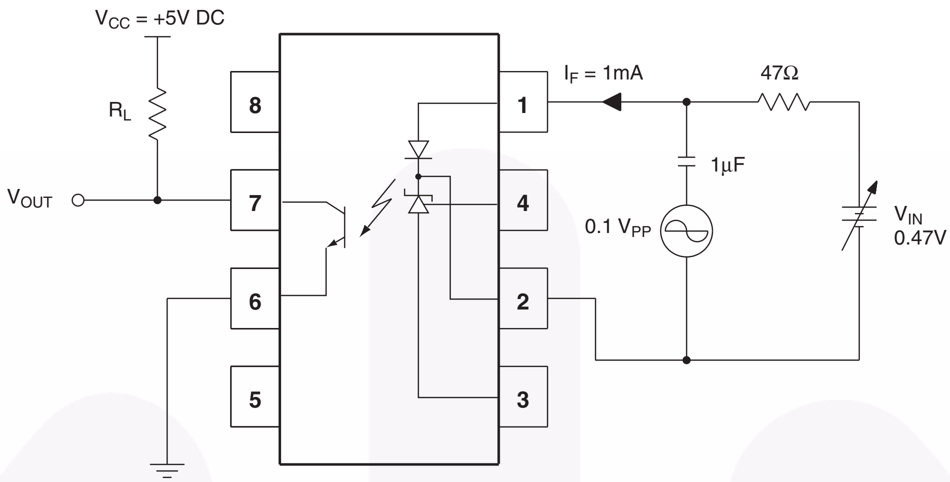


Figure 7. Frequency Response Test Circuit.

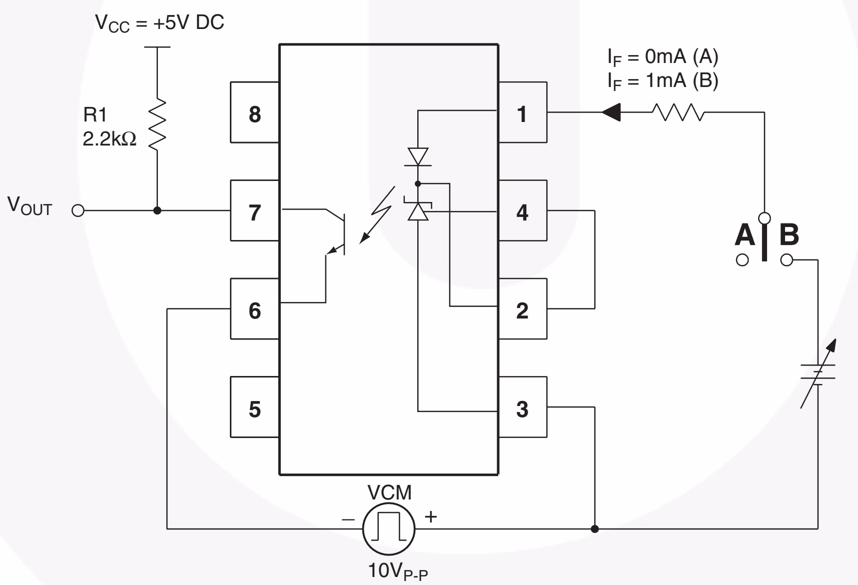


Figure 8. CMH and CML Test Circuit

Typical Performance Curves

Fig. 9a – LED Current vs. Cathode Voltage

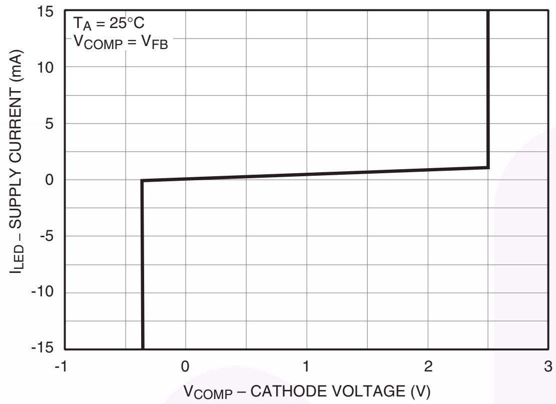


Fig. 9b – LED Current vs. Cathode Voltage

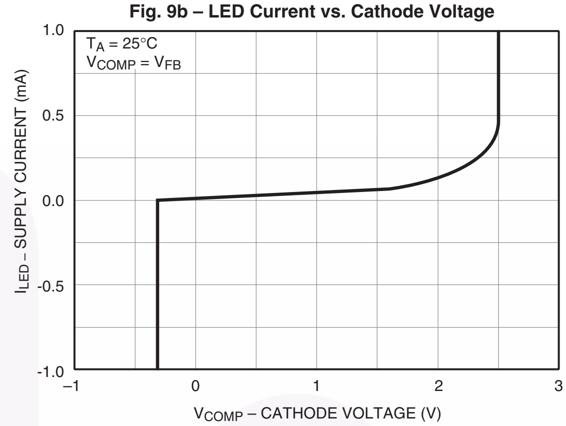


Fig. 10 – Reference Voltage Variation vs. Ambient Temperature

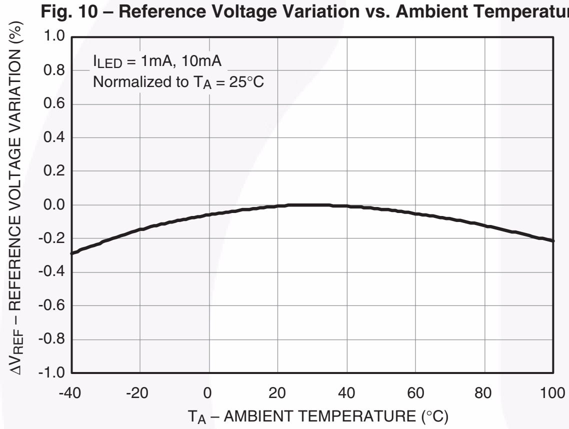


Fig. 11 – Reference Current vs Ambient Temperature

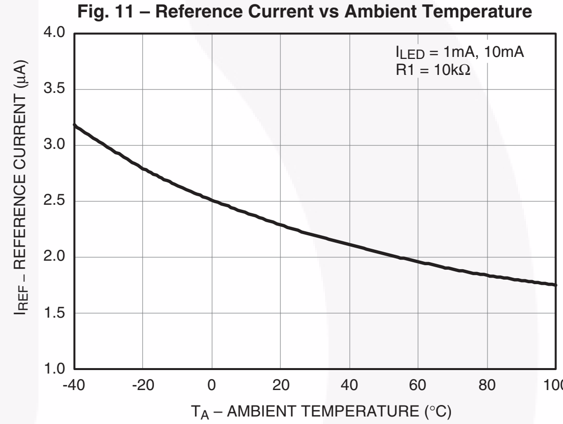


Fig. 12 – Off–State Current vs. Ambient Temperature

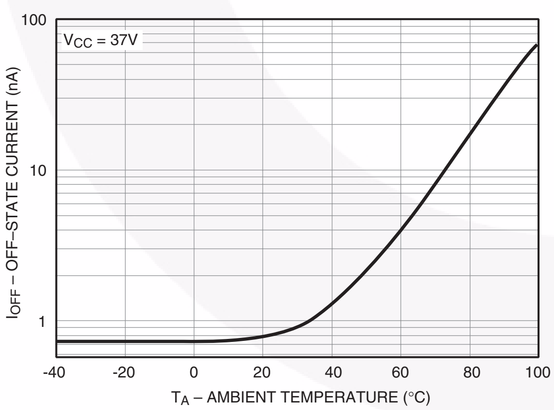
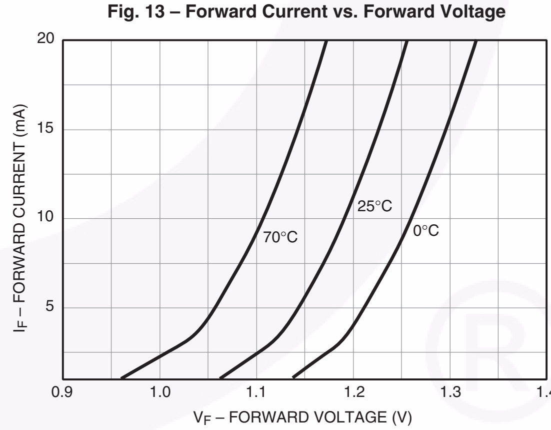


Fig. 13 – Forward Current vs. Forward Voltage



Typical Performance Curves (Continued)

Fig. 14 – Dark Current vs. Ambient Temperature

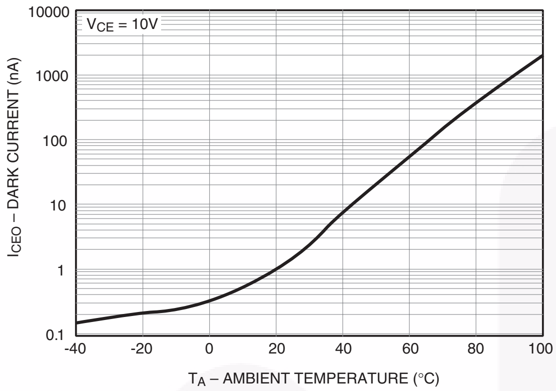


Fig. 15 – Collector Current vs. Ambient Temperature

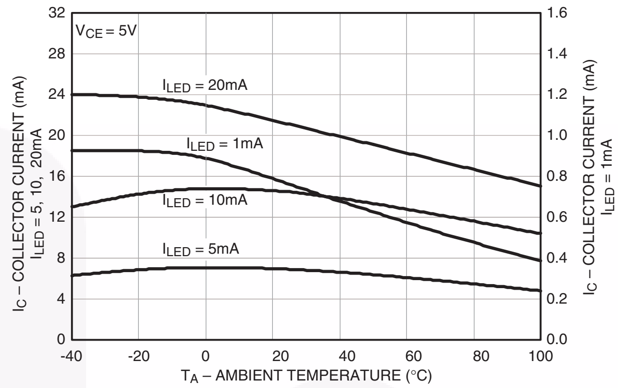


Fig. 16 – Current Transfer Ratio vs. LED Current

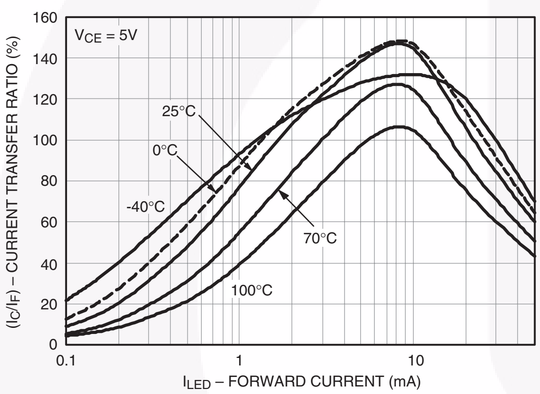


Fig. 17 – Saturation Voltage vs. Ambient Temperature

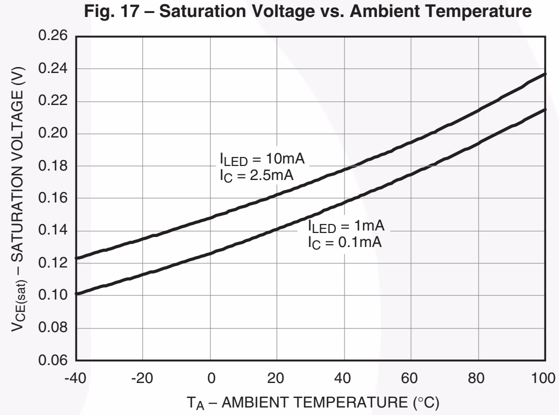


Fig. 18 – Collector Current vs. Collector Voltage

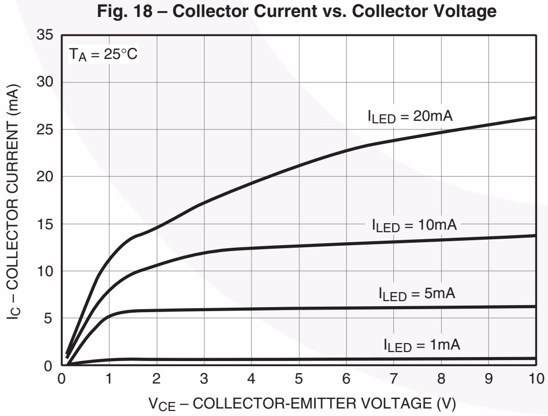
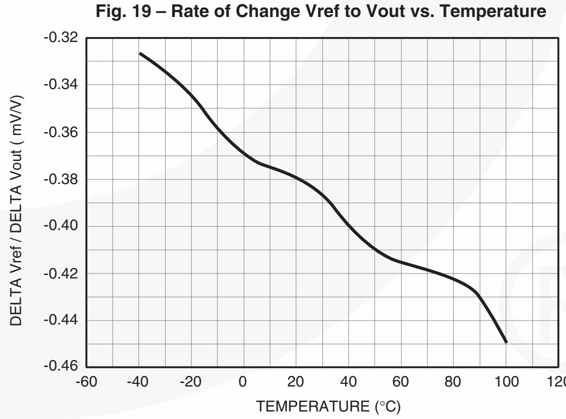


Fig. 19 – Rate of Change Vref to Vout vs. Temperature



Typical Performance Curves (Continued)

Fig. 20 – Voltage Gain vs. Frequency

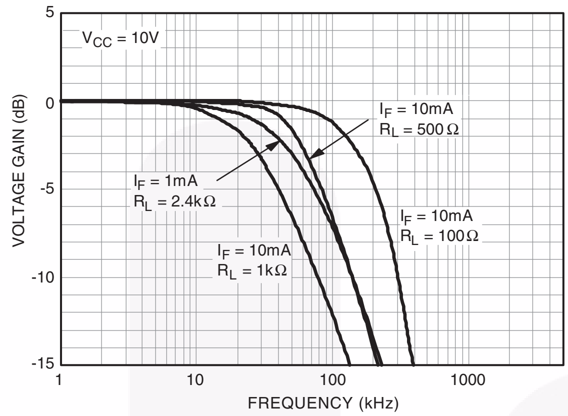
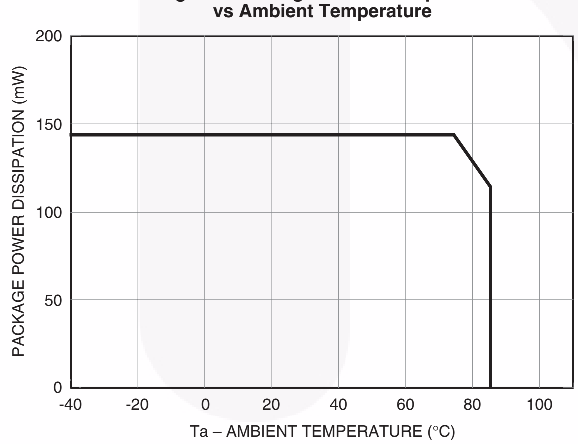


Fig. 21 – Package Power Dissipation vs Ambient Temperature



The FOD2743

The FOD2743 is an optically isolated error amplifier. It incorporates three of the most common elements necessary to make an isolated power supply, a reference voltage, an error amplifier, and an optocoupler. It is functionally equivalent to the popular KA431 shunt voltage regulator plus the CNY17F-X optocoupler.

Powering the Secondary Side

The LED pin in the FOD2743 powers the secondary side, and in particular provides the current to run the LED. The actual structure of the FOD2743 dictates the minimum voltage that can be applied to the LED pin: The error amplifier output has a minimum of the reference voltage, and the LED is in series with that. Minimum voltage applied to the LED pin is thus 2.5V + 1.2V = 3.7V. This voltage can be generated either directly from the output of the converter, or else from a slaved secondary winding. The secondary winding will not affect regulation, as the input to the FB pin may still be taken from the output winding.

The LED pin needs to be fed through a current limiting resistor. The value of the resistor sets the amount of current through the LED, and thus must be carefully selected in conjunction with the selection of the primary side resistor.

Feedback

Output voltage of a converter is determined by selecting a resistor divider from the regulated output to the FB pin. The FOD2743 attempts to regulate its FB pin to the reference voltage, 2.5V. The ratio of the two resistors should thus be:

$$\frac{R_{TOP}}{R_{BOTTOM}} = \frac{V_{OUT}}{V_{REF}} - 1$$

The absolute value of the top resistor is set by the input offset current of 5.2µA. To achieve 0.5% accuracy, the resistance of R_{TOP} should be:

$$\frac{V_{OUT} - 2.5}{R_{TOP}} > 1040\mu A$$

Compensation

The compensation pin of the FOD2743 provides the opportunity for the designer to design the frequency response of the converter. A compensation network may be placed between the COMP pin and the FB pin. In typical low-bandwidth systems, a 0.1µF capacitor may be used. For converters with more stringent requirements, a network should be designed based on measurements of the system's loop. An excellent reference for this process may be found in "Practical Design of Power Supplies" by Ron Lenk, IEEE Press, 1998.

Secondary Ground

The GND pin should be connected to the secondary ground of the converter.

No Connect Pins

The NC pins have no internal connection. They should not have any connection to the secondary side, as this may compromise the isolation structure.

Photo-Transistor

The Photo-transistor is the output of the FOD2743. In a normal configuration the collector will be attached to a pull-up resistor and the emitter grounded. There is no base connection necessary.

The value of the pull-up resistor, and the current limiting resistor feeding the LED, must be carefully selected to account for voltage range accepted by the PWM IC, and for the variation in current transfer ratio (CTR) of the opto-isolator itself.

Example: The voltage feeding the LED pins is +12V, the voltage feeding the collector pull-up is +10V, and the PWM IC is the Fairchild FAN4803, which has a 5V reference. If we select a 10kΩ resistor for the LED, the maximum current the LED can see is:

(12V – 4V) / 10kΩ = 800µA.

The CTR of the opto-isolator is a minimum of 50%, so the minimum collector current of the photo-transistor when the diode is full on is 400µA. The collector resistor must thus be such that:

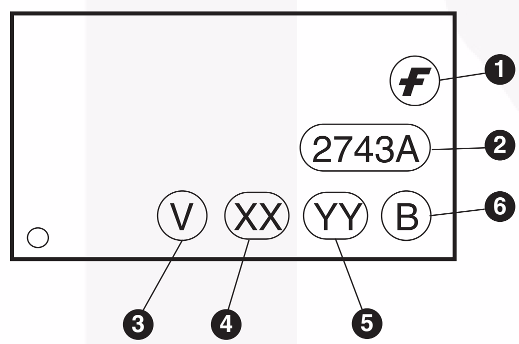
$$\frac{10V - 5V}{R_{COLLECTOR}} < 400\mu A \text{ or } R_{COLLECTOR} > 12.5k\Omega;$$

select 20kΩ to allow some margin.

Ordering Information

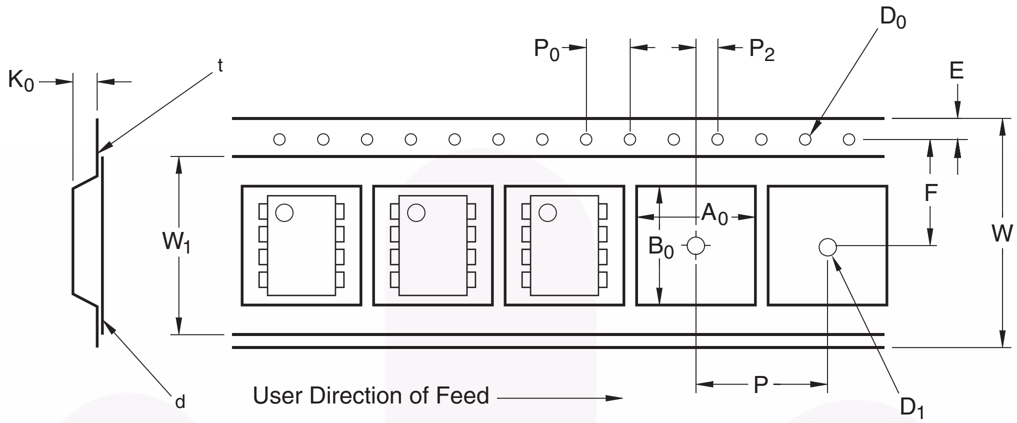
Option	Example Part Number	Description
No Option	FOD2743A	Standard Through Hole
S	FOD2743AS	Surface Mount Lead Bend
SD	FOD2743ASD	Surface Mount; Tape and Reel
T	FOD2743AT	0.4" Lead Spacing
V	FOD2743AV	VDE0884
TV	FOD2743ATV	VDE0884; 0.4" Lead Spacing
SV	FOD2743ASV	VDE0884; Surface Mount
SDV	FOD2743ASDV	VDE0884; Surface Mount; Tape and Reel

Marking Information



Definitions	
1	Fairchild logo
2	Device number
3	VDE mark (Note: Only appears on parts ordered with VDE option – See order entry table)
4	Two digit year code, e.g., '03'
5	Two digit work week ranging from '01' to '53'
6	Assembly package code

Carrier Tape Specifications



Symbol	Description	Dimension in mm
W	Tape Width	16.0 ± 0.3
t	Tape Thickness	0.30 ± 0.05
P_0	Sprocket Hole Pitch	4.0 ± 0.1
D_0	Sprocket Hole Diameter	1.55 ± 0.05
E	Sprocket Hole Location	1.75 ± 0.10
F	Pocket Location	7.5 ± 0.1
P_2		4.0 ± 0.1
P	Pocket Pitch	12.0 ± 0.1
A_0	Pocket Dimensions	10.30 ±0.20
B_0		10.30 ±0.20
K_0		4.90 ±0.20
W_1	Cover Tape Width	1.6 ± 0.1
d	Cover Tape Thickness	0.1 max
	Max. Component Rotation or Tilt	10°
R	Min. Bending Radius	30

Reflow Profile

- Peak reflow temperature — 260°C (package surface temperature)
- Time of temperature higher than 245°C — 40 seconds or less
- Number of reflows — Three

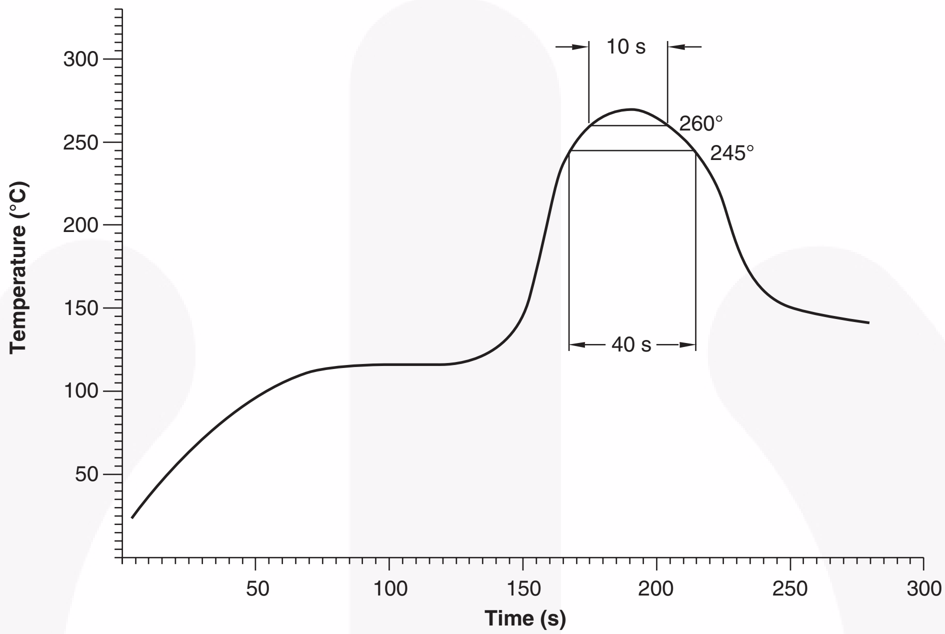
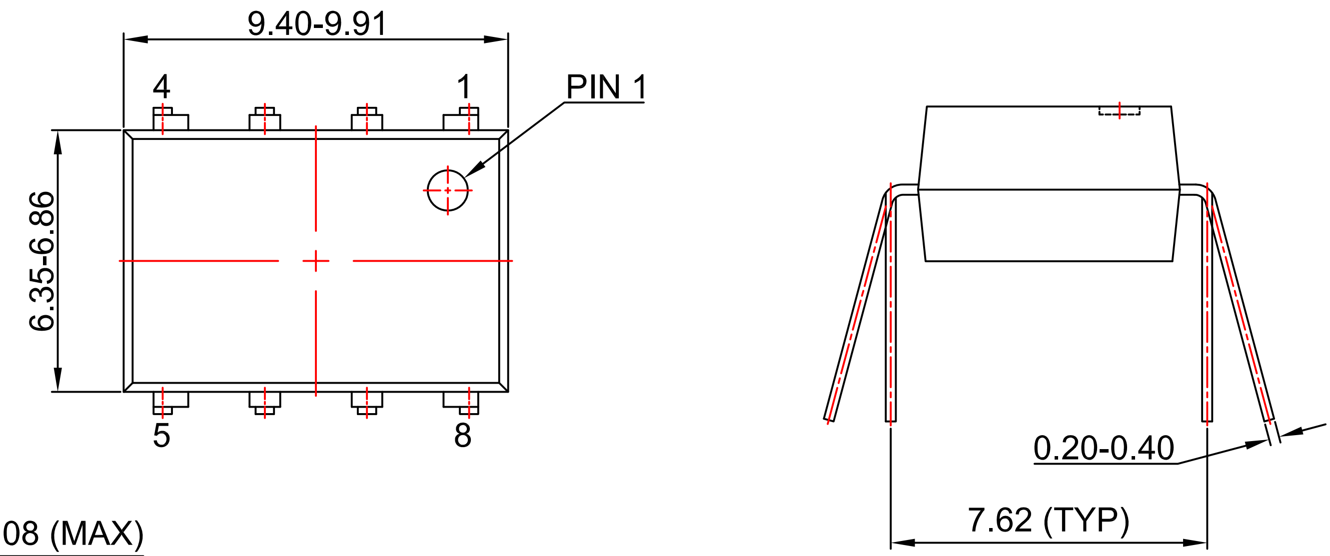
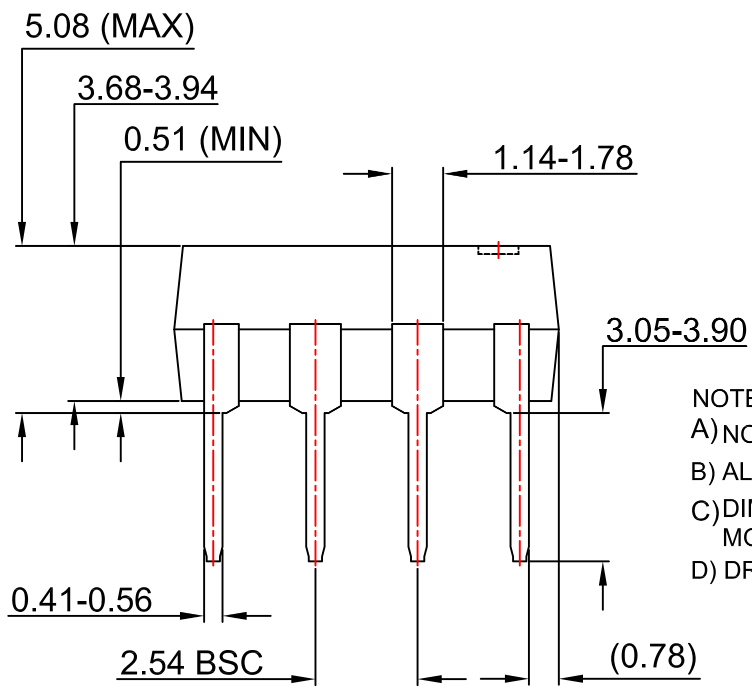


Figure 22. Recommended IR Reflow Profile





NOTES:

A) NO STANDARD APPLIES TO THIS PACKAGE

B) ALL DIMENSIONS ARE IN MILLIMETERS.

C) DIMENSIONS ARE EXCLUSIVE OF BURRS, MOLD FLASH, AND TIE BAR EXTRUSION

D) DRAWING FILENAME AND REVSION: MKT-N08GREV7

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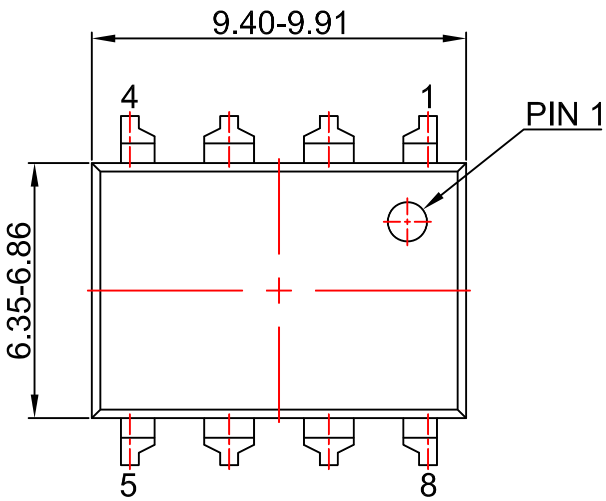
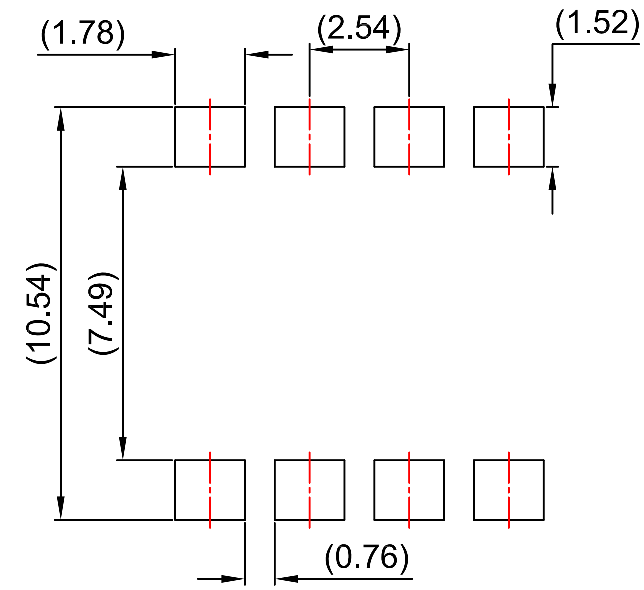
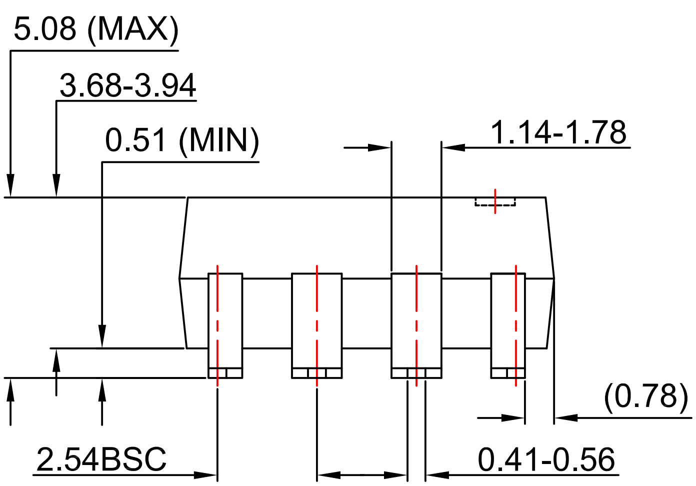
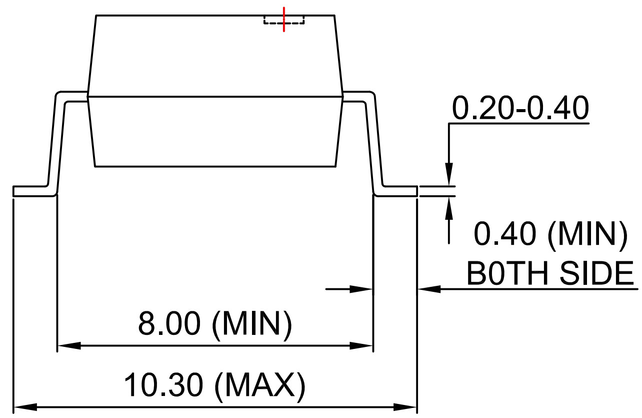




LAND PATTERN RECOMMENDATION





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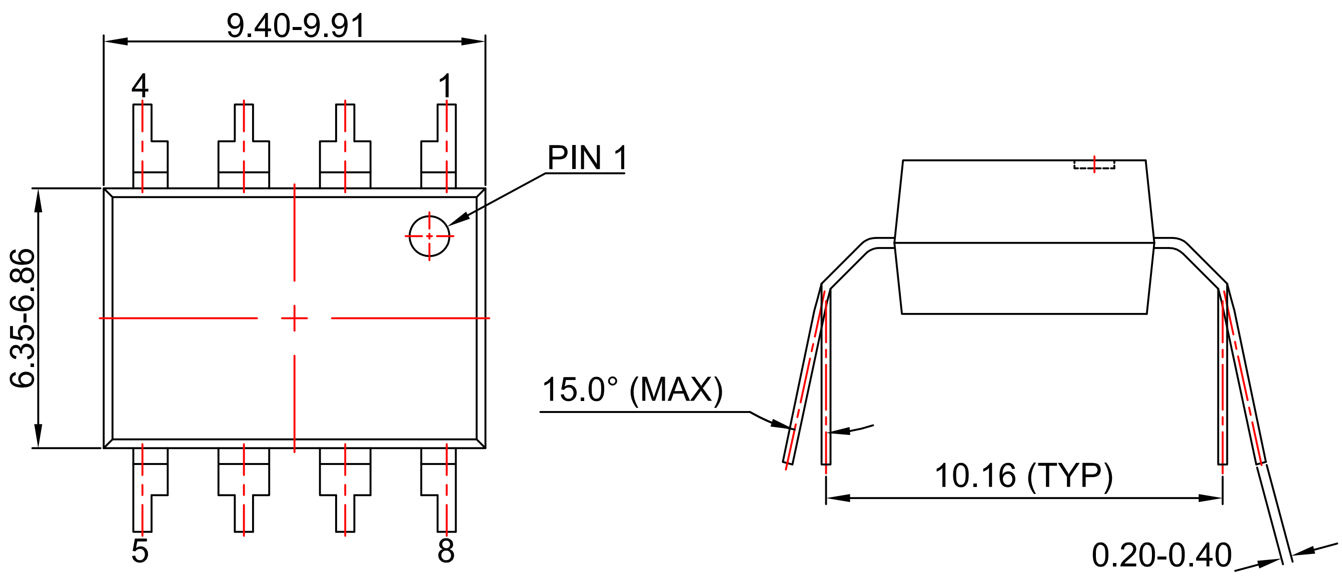

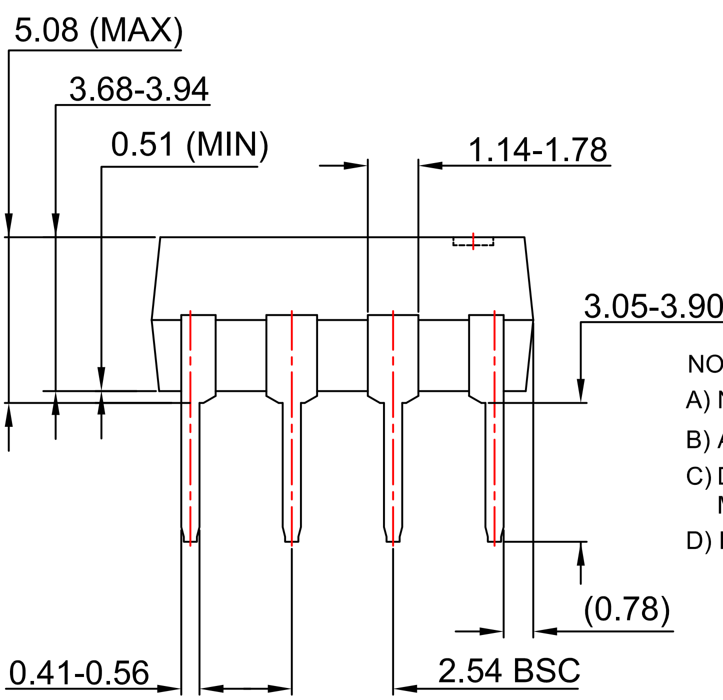

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