

# FAN7387

## Self-Oscillated, High-Voltage Gate Driver

### Features

- Internal Clock Using RCT
- External Sync Function Using RCT
- Dead Time Control Using Resistor
- Shut Down (Disable Mode)
- Internal Shunt Regulator
- UVLO Function, High and Low Side

### Description

The FAN7387 is a simple control IC for common half-bridge inverters, SMPS, and ballast for fluorescent and HID lamps. The FAN7387 has an oscillating circuit using an external resistor and capacitor. The frequency variation is very stable across a wide temperature range. The FAN7387 has a external pin for dead time control and shutdown. Using this resistor, the designer can choose the optimum dead time to reduce power loss on switching devices, such as transistors and MOSFETs.

### Applications

- Half-Bridge Inverter
- SMPS
- Ballast Solution for High-Intensity Discharge (HID) Lamp
- Ballast for Fluorescent Lamp

8-DIP



8-SOP



### Ordering Information

Part Number	Package	Operating Temperature Range	Packing Method
FAN7387M <sup>(1)</sup>	8-SOP	-40°C ~ 125°C	Tube
FAN7387MX <sup>(1)</sup>			Tape & Reel
FAN7387N	8-DIP		Tube



All standard Fairchild Semiconductor products are RoHS compliant and many are also "GREEN" or going green. For Fairchild's definition of "green" please visit: [http://www.fairchildsemi.com/company/green/rohs\\_green.html](http://www.fairchildsemi.com/company/green/rohs_green.html).

#### Note:

1. These devices passed wave soldering test by JESD22A-111.

Typical Application Diagrams

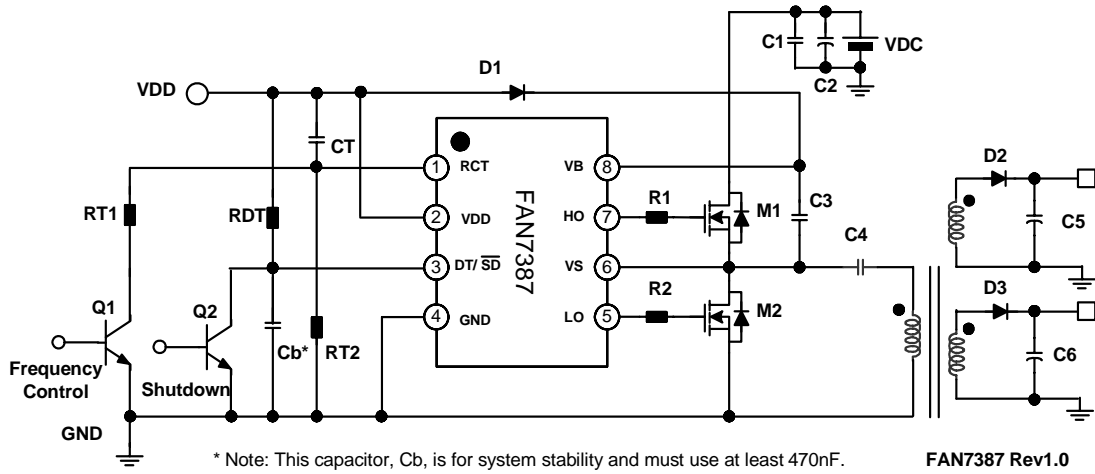


Figure 1. Typical Application Circuit for SMPS (Self Oscillation Method)

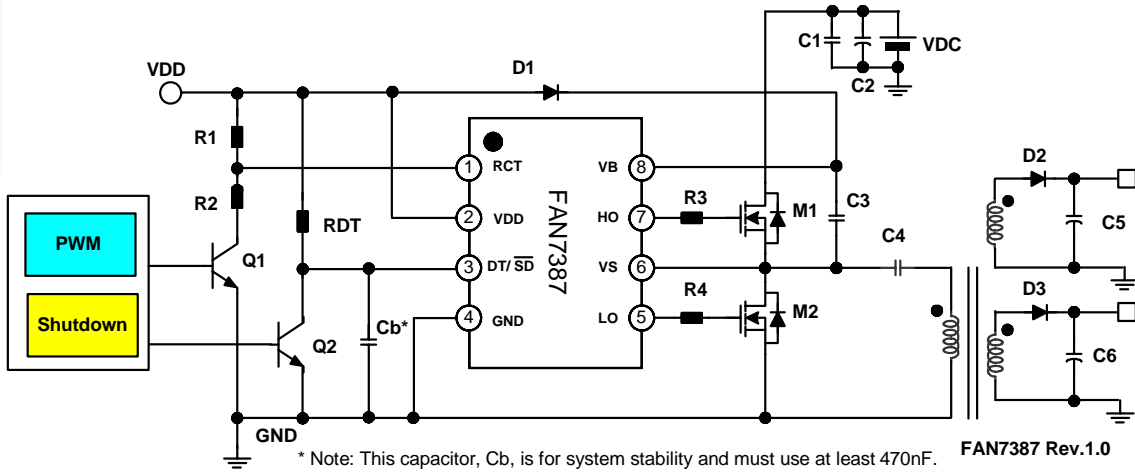


Figure 2. Typical Application Circuit for SMPS Using External Signal

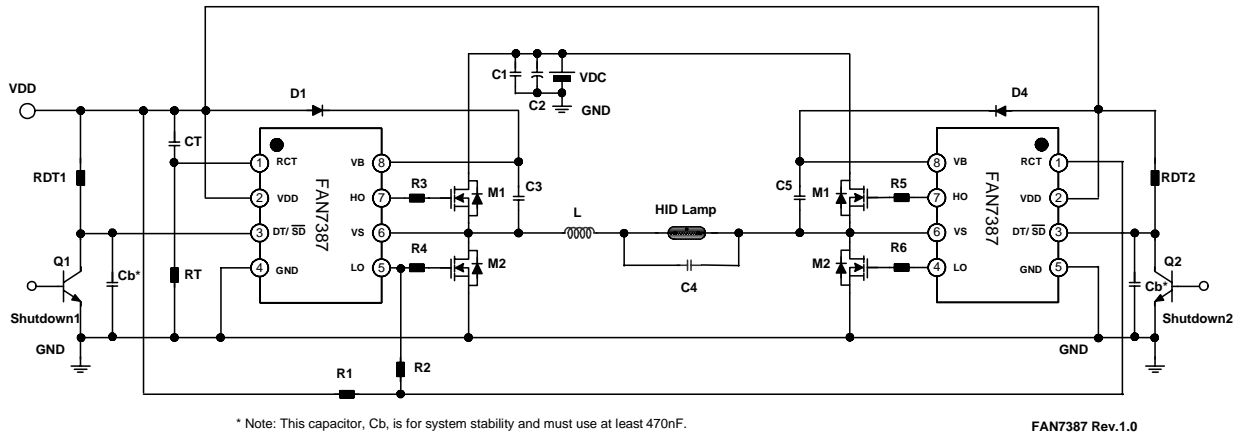


Figure 3. Typical Application Circuit for Full-Bridge Converter

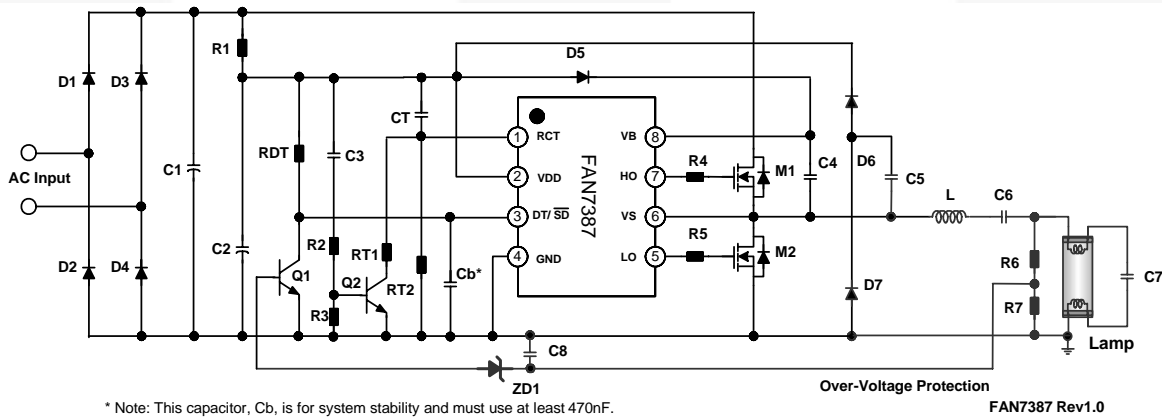


Figure 4. Typical Application Circuit for Fluorescent Lamp Ballast

Internal Block Diagram

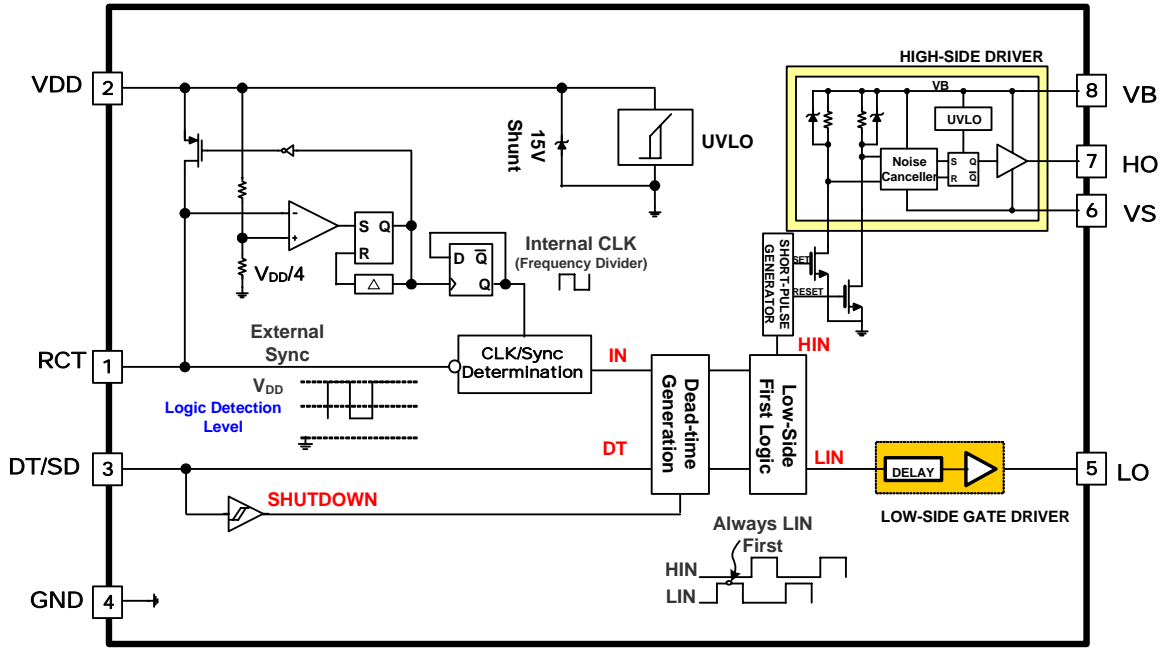


Figure 5. Functional Block Diagram

## Pin Configuration

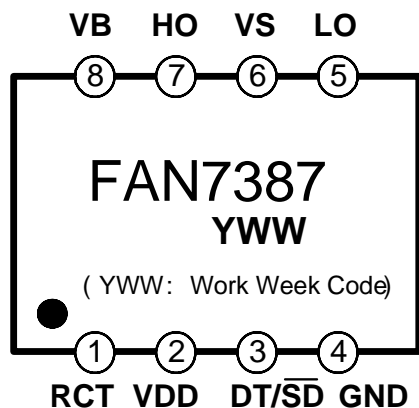


Figure 6. Pin Configuration (Top View)

## Pin Definitions

Pin #	Name	Description
1	RCT	Oscillator frequency set resistor and capacitor
2	VDD	Supply voltage
3	DT/ $\overline{SD}$	Dead-time control and shutdown (active LOW)
4	GND	Signal ground
5	LO	Low-side output
6	VS	High-side floating supply return
7	HO	High-side output
8	VB	High-side floating supply

## Absolute Maximum Ratings

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.  $T_A=25^{\circ}\text{C}$  unless otherwise specified.

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_B$	High-side floating supply voltage	-0.3		625.0	V
$V_S$	High-side offset voltage	-0.3		600.0	V
$V_{RCT}$	RCT pins input voltage			$V_{CL}$	V
$I_{CL}$	Clamping current level <sup>(2)</sup>			25	mA
$dV_S/dt$	Allowable offset voltage slew rate		50		V/ns
$T_A$	Operating temperature range	-40		+125	$^{\circ}\text{C}$
$T_{STG}$	Storage temperature range	-65		+150	$^{\circ}\text{C}$
$P_D$	Power dissipation	8-DIP	1.2		W
		8-SOP	0.625		
$\theta_{JA}$	Thermal resistance (Junction-to-Air)	8-DIP	100		$^{\circ}\text{C}/\text{W}$
		8-SOP	200		

### Note:

- Do not supply a low-impedance voltage source to the internal clamping Zener diode between the GND and the  $V_{DD}$  pin of this device.

## Recommended Operating Ratings

The Recommended Operating Conditions table defines the conditions for actual device operation. Recommended operating conditions are specified to ensure optimal performance to the datasheet specifications. Fairchild does not recommend exceeding them or designing to absolute maximum ratings

Symbol	Parameter	Min.	Max.	Unit
$V_B$	High-side floating supply voltage	$V_S+11$	$V_S+14$	V
$V_S$	High-side offset voltage	$6-V_{DD}$	600	V
$V_{DD}$	Low-side supply voltage	11	14	V
$V_{HO}$	High-side (HO) output voltage	GND	$V_{DD}$	V
$V_{LO}$	Low-side (LO) output voltage	GND	$V_{DD}$	V
$V_{IH}$	Logic "1" input voltage of RCT	$(3/4 V_{DD})+1$		V
$V_{IL}$	Logic "0" input voltage of RCT		$(3/5 V_{DD})-1$	V
RT	Timing resistor value of RCT	2		$\text{k}\Omega$
CT	Timing capacitor value of RCT	100		pF
$T_A$	Ambient temperature	-40	+125	$^{\circ}\text{C}$

## Electrical Characteristics

$V_{BIAS}$  ( $V_{DD}$ ,  $V_B - V_S$ )=14.0V,  $C_L$ =1nF,  $R_T$ =50k and  $C_T$ =330pF and  $T_A$ =25°C, unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
<b>Low-Side Supply Characteristics (<math>V_{DD}</math>)</b>						
$V_{DDUV+}$	$V_{DD}$ supply under-voltage positive going threshold	$V_{DD}$ Increasing	9.5	11.0	12.5	V
$V_{DDUV-}$	$V_{DD}$ supply under-voltage negative going threshold	$V_{DD}$ Decreasing	7.5	9.0	10.5	V
$V_{DDUVH}$	$V_{DD}$ supply under-voltage lockout hysteresis			2		V
$V_{CL}$	Supply clamping voltage	$I_{DD}$ =10mA	14.8	15.4		V
$I_{QDD}$	Low-side quiescent supply current	$R_{DT}$ =100k		220	500	$\mu$ A
$I_{ST}$	Start-up supply current	$V_{DD}$ =9V		50	130	$\mu$ A
$I_{LK}$	Offset supply leakage current	$V_B = V_S = 600V$			10	$\mu$ A
$I_{PDD}$	Low-side dynamic operating supply current			0.8		mA
<b>High-Side Supply Characteristics (<math>V_B - V_S</math>)</b>						
$V_{BSUV+}$	$V_{BS}$ supply under-voltage negative going threshold	$V_B - V_S$ Increasing	7.7	9.2	10.7	V
$V_{BSUV-}$	$V_{BS}$ supply under-voltage negative going threshold	$V_B - V_S$ Decreasing	7.1	8.6	10.1	V
$V_{BSUVH}$	$V_{BS}$ supply under-voltage lockout hysteresis			0.6		V
$I_{QBS}$	High-side quiescent supply current			50	130	$\mu$ A
$I_{PBS}$	High-side dynamic operating supply current			400	800	$\mu$ A
<b>Oscillator Characteristics</b>						
$f_{osc1}$	Oscillation frequency 1	$R_T$ =50k, $C_T$ =330pF	18	20	22	kHz
$f_{osc2}$	Oscillation frequency 2	$R_T$ =1k, $C_T$ =1nF	210	250	290	
D	Duty cycle	Running Mode	47.5	49.0		%
$V_{RCT+}$	Upper threshold voltage of RCT	Running Mode		$V_{DD}$		V
$V_{RCT-}$	Lower threshold voltage of RCT	Running Mode		$V_{DD}/4$		V
$V_{IH}$	Logic "1" input voltage of RCT	Running Mode		$3/4V_{DD}$		V
$V_{IL}$	Logic "0" input voltage of RCT	Running Mode			$3/5V_{DD}$	V
DT	Dead time	$R_{DT}$ =100k	500	600	700	ns
$DT_{MIN}$	Minimum dead time	$V_{DT/\overline{SD}} = V_{DD}$	300	400	500	
<b>Output Characteristics</b>						
$I_{O+}^{(3)}$	Output high, short-circuit pulse current	$PW \leq 10\mu s$		350		mA
$I_{O-}^{(3)}$	Output low, short-circuit pulse current	$PW = 10\mu s$		650		mA
$V_S$	Allowable negative $V_S$ pin voltage for input signal ( $V_{RCT}$ ) propagation to HO			-9.8	-7.0	V

**Note:**

3. These parameters, although guaranteed, is not 100% tested in production.

Continued on the following page...

**Electrical Characteristics** (Continued)

$V_{BIAS} (V_{DD}, V_B - V_S) = 14.0V$ ,  $C_L = 1nF$ ,  $R_T = 50k$  and  $C_T = 330pF$  and  $T_A = 25^\circ C$ , unless otherwise specified.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
<b>Output Characteristics</b>						
$t_{ON}$	Turn-on propagation time	$V_{DD} = V_{BS} = 14V$ , $V_{DT/SD} = V_{DD}$ , $V_{RCT} = 4V \sim V_{DD}$ , $f_{OSC} = 20kHz$		550		ns
$t_{OFF}$	Turn-off propagation time	$V_{DD} = V_{BS} = 14V$ , $V_{DT/SD} = V_{DD}$ , $V_{RCT} = 4V \sim V_{DD}$ , $f_{OSC} = 20kHz$		160		ns
$t_R$	Turn on rising time	$C_L = 1000pF$		50	120	ns
$t_F$	Turn off falling time	$C_L = 1000pF$		30	70	ns
<b>Protection Characteristics</b>						
$\overline{SD+}$	Shutdown "1" input voltage		2.7			V
$\overline{SD+}$	Shutdown "0" input voltage				1	V
$I_{SD}$	Shutdown Current	$V_{SD/\overline{DT}} = 0$ After Running Mode		250		$\mu A$
$T_{SD}$	Shutdown Propagation Delay			180		ns



### Switching Definitions

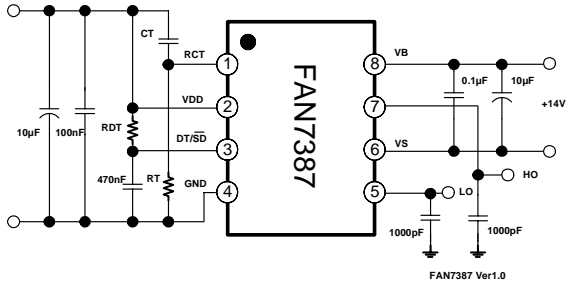


Figure 7. Test Circuit for Self-oscillation Method

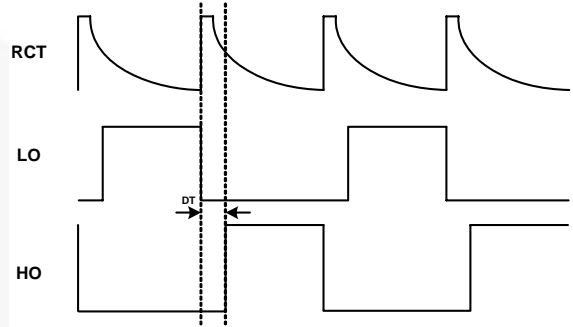


Figure 8. Basic Operating Waveforms of Self-oscillation

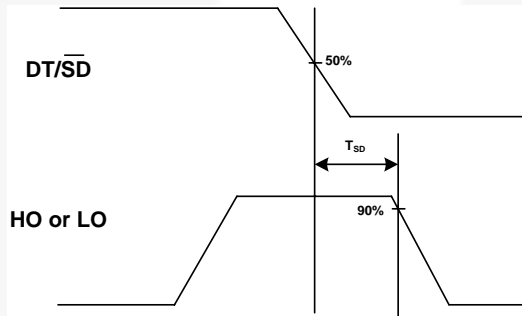


Figure 9. Shutdown Delay Definition

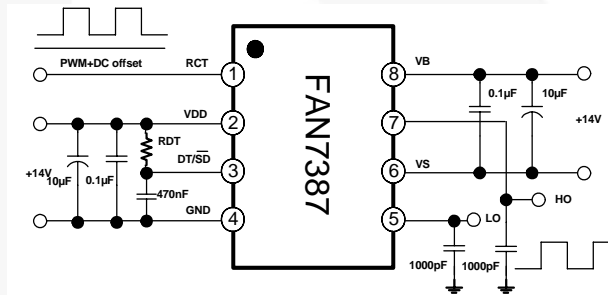


Figure 10. Test Circuit for Forced-oscillation Method Using External Signal

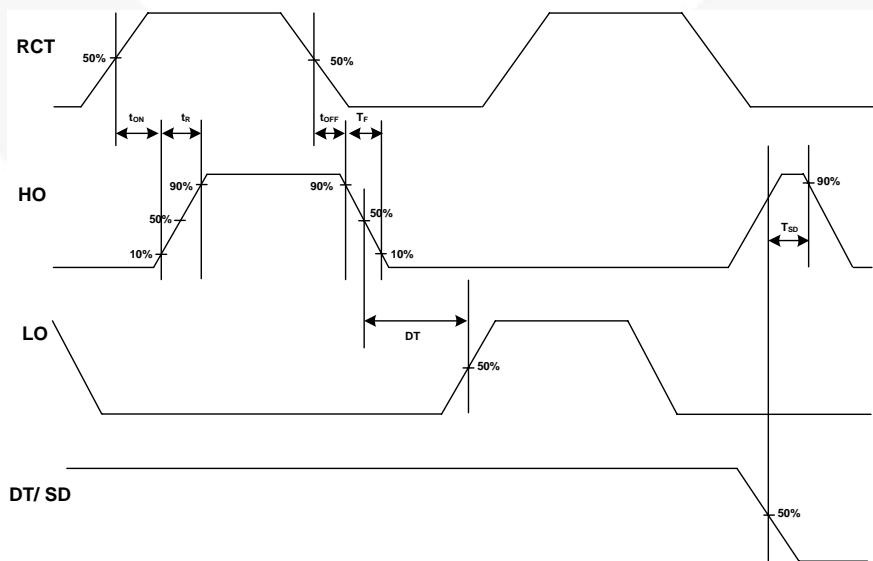


Figure 11. Basic Operation Waveforms of Forced-oscillation Method Using External Signal

## Typical Characteristics

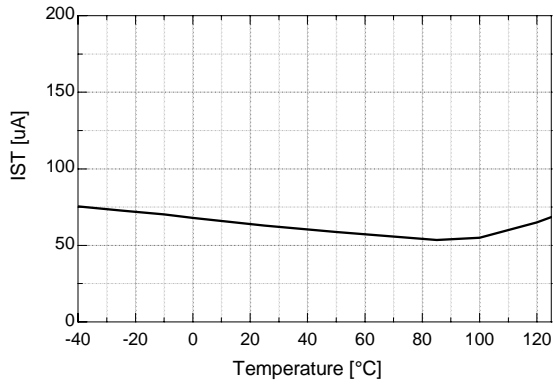


Figure 12. Start-Up Current vs. Temp.

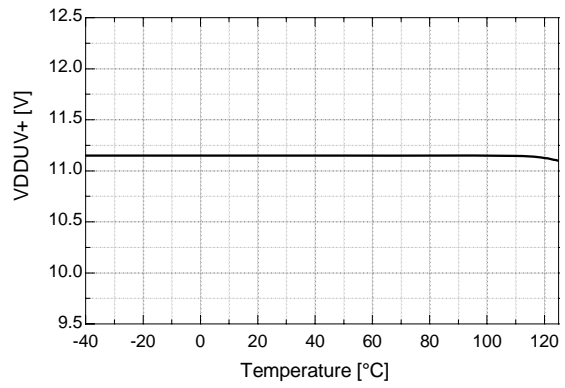


Figure 13.  $V_{DD}$  UVLO+ vs. Temp.

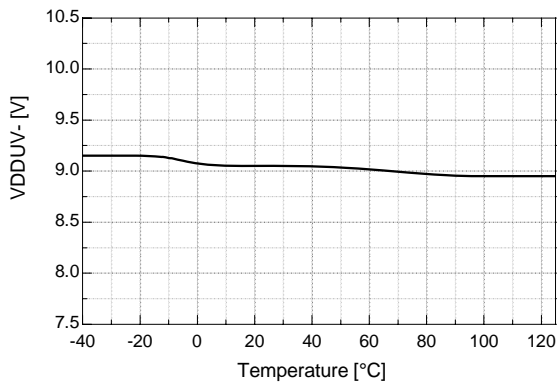


Figure 14.  $V_{DD}$  UVLO- vs. Temp.

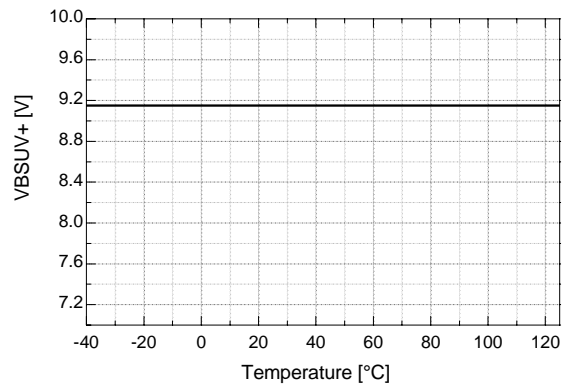


Figure 15.  $V_{BS}$  UVLO+ vs. Temp.

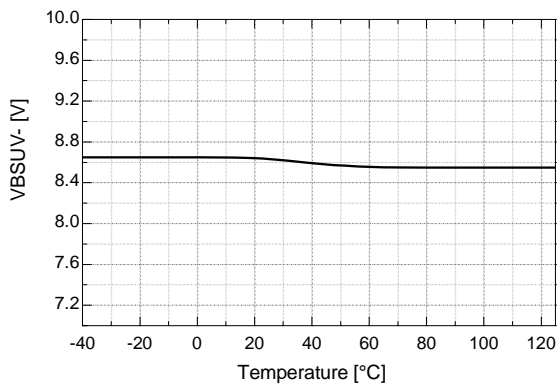


Figure 16.  $V_{BS}$  UVLO- vs. Temp.

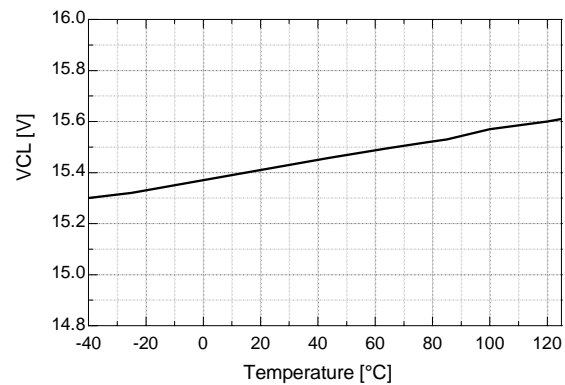


Figure 17.  $V_{CL}$  vs. Temp.

Typical Characteristics (Continued)

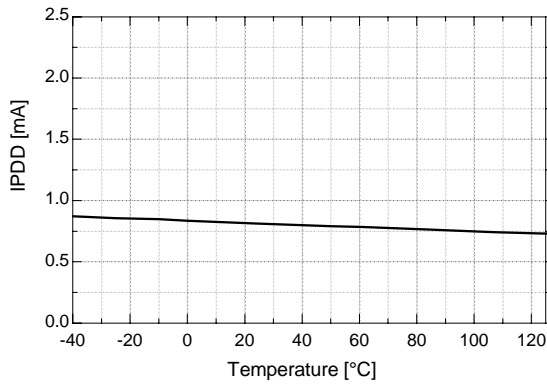


Figure 18.  $I_{PDD}$  vs. Temp.

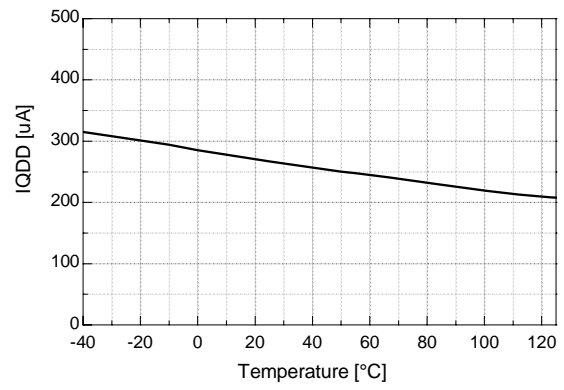


Figure 19.  $I_{QDD}$  vs. Temp.

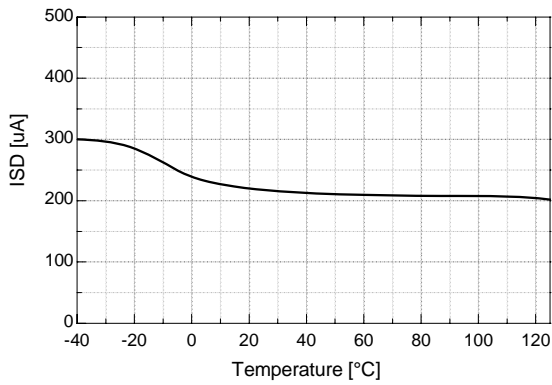


Figure 20.  $I_{SD}$  vs. Temp.

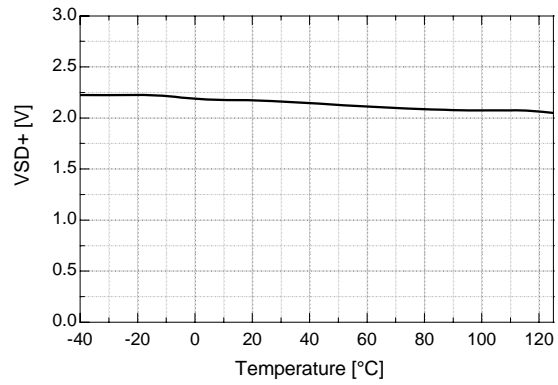


Figure 21.  $V_{SD+}$  vs. Temp.

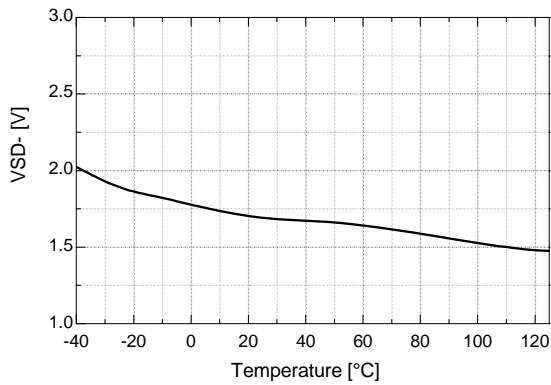


Figure 22.  $V_{SD-}$  vs. Temp.

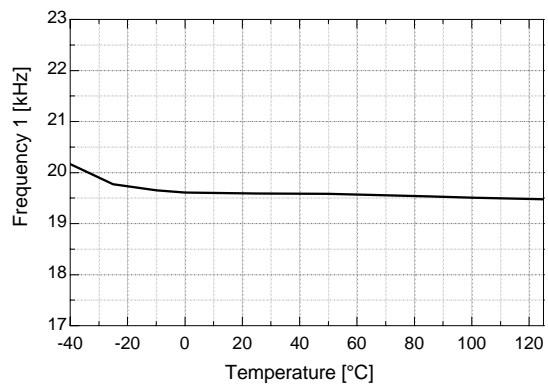


Figure 23. Operating Frequency 1 vs. Temp.

Typical Characteristics (Continued)

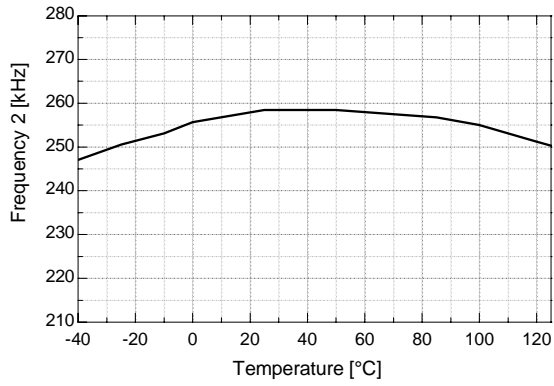


Figure 24. Operating Frequency 2 vs. Temp.

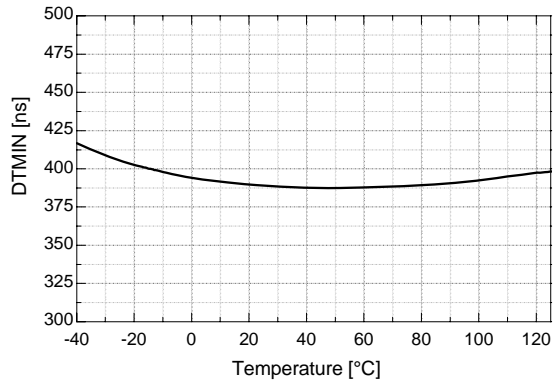


Figure 25. Minimum DT vs. Temp.

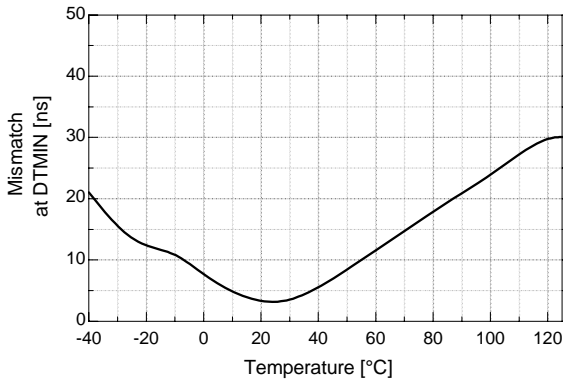


Figure 26. Dead Time Mismatch vs. Temp.

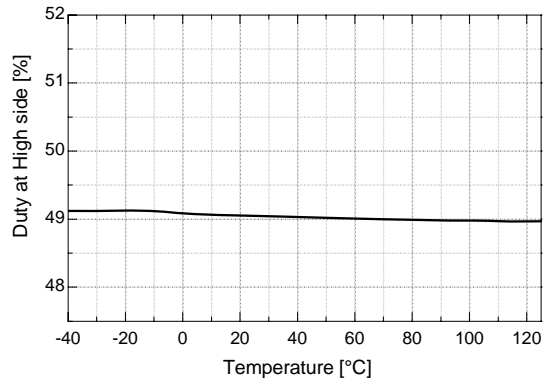


Figure 27. High-side Duty Ratio vs. Temp.

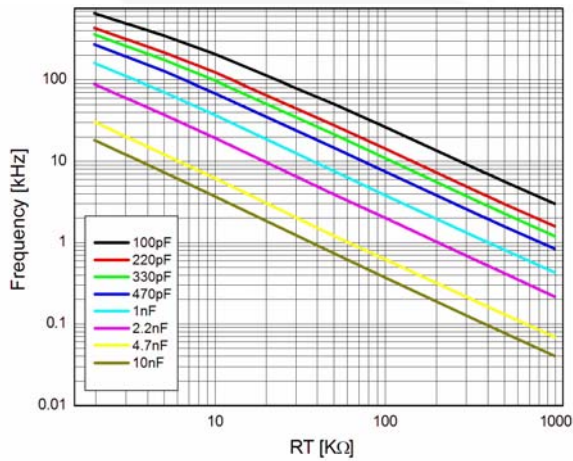


Figure 28. Frequency vs. RT

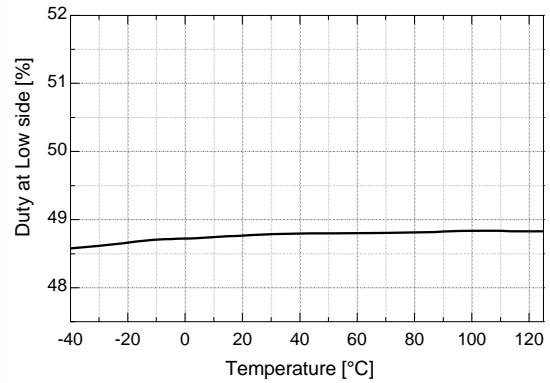


Figure 29. Low-side Duty Ratio vs. Temp

## Typical Application Informations

### 1. UVLO (Under-Voltage Lockout) Function

FAN7387 has a UVLO circuit for a low-side and high-side block. When  $V_{DD}$  reaches to the  $V_{DDUV+}$ , the UVLO circuit is released and the FAN7387 operates normally. At UVLO condition, the FAN7387 has a low supply current of less than 130 $\mu$ A. Once UVLO is released, FAN7387 operates normally until  $V_{DD}$  goes below  $V_{DDUV-}$ , the UVLO hysteresis.

FAN7387 also has a high-side gate driver. The supply for the high-side driver is applied between  $V_B$  and  $V_S$ . To prevent malfunction at low supply voltage between  $V_B$  and  $V_S$ , FAN7387 provides an additional UVLO circuit. If  $V_B-V_S$  is under  $V_{BSUV+}$ , the driver holds LOW state to turn off the high-side switch. Once the voltage of  $V_B-V_S$  is higher than  $V_{BSUVH}$  after  $V_B-V_S$  exceeds  $V_{BSUV-}$ , the operation of driver resumes.

### 2. Oscillator

The running frequency is determined by an external timing resistor ( $R_T$ ) and timing capacitor ( $C_T$ ). The charge time of capacitor  $C_T$  from  $1/4 V_{DD}$  to  $V_{DD}$  determines the running frequency of LO and HO gate driver output. Figure 30 shows connection configuration.

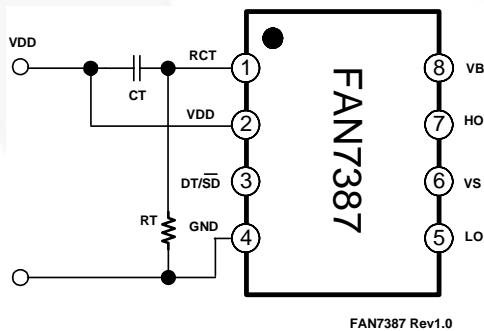


Figure 30. Typical Connection Method

Figure 31 shows the typical waveforms of RCT, LO, and HO. From the circuit analysis, the discharging time of RCT,  $t$ , is given by Equation 1:

$$V_{RCT}(t) = V_{DD} \times \ln\left(\frac{-t}{RT \cdot CT}\right) \quad (1)$$

From Equation 1, it is possible to calculate discharging time,  $t$ , from  $V_{DD}$  to  $1/4 V_{DD}$  by substituting  $V_{RCT(t)}$  with  $1/4 V_{DD}$ .

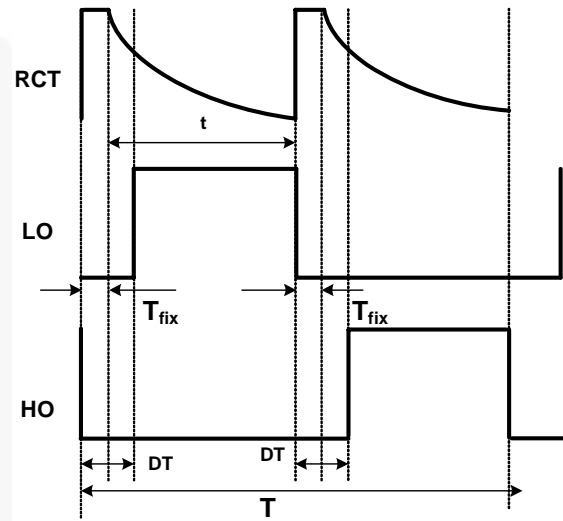


Figure 31. Typical Waveforms of RCT, LO, and HO

$$t = 1.38 \cdot RT \cdot CT \quad (2)$$

The running frequency of IC is determined by  $1/T$  and is approximately given as:

$$f_{\text{running}} = \frac{1}{T} = \frac{1}{2(t + T_{\text{fix}})} \quad (3)$$

where  $t$  is the discharging time of the RCT voltage and  $T_{\text{fix}}$  is constant value about 450ns of IC.

### 3. Programming Dead Time Control / Shutdown

A multi-function pin controls dead time using an external resistor ( $R_{DT}$ ) and protects abnormal condition using an external switch. This pin should be connected to an external capacitor to maintain stable operation.

If the voltage of  $DT/\overline{SD}$  is decreased under 1V by an external switch, such as the TR or MOSFET, the FAN7387 enters shutdown mode. In this mode, the FAN7387 doesn't have any output signal.

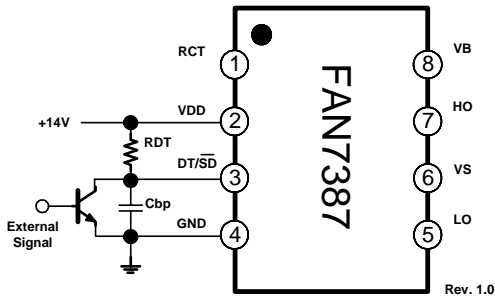


Figure 32. External Shutdown Circuit

#### 4. Gate Driver Operation

The FAN7387 has a two operating modes. One is the self-oscillation mode by using external timing resistor ( $R_T$ ) and external timing capacitor ( $C_T$ ) and the other is the forced oscillation mode by external PWM signal comes from U-com and the other devices.

Figure 33 shows how to operate IC by using external PWM circuit with additional resistors ( $R_1$  and  $R_2$ ) because of internal limitation of IC. The input signal range from an external circuit must be within  $3/5 V_{DD}$  and  $3/4 V_{DD}$ . The external signal produce the HO and LO output and HO signal is to in-phase with the external input signal.

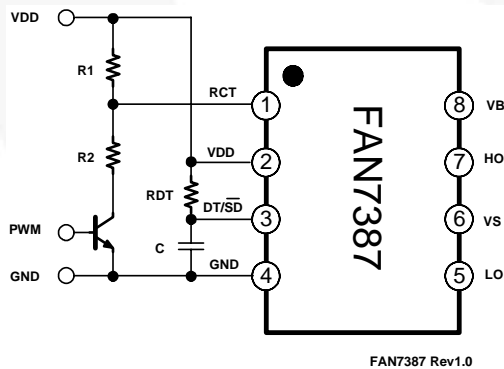
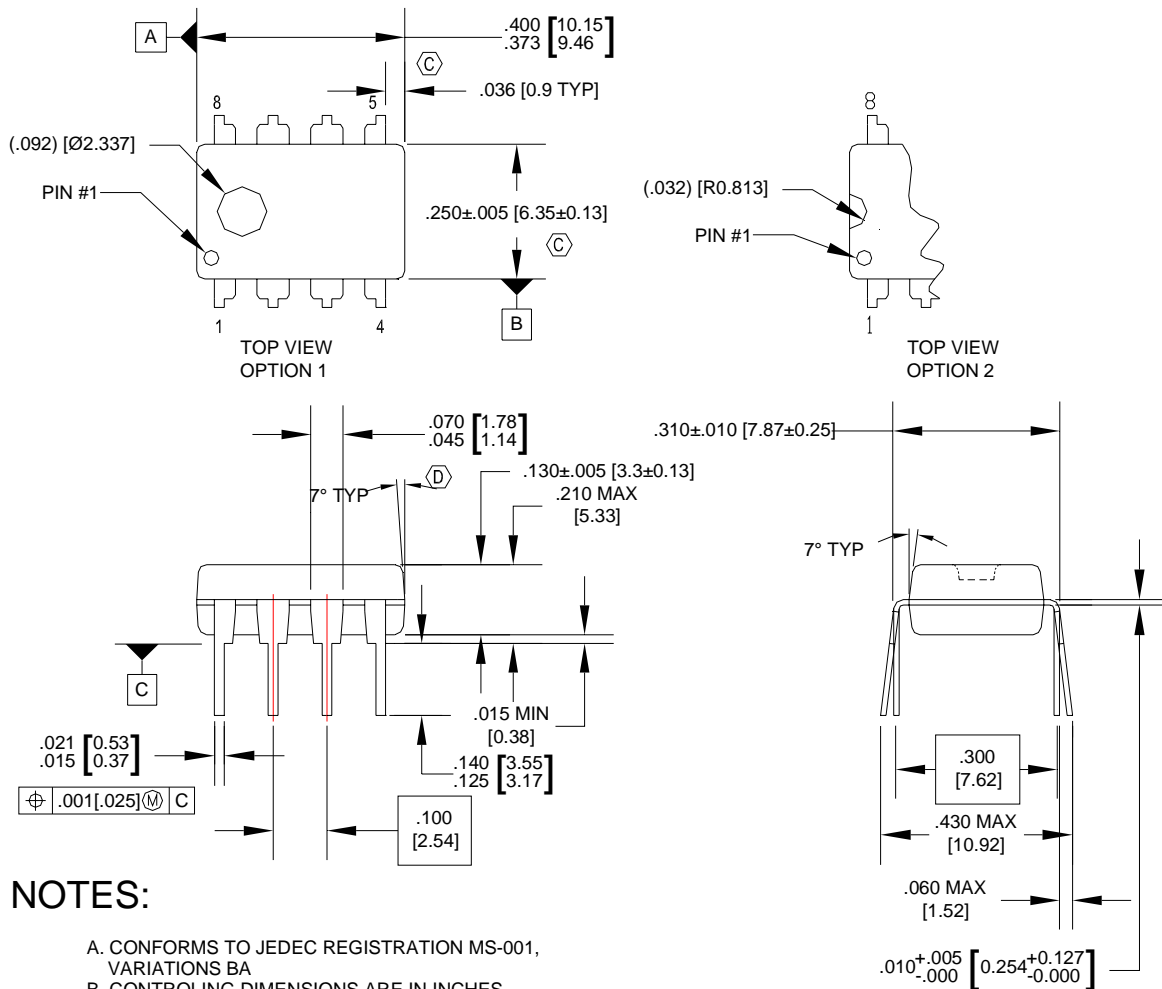


Figure 33. Gate Driver Using External PWM Signal

### Package Dimensions



### NOTES:

- A. CONFORMS TO JEDEC REGISTRATION MS-001, VARIATIONS BA
- B. CONTROLLING DIMENSIONS ARE IN INCHES  
REFERENCE DIMENSIONS ARE IN MILLIMETERS
- (C) DOES NOT INCLUDE MOLD FLASH OR PROTRUSIONS.  
MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED .010 INCHES OR 0.25MM.
- (D) DOES NOT INCLUDE DAMBAR PROTRUSIONS.  
DAMBAR PROTRUSIONS SHALL NOT EXCEED .010 INCHES OR 0.25MM.
- E. DIMENSIONING AND TOLERANCING PER ASME Y14.5M-1994.

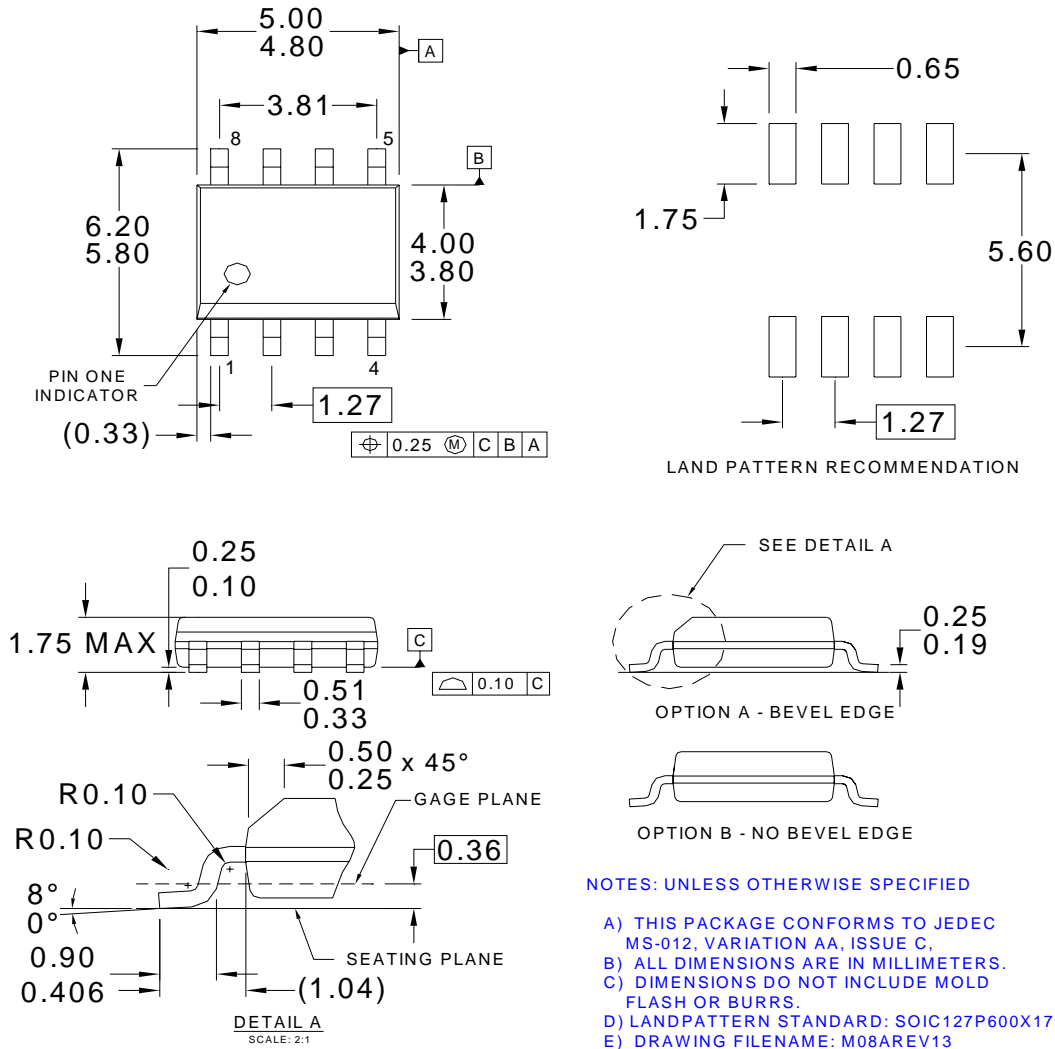
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Figure 34. 8-Lead Dual Inline Package (DIP)

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## Package Dimensions



**Figure 35. 8-Lead Small Outline Package (SOP)**

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



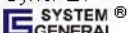
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| Build it Now <sup>™</sup>   | F-PFS <sup>™</sup>  | Power-SPM <sup>™</sup>  |  |
| CorePLUS <sup>™</sup>   | FRFET <sup>®</sup>  | PowerTrench <sup>®</sup>  | TinyBoost <sup>™</sup>  |
| CorePOWER <sup>™</sup>  | Global Power Resource <sup>SM</sup>   | Programmable Active Droop <sup>™</sup>  | TinyBuck <sup>™</sup>   |
| CROSSVOLT <sup>™</sup>  | Green FPS <sup>™</sup>  | QFET <sup>®</sup>   | TinyLogic <sup>®</sup>  |
| CTL <sup>™</sup>  | Green FPS <sup>™</sup> e-Series <sup>™</sup>                                      | QS <sup>™</sup>   | TINYOPTO <sup>™</sup>   |
| Current Transfer Logic <sup>™</sup>   | GTO <sup>™</sup>  | Quiet Series <sup>™</sup>   | TinyPower <sup>™</sup>  |
| EcoSPARK <sup>®</sup>   | IntelliMAX <sup>™</sup>   | RapidConfigure <sup>™</sup>   | TinyPWM <sup>™</sup>  |
| EfficientMax <sup>™</sup>   | ISOPLANAR <sup>™</sup>  | Saving our world, 1mW at a time <sup>™</sup>                                      | TinyWire <sup>™</sup>   |
| EZSWITCH <sup>™</sup> *   | MegaBuck <sup>™</sup>   | SmartMax <sup>™</sup>   | μSerDes <sup>™</sup>  |
|  | MICROCOUPLER <sup>™</sup>   | SMART START <sup>™</sup>  |  |
|  | MicroFET <sup>™</sup>   | SPM <sup>®</sup>  | UHC <sup>®</sup>  |
| Fairchild <sup>®</sup>  | MicroPak <sup>™</sup>   | STEALTH <sup>™</sup>  | Ultra FRFET <sup>™</sup>  |
| Fairchild Semiconductor <sup>®</sup>  | MillerDrive <sup>™</sup>  | SuperFET <sup>™</sup>   | UniFET <sup>™</sup>   |
| FACT Quiet Series <sup>™</sup>  | MotionMax <sup>™</sup>  | SuperSOT <sup>™</sup> -3  | VCX <sup>™</sup>  |
| FACT <sup>®</sup>   | Motion-SPM <sup>™</sup>   | SuperSOT <sup>™</sup> -6  | VisualMax <sup>™</sup>  |
| FAST <sup>®</sup>   | OPTOLOGIC <sup>®</sup>  | SuperSOT <sup>™</sup> -8  |   |
| FastvCore <sup>™</sup>  | OPTOPLANAR <sup>®</sup>   | SupreMOS <sup>™</sup>   |   |
| FlashWriter <sup>®</sup> *  |  | SyncFET <sup>™</sup>  |   |
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**PRODUCT STATUS DEFINITIONS**

**Definition of Terms**

Datasheet Identification	Product Status	Definition
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