FAIRCHILD SEMICONDUCTOR®

May 2008

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(1)	8-SOP	-40°C ~ 125°C	Tube
FAN7387MX(1)			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.*

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

Typical Application Diagrams

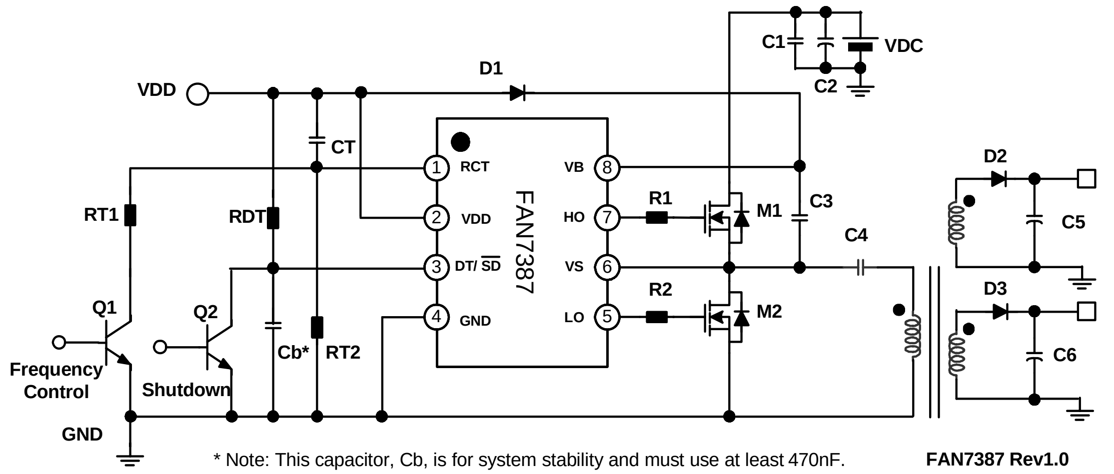


Figure 1. Typical Application Circuit for SMPS (Self Oscillation Method)

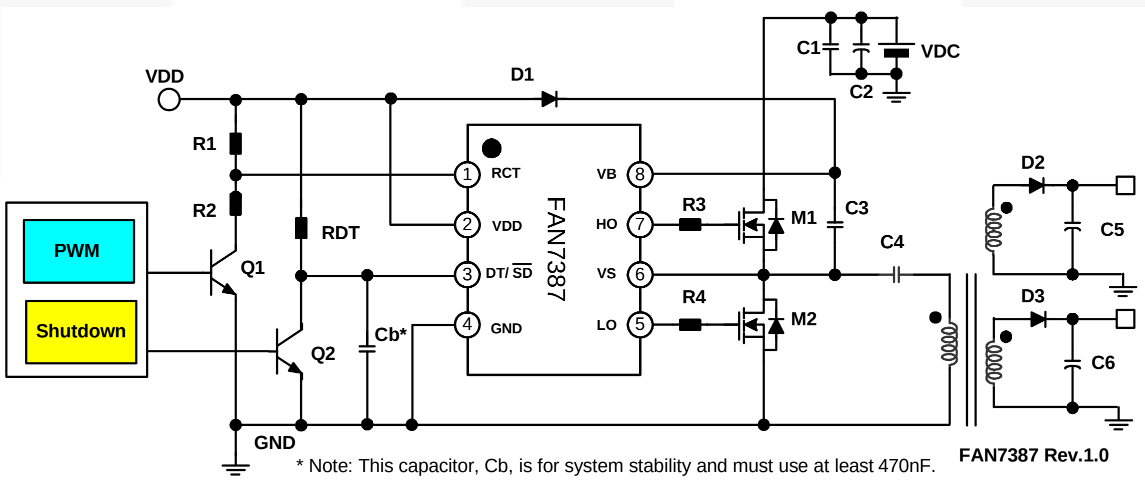


Figure 2. Typical Application Circuit for SMPS Using External Signal

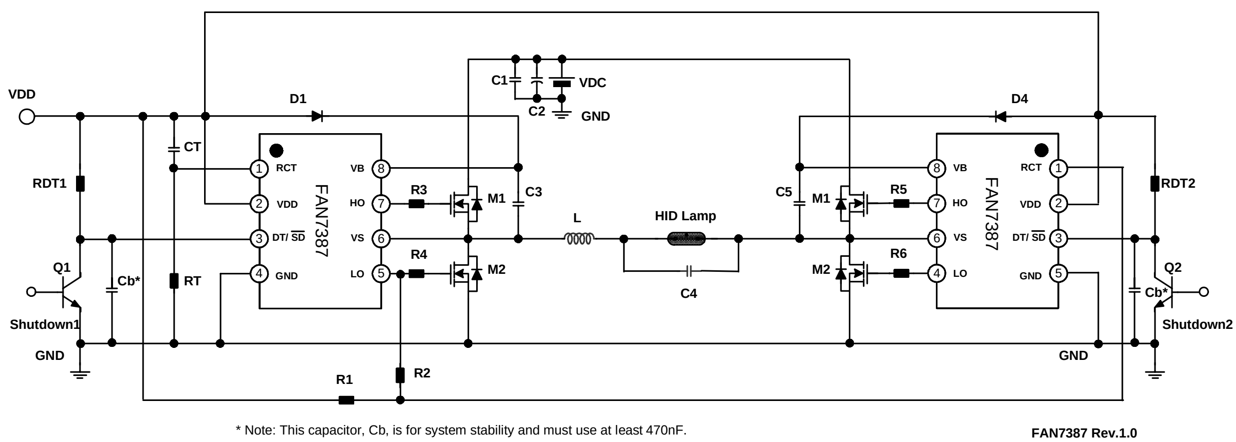


Figure 3. Typical Application Circuit for Full-Bridge Converter

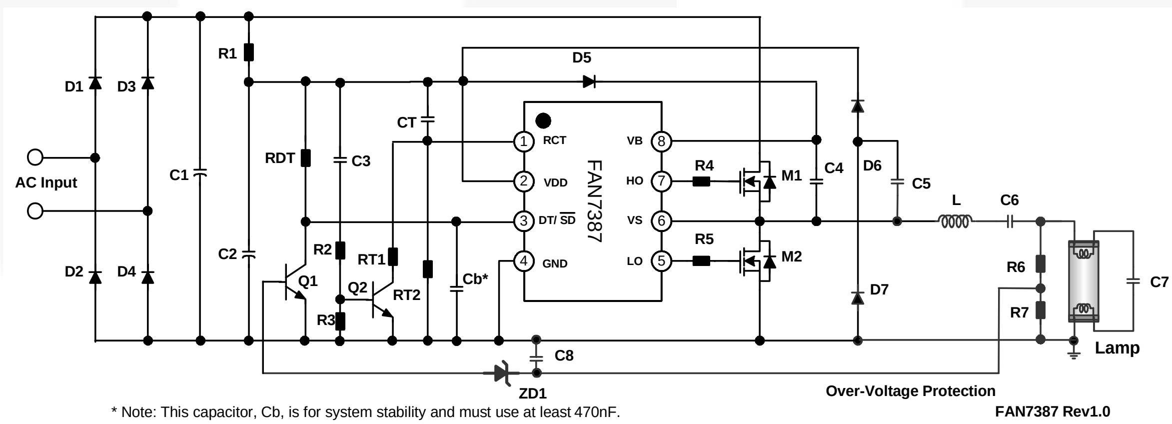


Figure 4. Typical Application Circuit for Fluorescent Lamp Ballast

Internal Block Diagram

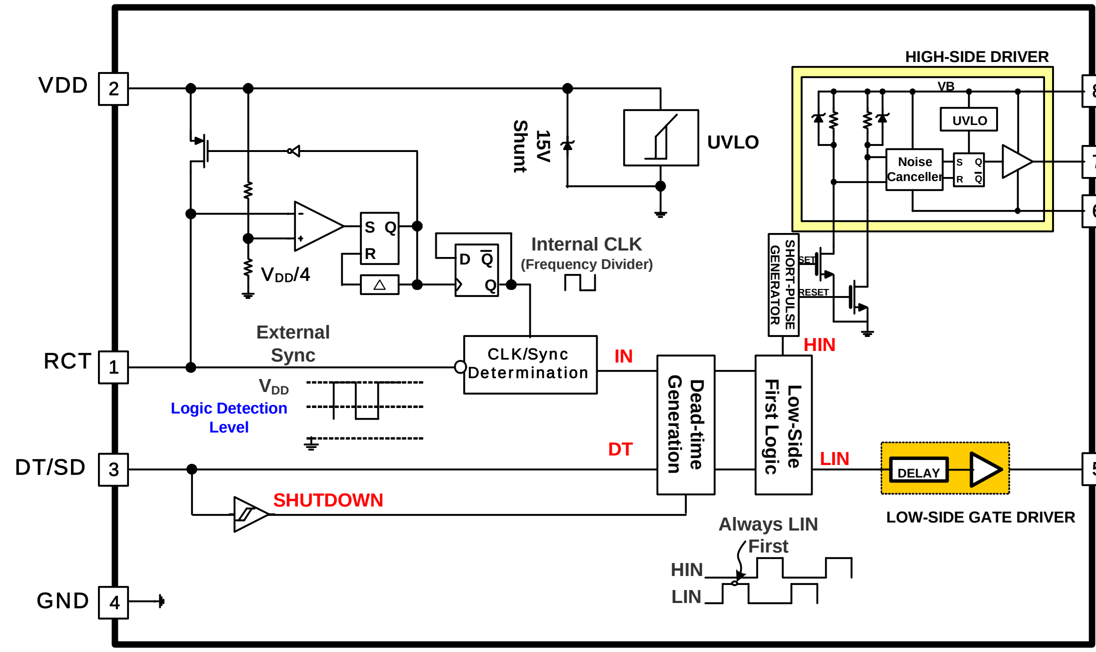


Figure 5. Functional Block Diagram

Pin Configuration

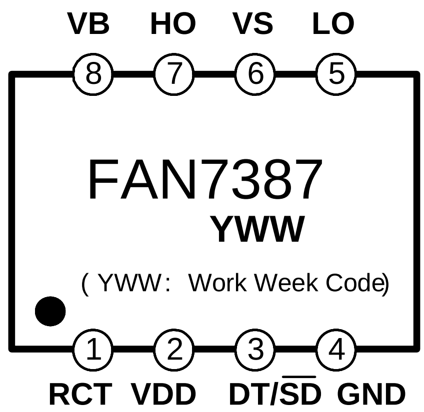


Figure 6. Pin Configuration (Top View)

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°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(2)				25	mA
dV_S/dt	Allowable offset voltage slew rate			50		V/ns
T_A	Operating temperature range		-40		+125	°C
T_{STG}	Storage temperature range		-65		+150	°C
P_D	Power dissipation	8-DIP		1.2		W
		8-SOP		0.625		
θ_{JA}	Thermal resistance (Junction-to-Air)	8-DIP		100		°C/W
		8-SOP		200		

Note:

2. 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		kΩ
CT	Timing capacitor value of RCT	100		pF
T_A	Ambient temperature	-40	+125	°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
Low-Side Supply Characteristics (V_{DD})						
VDD_{UV+}	V_{DD} supply under-voltage positive going threshold	V_{DD} Increasing	9.5	11.0	12.5	V
VDD_{UV-}	V_{DD} supply under-voltage negative going threshold	V_{DD} Decreasing	7.5	9.0	10.5	V
VDD_{UVH}	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	µA
I_{ST}	Start-up supply current	V_{DD}=9V		50	130	µA
I_{LK}	Offset supply leakage current	V_B=V_S=600V			10	µA
I_{PDD}	Low-side dynamic operating supply current			0.8		mA
High-Side Supply Characteristics (V_B-V_S)						
VBS_{UV+}	V_{BS} supply under-voltage negative going threshold	V_B -V_S Increasing	7.7	9.2	10.7	V
VBS_{UV-}	V_{BS} supply under-voltage negative going threshold	V_B -V_S Decreasing	7.1	8.6	10.1	V
VBS_{UVH}	V_{BS} supply under-voltage lockout hysteresis			0.6		V
I_{QBS}	High-side quiescent supply current			50	130	µA
I_{PBS}	High-side dynamic operating supply current			400	800	µA
Oscillator Characteristics						
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	kHz
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	ns
Output Characteristics						
I_{O+}[3]	Output high, short-circuit pulse current	PW<=10µs		350		mA
I_{O-}[3]	Output low, short-circuit pulse current	PW=10µs		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°C, unless otherwise specified.

Symbol	Parameter	Condition	Min.	Typ.	Max.	Unit
Output Characteristics						
t_{ON}	Turn-on propagation time	V_{DD}=V_{BS}=14V, $V_{DT/SD}$=V_{DD}, V_{RCT}=4V~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~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
Protection Characteristics						
$\overline{SD}$+	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		μA
T_{SD}	Shutdown Propagation Delay			180		ns

Switching Definitions

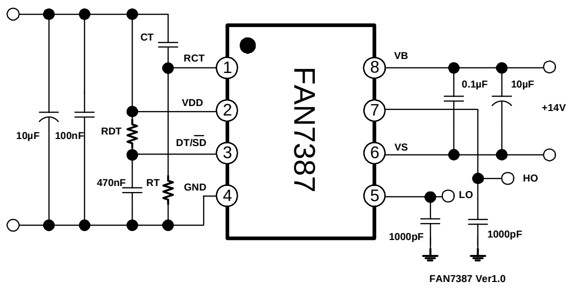


Figure 7. Test Circuit for Self-oscillation Method

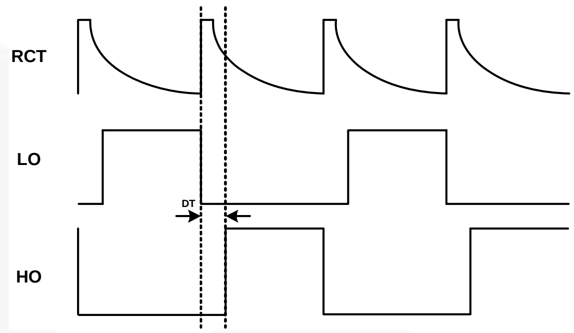


Figure 8. Basic Operating Waveforms of Self-oscillation

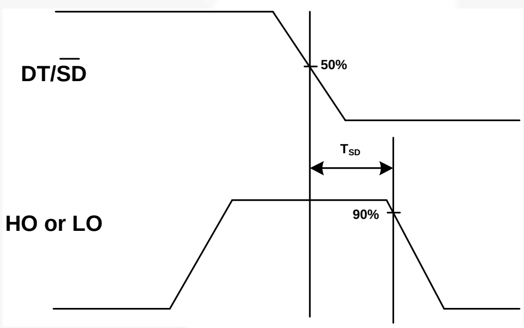


Figure 9. Shutdown Delay Definition

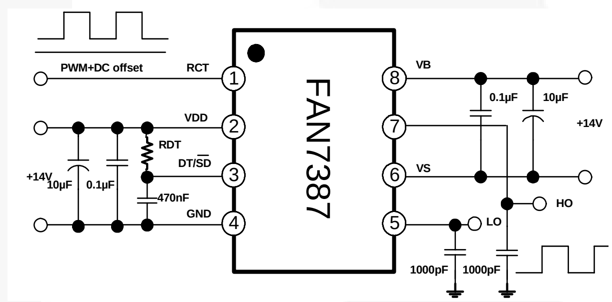


Figure 10. Test Circuit for Forced-oscillation Method Using External Signal

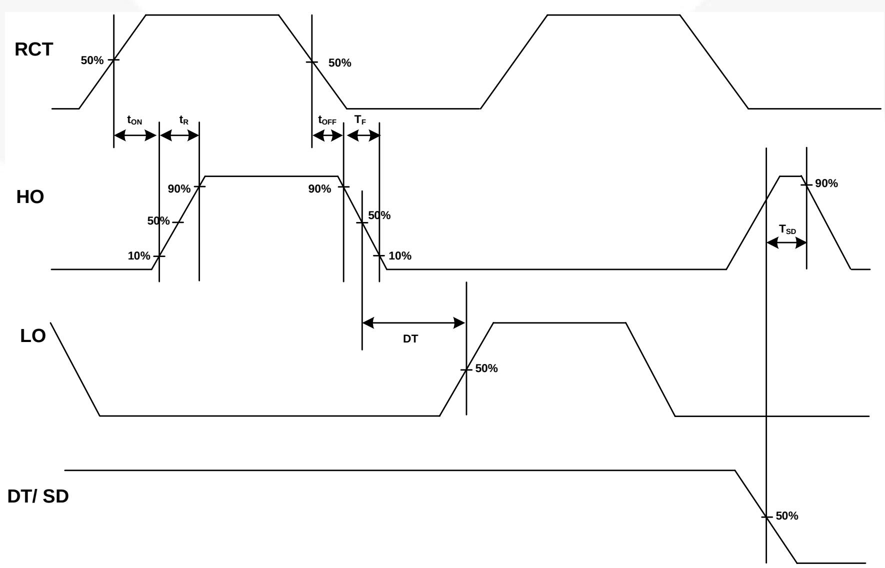


Figure 11. Basic Operation Waveforms of Forced-oscillation Method Using External Signal

Typical Characteristics

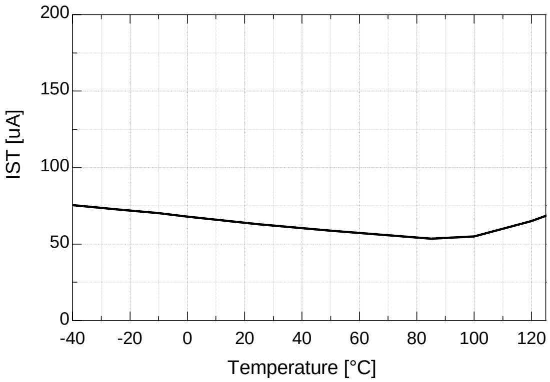


Figure 12. Start-Up Current vs. Temp.

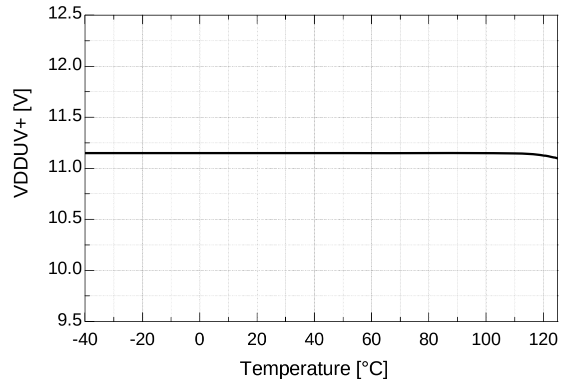


Figure 13. V_{DD} UVLO+ vs. Temp.

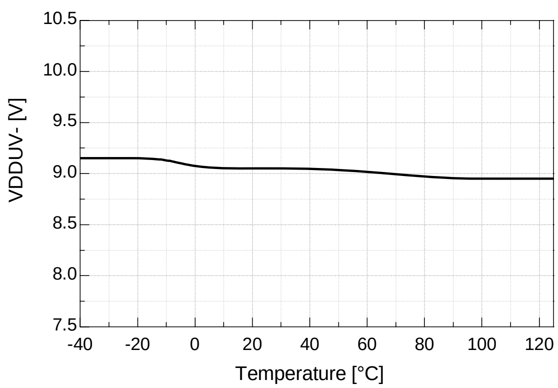


Figure 14. V_{DD} UVLO- vs. Temp.

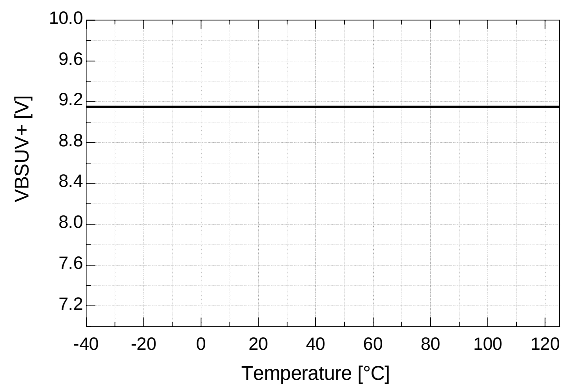


Figure 15. V_{BS} UVLO+ vs. Temp.

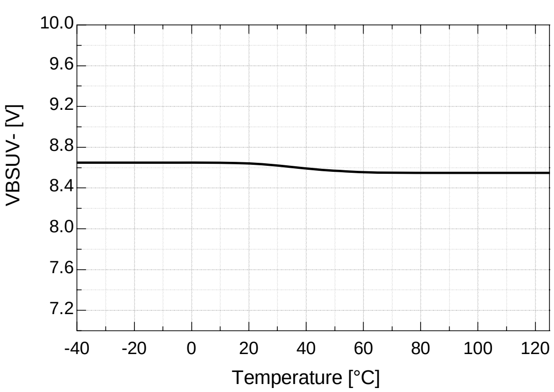


Figure 16. V_{BS} UVLO- vs. Temp.

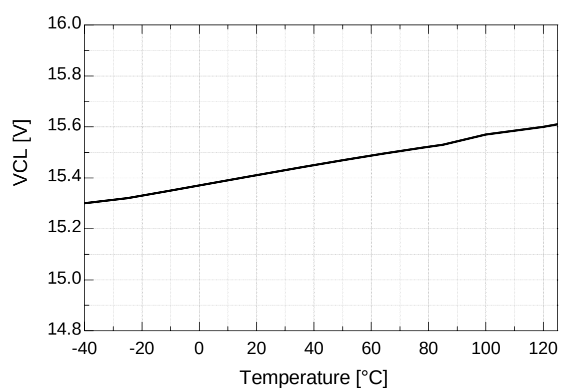


Figure 17. V_{CL} vs. Temp.

Typical Characteristics (Continued)

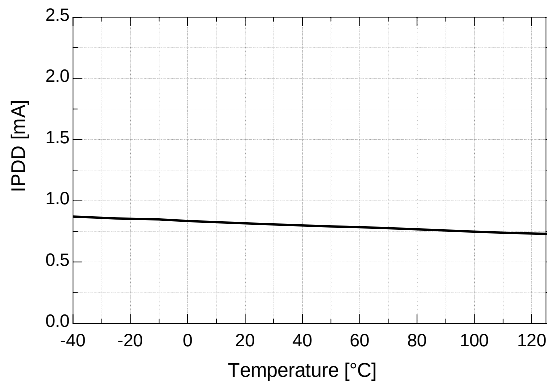


Figure 18. I_{PDD} vs. Temp.

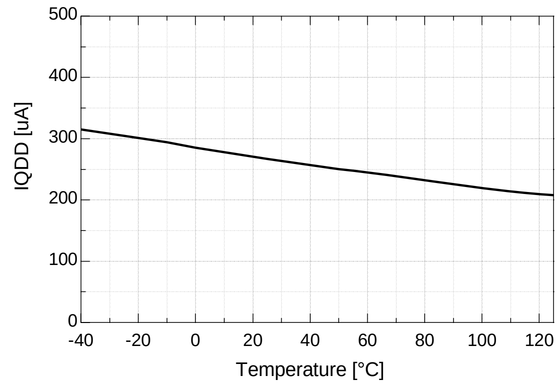


Figure 19. I_{QDD} vs. Temp.

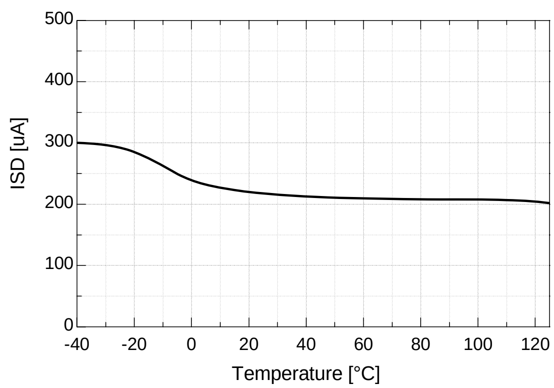


Figure 20. I_{SD} vs. Temp.

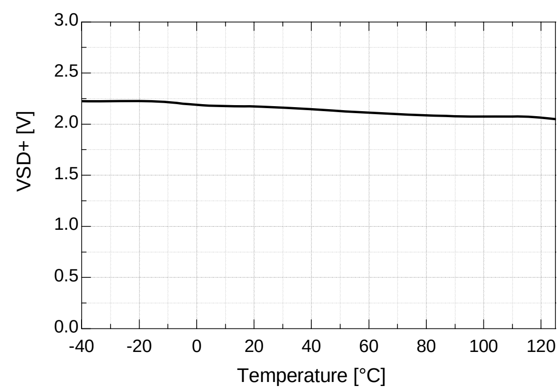


Figure 21. V_{SD}+ vs. Temp.

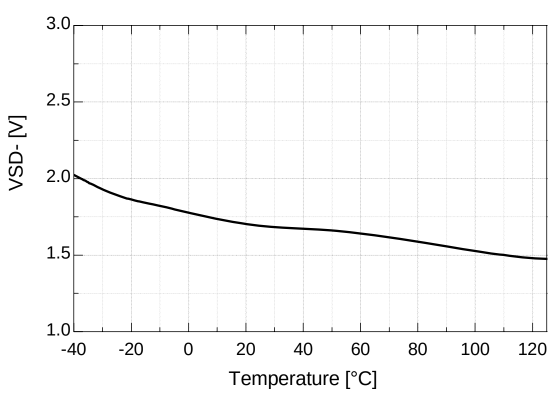


Figure 22. V_{SD}- vs. Temp.

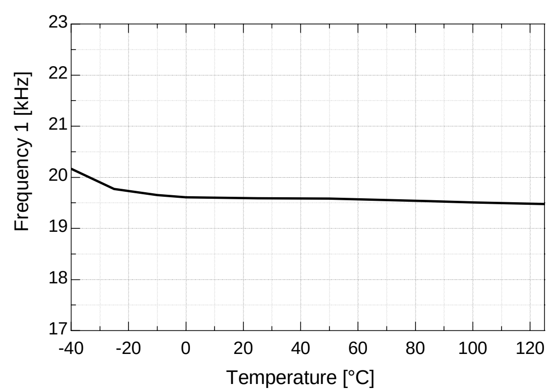


Figure 23. Operating Frequency 1 vs. Temp.

Typical Characteristics (Continued)

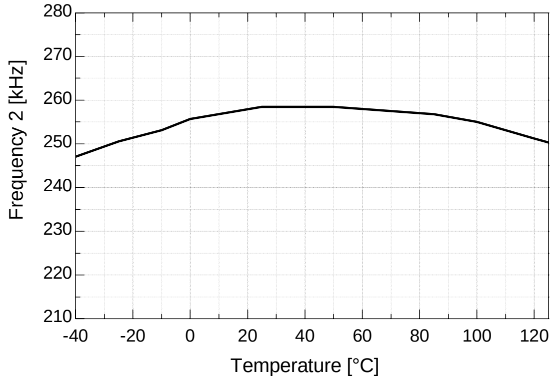


Figure 24. Operating Frequency 2 vs. Temp.

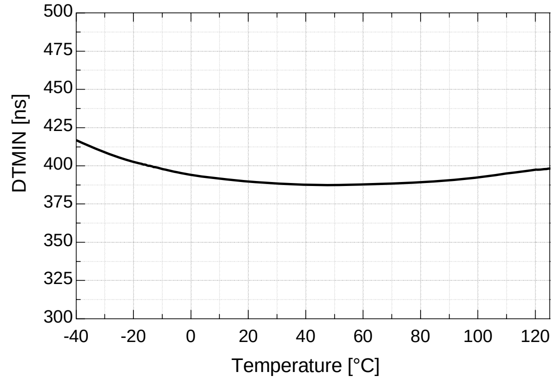


Figure 25. Minimum DT vs. Temp.

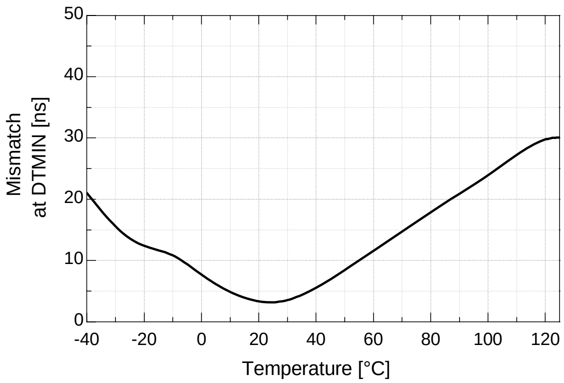


Figure 26. Dead Time Mismatch vs. Temp.

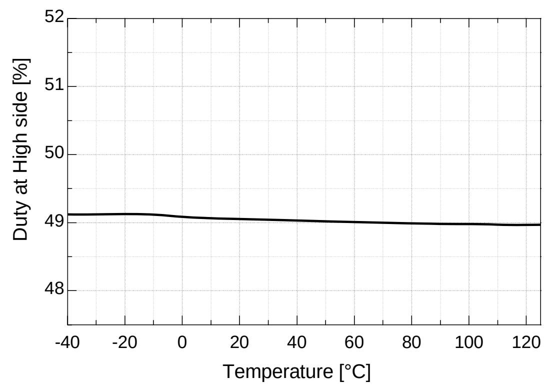


Figure 27. High-side Duty Ratio vs. Temp.

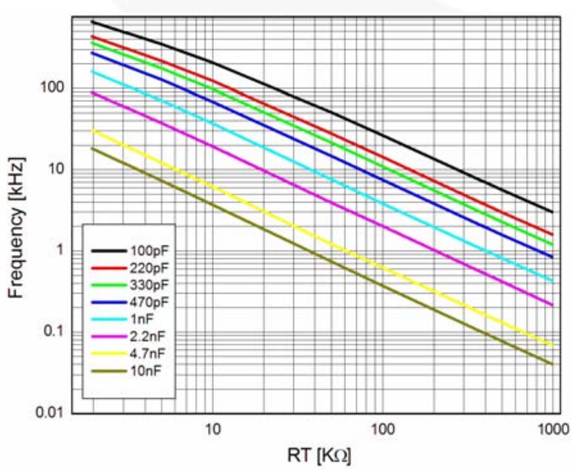


Figure 28. Frequency vs. RT

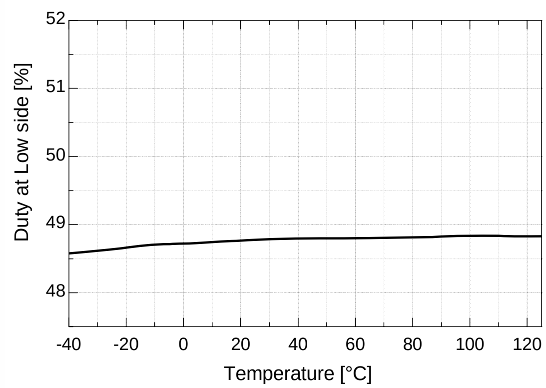


Figure 29. Low-side Duty Ratio vs. Temp

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 130µA. 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.

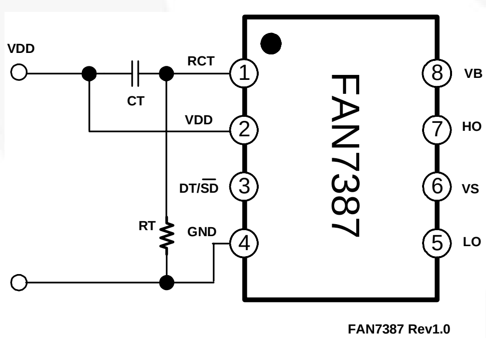


Figure 30. Typical Connection Method

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:

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

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}.

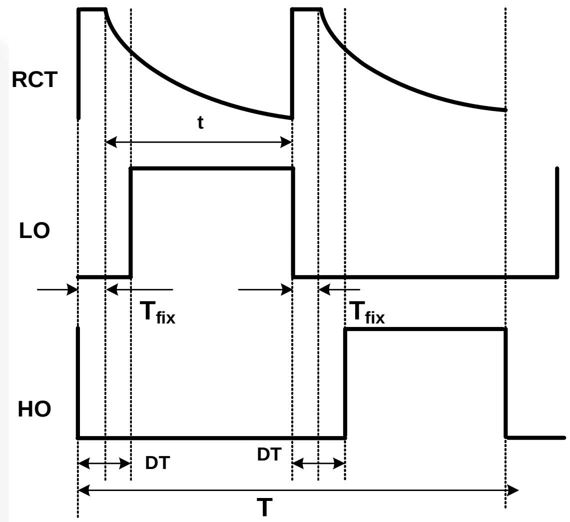


Figure 31. Typical Waveforms of RCT, LO, and HO

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

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

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

where t is the discharging time of the RCT voltage and and T_{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.

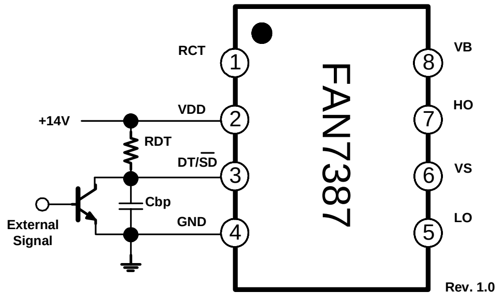


Figure 32. External Shutdown Circuit

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 (R1 and R2) because of internal limitation of IC. The input signal range from an external circuit must by 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.

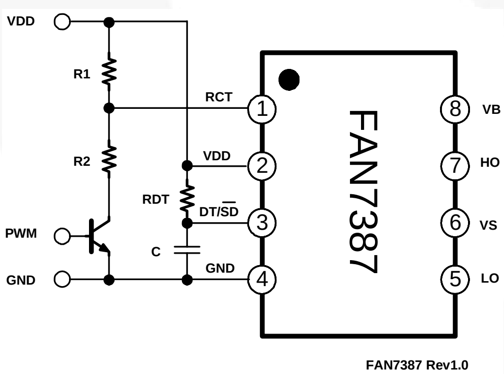
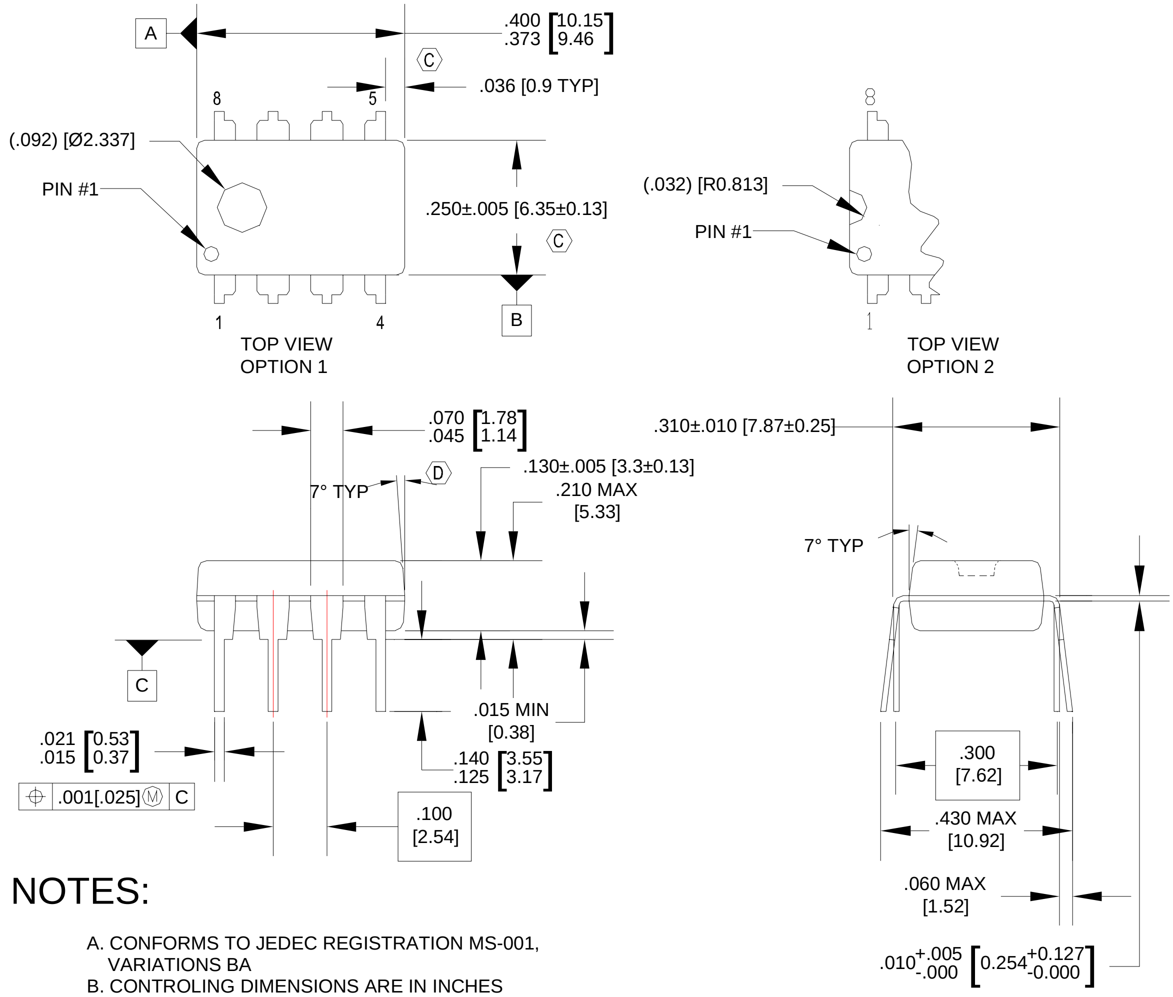


Figure 33. Gate Driver Using External PWM Signal

Package Dimensions



NOTES:

A. CONFORMS TO JEDEC REGISTRATION MS-001, VARIATIONS BA
B. CONTROLING 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.

N08EREVG

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

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Package Dimensions

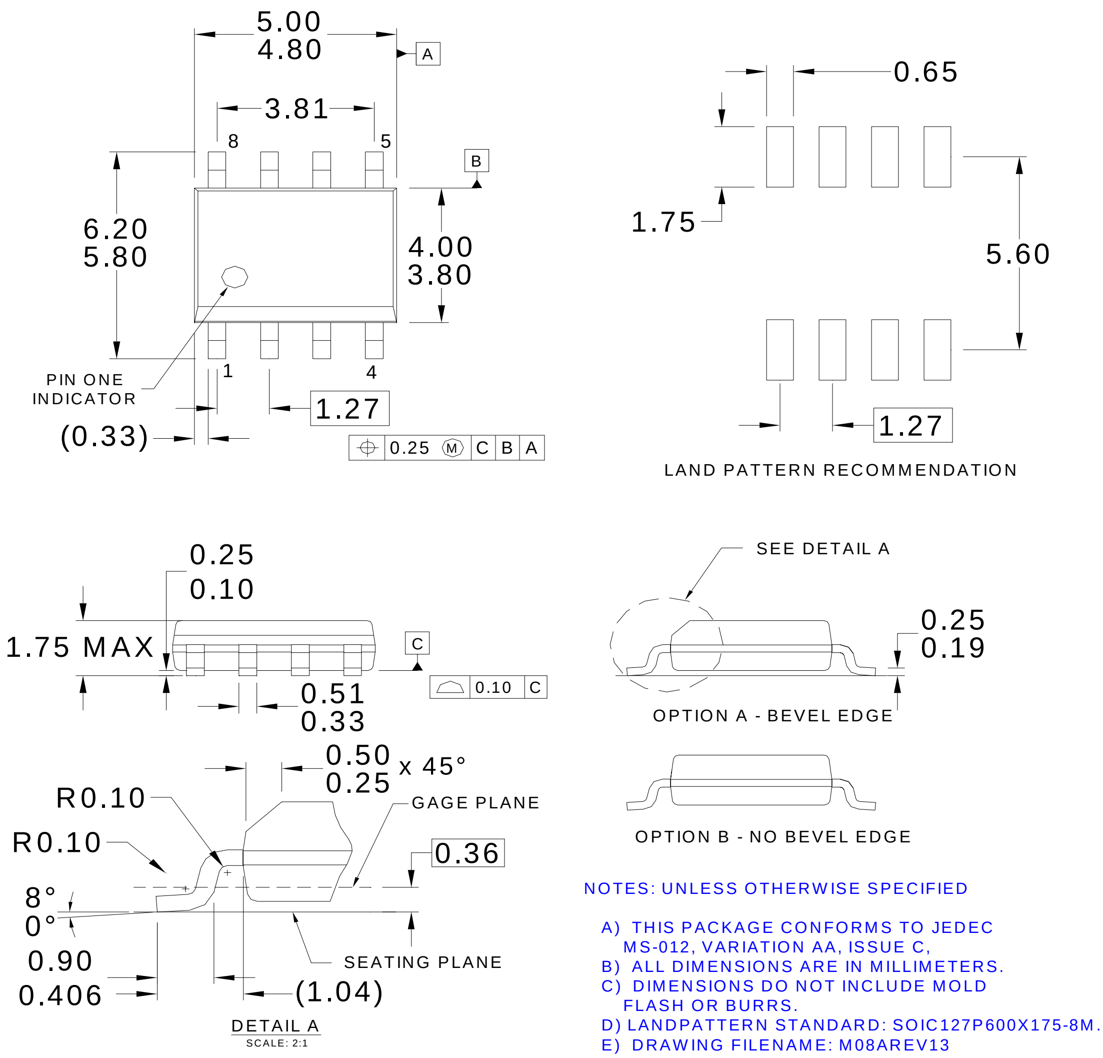

Figure 35. 8-Lead Small Outline Package (SOP)

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FPS™
F-PFS™
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SmartMax™
SMART START™
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SuperFET™
SuperSOT™-3
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SuperSOT™-8
SupreMOS™
SyncFET™
SYSTEM GENERAL®
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PRODUCT STATUS DEFINITIONS

Definition of Terms

Datasheet Identification	Product Status	Definition
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