FAIRCHILD

May 2024

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

Applications

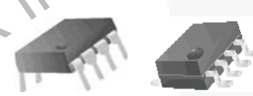
- Half-Bridge Inverter
- SMPS
- Ballast Solution for High-Intensity Discharge (HID) Lamp
- Ballast for Fluorescent Lamp

Description

The FAN7387 is a simple control IC for common half-bridge inverter, 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 an external pin for dead-time control and shutdown. Using this resistor, the designer can choose the optimum dead time to reduce power loss of switching devices, such as transistors and MOSFETs.

8-DIP 8-SOP

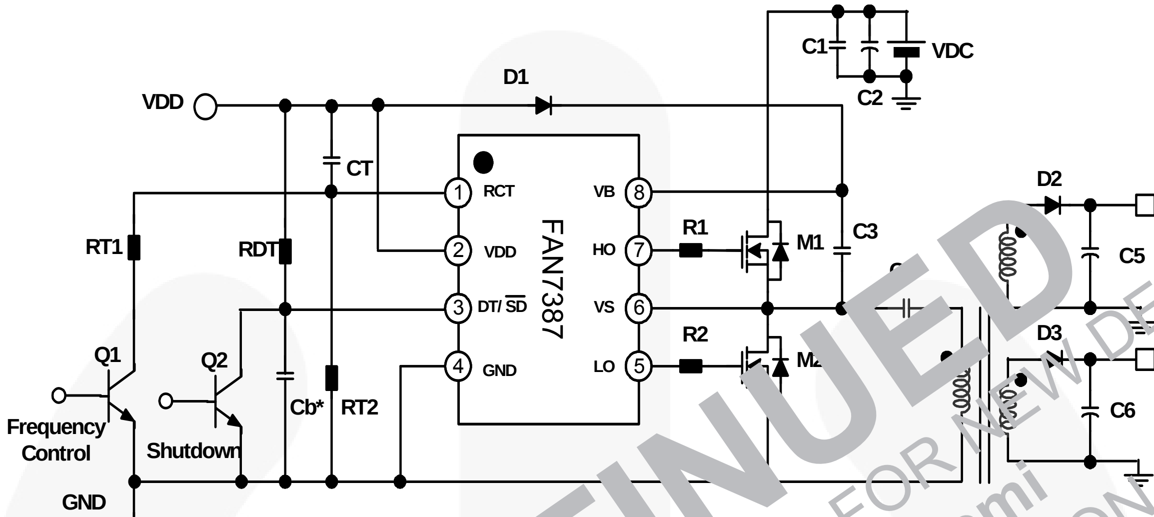


Ordering Information

Part Number	Package	Operating Temperature	Packing Method
FAN7387MX[1]	8-SOP	-40 to +125°C	Tape & Reel

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

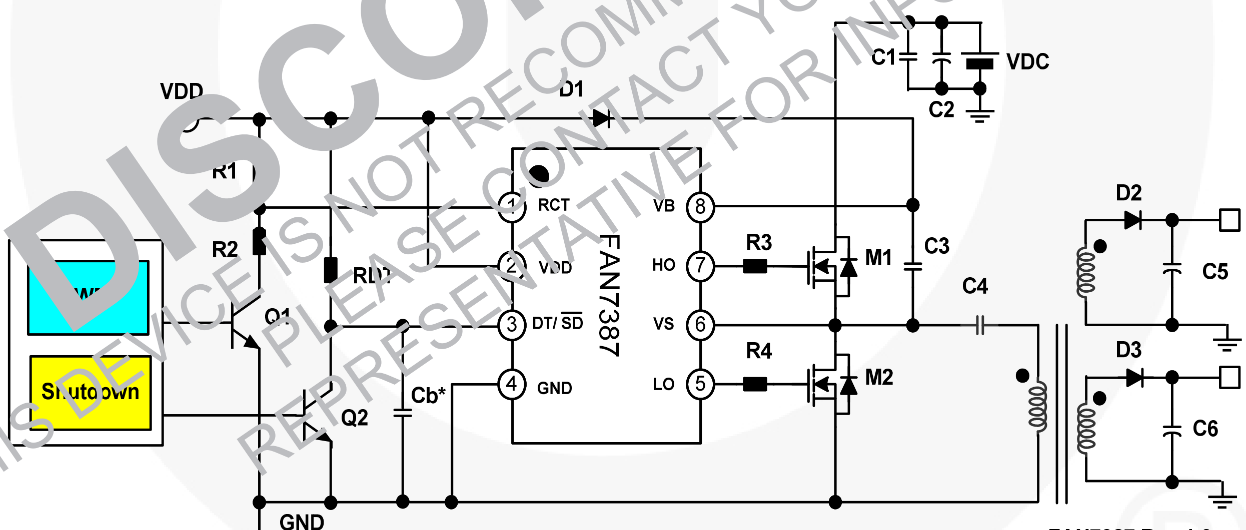
Typical Applications Diagrams



* Note: This capacitor, Cb, is for system stability and must use at least 470nF.

FAN7387 Rev1.0

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



* Note: This capacitor, Cb, is for system stability and must use at least 470nF.

FAN7387 Rev.1.0

Figure 2. Typical Application Circuit for SMPS by Using External Signal

Typical Application Diagrams (Continued)

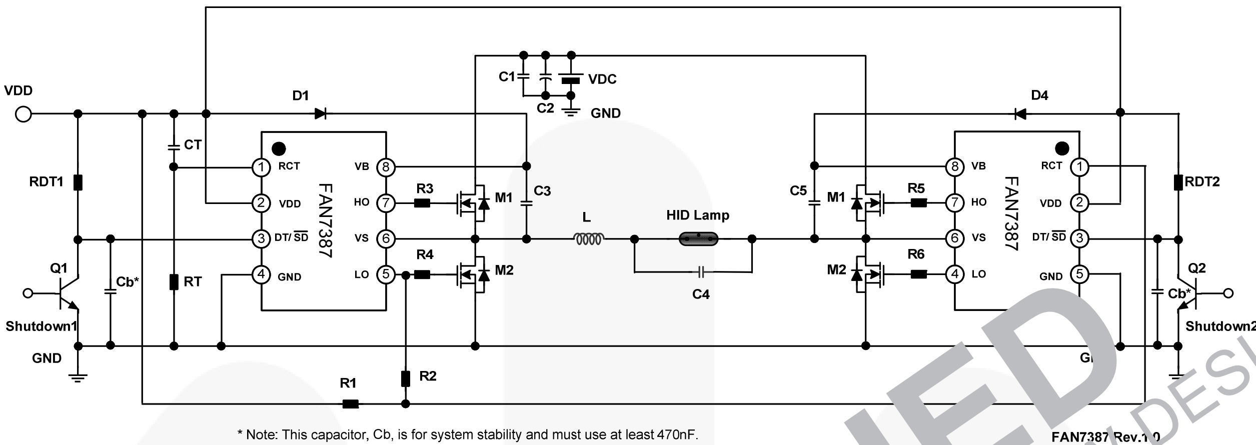


Figure 3. Typical Application Circuit for Full-Bridge Converter

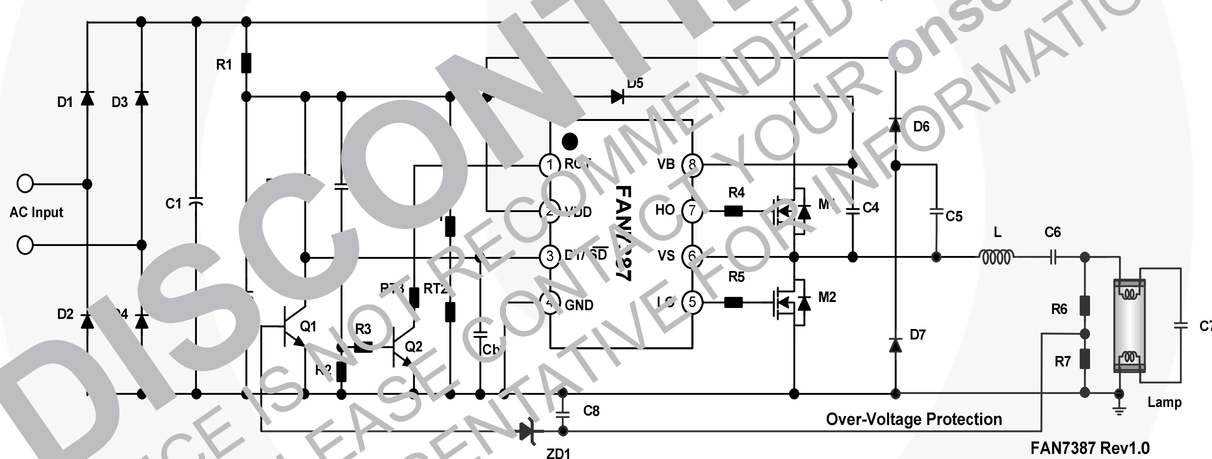


Figure 4. Typical Application Circuit for Fluorescent Lamp Ballast

Internal Block Diagram

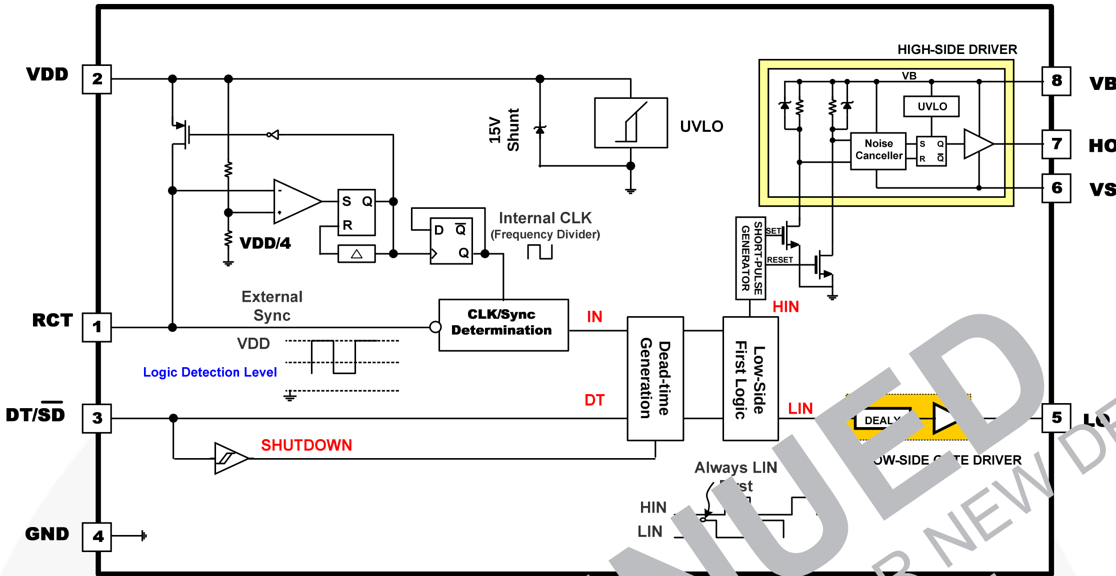


Figure 5. Functional Block Diagram

Pin Configuration

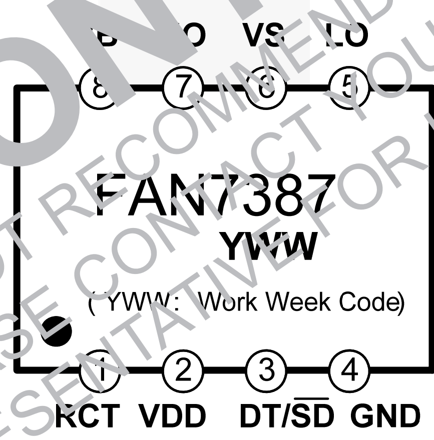


Figure 6. Pin Configurations (Top View)

Pin Definitions

Pin #	Name	Description
1	RCT	Oscillator frequency set resistor and capacitor.
2	VDD	Supply Voltage.
3	DT/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		0.625		W
Θ_{JA}	Thermal Resistance (Junction-to-Air)		200		°C/W

Note:
2. Do not supply a low-impedance voltage source to the internal clamping Zener diode between the GND and the VDD 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
R_T	Timing Resistor Value of RCT	2		kΩ
C_T	Timing Capacitor Value of RCT	100		pF
T_A	Ambient Temperature	-40	+125	°C

Electrical Characteristics

V_{BIAS} (V_{DD}, V_B -V_S)=14.0 V, C_L=1 nF, R_T=50 kΩ and C_T=330 pF 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	9.50	11.00	12.50	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 Camping Voltage	I_{DD}=10 mA	14.8	15.4		V
I_{QDD}	Low-Side Quiescent Supply Current	R_{DT}=100 kΩ		[illegible]	500	μA
I_{ST}	Startup Supply Current	V_{DD}=9 V		50	130	μA
I_{LK}	Offset Supply Leakage Current	V_B=V_S=600 V			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=50 kΩ, C_T=330 pF	18	20	22	kHz
f_{osc2}	Oscillation Frequency 2	R_T=1 kΩ, C_T=1 nF	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		3/4 V_{DD}		V
V_{IL}	Logic "0" Input Voltage of RCT	Running Mode			3/5 V_{DD}	V
t_D	Dead-Time	R_{DT}=100 kΩ	500	600	700	ns
t_{DMIN}	Minimum Dead-Time	$V_{DT/SD}$=V_{DD}	300	400	500	ns
Output Characteristics						
I_{O+}	Output High, Short-Circuit Pulse Current(3)	PW≤10 μs		350		mA
I_{O-}	Output Low, Short-Circuit Pulse Current(3)	PW≤10 μs		650		mA
V_S	Allowable Negative V_S Pin voltage for Input Signal (V_{RCT}) Propagation to HO			-9.8	-7.0	V

Continued on the following page...

Electrical Characteristics (Continued)

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

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
Output Characteristics						
t_{ON}	Turn-On Propagation Time	V_{DD}=V_{BS}=14 V, $V_{DT/SD}$=V_{DD}, V_{RCT}=4 V~V_{DD}, f_{OSC}=20 kHz		550		ns
t_{OFF}	Turn-Off Propagation Time	V_{DD}=V_{BS}=14 V, $V_{DT/SD}$=V_{DD}, V_{RCT}=4 V~V_{DD}, f_{OSC}=20 kHz		160		ns
t_R	Turn-On Rising Time	C_L=1000 pF		50	120	ns
t_F	Turn-Off Falling Time	C_L=1000 pF		[illegible]	70	ns
Protection Characteristics						
/SD+	Shutdown "1" Input Voltage		[illegible]			V
/SD-	Shutdown "0" Input Voltage				1	V
I_{SD}	Shutdown Current	$V_{DT/SD}$=0 After Running Mode		250		μA
t_{SD}	Shutdown Propagation Delay			180		ns

Note:

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

Switching Definitions

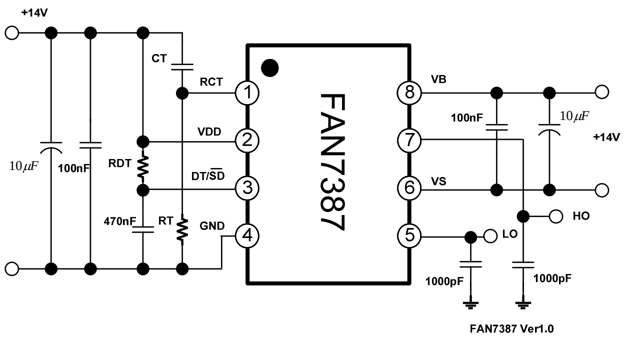


Figure 7. Test Circuit for Self-Oscillation Method

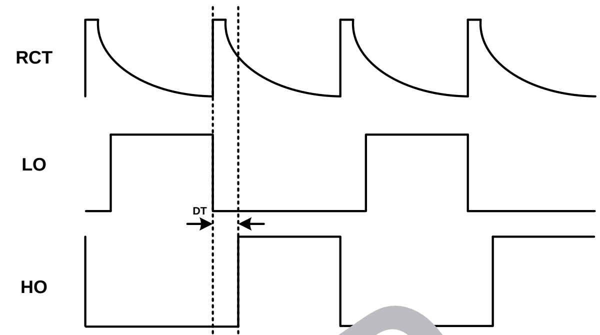


Figure 8. Basic Operating Waveforms of Self-Oscillation

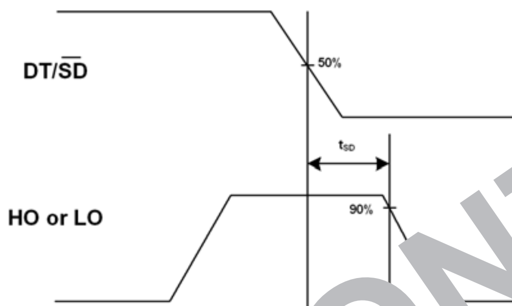


Figure 9. Shutdown Delay Definition

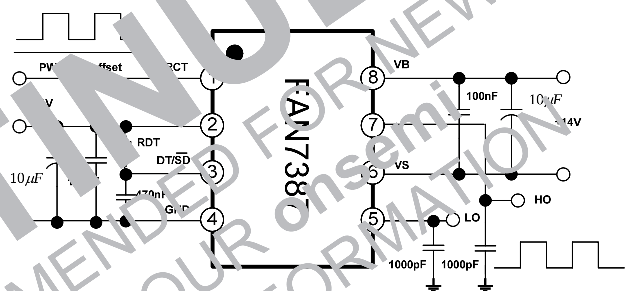


Figure 10. Test Circuit for Forced-Oscillation Method Using External Signal

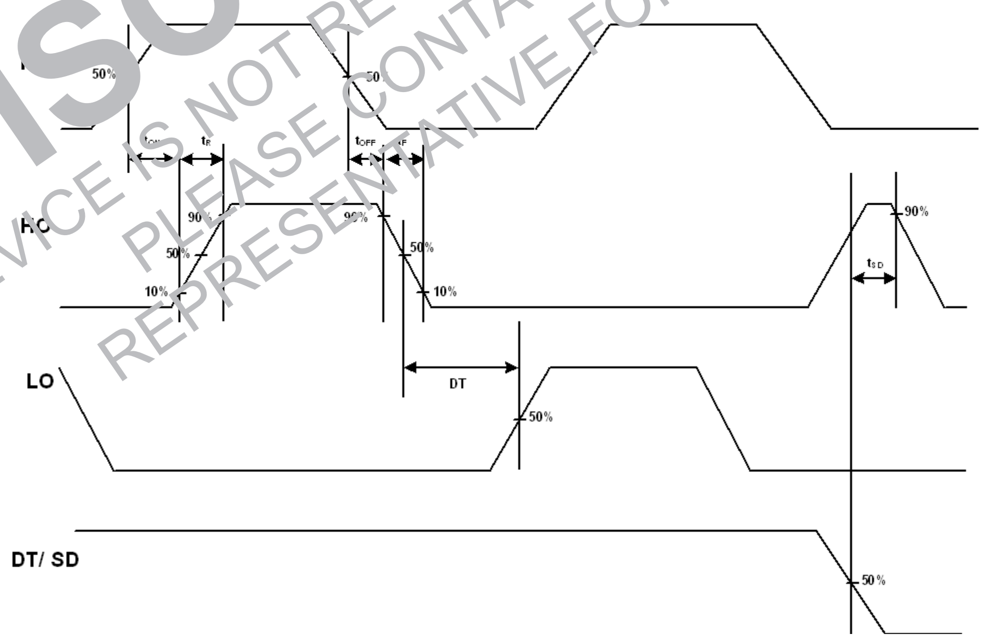


Figure 11. Basic Operation Waveforms of Forced-oscillation Method Using External Signal

Typical Performance Characteristics

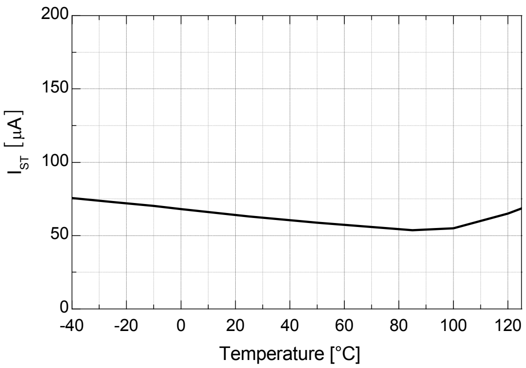


Figure 12. Startup Current vs. Temperature

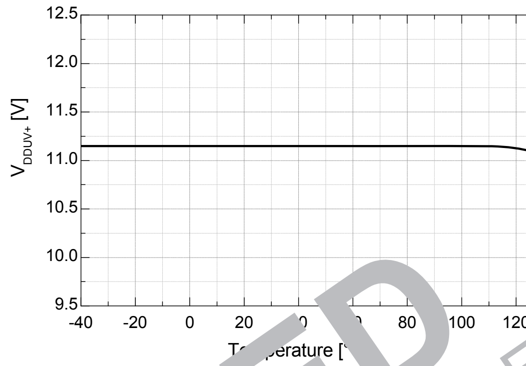


Figure 13. V_{DD} UVLO+ vs. Temperature

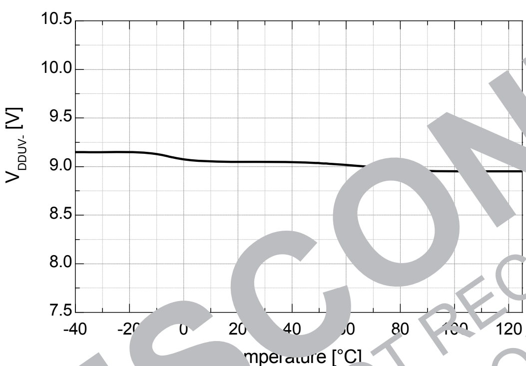


Figure 14. V_{DD} UVLO- vs. Temperature

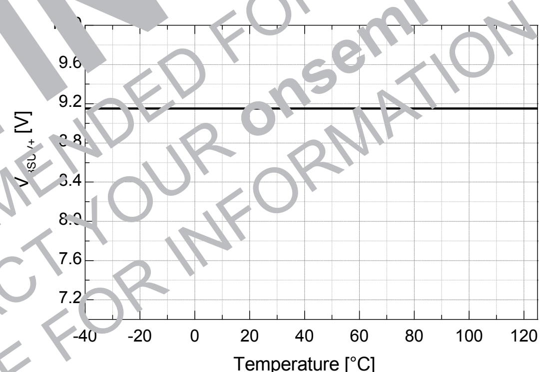


Figure 15. V_{BS} UVLO+ vs. Temperature

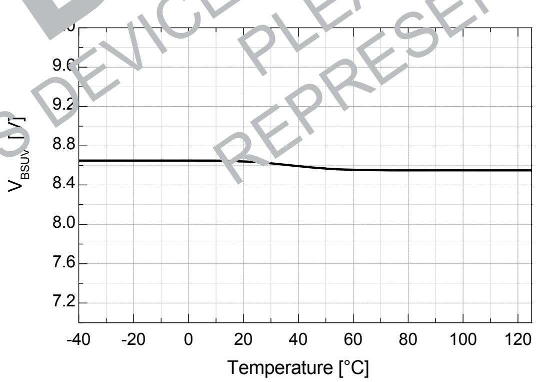


Figure 16. V_{BS} UVLO- vs. Temperature

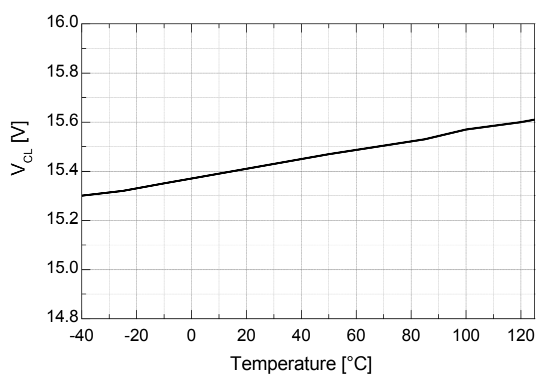


Figure 17. V_{CL} vs. Temperature

Typical Performance Characteristics (Continued)

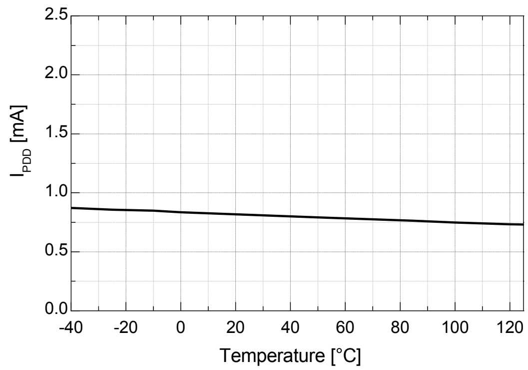


Figure 18. I_{PDD} vs. Temperature

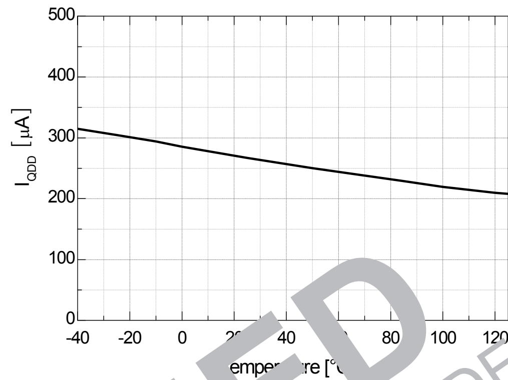


Figure 19. I_{QDD} vs. Temperature

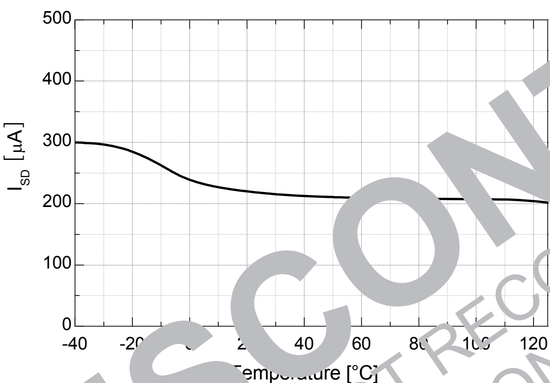


Figure 20. I_{SD} vs. Temperature

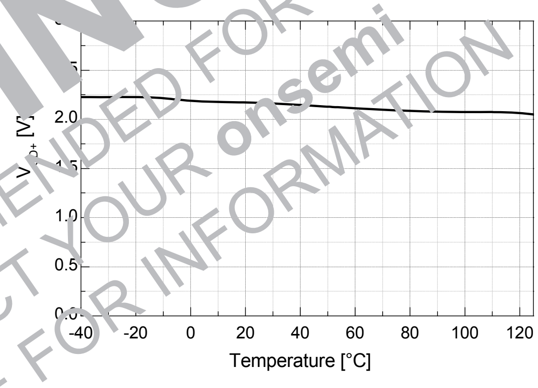


Figure 21. V_{SD}+ vs. Temperature

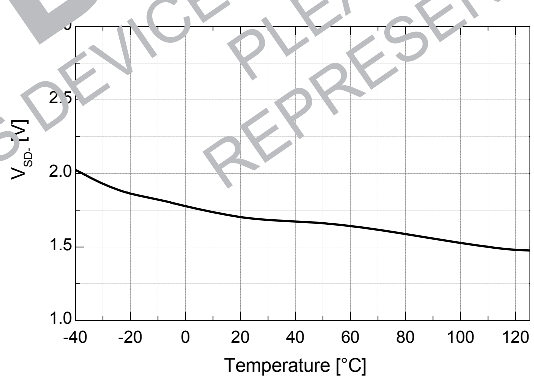


Figure 22. V_{SD}- vs. Temperature

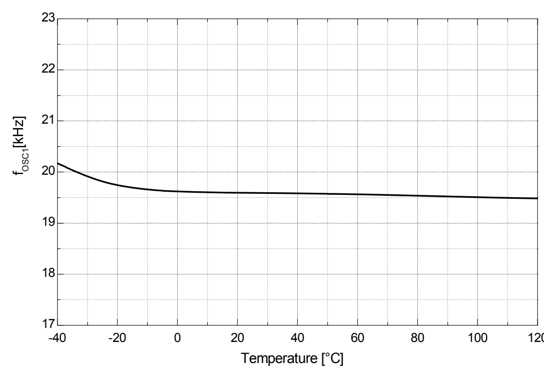


Figure 23. Operating Frequency 1 vs. Temperature

Typical Performance Characteristics (Continued)

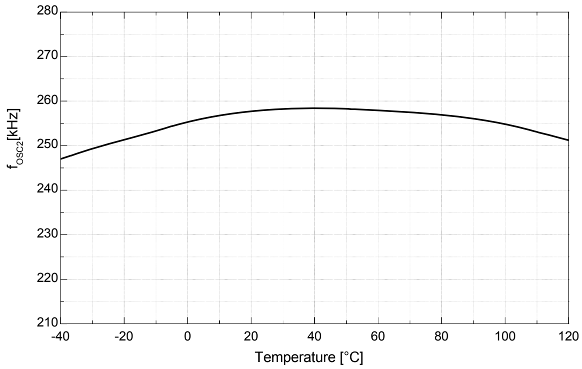


Figure 24. Operating Frequency 2 vs. Temperature

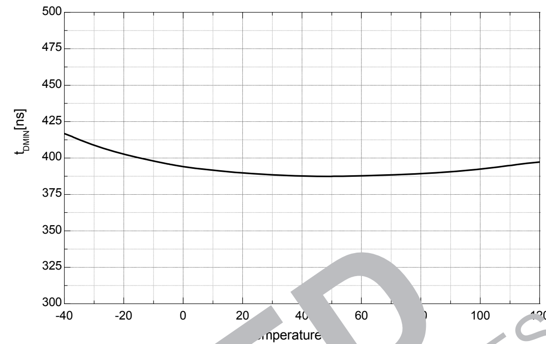


Figure 25. t_{DMIN} vs. Temperature

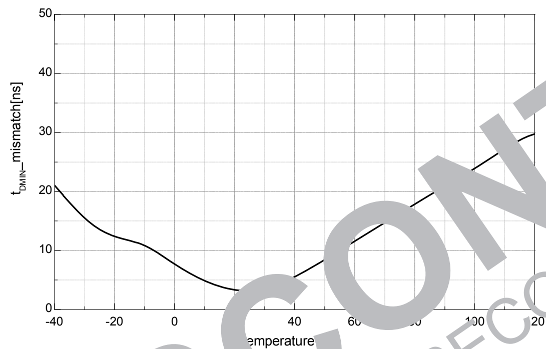


Figure 26. Dead-Time Mismatch vs. Temperature

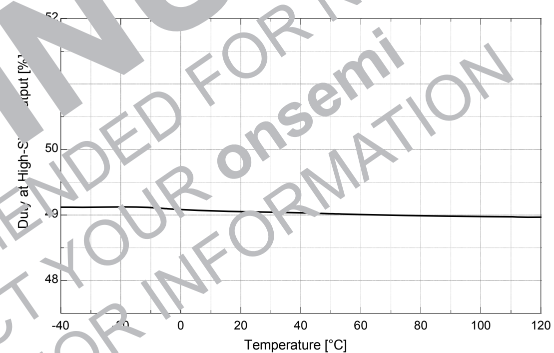


Figure 27. High-Side Duty Ratio vs. Temperature

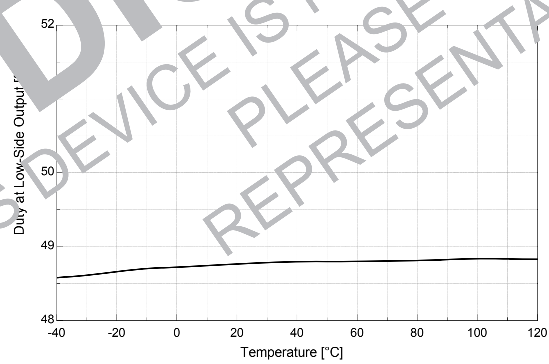


Figure 28. Low-Side Duty Ratio vs. Temperature

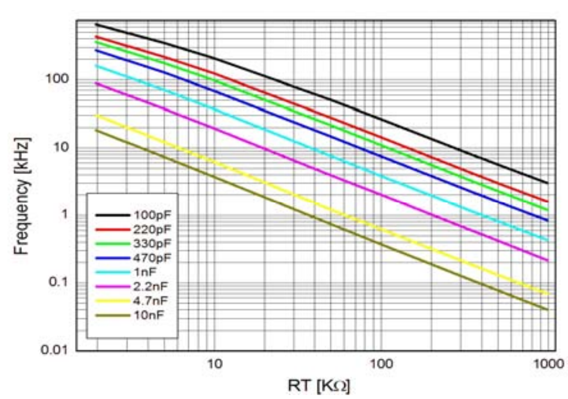


Figure 29. Frequency vs. RT

Functional Description

1. Under-Voltage Lockout (UVLO) Function

FAN7387 has a UVLO circuit for a low-side and high-side block. When V_{DD} reaches to the $VDD_{UV}+$, the UVLO circuit is released and the FAN7387 operates normally. At UVLO condition, the FAN7387 has a low supply current of less than 130 µA. Once UVLO is released, FAN7387 operates normally until V_{DD} goes below $VDD_{UV}-$, 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 $VBS_{UV}+$, the driver holds LOW state to turn off the high-side switch. Once the voltage of V_B-V_S is higher than $VBS_{UVH,}$ after V_B-V_S exceeds $VBS_{UV}-$, 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.

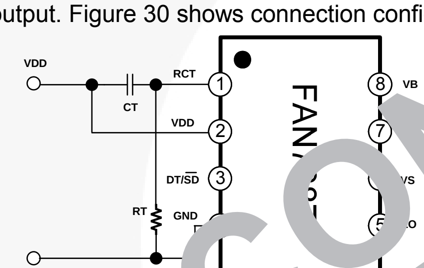


Figure 30. Typical Connection Method

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

$$V_{RCT(t)} = V_{DD} \times ln(\frac{-t}{R_t \times C_t}) \quad (1)$$

Equation 1 enables calculation of discharging time, t, from V_{DD} to 1/4 V_{DD} by substituting $V_{RCT(t)}$ with 1/4 V_{DD}.

$$t = 1.38 \times R_t \times C_t \quad (2)$$

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

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

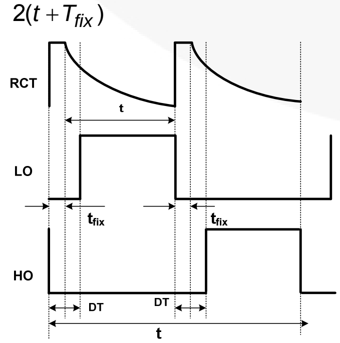


Figure 31. Typical Waveforms of RCT,LO and HO

where, t is the discharging time of the RCT voltage and t_{fix} is constant value about 450 ns 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/SD is decreased under 1 V 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.

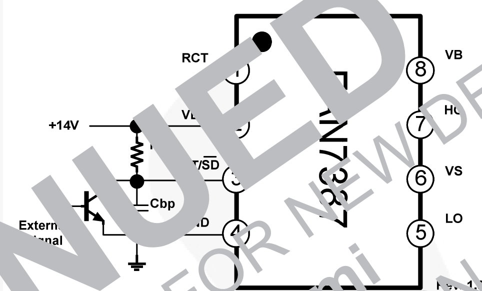


Figure 32. External Shutdown Circuit

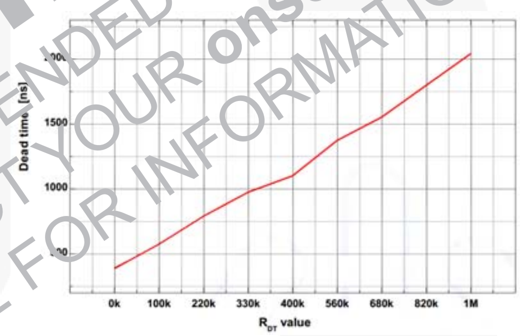


Figure 33. Adjustable Dead Time

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 operation of the IC using an external PWM circuit with additional resistors (R1 and R2) for internal limitation of the IC. The input signal range from an external circuit must be within 3/5 V_{DD} and 3/4 V_{DD}. The external signal produces the HO and LO output and HO signal is in-phase with the external input signal.

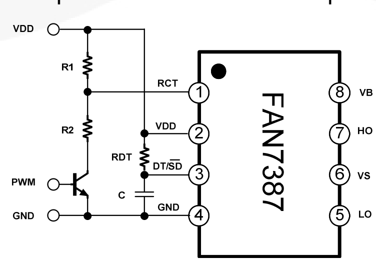


Figure 34. Gate Driver Using External PWM Signal

Physical Dimensions

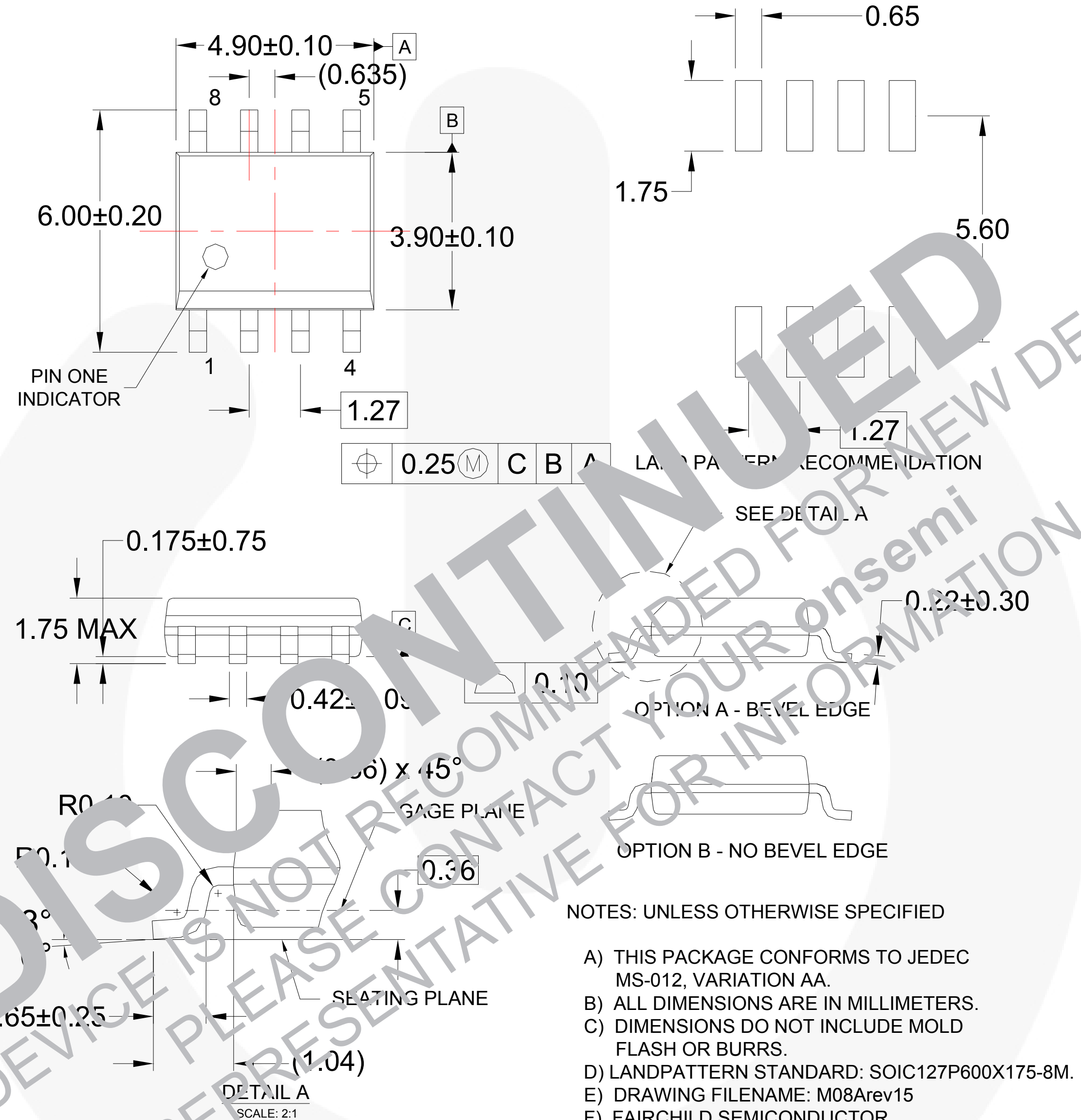


Figure 35. 8-Lead Small Outline Package (SOP)

Package drawings are provided as a service to customers considering Fairchild components. Drawings may change in any manner without notice. Please note the revision and/or date on the drawing and contact a Fairchild Semiconductor representative to verify or obtain the most recent revision. Package specifications do not expand the terms of Fairchild's worldwide terms and conditions, specifically the warranty therein, which covers Fairchild products.

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EcoSPARK®
EfficientMax™
ESBC™
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FACT®
FAST®
FastvCore™
FETBench™
FPS™
F-PFS™
FRFET®
Global Power Resource℠
GreenBridge™
Green FPS™
Green FPS™ e-Series™
G*max*™
GTO™
IntelliMAX™
ISOPLANAR™
Making Small Speakers Sound Louder and Better™
MegaBuck™
MICROCOUPLER™
MicroFET™
MicroPak™
MicroPak2™
MillerDrive™
MotionMax™
mWSaver®
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OPTOLOGIC®
OPTOPLANAR®
PowerTrench®
PowerXS™
Programmable Active Droop™
QFET®
QS™
Quiet Series™
RapidConfigure™
Saving our world, 1mW/W/kW at a time™
SignalWise™
SmartMax™
SMART START™
Solutions for Your Success™
SPM®
STEALTH™
SuperFET®
SuperSOT™-3
SuperSOT™-6
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