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FAN7387V

Ballast Control IC for Compact Fluorescent Lamp

Features

- Integrated Half-Bridge MOSFET
- Internal Clock Using RCT
- Enable External Sync Function Using RCT
- Dead-Time Control by using Resistor
- Shut Down (Disable Mode)
- Internal Shunt Regulator
- UVLO Function High and Low Side

Applications

- Compact Fluorescent Lamp Ballast

Description

The FAN7387V, developed using Fairchild's unique high-voltage process and system-in-package (SiP) concept, is a ballast-control integrated circuit (IC) for a compact fluorescent lamp (CFL). The FAN7387V has a simple oscillating circuit using an external resistor and capacitor so the frequency variation is stable across the temperature range. FAN7387V has a external pin for dead time control and shutdown. By using this resistor, a designer can choose the optimum dead time to reduce the power loss on internal switching devices (MOSFETs).

8-DIP



Ordering Information

Part Number	Operating Temperature	Package	Packing Method
FAN7387VN	-40 to +125°C	8-Lead, Dual-In-line Package (DIP)	Tube

Typical Applications Diagrams

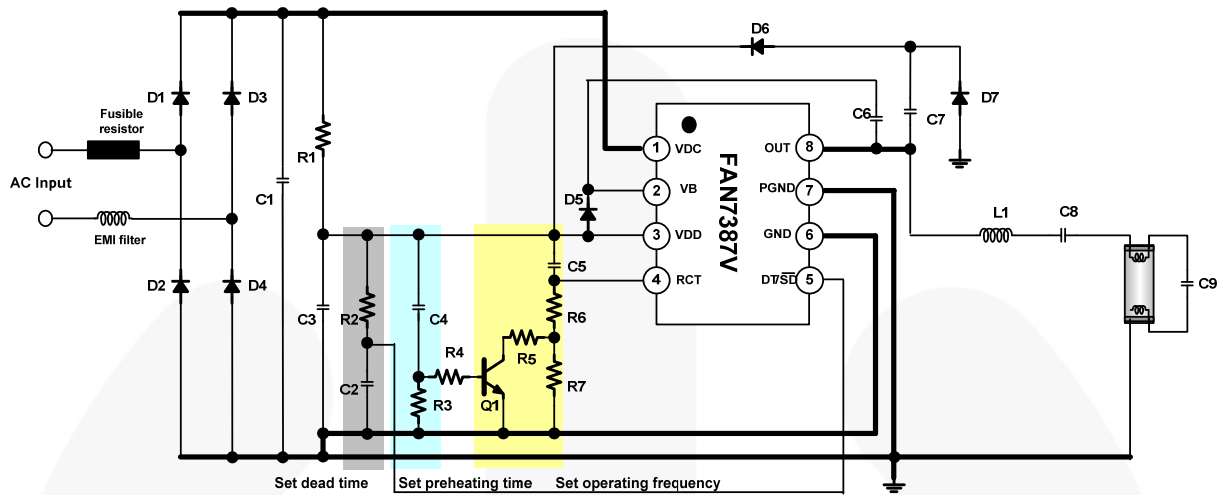


Figure 1. Typical Application Circuit for Fluorescent Lamp (Rapid Starting Method without PTC)

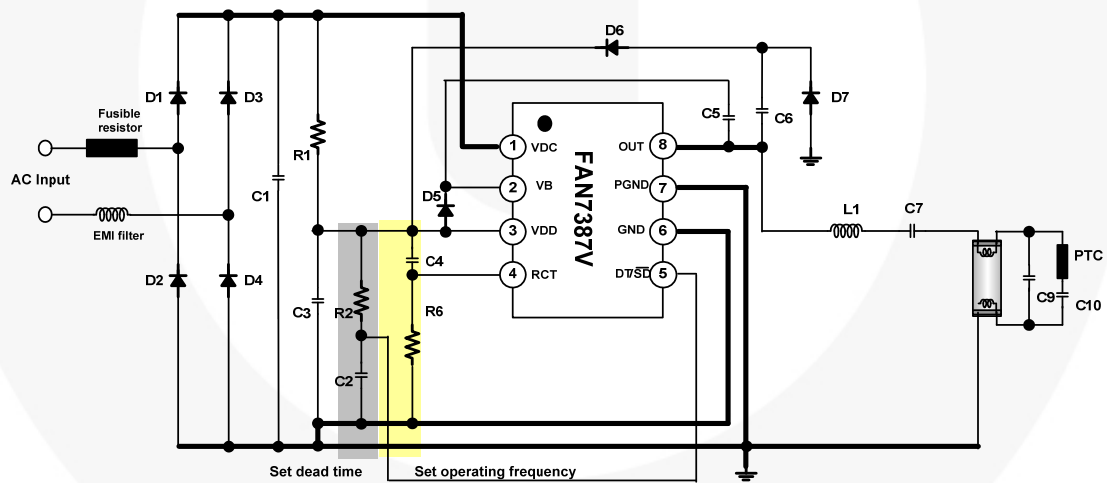


Figure 2. Typical Application Circuit for Fluorescent Lamp (Rapid Starting Method with PTC)

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
VB	High-Side Floating Supply	-0.3		465.0	V
V _{OUT}	High-Side Floating Supply Return	-0.3		440.0	V
V _{RCT}	RCT Pins Input Voltage		V _{DD}		V
I _{CL}	Clamping Current Level ⁽¹⁾			25	mA
dV _{OUT} /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		2.1		W
Θ _{JA}	Thermal Resistance (Junction-to-Air)		70		°C/W

Note:

- Do not supply a low-impedance voltage source to the internal clamping Zener diode between the GND and the VDD pin of this device.

Electrical Characteristics

V_{BIAS} (V_{DD} , V_B - V_{OUT})=14.0V, T_A =25°C, unless otherwise specified.

Symbol	Parameter	Conditions	Min.	Typ.	Max.	Unit
High Voltage Supply Section						
V _{DC}	High Voltage Supply Voltage		440			V
Low-Side Supply Characteristics (V _{DD})						
V _{DDUV+}	V _{DD} UVLO Positive-Going Threshold	V _{DD} Increasing	9	11	13	V
V _{DDUV-}	V _{DD} UVLO Negative-Going Threshold	V _{DD} Decreasing	7.8	8.8	9.8	
V _{DDUHY}	V _{DD} -Side UVLO Hysteresis			2.2		
V _{CL}	Supply Camping Voltage	I _{DD} =10mA	14.4	15.4		
I _{ST}	Startup Supply Current	V _{DD} =9V		60	90	μA
I _{QDD}	Low-Side Quiescent Supply Current	R _{DT} =100kΩ		230	380	
I _{DD}	Dynamic Operating Supply Current	20kHz, C _L =1nF		0.6		
High-Side Supply Characteristics (V _B -V _{OUT})						
V _{HSUV+}	High-Side UVLO Positive-Going Threshold	V _B -V _{OUT} Increasing	8	9	10	V
V _{HSUV-}	High-Side UVLO Negative-Going Threshold	V _B -V _{OUT} Decreasing	7.5	8.5	9.5	
V _{HSUHY}	V _{BS} Supply UVLO Hysteresis			0.5		
I _{QHS}	High-Side Quiescent Supply Current			50	90	μA
I _{PBS}	High-Side Dynamic Operating Supply Current	20kHz, C _L =1nF		130	180	
Oscillator Characteristics						
f _{osc}	Oscillation Frequency	R _T =50kΩ, C _T =330pF	18	20	22	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 _{IH}	Logic “1” Input Voltage of RCT	Running Mode		3/4 V _{DD}		
V _{IL}	Logic “0” Input Voltage of RCT	Running Mode			3/5 V _{DD}	
t _D	Dead Time	R _{DT} =100kΩ	440	540	640	ns
t _{DMIN}	Minimum Dead Time	V _{DT/SD} =V _{DD}	280	400	520	
Protection Characteristics						
V _{SD+}	Shutdown “1” Input Voltage	V _{SD/DT} =0 After Run Mode	2.5			V
V _{SD-}	Shutdown “0” Input Voltage				1	
I _{SD}	Shutdown Current				350	μA
t _{SD}	Shutdown Propagation Delay				180	Ns
Internal MOSFET Section						
I _{LKMOS}	Internal MOSFET Leakage Current	V _{DS} =400V			50	μA
R _{ON}	Static Drain-Source On-Resistance	V _{GS} =10V, I _D =190mA		4.6	6.0	Ω
I _S	Maximum Continuous Drain-Source Diode Forward Current			0.38		A
I _{SM}	Maximum Pulsed Continuous Drain-Source Diode Forward Current			3.04		A
V _{SD}	Drain-Source Diode Forward Voltage	V _{GS} =0V, I _S =0.38A			1.2	V

Typical Performance Characteristics

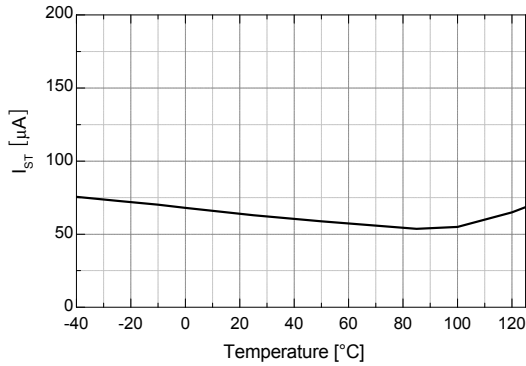


Figure 5. Startup Current vs. Temperature

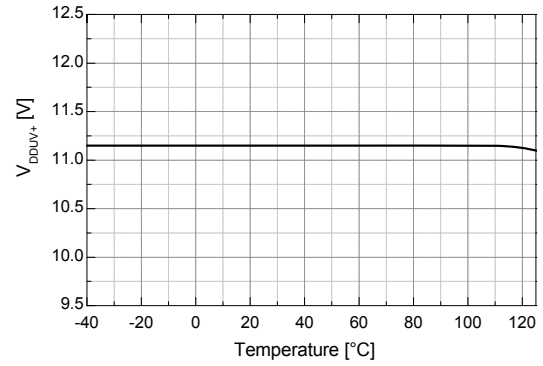


Figure 6. V_{DD} UVLO+ vs. Temperature

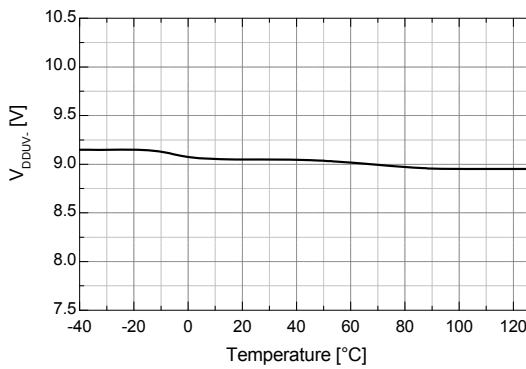


Figure 7. V_{DD} UVLO- vs. Temperature

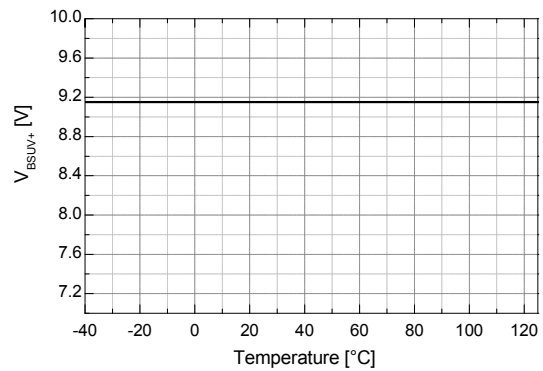


Figure 8. $V_{B.V_{OUT}}$ UVLO+ vs. Temperature

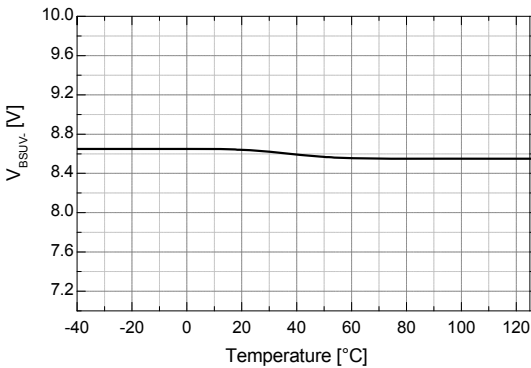


Figure 9. $V_{B.V_{OUT}}$ UVLO- vs. Temperature

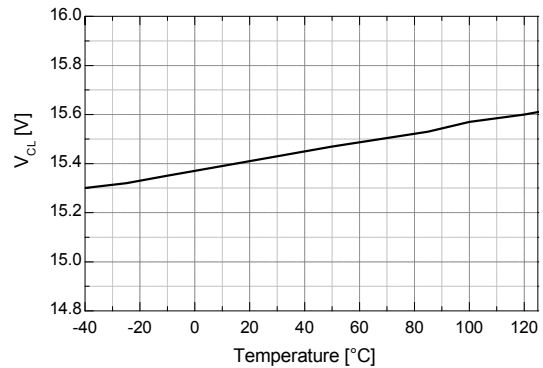


Figure 10. V_{CL} vs. Temperature

Typical Performance Characteristics (Continued)

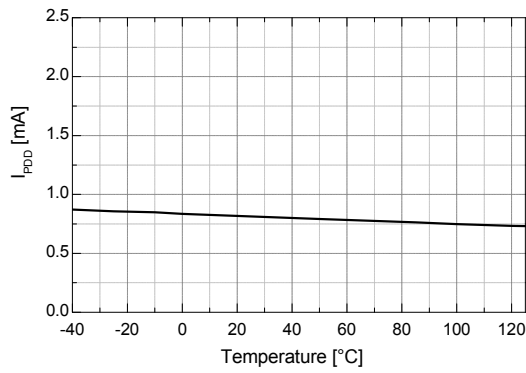


Figure 11. I_{PDD} vs. Temperature

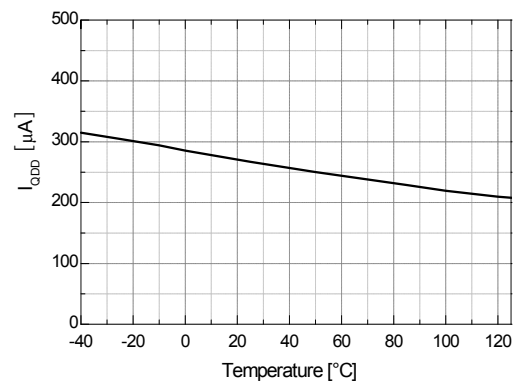


Figure 12. I_{QDD} vs. Temperature

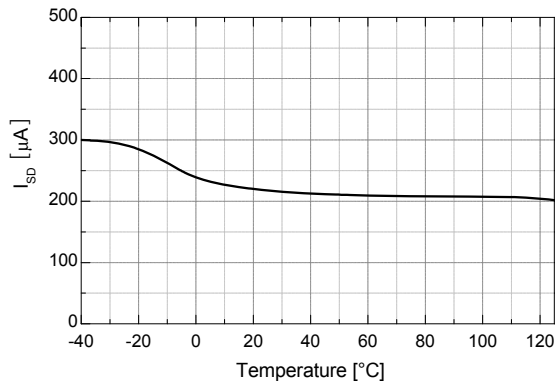


Figure 13. I_{SD} vs. Temperature

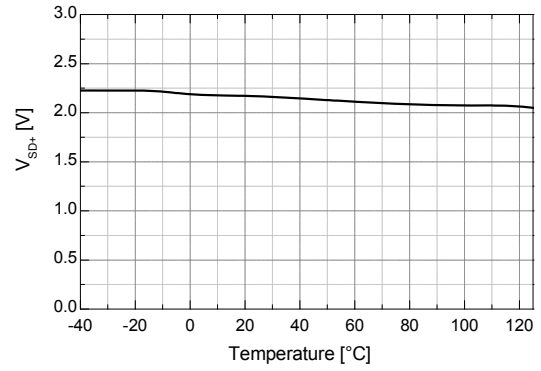


Figure 14. V_{SD+} vs. Temperature

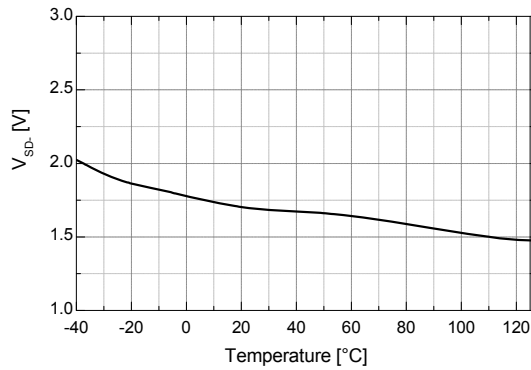


Figure 15. V_{SD-} vs. Temperature

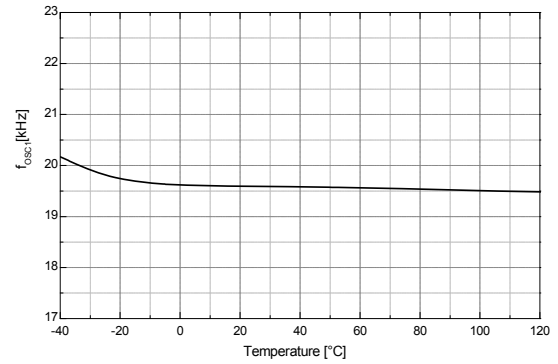


Figure 16. Operating Frequency vs. Temperature

Typical Performance Characteristics (Continued)

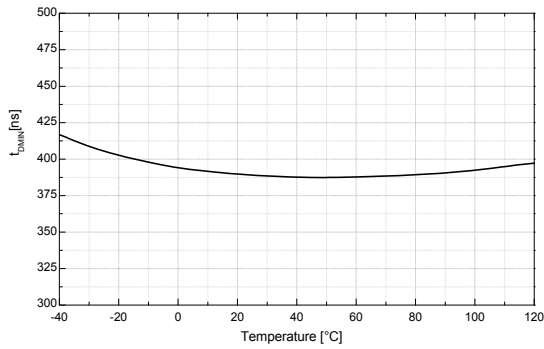


Figure 17. t_{DMIN} vs. Temperature

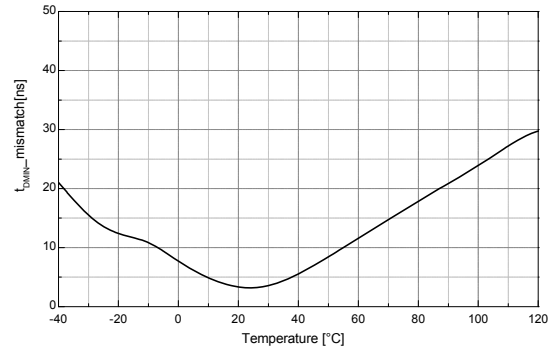


Figure 18. Dead-Time Mismatch vs. Temperature

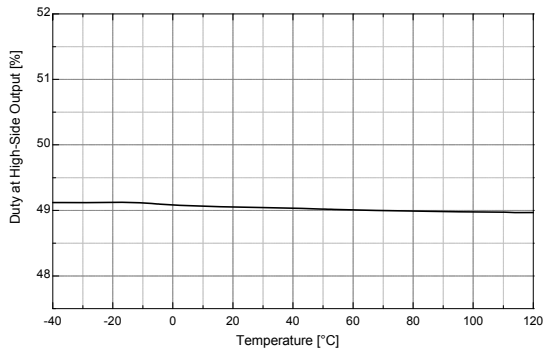


Figure 19. High-Side Duty Ratio vs. Temperature

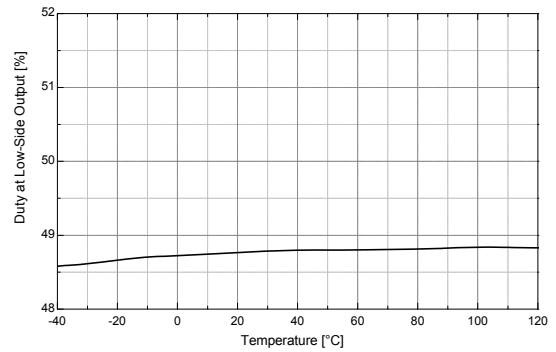


Figure 20. Low-Side Duty Ratio vs. Temperature

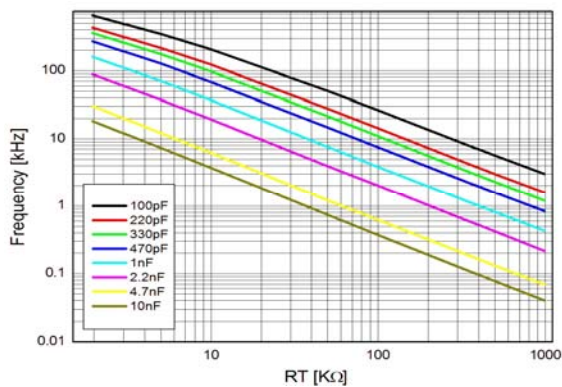


Figure 21. Frequency vs. R_T

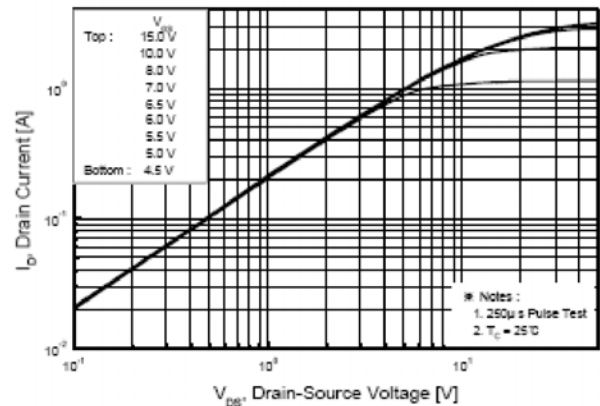


Figure 22. On-Region Characteristics

Typical Performance Characteristics (Continued)

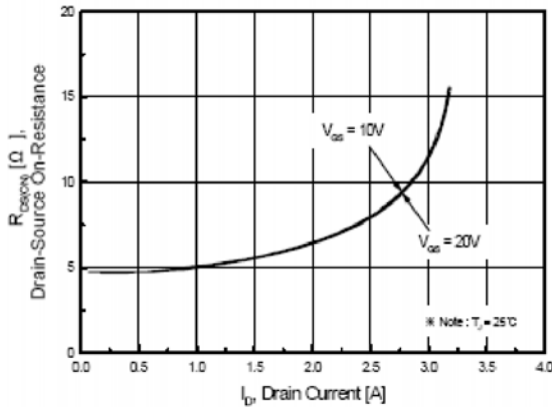


Figure 23. On-Resistance Variation vs. Drain Current and Gate Voltage

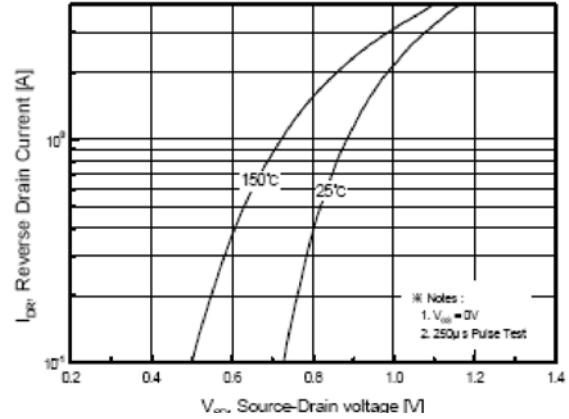


Figure 24. Body Diode Forward Voltage Variation vs. Source Current and Temperature

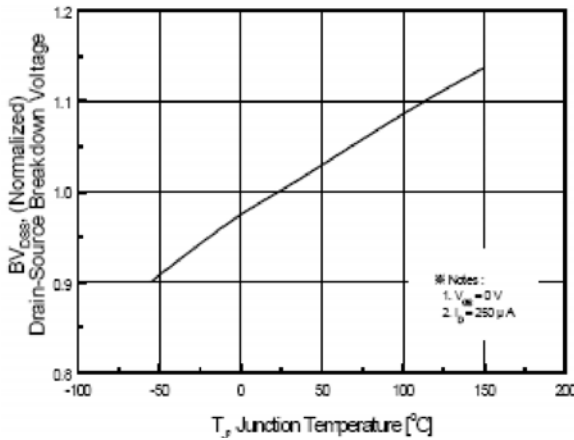


Figure 25. Breakdown Voltage Variation vs. Temperature

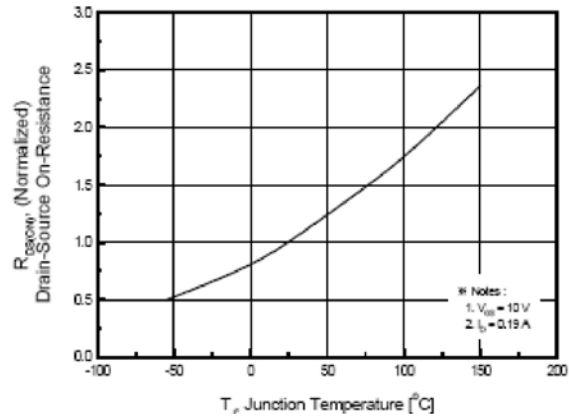


Figure 26. On-Resistance Variation vs. Temperature

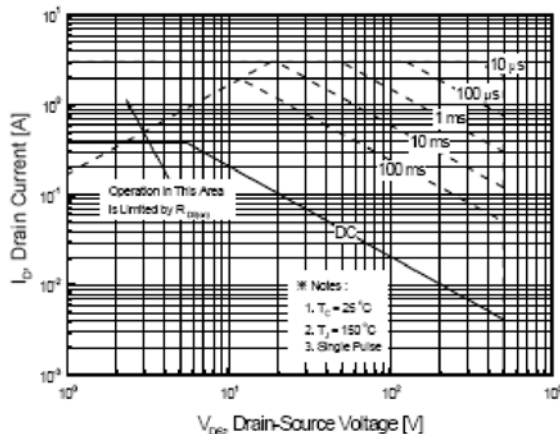


Figure 27. Maximum Safe Operating Area

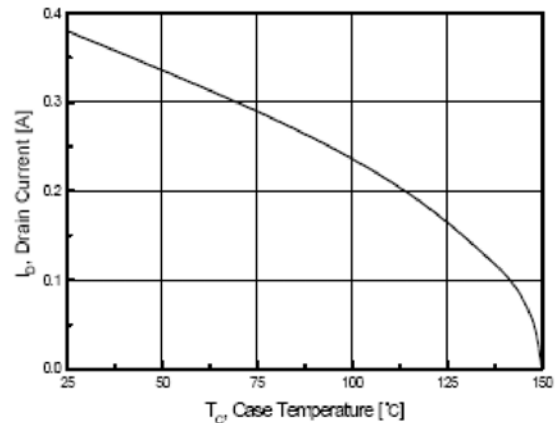


Figure 28. Maximum Drain-Current vs. Case Temperature

Application Information

1. Under-Voltage Lockout (UVLO) Function

FAN7387V has a UVLO circuit for a low-side and high-side block. When V_{DD} reaches to the $V_{DD_{UV+}}$, the UVLO circuit is released and the FAN7387V operates normally. At UVLO condition, the FAN7387V has a low supply current of less than 130 μ A. Once UVLO is released, FAN7387V operates normally until V_{DD} goes below $V_{DD_{UV-}}$, the UVLO hysteresis. FAN7387V also has a high-side gate driver. The supply for the high-side driver is applied between VB and V_{OUT} . To prevent malfunction at low supply voltage between VB and V_{OUT} , FAN7387V provides an additional UVLO circuit. If VB- V_{OUT} is under V_{HSUV+} , the driver holds LOW state to turn off the high-side switch. Once the voltage of VB- V_{OUT} is higher than V_{HSUV+} , after VB- V_{OUT} exceeds V_{HSUV-} , 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 gate driver output (V_{OUT}).

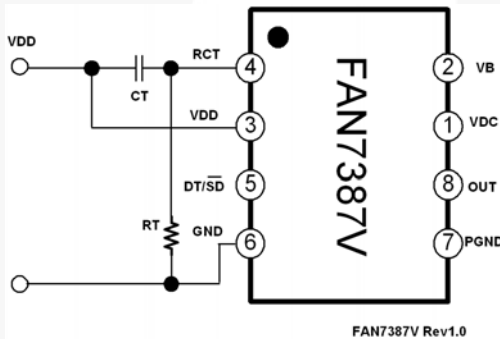


Figure 29. Typical Connection Method

Figure 30 shows the typical waveforms of RCT and internal signals (LO and HO) of IC. From the circuit analysis, the discharging time of RCT, t , is given by:

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

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

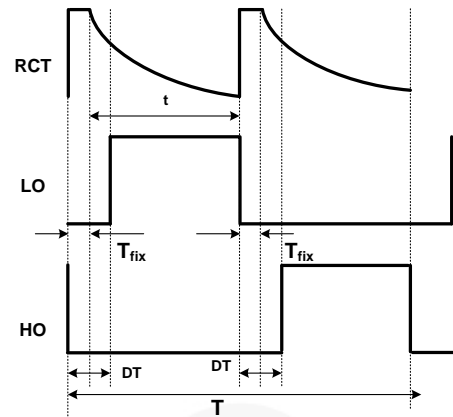


Figure 30. Typical Waveforms of RCT and Internal Signal (LO, HO) of IC

$$t = 1.38 \cdot R_T \cdot C_T \quad (2)$$

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_{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/SD is decreased to under 1V by an external switch, such as the TR or MOSFET, the FAN7387V enters shutdown mode. In this mode, the FAN7387V doesn't have any output signal.

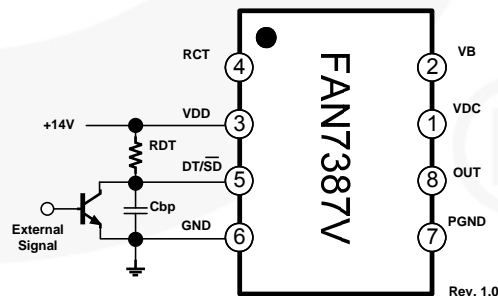
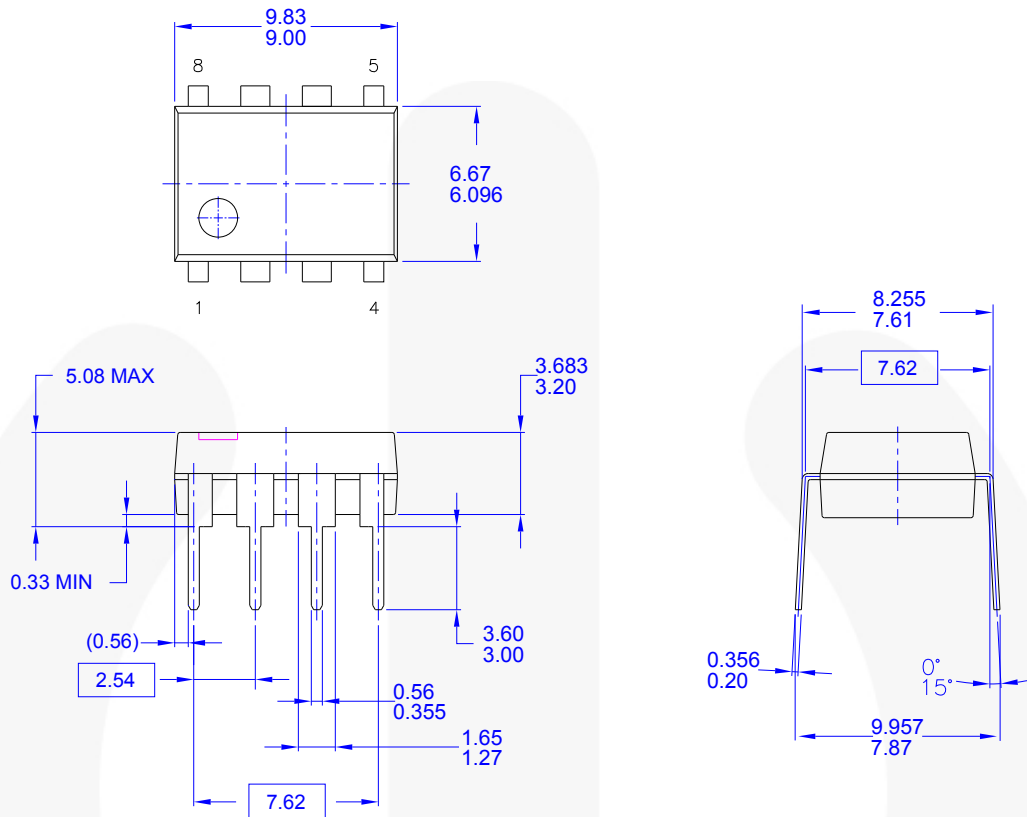


Figure 31. External Shutdown Circuit

Physical Dimensions



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Figure 32. 8-Lead Dual Inline Package (DIP)

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