APX9283

Single-Phase Full-Wave Motor Pre-Driver for Fan Motor

Features

- **Single Phase Fan Pre-driver**
- **Built-in Soft Start Function**
- **Selectable PWM or DC control**
- **Minimum and Shutdown Duty Setting**
- **Adjustable Off Side Angle Function**
- **Adjustable Leading Angle Function**
- **Built-in Current Limit Circuit**
- **Built-in Over Current Protection**
- **Power Saving Function (Standby Mode)**
- **Built-in Lock Protection and Auto Restart Function**
- **FG (Rotation Speed) or RD (Rotation Detection) Output**
- **Built-in Thermal Protection Circuit**
- **Lead Free and Green Device Available (RoHS Compliant)**

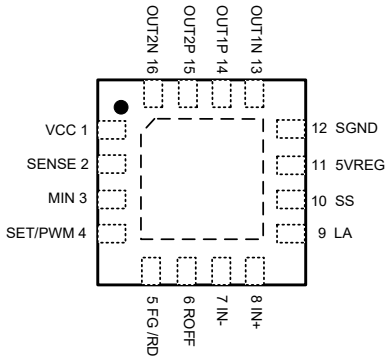
Applications

- **Mainframe and Personal Computer Fans and Blowers**
- **Instrumentation Fans**
- **Variable Speed Control Fans**

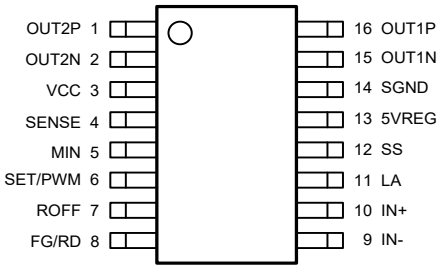
General Description

The APX9283 is a single-phase full-wave motor pre-driver for DC fan motors. It's suitable for variable speed curve applications, and then it is suitable for cooler DC fan that needs silent drivers. In normal operation, the supply current is less than 7mA. The APX9283 is available in TSSOP-16 and TQFN3x3-16 packages.

Pin Configuration

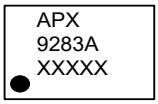
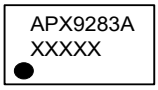


TQFN3x3-16
Top View



TSSOP-16
Top View

Ordering and Marking Information

APX9283A □□□-□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code QB:TQFN3X3 - 16 O: TSSOP – 16 Operating Ambient Temperature Range I : -40 to 105 °C Handling Code TR : Tape & Reel Assembly Material G: Green Part
APX9283A QB : 	XXXXX - Date Code
APX9283A O : 	XXXXX - Date Code

Note: ANPEC lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. ANPEC lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020C for MSL classification at lead-free peak reflow temperature. ANPEC defines “Green” to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight inhomogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

Absolute Maximum Ratings (Note 1)

Symbol	Parameter	Ratings	Unit
V_{CC}	VCC Pin Supply Voltage (VCC to SGND)	20	V
V_{OUTP}	High-Side Output Pin Voltage	V_{CC}-7 to V_{CC}	V
V_{OUTN}	Low-Side Output Pin Voltage	-0.3 to 7	V
I_{OUTP}	Output Pin (OUT1P, OUT2P) Sink and Source Current	20	mA
I_{OUTN}	Output Pin (OUT1N, OUT2N) Sink and Source Current	20	mA
$V_{FG/RD}$	FG/RD Pin Output Voltage	-0.3 to 20	V
$I_{FG/RD}$	FG/RD Pin Maximum Output Sink Current	10	mA
V_{PWM}	PWM Pin Input Voltage(PWM to SGND)	-0.3 to 20	V
V_{SET}	SET Pin Input Voltage(SET to SGND)	-0.3 to V_{5VREG}	V
V_{SENSE}	SENSE Pin Withstand Voltage (SENSE to SGND)	-0.3 to 7	V
V_{ROFF}	ROFF Pin Input Voltage (ROFF to SGND)	-0.3 to 7	V
V_{LA}	LA Pin Input Voltage (LA to SGND)	-0.3 to 7	V
V_{SS}	SS Pin Input Voltage (SS to SGND)	-0.3 to 7	V
V_{MIN}	MIN Pin Input Voltage (MIN to SGND)	-0.3 to 7	V
I_{5VREG}	5VREG Pin Output Current	20	mA
T_J	Maximum Junction Temperature	150	°C
T_{STG}	Storage Temperature	-65 to 150	°C
T_{SDR}	Maximum Lead Soldering Temperature, 10 Seconds	260	°C

Note 1: Absolute Maximum Ratings are those values beyond which the life of a device may be impaired. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Thermal Characteristics

Symbol	Parameter		Typical Value	Unit
θ_{JA}	Thermal Resistance-Junction to Ambient (Note 2)	TQFN3x3-16	83	°C/W
		TSSOP-16	147	
P_D	Power Dissipation, T_A=25°C	TQFN3x3-16	1.5	W
		TSSOP-16	0.85	

Note 2: The maximum allowable power dissipation at any T_A (ambient temperature) is calculated using: $P_D = (T_J - T_A) / R_{TH,JA}$; T_J = 150°C. Exceeding the maximum allowable power dissipation will result in excessive die temperature.

Recommended Operating Conditions (Note 3)

Symbol	Parameter	Range	Unit
V_{CC}	VCC Pin Supply Voltage Range	4 to 18	V
V_{ICM}	Hall Input (IN+, IN-) Common-Phase Input Voltage Range	0.2 to 3	V
V_{LA}	LA Pin Input Voltage (LA to SGND)	0 to V_{5VREG}	V
V_{ROFF}	ROFF Pin Input Voltage (ROFF to SGND)	0 to V_{5VREG}	V
V_{MIN}	MIN Pin Input Voltage (MIN to SGND)	0 to V_{5VREG}	V
V_{SS}	SS Pin Input Voltage (SS to SGND)	0 to V_{5VREG}	V
V_{SET}	SET Pin Input Voltage (SET to SGND)	0 to V_{5VREG}	V
T_A	Ambient Temperature	-40 to 105	°C
T_J	Junction Temperature	-40 to 125	°C

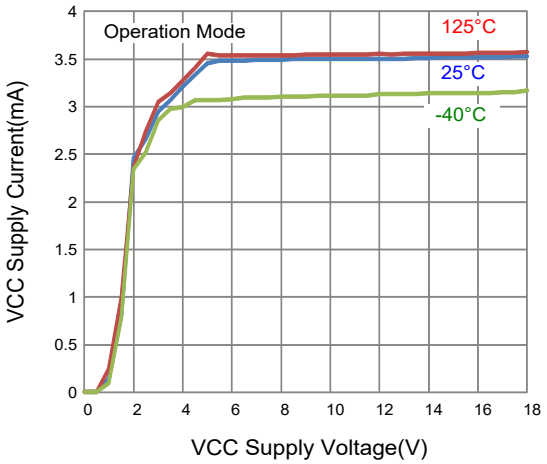
Note 3: Refer to the typical application circuit.

Electrical Characteristics (T_A = 25°C & Register Mode, unless otherwise specified)

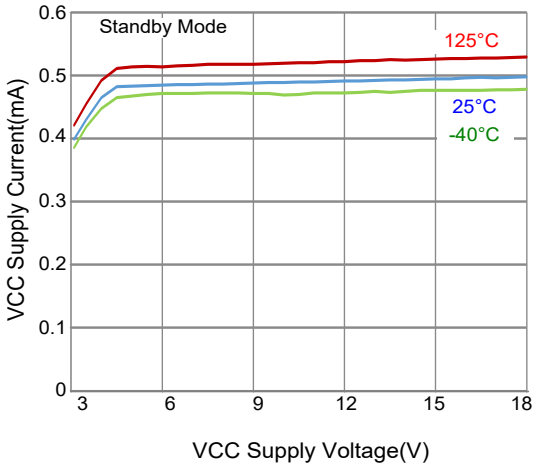
Symbol	Parameter	Test Conditions	APX9283			Unit
			Min	Typ	Max	
POWER SUPPLY						
V_{5VREG}	5VREG Pin Output Voltage	I_{5VREG} = 5mA	4.8	5	5.2	V
I_{CC1}	Operating Current	Rotation Mode	-	4	7	mA
I_{CC2}		Shutdown Mode	-	4	7	mA
I_{CC3}		Standby Mode, PWM = 0% (SD mode & FG Output)	-	500	900	μA
V_{Pon}	Power On Reset Voltage	Vcc Rise	-	2.8	-	V
V_{Poff}	Power Off Reset Voltage	Vcc Fall	-	2.7	-	V
LOCK PROTECTION						
T_{LDT1}	Lock Protection Detection Time	OUTPUT Duty>20%	-	0.12	-	sec
T_{LDT2}	Lock Protection Detection Time	OUTPUT Duty<20%	-	0.3	-	sec
T_{ON}	Lock Protection Re-start On Time	Define by V_{ss}	-	$0.15T_{ss1}$+0.24	-	sec
T_{OFF}	Lock Protection Shutdown Off Time		-	6	-	sec
T_{QS}	Quick Start Enable Time		-	60	-	ms
OUTPUT DRIVERS						
V_{OUTPH}	OUT1P & OUT2P Output High Voltage	I_{OUTP} = -5mA	-	VCC-0.3	-	V
V_{OUTPL}	OUT1P & OUT2P Output Low Voltage	I_{OUTP} = 5mA	-	VCC-4.75	-	V
V_{OUTNH}	OUT1N & OUT2N Output High Voltage	I_{OUTN} = -5mA	-	V_{5VREG}-0.35	-	V
V_{OUTNL}	OUT1N & OUT2N Output Low Voltage	I_{OUTN} = 5mA	-	0.2	-	V
$V_{FG/RD}$	FG/RD Pin Low Voltage	$I_{FG/RD}$ = 5mA	-	0.1	0.3	V
$I_{FG/RD}$	FG/RD Pin Leakage Current	$V_{FG/RD}$ = 12V	-	<0.1	1	μA
PWM/SET CONTROL						
V_{PWMH}	PWM Input High Level Voltage		2	-	V_{CC}	V
V_{PWML}	PWM Input Low Level Voltage		-0.3	-	0.8	V
R_{PWM_PU}	PWM Internal pull-up Resistor		-	80	-	KΩ
V_{PWM_PU}	PWM Internal pull-up Voltage		-	4.8	-	V
F_{PWM}	PWM Input Frequency		0.6	-	50	kHz
F_{OUT}	Output PWM Switch Frequency		-	33	-	kHz
SET CONTROL						
T_{SET_REL}	Shut Down Relese Delay Time	SET Duty < DI_{OFF}	-	10~170	-	ms
V_{SET}	SET Control range		0.2 x V_{5VREG}	-	0.7 x V_{5VREG}	V
Soft Start						
T_{SS1}	Soft Start Time	Define by V_{SS}	-	0.5~12	-	sec
D_{SS}	Soft Start Initial Duty		-	5	-	%
CURRENT PROTECTION						
V_{LIM}	Current Limit Level		-	150	-	mV
V_{OCP}	Over Current Protection		-	200	-	mV
HALL SENSITIVITY						
V_{HN}	Hall Input Sensitivity	Zero to peak including offset and hysteresis	-	10	15	mV
THERMAL PROTECTION						
	Over Temperature Shutdown Threshold		-	170	-	°C
	Over Temperature Shutdown Hysteresis		-	30	-	
	Over Thermal Protection release delay time		-	4	-	sec

Typical Operation Characteristics

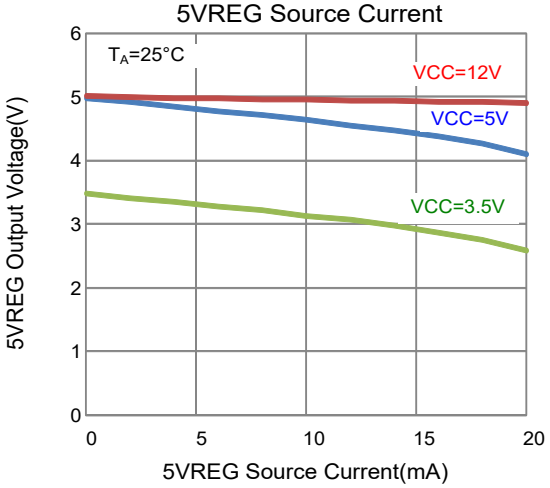
VCC Supply Current vs. VCC Supply Voltage



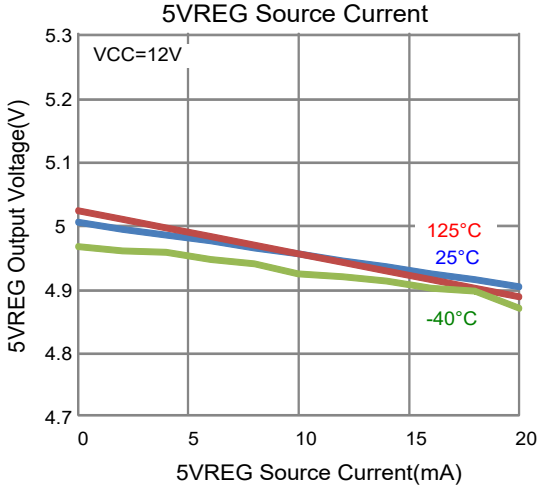
VCC Supply Current vs. VCC Supply Voltage



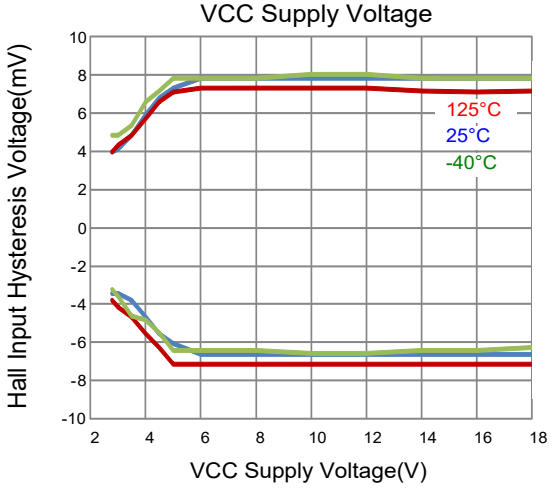
5VREG Output Voltage vs. 5VREG Source Current



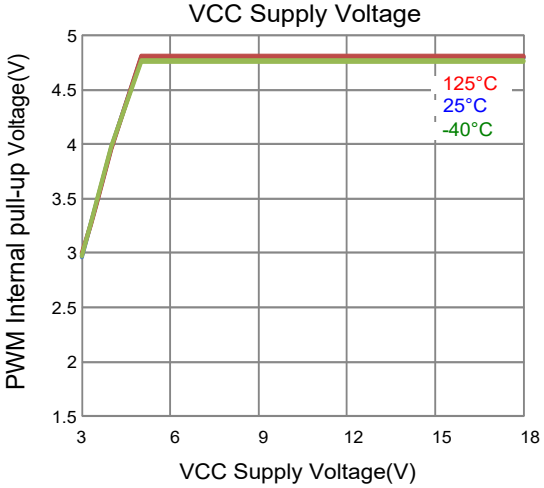
5VREG Output Voltage vs. 5VREG Source Current



Hall Input Hysteresis Voltage vs. VCC Supply Voltage

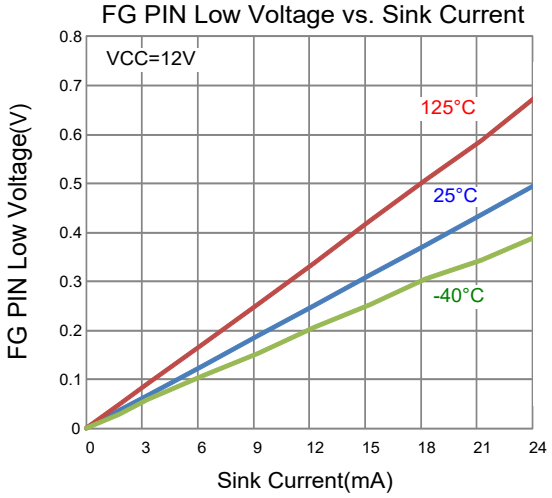


PWM Internal pull-up Voltage vs. VCC Supply Voltage

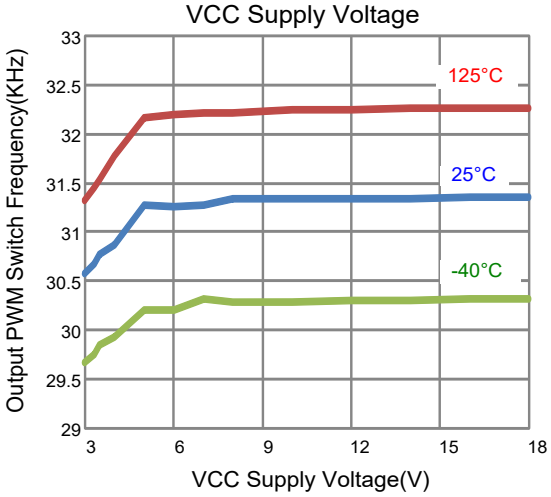


Typical Operation Characteristics (Cont.)

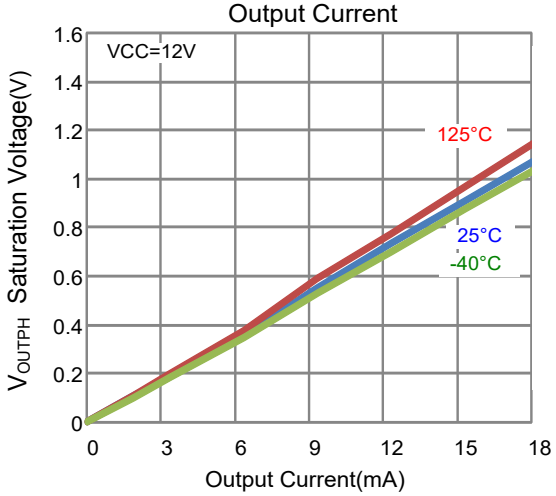
FG PIN Low Voltage vs. Sink Current



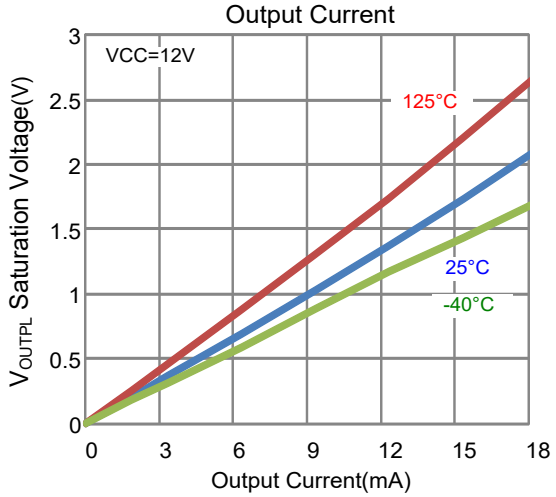
Output PWM Switch Frequency vs. VCC Supply Voltage



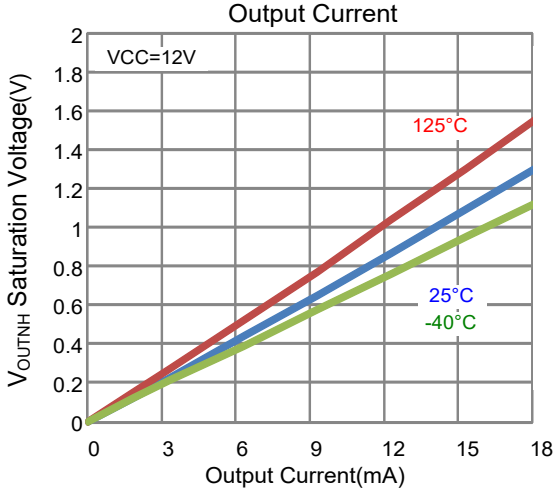
PMOS High-side Saturation Voltage vs. Output Current



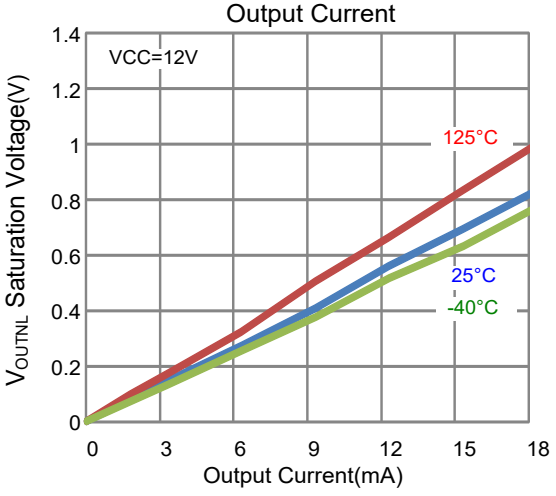
PMOS Low-side Saturation Voltage vs. Output Current



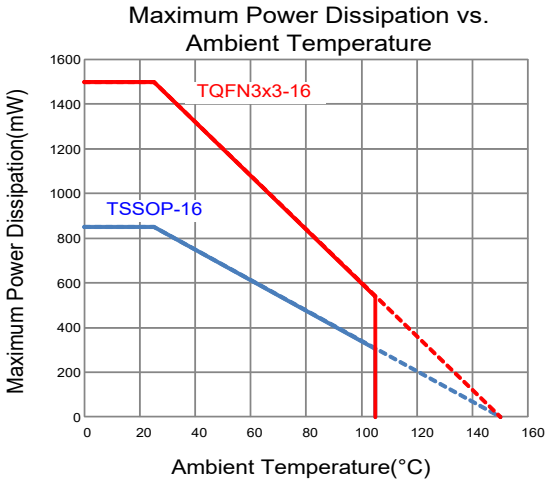
NMOS High-side Saturation Voltage vs. Output Current



NMOS Low-side Saturation Voltage vs. Output Current



Typical Operation Characteristics (Cont.)

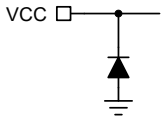


Pin Descriptions

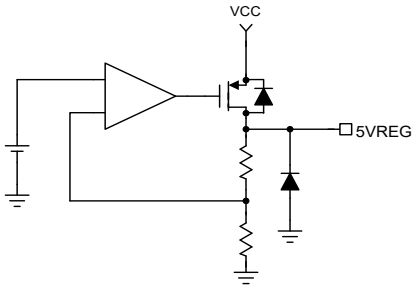
PIN NAME	PIN No.		FUNCTION
	TSSOP-16	TQFN3x3-16	
OUT2P	1	15	High side external H-bridge Driver. Connect this pin to the upper P-MOSFET gate of OUT2.
OUT2N	2	16	Low side external H-bridge Driver. Connect this pin to the lower N-MOSFET gate of OUT2.
VCC	3	1	Power supply pin.
SENSE	4	2	Current-Limit Input. Connect to external N-MOSFET source pins and connect a resistor R_{SENSE} to PGND to sense coil current.
MIN	5	3	Minimum Output Duty Setting and Select pin for FG/RD pin of FG signal or RD signal.
SET/ PWM	6	4	DC/PWM Signal Input Terminal.
ROFF	7	6	Off Side Angle (Direct PWM Mode or SET Mode).
FG/RD	8	5	Rotation Speed Output or Rotation Detection Output. This is an open-drain output.
IN-	9	7	Hall Input -. Connect to hall element negative output.
IN+	10	8	Hall Input +. Connect to hall element positive output.
LA	11	9	Lead Angle Setting and Speed Curve Type Select (Shutdown or Minimum Speed Curve).
SS	12	10	Soft-Start time setting.
5VREG	13	11	5V regulator output.
SGND	14	12	Signal GND.
OUT1N	15	13	Low side external H-bridge Driver. Connect this pin to the lower N-MOSFET gate of OUT1.
OUT1P	16	14	High side external H-bridge Driver. Connect this pin to the upper P-MOSFET gate of OUT1.

I/O Equivalent Circuits

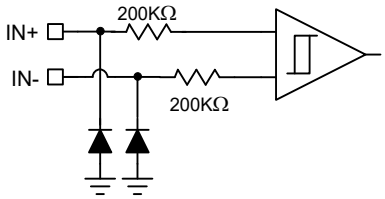
(1) Power supply input pin (VCC)



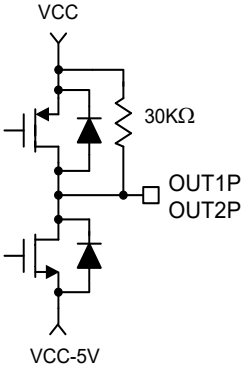
(2) Regulator output pin (5VREG)



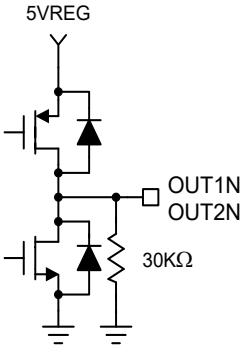
(3) Hall signal input pin (IN+, IN-)



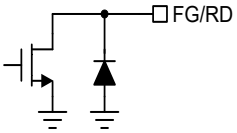
(4) Driver output pin (OUT1P, OUT2P)



(5) Driver output pin (OUT1N, OUT2N)

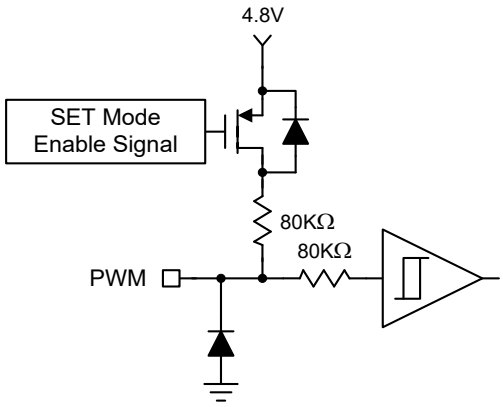


(6) Rotation speed output pin (FG/RD)

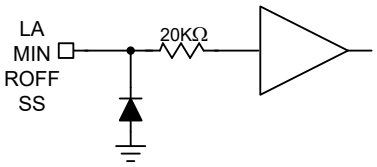


I/O Equivalent Circuits (Cont.)

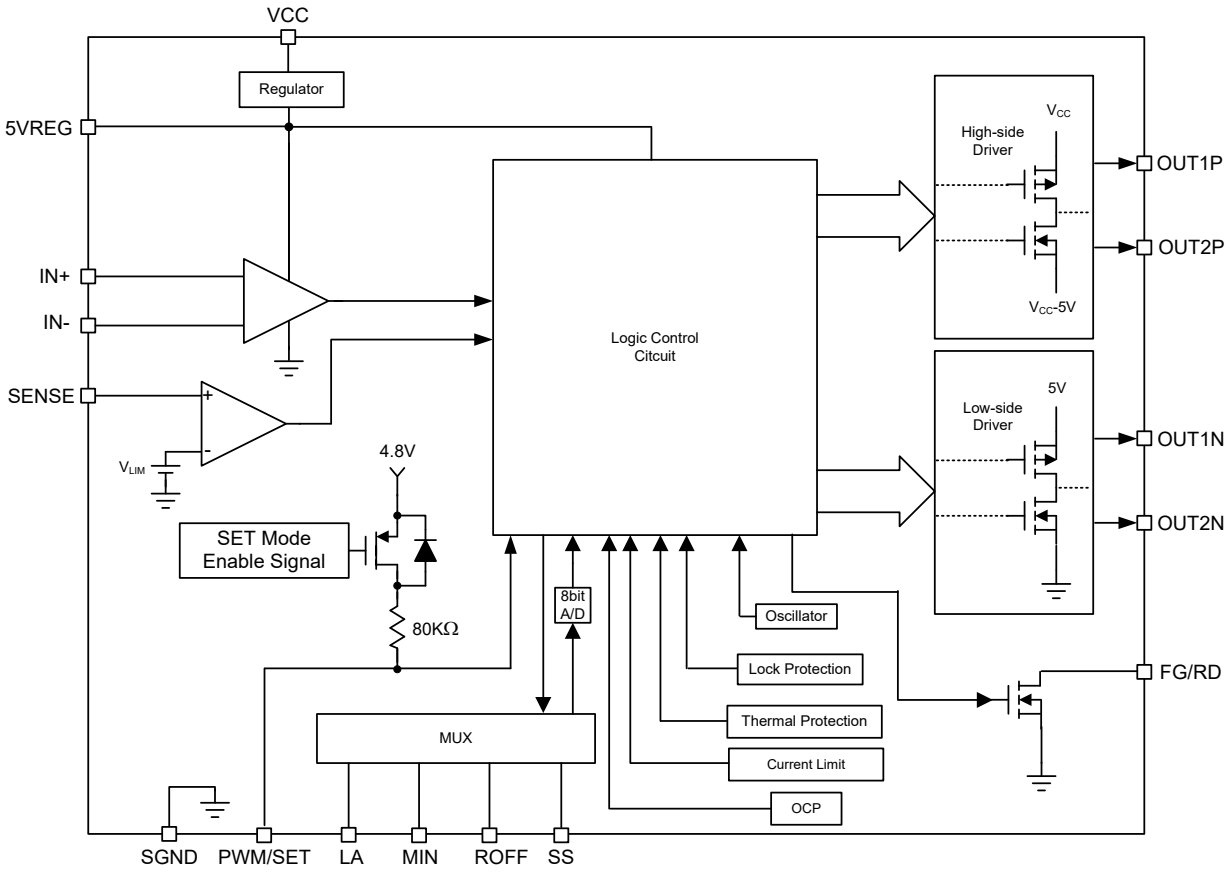
(7) Speed control input pin (PWM/SET)



(8) Input and output setting pin (LA, MIN, ROFF, SS)

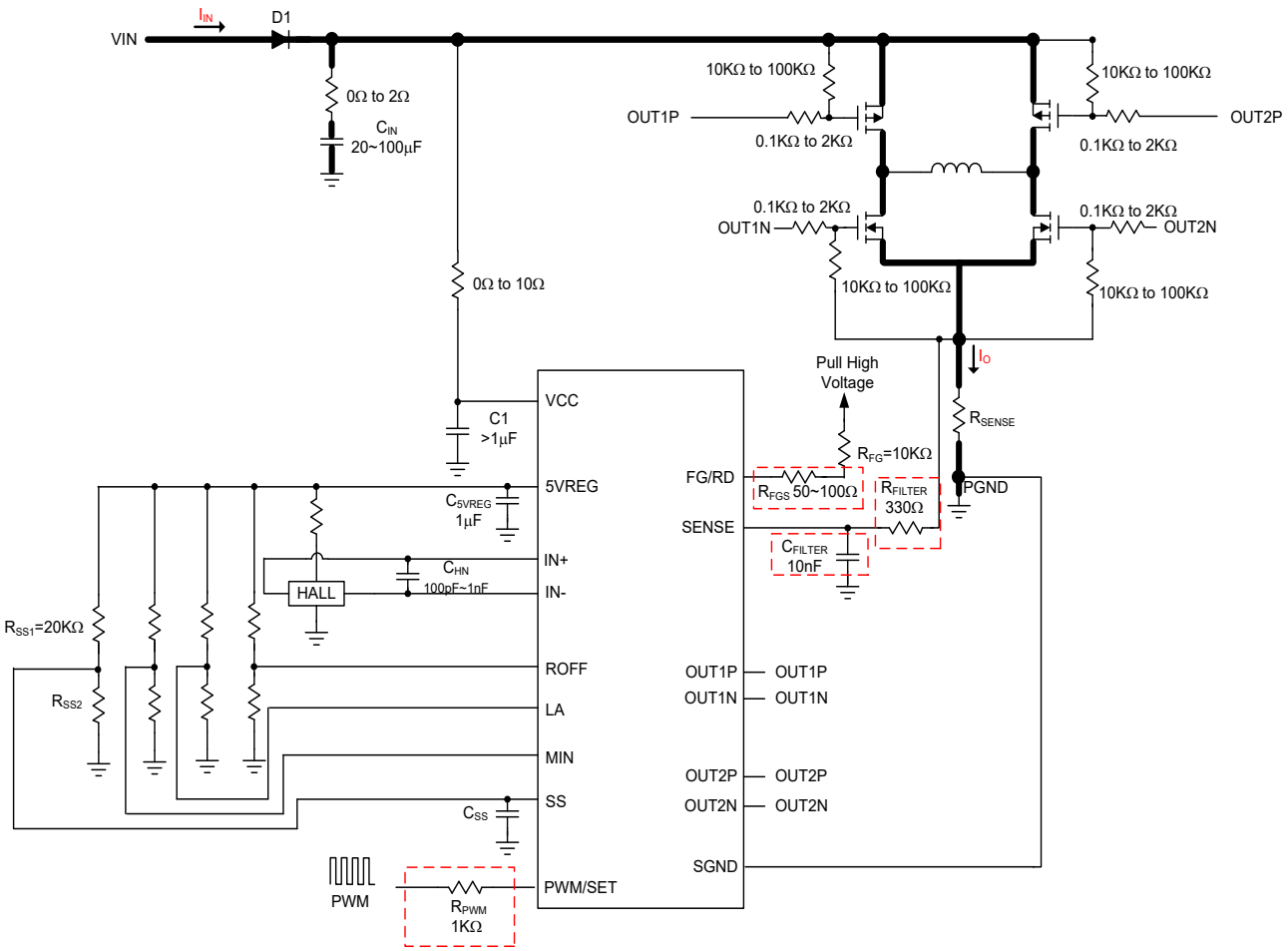


Block Diagram



Typical Application Circuit

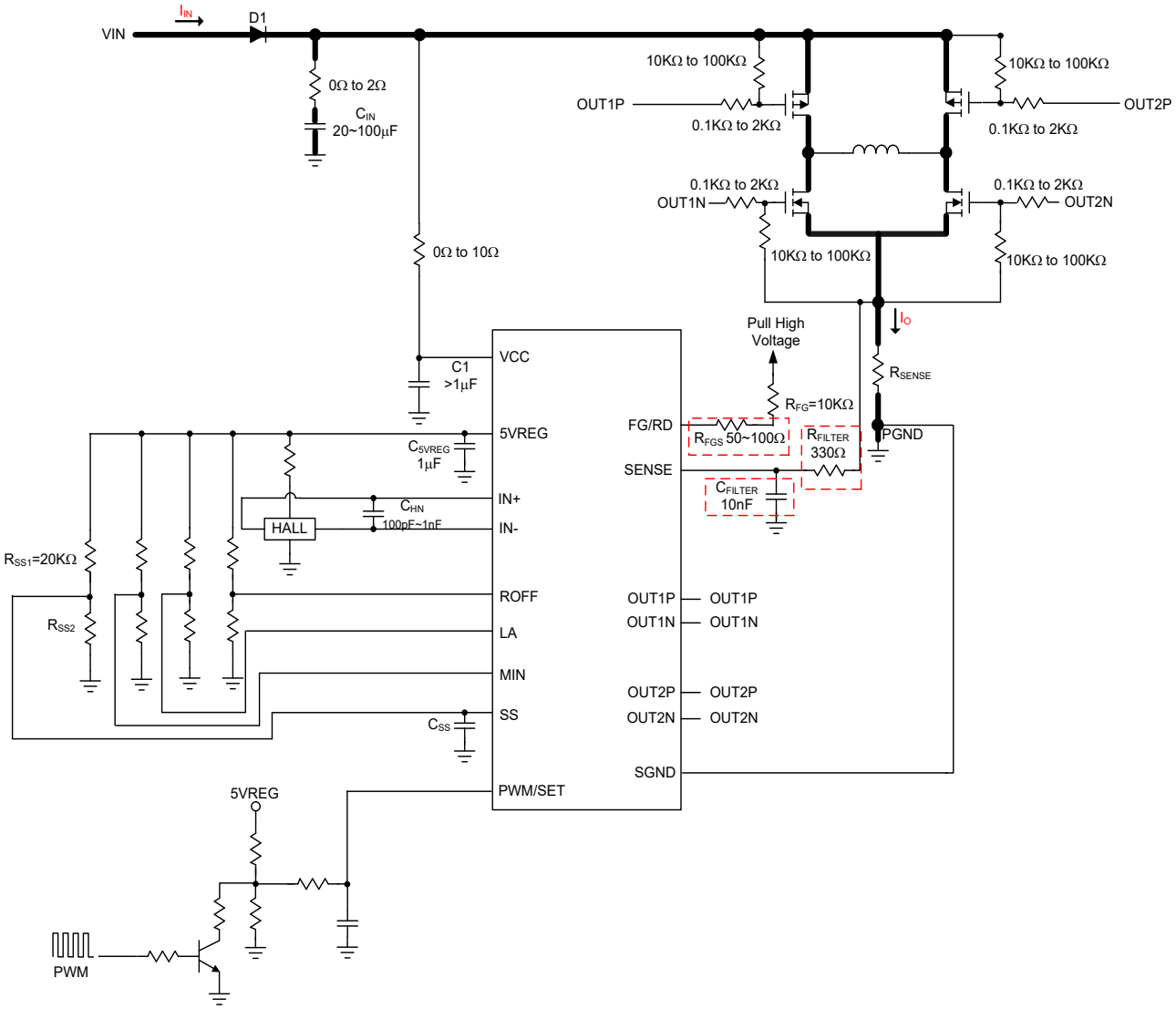
Direct PWM Mode Speed Control



Note: R_{PWM} and R_{FGS} are optional to protect internal circuit for abnormal voltage stress.
R_{FILTER} and C_{FILTER} are optional to suppress the noise on sense pin.

Typical Application Circuit (Cont.)

SET Mode Speed Control



Note: R_{FGS} is optional to protect internal circuit for abnormal voltage stress.
R_{FILTER} and C_{FILTER} are optional to suppress the noise on sense pin.

Function Descriptions

Multi-function pins of APX9283

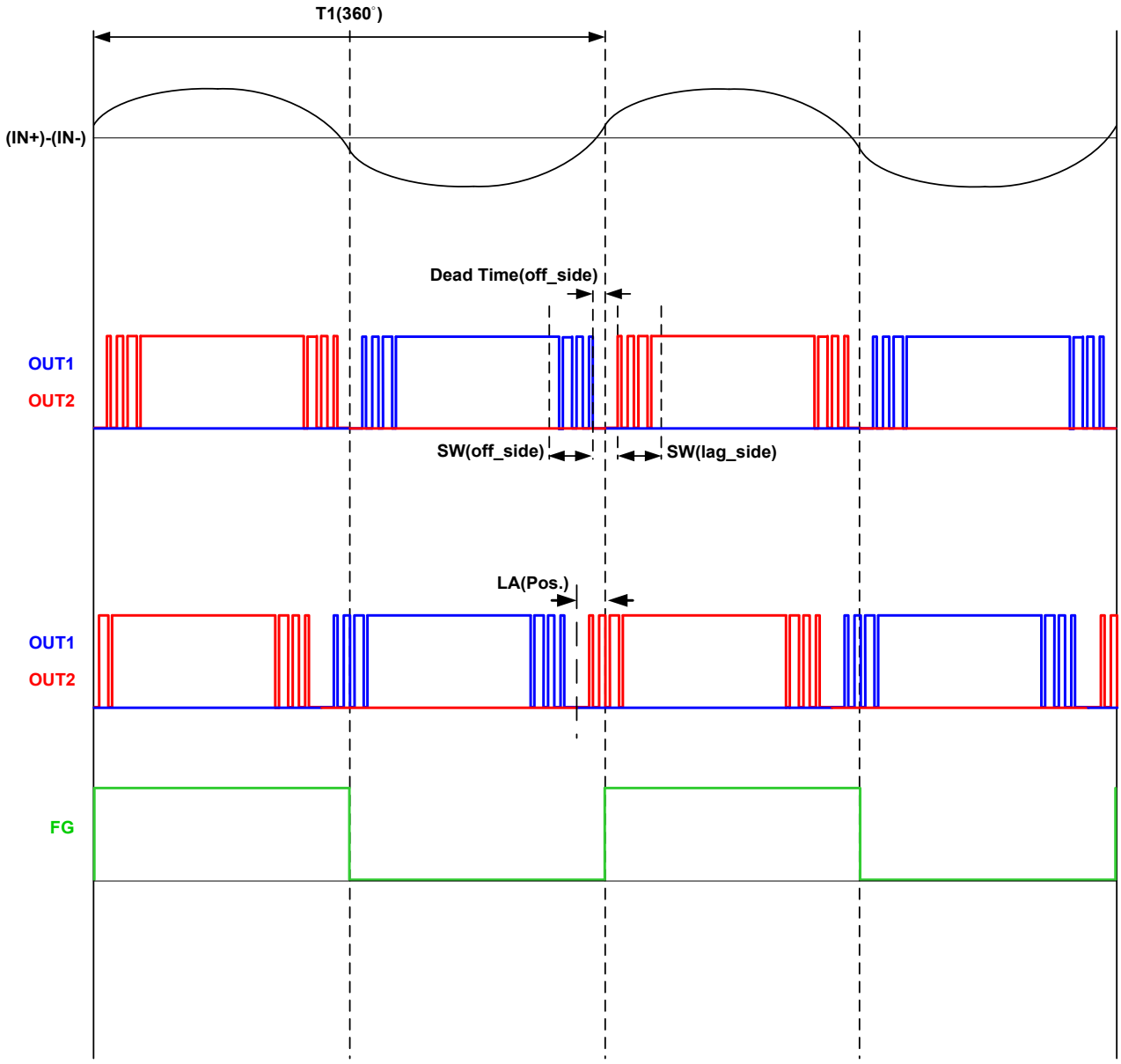
The APX9283 has some multi-function pins. It's in order to reduce the number of IC Pin. The summary of multi-function pins is showed below.

	ROFF pin	LA pin	MIN pin
Primary function	Function of OFF time control	Function of Lead angle setting	Function of minimum output duty setting

	The range of operating voltage (1)	The range of operating voltage (2)
Secondary function of ROFF pin	2.63V to V_{5VREG}	0V to 2.38V
	PWM control.	DC control. (SET Mode)
Secondary function of LA pin	2.63V to V_{5VREG}	0V to 2.38V
	Curve of output duty has minimum duty. (min curve)	Curve of output duty has shutdown area. (shutdown curve)
Secondary function of MIN pin	2.74V to V_{5VREG}	0 to 2.26V
	Output signal of FG/RD pin is FG function.	Output signal of FG/RD pin is RD function.

Function Descriptions (Cont.)

The SW, LA and ROFF (dead time) are following figure to define the behavior.



SW, LA and Dead Time Schematic Diagram

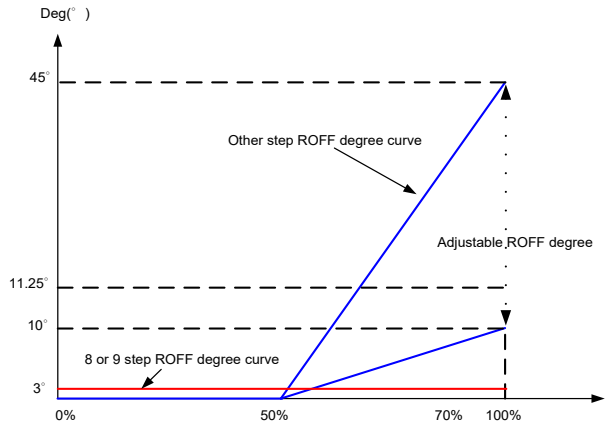
Function Descriptions (Cont.)

Speed Control Pin Setting Description

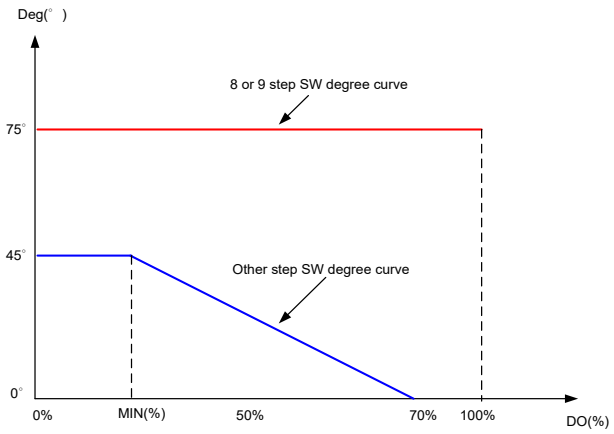
The ROFF pin contain of multi function by input voltage setting. In this pin, the ROFF degree setting is primary function and the secondary function is setting speed control is setting PWM pin Input signal type (direct PWM signal input or DC voltage input). In addition, the output duty drop the ROFF degree decrease and the soft switch degree increases. It can setting voltage range to control ROFF degree and soft switching degree with output duty relation following the figure and table.

Step	V_{ROFF} (V)	ROFF degree (°)	SW degree (°)	Output frequency (Hz)	Secondary Function
	>4.85	10	0~45	33K	PWM Mode
16	4.38	45			
15	4.14	39.375			
14	3.89	33.75			
13	3.64	28.125			
12	3.39	22.5			
11	3.14	16.875			
10	2.88	11.25			
9	2.63	3 (Fix)	75 (Fix)	66K	
Forbidden					
8	2.38	3 (Fix)	75 (Fix)	66K	SET Mode
7	2.13	11.25	0~45	33K	
6	1.88	16.875			
5	1.63	22.5			
4	1.38	28.125			
3	1.13	33.75			
2	0.88	39.375			
1	0.63	45			
	<0.15	10			

ROFF Input Voltage Setting Table



ROFF degree with output duty relation



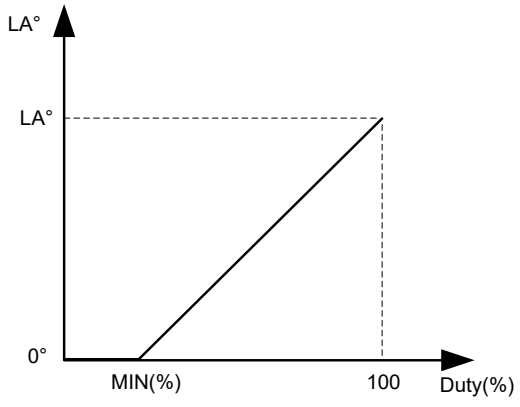
Soft Switching degree with output duty relation

Function Descriptions (Cont.)

The LA pin contain of multi function by input voltage setting. In this pin, the primary function is setting LA degree at output duty equal to 100% and the secondary function is setting speed control curve with shutdown or minimum speed curve. The APX9283 provides adjustable lead angle function which can follow the output duty. It can set up voltage range and lead angle degree with output duty relation following the table and figure.

Step	V_{LA} (V)	LA degree (°)	Secondary Function
	>4.85	5	MIN Mode
16	4.38	22.5	
15	4.14	19.6875	
14	3.89	16.875	
13	3.64	14.0625	
12	3.39	11.25	
11	3.14	8.4375	
10	2.88	5.625	
9	2.63	0	
Forbidden			
8	2.38	0	SD Mode
7	2.13	5.625	
6	1.88	8.4375	
5	1.63	11.25	
4	1.38	14.0625	
3	1.13	16.875	
2	0.88	19.6875	
1	0.63	22.5	
	<0.15	5	

LA Input Voltage Setting Table



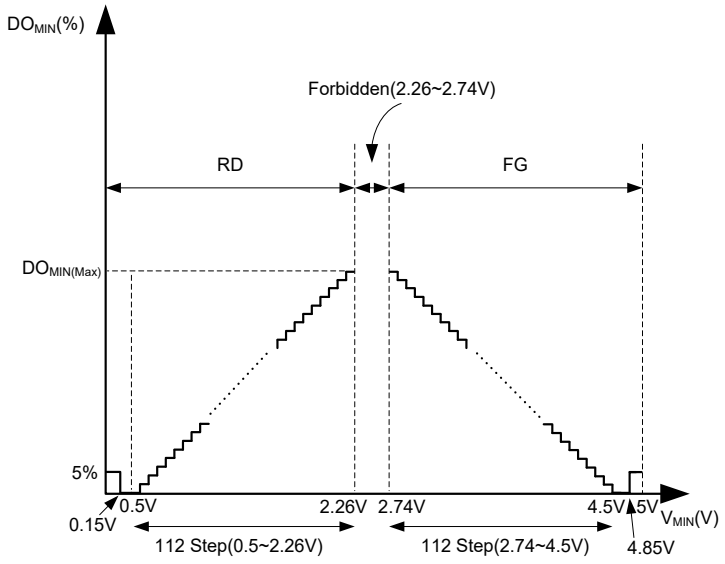
Lead Angle degree with output duty relation

Function Descriptions (Cont.)

The MIN pin contain of multi function by input voltage setting. In this pin, the minimum output duty setting is primary function and the secondary function is setting FG or RD signal output.

Step	V_{MIN} (V)	DO_{MIN} (%)	Secondary Function
	>4.85	5	FG
255	4.5	0	
143	2.74	43.92	
Forbidden			
112	2.26	43.92	RD
0	0.5	0	
	<0.15	5	

MIN Input Voltage Setting Table

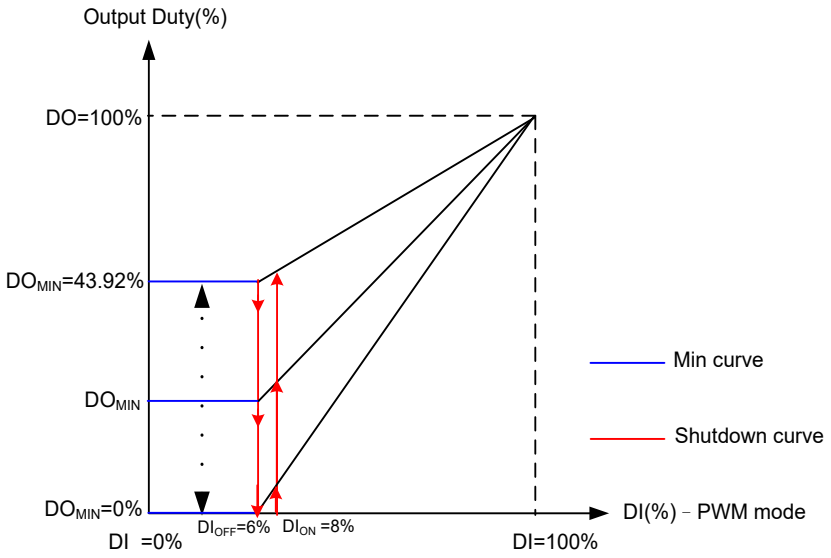


Curve of adjustable range of minimum duty setting

Function Descriptions (Cont.)

Speed Control Curve

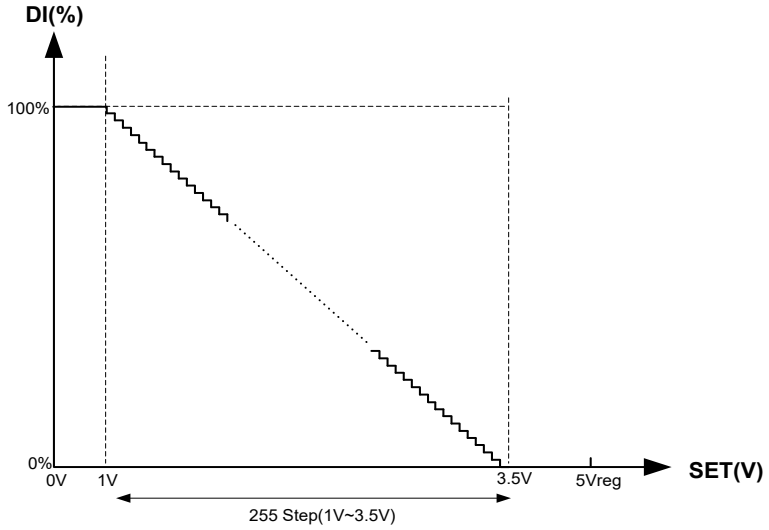
The APX9283 has two types PWM speed control curve, it select by LA pin voltage setting. The first type of PWM speed control curve is shutdown mode. When PWM input duty is less than DI_{OFF} = 6% the output will close, until PWM input duty is rising more than DI_{ON} = 8% the output will startup. The second type of PWM speed control curve is minimum speed mode. When PWM input duty is less than DI_{OFF} = 6%the output duty will keep minimum output duty.



Shutdown and Min Mode for PWM Speed Curve

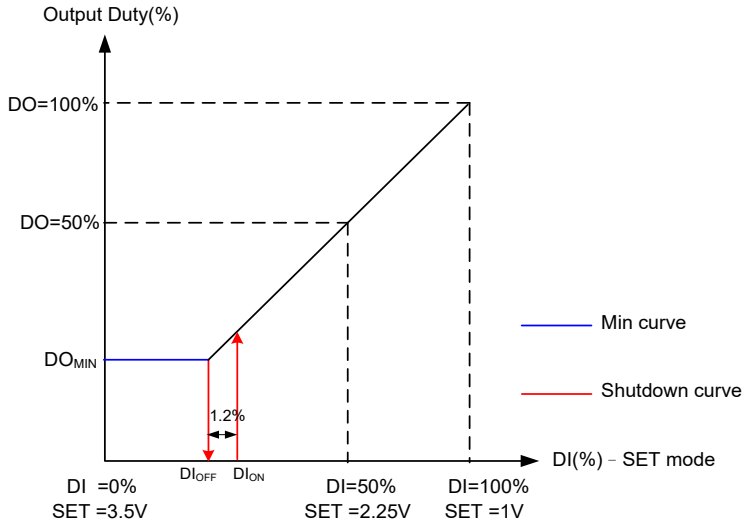
SET Speed Control

In SET mode, the speed conrtol signal is DC voltage. The IC internal circuit will transfer to input duty (DI) for motor speed setting. The APX9283 has two types SET speed control curve, it select by LA pin voltage setting. The first type of SET speed control curve is shutdown mode. When input duty (DI) is less than DI_{OFF} the output will close, until input duty (DI) is rising more than DI_{OFF}+1.2% (DI_{ON}) the output will startup. The second type of SET speed control curve is minimum speed mode. When SET input voltage is less than DI_{OFF} the output duty will keep minimum output duty.



SET Voltage Setting Range

Function Descriptions (Cont.)

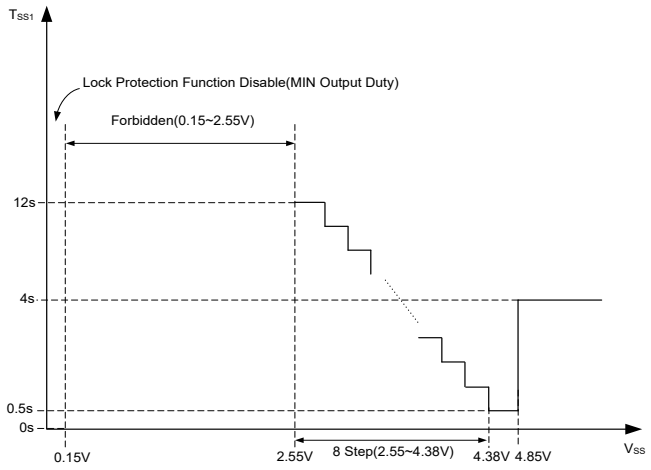


SET Speed Curve

Function Descriptions (Cont.)

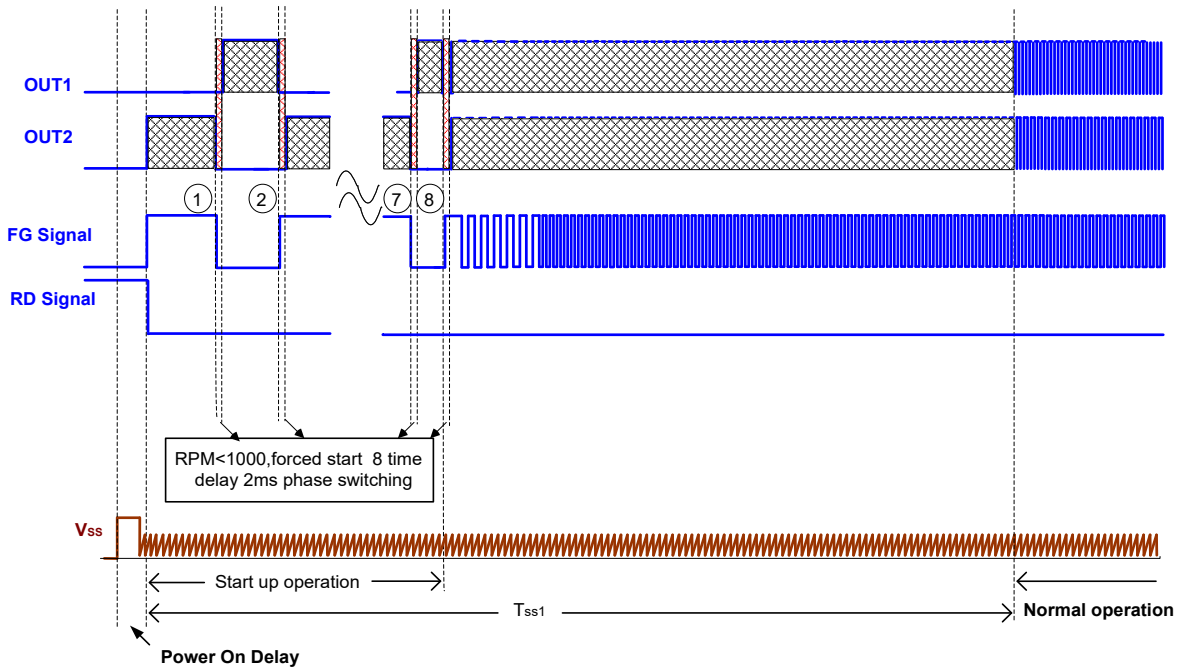
Soft-Start Function

The APX9283 provides the soft-start function to avoid peak current during power-on and lock-restart. The soft-start time T_{SS1} . The T_{SS1} is the time which output changes from 0% to 100%. The T_{SS1} is defined by input voltage of SS pin at start-up. At the beginning of soft-start period, the initial duty of output changes from 5% . The time of T_{SS1} can be set whose range follows the figure and table below.



V_{SS} Voltage Setting Table		
STEP	V_{SS} (V)	T_{SS1} (s)
	>4.85	4
8	4.38	0.5
7	4.14	1
6	3.89	2
5	3.64	4
4	3.39	6
3	3.14	8
2	2.88	10
1	2.63	12

Voltage Range Setting of T_{SS1}



Soft-Start Timing Chart

Function Descriptions (Cont.)

Change Rate of Output PWM Duty

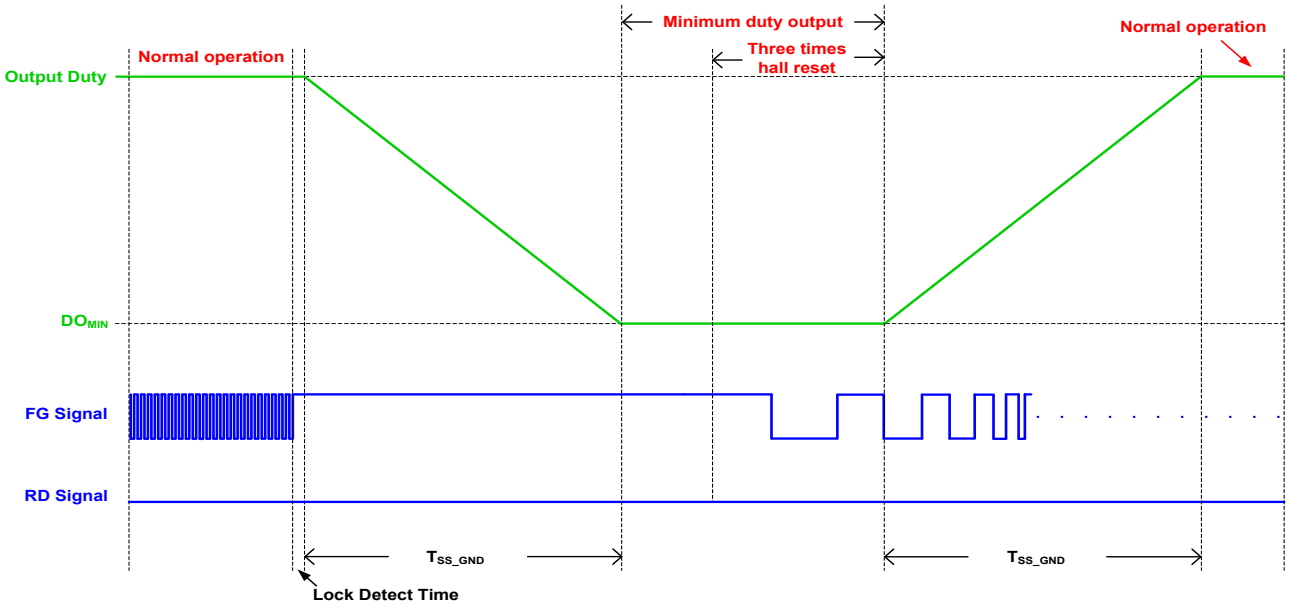
The C_{ss} capacitor is used to set the output duty change rate for T_{ss2} time. If user can't set C_{ss}, T_{ss2} time is equal to T_{ss1} time. The change rate of increasing period follows T_{SS2}, but decreasing period is half of increasing period. According to the table below, users can set T_{SS2} quickly.

T_{SS2} time Setting reference table

				1nF	2.2nF	4.7nF	10nF
R_{SS1} (Ω)	R_{SS2} (Ω)	R_{TOTAL} (Ω)	V_{SS} (DC)	T_{SS2} (s)			
20K	22K	42K	2.62	1.1	2.3	4.7	10.1
20K	27K	47K	2.87	1	2.2	4.3	9.2
20K	33K	53K	3.11	0.9	1.9	3.9	8.4
20K	43K	63K	3.41	0.8	1.8	3.7	7.9
20K	51K	71K	3.59	0.8	1.7	3.5	7.6
20K	68K	88K	3.86	0.8	1.6	3.4	7.3
20K	100K	120K	4.16	0.8	1.6	3.4	7.2
20K	150K	170K	4.41	0.7	1.6	3.3	7

Disable Lock Protection Function

When SS pin is connected to GND, the lock protection function will be disabled. In this setting, if the fan motor is locked, the output duty will keep minimum duty. Until the IC detects the hall signal three times cross, the output duty is increased to target duty. In addition, the soft start time and output duty change rate are fix in this mode.

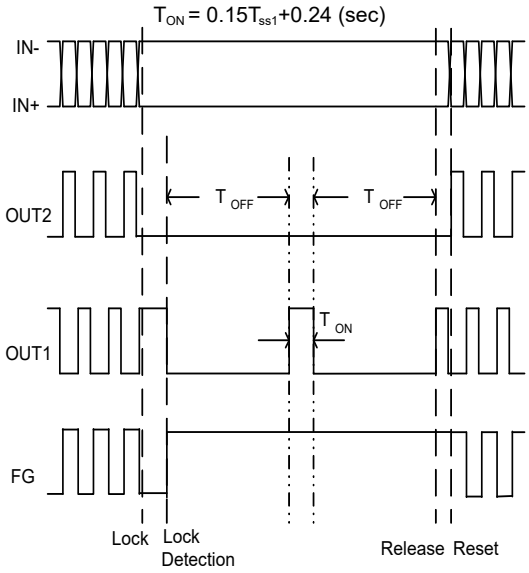


Disable Lock Protection Timing Char

Function Descriptions (Cont.)

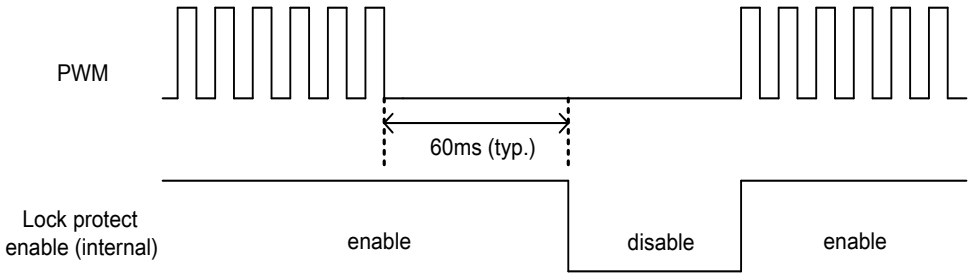
Lockup Protection and Automatic Restart

The APX9283 provides the lockup protection and automatic restart functions for preventing the coil burn-out when the fan is locked. This IC has an internal counter to determine the shutdown time (T_{OFF}) and restart time (T_{ON}). During shutdown time, the output drivers keep turning off for T_{OFF} and then enter the restart time. During the restart time, one output is high (soft-start function contained) and the other is low, which makes a torque for fan rotation. Furthermore, T_{OFF} is fixed at 6 sec and T_{ON} which is variable follows the formula below.



Quick Start and Standby Mode

This IC would enter standby mode when the PWM input keeps low level for then 60ms (typ.). In standby mode, it will shutdown amplifier and FG. In standby mode, the lock protection function doesn't work, therefore, starting fan is unobstructed when releasing standby mode.



Thermal Protection

The APX9283 has thermal protection. When internal junction temperature reaches 170°C, the output devices will be switched off. When the IC's junction temperature cools by 30°C and wait 4 second, the thermal sensor will turn the output devices on again, resulting in a pulsed output during continuous thermal protection.

Truth Table

Input		Output				Mode
IN-	IN+	OUT1	OUT2	FG	RD	
H	L	H	L	L	L	Operation Mode (PWM H)
L	H	L	H	OFF	L	
H	L	OFF	L	L	L	Operation Mode (PWM L)
L	H	L	OFF	OFF	L	
H	L	L	L	OFF	OFF	Lock Mode
L	H	L	L	OFF	OFF	

Application Information

Input Protection Diode & Capacitor

The IC should be added a protection diode (D1) to prevent the damage from the power reverse connection. However, the protection diode will cause a voltage drop on the supply voltage. The current rating of the diode must be greater than the maximum output current. For the noise reduction purpose, a capacitor (C_{IN}) must connect between VCC and GND. It is the suggestion that C_{IN} should be placed as close as possible to the device VCC pin.

Current Limit and Over Current Protection (OCP)

The APX9283 is equipped with external current limit circuit and over-current protection (OCP). The external current limit circuit works when SENSE pin voltage is higher than V_{LIM} (150mV). If the instantaneous current exceeds the current limit value, the current limit function is triggered. When SENSE pin voltage is higher than V_{OCP} (200mV), the OCP function will be enable to turn-off all of the output driver to prevent output short through condition until wait 6.4 seconds to automatic restart or quick start (Only shutdown mode set) or re-power on.

$$\text{Current Limit} = \frac{V_{LIM}}{R_{SENSE}}$$

Where:
V_{LIM} = internal reference voltage for current limit
R_{SENSE} = SENSE pin resistor

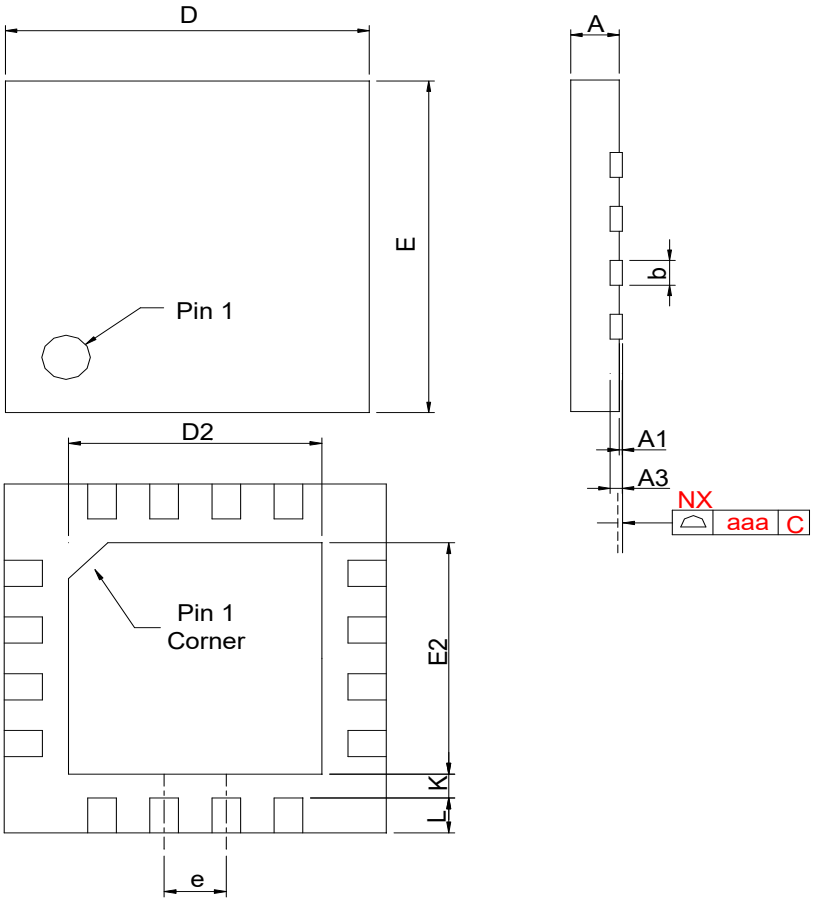
For example:
V_{LIM} = 150mV, V_{OCP} = 200mV, R_{SENSE} = 0.1Ω
Limit Current = 1.5A OCP Current=2A

Shutdown Time (T_{OFF}) and Restart Time (T_{ON})

The restart time (T_{ON}) is related to soft start time (T_{SS1}). The shutdown time (T_{OFF}) is fixed time.
Following the formula to calculate shutdown time and restart time.
Restart Time (T_{ON}) = (T_{SS1} x 0.15)+0.24(s)
Shutdown Time (T_{OFF}) = 0.3 x 20(s)

Package Information

TQFN3x3-16

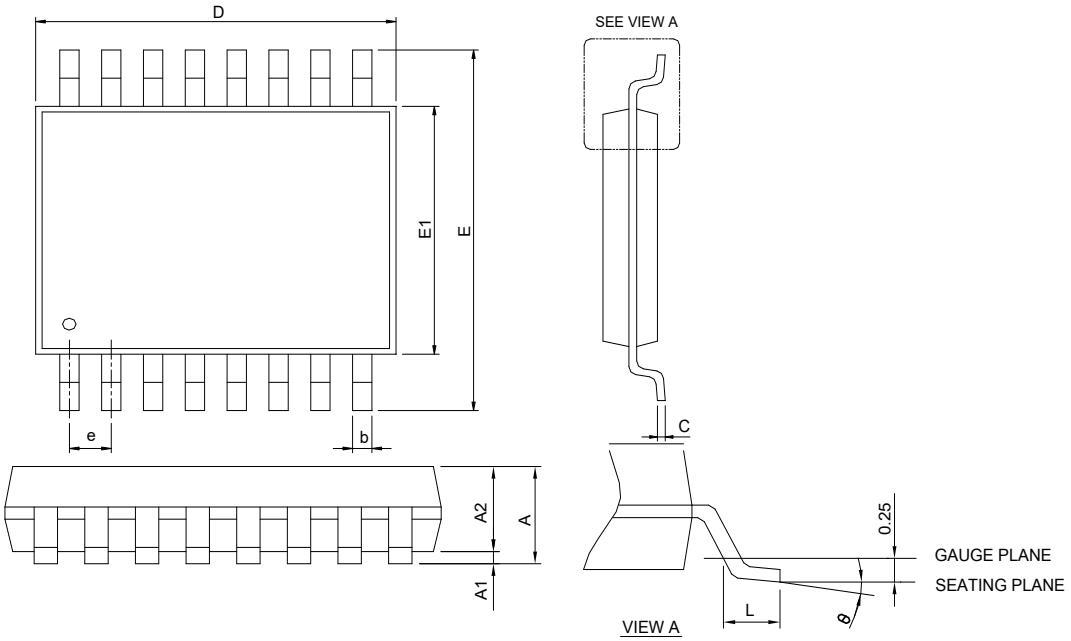


SYMBOL	TQFN3*3-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A	0.70	0.80	0.028	0.031
A1	0.00	0.05	0.000	0.002
A3	0.20 REF		0.008 REF	
b	0.18	0.30	0.007	0.012
D	2.90	3.10	0.114	0.122
D2	1.50	1.80	0.059	0.071
E	2.90	3.10	0.114	0.122
E2	1.50	1.80	0.059	0.071
e	0.50 BSC		0.020 BSC	
L	0.30	0.50	0.012	0.020
K	0.20		0.008	
aaa	0.08		0.003	

Note : 1. Followed from JEDEC MO-220 WEED-4.

Package Information

TSSOP-16



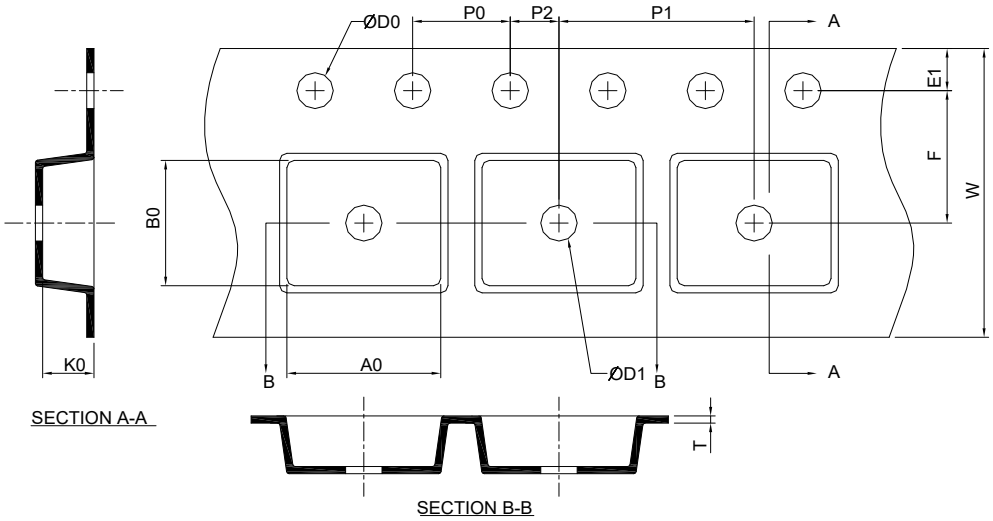
SYMBOL	TSSOP-16			
	MILLIMETERS		INCHES	
	MIN.	MAX.	MIN.	MAX.
A		1.20		0.047
A1	0.05	0.15	0.002	0.006
A2	0.80	1.05	0.031	0.041
b	0.19	0.30	0.007	0.012
c	0.09	0.20	0.004	0.008
D	4.90	5.10	0.193	0.201
E	6.20	6.60	0.244	0.260
E1	4.30	4.50	0.169	0.177
e	0.65 BSC		0.026 BSC	
L	0.45	0.75	0.018	0.030
θ	0°	8°	0°	8°

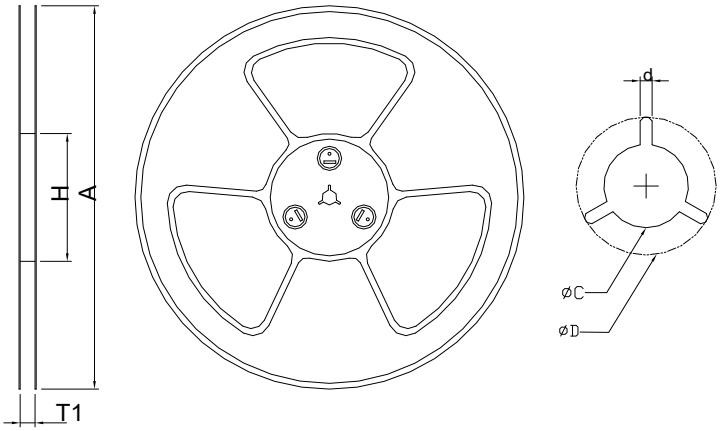
Note : 1. Follow from JEDEC MO-153 AB.

2. Dimension "D" does not include mold flash, protrusions or gate burrs. Mold flash, protrusion or gate burrs shall not exceed 6 mil per side.

3. Dimension "E1" does not include inter-lead flash or protrusions. Inter-lead flash and protrusions shall not exceed 10 mil per side.

Carrier Tape & Reel Dimensions





Application	A	H	T1	C	d	D	W	E1	F
TQFN 3*3	330±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.5±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.0±0.10	8.0±0.10	2.0±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	3.30±0.20	3.30±0.20	1.00±0.20
Application	**A**	**H**	**T1**	**C**	**d**	**D**	**W**	**E1**	**F**
TSSOP-16	330.0±2.00	50 MIN.	12.4+2.00 -0.00	13.0+0.50 -0.20	1.5 MIN.	20.2 MIN.	12.0±0.30	1.75±0.10	5.50±0.05
	P0	**P1**	**P2**	**D0**	**D1**	**T**	**A0**	**B0**	**K0**
	4.00±0.10	8.00±0.10	2.00±0.05	1.5+0.10 -0.00	1.5 MIN.	0.6+0.00 -0.40	6.90±0.20	5.40±0.20	1.60±0.20

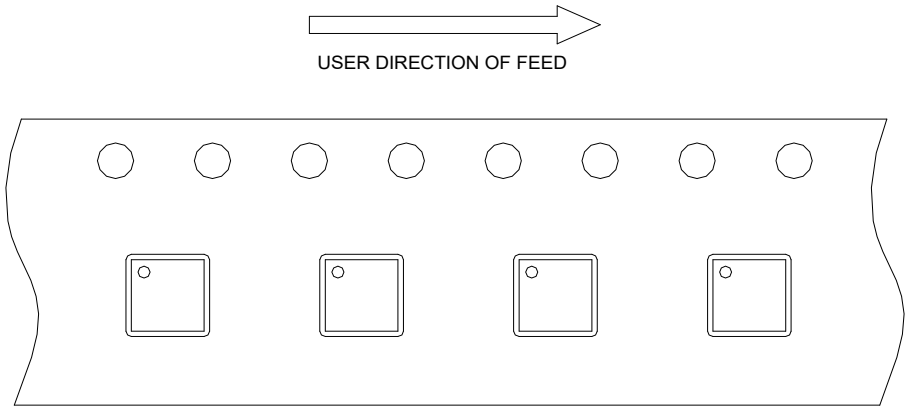
(mm)

Devices Per Unit

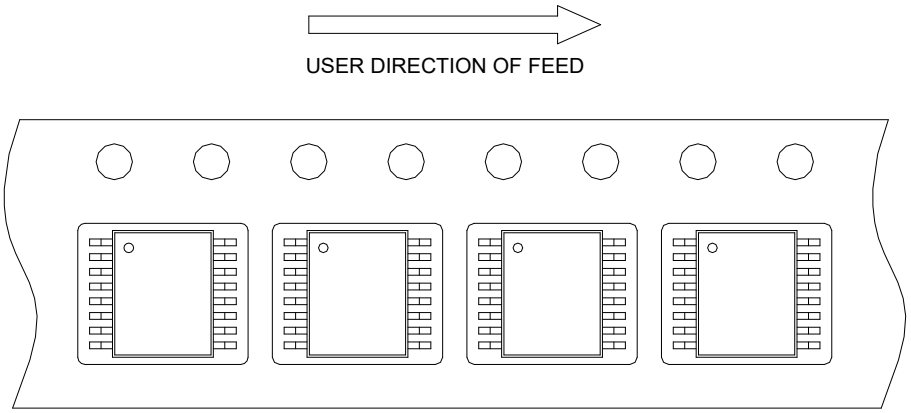
Application	Packing		Devices Per Reel
TQFN3x3	Tape & Reel		3000
Application	**Carrier Width**	**Cover Tape Width**	**Devices Per Reel**
TSSOP-16	12	-	2500

Taping Direction Information

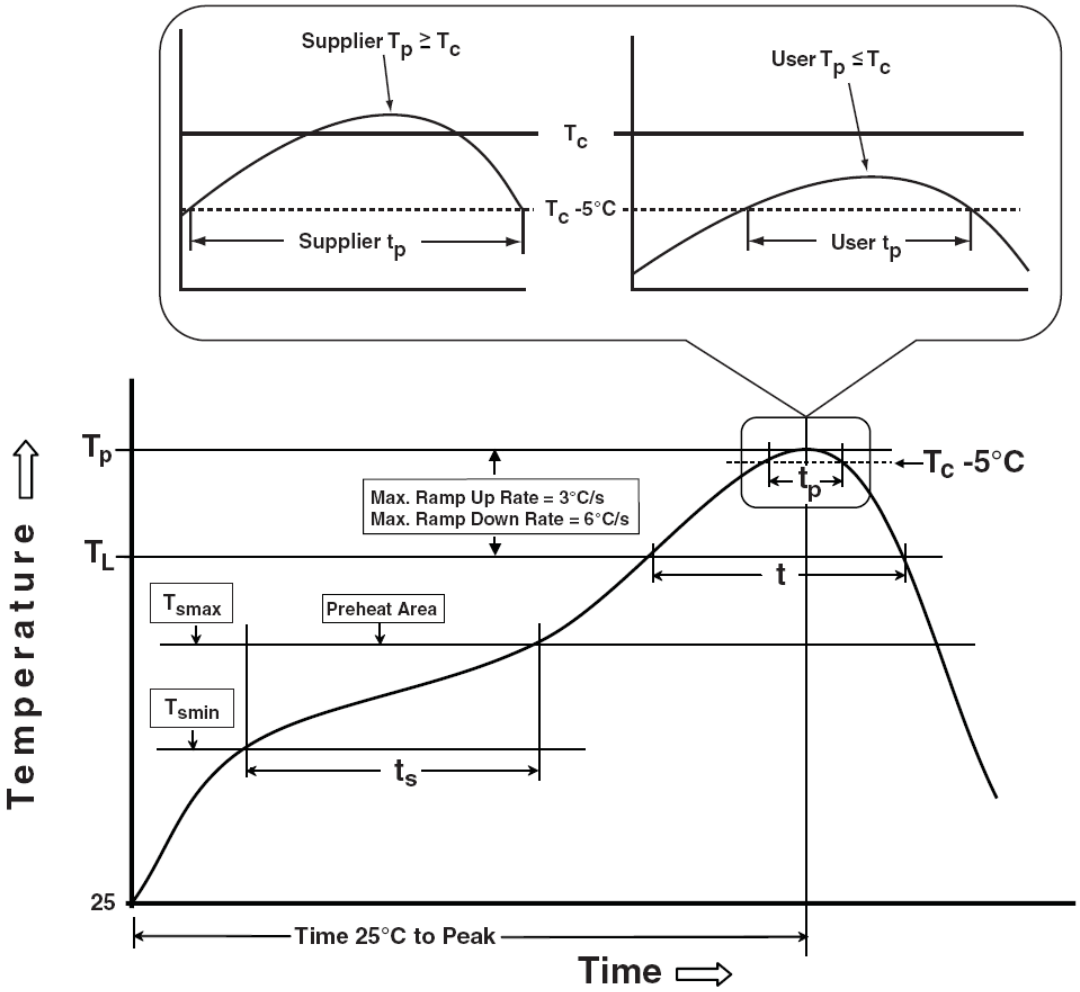
TQFN3x3-16



TSSOP-16



Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_P)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum. ** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (Tc)

Package Thickness	Volume mm^3 <350	Volume mm^3 350-2000	Volume mm^3 >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HOLT	JESD-22, A108	1000 Hrs, Bias @ T_j=125°C
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C
HBM	MIL-STD-883-3015.7	VHBM ≧ 2KV
MM	JESD-22, A115	VMM ≧ 200V
Latch-Up	JESD 78	10ms, 1_{tr} ≧ 100mA

Customer Service

Anpec Electronics Corp.
Head Office :
No.6, Dusing 1st Road, SBIP,
Hsin-Chu, Taiwan, R.O.C.
Tel : 886-3-5642000
Fax : 886-3-5642050

Taipei Branch :
2F, No. 11, Lane 218, Sec 2 Jhongsing Rd.,
Sindian Dist, Sinbei City 23146, Taiwan.
Tel : 886-2-2910-3838
Fax : 886-2-2917-3838