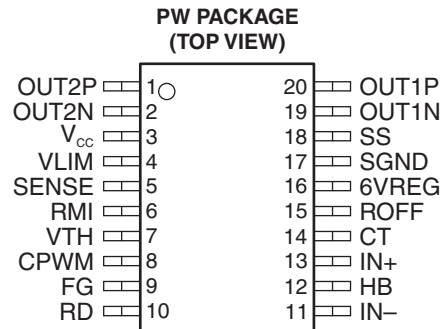# VARIABLE-SPEED SINGLE-PHASE FULL-WAVE FAN-MOTOR PRE-DRIVER

FEATURES

- **Pre-Driver for Single-Phase Full-Wave Drive**
  - **PNP-NMOS is used as an external power TR, enabling high-efficiency low-consumption drive by means of the low-saturation output and single-phase full-wave drive. (PMOS-NMOS also applicable)**
- **External PWM Input Enables Variable-Speed Control**
  - **Separately-excited upper direct PWM (f = 25 kHz) control method, enabling highly silent speed control**
- **Current-Limiter Circuit**
  - **Chopper-type current limit at start**
- **Reactive Current-Cut Circuit**
  - **Reactive current before phase change is cut to enable silent and low-consumption drive**
- **Minimum Speed Setting Pin**
  - **Minimum speed can be set with external resistor. The start assistance circuit enables start at extremely low speed.**
- **Constant-Voltage Output Pin for Hall Bias**
- **Lock Protection and Automatic Reset Functions**
- **Rotation Speed Detection (FG) and Lock Detection (RD) Outputs**

PW PACKAGE
(TOP VIEW)

OUT2P	1	20	OUT1P
OUT2N	2	19	OUT1N
V_{CC}	3	18	SS
VLIM	4	17	SGND
SENSE	5	16	6VREG
RMI	6	15	ROFF
VTH	7	14	CT
CPWM	8	13	IN+
FG	9	12	HB
RD	10	11	IN−

DESCRIPTION/ ORDERING INFORMATION

The TMP816 is a single-phase bipolar variable-speed fan-motor predriver that works with an external PWM signal. A highly efficient, quiet and low power consumption motor driver circuit with a large variable speed can be implemented by adding a small number of external components.

This device is optimal for driving large-scale fan motors (with large air volume and large current) such as those used in servers and consumer products.

ORDERING INFORMATION[1]

| T_A	PACKAGE[2]		ORDERABLE PART NUMBER	TOP-SIDE MARKING
−30°C to 95°C	TSSOP – PW	Reel of 2000	TMP816PWR	TMP816

(1) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

⚠ Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

TMP816

TEXAS INSTRUMENTS

BLOCK DIAGRAM
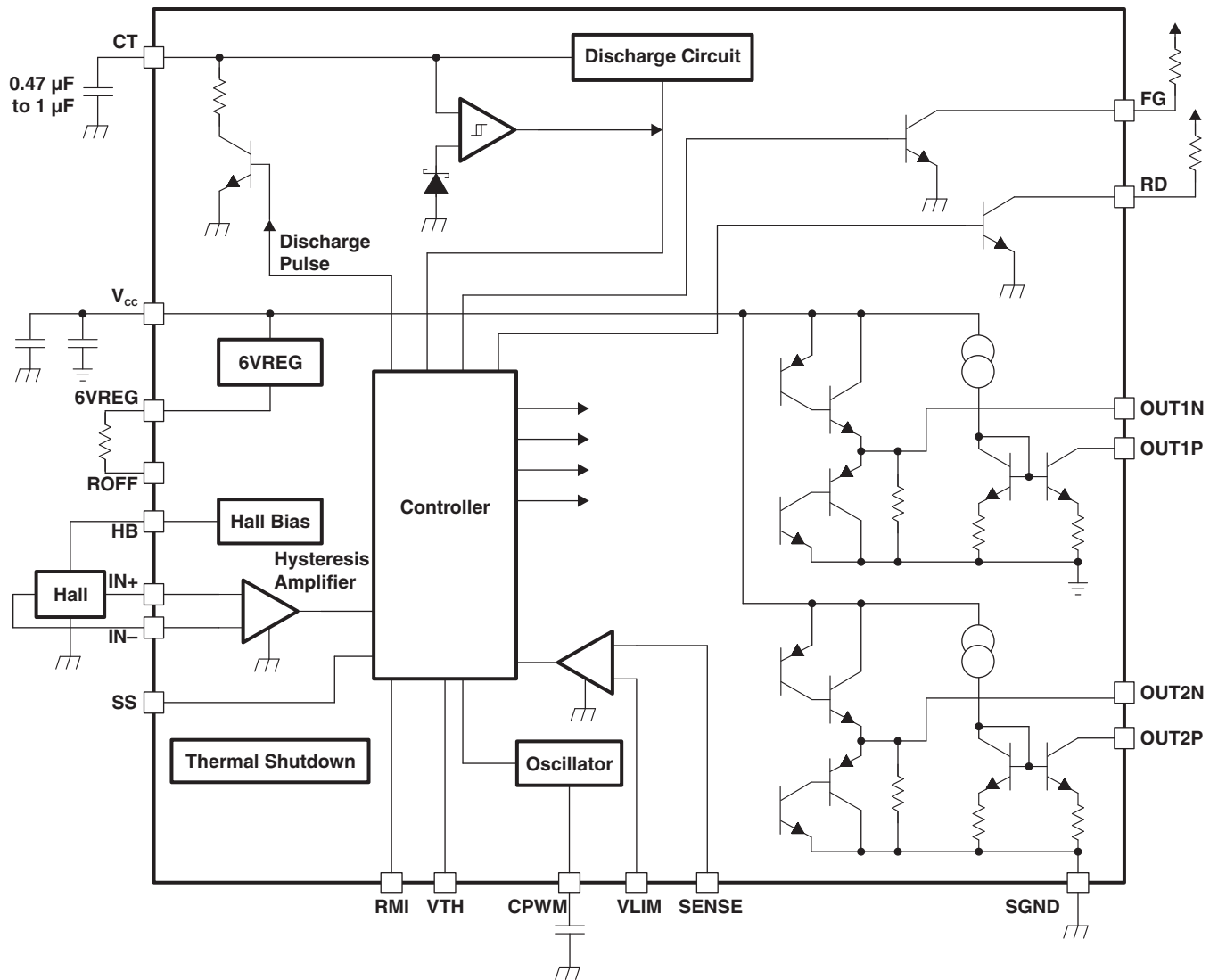
TRUTH TABLE

During full-speed rotation

IN−	IN+	CT	OUT1P	OUT1N	OUT2P	OUT2N	FG	RD	MODE
H	L	L	L	–	–	H	L	L	OUT1 → 2 drive
L	H		–	H	L	–	OFF		OUT2 → 1 drive
H	L	H	OFF	–	–	H	L	OFF	Lock protection
L	H		–	H	OFF	–	OFF		

VTH	CPWM	IN−	IN+	OUT1P	OUT1N	OUT2P	OUT2N	MODE
L	H	H	L	L	–	–	H	OUT1 → 2 Drive
		L	H	–	H	L	–	OUT2 → 1 Drive
H	L	H	L	OFF	–	–	H	During rotation, regeneration in lower TR
		L	H	–	H	OFF	–	

TEXAS INSTRUMENTS

TMP816

TERMINAL FUNCTIONS

TERMINAL		I/O	DESCRIPTION
NAME	NO.		
OUT2P	1	O	Upper-side driver output
OUT2N	2	O	Lower-side driver output
VCC	3		Power supply. For the CM capacitor that is a power stabilization capacitor for PWM drive and for absorption of kickback, the capacitance of 0.1 µF to 1 µF is used. In this device, the lower TR performs current regeneration by switching the upper TR. Connect CM between V_{CC} and GND, with the thick pattern and along the shortest route. Use a zener diode if kickback causes excessive increase of the supply voltage, because such increase may damage the device.
VLIM	4	I	Activates the current limiter when SENSE voltage is higher than VLIM voltage. Connect to 6VREG when not used.
SENSE	5	I	Sense input. Connect to GND when not used.
RMI	6	I	Minimum speed setting. Connect to 6VREG when not used. If device power can be removed before power is removed from RMI, insert a current limiting resistor to prevent inflow of large current.
VTH	7	I	VTH voltage is generated by filtering the PWM-IN input. If device power can be removed before power is removed from VTH, insert a current limiting resistor to prevent inflow of large current.
CPWM	8	O	Connect to capacitor CP to set the PWM oscillation frequency. With CP = 100 pF, oscillation occurs at 25 kHz and provides the basic frequency of PWM.
FG	9	O	Open collector output, which can detect the rotation speed using the FG output according to the phase shift. Leave open when not used.
RD	10	O	Open collector output. Outputs low during rotation and high at stop. Leave open when not used.
IN–	11	I	Hall input
HB	12	O	This is a Hall element bias, that is, the 1.5-V constant-voltage output.
IN+	13	I	Hall input. Make connecting traces as short as possible to prevent carrying of noise. To futher limit noise, insert a capacitor between IN+ and IN–. The Hall input circuit is a comparator having a hysteresis of 20 mV. The application should ensure that the Hall input level more than three times (60 mVp-p) this hysteresis.
CT	14	O	Lock detection time setting. Capacitor CT is connected.
ROFF	15	I	Sets the soft switching time to cut the reactive current before phase change. Connect to 6VREG when not used.
6VREG	16	O	6-V regulator output
SGND	17		Connected to the control circuit power supply system.
SS	18	O	Connect to soft-start setting capacitor. Connect the capacitor between 6VREG and SS. Enables setting of the soft-start time according to the capacity of the capacitor (see Figure 3 and Figure 4). Connect to ground if not used.
OUT1N	19	O	Lower-side driver output
OUT1P	20	O	Upper-side driver output

TMP816

TEXAS INSTRUMENTS

ABSOLUTE MAXIMUM RATINGS[1]

over operating free-air temperature range (unless otherwise noted)

			VALUE
V_{CC}	Supply voltage		18 V
V_{OUT}	Output voltage	OUT1P, OUT1N, OUT2P, OUT2N	18 V
I_{OUT}	Continuous output current	OUT1P, OUT1N, OUT2P, OUT2N	50 mA
I_{HB}	Continuous output current	HB	10 mA
V_{TH}	Input voltage	VTH	8 mA
V_{RD} V_{FG}	Output voltage	RD, FG	18 V
I_{RD} I_{FG}	Continuous output current	RD, FG	10 mA
θ_{JA}	Package thermal impedance[2]		83°C/W
T_{stg}	Storage temperature range		−65°C to 150°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

$T_A = 25°C$

			MIN	MAX	UNIT
V_{CC}	Supply voltage		6	16	V
V_{TH}	VTH input voltage	Full-speed mode	0	7	V
V_{ICM}	Hall input common phase input voltage		0.2	3	V
T_A	Operating free-air temperature		−30	95	°C

ELECTRICAL CHARACTERISTICS

$V_{CC} = 12$ V, $T_A = 25°C$ (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{6VREG}	Output voltage	6VREG	$I_{HB} = 5$ mA	5.8	6	6.15	V
V_{CRH}	High-level output voltage	CPWM		4.35	4.55	4.75	V
V_{CRL}	Low-level output voltage			1.45	1.65	1.85	V
f_{PWM}	Oscillation frequency		CP = 100 pF	18	25	32	kHz
V_{CTH}	High-level output voltage	CT		3.4	3.6	3.8	V
V_{CTL}	Low-level output voltage			1.4	1.6	1.8	V
I_{CT1}	Charge current			1.6	2	2.5	µA
I_{CT2}	Discharge current			0.16	0.2	0.28	µA
R_{CT}	Charge/discharge current ratio			8	10	12	
V_{ON}	Output voltage	OUT_N	$I_O = 20$ mA	4	10		V
I_{OP}	Sink current	OUT_P		15	20		mA
V_{HN}	Hall input sensitivity	H+, H-	Zero peak value (including offset and hysteresis)		10	20	mV
V_{RD} V_{FG}	Low-level output voltage	RD, FG	$I_{RD} = 5$ mA or $I_{FG} = 5$ mA		0.15	0.3	V
I_{RDL} I_{FGL}	Output leakage current		$V_{RD} = 16$ V or $V_{FG} = 16$ V			30	µA
I_{SS}	Discharge current	SS	$V_{SS} = 1$ V	0.4	0.5	0.6	µA
I_{CC}	Supply current		During drive	4	10	14	mA
			During lock protection	4	10	14	

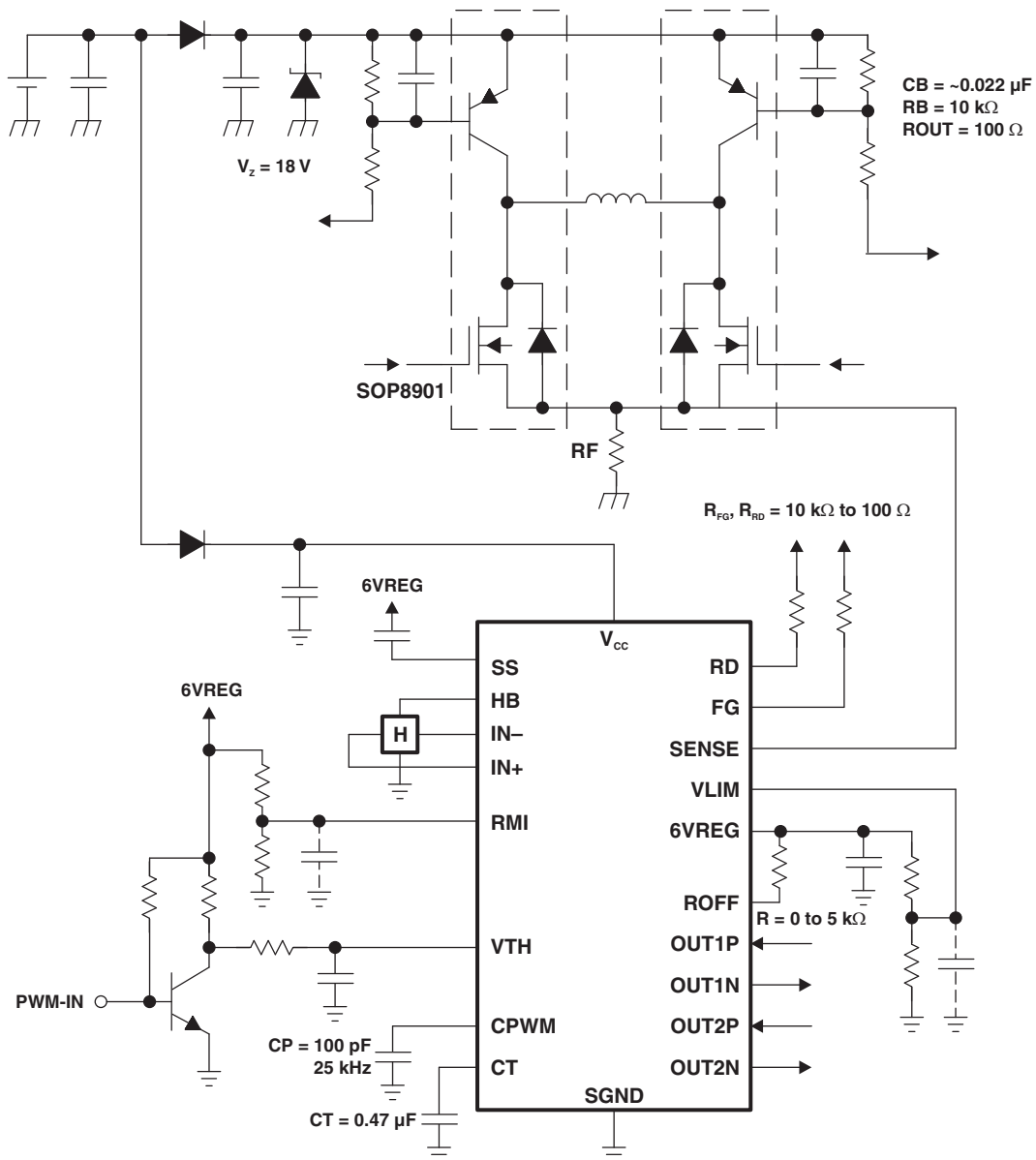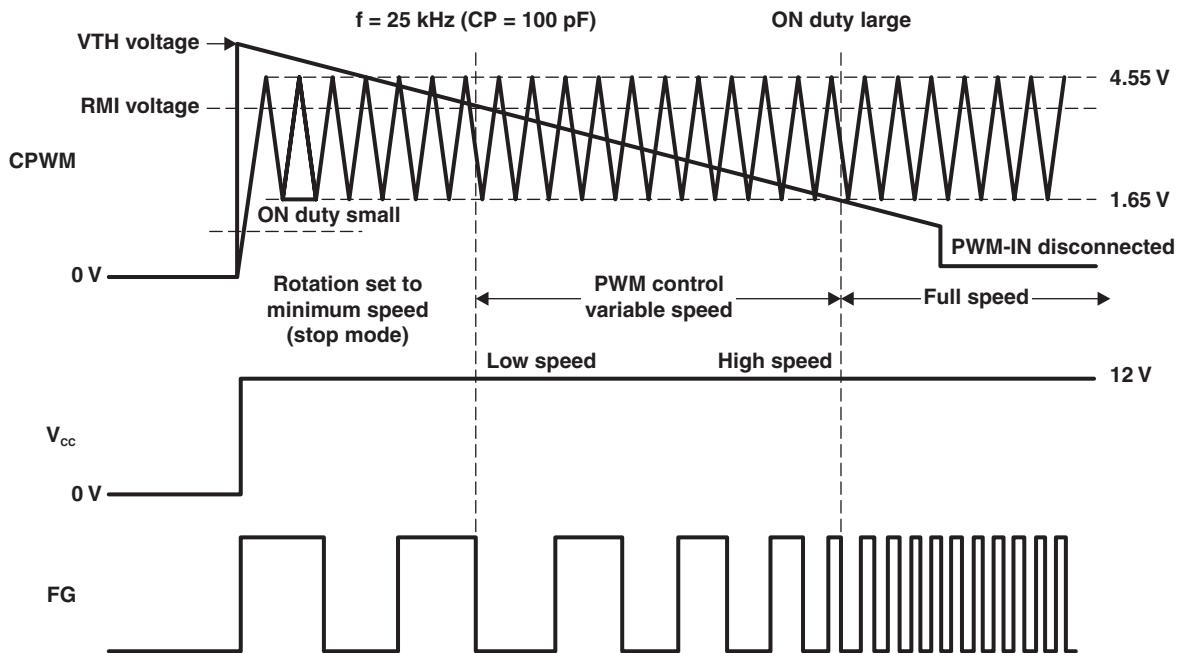## APPLICATION INFORMATION

Figure 1. 12-V Sample Application Circuit

A. Minimum speed setting (stop) mode

PWM-IN input is filtered to generate the VTH voltage. At low speed, the fan rotates with the minimum speed set with RMI during low speed. If the minimum speed is not set (RMI = 6VREG), the fan stops.

B. Low ↔ high speed mode

PWM control is made through comparison of oscillation and VTH voltages with CPWM changing between 1.6 V ↔ 4.6 V.

Upper and lower TRs are turned ON when the VTH voltage is higher. The upper output TR is turned OFF when the VTH voltage is lower, and the coil current is regenerated in the lower TR. Therefore, as the VTH voltage lowers, the output ON duty increases, increasing the coil current and raising the motor speed. The rotation speed is fed back by the FG output.

C. Full speed mode

The full-speed mode becomes effective with the VTH voltage of 1.65 V or less. (VTH must be equal to GND when the speed control is not used.)

D. PWM-IN input disconnection mode

When the PWM-IN input pin is disconnected, VTH becomes 1.65 V or less and the output enables full drive at 100%. The fan runs at full speed (see Figure 1).

Figure 2. Control Timing
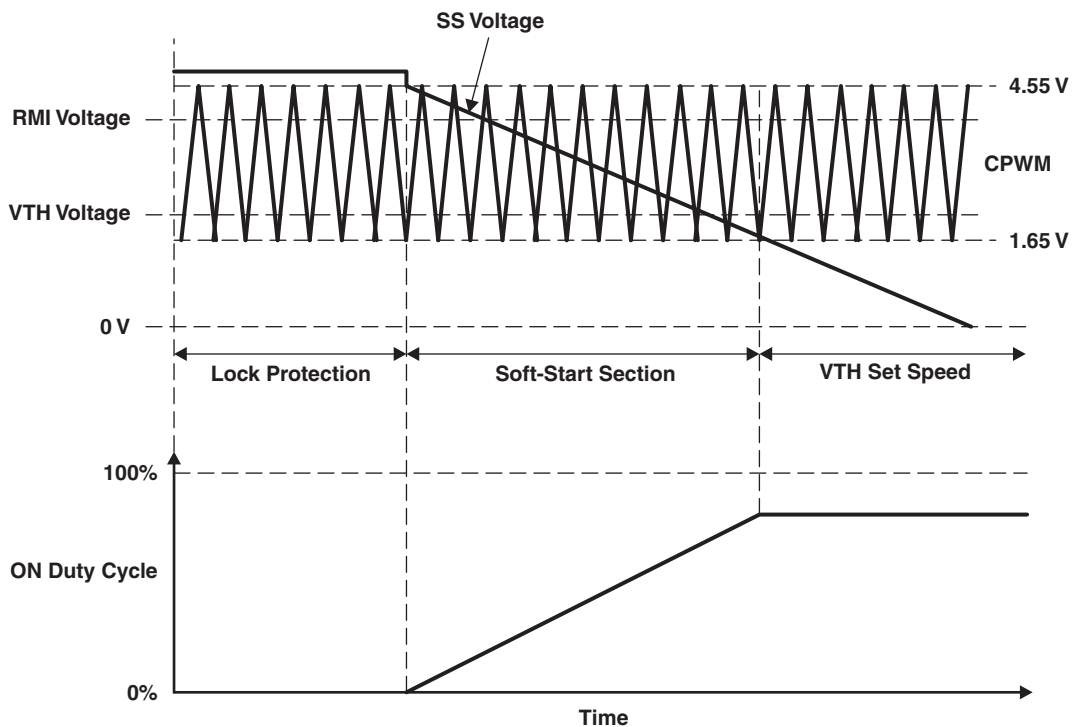
Figure 3. Soft-Start Control Timing (VTH < RMI Voltage)
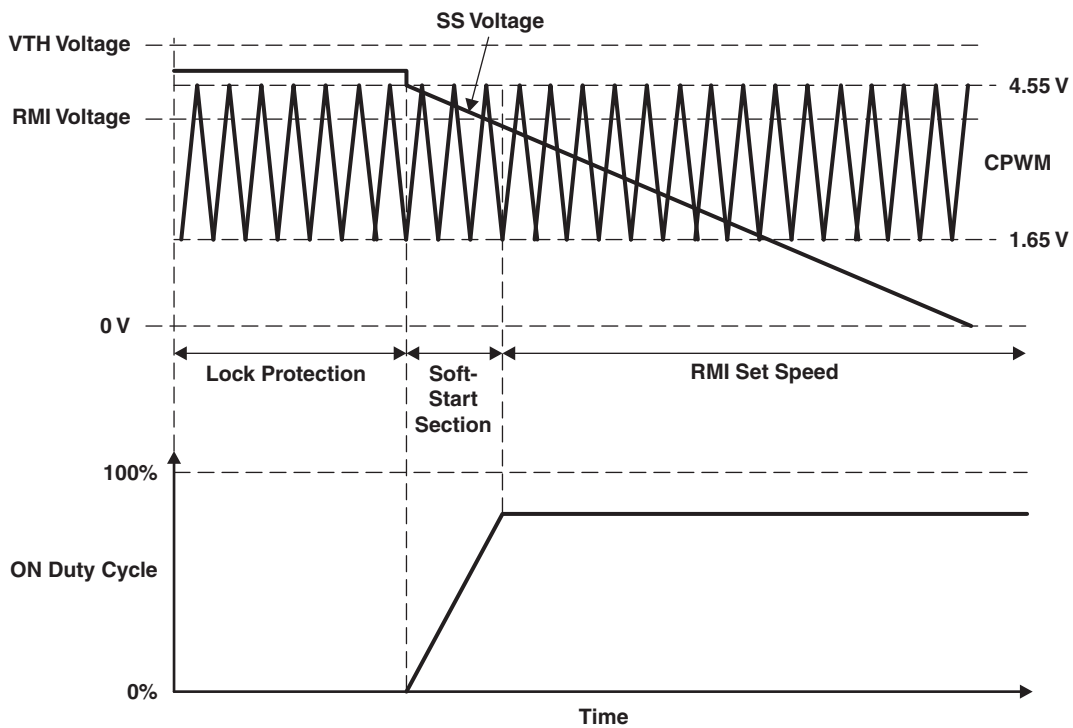
Figure 4. Soft-Start Control Timing (VTH > RMI Voltage)

![Texas Instruments] **PACKAGE MATERIALS INFORMATION**

TAPE AND REEL INFORMATION

REEL DIMENSIONS

TAPE DIMENSIONS

A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMP816PWR	TSSOP	PW	20	2000	330.0	16.4	6.95	7.1	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP816PWR	TSSOP	PW	20	2000	367.0	367.0	38.0

PW (R−PDSO−G20)   PLASTIC SMALL OUTLINE

0,65

0,30
0,19

⊕ | 0,10 Ⓜ

20   11

4,50
4,30

6,60
6,20

1   10

6,60
6,40

△C

0,15 NOM

Gage Plane

0,25

0°−8°

0,75
0,50

1,20 MAX

0,15
0,05

Seating Plane

0,10

△ | 0,10

4040064−5/G 02/11

NOTES: A.   All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M−1994.
         B.   This drawing is subject to change without notice.
         △C   Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall
              not exceed 0,15 each side.
         △D   Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
         E.   Falls within JEDEC MO−153

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PW (R−PDSO−G20)   PLASTIC SMALL OUTLINE

Example Board Layout

Based on a stencil thickness
of .127mm (.005inch).

18x0,65

20x0,25

1,55

5,6

5,6

18x0,65

Example
Non Soldermask Defined Pad

Example
Solder Mask Opening
(See Note F)

0,3

1,6

Pad Geometry

0,07
All Around

4211284−5/E 07/12
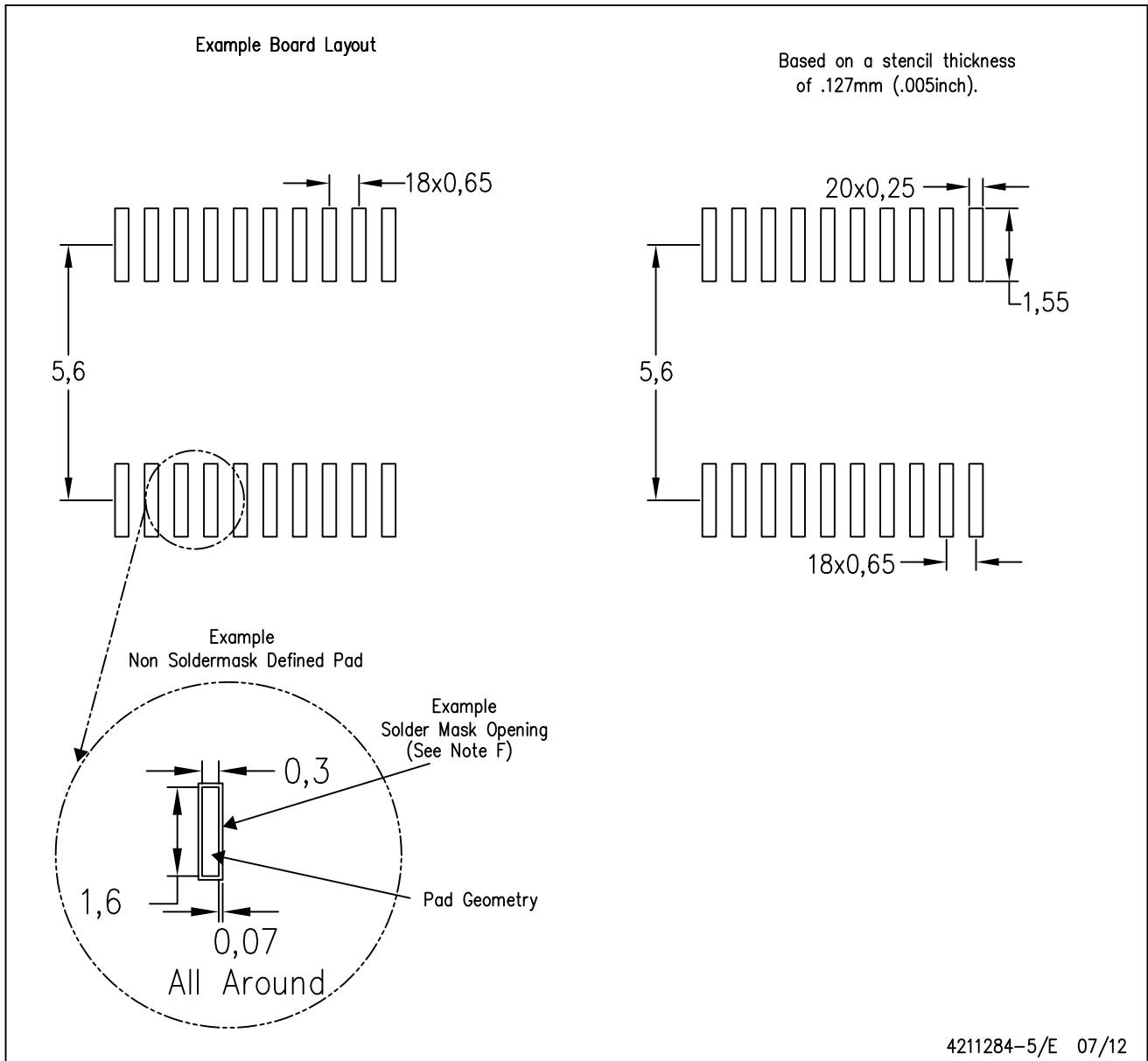
NOTES: A. All linear dimensions are in millimeters.
        B. This drawing is subject to change without notice.
        C. Publication IPC−7351 is recommended for alternate design.
        D. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should
           contact their board assembly site for stencil design recommendations. Refer to IPC−7525 for other stencil recommendations.
        E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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