

## POWER MANAGEMENT

### Description

The SC2646B controller provides a microprocessor core voltage regulation solution for up to 4 paralleled PWM channels. The solution can be configured in 2, 3, or 4-phase form. This multi-phase buck regulator utilizes phase-shift timing control to allow interleaved switching of the power switches. The product's architecture minimizes the core voltage ripple and the input current ripple, which leads to optimized voltage regulator design for power density, transient responses, and thermal performances.

To satisfy the highly dynamic nature of the modern microprocessors, the SC2646B adopts peak current mode control topology which ensures wide control loop bandwidth and fast transient responses. The current mode control provides intrinsic phase current matching. The maximum ripple frequency is greater than 2MHz.

One of the outstanding features of the SC2646B device is its voltage regulation accuracy. Not only does it provide 0.5% set point accuracy, but also the accuracy to be fully compliant with stringent load line slope specifications mandated by the modern microprocessors. Lossless output current sensing ensures the regulator output voltage is accurately positioned according to the load current condition.

Semtech's patented Combi-Sense™ topology is employed by SC2646B controller. The MOSFET  $R_{ds(on)}$  and the output inductor winding resistance is used to generate the phase current information. Semtech's SC1211 Combi-Sense™ MOSFET driver works with the SC2646B to enable a complete solution.

The cycle-by-cycle current limit plus the intelligent over current shut down provide the maximum versatility of the system without false tripping under all possible changes of VID and load conditions. The differential voltage feedback sense eliminates the error caused by high load current on the ground plane. External offset is easy to achieve for the VID settings. The enable function is also provided to interface with the corresponding system signal for correct start up timing and shut down timing.

### Features

- ◆ VRD/VRM10.X compliant
- ◆ Core Voltage Set Point Accuracy 0.5%
- ◆ Combi-Sense™ Current Mode Control
- ◆ Intrinsic Phase Current Matching
- ◆ Fast Transient Responses
- ◆ Active Droop to Meet Load Line Slope
- ◆ Enable Function for Power Sequencing
- ◆ Cycle-by-Cycle Peak Current Limit
- ◆ Intelligent Over Current Shut Down
- ◆ Over Voltage Protection When Using Semtech Combi-Sense™ Driver SC1211
- ◆ Under Voltage Protection Built in
- ◆ Externally Programmable Soft-Start
- ◆ Externally Programmable Switching Frequency
- ◆ 2, 3, or 4-Phase Configurations
- ◆ 24-Pin TSSOP Package

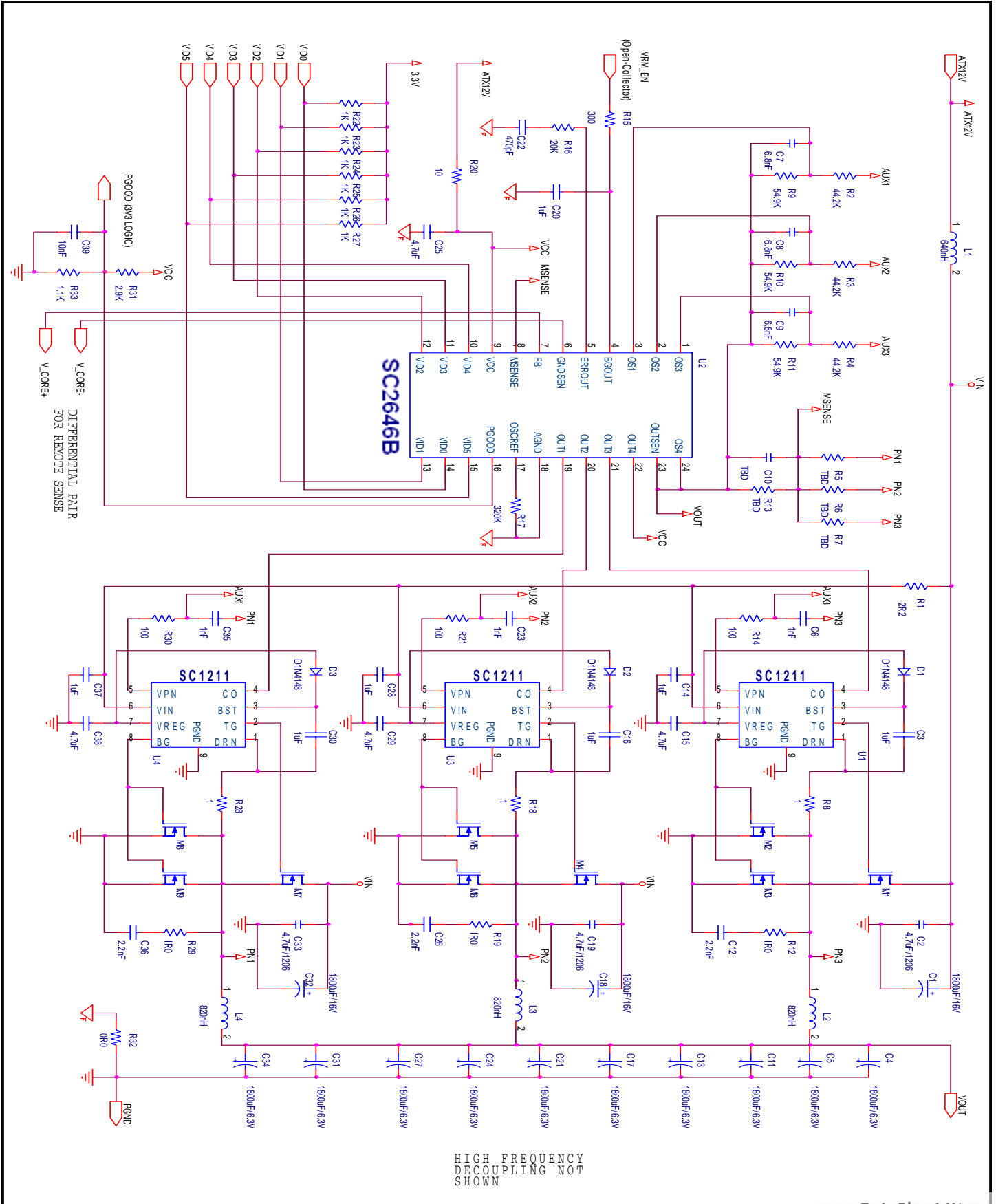
Combi-Sense™ is a Trademark of Semtech Corporation

### Applications

- ◆ Voltage Regulator VRD/VRM10.X
- ◆ Voltage Regulation Modules
- ◆ High Current, Low Voltage Step Down DC/DC Converters

## POWER MANAGEMENT

### Typical Application Circuit



**POWER MANAGEMENT**
**Absolute Maximum Ratings**

Exceeding the specifications below may result in permanent damage to the device, or device malfunction. Operation outside of the parameters specified in the Electrical Characteristics section is not implied.

Parameter	Symbol	Maximum	Units
Supply Voltage	$V_{CC}$	20	V
Combi-Sense/Direct Output Voltage	OS1, OS2, OS3, OS4, OUTSEN	5	V
Ambient Temperature Range	$T_A$	0 to 85	°C
Junction Temperature Range	$T_J$	0 to 125	°C
Storage Temperature Range	$T_{STG}$	-65 to +150	°C
Lead Temperature (Soldering) 10 Sec.	$T_{LEAD}$	260	°C

**Electrical Characteristics**

Unless specified:  $V_{CC} = 12V$ ,  $F_{OSC} = 600kHz$ , 4 phase operation,  $V_{OUT} = 1.28V$ ,  $T_A = 27^\circ C$ . See Typical Application Circuit. Specifications subject to change without notice.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Chip_Supply</b>						
IC Supply Voltage	$V_{CC}$		10	12	14	V
IC Supply Current	$I_{CC}$			5.4	8.0	mA
UVLO Ramp Up				6.3	7.0	V
UVLO Hysteresis			700	890		mV
<b>Reference Section</b>						
Bandgap Output	$V_{BGOUT}$	$C_{BGOUT} = 4.7nF$		1.5		V
Source Current			55	70	95	$\mu A$
Supply Rejection		$V_{CC} = 10.0V \sim 14.0V$		0.5		mV/V
Temperature Stability <sup>(1)</sup>		$0^\circ C < T_A < 85^\circ C$		0.5		%
Voltage Accuracy	$V_{OUT}$	Internal offset is -20mV	-0.5		+0.5	%
<b>Oscillator Section</b>						
Oscillator Frequency	$F_{OSC}$	$R_{OSC} = 320K$	540	600	660	kHz
Oscillator Frequency Range	$F_{OSC}$		500		3000	kHz
Temperature Stability <sup>(1)</sup>		$0^\circ C < T_A < 85^\circ C$		+/- 5		%
<b>Voltage Error Amplifier</b>						
Input Bias Current <sup>(1)</sup>				25		nA
Open Loop Gain <sup>(1)</sup>		$1V < V_{ERROUT} < 3.4V$		80		dB

**POWER MANAGEMENT**
**Electrical Characteristics (Cont.)**

 Unless specified:  $V_{CC} = 12V$ ,  $F_{OSC} = 600kHz$ , 4 phase operation,  $V_{OUT} = 1.28V$ ,  $T_A = 27^{\circ}C$ . See Typical Application Circuit. Specifications subject to change

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Unity Gain Bandwidth <sup>(1)</sup>	$G_{BW}$	$C_{ERR\,OUT} = 10pF$		5		MHz
Source Current		$V_{BG} > 1.8V$ , $V_{FB} = 0V$ , $V_{ERR\,OUT} = 0.8V$	60	80	90	$\mu A$
Sink Current		$V_{BG} > 1V$ , $V_{FB} = 2V$ , $V_{ERR\,OUT} = 2V$	-90	-80	-60	$\mu A$
Transconductance Gain	$G_M$		0.62	0.82	1.03	$mA/V$
<b>Current Sense Amplifiers</b>						
Input Offset Voltage	$V_{IO}$			+/-3		mV
Input Bias Current	$I_M$			50		nA
Gain	$G_{ca}$			12.45		V/V
CMRR <sup>(1)</sup>		0 to 3V		80		dB
Input Common Mode Range			-0.3		3	V
Gain Match				5	6	%
Bandwidth <sup>(1)</sup>				6		MHz
<b>Drop Amplifier</b>						
Gain	$A_{DRP}$	$V_{MSENSE} - V_{OUTSEN} = 20mV$	11.1	11.7	12.3	V/V
<b>VIDs</b>						
Logic High		[VID0:5]		0.8		V
Logic Low		[VID0:5]		0.4		V
Internal Pull-up Impedance <sup>(1)</sup>		[VID0:4]		26		Kohm
Internal Pull-up Voltage <sup>(1)</sup>		[VID0:4]		1.4		V
<b>3-Phase Operation</b>						
Output 4 pull up Threshold			3.88	4.0	4.5	V
<b>Power Good</b>						
Threshold Rising		VID - Power Good Threshold		100		mV
Threshold Falling		VID - Power Good Threshold		250		mV
Power Good Delay <sup>(1)</sup>		From Cross Rising Threshold	4.0	5	6.5	mS
Output High Leakage		$Pwrgood = V_{CC}$		60		nA
Output Voltage Low Level		Sink Current = 1mA		0.48	0.5	V
<b>Current Limit Section</b>						
Max. Error Amp Voltage for Current Limit	$V_{OC}$		3.45	3.63	3.81	V
Shutdown Voltage	$V_{SD}$	VID - Shut Down Threshold	180	210	280	mV

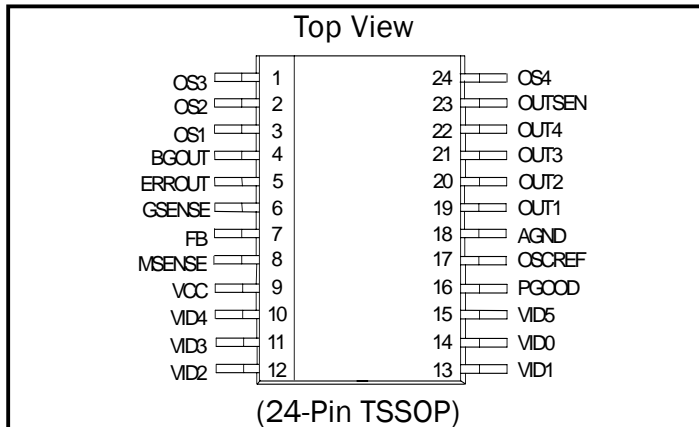
Note:

(1). Guaranteed by design, not tested in production.

(2). This device is ESD sensitive. Use of standard ESD handling precautions is required.

**POWER MANAGEMENT**

**Pin Configurations**



**Ordering Information**

Part Number	Package	Temp. Range (T <sub>j</sub> )
SC2646BTSTRT <sup>(1) (2)</sup>	TSSOP-24	0 to 125 °C
SC2646BEVB	Embedded Evaluation Board	

**Note:**

(1) Only available in tape and reel packaging. A reel contains 2500 devices for the TSSOP-24 package.

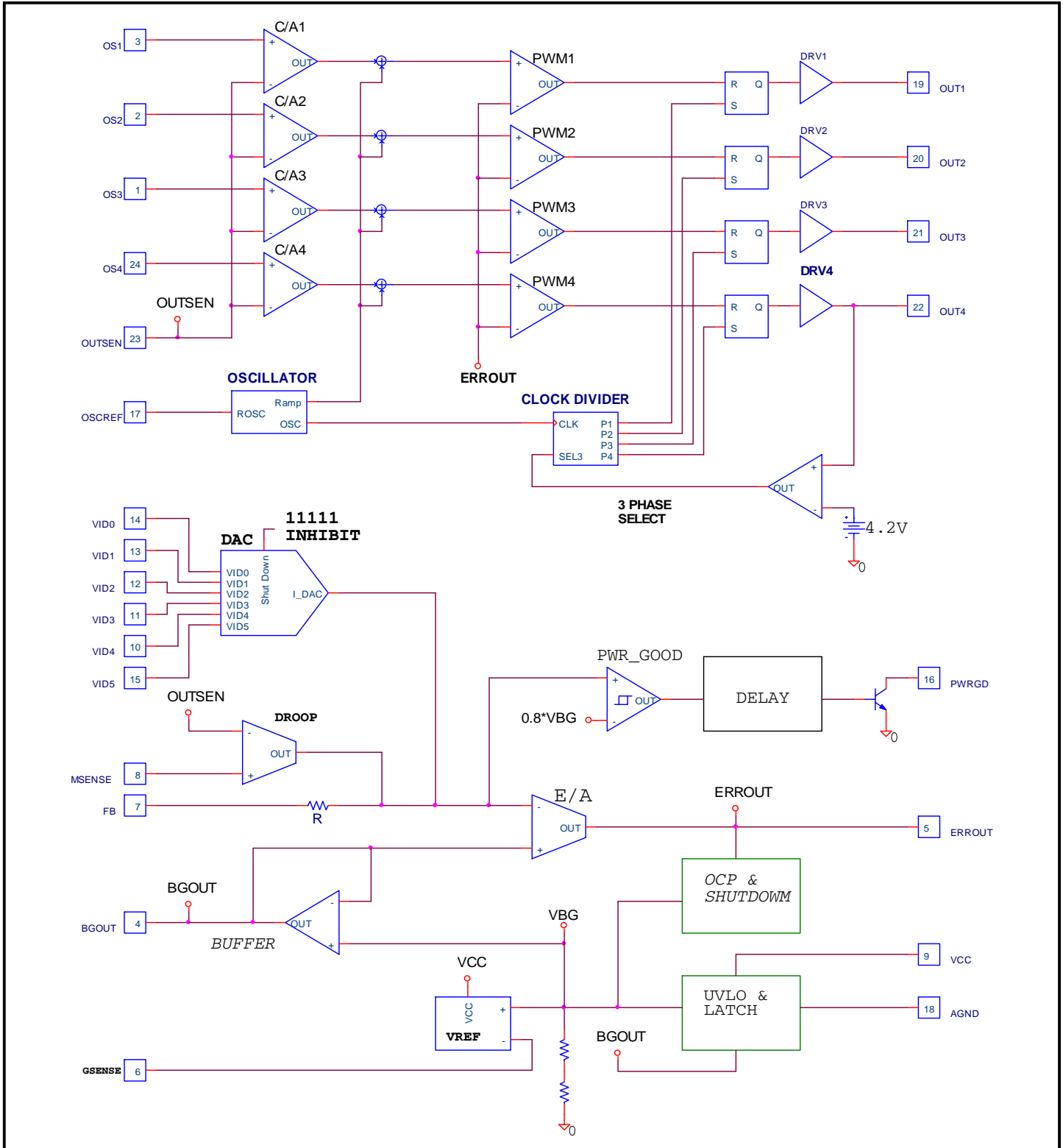
(2) Lead free package. Device is fully WEEE and RoHS compliant.

**Pin Descriptions**

Pin#	Pin Name	Pin Function
1	OS3	Current sense input
2	OS2	Current sense input. Connect to OUTSEN for 2 phase operation.
3	OS1	Current sense input
4	BGOUT	Bandgap reference voltage. Connect soft start cap to AGND.
5	ERROUT	Error-amplifier output. Connect compensation network to AGND.
6	GSENSE	Remote sense for GND.
7	FB	Feedback pin. Route FB and Gsense as differential pair to CPU sense point.
8	MSENSE	Voltage regulator module output current sense.
9	VCC	Power supply for chip.
10	VID[4:0]	VID MSB to LSB.
15	VID5	12.5mV bit.
16	PGOOD	Power good. Open collector output.
17	OSCREF	Oscillator frequency setting. Connect a resistor to AGND.
18	AGND	Clean ground for analog signals.
19	OUT1	PWM output1.
20	OUT2	PWM output2.
21	OUT3	PWM output3.
22	OUT4	PWM output4. Connect to VCC for 3 phase operation.
23	OUTSEN	Direct output sense.
24	OS4	Current sense input. Connect to OUTSEN for 2 or 3 phase operation.

POWER MANAGEMENT

Block Diagram



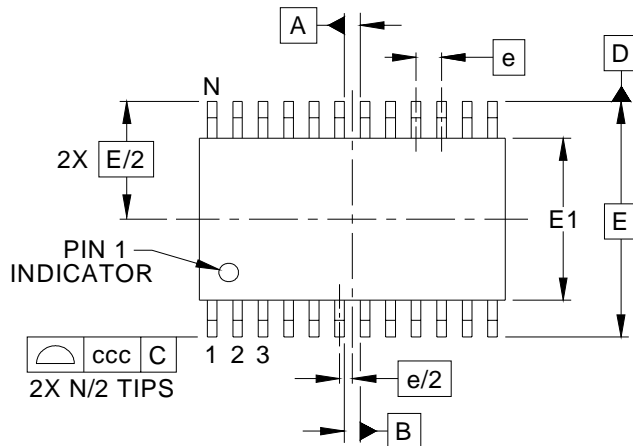
**POWER MANAGEMENT**

**Applications Information- Output Voltage**

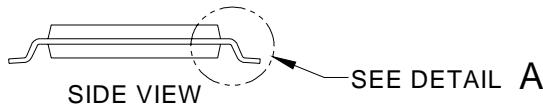
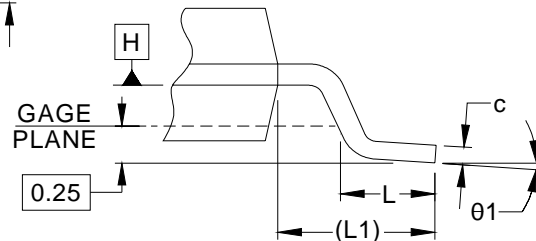
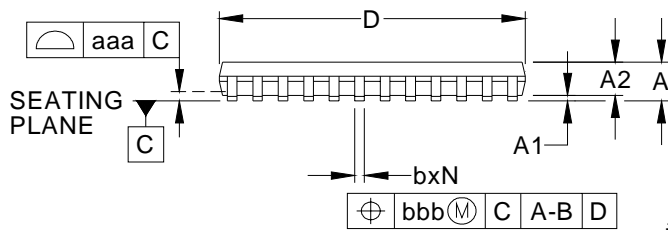
VRD10 Output Voltage							Vout (V)
Unless specified: 0 = GND; 1 = High. T <sub>A</sub> = 25°C, V <sub>CC</sub> = 12V							
VID5	VID4	VID3	VID2	VID1	VID0		
0	0	1	0	1	0	0.8375	
1	0	1	0	0	1	0.8500	
0	0	1	0	0	1	0.8625	
1	0	1	0	0	0	0.8750	
0	0	1	0	0	0	0.8875	
1	0	0	1	1	1	0.9000	
0	0	0	1	1	1	0.9125	
1	0	0	1	1	0	0.9250	
0	0	0	1	1	0	0.9375	
1	0	0	1	0	1	0.9500	
0	0	0	1	0	1	0.9625	
1	0	0	1	0	0	0.9750	
0	0	0	1	0	0	0.9875	
1	0	0	0	1	1	1.0000	
0	0	0	0	1	1	1.0125	
1	0	0	0	1	0	1.0250	
0	0	0	0	1	0	1.0375	
1	0	0	0	0	1	1.0500	
0	0	0	0	0	1	1.0625	
1	0	0	0	0	0	1.0750	
0	0	0	0	0	0	1.0875	
1	1	1	1	1	1	OFF	
0	1	1	1	1	1	OFF	
1	1	1	1	1	0	1.1000	
0	1	1	1	1	0	1.1125	
1	1	1	1	0	1	1.1250	
0	1	1	1	0	1	1.1375	
1	1	1	1	0	0	1.1500	
0	1	1	1	0	0	1.1625	
1	1	1	0	1	1	1.1750	
0	1	1	0	1	1	1.1875	
1	1	1	0	1	0	1.2000	
0	1	1	0	1	0	1.2125	
1	1	1	0	0	1	1.2250	
0	1	1	0	0	1	1.2375	
1	1	1	0	0	0	1.2500	
0	1	1	0	0	0	1.2625	
1	1	0	1	1	1	1.2750	
0	1	0	1	1	1	1.2875	
1	1	0	1	1	0	1.3000	
0	1	0	1	1	0	1.3125	
1	1	0	1	0	1	1.3250	
0	1	0	1	0	1	1.3375	
1	1	0	1	0	0	1.3500	
0	1	0	1	0	0	1.3625	
1	1	0	0	1	1	1.3750	
0	1	0	0	1	1	1.3875	
1	1	0	0	1	0	1.4000	
0	1	0	0	1	0	1.4125	
1	1	0	0	0	1	1.4250	
0	1	0	0	0	1	1.4375	
1	1	0	0	0	0	1.4500	
0	1	0	0	0	0	1.4625	
1	0	1	1	1	1	1.4750	
0	0	1	1	1	1	1.4875	
1	0	1	1	1	0	1.5000	
0	0	1	1	1	0	1.5125	
1	0	1	1	0	1	1.5250	
0	0	1	1	0	1	1.5375	
1	0	1	1	0	0	1.5500	
0	0	1	1	0	0	1.5625	
1	0	1	0	1	1	1.5750	
0	0	1	0	1	1	1.5875	
1	0	1	0	1	0	1.6000	

POWER MANAGEMENT

Outline Drawing - TSSOP-24



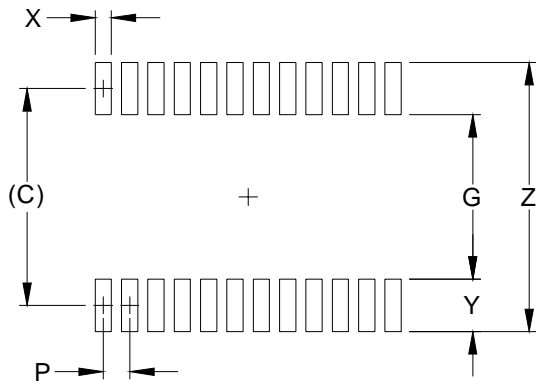
DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	.047	-	-	1.20
A1	.002	-	.006	0.05	-	0.15
A2	.031	-	.042	0.80	-	1.05
b	.007	-	.012	0.19	-	0.30
c	.003	-	.007	0.09	-	0.20
D	.303	.307	.311	7.70	7.80	7.90
E1	.169	.173	.177	4.30	4.40	4.50
E	.252 BSC			6.40 BSC		
e	.026 BSC			0.65 BSC		
L	.018	.024	.030	0.45	0.60	0.75
L1	(.039)			(1.0)		
N	24			24		
θ1	0	-	8	0	-	8
aaa	.004			0.10		
bbb	.004			0.10		
ccc	.008			0.20		



NOTES:

1. CONTROLLING DIMENSIONS ARE IN MILLIMETERS (ANGLES IN DEGREES).
2. DATUMS **-A-** AND **-B-** TO BE DETERMINED AT DATUM PLANE **-H-**
3. DIMENSIONS "E1" AND "D" DO NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS.
4. REFERENCE JEDEC STD MO-153, VARIATION AD.



**POWER MANAGEMENT**
**Land Pattern - TSSOP-24**


DIMENSIONS		
DIM	INCHES	MILLIMETERS
C	(.222)	(5.65)
G	.161	4.10
P	.026	0.65
X	.016	0.40
Y	.061	1.55
Z	.283	7.20

**NOTES:**

1. THIS LAND PATTERN IS FOR REFERENCE PURPOSES ONLY. CONSULT YOUR MANUFACTURING GROUP TO ENSURE YOUR COMPANY'S MANUFACTURING GUIDELINES ARE MET.

**Contact Information**

Semtech Corporation  
 Power Management Products Division  
 200 Flynn Rd., Camarillo, CA 93012  
 Phone: (805)498-2111 FAX (805)498-3804