

**POWER MANAGEMENT****Description**

The SC2643VX provides a solution for microprocessor core voltage regulation with up to 4 paralleled PWM channels. The solution can also be configured as 2, 3, or 4-phase form. This multi-phase buck regulator utilizes the phase-shift timing control to allow interleaved switching of the power switches. This architecture minimizes the core voltage ripple and the input current ripple, which leads to optimized voltage regulator design for power density, transient responses, and the thermal performances.

To satisfy the highly dynamic nature of the modern microprocessors, the SC2643VX 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 2.8MHz.

One of the outstanding features of the SC2643VX is its voltage regulation accuracy. Not only does it provide better than 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, and an internal temperature compensation technology further enhances the performance of voltage accuracy.

The patented Combi-Sense™ topology is employed by SC2643VX. The MOSFET  $R_{ds(on)}$  and the output inductor winding resistance are used to generate the phase current information. The Combi-Sense™ MOSFET driver plus the SC2643VX enables the complete solution.

The SC2643VX is a multi-platform controller. It conforms to Intel VRM/VRD10.X, VRM9.X, and AMD K-8 (Opteron™) VID specifications. With very minor changes of the schematic and the layout, the SC2643VX based solution can be ported from one platform to another. This greatly benefits system manufactures by reducing design cycle times and streamlining inventory management.

The SC2643VX supports VID-on-Fly applications for any platform. 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 any platforms and 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.

**(Multiple Patents Pending)****Features**

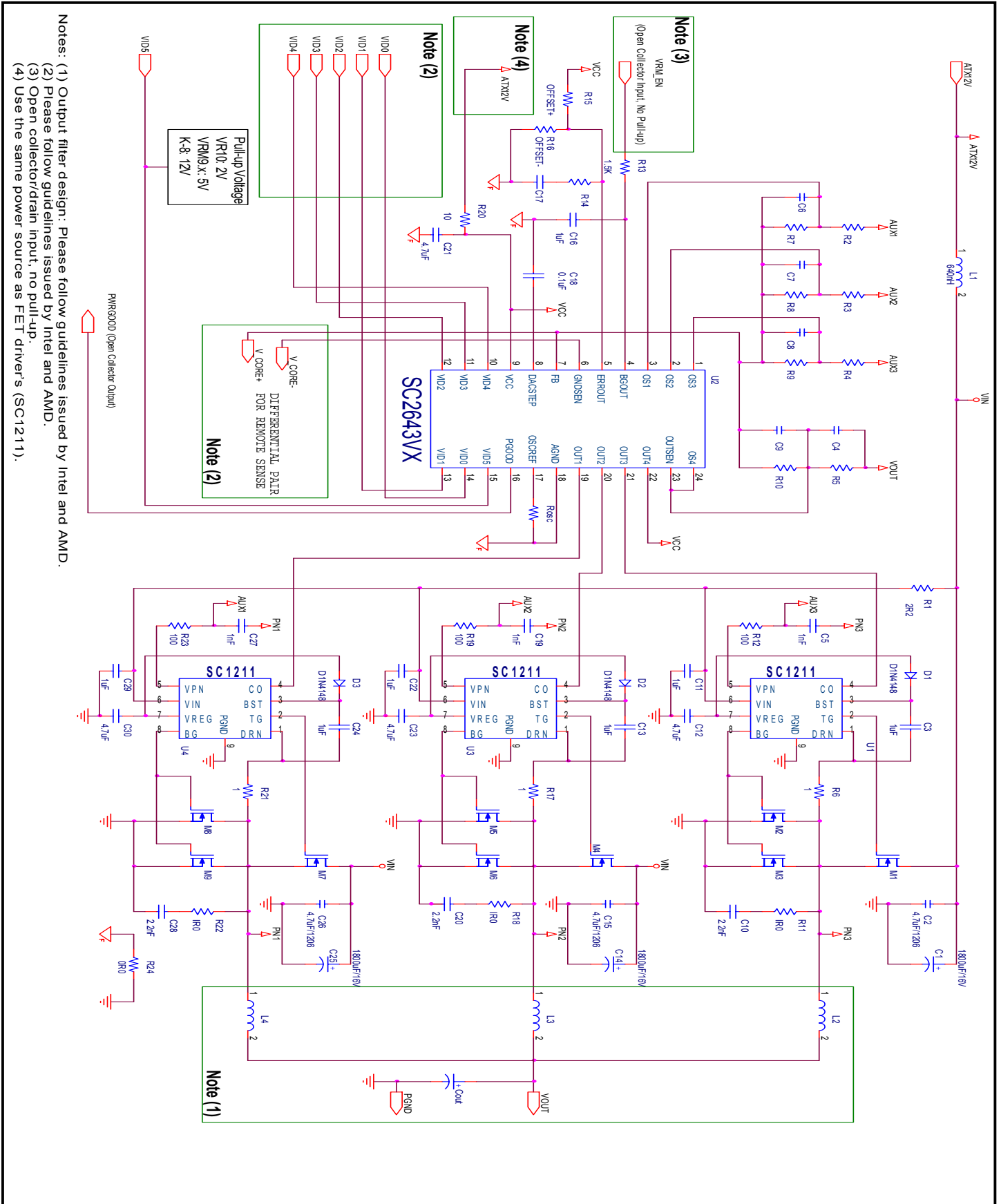
- ◆ VRD/VRM10.X, VRM9.X, and K-8 compliant
- ◆ Core Voltage Set Point Accuracy 0.5%
- ◆ Combi-Sense™ Current Mode Control
- ◆ Intrinsic Phase Current Matching
- ◆ Fast Transient Responses
- ◆ Active Droop with Temperature Compensation to Meet Load Line Slope
- ◆ Support VID-on-Fly with 5 or 6 bit VID
- ◆ 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
- ◆ Under Voltage Protection Built in
- ◆ External programmable Soft-Start
- ◆ Externally programmable switching frequency (up to 2.8MHz output voltage ripple frequency)
- ◆ 2, 3, or 4-Phase Configurations

**Applications**

- ◆ Voltage Regulator VRD/VRM10.X
- ◆ Voltage Regulator VRM9.X
- ◆ Voltage Regulator K-8
- ◆ 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. Unless otherwise specified, all other voltages are referenced to AGND.

Parameter	Symbol	Maximum	Units
V <sub>CC</sub> Supply Voltage	V <sub>CC</sub>	-0.3 to 20	V
Combi-Sense/Direct Output Voltage	OS1, OS2, OS3, OS4, OUTSEN	5	V
VID Pins Except VID5	VID0 ~ VID4	7	V
VID5	VID5	-0.3 to V <sub>CC</sub> +0.3	V
Oscillator Frequency Setting and OUT Pins	OUT1, OUT2, OUT3, OSCREF	7	V
Ground Sense	GSENSE	-0.3 to +0.3	V
All Other Pins	OUT4, FB, DACSTEP	-0.3 to V <sub>CC</sub> +0.3	V
Thermal Resistance of Junction to Case	θ <sub>JC</sub>	15.6	°C/W
Ambient Temperature Range	T <sub>A</sub>	0 to 105	°C
Junction Temperature Range	T <sub>J</sub>	0 to 125	°C
Storage Temperature Range	T <sub>STG</sub>	-65 to 150	°C
Lead Temperature (Soldering) 10 Sec.	T <sub>LEAD</sub>	260	°C

**Electrical Characteristics**

Unless specified: V<sub>CC</sub> = 12V, VID=1.30V (110110,VRD10) or 1.50V (101110,VRD10), F<sub>OSC</sub> = 600kHz, T<sub>A</sub> = 27°C. See Typical Application Circuit.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Chip_Supply</b>						
IC Supply Voltage	V <sub>CC</sub>		7.5	12	14	V
IC Supply Current	I <sub>CC</sub>			10	13	mA
UVLO Ramp Up	UVLO	Vcc Rising		7.3	7.5	V
UVLO Ramp Down	UVLO	Vcc Falling	6.4	6.5		V
<b>Reference Section</b>						
Bandgap Output	V <sub>BGOUT</sub>	C <sub>BGOUT</sub> = 4.7nF	2.945	2.990	3.035	V
Source Current			220	300	330	μA
Supply Rejection		V <sub>CC</sub> = 10.0V ~ 14.0V		0.5		mV/V
Temperature Stability		0°C < T <sub>A</sub> < 85°C		0.5		%
VID Step		VRM9.X, K-8, LSB		25		mV
VID Step		VRD/VRM10, LSB		12.5		mV
Voltage Accuracy	V <sub>OUT</sub>	VRD10 ; Internal offset=-20mV	-0.5		+0.5	%
		VRM9.x ; Internal offset=-20mV	-1		+1	%
		K-8 ; Internal offset=+25mV	-1		+1	%

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

Unless specified:  $V_{CC} = 1.2V$ ,  $V_{ID} = 1.30V$  (110110,VRD10) or  $1.50V$  (101110,VRD10),  $F_{osc} = 600kHz$ ,  $T_A = 27^\circ C$ . See Typical Application Circuit.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Voltage Error Amplifier</b>						
Input Offset Voltage				±3		mV
Input Bias Current				25		nA
Open Loop Gain		$1V < V_{ERR\,OUT} < 4V$		80		dB
Unity Gain Bandwidth		$C_{ERR\,OUT} = 10pF$		10		MHz
Slew Rate				10		V/μs
Transconductance Gain	$G_{EA}$			0.5		mA/V
Clamp Level for OCP	$V_{eoMAX}$			4.4		V
Clamp Level Accuracy			-8		+8	%
<b>Current Sense Amplifiers</b>						
Input Offset Voltage				±3		mV
Input Bias Current				50		nA
Gain	$G_{CA}$			10		V/V
CMRR		0 to 3V		80		dB
Input Common Mode Range			-0.3		3	V
Gain Match				2		%
Bandwidth				6		MHz
<b>Power Good</b>						
Threshold for Vcore Rising		VID - Power Good Threshold	250	350	400	mV
Threshold for Vcore Falling		VID - Power Good Threshold		575		mV
Output High Leakage		$Pwrgood = V_{CC}$		100		nA
Output Low Sink		$Pwrgood = 0.8V$	2			mA
<b>VIDs</b>						
Input Low Voltage Threshold		[VID0:5]			1.2	V
Input High Voltage Threshold		[VID0:5]	1.8			
Bias Current		[VID0:4]=0V	120	185	250	μA
VID5 Pull-up Voltage for VRD/VRM10		VID5	1.8		2.5	V
VID5 Pull-up voltage for VRM9.X		VID5	4		6	V
VID5 Pull-up voltage for K-8		VID5	8		Vcc	V

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

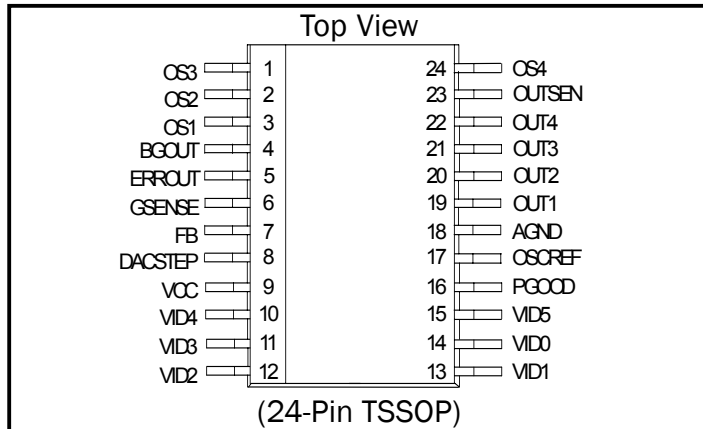
Unless specified:  $V_{CC} = 12V$ , VID=1.30V (110110,VRD10) or 1.50V (101110,VRD10),  $F_{OSC} = 600kHz$ ,  $T_A = 27^{\circ}C$ . See Typical Application Circuit.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
<b>Oscillator Section</b>						
Oscillator Frequency	$F_{OSC}$	$R_{OSC} = 309K$	540	600	660	kHz
Oscillator Frequency Range	$F_{OSC}$		330		2800	kHz
Temperature Stability		$0^{\circ}C < T_A < 85^{\circ}C$		$\pm 5$		%
<b>3-Phase Operation</b>						
Output 4 pull up Threshold		For 3-phase operation	3.5	4	4.5	V
<b>Droop Amplifier</b>						
Gain	$G_{DA}$			5.4		V/V
Gain Accuracy <sup>(1)</sup>				$\pm 5$		%
<b>Current Limit Section</b>						
Shutdown Voltage		VID - Shut Down Threshold	550	650	750	mV
<b>Dynamic VID Section</b>						
Sinking Current of DACSTEP	$I_{DAC\_SINK}$			390		$\mu A$
Sourcing Current of DACSTEP	$I_{DAC\_SRC}$			340		$\mu A$

NOTES: 1) Guaranteed by design, not tested in production.  
Specifications subject to change without notice.

## POWER MANAGEMENT

### Pin Configurations



### Ordering Information

Part Number	Package	Temp. Range (T <sub>j</sub> )
SC2643VXTSTR <sup>(1)</sup>	TSSOP-24	0 to 125 °C
SC2643VXTSTRT <sup>(1)(2)</sup>	TSSOP-24	0 to 125 °C
SC2643VXEVB	Evaluation Board	

**Note:**

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

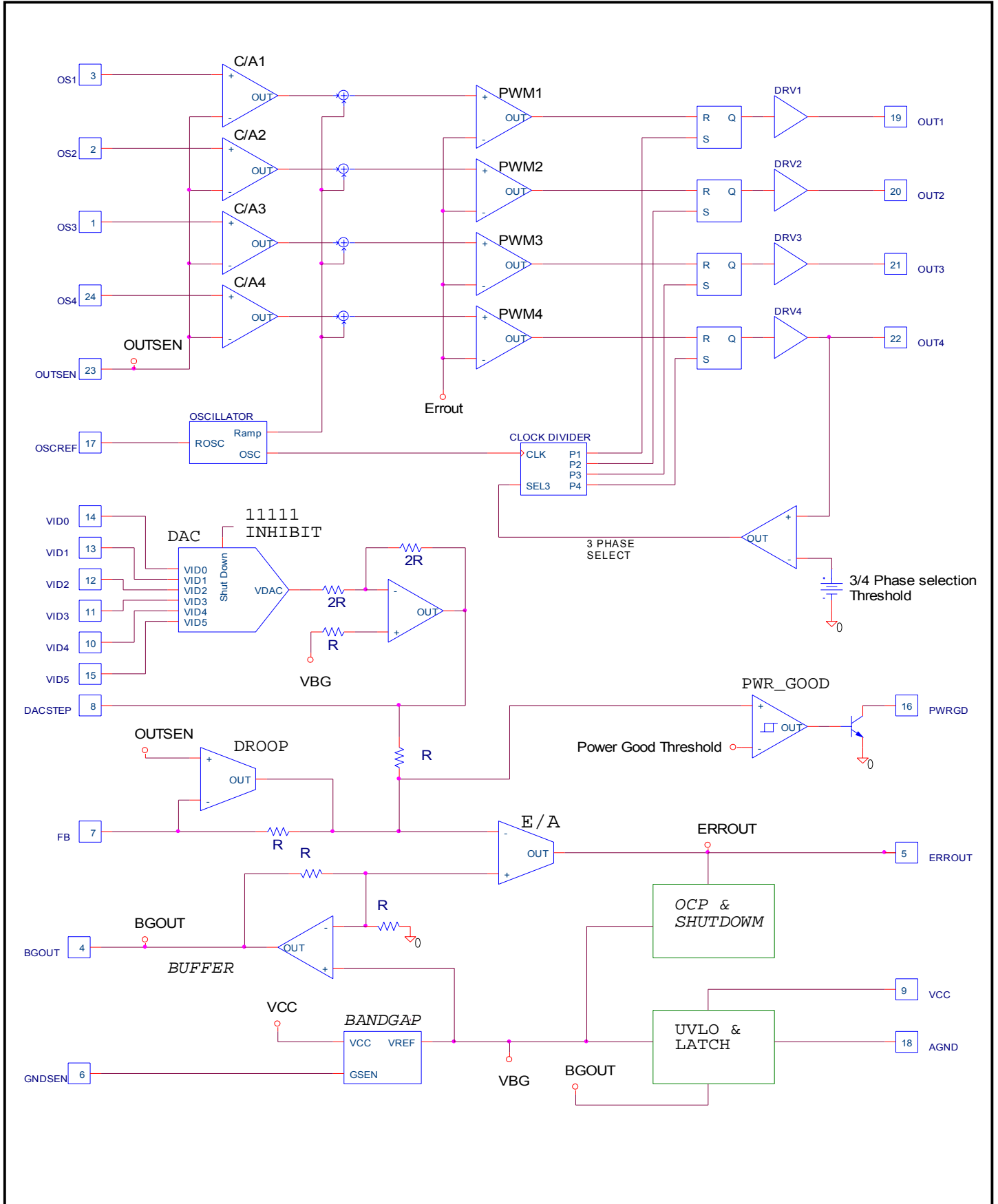
(2) Lead free package. Device is fully WEEE and RoHS compliant.

### Pin Descriptions

Pin#	Pin Name	Pin Function
1	OS3	Combi-SenseCurrent 3.
2	OS2	Combi-Sense Current 2. Connect to OUTSEN for 2 phase operation
3	OS1	Combi-Sense Current 1.
4	BGOUT	BG reference pin.
5	ERROUT	Error-amplifier output.
6	GSENSE	Remote sense for GND.
7	FB	Feedback pin.
8	DACSTEP	VID step speed.
9	VCC	Power supply for chip.
10	VID4	VID MSB.
11	VID3	
12	VID2	
13	VID1	
14	VID0	VID LSB.
15	VID5	VID 1/2 LSB / VID type select. VID5 pull-up to VCC for K-8; VID5 pull-up to 5V for VRM9.X.
16	PGOOD	Power good.
17	OSCREF	Oscillator frequency setting.
18	AGND	Clean ground for analog.
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	Combi-Sense Current 4. Connect to OUTSEN for 2 or 3 phase operation.

POWER MANAGEMENT

Block Diagram



**POWER MANAGEMENT**
**Applications Information- Output Voltage**

VRM9.X Output Voltage					
Unless specified: 0 = GND; 1 = High (or Floating). T <sub>A</sub> = 25°C, V <sub>CC</sub> = 12V					
VID4	VID3	VID2	VID1	VID0	Vout (V)
1	1	1	1	1	OFF
1	1	1	1	0	1.1
1	1	1	0	1	1.125
1	1	1	0	0	1.15
1	1	0	1	1	1.175
1	1	0	1	0	1.2
1	1	0	0	1	1.225
1	1	0	0	0	1.25
1	0	1	1	1	1.275
1	0	1	1	0	1.3
1	0	1	0	1	1.325
1	0	1	0	0	1.35
1	0	0	1	1	1.375
1	0	0	1	0	1.4
1	0	0	0	1	1.425
1	0	0	0	0	1.45
0	1	1	1	1	1.475
0	1	1	1	0	1.5
0	1	1	0	1	1.525
0	1	1	0	0	1.55
0	1	0	1	1	1.575
0	1	0	1	0	1.6
0	1	0	0	1	1.625
0	1	0	0	0	1.65
0	0	1	1	1	1.675
0	0	1	1	0	1.7
0	0	1	0	1	1.725
0	0	1	0	0	1.75
0	0	0	1	1	1.775
0	0	0	1	0	1.8
0	0	0	0	1	1.825
0	0	0	0	0	1.85



**POWER MANAGEMENT**

**Applications Information- Output Voltage**

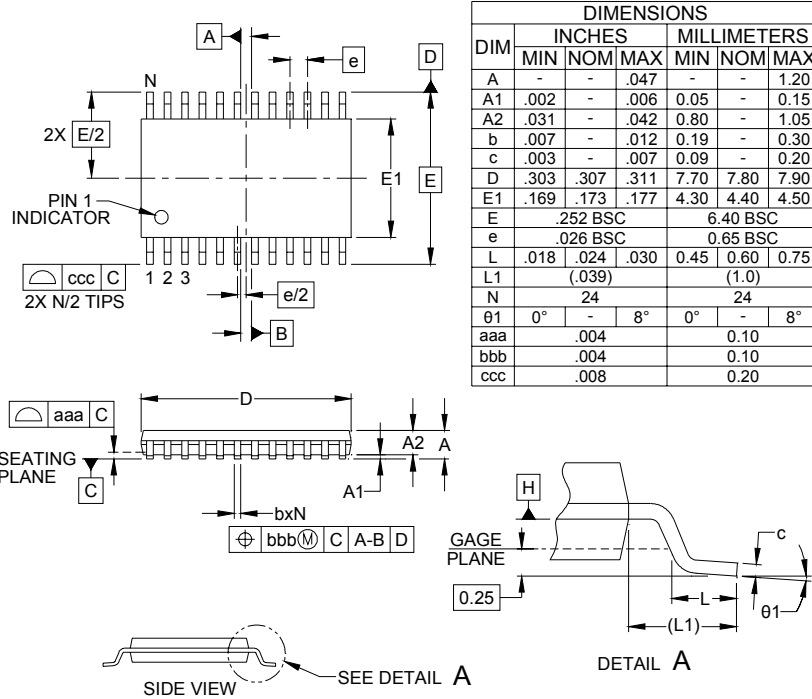
VRD10 Output Voltage							Vout (V)
Unless specified: 0 = GND; 1 = High. T <sub>A</sub> = 25°C, V <sub>CC</sub> = 12V							
VID5	VID4	VID3	VID2	VID1	VID0		
0	0	1	0	1	0	0.8375	
1	0	1	0	0	1	0.8500	
0	0	1	0	0	0	0.8625	
1	0	1	0	0	0	0.8750	
0	0	1	0	0	0	0.8875	
1	0	0	1	1	1	0.9000	
0	0	0	1	1	1	0.9125	
1	0	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	1	1	1.1250	
0	1	1	1	1	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**
**Applications Information- Output Voltage**

K-8 Output Voltage					
Unless specified: 0 = GND; 1 = High (or Floating). T <sub>A</sub> = 25°C, V <sub>CC</sub> = 12V					
VID4	VID3	VID2	VID1	VID0	V <sub>OUT</sub> (V)
0	0	0	0	0	1.550
0	0	0	0	1	1.525
0	0	0	1	0	1.500
0	0	0	1	1	1.475
0	0	1	0	0	1.450
0	0	1	0	1	1.425
0	0	1	1	0	1.400
0	0	1	1	1	1.375
0	1	0	0	0	1.350
0	1	0	0	1	1.325
0	1	0	1	0	1.300
0	1	0	1	1	1.275
0	1	1	0	0	1.250
0	1	1	0	1	1.225
0	1	1	1	0	1.200
0	1	1	1	1	1.175
1	0	0	0	0	1.150
1	0	0	0	1	1.125
1	0	0	1	0	1.100
1	0	0	1	1	1.075
1	0	1	0	0	1.050
1	0	1	0	1	1.025
1	0	1	1	0	1.000
1	0	1	1	1	0.975
1	1	0	0	0	0.950
1	1	0	0	1	0.925
1	1	0	1	0	0.900
1	1	0	1	1	0.875
1	1	1	0	0	0.850
1	1	1	0	1	0.825
1	1	1	1	0	0.800
1	1	1	1	1	OFF

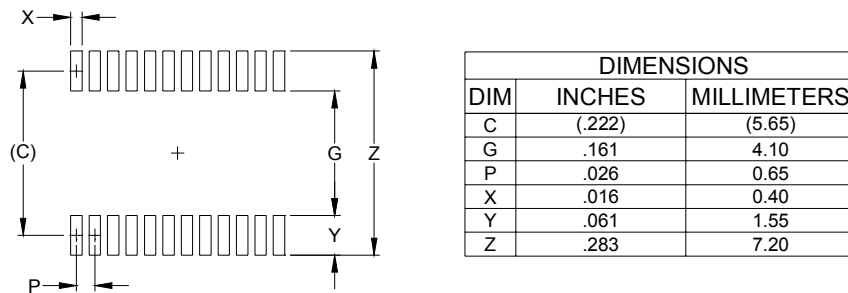
POWER MANAGEMENT

Outline Drawing - TSSOP-24



- 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.

Land Pattern - TSSOP-24



- 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