SC2643VX
Multi-Platform
Multi-Phase PWM Controller

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 form 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

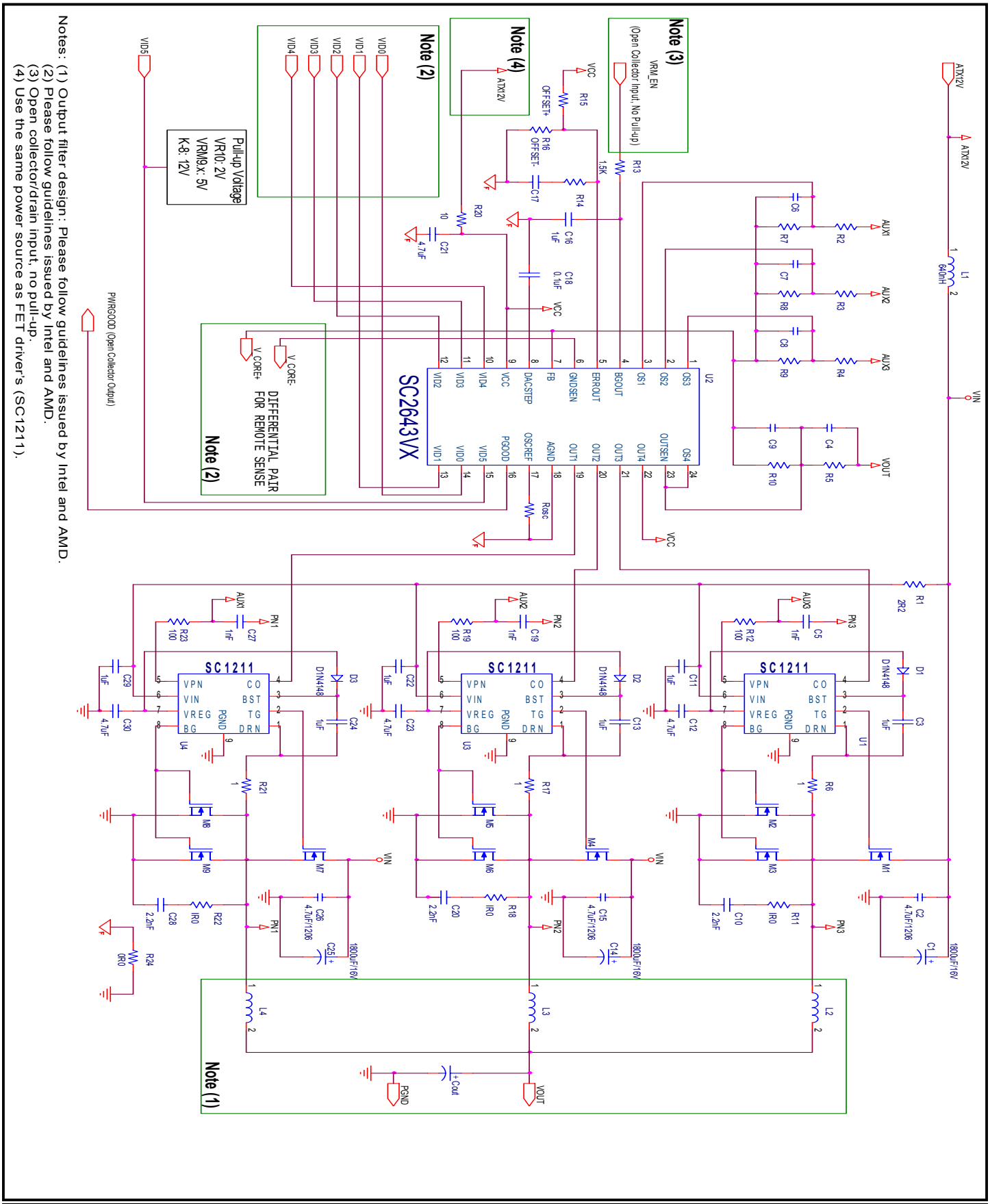
- VRD/VRM10.X, VRM9.X, and K-8 compliant
- Core Voltage Set Point Accuracy 0.5%
- Combi-Sense™ Current Mode Control
- Intrinsic Phase Current Matching
- Fast Transient Responses
- Active Droop with Temperature Compensation to Meet Load Line Slope
- Support VID-on-Fly with 5 or 6 bit VID
- Enable Function 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



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_{CC} Supply Voltage	V_{CC}	-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_{CC}+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_{CC}+0.3	V
Thermal Resistance of Junction to Case	θ_{JC}	15.6	°C/W
Ambient Temperature Range	T_A	0 to 105	°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, VID=1.30V (110110,VRD10) or 1.50V (101110,VRD10), F_{OSC} = 600kHz, T_A = 27°C. See Typical Application Circuit.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Chip_Supply						
IC Supply Voltage	V_{CC}		7.5	12	14	V
IC Supply Current	I_{CC}			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
Reference Section						
Bandgap Output	V_{BGOUT}	C_{BGOUT} = 4.7nF	2.945	2.990	3.035	V
Source Current			220	300	330	µA
Supply Rejection		V_{CC} = 10.0V ~ 14.0V		0.5		mV/V
Temperature Stability		0°C < T_A < 85°C		0.5		%
VID Step		VRM9.X, K-8, LSB		25		mV
VID Step		VRD/VRM10, LSB		12.5		mV
Voltage Accuracy	V_{OUT}	VRD10 ; Internal offset=-20mV	-0.5		+0.5	%
		VRM9.x ; Internal offset=-20mV	-1		+1	%
		K-8 ; Internal offset=+25mV	-1		+1	%

Electrical Characteristics (Cont.)

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

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Voltage Error Amplifier						
Input Offset Voltage				±3		mV
Input Bias Current				25		nA
Open Loop Gain		1V < V_{ERROUT} < 4V		80		dB
Unity Gain Bandwidth		C_{ERROUT} = 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	%
Current Sense Amplifiers						
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
Power Good						
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
VIDs						
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

Electrical Characteristics (Cont.)

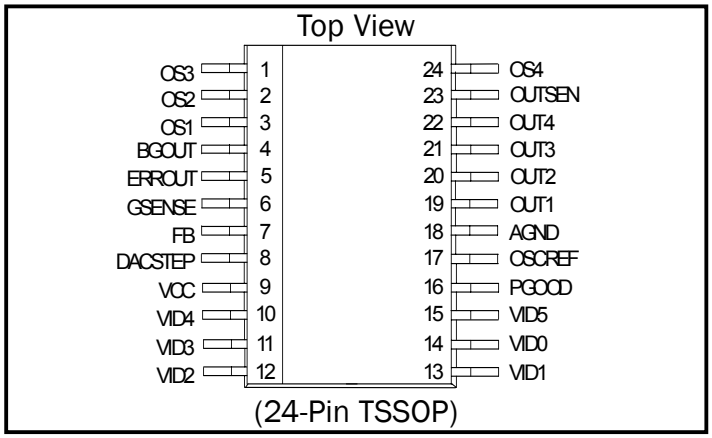
Unless specified: V_{CC} = 12V, VID=1.30V (110110,VRD10) or 1.50V (101110,VRD10), F_{OSC} = 600kHz, T_A = 27°C. See Typical Application Circuit.

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

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

POWER MANAGEMENT

Pin Configurations



Ordering Information

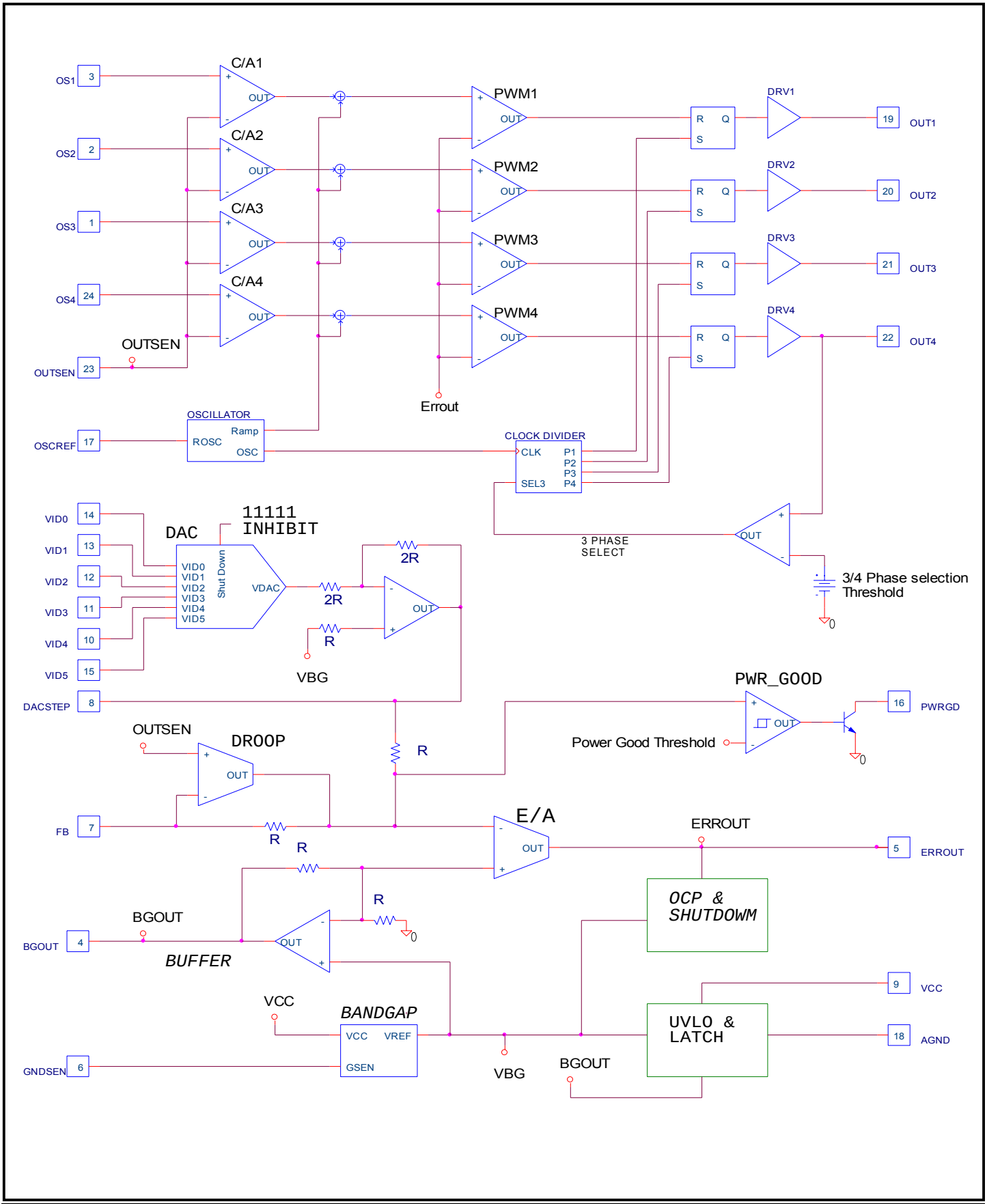
Part Number	Package	Temp. Range (T_J)
SC2643VXTSTR (1)	TSSOP-24	0 to 125 °C
SC2643VXTSTRT (1)(2)	TSSOP-24	0 to 125 °C
SC2643VXEVB	Evaluation Board	

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.

Block Diagram



Applications Information- Output Voltage

VRM9.X Output Voltage					
Unless specified: 0 = GND; 1 = High (or Floating). T_A = 25°C, V_{CC} = 12V					Vout (V)
VID4	**VID3**	**VID2**	**VID1**	**VID0**	
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

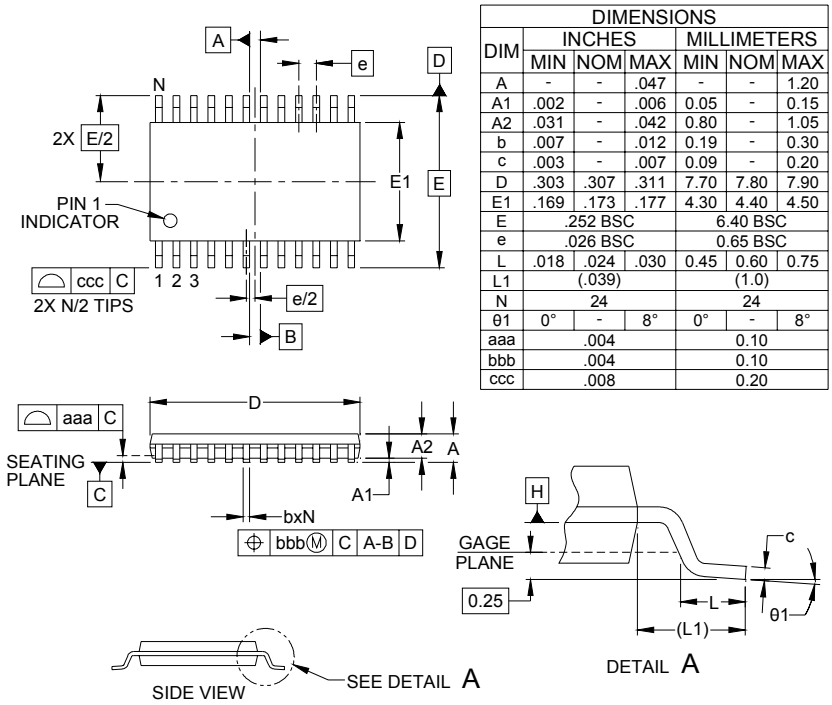
Applications Information- Output Voltage

VRD10 Output Voltage						
Unless specified: 0 = GND; 1 = High. T_A = 25°C, V_{CC} = 12V						Vout (V)
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

Applications Information- Output Voltage

K-8 Output Voltage					
Unless specified: 0 = GND; 1 = High (or Floating). T_A = 25°C, V_{CC} = 12V					
VID4	**VID3**	**VID2**	**VID1**	**VID0**	**V_{OUT} (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

Outline Drawing - TSSOP-24

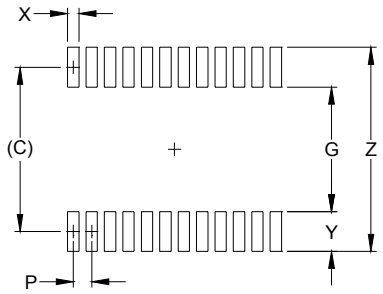


DIM	INCHES			MILLIMETERS		
	MIN	NOM	MAX	MIN	NOM	MAX
A	-	-	.047	-	-	1.20
A1	.002	-	.006	0.05	-	0.15
A2	.031	-	.042	0.80	-	1.05
b	.007	-	.012	0.19	-	0.30
c	.003	-	.007	0.09	-	0.20
D	.303	.307	.311	7.70	7.80	7.90
E1	.169	.173	.177	4.30	4.40	4.50
E	.252 BSC			6.40 BSC		
e	.026 BSC			0.65 BSC		
L	.018	.024	.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.

Land Pattern - TSSOP-24



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.

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