SC2646B
2, 3 or 4 Phase
Combi-Sense™ PWM Controller

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

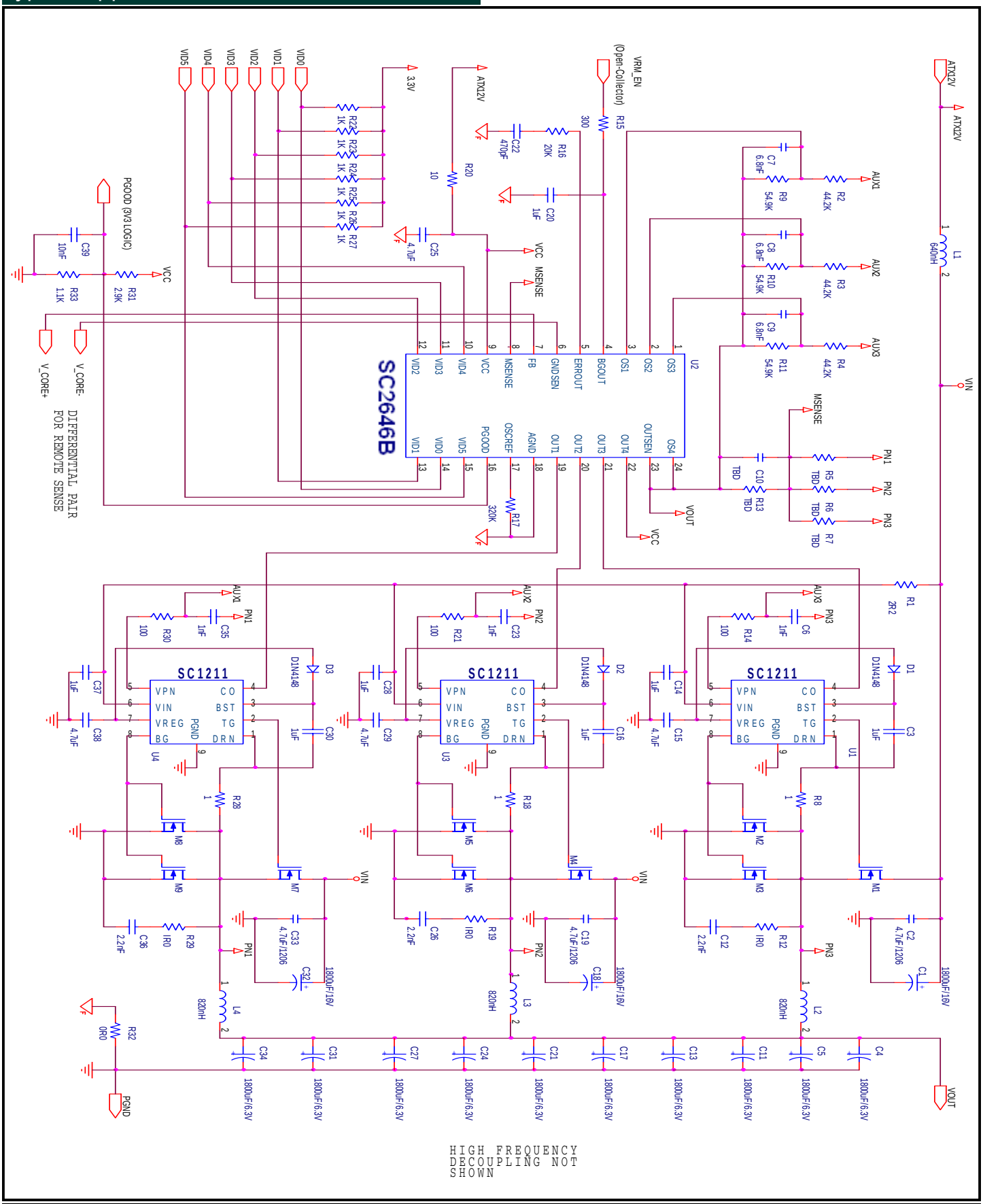
- VRD/VRM10.X compliant
- Core Voltage Set Point Accuracy 0.5%
- Combi-Sense™ Current Mode Control
- Intrinsic Phase Current Matching
- Fast Transient Responses
- Active Droop to Meet Load Line Slope
- Enable Function for Power Sequencing
- Cycle-by-Cycle Peak Current Limit
- Intelligent Over Current 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

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.

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°C. See Typical Application Circuit. Specifications subject to change without notice.

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Chip_Supply						
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
Reference Section						
Bandgap Output	V_{BGOUT}	C_{BGOUT} = 4.7nF		1.5		V
Source Current			55	70	95	µA
Supply Rejection		V_{CC} = 10.0V ~ 14.0V		0.5		mV/V
Temperature Stability (1)		0°C < T_A < 85°C		0.5		%
Voltage Accuracy	V_{OUT}	Internal offset is -20mV	-0.5		+0.5	%
Oscillator Section						
Oscillator Frequency	F_{OSC}	R_{OSC} = 320K	540	600	660	kHz
Oscillator Frequency Range	F_{OSC}		500		3000	kHz
Temperature Stability (1)		0°C < T_A < 85°C		+/- 5		%
Voltage Error Amplifier						
Input Bias Current (1)				25		nA
Open Loop Gain (1)		1V < V_{ERROUT} < 3.4V		80		dB

Electrical Characteristics (Cont.)

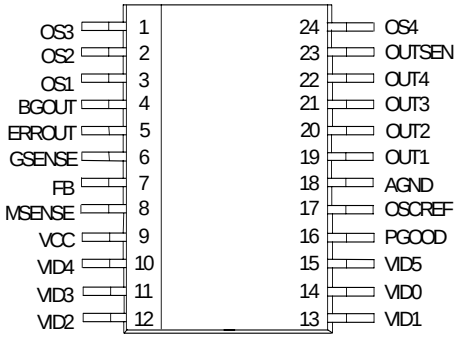
Unless specified: V_{CC} = 12V, F_{OSC} = 600kHz, 4 phase operation, V_{OUT} = 1.28V, T_A = 27°C. See Typical Application Circuit. Specifications subject to change

Parameter	Symbol	Test Conditions	Min	Typ	Max	Units
Unity Gain Bandwidth (1)	G_{BW}	C_{ERROUT} = 10pF		5		MHz
Source Current		V_{BG} > 1.8V, V_{FB} = 0V, V_{ERROUT} = 0.8V	60	80	90	uA
Sink Current		V_{BG} > 1V, V_{FB} = 2V, V_{ERROUT} = 2V	-90	-80	-60	uA
Transconductance Gain	G_M		0.62	0.82	1.03	mA/V
Current Sense Amplifiers						
Input Offset Voltage	V_{IO}			+/-3		mV
Input Bias Current	I_M			50		nA
Gain	G_{ca}			12.45		V/V
CMRR (1)		0 to 3V		80		dB
Input Common Mode Range			-0.3		3	V
Gain Match				5	6	%
Bandwidth (1)				6		MHz
Droop Amplifier						
Gain	A_{DRP}	V_{MSENSE}-V_{OUTSEN} = 20mV	11.1	11.7	12.3	V/V
VIDs						
Logic High		[VID0:5]		0.8		V
Logic Low		[VID0:5]		0.4		V
Internal Pull-up Impedance (1)		[VID0:4]		26		Kohm
Internal Pull-up Voltage (1)		[VID0:4]		1.4		V
3-Phase Operation						
Output 4 pull up Threshold			3.88	4.0	4.5	V
Power Good						
Threshold Rising		VID - Power Good Threshold		100		mV
Threshold Falling		VID - Power Good Threshold		250		mV
Power Good Delay (1)		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
Current Limit Section						
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.

Pin Configurations

Top View



(24-Pin TSSOP)

Ordering Information

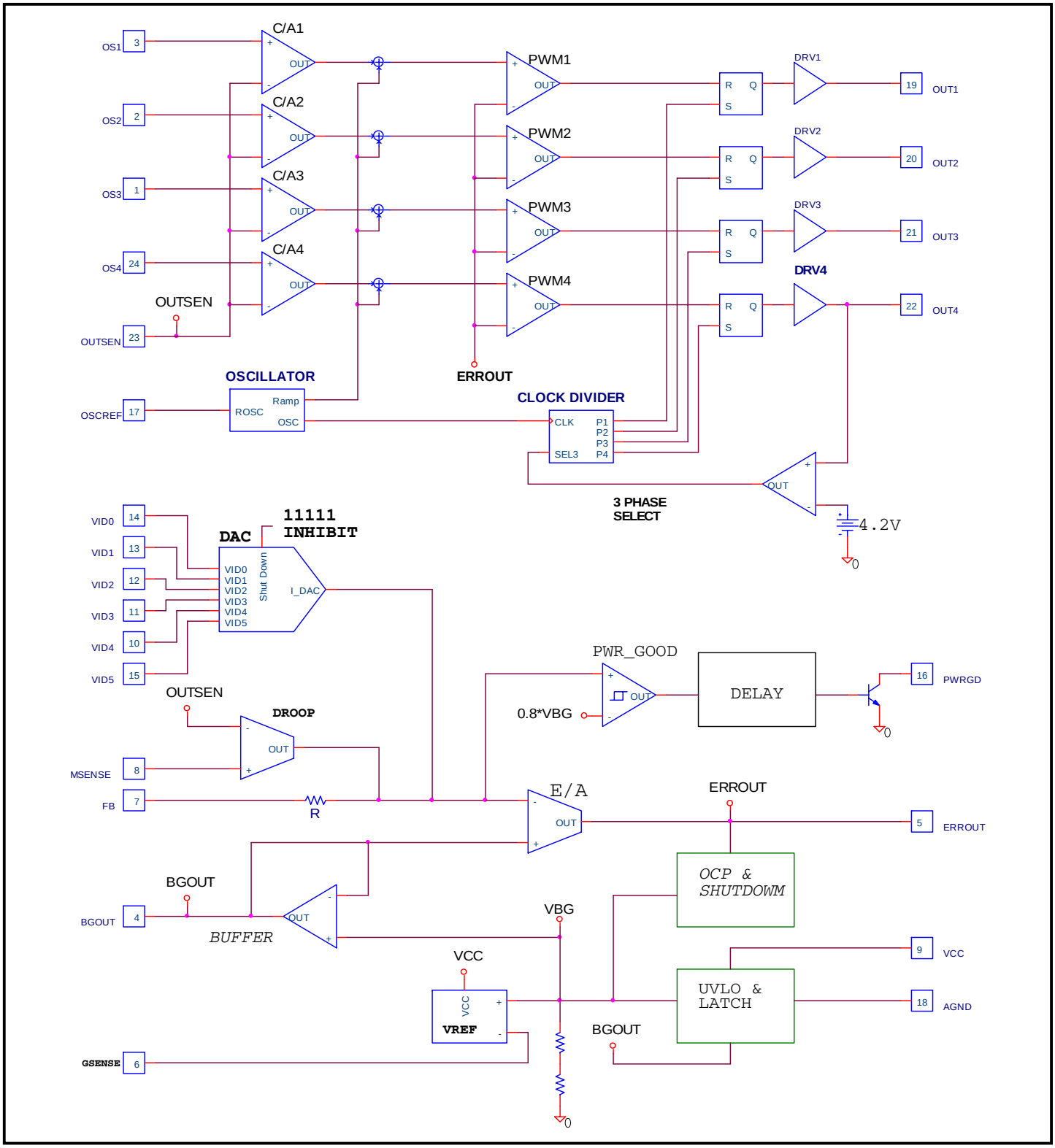
Part Number	Package	Temp. Range (T_J)
SC2646BTSTRT (1) (2)	TSSOP-24	0 to 125 °C
SC2646BEVB	Embedded Evaluation Board	

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.

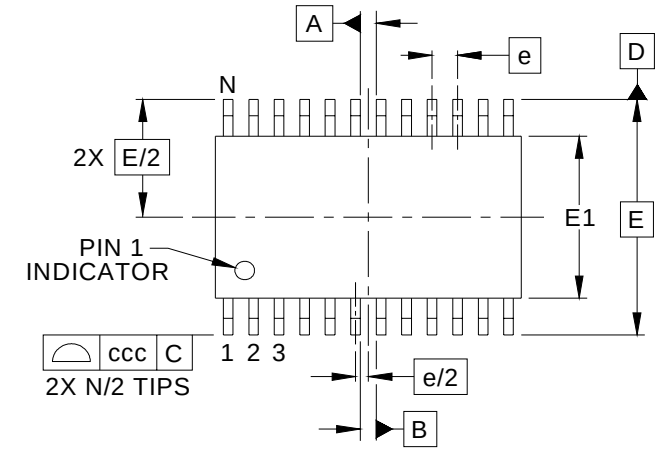
Block Diagram



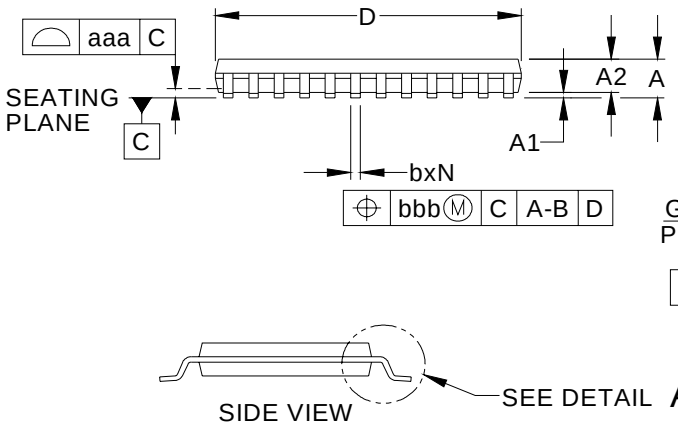
Applications Information- Output Voltage

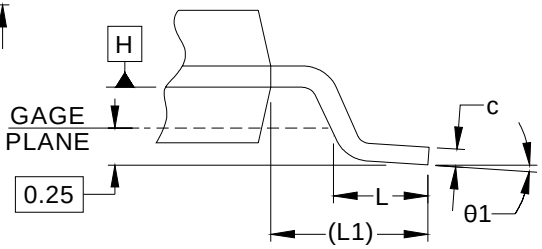
VRD10 Output Voltage						
Unless specified: 0 = GND; 1 = High. T_A = 25°C, V_{CC} = 12V						Vout (V)
VID5	VID4	VID3	VID2	VID1	VID0	
0	0	1	0	1	0	0.8375
1	0	1	0	0	1	0.8500
0	0	1	0	0	1	0.8625
1	0	1	0	0	0	0.8750
0	0	1	0	0	0	0.8875
1	0	0	1	1	1	0.9000
0	0	0	1	1	1	0.9125
1	0	0	1	1	0	0.9250
0	0	0	1	1	0	0.9375
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

Outline Drawing - TSSOP-24



DIMENSIONS						
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		



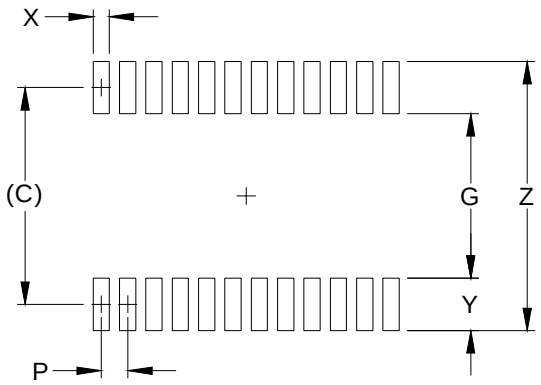


DETAIL A

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



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.

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