VRP4-C2E2A0 Series

Non-Isolated DC-DC Converter

The VRP4-C2E2A0 series are non-isolated stepdown DC/DC converters, and designed to be compatible with Intel VRM11.1 requirements. Standard features include current monitor, remote on/off, over current protection, remote sense, 8 bit VID digital voltage programming and a power good signal. This product also makes use of adaptive positioning to improve transient response performance. These products may be used almost anywhere low-voltage silicon is being employed and a nominal 12 VDC source is available. Typical applications include file servers, work stations and other computing applications

RoHS Compliant

Key Features & Benefits

- 10.2 VDC – 13.8 VDC Input
- 0.5 VDC – 1.6 VDC Output, VRM11.1 Compatible
- Non-Isolated
- Input Under-Voltage Lockout
- High Efficiency
- OCP/SCP
- Fixed Frequency
- 2-Wire Remote sense
- Remote On/Off
- 8 Bit VID Digital Voltage Programming
- Class II, Category 2, Non-Isolated DC/DC Converter (refer to IPC-9592B)

Applications

- Networking
- Computers and peripherals
- Telecommunications

1. MODEL SELECTION

OUTPUT VOLTAGE	INPUT VOLTAGE	MAX. OUTPUT CURRENT	MAX. OUTPUT POWER	TYPICAL EFFICIENCY	MODEL NUMBER ACTIVE HIGH
0.5VDC – 1.6VDC	10.2VDC – 13.2VDC	120 A	192 W	80%	VRP4-C2E2A0

NOTE: 1. Add "G" suffix at the end of the model number to indicate Tray Packaging.

PART NUMBER EXPLANATION

V	R	P4	-	C2	E	2A	0	x
Mounting type	RoHS Status	Series name		Output power	Input range	Output voltage	Active logic and HSK feature	Package type
Vertical mount	RoHS 6	P4		192W	10.2-13.8V	0.5-1.6V	active high, without HSK	G – Tray packaging

2. ABSOLUTE MAXIMUM RATINGS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNITS
Continuous non-operating Input Voltage		-0.3	-	15	V
Remote On/Off		-0.3	-	5.3	V
Ambient Temperature		0	-	70	°C
Storage Temperature		-55	-	125	°C
Altitude		-	-	2000	m

NOTE: Ratings used beyond the maximum ratings may cause a reliability degradation of the converter or may permanently damage the device.

3. INPUT SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Operating Input Voltage		10.2	12	13.8	V
Input Current		-	-	27	A
Input Current (no load)		-	-	700	mA
Input Current (no load, PSI# mode)		-	-	250	mA
Remote Off Input Current		-	50	70	mA
Input Reflected Ripple Current (rms)		-	5	10	mA
Input Reflected Ripple Current (pk-pk)		-	20	50	mA
Turn on Voltage Threshold		9.0	9.7	10.1	V
Turn off Voltage Threshold		8.1	8.6	9.1	V
I2t Inrush Current Transient		-	-	1	A2s

NOTE: All specifications are typical at 25 °C unless otherwise stated

4. OUTPUT SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Output Voltage Set Point	VID=0x62 , Io=0A, Ta=25° C	0.97	0.985	1.0	V
Adaptive Positioning	Droop Impedance	-	0.8	-	mOhm
Line Regulation		-	±5	-	mV
Regulation Over Temperature (0 ℃-70 ℃)		-	±5	±10	mV
Ripple and Noise (pk-pk)	Vin=12V Io=100A 0-20MHz BW	-	-	15	mV
Ripple and Noise (rms)		-	-	5	mV
Output Current Range	Thermal Design Current	0	-	100	A
	Peak Current Rating	-	-	120	A
Output DC Current Limit		125	-	155	A
Short Circuit Surge Transient		-	-	5	A2s
Turn on Time		-	2.5	5	ms
Overshoot at Turn on	.	-	-	1	%
Output Capacitance [1]	Measure with Co:16x 330µF Polymer 7mΩ, 33x 22µF MLCC, 3mΩ, 75x 4.7µF MLCC, 6mΩ	-	6358.5	-	µF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
TRANSIENT RESPONSE						
ΔV 50% ~ 100% of Max Load	Overshoot	di/dt=300A/µs, Vin=12VDC, Ta=25°C	-	-	50	mV
	Settling Time		-	-	25	µs
ΔV 100% ~ 50% of Max Load	Overshoot		-	-	50	mV
	Settling Time		-	-	25	µs

NOTES: 1. Consult factory regarding external capacitance outside of this range.
2. All specifications are typical at nominal input, full load at 25°C unless otherwise stated

5. GENERAL SPECIFICATIONS

PARAMETER	DESCRIPTION	MIN	TYP	MAX	UNIT
Efficiency	Vo=1V, Vin=12V, Iout=100A, PSI#=1	78	80	-	%
	Vo=1V, Vin=12V, Iout=20A, PSI#=0	79	81	-	%
	Vo=1.5V, Vin=12V, Iout=70A, PSI#=1	84	86	-	%
Switching Frequency		-	400	-	kHz
FIT*			TBD		-
Over Temperature Alert		100	-	110	°C
Over Voltage Protection		-	Vo,set + 0.175	-	V
Dimensions (L × W ×H)			2.40 x 0.78 x 0.74		inch
			60.96 x 19.81 x 18.80		mm
Weight		-	27.7	-	g

NOTE: All specifications are typical at 25 °C unless otherwise stated

6. EFFICIENCY DATA

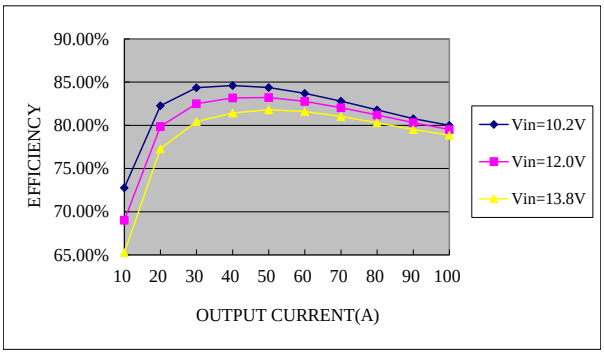


Figure 1. VID=0x62 (Vo = 1.0V at no load) , PSI#=1

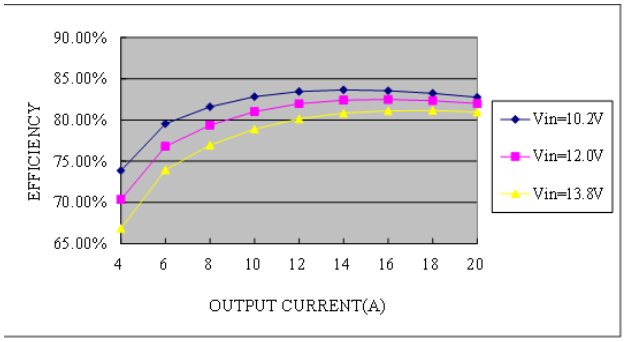
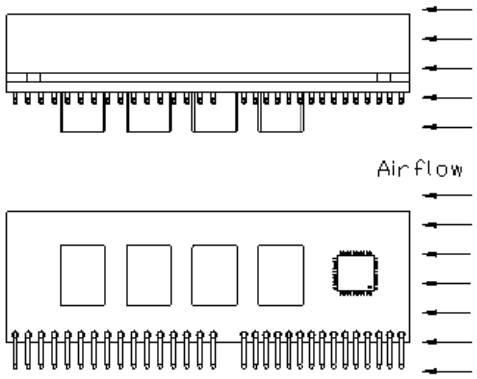
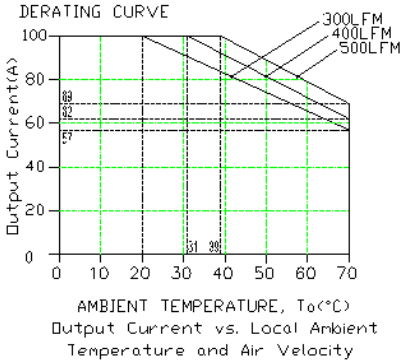


Figure 2. VID=0x62 (Vo = 1.0V at no load) , PSI#=0

7. THERMAL DERATING CURVES

Derating Curve Under Normal Input

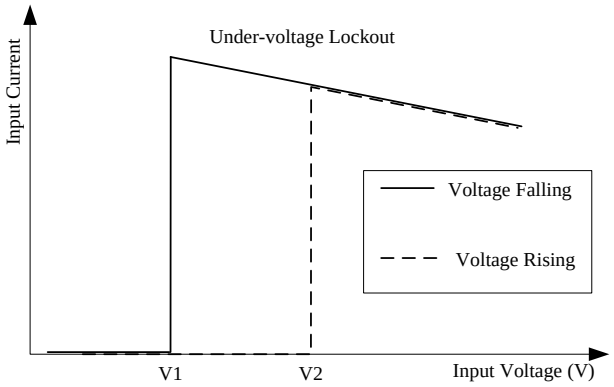




8. REMOTE ON/OFF

PARAMETER		DESCRIPTION	MIN	TYP	MAX	UNIT
REMOTE ON/OFF						
Signal Low (Unit On)	Active High	Remote On/Off pin is open, the module is off.	-0.3	-	0.4	V
Signal High (Unit Off)			1.0	-	5.3	
Current Sink			0	-	1	mA

9. INPUT UNDER-VOLTAGE LOCKOUT



V1=8.6V

V2=9.7V

10. OVER CURRENT PROTECTION

To provide protection in a fault output overload condition, the module is equipped with internal current-limiting circuitry and can endure current limiting for a few mili-seconds. If the overcurrent condition persists beyond a few milliseconds, the module will shut down into hiccup mode. The module operates normally when the output current goes into specified range.

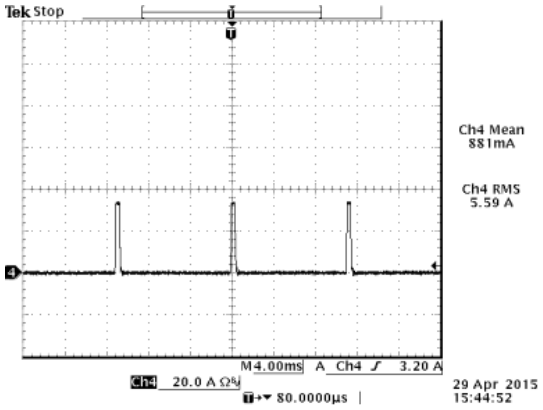


Figure 3. Test condition: VID=0x62, Vin=12V

11. RIPPLE AND NOISE WAVEFORMS

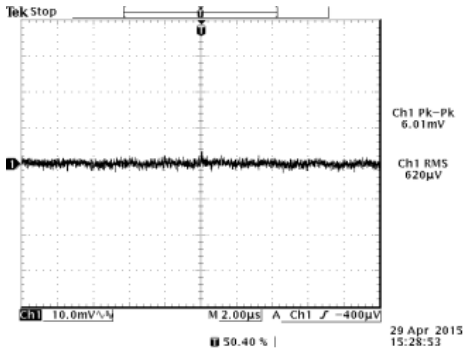


Figure 4. Ripple and noise at 12VDC input, VID=0x62, Iout=100A, PSI#=1 and Ta=25 ˚C

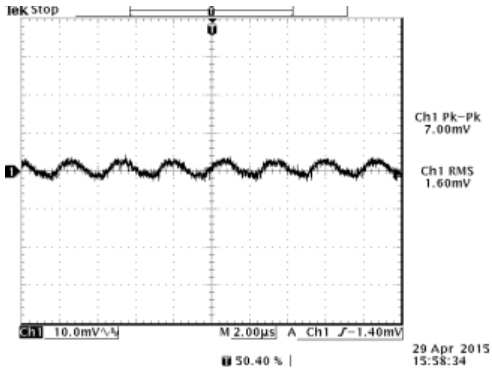
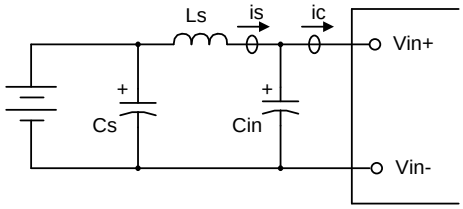


Figure 5. Ripple and noise at 12VDC input, VID=0x62, Iout=20A, PSI#=0 and Ta=25 ˚C

12. INPUT REFLECTED RIPPLE CURRENT

Testing setup



NOTES AND VALUES IN TESTING.

is: Input Reflected Ripple Current
ic: Input Terminal Ripple Current
Ls: Simulated Source Impedance (0.9 µH)
Cs: Offset possible source Impedance (180µF, , ESR<16mR @ 100kHz to 300KHz, 20 ˚C)
Cin: Electrolytic capacitor, should be as closed as possible to the power module to swallow ic ripple current and help with stability. Recommendation:. 180µF, ESR<16mR @ 100kHz to 300KHz, 20 ˚C and 4* MLCC 22µF/16V

Below measured waveforms are based on above simulated and recommended inductance and capacitance.

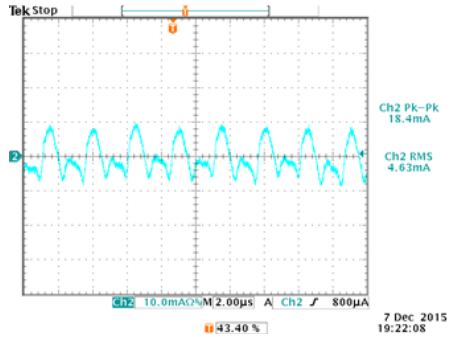


Figure 6. is (input reflected ripple current), AC component

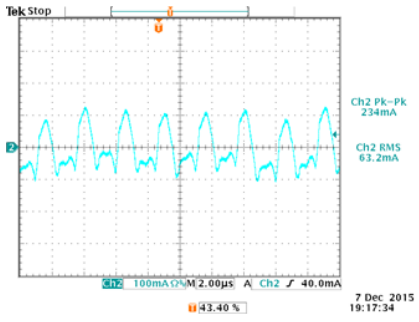


Figure 7. ic (input terminal ripple current), AC component

NOTE : Test condition: 12VDC input, 1.0VDC/100A output and Ta=25 ˚C, with 33*22µF MLCC + 75*4.7µF MLCC + 16*330µF Polymer at output.

13. POWER GOOD

1. This module has a power good indicator output. Power good pin used positive logic and is open collector.
2. Power good pin can sink 10mA.
3. The maximum voltage pulled up externally on Power Good pin should not exceed 5V.
4. When the output reaches the VID setting, the power good pin will be pulled high with the fixed delay of 85us.

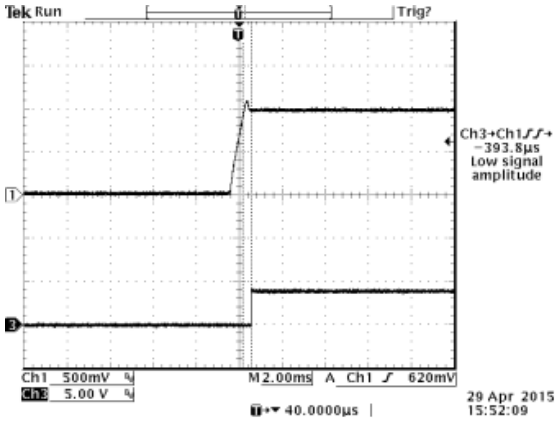
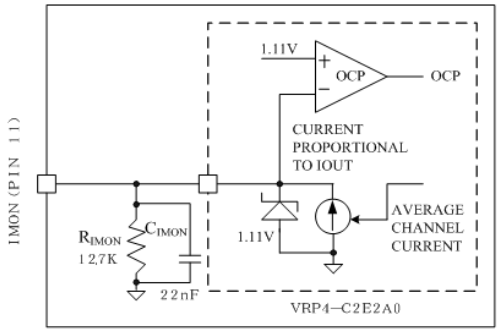


Figure 8. Typical Start-up Using Remote ON/OFF
(Vin=12.0V, Vo=1.0V, Io=0A)
Ch1: Vout
Ch3: VR_READY

14. IMON DIAGRAM



IMON is the output pin of the sensed, thermally compensated, average current. The voltage at IMON pin is proportional to the load current and the resistor value (RIMON), and internally clamped to 1.11V plus the remote ground potential difference. If the clamped voltage (1.11V) is triggered, it will initiate the over-current shutdown. During the dynamic VID, the OCP function of this pin is disabled to avoid falsely triggering.

15. STARTUP & SHUTDOWN

RISE TIME

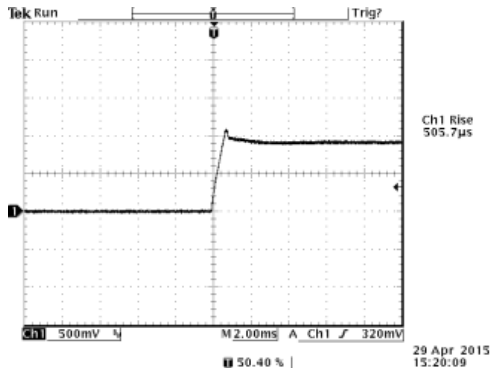


Figure 7. VID=0x62, Vin=12V, Iout=100A

STARTUP TIME

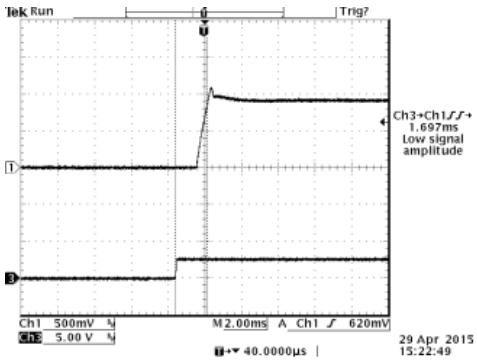
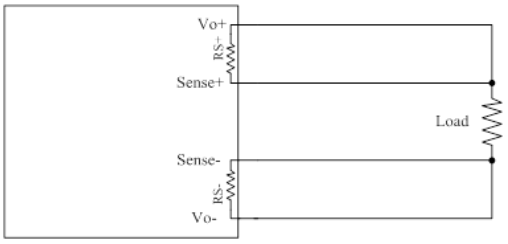


Figure 8.VID=0x62, Vin=12V, Iout=100A
Ch1: Vout
Ch3: OUTEN

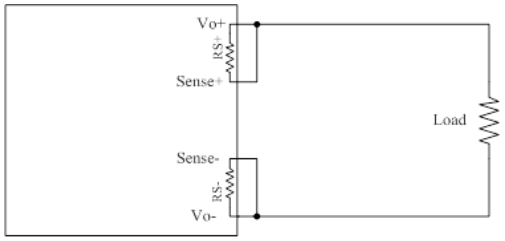
16. REMOTE SENSE

This module has remote sense compensation feature. It can minimizes the effects of resistance between moudle's output and load in system layout and facilitates accurate voltage regulation at load terminals or other selected point.

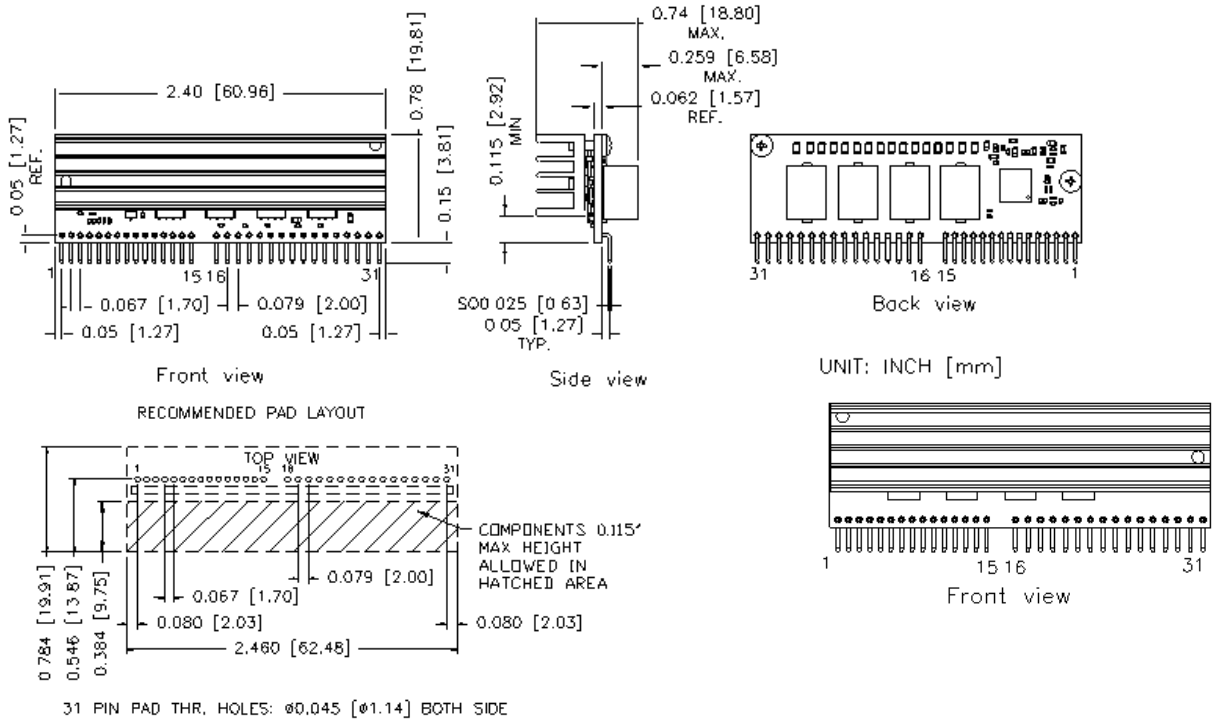
1. The remote sense lines carries very little current and hence do not require a large cross-sectional area.
2. This module compensates for a maximum drop of 10% of the nominal output voltage.
3. When using remote sense compensation, all the resistance, parasitic inductance and capacitance of the system are incorporated within the feedback loop of this module. The can make an effect on the module's compensation, affecting the stability and dynamic response. A 0.1µF ceramic capacitor can be connected at the point of load to de-couple noise on the sense wires.
4. Recommend the connection of remote sense compensation as below figure. There are a resistor RS+ (5.11K) from Vo+ to Sense+ and a resistor RS- (5.11K)) from Vo- to Sense- inside of this module.



5. If not using remote sense compensation, please connect sense directly to output at module's pin, that is, connect sense+ to Vo+ and sense- to Vo- at module's pin, the shorter the better. See below figure.



17. MECHANICAL OUTLINE



PIN CONNECTIONS

PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION	PIN	FUNCTION
1	VID0	9	Vsense+	17	Vout	25	GND
2	VID1	10	Vesnse-	18	Vout	26	Vout
3	VID2	11	IMON	19	GND	27	Vout
4	VID3	12	PSI#	20	GND	28	GND
5	VID4	13	OUTEN	21	Vout	29	GND
6	VID5	14	VR_READY	22	Vout	30	Vin
7	VID6	15	VR_HOT	23	Vout	31	Vin
8	VID7	16	GND	24	GND		

NOTE: This module is recommended and compatible with Pb-Free Wave Soldering and must be soldered using a peak solder temperature of no more than 260 °C for less than 5 seconds.

NOTE: *1) All Pins: Material - Copper Alloy;*
Finish – 3 micro inches minimum Gold over 50 micro inches minimum Nickel plate
2) Undimensioned components are shown for visual reference only.
3) All dimensions in inches (mm); Tolerances: x.xx +/-0.02 in. (x.x +/-0.5mm) x.xxx +/-0.010 in. (x.xx +/-0.25mm).

18. ASSEMBLY NOTE

Modules were designed for vertical insertion into host board. Experiments should be performed to make sure that the units meet the intended tilt specification. A fixture may be needed to make the module stand upright in assembly

19. SIGNAL DEFINITIONS

VID0, VID1, VID2, VID3, VID4, VID5, VID6, VID7	Logic level inputs used to set the output voltage, refer to VID table. Connect VID0 thru VID7 pins to open-drain outputs with external pull-up resistors or to active-pull-up outputs. Valid logic low is -0.3V to 0.4V, valid logic high level is 0.8V to 5.3V.
Vsense+, Vsense-	Remote voltage sense lines. Connect these at the point of load, to VOUT and GND respectively.
IMON	The output pin of sensed, thermally compensated average current. The voltage at IMON pin is proportional to the load current, and internally clamped to 1.11V plus the remote ground potential difference. If the clamped voltage (1.11V) is triggered, it will initiate the overcurrent shutdown. During the dynamic VID, the OCP function of this pin is disable to avoid falsely triggering.
PSI#	A low input signal indicates the low power mode operation of the processor. The controller drops the number of active phases to single phase operation. A high input signal pulls the controller back to normal operation.
OUTEN	Logic level input used to enable the converter when high. Valid logic low is -0.3V to 0.4V, valid logic high level is 0.9V to 5.3V.
VR_READY	VR_READY indicates that soft-start has completed and the output voltage is within the regulated range around VID setting. It is an open-drain logic output. When OCP or OVP occurs, VR_READY will be pulled to low. It will also be pulled low if the output voltage is below the undervoltage threshold.
VR_HOT	VR_HOT is used as an indication of high VR temperature. It will be pulled high if the measured VR temperature is less than a certain level, and pulled low when the measured VR temperature reaches a certain level.
Vout	Output voltage available to the load.
GND	Common return for both input and output
Vin	Input power to the converter

20. VID CODES

VRM11.1 VID CODES

HEX (VID7 - VID0)		Vout (VDC)
0	0	OFF
0	1	OFF
0	2	1.60000
0	3	1.59375
0	4	1.58750
0	5	1.58125
0	6	1.57500
0	7	1.56875
0	8	1.56250
0	9	1.55625
0	A	1.55000
0	B	1.54375
0	C	1.53750
0	D	1.53125
0	E	1.52500
0	F	1.51875
1	0	1.51250
1	1	1.50625
1	2	1.50000
1	3	1.49375
1	4	1.48750
1	5	1.48125
1	6	1.47500
1	7	1.46875
1	8	1.46250
1	9	1.45625
1	A	1.45000
1	B	1.44375
1	C	1.43750
1	D	1.43125
1	E	1.42500
1	F	1.41875
2	0	1.41250
2	1	1.40625
2	2	1.40000
2	3	1.39375
2	4	1.38750
2	5	1.38125
2	6	1.37500
2	7	1.36875
2	8	1.36250
2	9	1.35625
2	A	1.35000
2	B	1.34375
2	C	1.33750
2	D	1.33125
2	E	1.32500
2	F	1.31875

HEX (VID7 - VID0)		Vout (VDC)
3	0	1.31250
3	1	1.30625
3	2	1.30000
3	3	1.29375
3	4	1.28750
3	5	1.28125
3	6	1.27500
3	7	1.26875
3	8	1.26250
3	9	1.25625
3	A	1.25000
3	B	1.24375
3	C	1.23750
3	D	1.23125
3	E	1.22500
3	F	1.21875
4	0	1.21250
4	1	1.20625
4	2	1.20000
4	3	1.19375
4	4	1.18750
4	5	1.18125
4	6	1.17500
4	7	1.16875
4	8	1.16250
4	9	1.15625
4	A	1.15000
4	B	1.14375
4	C	1.13750
4	D	1.13125
4	E	1.12500
4	F	1.11875
5	0	1.11250
5	1	1.10625
5	2	1.10000
5	3	1.09375
5	4	1.08750
5	5	1.08125
5	6	1.07500
5	7	1.06875
5	8	1.06250
5	9	1.05625
5	A	1.05000
5	B	1.04375
5	C	1.03750
5	D	1.03125
5	E	1.02500
5	F	1.01875

HEX (VID7 - VID0)		Vout (VDC)
6	0	1.01250
6	1	1.00625
6	2	1.00000
6	3	0.99375
6	4	0.98750
6	5	0.98125
6	6	0.97500
6	7	0.96875
6	8	0.96250
6	9	0.95625
6	A	0.95000
6	B	0.94375
6	C	0.93750
6	D	0.93125
6	E	0.92500
6	F	0.91875
7	0	0.91250
7	1	0.90625
7	2	0.90000
7	3	0.89375
7	4	0.88750
7	5	0.88125
7	6	0.87500
7	7	0.86875
7	8	0.86250
7	9	0.85625
7	A	0.85000
7	B	0.84375
7	C	0.83750
7	D	0.83125
7	E	0.82500
7	F	0.81875
8	0	0.81250
8	1	0.80625
8	2	0.80000
8	3	0.79375
8	4	0.78750
8	5	0.78125
8	6	0.77500
8	7	0.76875
8	8	0.76250
8	9	0.75625
8	A	0.75000
8	B	0.74375
8	C	0.73750
8	D	0.73125
8	E	0.72500
8	F	0.71875

HEX (VID7 - VID0)		Vout (VDC)
9	0	0.71250
9	1	0.70625
9	2	0.70000
9	3	0.69375
9	4	0.68750
9	5	0.68125
9	6	0.67500
9	7	0.66875
9	8	0.66250
9	9	0.65625
9	A	0.65000
9	B	0.64375
9	C	0.63750
9	D	0.63125
9	E	0.62500
9	F	0.61875
A	0	0.61250
A	1	0.60625
A	2	0.60000
A	3	0.59375
A	4	0.58750
A	5	0.58125
A	6	0.57500
A	7	0.56875
A	8	0.56250
A	9	0.55625
A	A	0.55000
A	B	0.54375
A	C	0.53750
A	D	0.53125
A	E	0.52500
A	F	0.51875
B	0	0.51250
B	1	0.50625
B	2	0.50000
F	E	OFF
F	F	OFF

21. REVISION HISTORY

DATE	REVISION	CHANGES DETAIL	APPROVAL
2015-2-26	A	First release	J Yan
2015-5-7	B	Update input specs、output specs、general、efficiency data、TD、NR、Remote sense、OCP、UVLO、Imon	J Yan
2015-09-22	C	Update Cover, MD	J Yan
2015-12-22	D	Add input noise and output voltage set point notes, update remote on/off signal high (Unit On) min from 0.9V to 1.0V, Add Assembly Note.	J Yan
2016-04-11	E	Again: Add input noise and output voltage set point notes, update remote on/off signal high (Unit On) min from 0.9V to 1.0V, Add Assembly Note.	J Yan