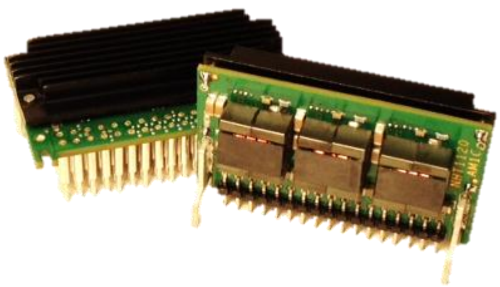
NetPower
Leading the Advancement of Power Conversion

8-14V Input 100A Output Point-of-Load Converter



Features

- High output current: 100A up to 1.6V;
- Wide input ranges: 8V –14V
- High efficiency: 89% @1.6V/100A
- Vertical, horizontal, and SMT packages
- Remote sense, output trim, remote On/Off
- Over-temperature protection
- Output over-voltage/over-current/short-circuit protection
- All components meet UL 94V0

Applications

- Microprocessor core voltage supply
- Telecom, datacom, networking equipment
- Electronic data processing, servers
- Distributed power architectures

Options

- Active load current sharing (I-Share)
- Vertical, horizontal, and SMT packages
- Negative/Positive enable logic
- Power good, fan control, or load current monitor
- 8-Bit VID control with VR10 or VR11

Part Numbering System

NHT	1	□□□	□	100	□	□	□	6
Series Name	**Nominal Input Voltage**	**Preset Output Voltage***	**Enabling Logic**	**Rated Output Current**	**Pin Options**	**Electrical Option 1**	**Electrical Option 2**	**Mechanical Options (ROHS6 Compliant)**
NHT	**1:** 8 – 14V	**000:** 1.6V **011:** 1.1V **010:** 1.0V	**P:** Positive **N**: Negative	**Unit:** A **100:**100A	**H**:Horizontal (0.18'') **R:**Vertical (0.13") **T:**Vertical (0.17'') **S:** SMT	**0:** No VID **1:** VID	**0:** VR_RDY **1:** VR_FAN. **2:** IOUT **3:** I-Share Note: This digit must be either "2" or "3" if VID is selected in Electrical Option 1.	**6:** Heatsink

***** For the availability of other preset output voltages, consult with the factory.

Absolute Maximum Ratings

Excessive stresses over these absolute maximum ratings can cause permanent damage to the converter. Operation should be limited to the conditions outlined under the Electrical Specification Section.

Parameter	Symbol	Min	Max	Unit
Input Voltage (continuous)	Vi	-0.5	16	Vdc
ON/OFF pin input voltage		-0.3	Vi	Vdc
All other input Pins(VID,VRSEL,EN_VTT)		-0.3	5	Vdc
Operating Ambient Temperature (See Thermal Consideration section)	To	-40	85	˚C
Storage Temperature	Tstg	-55	125	˚C

Electrical Specifications

These specifications are valid over the converter's full range of input voltage, resistive load, and temperature unless noted otherwise.

Input Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Input Voltage	Vi	8	12	14	Vdc
Input Current	Ii,max	-	-	30	A
Quiescent Input Current (Vin = 12, Vo = 1.0V)	Ii,Qsnt	-	140	160	mA
Standby Input Current	Ii,stdby	-	22		mA
Input Ripple Rejection (120 Hz)	-		30	-	dB
Input Turn-on Voltage Threshold	Vi,onth	7	7.5	8	V
Input Turn-off Voltage Threshold	Vi,offth	6	6.5	7	V

Output Specifications

Parameter		Symbol	Min	Typical	Max	Unit
Output Voltage Set Point Tolerance (Vi = 12 V; Io = Io,max; Ta = 25°C)		-	-2.0	-	2.0	%
Output Voltage Set Point Tolerance (over all conditions)		-	-2.5	-	3.50	%
Output Regulation:						
Line Regulation (Vi = 8V to 14V, Io = 1/2 of load)		-	-	0.2		%Vo
Load Regulation (Io = Io,min to Io,max, Vi = 12V)		-	-	0.3		%Vo
Temperature (Ta = -40°C to 85 °C)		-	-	0.2		%Vo
Output Ripple and Noise Voltage (5 Hz to 20 MHz bandwidth, Vin = 12V)		Peak-to-peak -	-	1.5		%Vo
		RMS		1.0		%Vo
External Load Capacitance (non-ceramic type)		Co,ext	660	-	15,000	μF
External input Capacitance		Ci,ext	660	1000		uF
Output Current		Io	0	-	100	A
Output Current-limit Trip Point (hiccup mode)		Io,cli	105	113	130	A
Output Under Voltage Trip Point (hiccup mode)		Vo,uvp		50		%Vo
Output Over Voltage Trip Point (hiccup mode)		Vo,ovp		Vo+0.175		V
Efficiency (Vi = 12V; Io = 60A, TA = 25ºC)	Vo = 0.8V	η		85.29		%
	Vo = 1.2V	η		89.56		%
	Vo = 1.6V	η		92.1		%
Efficiency (Vi = 12V; Io = 100A, TA = 25ºC)	Vo = 0.8V	η		80.59		%
	Vo = 1.2V	η		85.8		%
	Vo = 1.6V	η		88.76		%

Output Specifications (continued)

Parameter	Symbol	Min	Typical	Max	Unit	Parameter
Dynamic Response (Vi = 12V; Vo=1.2V;Ta = 25°C)						
Load transient 50A⇔75Aat 2.5A/μs, Co,ex t=660uF						
Peak deviation				110		mV
Settling time (to 10% band of Vo deviation)				50		μs
Load transient 50A⇔75Aat 2.5A/μs, Co,ext=3300uF						
Peak deviation				85		mV
Settling time (to 10% band of Vo deviation)				50		μs
Load transient 50A⇔100Aat 1A/μs, Co,ext=660uF						
Peak deviation				100		mV
Settling time (to 10% band of Vo deviation)				50		μs
Load transient 50A⇔100Aat 1A/μs, Co,ext=3300uF						
Peak deviation				70		mV
Settling time (to 10% band of Vo deviation)				50		μs

General Specifications

Parameter		Symbol	Min	Typical	Max	Unit
Remote Enable						
Logic Low:						
	ION/OFF = 1.0mA	VON/OFF	-	-	0.5	V
	VON/OFF = 0.0V	ION/OFF	-	-	1.0	mA
Logic High:	ION/OFF = 0.0μA	VON/OFF	2.5	-	Vin	V
	Leakage Current	ION/OFF	-	-	50	μA
Output Ripple Frequency		Fsw	840	900	960	kHz

Pin Functions

Pin #	Name	Description
1, 2	Vo	Positive terminal of the output voltage
3	Sense+	Positive remote sense
4	Vo	Positive terminal of the output voltage
5, 6	GND	Ground terminal, the return or negative terminal of both the input voltage and the output voltage
7, 8, 9	Vo	Positive terminal of the output voltage
10	Sense-	Negative remote sense
11	Trim	Output voltage adjustment (non-I-Share version only)
12	On/Off	Input signal for enable control. Require EN_VTT set to low.
13	Vin	Positive terminal of the input voltage
14	Option	In “Without VID” version, it can be one of the four options (VR_RDY, VR_FAN, IOUT or I-Share) as defined in the Part Numbering table. In “With VID” version, it is fixed to be IOUT.
15	GND	Ground terminal, the return or negative terminal of both the input voltage and the output voltage
16, 17	Vin	Positive terminal of the input voltage
18	VR_RDY	Open drain logic output. When soft start completed and output voltage is regulated, VR_RDY is open.
19	VR_FAN	Open drain logic output. It is open when the module temperature is high and more cooling is needed.
20	GND	Ground terminal, the return or negative terminal of both the input voltage and the output voltage
21	VR_HOT	Open drain logic output. It is open when the module temperature is hot and it informs microprocessor to reduce power consumption.
22	Vin	Positive terminal of the input voltage
23	EN_VTT	Input signal for enable control from microprocessor. Require On/Off pin set to Off. When voltage at this pin is higher than 2V, the converter is enabled.
24 - 31	ID7 – ID0	ID inputs from microprocessor. These codes determine output voltage set point.
32	VRSEL	Input signal for selecting VR code system. When it is tied to GND, the extended VR10 is selected. When it is floated or tied to high, VR11 is selected.
33, 34	Vo	Positive terminal of the output voltage
Stand-off Pins	GND	Ground terminal, the return or negative terminal of both the input voltage and the output voltage

Note: When “No VID” is selected in the part number, Pin 18 through Pin 34 will not be installed.

Characteristic Curves

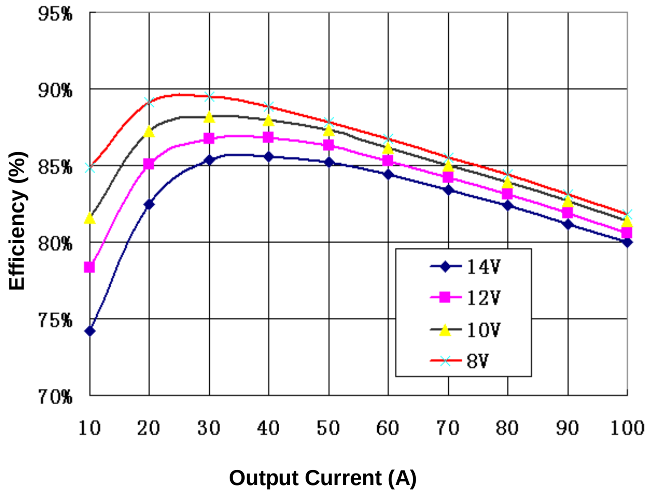


Figure 1. Efficiency Vs. Load Current (Vo=0.8V

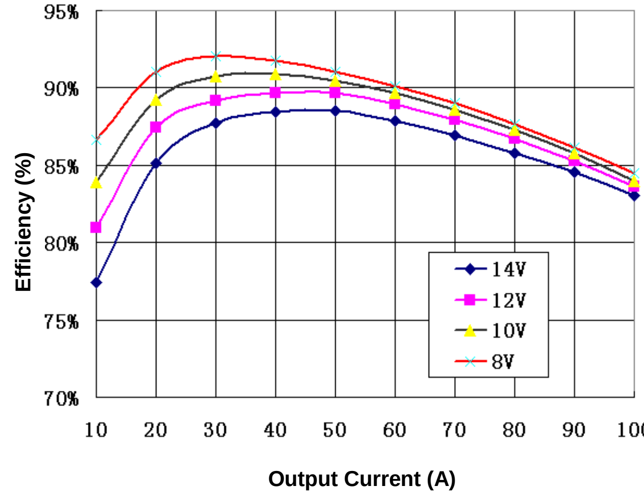


Figure 2. Efficiency Vs. Load Current(Vo=1.0V)

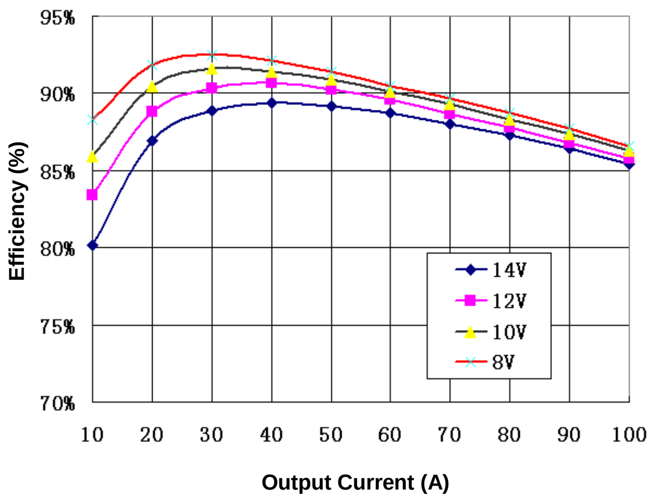


Figure 3. Efficiency Vs. Load Current (Vo=1.2V)

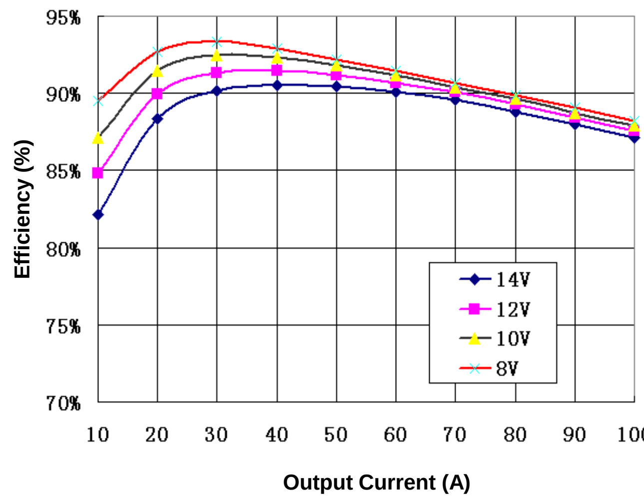


Figure 4. Efficiency Vs. Load Current (Vo=1.4V)

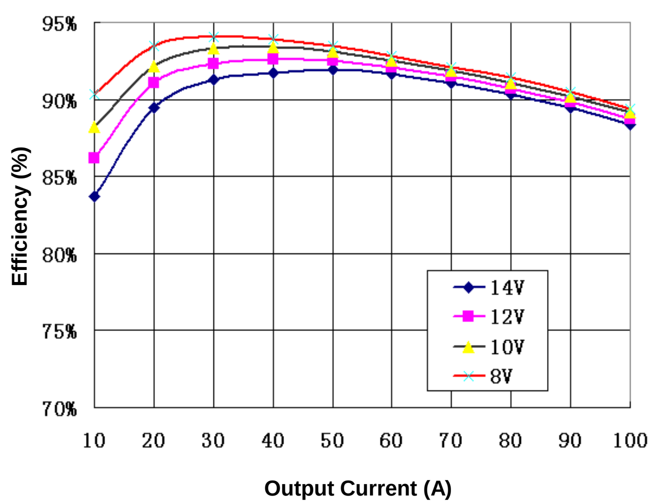


Figure 5. Efficiency Vs. Load Current (Vo=1.6V)

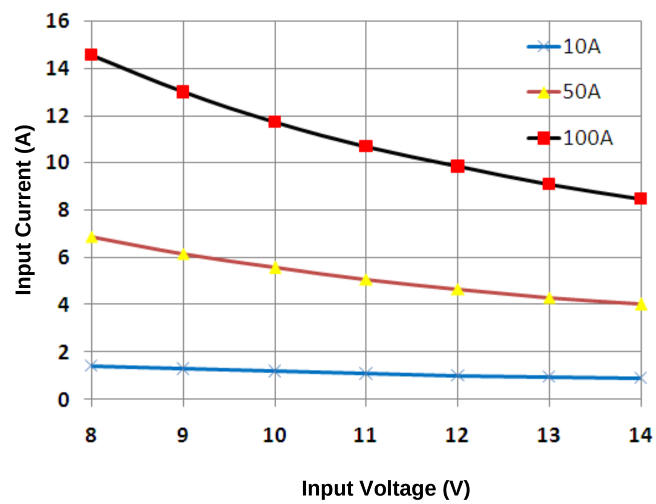


Figure 6. Input Characteristic(1.0V output)

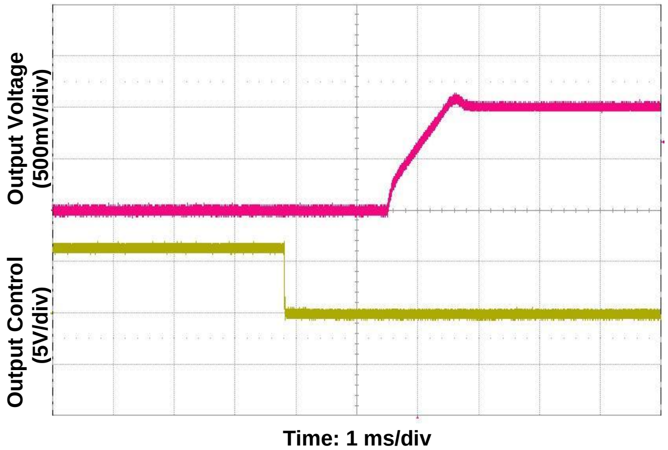


Figure 7. Start-Up from ON/OFF Control
(Input 12V, Output 1V/ 0A)

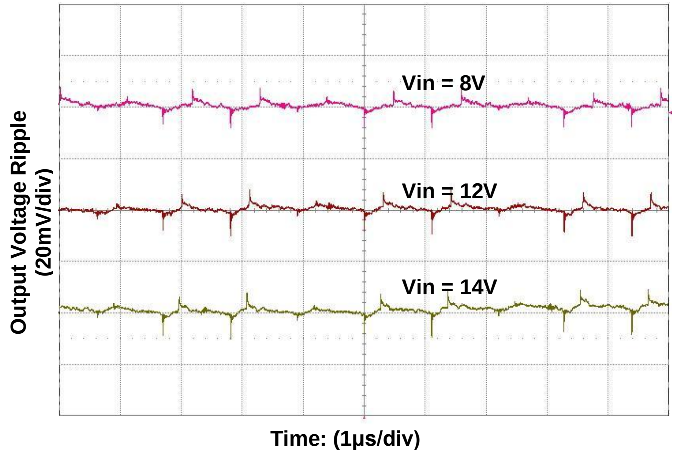


Figure 8. Output Ripple Voltage at 1.0V, 100A Output

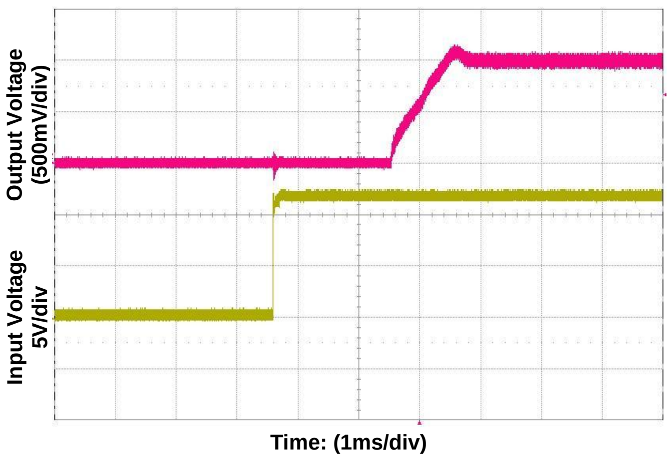


Figure 9. Start-Up from Application of Input Voltage
(Input 12V, Output 1V/ 0A)

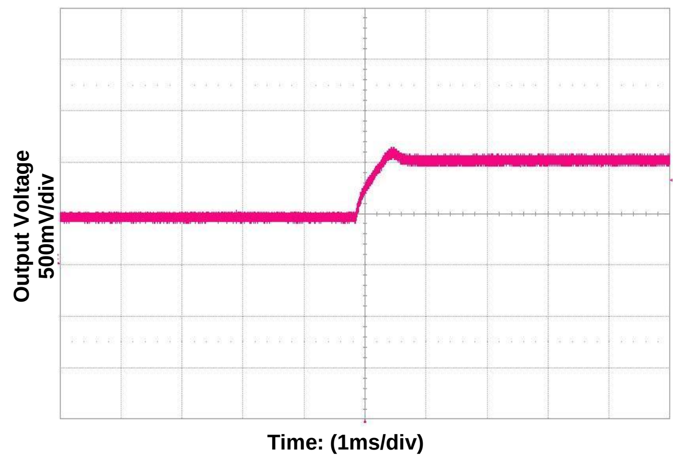


Figure 10. Start-Up with Pre-bias
(Input 12V, Output 1V/ 0A with 0.5V pre-bias)

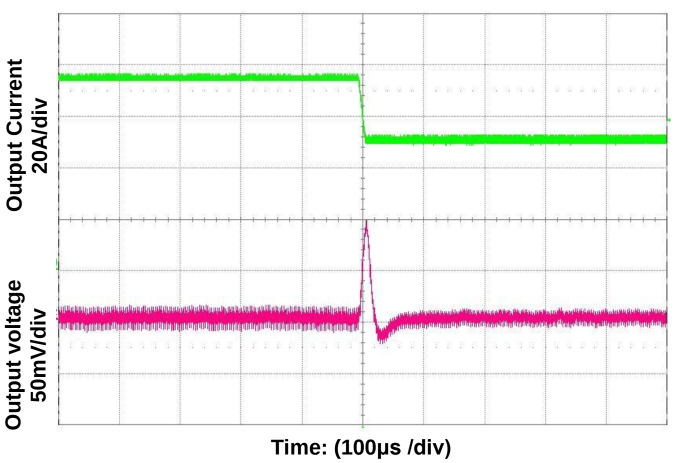


Figure 11. Transient Load Response.
(Input voltage 12V, Output voltage 1.0V, Output current 75A→50A, Slew rate 2.5A/µs)

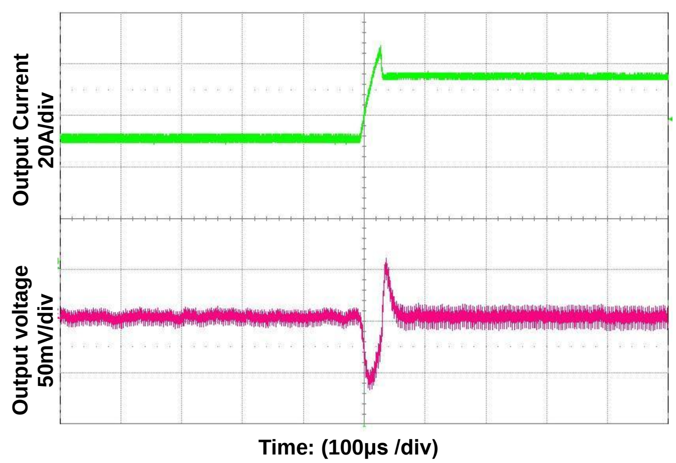


Figure 12. Transient Load Response.
(Input voltage 12V, Output voltage 1.0V, Output current 50A→75A, Slew rate 2.5A/µs)

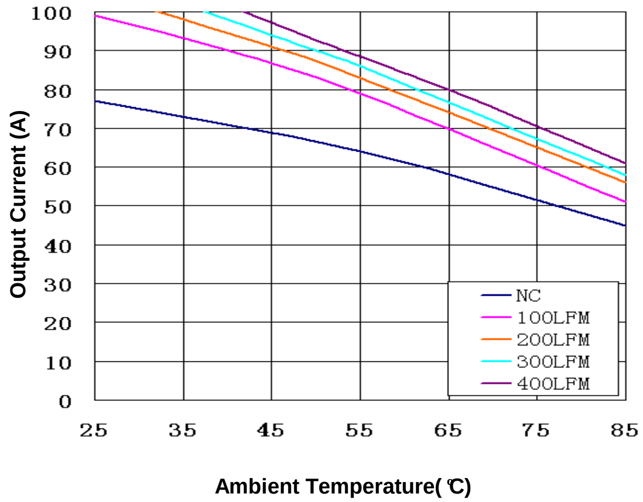


Figure 13(a). Output Current Derating (Vin=12V; Vo=0.8V)

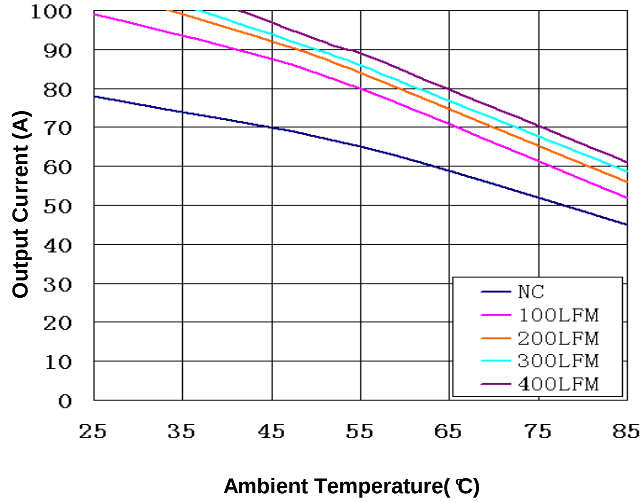


Figure 13(b). Output Current Derating (Vin=12V; Vo=1.0V)

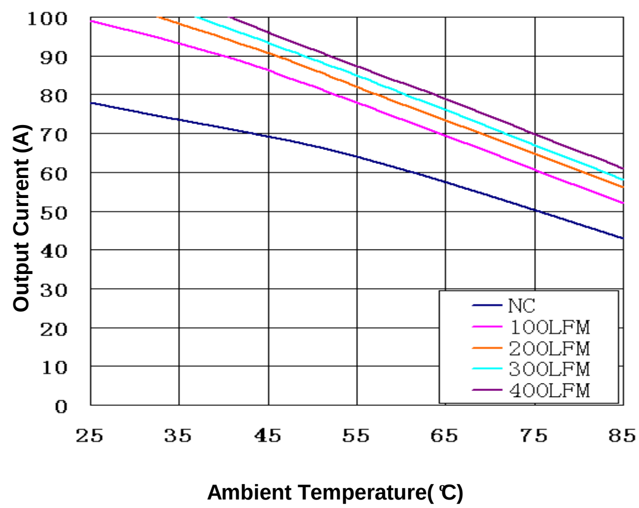


Figure 13(c). Output Current Derating(Vin=12V; Vo=1.2V)

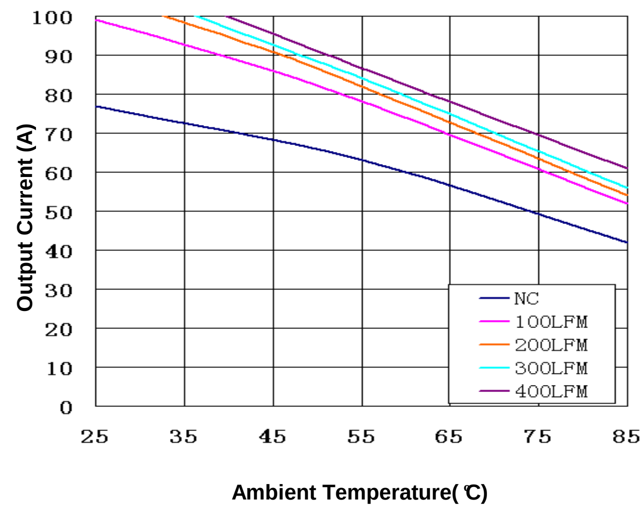


Figure 13(d). Output Current Derating (Vin=12V; Vo=1.4V)

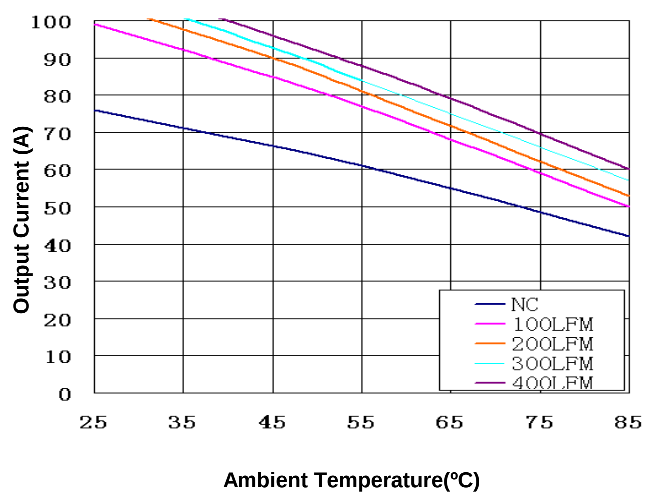


Figure 13(e). Output Current Derating(Vin=12V; Vo=1.6V)

Feature Descriptions

Enable Control (ON/OFF)

There are two enable control pins in the NHT1 converter: ON/OFF pin (pin 12) and EN_VTT pin (pin 23). The ON/OFF pin is intended for use without VID, and the EN_VTT pin is intended for use with VID. The on/off of the converter is determined by the AND logic operation of the two signals at both pins. If only one of the two enable pins is used, the unused pin should be set to enable state.

The EN_VTT control is positive enabling logic while the enabling logic type of ON/OFF control is optional. The NHT1 converter can be ordered with positive or negative enabling logic ON/OFF control.

With the negative control logic, the converter is turned on when the ON/OFF pin is at logic low level, and turned off when the ON/OFF pin is at logic high level. With the positive control logic, the converter is turned on when the ON/OFF pin is at logic high level and turned off when the ON/OFF pin is at logic low level. Since there is no internal pull-up resistor inside the converter, the converter is turned on when ON/OFF pin is left open (unconnected), no matter what control logic of the converter is.

When EN_VTT pin is set to high (enable), the converter can be turned on and off by changing the voltage or resistance between the ON/OFF pin and GND. When ON/OFF pin is set to ON, the converter can be turned on with a voltage above 2V at EN_VTT pin, and turned off with a voltage below 0.5V at EN_VTT pin.

For a negative ON/OFF NHT1 converter, the enabling control function is:

$$Enable = \overline{ON/OFF} \cdot EN\_VTT$$

For a positive ON/OFF NHT1 converter, the enabling control function is:

$$Enable = ON/OFF \cdot EN\_VTT$$

Figure 14 is the recommended ON/OFF control circuit for positive logic modules, while Figure 15 is for negative logic modules. Recommended value of the pull up resistor R_{pull_up} is 50K. The maximum allowable leakage current of the switch device when it is off (at logic-high level) is 50μA.

The logic-low level is from 0V to 0.5V. The logic-high level is from 2.5V to input voltage.

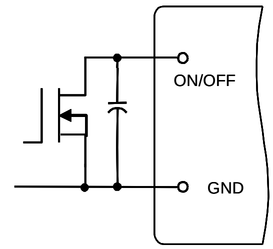


Figure 14. Circuit for Positive Logic ON/OFF Control

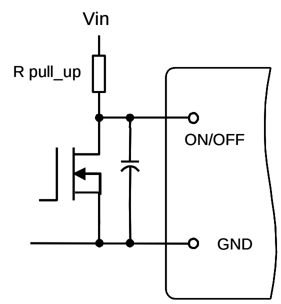


Figure 15. Circuit for Negative Logic ON/OFF Control

Remote sense

The remote sense feature makes the tight regulation at a load point possible. The Sense+ pin (pin 3) and the Sense- pin (pin 10) should be connected to the points where the regulation is desired. However, use of remote sense generally will lead to a higher output voltage at the power module output terminals. The output voltage of the module shall not exceed the operating range of this converter shown in the specification table.

The traces connecting Sense pins should not carry significant current for good load point voltage regulation accuracy.

When remote sense is not used, the Sense pins should be connected to the corresponding output terminals. If the Sense pins are left floating, the converter may deliver an output voltage slightly higher than the specified output voltage.

Output Voltage Adjustment without VID

For an NHT module without VID feature, the output voltage can be preset to a voltage between 0.5-1.6V. If the NHT module is without I-Share option, trim feature is available. With trim feature, the output voltage can be adjusted down based on the preset output voltage using an external resistor R_{trim_down} between the TRIM pin (pin 11) and the Sense- pin (pin 10).

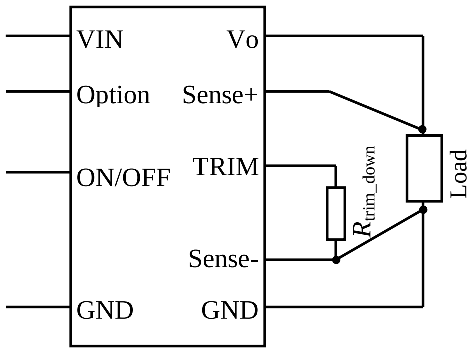


Figure 16. Circuit configuration for output voltage trim down

The circuit configuration for trim down is shown in Figure 16. Because the output voltage regulation circuit uses Sense- as the reference, R_{trim_down} should be placed as close possible to Sense- pin.

The trim down resistance R_{trim_down} is determined by below equation:

$$R_{trim\_down} = \frac{400}{\Delta V_o} (\Omega)$$

Where,

$\Delta V_o = |Vo - Vonom|$ — Difference between the preset output voltage and the trimmed output voltage, unit volt.

The Maximum trim down ratio is 25% of the preset output voltage (Vonom).

Output Voltage Adjustment with VID

For modules with VID feature, the output voltage can be programmed through signals applied to pins ID0 – ID7. The voltage level on VRSEL pin is used to select between VR10 and VR11 standards. Logic low at VRSEL pin (tied to ground) selects VR10 and logic high (or floating) selects VR11. The coding for the output voltage under VR10 and VR11 are provided in Table 1 and Table 2, respectively.

Power Good Signal (VR_RDY)

VR_RDY is an open drain logic output signal. An external pull-up resistor is required. After soft start process completes and the output voltage reaches its set point, VR_RDY becomes logic high. With “VID” option, the VR_RDY signal is provided at pin 18. With “no VID” option, the VR_RDY signal is one of the three optional signals (VR_RDY, VR_FAN, or IOUT) provided at pin 14.

Fan Control Signal (VR_FAN) and Module Hot Signal (VR_HOT)

VR_FAN and VR_HOT are both open drain logic output signals. External pull-up resistors are required. VR_FAN is designed to provide a control signal to the cooling fan. It becomes logic high when a temperature sensor on the module reaches 100°C typical; and it returns to logic low when the temperature at the sensor decreases to around 90°C typical. VR_HOT is designed to inform the system that the module is overheating and the system controller should reduce its load. It becomes logic high when the sensor temperature reaches 110°C typical; and it returns to logic low when the temperature at the sensor decreases to 100°C typical. With “VID” option, VR_FAN and VR_HOT signals are provided at pin 19 and pin 21, respectively. With “no VID” option, VR_FAN signal is one of the three optional signals (VR_RDY, VR_FAN, or IOUT) provided at pin 14 and VR_HOT is not provided.

Output Current Monitor (IOUT)

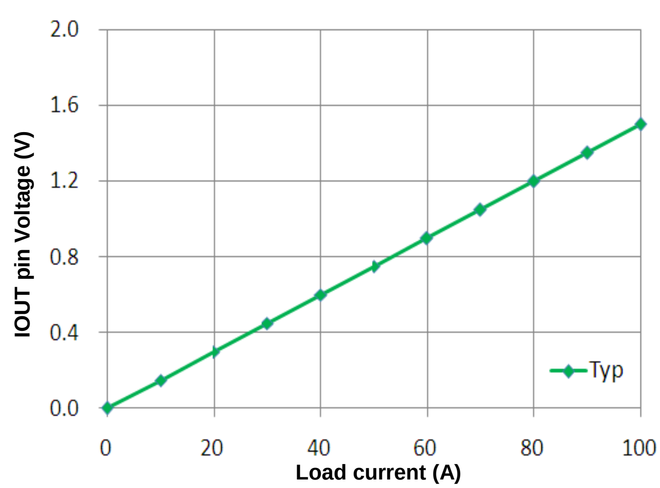


Figure 17. IOUT Pin Voltage vs. Load Current

The IOUT is an analog voltage signal proportional to the load current. With "no VID" option, the IOUT signal is one of the three optional signals (VR_RDY, VR_FAN, or IOUT) provided at pin 14. With "VID" option, pin 14 is fixed to IOUT. Therefore the "Electrical Option 2" in the Part Numbering System Table must be "2". Figure 17 shows the curve of the voltage at IOUT pin vs. the load current. The detecting accuracy of the IOUT is ±10%.

Active load current sharing (I-Share)

Active load current sharing technique is used in the NHT module to allow multiple NHT modules operating in parallel to share the load current while keeping the tight regulation accuracy. The active load current sharing (I-Share) feature is one of the four options designated at "Electrical Option 2" in the part numbering system. To keep a better load sharing accuracy, maximum four NHT modules in parallel is recommended.

The circuit configuration for NHT modules operating in parallel is shown in Figure 18. All the Trim pins should be connected together and all the Option pins should be connected together. The ON/OFF pins should be connected together as well to use the same enable signal.

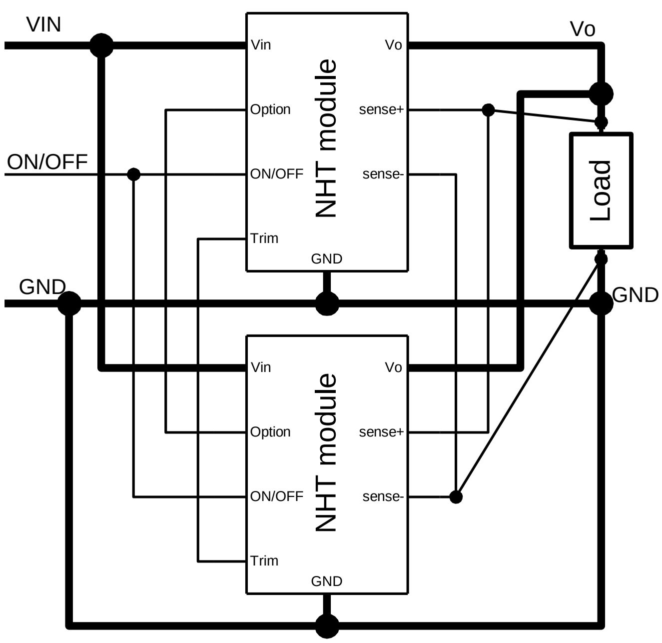


Figure 18. Circuit configuration for active load sharing

Note that if the I-Share option is selected, the trim feature is no longer available and the Trim pin serves as a signal pin connected among the paralleling modules. The signals through Opation pins and Trim pins are noise sensitive. The loop formed by the traces connecting the Option pins and Trim pins should be minimized to avoid noise coupling into the modules.

It is recommended that the input and output power traces for the NHT converters are arranged in symmetrical way and all the converters see even airflow.

Input Under-Voltage Lockout

This feature prevents the converter from turning on until the input voltage reaches 7.5V typical, and turns the converter off when the input voltage drops down to 6.5V typical.

Output Over-Current Protection

As a standard feature, the converter shuts off when the load current exceeds the current limit. If the over-current or short circuit condition persists, the converter will operate in a hiccup mode (repeatedly trying to restart) until the over-current condition is cleared.

Thermal Shutdown

The converter has a temperature sensor that detects the thermal condition of the converter. The converter shuts off when the temperature at the sensor reaches 130°C. The converter will resume operation after it cools down.

Output Over-Voltage and Under-Voltage Protection

If the output voltage sensed is 50% lower or 0.175V higher than the set point, the converter will enter hiccup mode. The converter automatically resumes normal operation after the fault condition is cleared.

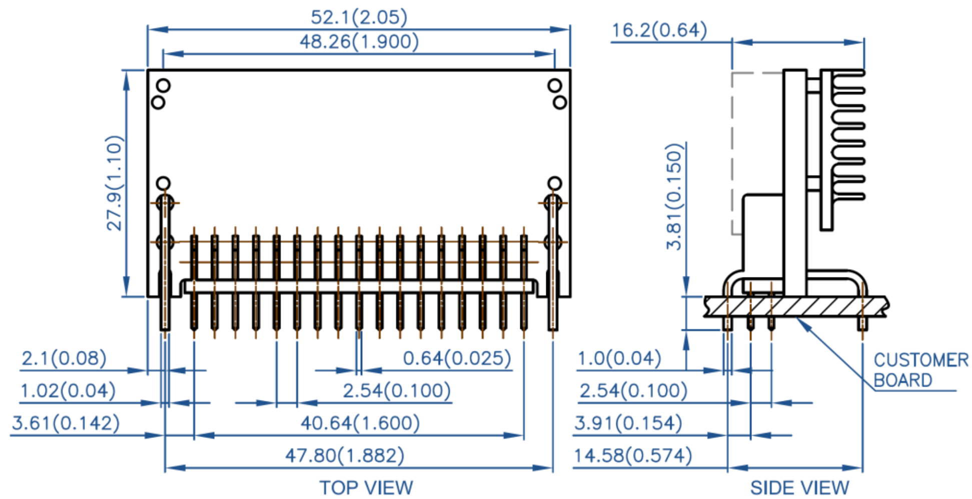
Design Considerations

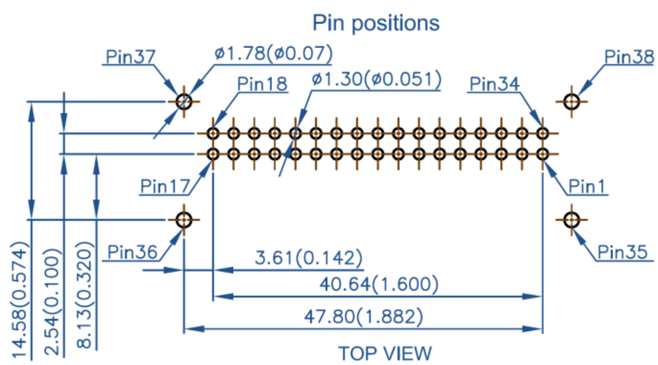
The stability of DC/DC converter will be compromised if the source impedance is high, especially in inductive impedance. It's desirable to keep the input source AC impedance as low as possible. To reduce switching frequency ripple current getting into the input circuit (especially the ground/return conductor), it is desirable to place some low ESR capacitors at the input. Due to the existence of some inductance (such as the trace inductance, connector inductance, etc.) in the input circuit, possible oscillation may occur at the input of the converter. Because the relatively high input current of low input voltage power system, it may not be practical or economical to have separate damping or soft start circuit in front of POL converters. We recommend using a combination of ceramic capacitors and Tantalum/Polymer capacitors at the input, so the relatively higher ERS of Tantalum/Polymer capacitors can help to damp the possible oscillation.

The converter is designed to be stable without additional output capacitors. To further reduce the output voltage ripple and improve the transient response, additional output capacitors are often used in applications. When additional output capacitors are used, a combination of ceramic capacitors and tantalum/polymer capacitors shall be used to provide good filtering while assuring the stability of the converter.

Mechanical Information

Vertical Version





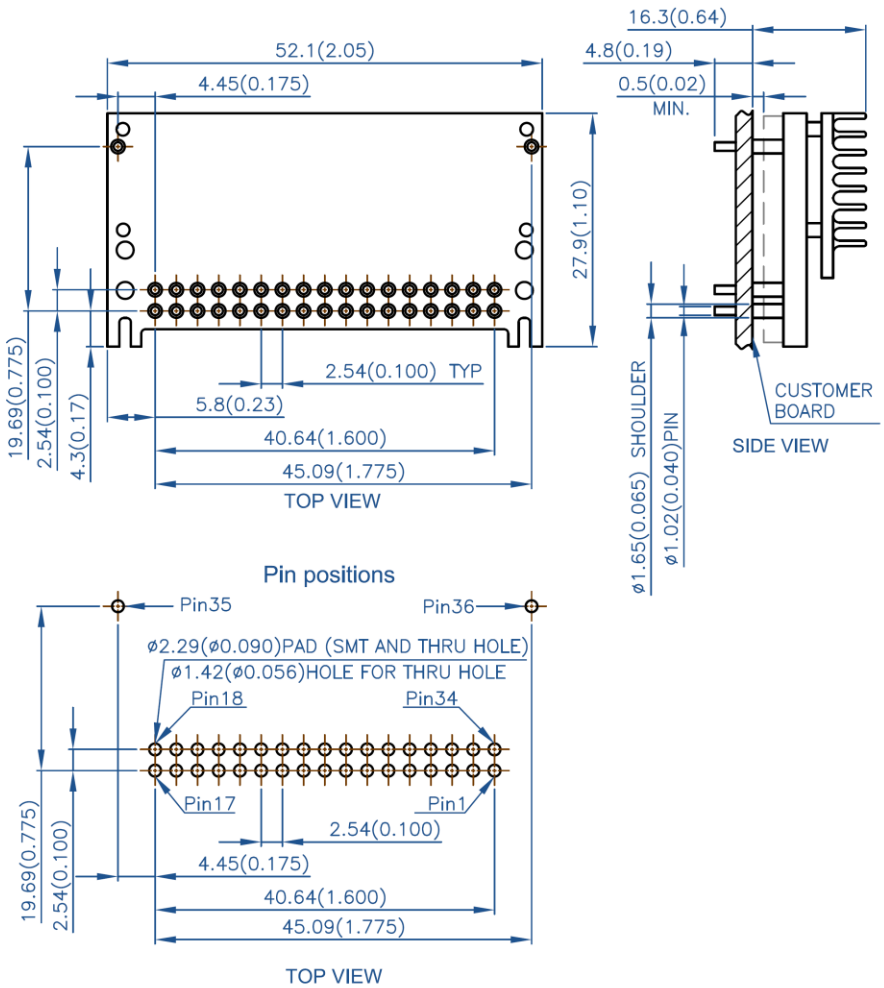
Pin Definition

Vo	Vo	VRSEL	ID0	ID1	ID2	ID3	ID4	ID5	ID6	ID7	EN_VTT	VIN	VR_HOT	GND	VR_FAN	VR_RDY
34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Vo	Vo	Sense+	Vo	GND	GND	Vo	Vo	Vo	Sense-	TRIM	ON/OFF	VIN	OPTION	GND	VIN	VIN

35	36	37	38
GND	GND	GND	GND

Pin35 - Pin38 are supporter and GND pins. They must be connected to ground.

Horizontal Version



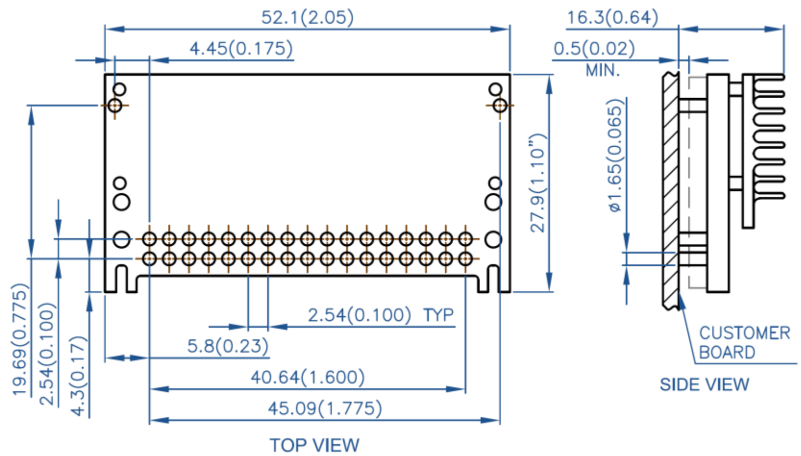
Pin Definition

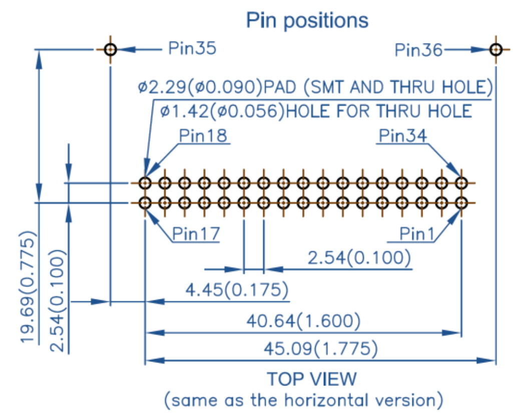
Vo	Vo	VRSEL	ID0	ID1	ID2	ID3	ID4	ID5	ID6	ID7	EN_VTT	VIN	VR_HOT	GND	VR_FAN	VR_RDY
34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Vo	Vo	Sense+	Vo	GND	GND	Vo	Vo	Vo	Sense-	TRIM	ON/OFF	VIN	OPTION	GND	VIN	VIN

35	36
GND	GND

Pin35 and Pin36 are supporter and GND pins. They must be connected to ground.

SMT Version





Notes

1) All dimensions in mm (inch) (1 inch = 25.4mm).
Tolerances:
.x (.xx): ± 0.5 (0.020'')
.xxx: ± 0.25 (0.010'')
2) All pins are coated with 90%/10% solder, Gold, or Matte Tin finish with Nickel under plating.
3) When "No VID" is selected in the part number, Pin 18 through Pin 34 will not be installed
4) Workmanship: Meet or exceeds IPC-A-610 Class II

Pin Definition

Vo	Vo	VRSEL	ID0	ID1	ID2	ID3	ID4	ID5	ID6	ID7	EN_VTT	VIN	VR_HOT	GND	VR_FAN	VR_RDY
34	33	32	31	30	29	28	27	26	25	24	23	22	21	20	19	18
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Vo	Vo	Sense+	Vo	GND	GND	Vo	Vo	Vo	Sense-	TRIM	ON/OFF	VIN	OPTION	GND	VIN	VIN

35	36
GND	GND

Pin35 and Pin36 are supporter and GND pins. They must be connected to ground.

Table 1: VR10 ID Table (with 6.25mV Extension)

ID4 400mV	ID3 200mV	ID2 100mV	ID1 50mV	ID0 25mV	ID5 12.5mV	ID6 6.25mV	VOLTAGE (V)
0	1	0	1	0	1	1	1.60000
0	1	0	1	0	1	0	1.59375
0	1	0	1	1	0	1	1.58750
0	1	0	1	1	0	0	1.58125
0	1	0	1	1	1	1	1.57500
0	1	0	1	1	1	0	1.56875
0	1	1	0	0	0	1	1.56250
0	1	1	0	0	0	0	1.55625
0	1	1	0	0	1	1	1.55000
0	1	1	0	0	1	0	1.54375
0	1	1	0	1	0	1	1.53750
0	1	1	0	1	0	0	1.53125
0	1	1	0	1	1	1	1.52500
0	1	1	0	1	1	0	1.51875
0	1	1	1	0	0	1	1.51250
0	1	1	1	0	0	0	1.50625
0	1	1	1	0	1	1	1.50000
0	1	1	1	0	1	0	1.49375
0	1	1	1	1	0	1	1.48750
0	1	1	1	1	0	0	1.48125
0	1	1	1	1	1	1	1.47500
0	1	1	1	1	1	0	1.46875
1	0	0	0	0	0	1	1.46250
1	0	0	0	0	0	0	1.45625
1	0	0	0	0	1	1	1.45000
1	0	0	0	0	1	0	1.44375
1	0	0	0	1	0	1	1.43750
1	0	0	0	1	0	0	1.43125
1	0	0	0	1	1	1	1.42500
1	0	0	0	1	1	0	1.41875
1	0	0	1	0	0	1	1.41250
1	0	0	1	0	0	0	1.40625
1	0	0	1	0	1	1	1.40000
1	0	0	1	0	1	0	1.39375
1	0	0	1	1	0	1	1.38750
1	0	0	1	1	0	0	1.38125
1	0	0	1	1	1	1	1.37500
1	0	0	1	1	1	0	1.36875
1	0	1	0	0	0	1	1.36250
1	0	1	0	0	0	0	1.35625
1	0	1	0	0	1	1	1.35000
1	0	1	0	0	1	0	1.34375
1	0	1	0	1	0	1	1.33750
1	0	1	0	1	0	0	1.33125
1	0	1	0	1	1	1	1.32500
1	0	1	0	1	1	0	1.31875
1	0	1	1	0	0	1	1.31250
1	0	1	1	0	0	0	1.30625
1	0	1	1	0	1	1	1.30000
1	0	1	1	0	1	0	1.29375
1	0	1	1	1	0	1	1.28750
1	0	1	1	1	0	0	1.28125
1	0	1	1	1	1	1	1.27500
1	0	1	1	1	1	0	1.26875
1	1	0	0	0	0	1	1.26250
1	1	0	0	0	0	0	1.25625
1	1	0	0	0	1	1	1.25000

ID4 400mV	ID3 200mV	ID2 100mV	ID1 50mV	ID0 25mV	ID5 12.5mV	ID6 6.25mV	VOLTAGE (V)
1	1	0	0	0	1	0	1.24375
1	1	0	0	1	0	1	1.23750
1	1	0	0	1	0	0	1.23125
1	1	0	0	1	1	1	1.22500
1	1	0	0	1	1	0	1.21875
1	1	0	1	0	0	1	1.21250
1	1	0	1	0	0	0	1.20625
1	1	0	1	0	1	1	1.20000
1	1	0	1	0	1	0	1.19375
1	1	0	1	1	0	1	1.18750
1	1	0	1	1	0	0	1.18125
1	1	0	1	1	1	1	1.17500
1	1	0	1	1	1	0	1.16875
1	1	1	0	0	0	1	1.16250
1	1	1	0	0	0	0	1.15625
1	1	1	0	0	1	1	1.15000
1	1	1	0	0	1	0	1.14375
1	1	1	0	1	0	1	1.13750
1	1	1	0	1	0	0	1.13125
1	1	1	0	1	1	1	1.12500
1	1	1	0	1	1	0	1.11875
1	1	1	1	0	0	1	1.11250
1	1	1	1	0	0	0	1.10625
1	1	1	1	0	1	1	1.10000
1	1	1	1	0	1	0	1.09375
1	1	1	1	1	0	1	OFF
1	1	1	1	1	0	0	OFF
1	1	1	1	1	1	1	OFF
1	1	1	1	1	1	0	OFF
0	0	0	0	0	0	1	1.08750
0	0	0	0	0	0	0	1.08125
0	0	0	0	0	1	1	1.07500
0	0	0	0	0	1	0	1.06875
0	0	0	0	1	0	1	1.06250
0	0	0	0	1	0	0	1.05625
0	0	0	0	1	1	1	1.05000
0	0	0	0	1	1	0	1.04375
0	0	0	1	0	0	1	1.03750
0	0	0	1	0	0	0	1.03125
0	0	0	1	0	1	1	1.02500
0	0	0	1	0	1	0	1.01875
0	0	0	1	1	0	1	1.01250
0	0	0	1	1	0	0	1.00625
0	0	0	1	1	1	1	1.00000
0	0	0	1	1	1	0	0.99375
0	0	1	0	0	0	1	0.98750
0	0	1	0	0	0	0	0.98125
0	0	1	0	0	1	1	0.97500
0	0	1	0	0	1	0	0.96875
0	0	1	0	1	0	1	0.96250
0	0	1	0	1	0	0	0.95625
0	0	1	0	1	1	1	0.95000
0	0	1	0	1	1	0	0.94375
0	0	1	1	0	0	1	0.93750
0	0	1	1	0	0	0	0.93125
0	0	1	1	0	1	1	0.92500
0	0	1	1	0	1	0	0.91875

Table 1: VR10 ID Table (with 6.25mV Extension) (continued)

ID4	ID3	ID2	ID1	ID0	ID5	ID6	VOLTAGE
400mV	200mV	100mV	50mV	25mV	12.5mV	6.25mV	(V)
0	0	1	1	1	0	1	0.91250
0	0	1	1	1	0	0	0.90625
0	0	1	1	1	1	1	0.90000
0	0	1	1	1	1	0	0.89375
0	1	0	0	0	0	1	0.88750
0	1	0	0	0	0	0	0.88125
0	1	0	0	0	1	1	0.87500
0	1	0	0	0	1	0	0.86875
0	1	0	0	1	0	1	0.86250
0	1	0	0	1	0	0	0.85625
0	1	0	0	1	1	1	0.85000
0	1	0	0	1	1	0	0.84375
0	1	0	1	0	0	1	0.83750
0	1	0	1	0	0	0	0.83125

Table 2: VR11 VID 8-BIT

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	VOLTAGE
0	0	0	0	0	0	0	0	OFF
0	0	0	0	0	0	0	1	OFF
0	0	0	0	0	0	1	0	1.60000
0	0	0	0	0	0	1	1	1.59375
0	0	0	0	0	1	0	0	1.58750
0	0	0	0	0	1	0	1	1.58125
0	0	0	0	0	1	1	0	1.57500
0	0	0	0	0	1	1	1	1.56875
0	0	0	0	1	0	0	0	1.56250
0	0	0	0	1	0	0	1	1.55625
0	0	0	0	1	0	1	0	1.55000
0	0	0	0	1	0	1	1	1.54375
0	0	0	0	1	1	0	0	1.53750
0	0	0	0	1	1	0	1	1.53125
0	0	0	0	1	1	1	0	1.52500
0	0	0	0	1	1	1	1	1.51875
0	0	0	1	0	0	0	0	1.51250
0	0	0	1	0	0	0	1	1.50625
0	0	0	1	0	0	1	0	1.50000
0	0	0	1	0	0	1	1	1.49375
0	0	0	1	0	1	0	0	1.48750
0	0	0	1	0	1	0	1	1.48125
0	0	0	1	0	1	1	0	1.47500
0	0	0	1	0	1	1	1	1.46875
0	0	0	1	1	0	0	0	1.46250
0	0	0	1	1	0	0	1	1.45625
0	0	0	1	1	0	1	0	1.45000
0	0	0	1	1	0	1	1	1.44375
0	0	0	1	1	1	0	0	1.43750
0	0	0	1	1	1	0	1	1.43125
0	0	0	1	1	1	1	0	1.42500
0	0	0	1	1	1	1	1	1.41875
0	0	1	0	0	0	0	0	1.41250
0	0	1	0	0	0	0	1	1.40625
0	0	1	0	0	0	1	0	1.40000
0	0	1	0	0	0	1	1	1.39375
0	0	1	0	0	1	0	0	1.38750
0	0	1	0	0	1	0	1	1.38125
0	0	1	0	0	1	1	0	1.37500

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	VOLTAGE
0	0	1	0	0	1	1	1	1.36875
0	0	1	0	1	0	0	0	1.36250
0	0	1	0	1	0	0	1	1.35625
0	0	1	0	1	0	1	0	1.35000
0	0	1	0	1	0	1	1	1.34375
0	0	1	0	1	1	0	0	1.33750
0	0	1	0	1	1	0	1	1.33125
0	0	1	0	1	1	1	0	1.32500
0	0	1	0	1	1	1	1	1.31875
0	0	1	1	0	0	0	0	1.31250
0	0	1	1	0	0	0	1	1.30625
0	0	1	1	0	0	1	0	1.30000
0	0	1	1	0	0	1	1	1.29375
0	0	1	1	0	1	0	0	1.28750
0	0	1	1	0	1	0	1	1.28125
0	0	1	1	0	1	1	0	1.27500
0	0	1	1	0	1	1	1	1.26875
0	0	1	1	1	0	0	0	1.26250
0	0	1	1	1	0	0	1	1.25625
0	0	1	1	1	0	1	0	1.25000
0	0	1	1	1	0	1	1	1.24375
0	0	1	1	1	1	0	0	1.23750
0	0	1	1	1	1	0	1	1.23125
0	0	1	1	1	1	1	0	1.22500
0	0	1	1	1	1	1	1	1.21875
0	1	0	0	0	0	0	0	1.21250
0	1	0	0	0	0	0	1	1.20625
0	1	0	0	0	0	1	0	1.20000
0	1	0	0	0	0	1	1	1.19375
0	1	0	0	0	1	0	0	1.18750
0	1	0	0	0	1	0	1	1.18125
0	1	0	0	0	1	1	0	1.17500
0	1	0	0	0	1	1	1	1.16875
0	1	0	0	1	0	0	0	1.16250
0	1	0	0	1	0	0	1	1.15625
0	1	0	0	1	0	1	0	1.15000
0	1	0	0	1	0	1	1	1.14375
0	1	0	0	1	1	0	0	1.13750
0	1	0	0	1	1	0	1	1.13125

Table 2: VR11 VID 8-BIT (continued)

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	VOLTAGE
0	1	0	0	1	1	1	0	1.12500
0	1	0	0	1	1	1	1	1.11875
0	1	0	1	0	0	0	0	1.11250
0	1	0	1	0	0	0	1	1.10625
0	1	0	1	0	0	1	0	1.10000
0	1	0	1	0	0	1	1	1.09375
0	1	0	1	0	1	0	0	1.08750
0	1	0	1	0	1	0	1	1.08125
0	1	0	1	0	1	1	0	1.07500
0	1	0	1	0	1	1	1	1.06875
0	1	0	1	1	0	0	0	1.06250
0	1	0	1	1	0	0	1	1.05625
0	1	0	1	1	0	1	0	1.05000
0	1	0	1	1	0	1	1	1.04375
0	1	0	1	1	1	0	0	1.03750
0	1	0	1	1	1	0	1	1.03125
0	1	0	1	1	1	1	0	1.02500
0	1	0	1	1	1	1	1	1.01875
0	1	1	0	0	0	0	0	1.01250
0	1	1	0	0	0	0	1	1.00625
0	1	1	0	0	0	1	0	1.00000
0	1	1	0	0	0	1	1	0.99375
0	1	1	0	0	1	0	0	0.98750
0	1	1	0	0	1	0	1	0.98125
0	1	1	0	0	1	1	0	0.97500
0	1	1	0	0	1	1	1	0.96875
0	1	1	0	1	0	0	0	0.96250
0	1	1	0	1	0	0	1	0.95625
0	1	1	0	1	0	1	0	0.95000
0	1	1	0	1	0	1	1	0.94375
0	1	1	0	1	1	0	0	0.93750
0	1	1	0	1	1	0	1	0.93125
0	1	1	0	1	1	1	0	0.92500
0	1	1	0	1	1	1	1	0.91875
0	1	1	1	0	0	0	0	0.91250
0	1	1	1	0	0	0	1	0.90625
0	1	1	1	0	0	1	0	0.90000
0	1	1	1	0	0	1	1	0.89375
0	1	1	1	0	1	0	0	0.88750
0	1	1	1	0	1	0	1	0.88125
0	1	1	1	0	1	1	0	0.87500
0	1	1	1	0	1	1	1	0.86875
0	1	1	1	1	0	0	0	0.86250
0	1	1	1	1	0	0	1	0.85625
0	1	1	1	1	0	1	0	0.85000
0	1	1	1	1	0	1	1	0.84375
0	1	1	1	1	1	0	0	0.83750
0	1	1	1	1	1	0	1	0.83125
0	1	1	1	1	1	1	0	0.82500
0	1	1	1	1	1	1	1	0.81875
1	0	0	0	0	0	0	0	0.81250
1	0	0	0	0	0	0	1	0.80625
1	0	0	0	0	0	1	0	0.80000
1	0	0	0	0	0	1	1	0.79375
1	0	0	0	0	1	0	0	0.78750
1	0	0	0	0	1	0	1	0.78125
1	0	0	0	0	1	1	0	0.77500

ID7	ID6	ID5	ID4	ID3	ID2	ID1	ID0	VOLTAGE
1	0	0	0	0	1	1	1	0.76875
1	0	0	0	1	0	0	0	0.76250
1	0	0	0	1	0	0	1	0.75625
1	0	0	0	1	0	1	0	0.75000
1	0	0	0	1	0	1	1	0.74375
1	0	0	0	1	1	0	0	0.73750
1	0	0	0	1	1	0	1	0.73125
1	0	0	0	1	1	1	0	0.72500
1	0	0	0	1	1	1	1	0.71875
1	0	0	1	0	0	0	0	0.71250
1	0	0	1	0	0	0	1	0.70625
1	0	0	1	0	0	1	0	0.70000
1	0	0	1	0	0	1	1	0.69375
1	0	0	1	0	1	0	0	0.68750
1	0	0	1	0	1	0	1	0.68125
1	0	0	1	0	1	1	0	0.67500
1	0	0	1	0	1	1	1	0.66875
1	0	0	1	1	0	0	0	0.66250
1	0	0	1	1	0	0	1	0.65625
1	0	0	1	1	0	1	0	0.65000
1	0	0	1	1	0	1	1	0.64375
1	0	0	1	1	1	0	0	0.63750
1	0	0	1	1	1	0	1	0.63125
1	0	0	1	1	1	1	0	0.62500
1	0	0	1	1	1	1	1	0.61875
1	0	1	0	0	0	0	0	0.61250
1	0	1	0	0	0	0	1	0.60625
1	0	1	0	0	0	1	0	0.60000
1	0	1	0	0	0	1	1	0.59375
1	0	1	0	0	1	0	0	0.58750
1	0	1	0	0	1	0	1	0.58125
1	0	1	0	0	1	1	0	0.57500
1	0	1	0	0	1	1	1	0.56875
1	0	1	0	1	0	0	0	0.56250
1	0	1	0	1	0	0	1	0.55625
1	0	1	0	1	0	1	0	0.55000
1	0	1	0	1	0	1	1	0.54375
1	0	1	0	1	1	0	0	0.53750
1	0	1	0	1	1	0	1	0.53125
1	0	1	0	1	1	1	0	0.52500
1	0	1	0	1	1	1	1	0.51875
1	0	1	1	0	0	0	0	0.51250
1	0	1	1	0	0	0	1	0.50625
1	0	1	1	0	0	1	0	0.50000
1	1	1	1	1	1	1	0	OFF
1	1	1	1	1	1	1	1	OFF