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CUI INC

SERIES: NQB-D | **DESCRIPTION**: FULLY REGULATED ADVANCED BUS CONVERTERS

GENERAL CHARACTERISTICS

- configurable soft start/stop
- precision delay and ramp-up
- voltage margining
- voltage/current/temperature monitoring
- configurable output voltage
- configurable fault response
- power good

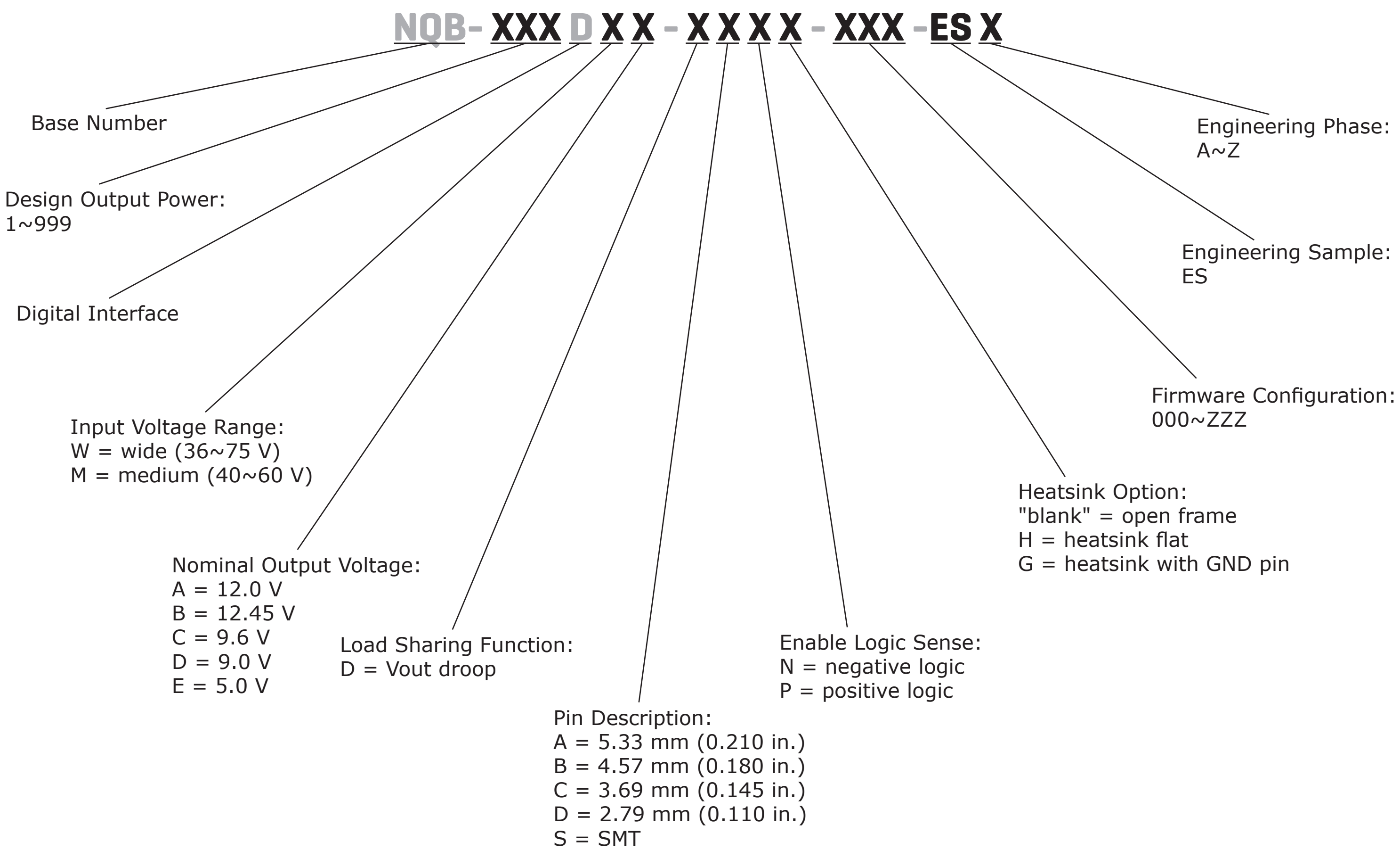
FEATURES

- pin and function compatible with Architects of Modern Power™ product standards
- quarter-brick with digital PMBus interface 57.9 x 36.8 x 11.3 mm (2.28 x 1.45 x 0.445 in)
- industry standard 5-pins for intermediate bus architectures
- industry-leading power density for telecom and datacom 127~141W / sq. in
- high efficiency, typ. 96.4% at half load, 12 Vout
- fully regulated advanced bus converter from 36~75Vin
- 2,250 Vdc input to output isolation
- fast feed forward regulation to manage line transients
- optional baseplate for high temperature applications
- droop load sharing with 10% current share accuracy
- PMBus Revision 1.2 compliant
- 2.9 million hours MTBF
- ISO 9001/14001 certified supplier

novum advanced power

MODEL	**input voltage** (Vdc)	**output voltage** (Vdc)	**output current** max (A)	**output wattage** max (W)
NQB-420DWA-AN	36~75	12	35	420
NQB-468DMA-AN	40~60	12	39	468
NQB-415DWB-AN	36~75	12.45	35	415
NQB-462DMB-AN	40~60	12.45	39	462

PART NUMBER KEY



Packaging:

20 converters(through hole pin)/tray, PE foam dissipative
20 converters(surface mount pin)/tray, Antistatic PPE

Example part number: **NQB-420DWA-AN-001**

420 W output power, digital pins
wide input voltage range, 12.0 V output
5.33 mm pins, negative enable logic
firmware revision 001

CONTENTS

General Information

Reliability

The failure rate (λ) and mean time between failures (MTBF= 1/ λ) is calculated at max output power and an operating ambient temperature (T_A) of +40°C. CUI Power Modules uses Telcordia SR-332 Issue 2 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ).

Telcordia SR-332 Issue 2 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

Mean steady-state failure rate, λ	Std. deviation, σ
421 n Failures/h	60.9 nFailures/h

MTBF (mean value) for the NQB series = 2.9 Mh.
MTBF at 90% confidence level = 2.4 Mh

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in CUI Power Modules products are found in the Statement of Compliance document.

Safety Specification

Reliability

CUI Power Modules DC/DC converters and DC/DC regulators are designed in accordance with the safety standards IEC 60950 1, EN 60950 1 and UL 60950 1 Safety of Information Technology Equipment.

IEC/EN/UL 60950 1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards

On-board DC/DC converters and DC/DC regulators are defined as component power supplies. As components they cannot fully comply with the provisions of any safety requirements without “conditions of acceptability”. Clearance between conductors and between conductive parts of the component power supply and conductors on the board in the final product must meet the applicable safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information for further information). It is the responsibility of the installer to ensure that the final product housing these components complies with the requirements of all applicable safety standards and regulations for the final product.

Component power supplies for general use should comply with the requirements in IEC/EN/UL 60950 1 *Safety of Information Technology Equipment*. Product related standards, e.g. IEEE 802.3af *Power over Ethernet*, and ETS 300132 2 *Power interface at the input to telecom equipment, operated by direct current (dc)* are based on IEC/EN/UL 60950 1 with regards to safety.

CUI Power Modules DC/DC converters and DC/DC regulators are UL 60950 1 recognized and certified in accordance with EN 60950 1. The flammability rating for all construction parts of the products meet requirements for V 0 class material according to IEC 60695 11 10, *Fire hazard testing, test flames* – 50 W horizontal and vertical flame test methods.

Isolated DC/DC converters

Galvanic isolation between input and output is verified in an electric strength test and the isolation voltage (V_{iso}) meets the voltage strength requirement for basic insulation according to IEC/EN/UL 60950-1.

It is recommended to use a slow blow fuse at the input of each DC/DC converter. If an input filter is used in the circuit the fuse should be placed in front of the input filter. In the rare event of a component problem that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the fault from the input power source so as not to affect the operation of other parts of the system
- Protect the distribution wiring from excessive current and power loss thus preventing hazardous overheating

The DC/DC converter output is considered as safety extra low voltage (SELV) if one of the following conditions is met:

- The input source has double or reinforced insulation from the AC mains according to IEC/EN/UL 60950-1
- The input source has basic or supplementary insulation from the AC mains and the input of the DC/DC converter is maximum 60 Vdc and connected to protective earth according to IEC/EN/UL 60950-1
- The input source has basic or supplementary insulation from the AC mains and the DC/DC converter output is connected to protective earth according to IEC/EN/UL 60950-1

Non - isolated DC/DC regulators

The DC/DC regulator output is SELV if the input source meets the requirements for SELV circuits according to IEC/EN/UL 60950-1.

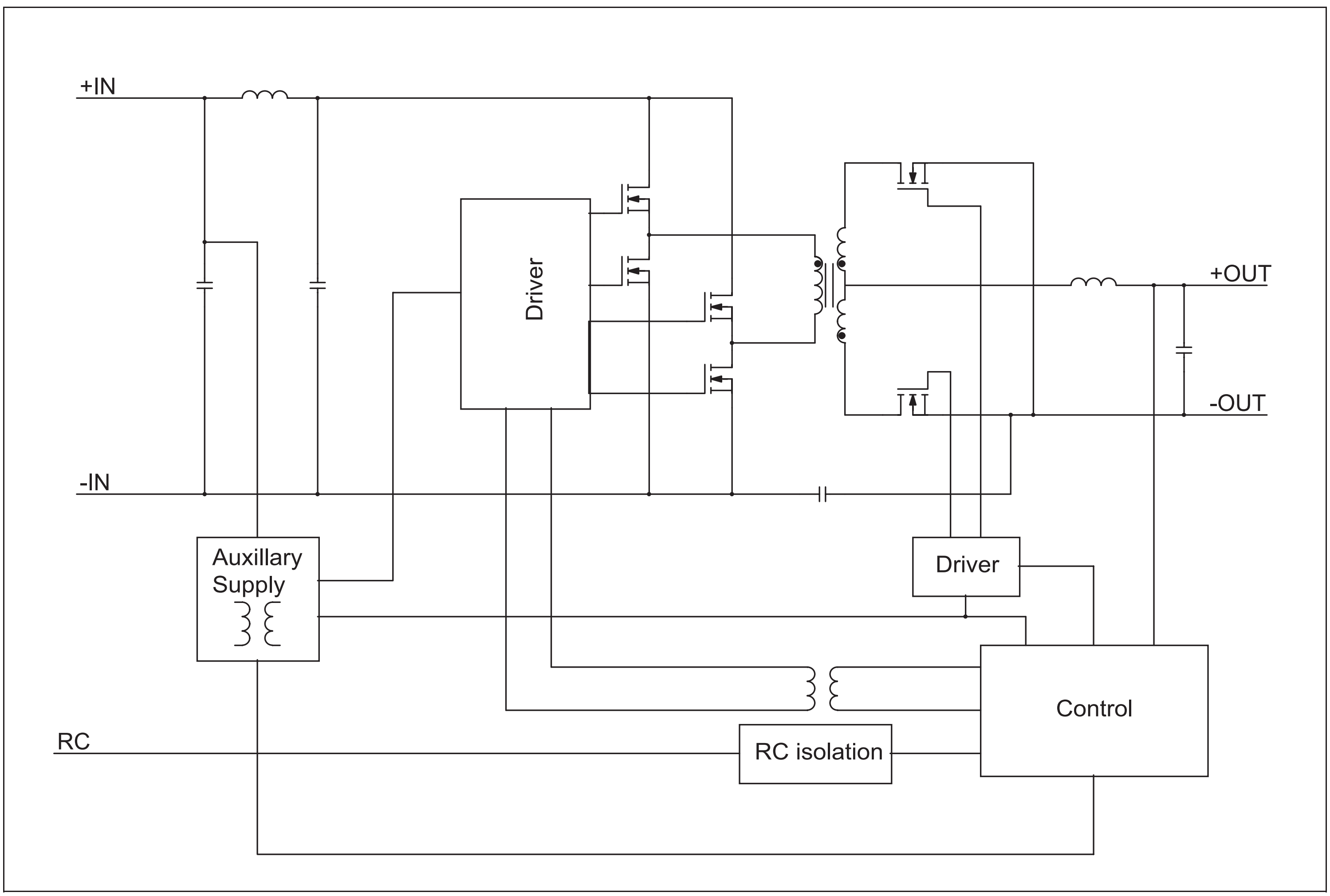
Absolute Maximum Ratings

parameter	conditions/description	min	typ	max	units
operating temperature (T_{P1})	see thermal consideration section	-40		+125	°C
storage temperature (T_S)		-55		+125	°C
input voltage (V_I)		-0.5		+80 +65*	V
isolation voltage (V_{iso})	input to output test voltage, see note 1			2250	Vdc
input voltage transient (V_{tr})	according to ETSI EN 300 132-2 and Telcordia GR-1089-CORE			+100 +80*	V
remote control pin voltage (V_{RC})	see operating information section	-0.3		18	V
SALERT, CTRL, SCL, SDA, SA0, SA1 (V Logic I/O)		-0.3		3.6	V

Stress in excess of Absolute Maximum Ratings may cause permanent damage. Absolute Maximum Ratings, sometimes referred to as no destruction limits, are normally tested with one parameter at a time exceeding the limits of Output data or Electrical Characteristics. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Note 1: Isolation voltage (input/output to base-plate) max 750 Vdc.
* Applies for the narrow input version V_I= 40-60 V

Fundamental Circuit Diagram



Functional Description

T_{P1}, T_{P3} = -40 to +90ºC, V_I = 36 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1}, T_{P3} = +25°C, V_I= 53 V, max I_O , unless otherwise specified under Conditions
Configuration File: 190 10-CDA 102 0314/001

parameter	conditions/description	min	typ	max	units
PMBus monitoring accuracy					
input voltage (VIN_READ)		-2	±0.2	2	%
output voltage (VOUT_READ)	V_I = 53V	-1.0	±0.1	1.0	%
output current (IOUT_READ)	V_I = 53V, 50-100% of max I_O V_I = 53V, 10% of max I_O	-6 -0.6	±0.15	6 0.6	% A
temperature (TEMP_READ)		-5	±3.5	5	ºC
fault protection characteristics					
input under voltage lockout (UVLO)	factory default setpoint accuracy hysteresis: factory default hysteresis: configurable via PMBus of threshold range, note 1 delay	 -2 0 	33 2 300	 2 	V % V V µs
output voltage - under voltage protection (VOUT_UV_FAULT_ LIMIT)	factory default configurable via PMBus, note 1 fault response time	 0 	0 200	 16 	V V µs
output voltage - over voltage protection (VOUT_OV_FAULT_ LIMIT)	factory default configurable via PMBus, note 1 fault response time	 V_{OUT} 	15.6 200	 16 	V V µs
over current protection (OCP)	setpoint accuracy (I_O) IOUT_OC_FAULT_LIMIT factory default IOUT_OC_FAULT_LIMIT, configurable via PMBus, note 1 fault response time	-6 0 	 41 200	6 100 	% A A µs
over temperature protection (OTP)	OTP_FAULT_LIMIT, factory default OTP_FAULT_LIMIT, configurable via PMBus, note 1 hysteresis, factory default hysteresis, configurable via PMBus, note 1 fault response time	 -50 0 	125 10 300	 125 125 	ºC ºC ºC ºC µs
logic input/output characteristics					
logic input low (V_{IL})	CTRL, SA0, SA1, PG, SCL, SDA			1.1	V
logic input high (V_{IH})	CTRL, SA0, SA1, PG, SCL, SDA	2.1			V
logic output low (V_{OL})	CTRL, PG, SALERT, SCL, SDA I_{OL} = 6 mA			0.25	V
logic output high (V_{OH})	CTRL, PG, SALERT, SCL, SDA I_{OH} = -6 mA	2.7			V
bus free time T(BUF)	note 2	1.3			µs

Note 1: See Operating Information section.
2: PMBus timing parameters according to PMBus spec.

Electrical Specification
12.0 V, 35 A, 420 W

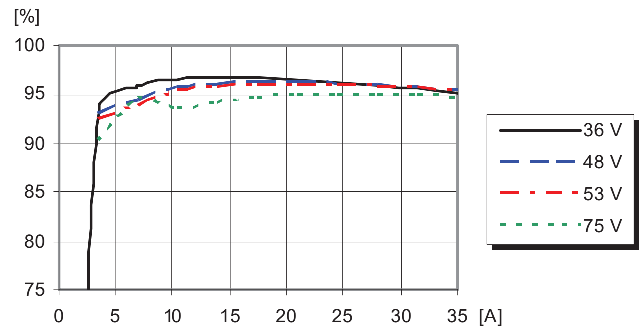
T_{P1}, T_{P3} = -40 to +90ºC, V_I = 36 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, max I_O, unless otherwise specified under Conditions.
Additional C_{out} = 3.5 mF, Configuration File: 19010-CDA 102 0314/001

parameter	conditions/description	min	typ	max	units
input voltage range (V_I)		36		75	V
turn-off input voltage (V_{Ioff})	decreasing input voltage	32	33	34	V
turn-on input voltage (V_{Ion})	increasing input voltage	34	35	36	V
internal input capacitance (C_I)			18		μF
output power (P_O)		0		420	W
efficiency (η)	50% of max I_O max I_O 50% of max I_O, V_I = 48 V max I_O, V_I = 48 V		96.2 95.5 96.4 95.5		% % % %
power dissipation (P_d)	max I_O		19.8	29.5	W
input idling power (P_{li})	I_O = 0 A, V_I = 53 V		3.3		W
input standby power (P_{RC})	V_I = 53 V (turned off with RC)		0.4		W
default switching frequency (f_s)	0-100% of max I_O	133	140	147	kHz
output voltage initial setting and accuracy (V_{Oi})	T_{P1} = +25°C, V_I = 53 V, I_O = 35 A	11.88	12.0	12.12	V
output adjust range (V_O)	see operating information	4.0		13.2	V
output voltage tolerance band (V_O)	0-100% of max I_O	11.76		12.24	V
line regulation (V_O)	max I_O		21	55	mV
load regulation (V_O)	V_I = 53 V, 0-100% of max I_O		6	40	mV
load transient voltage deviation (V_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		±0.4		V
load transient recovery time (t_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		150		μs
ramp-up time (t_r) - (from 10−90% of V_{Oi})	10-100% of max I_O, T_{P1}, T_{P3} = 25ºC, V_I = 53 V		8		ms
start-up time (t_s) - (from V_I connection to 90% of V_{Oi})	10-100% of max I_O, T_{P1}, T_{P3} = 25ºC, V_I = 53 V		24		ms
V_I shut-down fall time (t_f) - (from V_I off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		3.6 7		ms s
RC start-up time (t_{RC})	max I_O		12		ms
RC shut-down fall time (t_{RC}) - (from RC off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		5.1 7		ms s
output current (I_O)		0		35	A
current limit threshold (I_{lim})	V_O = 10.8 V, T_{P1}, T_{P3} < max T_{P1}, T_{P3}	37	41	44	A
short circuit current (I_{sc})	T_{P1}, T_{P3} = 25ºC, see Note 1		12		A
recommended capacitive load (C_{out})	T_{P1}, T_{P3} = 25ºC, see Note 2	0.1	3.5	6	mF
output ripple & noise (V_{Oac})	See ripple & noise section, max I_O , see Note 3		60	150	mVp-p
over voltage protection (OVP)	T_{P1}, T_{P3} = 25°C, V_I = 53 V, 10-100% of max I_O		15.6		V
remote control (RC)	sink current (note 4), see operating information trigger level, decreasing RC-voltage trigger level, increasing RC-voltage		 2.6 2.9	0.7 	mA V V

Note 1: OCP in hic-up mode
2: Low ESR-value
3: C_{out} = 100 μF, external capacitance
4: Sink current drawn by external device connected to the RC pin. Minimum sink current required guaranteeing activated RC function.

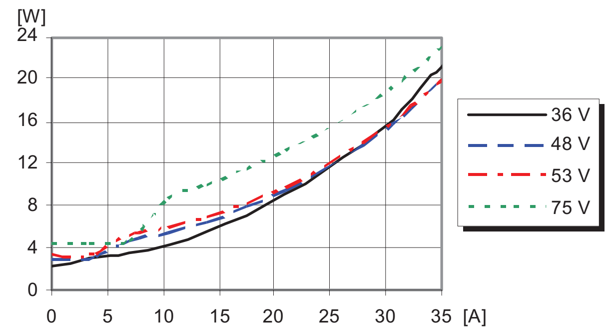
Typical Characteristics
12.0 V, 35 A / 420 W

Efficiency



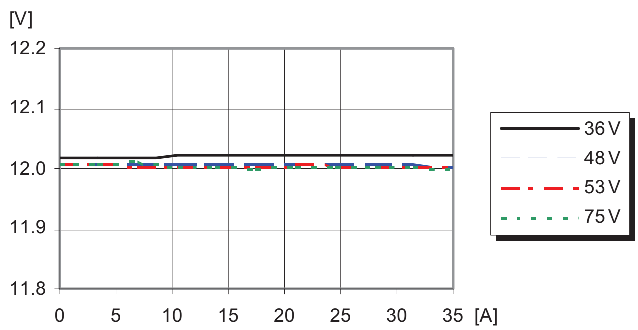
Efficiency vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Power Dissipation



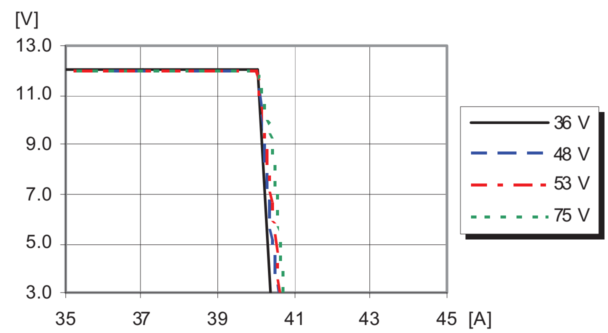
Dissipated power vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Output Characteristics



Output voltage vs. load current at T_{P1}, T_{P3} = +25°C

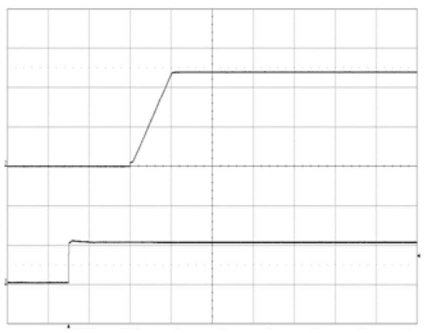
Current Limit Characteristics



Output voltage vs. load current at I_O > max I_O, T_{P1}, T_{P3} = +25°C

Typical Characteristics
12.0 V, 35 A / 420 W

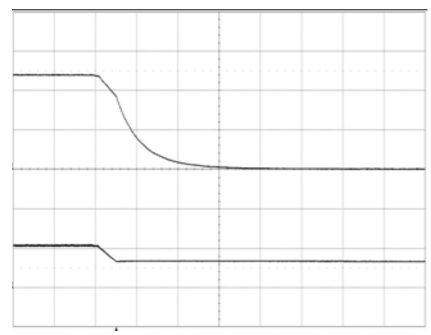
Start-up



Start-up enabled by connecting V_I at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, I_O = 35 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (10 ms/div.).

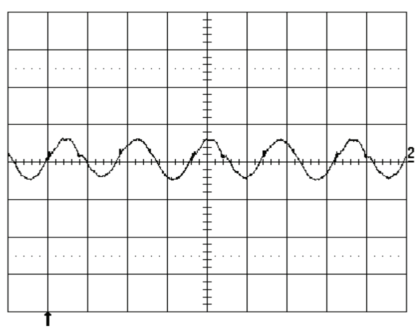
Shut-down



Shut-down enabled by disconnecting V_I at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, I_O =35 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (2 ms/div.).

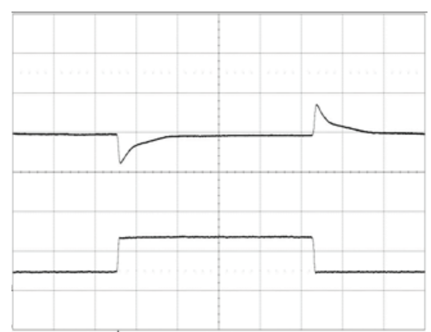
Output Ripple & Noise



Output voltage ripple at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, I_O = 35 A resistive load.

Trace: output voltage (50 mV/div.).
Time scale: (2 μs/div.).

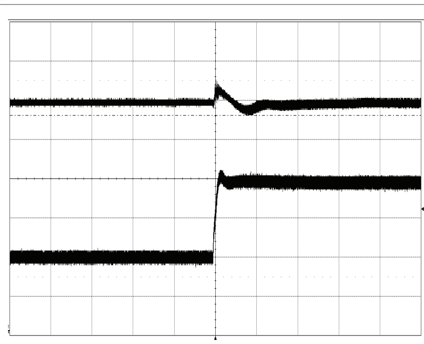
Output Load Transient Response



Output voltage response to load current step-change (8.75-26.25-8.75 A) at: T_{P1}, T_{P3} =+25°C, V_I = 53 V, C_O = 3.5 mF.

Top trace: output voltage (0.5 V/div.).
Bottom trace: output current (20 A/div.).
Time scale: (0.5 ms/div.).

Input Voltage Transient Response

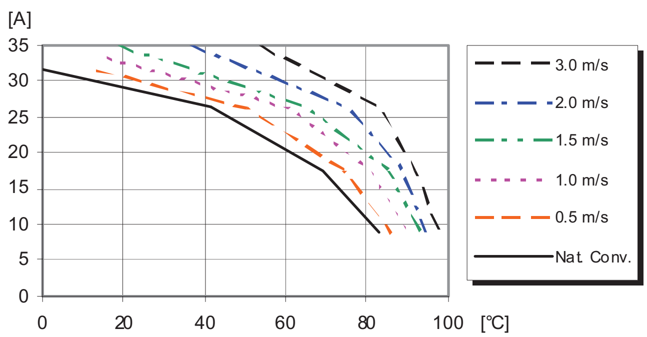


Output voltage response to input voltage transient at: T_{P1}, T_{P3} = +25°C, V_I = 36-75 V, I_O = 17 A resistive load, C_O = 3.5 mF

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (0.5 ms/div.).

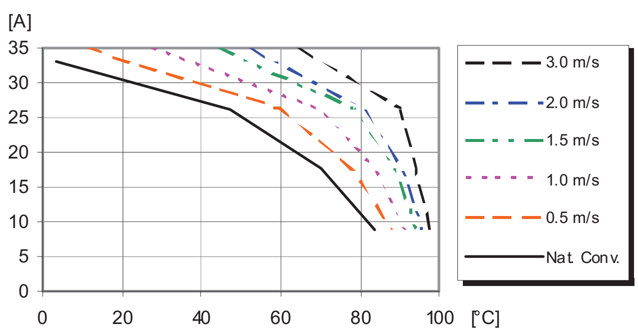
Typical Characteristics
12.0 V, 35 A / 420 W

Output Current Derating – Open frame



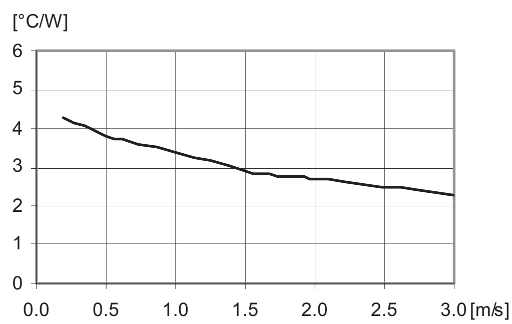
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Output Current Derating – Base plate



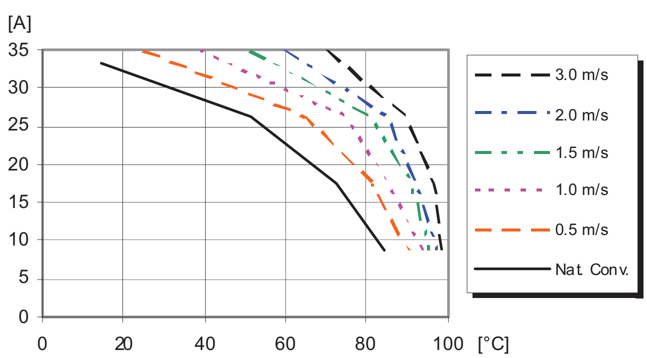
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Thermal Resistance – Base plate



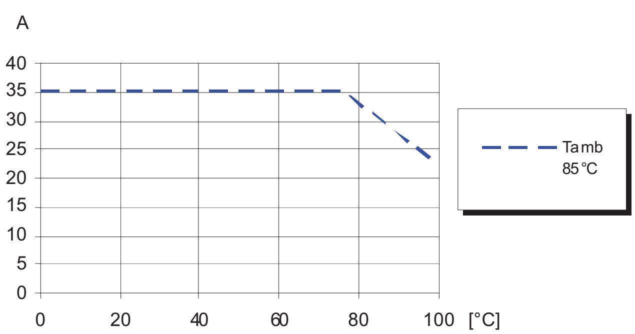
Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. V_I = 53 V.

Output Current Derating – Base plate + Heat sink



Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section. Tested with Plate Fin Transverse heatsink, height 0.23 In, P0114 Thermal Pad.

Output Current Derating – Cold wall sealed box



Available load current vs. base plate temperature at 85ºC ambient. V_I = 53 V. See Thermal Consideration section.

Electrical Specification
12.0 V, 39 A / 468 W

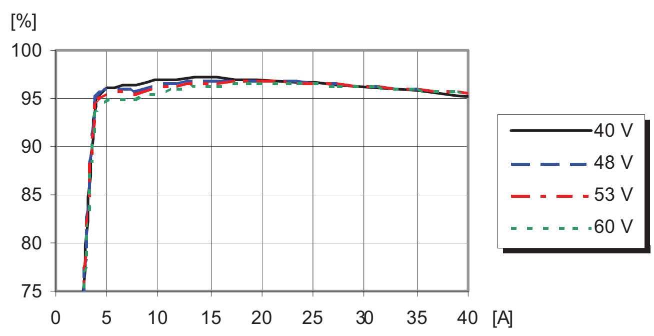
T_{P1}, T_{P3} = -40 to +90ºC, V_I = 40 to 60 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, max I_O, unless otherwise specified under Conditions.
Additional C_{out} = 3.9 mF, Configuration File: 19010-CDA 102 0314/002

parameter	conditions/description	min	typ	max	units
input voltage range (V_I)		40		60	V
turn-off input voltage (V_{Ioff})	decreasing input voltage	36	37	38	V
turn-on input voltage (V_{Ion})	increasing input voltage	38	39	40	V
internal input capacitance (C_I)			18		µF
output power (P_O)		0		468	W
efficiency (η)	50% of max I_O max I_O 50% of max I_O, V_I = 48 V max I_O, V_I = 48 V		96.7 95.7 96.8 95.6		% % % %
power dissipation (P_d)	max I_O		21.2	30.5	W
input idling power (P_{li})	I_O = 0 A, V_I = 53 V		2.8		W
input standby power (P_{RC})	V_I = 53 V (turned off with RC)		0.4		W
default switching frequency (f_s)	0-100% of max I_O	133	140	147	kHz
output voltage initial setting and accuracy (V_{Oi})	T_{P1} = +25°C, V_I = 53 V, I_O = 39 A	11.88	12.0	12.12	V
output adjust range (V_O)	see operating information	4.0		13.2	V
output voltage tolerance band (V_O)	0-100% of max I_O	11.76		12.24	V
line regulation (V_O)	max I_O		31	60	mV
load regulation (V_O)	V_I = 53 V, 1-100% of max I_O		5	25	mV
load transient voltage deviation (V_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/µs		±0.4		V
load transient recovery time (t_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/µs		150		µs
ramp-up time (t_r) - (from 10−90% of V_{Oi})	10-100% of max I_O, T_{P1} = 25ºC, V_I = 53 V		8		ms
start-up time (t_s) - (from V_I connection to 90% of V_{Oi})	10-100% of max I_O, T_{P1} = 25ºC, V_I = 53 V		24		ms
V_I shut-down fall time (t_f) - (from V_I off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		3 7		ms s
RC start-up time (t_{RC})	max I_O		12		ms
RC shut-down fall time (t_{RC}) - (from RC off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		4.5 7		ms s
output current (I_O)		0		39	A
current limit threshold (I_{lim})	V_O = 10.8 V, T_{P1}, T_{P3} < max T_{P1}, T_{P3}	41	44	47	A
short circuit current (I_{sc})	T_{P1} = 25ºC, see Note 1		14		A
recommended capacitive load (C_{out})	T_{P1} = 25ºC, see Note 2	0.1	3.9	6	mF
output ripple & noise (V_{Oac})	See ripple & noise section, max I_O , see Note 3		50	110	mVp-p
over voltage protection (OVP)	T_{P1}, T_{P3} = 25°C, V_I = 53 V, 10-100% of max I_O		15.6		V
remote control (RC)	sink current (note 4), see operating information trigger level, decreasing RC-voltage trigger level, increasing RC-voltage		 2.6 2.9	0.7	mA V V

Note 1: OCP in hic-up mode
2: Low ESR-value
3: C_{out} = 100 µF, external capacitance
4: Sink current drawn by external device connected to the RC pin. Minimum sink current required guaranteeing activated RC function.

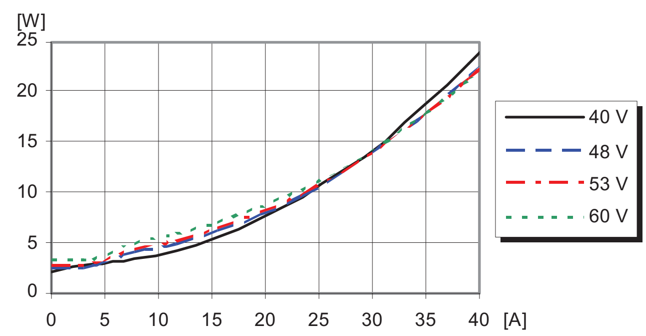
Typical Characteristics
12.0 V, 39 A / 468 W

Efficiency



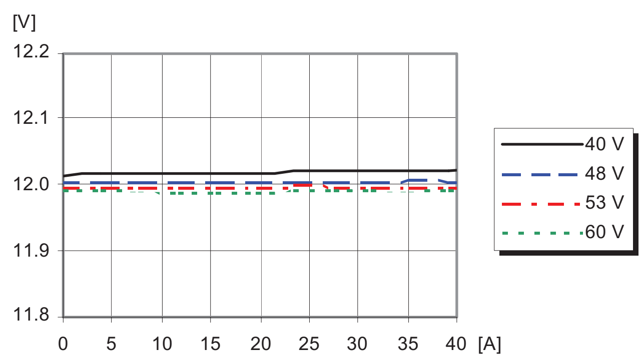
Efficiency vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Power Dissipation



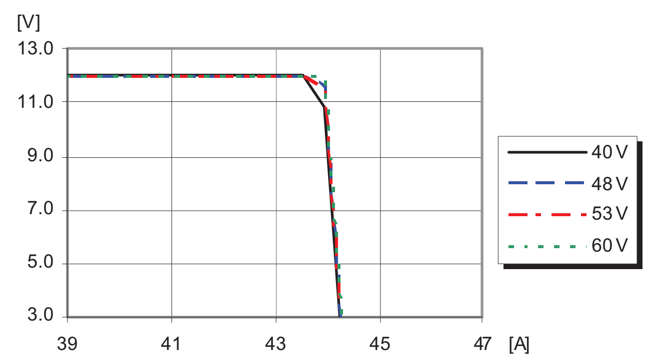
Dissipated power vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Output Characteristics



Output voltage vs. load current at T_{P1}, T_{P3} = +25°C

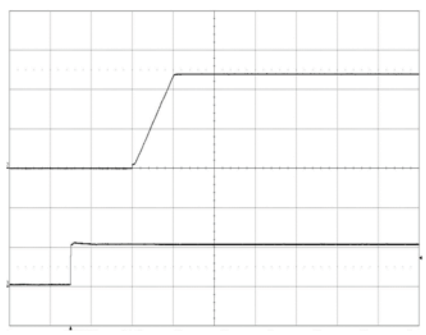
Current Limit Characteristics



Output voltage vs. load current at I_O > max I_O , T_{P1}, T_{P3} = +25°C

Typical Characteristics
12.0 V, 39 A / 468 W

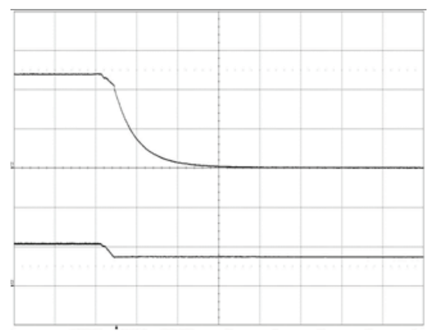
Start-up



Start-up enabled by connecting V_I at:
T_{P1}, T_{P3} = +25°C, V_I = 53 V,
I_O = 39 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (10 ms/div.).

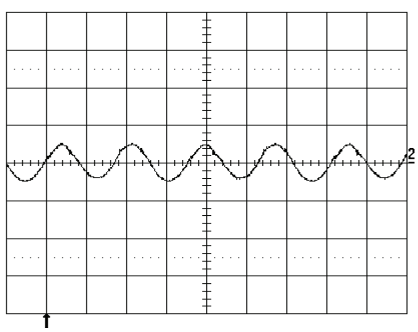
Shut-down



Shut-down enabled by disconnecting V_I at:
T_{P1}, T_{P3} = +25°C, V_I = 53 V,
I_O =39 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (2 ms/div.).

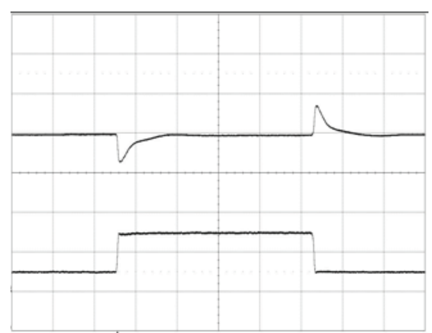
Output Ripple & Noise



Output voltage ripple at:
T_{P1}, T_{P3} = +25°C, V_I = 53 V,
I_O = 39 A resistive load.

Trace: output voltage (50 mV/div.).
Time scale: (2 µs/div.).

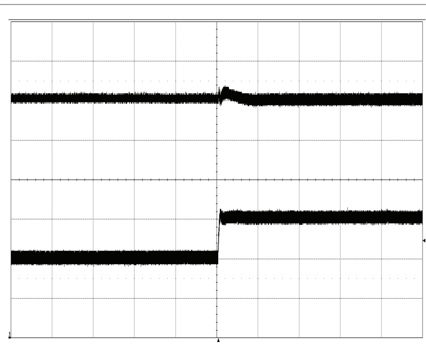
Output Load Transient Response



Output voltage response to load current step-change (9.75-29.25-9.75 A) at:
T_{P1}, T_{P3} =+25°C, V_I = 53 V, C_O = 3.9 mF.

Top trace: output voltage (0.5 V/div.).
Bottom trace: output current (20 A/div.).
Time scale: (0.5 ms/div.).

Input Voltage Transient Response

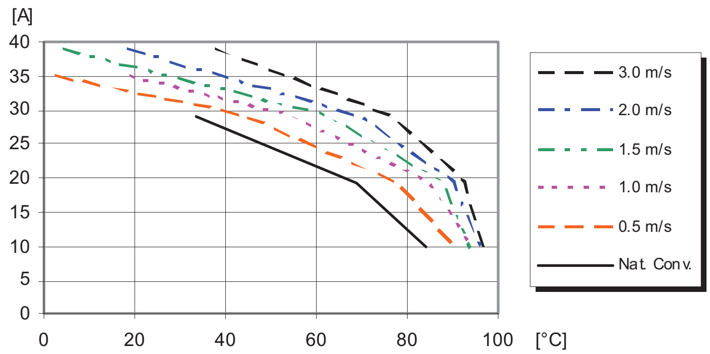


Output voltage response to input voltage transient at: T_{P1}, T_{P3} = +25°C, V_I = 40-60 V,
I_O = 19,5 A resistive load, C_O = 3.9 mF

Top trace: output voltage (2 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (0.5 ms/div.).

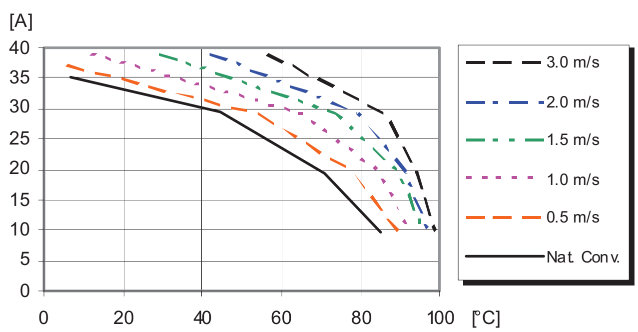
Typical Characteristics
12.0 V, 39 A / 468 W

Output Current Derating – Open frame



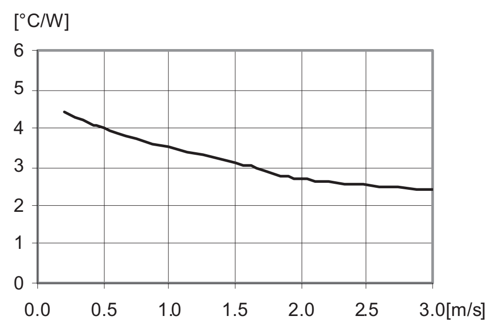
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Output Current Derating – Base plate



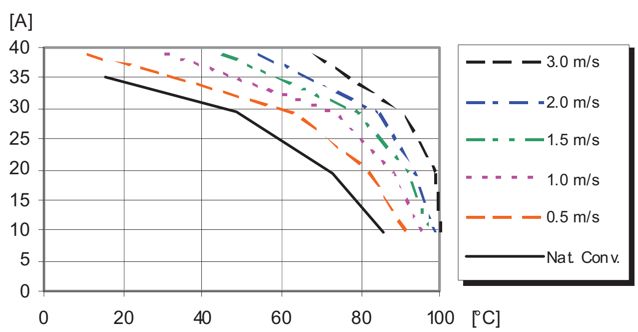
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Thermal Resistance – Base plate



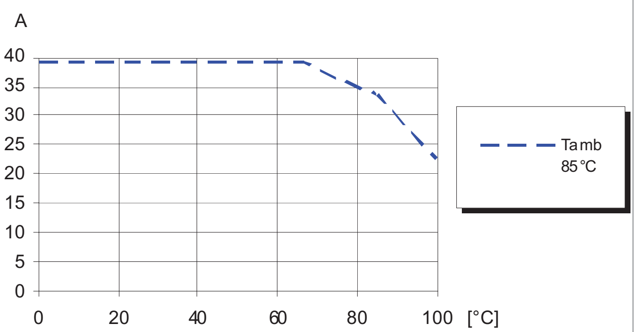
Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. V_I = 53 V.

Output Current Derating – Base Plate + Heat sink



Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section. Tested with Plate Fin Transverse heatsink, height 0.23 In, P0114 Thermal Pad.

Output Current Derating – Cold wall sealed box



Available load current vs. base plate temperature at 85ºC ambient. V_I = 53 V. See Thermal Consideration section.

Electrical Specification
12.45 V, 35 A / 415 W

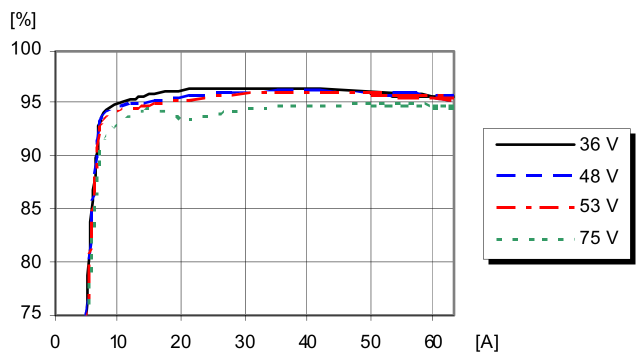
T_{P1}, T_{P3} = -40 to +90ºC, V_I = 36 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1}, T_{P3} = +25ºC, V_I = 53 V, max I_O, unless otherwise specified under Conditions.
Additional C_{out} = 3.9 mF, Configuration File: 19010-CDA 102 0314/014

parameter	conditions/description	min	typ	max	units
input voltage range (V_I)		36		75	V
turn-off input voltage (V_{Ioff})	decreasing input voltage	32	33	34	V
turn-on input voltage (V_{Ion})	increasing input voltage	34	35	36	V
internal input capacitance (C_I)			18		μF
output power (P_O)		0		415	W
efficiency (η)	50% of max I_O max I_O 50% of max I_O, V_I = 48 V max I_O, V_I = 48 V		96.2 95.5 96.4 95.5		% % % %
power dissipation (P_d)	max I_O		19.5	29.5	W
input idling power (P_{li})	I_O = 0 A, V_I = 53 V		3.2		W
input standby power (P_{RC})	V_I = 53 V (turned off with RC)		0.4		W
default switching frequency (f_s)	0-100% of max I_O	133	140	147	kHz
output voltage initial setting and accuracy (V_{Oi})	T_{P1} = 25°C, V_I = 53 V, I_O = 0 A	12.415	12.45	12.485	V
output adjust range (V_O)	see operating information	4.0		13.2	V
output voltage tolerance band (V_O)	0-100% of max I_O	11.5		12.7	V
line regulation (V_O)	max I_O		20	55	mV
load regulation (V_O)	V_I = 53 V, 0-100% of max I_O	500	600	700	mV
load transient voltage deviation (V_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		±0.4		V
load transient recovery time (t_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		150		μs
ramp-up time (t_r) - (from 10−90% of V_{Oi})	10-100% of max I_O, T_{P1}, T_{P3} = 25ºC, V_I = 53 V		23		ms
start-up time (t_s) - (from V_I connection to 90% of V_{Oi})	10-100% of max I_O, T_{P1}, T_{P3} = 25ºC, V_I = 53 V		39		ms
V_I shut-down fall time (t_f) - (from V_I off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		3.6 7		ms s
RC start-up time (t_{RC})	max I_O		27		ms
RC shut-down fall time (t_{RC}) - (from RC off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		5.1 7		ms s
output current (I_O)		0		35	A
current limit threshold (I_{lim})	V_O = 10.8 V, T_{P1}, T_{P3} < max T_{P1}, T_{P3}	37	41	44	A
short circuit current (I_{sc})	T_{P1}, T_{P3} = 25ºC, see Note 1		12		A
recommended capacitive load (C_{out})	T_{P1}, T_{P3} = 25ºC, see Note 2	0.1	3.5	6	mF
output ripple & noise (V_{Oac})	See ripple & noise section, max I_O , see Note 3		60	150	mVp-p
over voltage protection (OVP)	T_{P1}, T_{P3} = 25°C, V_I = 53 V, 10-100% of max I_O		15.6		V
remote control (RC)	sink current (note 4), see operating information trigger level, decreasing RC-voltage trigger level, increasing RC-voltage		 2.6 2.9	0.7 	mA V V

Note
1: OCP in hic-up mode
2: Low ESR-value
3: C_{out} = 100 μF, external capacitance
4: Sink current drawn by external device connected to the RC pin. Minimum sink current required guaranteeing activated RC function.

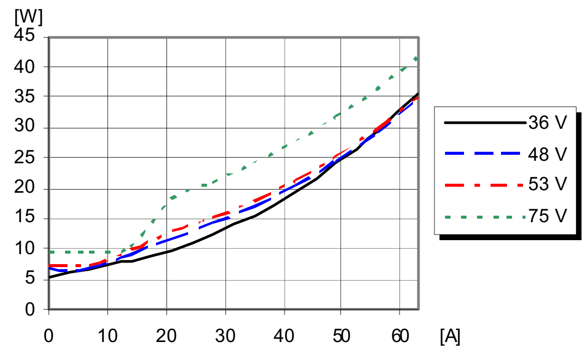
Typical Characteristics
12.45 V, 63 A / 747 W, two products in parallel

Efficiency



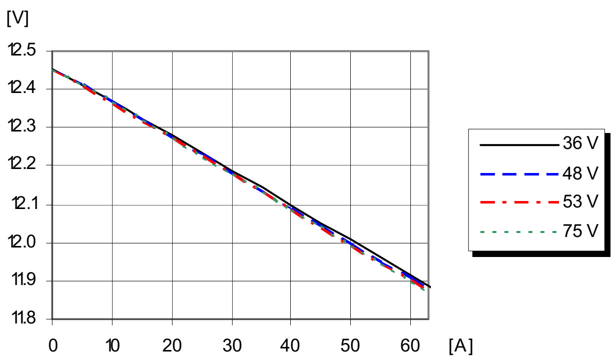
Efficiency vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Power Dissipation



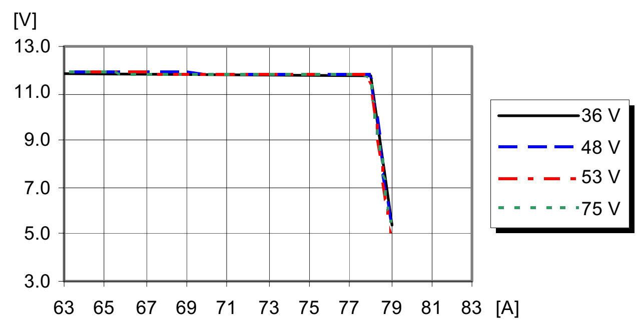
Dissipated power vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Output Characteristics



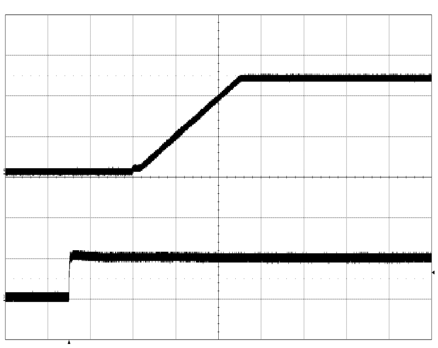
Output voltage vs. load current at T_{P1}, T_{P3} = +25°C

Current Limit Characteristics



Output voltage vs. load current at I_O > max I_O, T_{P1}, T_{P3} = +25°C

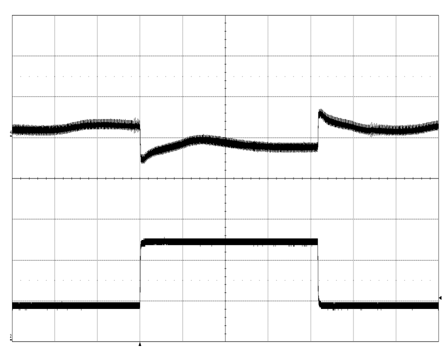
Start-up



Start-up enabled by connecting V_I at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, I_O = 63 A resistive load.

Top trace: output voltage (5 V/div.). Bottom trace: input voltage (50 V/div.). Time scale: (10 ms/div.).

Output Load Transient Response

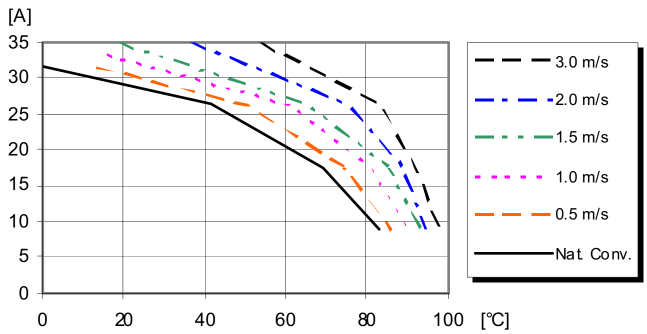


Output voltage response to load current step-change (15.8-47.3-15.8 A) at: T_{P1}, T_{P3} =+25°C, V_I = 53 V, C_O = 3.5 mF.

Top trace: output voltage (0.5 V/div.). Bottom trace: output current (20 A/div.). Time scale: (0.5 ms/div.).

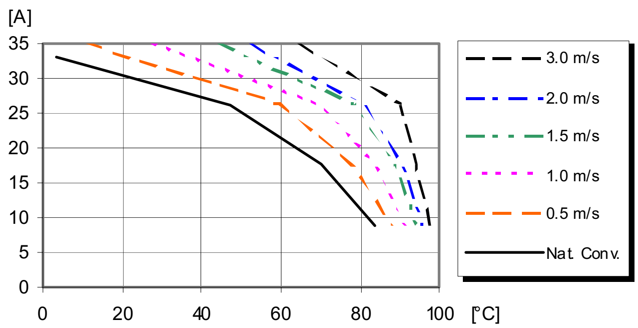
Typical Characteristics
12.45 V, 35 A / 415 W

Output Current Derating – Open frame



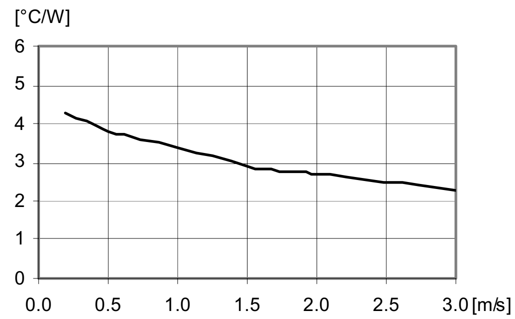
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Output Current Derating – Base plate



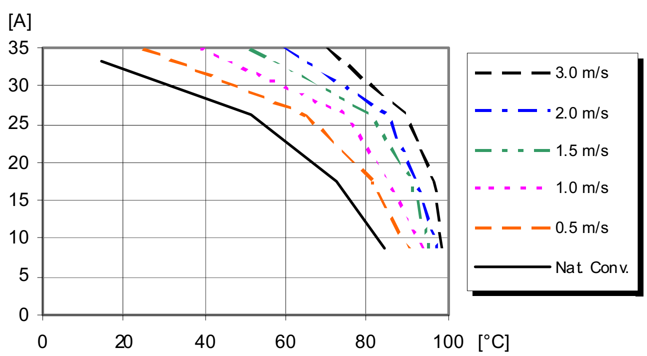
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Thermal Resistance – Base plate



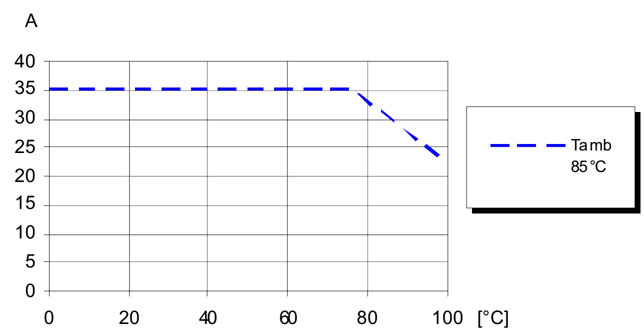
Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. V_I = 53 V.

Output Current Derating – Base plate + Heat sink



Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section. Tested with Plate Fin Transverse heatsink, height 0.23 In, P0114 Thermal Pad.

Output Current Derating – Cold wall sealed box



Available load current vs. base plate temperature at 85ºC ambient. V_I = 53 V. See Thermal Consideration section.

Electrical Specification
12.45 V, 39 A / 462 W

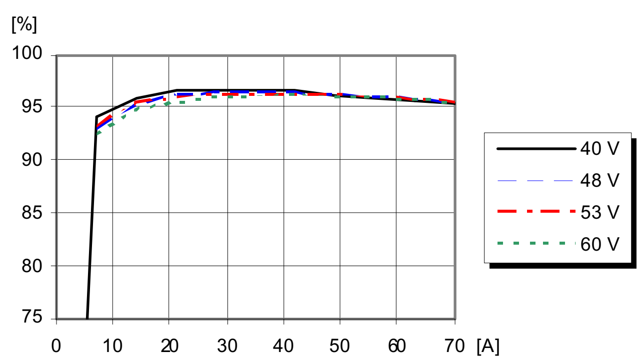
T_{P1}, T_{P3} = -40 to +90ºC, V_I = 40 to 60 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, max I_O, unless otherwise specified under Conditions.
Additional C_{out} = 3.9 mF, Configuration File: 19010-CDA 102 0314/017

parameter	conditions/description	min	typ	max	units
input voltage range (V_I)		40		60	V
turn-off input voltage (V_{Ioff})	decreasing input voltage	36	37	38	V
turn-on input voltage (V_{Ion})	increasing input voltage	38	39	40	V
internal input capacitance (C_I)			18		μF
output power (P_O)		0		462	W
efficiency (η)	50% of max I_O max I_O 50% of max I_O, V_I = 48 V max I_O, V_I = 48 V		96.7 95.7 96.8 95.6		% % % %
power dissipation (P_d)	max I_O		21.0	30.5	W
input idling power (P_{li})	I_O = 0 A, V_I = 53 V		2.8		W
input standby power (P_{RC})	V_I = 53 V (turned off with RC)		0.4		W
default switching frequency (f_s)	0-100% of max I_O	133	140	147	kHz
output voltage initial setting and accuracy (V_{Oi})	T_{P1} = 25°C, V_I = 53 V, I_O = 0 A	12.415	12.45	12.485	V
output adjust range (V_O)	see operating information	4.0		13.2	V
output voltage tolerance band (V_O)	0-100% of max I_O	11.5		12.7	V
line regulation (V_O)	max I_O		31	60	mV
load regulation (V_O)	V_I = 53 V, 0-100% of max I_O	500	600	700	mV
load transient voltage deviation (V_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		±0.4		V
load transient recovery time (t_{tr})	V_I = 53 V, load step 25-75-25% of max I_O, di/dt = 1 A/μs		150		μs
ramp-up time (t_r) - (from 10−90% of V_{Oi})	10-100% of max I_O, T_{P1} = 25ºC, V_I = 53 V		23		ms
start-up time (t_s) - (from V_I connection to 90% of V_{Oi})	10-100% of max I_O, T_{P1} = 25ºC, V_I = 53 V		39		ms
V_I shut-down fall time (t_f) - (from V_I off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		3 7		ms s
RC start-up time (t_{RC})	max I_O		27		ms
RC shut-down fall time (t_{RC}) - (from RC off to 10% of V_O)	max I_O I_O = 0 A, C_O = 0 mF		4.5 7		ms s
output current (I_O)		0		39	A
current limit threshold (I_{lim})	V_O = 10.8 V, T_{P1}, T_{P3} < max T_{P1}, T_{P3}	41	44	47	A
short circuit current (I_{sc})	T_{P1} = 25ºC, see Note 1		14		A
recommended capacitive load (C_{out})	T_{P1} = 25ºC, see Note 2	0.1	3.9	6	mF
output ripple & noise (V_{Oac})	See ripple & noise section, max I_O , see Note 3		50	110	mVp-p
over voltage protection (OVP)	T_{P1}, T_{P3} = 25°C, V_I = 53 V, 10-100% of max I_O		15.6		V
remote control (RC)	sink current (note 4), see operating information trigger level, decreasing RC-voltage trigger level, increasing RC-voltage		 2.6 2.9	0.7	mA V V

Note 1: OCP in hic-up mode
2: Low ESR-value
3: C_{out} = 100 μF, external capacitance
4: Sink current drawn by external device connected to the RC pin. Minimum sink current required guaranteeing activated RC function.

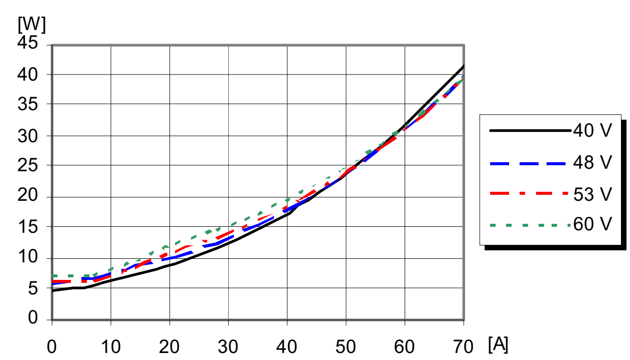
Typical Characteristics
12.45 V, 70 A / 830 W, two products in parallel

Efficiency



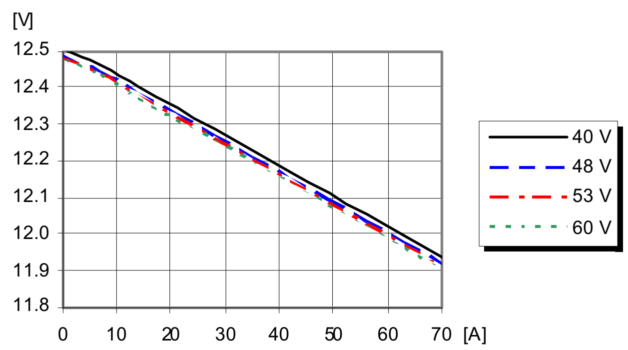
Efficiency vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Power Dissipation



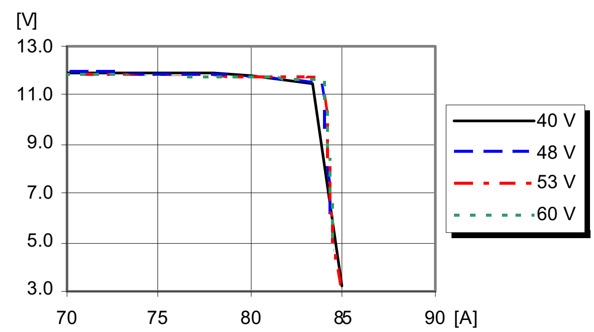
Dissipated power vs. load current and input voltage at T_{P1}, T_{P3} = +25°C

Output Characteristics



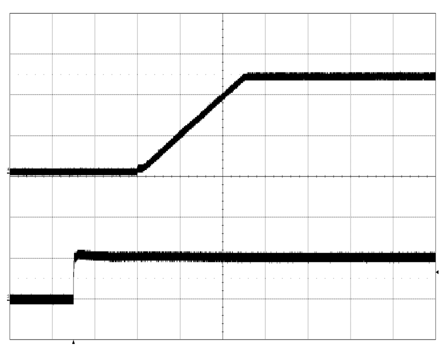
Output voltage vs. load current at T_{P1}, T_{P3} = +25°C

Current Limit Characteristics



Output voltage vs. load current at I_O > max I_O, T_{P1}, T_{P3} = +25°C

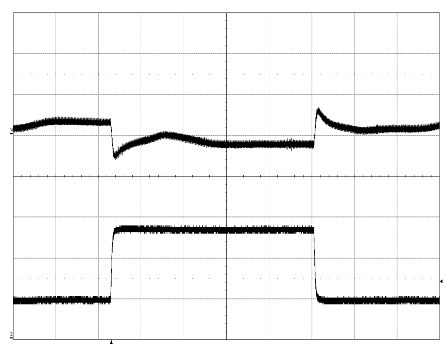
Start-up



Start-up enabled by connecting V_I at: T_{P1}, T_{P3} = +25°C, V_I = 53 V, I_O = 70 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (50 V/div.).
Time scale: (10 ms/div.).

Output Load Transient Response

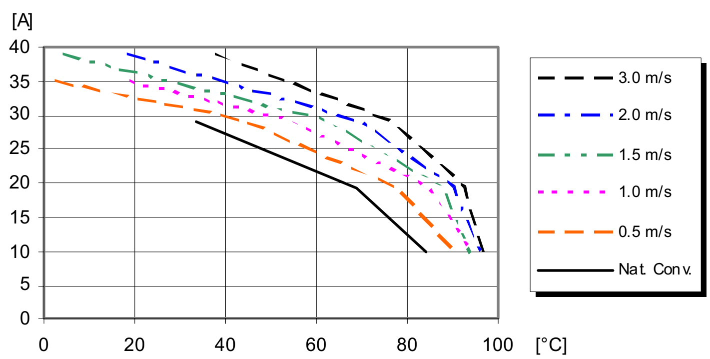


Output voltage response to load current step-change (17.5-52.5-17.5 A) at: T_{P1}, T_{P3} =+25°C, V_I = 53 V, C_O = 3.9 mF

Top trace: output voltage (0.5 V/div.).
Bottom trace: output current (20 A/div.).
Time scale: (0.5 ms/div.).

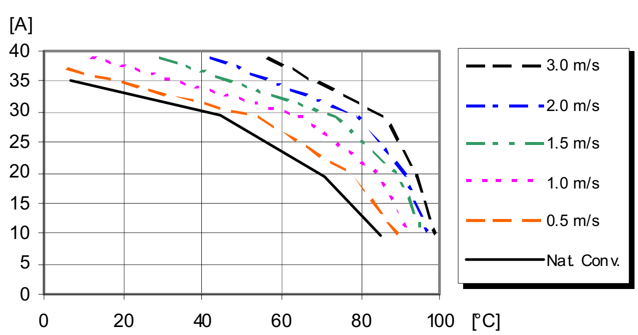
Typical Characteristics
12.45 V, 39 A / 462 W

Output Current Derating – Open frame



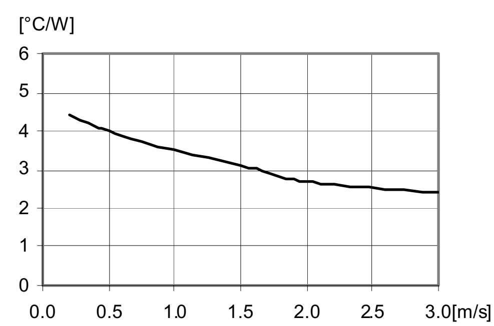
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Output Current Derating – Base plate



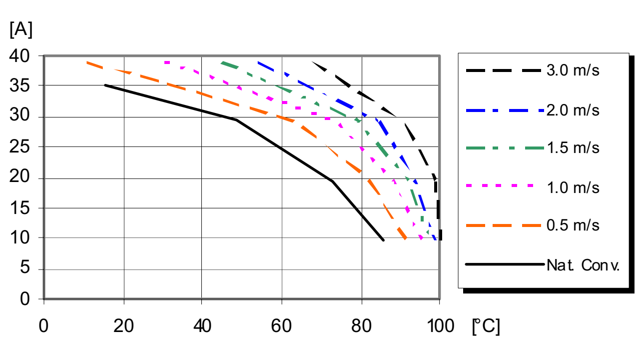
Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section.

Thermal Resistance – Base plate



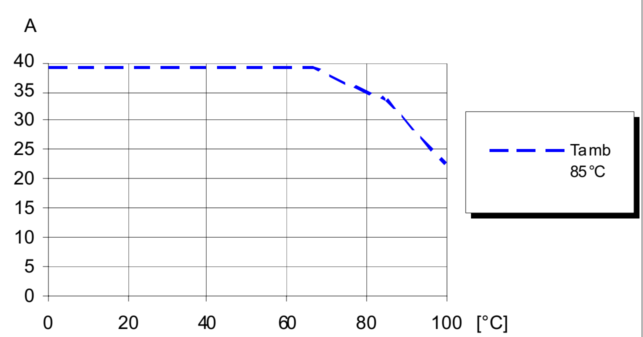
Thermal resistance vs. airspeed measured at the converter. Tested in wind tunnel with airflow and test conditions as per the Thermal consideration section. V_I = 53 V.

Output Current Derating – Base Plate + Heat sink



Available load current vs. ambient air temperature and airflow at V_I = 53 V. See Thermal Consideration section. Tested with Plate Fin Transverse heatsink, height 0.23 In, P0114 Thermal Pad.

Output Current Derating – Cold wall sealed box

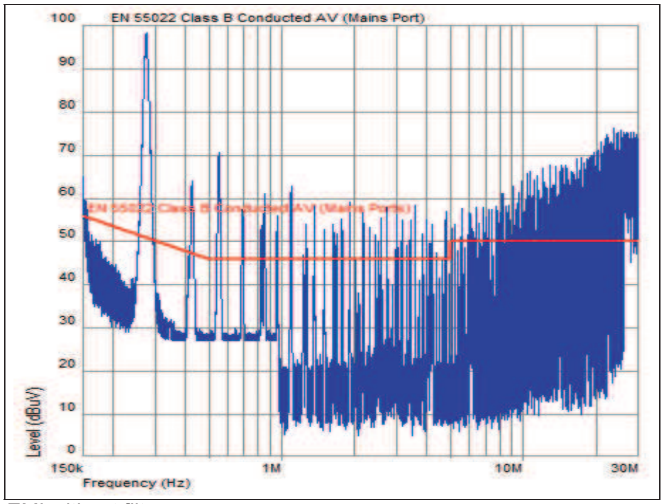


Available load current vs. base plate temperature at 85ºC ambient. V_I = 53 V. See Thermal Consideration section.

EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). The fundamental switching frequency is 140 kHz for NQB at V_I = 53 V, max I_O.

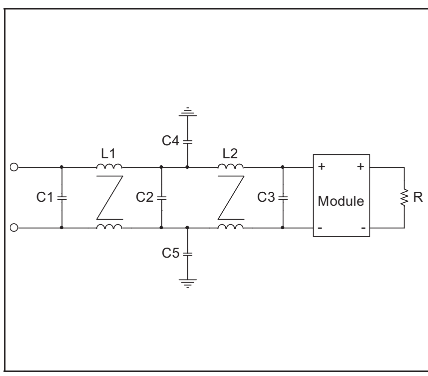
Conducted EMI Input terminal value (typ)



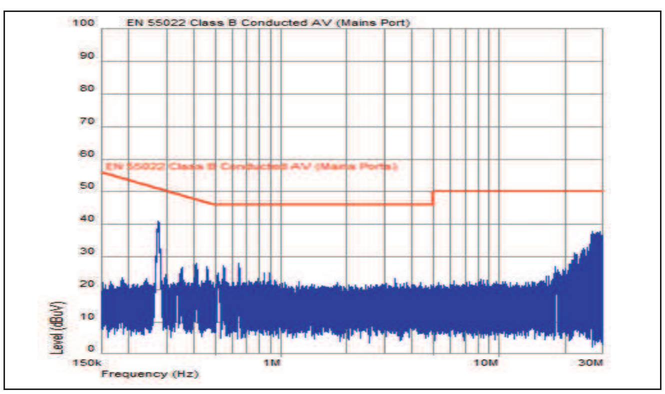
EMI without filter

Optional external filter for class B

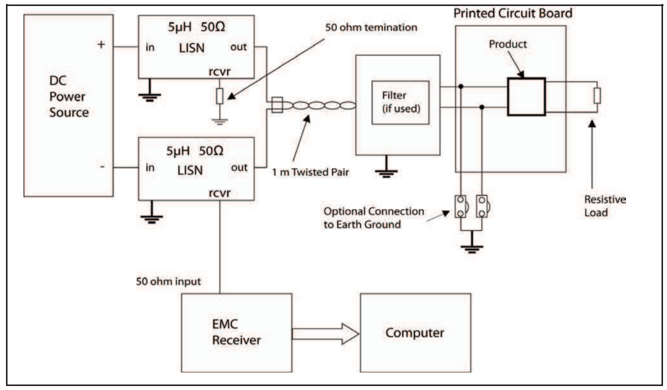
Suggested external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.



Filter components:
C1 = 1 μF
C2 = 1 μF+220 μF
C3 = 1 μF+220 μF
C4,C5 = 2.2 nF
L1 = 810 μH
L2 = 810 μH



EMI with filter



Test set-up

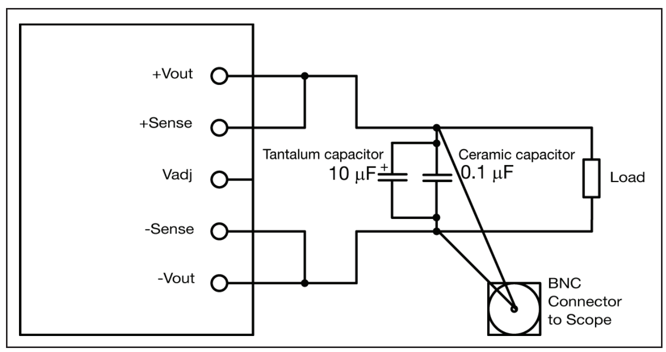
Layout recommendations

The radiated EMI performance of the product will depend on the PWB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis.

A ground layer will increase the stray capacitance in the PWB and improve the high frequency EMC performance.

Output ripple and noise

Output ripple and noise measured according to figure below.



Output ripple and noise test setup

Operating information

Power Management Overview

This product is equipped with a PMBus interface. The product incorporates a wide range of readable and configurable power management features that are simple to implement with a minimum of external components. Additionally, the product includes protection features that continuously safeguard the load from damage due to unexpected system faults. A fault is also shown as an alert on the SALERT pin. The following product parameters can continuously be monitored by a host: Input voltage, output voltage/current, duty cycle and internal temperature.

The product is delivered with a default configuration suitable for a wide range operation in terms of input voltage, output voltage, and load. The configuration is stored in an internal Non-Volatile Memory (NVM). All power management functions can be reconfigured using the PMBus interface. Please contact your local CUI Power Modules representative for design support of custom configurations or appropriate SW tools for design and down-load of your own configurations.

Input Voltage

The NQB consists of two different product families designed for two different input voltage ranges, 36 to 75 Vdc and 40 to 60 Vdc, see ordering information.

The input voltage range 36 to 75 Vdc meets the requirements of the European Telecom Standard ETS 300 132-2 for normal input voltage range in –48 and –60 Vdc systems, -40.5 to -57.0 V and –50.0 to -72 V respectively. At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and T_{P1} must be limited to absolute max +125°C. The absolute maximum continuous input voltage is 80 Vdc.

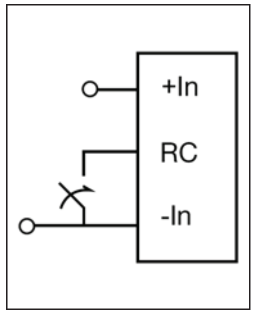
The input voltage range 40 to 60 Vdc meets the requirements for normal input voltage range in -48 V systems, -40.5 to -57.0 V. At input voltages exceeding 60 V, the power loss will be higher than at normal input voltage and T_{P1} must be limited to absolute max +125°C. The absolute maximum continuous input voltage is 65 Vdc.

Turn-off Input Voltage

The product monitors the input voltage and will turn on and turn off at predetermined levels. The minimum hysteresis between turn on and turn off input voltage is 2 V. The turn on and turn off levels of the product can be reconfigured using the PMBus interface

Remote Control (RC)

The products are fitted with a configurable remote control function. The primary remote control is referenced to the primary negative input connection (-In). The RC function allows the converter to be turned on/off by an external device like a semiconductor or mechanical switch. The RC pin has an internal pull up resistor. The remote control functions can also be configured using the PMBus. The device should be capable of sinking 0.7 mA. When the RC pin is left open, the voltage generated on the RC pin is max 6 V. The standard product is provided with "negative logic" remote control and will be off until the RC pin is connected to the -In. To turn on the product the voltage between RC pin and -In should be less than 1 V.



To turn off the product the RC pin should be left open for a minimum of time 150 µs, the same time requirement applies when the product shall turn on. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin can be wired directly to –In or disabled via the 0xE3 command. The logic option for the primary remote control is configured via 0xE3 command using the PMBus.

Remote Control (secondary side)

The CTRL-pin can be configured as remote control via the PMBus interface. In the default configuration the CTRL-pin is disabled and floating. The output can be configured to internal pull-up to 3.3 V using the MFR_MULTI_PIN_CONFIG (0xF9) PMBus command. The CTRL-pin can be left open when not used. The logic options for the secondary remote control can be positive or negative logic. The logic option for the secondary remote control is configured via ON_OFF_CONFIG (0x02) command using the PMBus interface, see also MFR_MULTI_PIN_CONFIG section.

Input and Output Impedance

The impedance of both the input source and the load will interact with the impedance of the product. It is important that the input source has low characteristic impedance. Minimum recommended external input capacitance is 100 µF. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors.

External Decoupling Capacitors

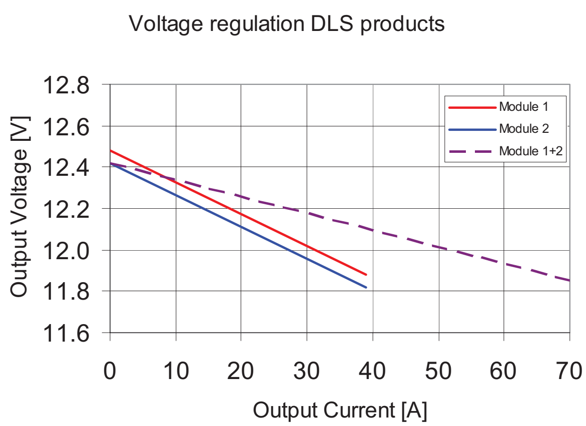
When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. Ceramic capacitors will also reduce any high frequency noise at the load. It is equally important to use low resistance and low inductance PWB layouts and cabling. External decoupling capacitors will become part of the product's control loop. The control loop is optimized for a wide range of external capacitance and the maximum recommended value that could be used without any additional analysis is found in the electrical specification. The ESR of the capacitors is a very important parameter. Stable operation is guaranteed with a verified ESR value of

>10 mΩ across the output connections.
For further information please contact your local CUI Power Modules representative.

Parallel Operation (Droop Load Share, DLS)

The NQB, DLS products are variants that can be connected in parallel. The products have a pre-configured voltage droop: The stated output voltage set point is at no load. The output voltage will decrease when the load current is increased. The voltage will droop 0.6 V while load reaches max load. This feature allows the products to be connected in parallel and share the current with 10% accuracy. Up to 90% of max output current can be used from each product.

When running DLS-products in parallel command (0xF9) must be set according to MFR_MULTI_PIN_CONFIG. To prevent unnecessary current stress, changes of the output voltage must be done with the output disabled. This must be considered for all commands that affect the output voltage.



Feed Forward Capability

The NQB products have a feed forward function implemented that can handle sudden input voltage changes. The output voltage will be regulated during an input transient and will typically stay within 10% when an input transient is applied.

PMBus configuration and support

The product provides a PMBus digital interface that enables the user to configure many aspects of the device operation as well as monitor the input and output parameters. Please contact your local CUI Power Modules representative for appropriate SW tools to down-load new configurations.

Output Voltage Adjust using PMBus

The output voltage of the product can be reconfigured using the PMBus interface.

Margin Up/Down Controls

These controls allow the output voltage to be momentarily adjusted, either up or down, by a nominal 10%. This provides a convenient method for dynamically testing the operation of the load circuit over its supply margin or range. It can also be used to verify the function of supply voltage supervisors.
The margin up and down levels of the product can be re-configured using the PMBus interface.

Soft-start Power Up

The default rise time of the ramp up is 10 ms. When starting by applying input voltage the control circuit boot-up time adds an additional 15 ms delay. The soft-start power up of the product can be reconfigured using the PMBus interface.
The DLS variants have a pre-configured ramp up time of 25 ms.

Remote Sense

The product has remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PWB ground layer to reduce noise susceptibility. The remote sense circuitry will compensate for up to 10% voltage drop between output pins and the point of load. If the remote sense is not needed +Sense should be connected to +Out and -Sense should be connected to -Out. To be able to use remote sense the converter must be equipped with a Communication interface.

Temperature Protection (OTP, UTP)

The products are protected from thermal overload by an internal temperature shutdown protection. When T_{P1} as defined in thermal consideration section is exceeded the product will shut down. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped below the temperature threshold set in the command OT_WARN_LIMIT (0x51); the hysteresis is defined in general electrical specification. The OTP and hysteresis of the product can be re-configured using the PMBus interface. The product has also an under temperature protection. The OTP and UTP fault limit and fault response can be configured via the PMBus. Note: using the fault response “continue without interruption” may cause permanent damage to the product

Over Voltage Protection (OVP)

The product includes over voltage limiting circuitry for protection of the load. The default OVP limit is 30% above the nominal output voltage. If the output voltage exceeds the OVP limit, the product can respond in different ways. The default response from an over voltage fault is to immediately shut down. The device will continuously check for the presence of the fault condition, and when the fault condition no longer exists the device will be re-enabled. The OVP fault level and fault response can be re-configured using the PMBus interface.

Over Current Protection (OCP)

The product includes current limiting circuitry for protection at continuous overload. The default setting for the product is hic-up mode if the maximum output current is exceeded and the output voltage is below $0.3 \times V_{out}$, set in command IOUT_OC_LV_FAULT_LIMIT (0x48). Above the trip voltage value in command 0x48 the product will continue operate while maintaining the output current at the value set by IOUT_OC_FAULT_LIMIT (0x46). The load distribution should be designed for the maximum output short circuit current specified.

Droop Load Share variants (DLS) will enter hic-up mode, with a trip voltage, $0.04 \times V_{out}$, set in command IOUT_OC_LV_FAULT_LIMIT (0x48). Above the trip voltage in command (0x48) the product will continue operate while maintaining the output current at the value set by IOUT_OC_FAULT_LIMIT (0x46).

The over current protection of the product can be reconfigured using the PMBus interface.

Input Over/Under voltage protection

The input of the product can be protected from high input voltage and low input voltage. The over/under-voltage fault level and fault response can be configured via the PMBus interface.

Pre-bias Start-up Capability

The product has a Pre-bias start up functionality and will not sink current during start up if a Pre-bias source is present at the output terminals. If the Pre-bias voltage is lower than the target value set in VOUT_COMMAND (0x21), the product will ramp up to the target value. If the Pre-bias voltage is higher than the target value set in VOUT_COMMAND (0x21), the product will ramp down to the target value and in this case sink current for a limited of time set in the command TOFF_MAX_WARN_LIMIT (0x66).

Power Good

The product provides Power Good (PG) flag in the Status Word register that indicates the output voltage is within a specified tolerance of its target level and no fault condition exists. If specified in section Connections, the product also provides a PG signal output. The Power Good signal is by default configured as active low, Push-pull and can be re-configured via the PMBus interface. The Power Good output can be configured as Push-pull or "High Z when active" to permit AND'ing of parallel devices. It is not recommended to use Push-pull when paralleling PG-pins, see MFR_MULTI_PIN_CONFIG.

Synchronization, Tracking and External reference

This product does not support synchronization, tracking or external reference.

Switching frequency adjust using PMBus

The switching frequency is set to 140 kHz as default but this can be reconfigured via the PMBus interface. The product is optimized at this frequency but can run at lower and higher frequency, (125-150 kHz). The electrical performance can be affected if the switching frequency is changed.

MFR_MULTI_PIN_CONFIG

The MFR_MULTI_PIN_CONFIG (0xF9) command enables or disables different functions inside the product. This command can be configured according to the table for different functions.

Bit 7:6 00 = Stand alone 01 = Slave (N/A) 10 = DLS 11 = Master (N/A)	1	1	1	1	1	1	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
Bit 5 Power Good High Z when active	0	0	0	0	1	1	0	0	0	0	1	1
Bit 4 Tracking enable (N/A)	0	0	0	0	0	0	0	0	0	0	0	0
Bit 3 External reference (N/A)	0	0	0	0	0	0	0	0	0	0	0	0
Bit 2 Power Good Enable	0	0	1	1	1	1	0	0	1	1	1	1
Bit 1 Reserved	1	1	1	1	1	1	0	0	0	0	0	0
Bit 0 Secondary Remote Control Pull up/down resistor enable 1)	0	1	0	1	0	1	0	1	0	1	0	1
1) When not used with PMBus, the CTRL input can be internally pulled up or down depending on if it is active high or low. When active low it will be pulled up and vice versa	DLS, PMBus Control (0x82)	DLS, Sec RC w/ pull up/down (0x83)	DLS, Power Good Push-pull, PMBus Control (0x86)	DLS, Power Good Push-pull, Sec RC w/ pull up/down (0x87)	DLS, Power Good High Z when active, PMBus Control (0xA6)	DLS, Power Good High Z when active, Sec RC w/ pull up/down (0xA7)	Stand alone, PMBus Control (0x00)	Stand alone, Sec RC w/ pull up/down (0x01)	Stand alone, Power Good Push-pull, PMBus Control (0x04)	Stand alone, Power Good Push-pull, Sec RC w/ pull up/down (0x05)	Stand alone, Power Good High Z when active, PMBus Control (0x24)	Stand alone, Power Good High Z when active, Sec RC w/ pull up/down (0x25)

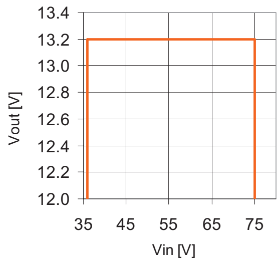
The MFR_MULTI_PIN_CONFIG can be reconfigured using the PMBus interface. Default configuration is set to Power Good Push-Pull (0x04) for stand alone variants and DLS Power Good Push-Pull (0x86) for Droop Load Share variants.

User customized settings

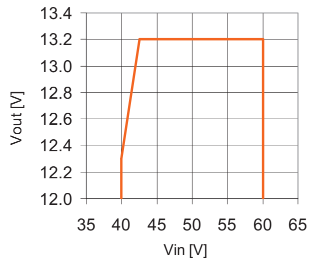
This product has two data storage set: Default data (CUI factory) and User data. The User data set's priority is higher than the Default data. The User data area is empty while shipped to customer. After boot-up, if the controller found no data stored in User data area, it will load Default data instead.
Customer can change the RAM data and store the changes into flash memory by PMBUS Store_User_All, next power cycle will load the User data into RAM for execute.
Store_Default_All is write protected to ensure the factory settings is always available for recovery.

Output Voltage Regulation

The NQB products are designed to be fully regulated within the plotted area. Operating outside this area is not recommended.



Vin range: 36-75Vdc



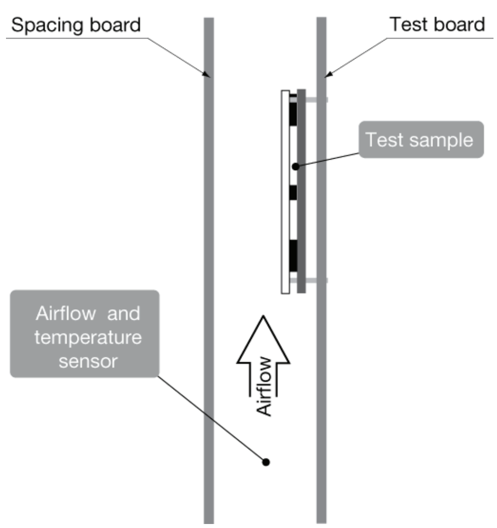
Vin range:40-60Vdc

Thermal Consideration

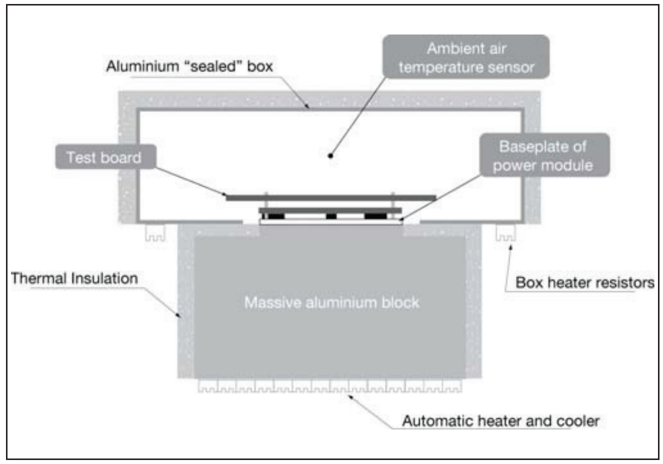
General

The product is designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation. For products mounted on a PWB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependant on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current Derating graph found in the output section for each model provides the available output current vs. ambient air temperature and air velocity at V_I =53 V.

The product is tested on a 254 x 254 mm, 35 µm (1 oz), 16-layer test board mounted vertically in a wind tunnel with a cross-section of 608 x 203 mm.



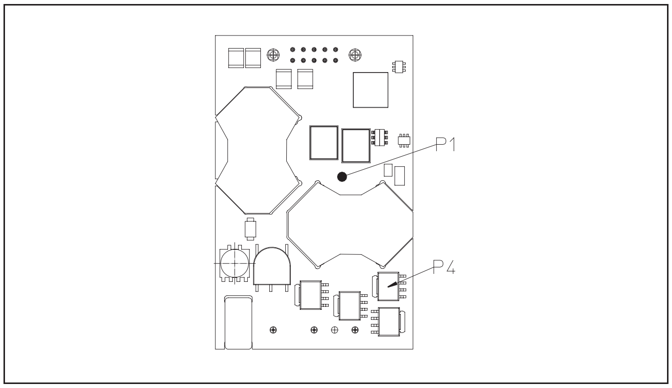
For products with base plate used in a sealed box/cold wall application, cooling is achieved mainly by conduction through the cold wall. The Output Current Derating graphs are found in the output section for each model. The product is tested in a sealed box test set up with ambient temperatures 85, 55 and 25°C.



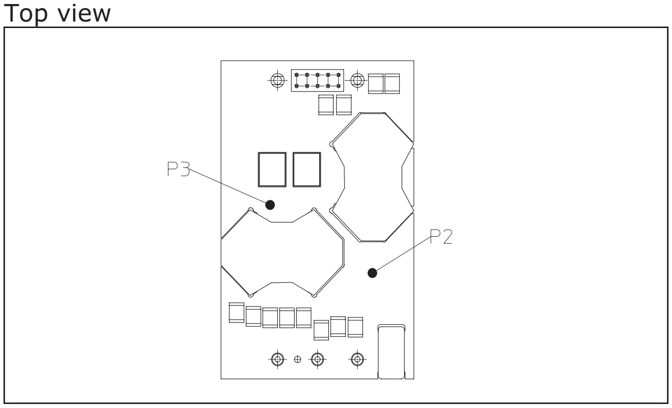
Definition of product operating temperature

The product operating temperature is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1, P2, P3 and P4. The temperature at these positions (T_{P1}, T_{P2}, T_{P3}, T_{P4}) should not exceed the maximum temperatures in the table below. The number of measurement points may vary with different thermal design and topology. Temperatures above maximum T_{P1}, measured at the reference point P1 (T_{P3} / $_{P3}$ for base plate versions) are not allowed and may cause permanent damage.

Position	Description	Max temperature
P1	PWB (reference point, open frame)	T_{P1}=125° C
P2	Opto-coupler	T_{P2}=105° C
P3	PWB (reference point for base-plate version)	T_{P3}=125° C
P4	Primary MOSFET	T_{P4}=125° C



Top view



Bottom view

(Best air flow direction is from positive to negative pins.)

Ambient Temperature Calculation

For products with base plate the maximum allowed ambient temperature can be calculated by using the thermal resistance.

1. The power loss is calculated by using the formula ((1/η) - 1) × output power = power losses (P_d).
η = efficiency of product. E.g. 95 % = 0.95

2. Find the thermal resistance (R_{th}) in the Thermal Resistance graph found in the Output section for each model. Note that the thermal resistance can be significantly reduced if a heat sink is mounted on the top of the base plate.

Calculate the temperature increase (ΔT).
$\Delta T = R_{th} \times P_d$

3. Max allowed ambient temperature is:
Max T_{P1} - ΔT.

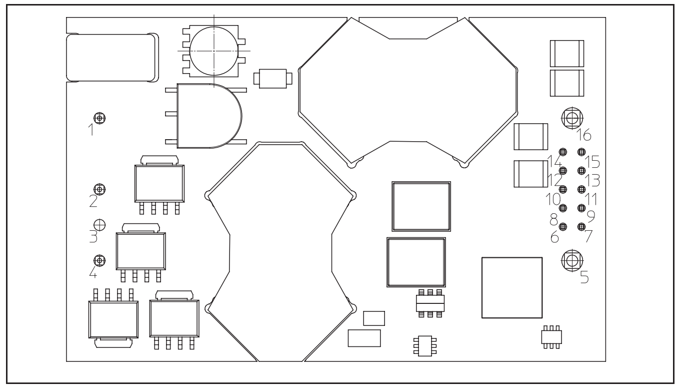
E.g. NQB-468 at 2m/s:

1. ((1/0.95) - 1) × 468 W = 24.6 W

2. 19.5 W × 2.8°C/W = 69.0°C}

3. 125 °C - 69.0°C = max ambient temperature is 56°C
The actual temperature will be dependent on several factors such as the PWB size, number of layers and direction of airflow.

Connections (Top view)



Pin	Designation	Function
1	+In	Positive Input
2	RC	Remote Control
3	Case	Case to GND (optional)
4	-In	Negative Input
5	-Out	Negative Output
6	S+	Positive Remote Sense
7	S-	Negative Remote Sense
8	SA0	Address pin 0
9	SA1	Address pin 1
10	SCL	PMBus Clock
11	SDA	PMBus Data
12	PG	Power Good output
13	DGND	PMBus ground
14	SALERT	PMBus alert signal
15	CTRL	PMBus remote control
16	+Out	Positive Output