Features

Power Module

- Wide Vin 5 to 60VDC
- High power density (LxWxH = 12.19x12.19x3.75)
- Wide operating temperature -40°C to 100°C at full load
- Efficiency up to 97%, no need for heat-sinks
- 6-sided shielding
- Thermally and EMI enhanced 25 pad LGA package
- Low profile

RECOM
DC/DC Converter

RPMH-1.5

1.5 Amp Single Output

YEAR 3 warranty



EN55032 compliant

Description

The RPMH-1.5 series is a wide input voltage, 1.5A non-isolated switching regulator power module. The module accepts up to 60VDC input and provides a trimmable output from 2.6 up to 28VDC and comes complete with a full set of features including adjustable output, on/off control, and power good signals. The ultra-compact module has a profile of only 3.75mm, but with an efficiency of up to 97%, the device can operate at full load in ambient temperatures as high as +100°C and with power derating up to 105°C without forced air cooling. The package is complete with 6-sided shielding for optimal EMC performance and excellent heat management.

Selection Guide

Part Number	Input Voltage Range [1] [VDC]	Output Voltage [VDC]	Vout Adjust Range [VDC]	Output Current max. [2] [A]	Efficiency typ. full load [%]	Max Capacitive typ. Load [3] [mF]
RPMH3.3-1.5	5 - 60	3.3	2.64 - 3.63	1.5	73	31.2
RPMH5.0-1.5	7 - 60	5	4 - 5.5	1.5	80	21.2
RPMH12-1.5	14 - 60	12	7.2 - 13.2	1.5	88	8.1
RPMH15-1.5	17 - 60	15	9 - 16.5	1.5	90	5.9
RPMH24-1.5	26 - 60	24	15 - 28	1.5	92	3.4

Notes:

Note1: Input voltage must be higher than desired output voltage. Refer to **"Buck mode"** and **"100% duty cycle mode [5]"**

Note2: Refer to **"Derating Graph"**

Note3: Max. Capacitive typ. Load is tested at nominal input and full resistive load. Max. rated output current within 1s

Model Numbering

RPMH___-1.5-___ Packaging [4]

Output Voltage

max. Output Current

Notes:

Note4: Add suffix "-CT" for tube packaging. For more details refer to **"PACKAGING INFORMATION"** without suffix, standard tape and reel packaging

EVAL BOARD available

www.recom-power.com/eval-ref-boards

Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

Parameter	Condition			Min.	Typ.	Max.
Internal Input Filter						capacitor
Input Voltage Range	Buck mode	3.3Vout 5Vout 12Vout 15Vout 24Vout		5VDC 7VDC 14VDC 17VDC 26VDC	48VDC	60VDC
	100% duty cycle mode [5]	Vout= Vin - Vdrop	3.3Vout 5Vout 12Vout 15Vout 24Vout	3VDC		5VDC 7VDC 14VDC 17VDC 26VDC
Absolute Maximum Input Voltage						66VDC
Input Current	nom. Vin= 48VDC	3.3Vout 5Vout 12Vout 15Vout 24Vout (1.33A)			140mA 194mA 420mA 512mA 750mA	
Quiescent Current (Vin nominal)	nom. Vin= 48VDC	3.3Vout, 5Vout 12Vout, 15Vout 24Vout			35µA 85µA 190µA	
Quiescent Current (max. Duty Cycle)	nom. Vin= 48VDC	3.3Vout 5Vout 12Vout 15Vout 24Vout			750µA 60µA 130µA 160µA 262µA	
Internal Power Dissipation	nom. Vin= 48VDC	3.3Vout 5Vout 12Vout 15Vout 24Vout (1.33A)			1.75W 1.81W 2.14W 2.27W 2.16W	2.12W 2.22W 2.62W 2.72W 2.66W
Output Voltage Trimming	refer to **"OUTPUT VOLTAGE TRIMMING"**			2.64VDC		28VDC
Minimum Dropout Voltage (Vdrop)	Vin min. = Vdrop + Vout	3.3Vout, 5Vout			1.5V/A	
		others			2V/A	
Minimum Load				0%		
Start-up Time	power up by using CTRL function			7.2ms	12ms	20.5ms
Rise-time					8ms	
ON/OFF CTRL	DC-DC ON DC-DC OFF					Open or 1.22V<V_{CTRL}<Vin Short or -0.3V<V_{CTRL}<1.144VDC
Standby Current	Vin=12VDC nom. Vin=48VDC	DC-DC ON DC-DC OFF		16µA	19µA 56µA	70µA
Internal Operating Frequency					1MHz	
Output Ripple and Noise [6]	20MHz BW	3.3Vout			70mVp-p	

Notes:

Note5: As input approaches output voltage set point, device enters maximum duty cycle mode. In 100% duty cycle mode, Vout equals Vin minus dropout voltage. Please refer to **"Dropout Voltage vs. Load"**. Output capacitor required. Please refer to **"Output Capacitor"**

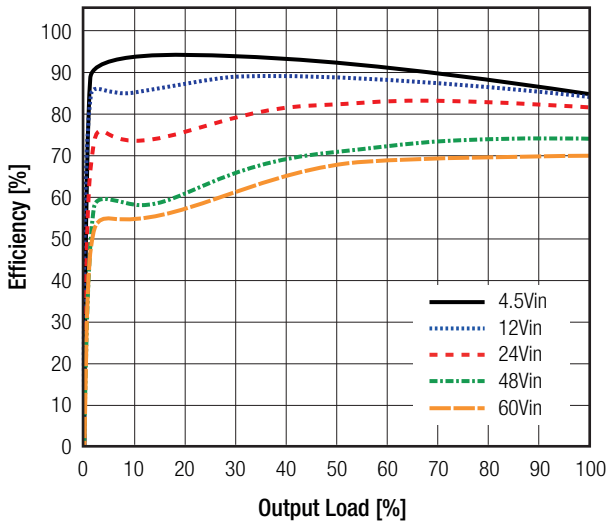
Note6: Measurements for Ripple and Noise are made with input EMC filter and output capacitors 22uF/50V MLCC for 12V, 15V, and 24V output voltage across output (low ESR)

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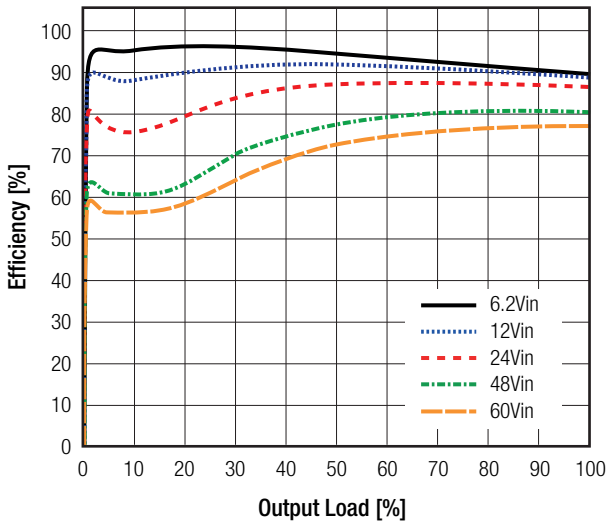
Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

Efficiency vs. Load

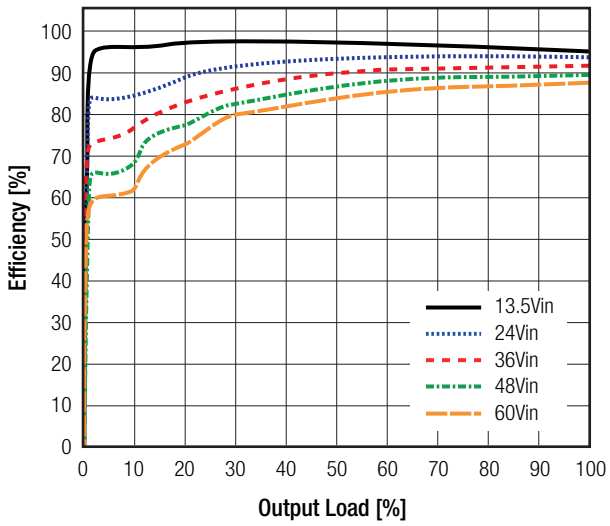
RPMH3.3-1.5



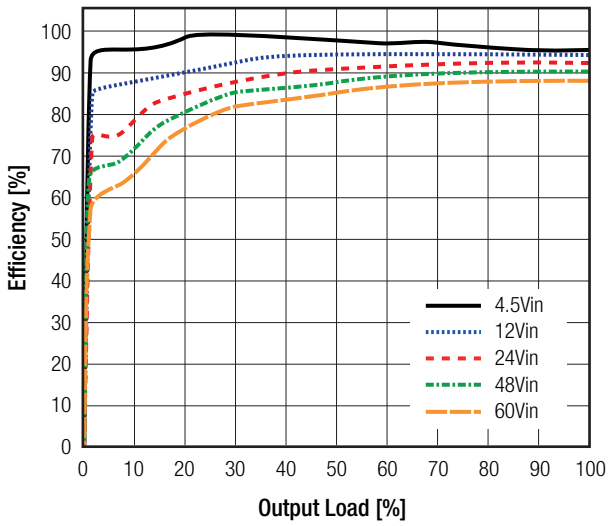
RPMH5.0-1.5



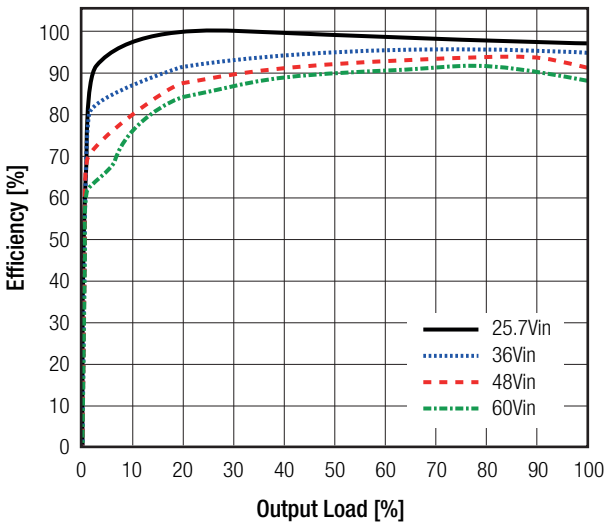
RPMH12-1.5



RPMH15-1.5



RPMH24-1.5

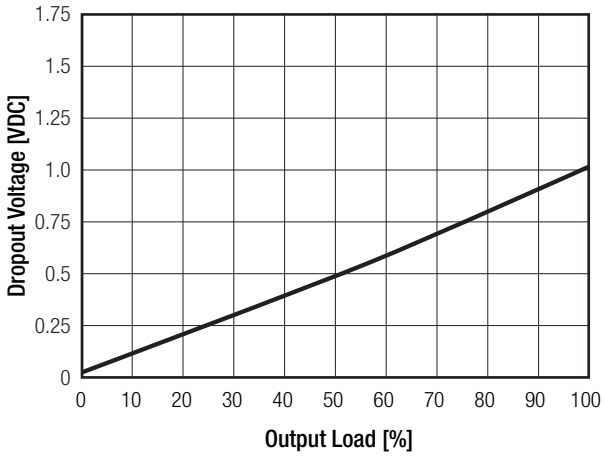


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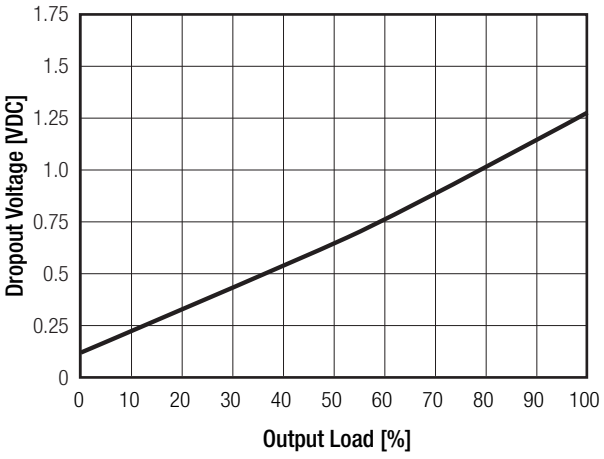
Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

Dropout Voltage vs. Load

RPMH3.3-1.5, and RPMH5.0-1.5



RPMH12-1.5, RPMH15-1.5, and RPMH24-1.5



Output Capacitor

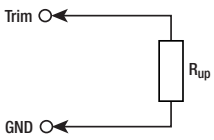
The RPMH requires MLCC output capacitor for normal operation (see below table)

Output Capacitance	
$Vout_{nom}$	C_{OUT}
12VDC	22µF 50V X7R
15VDC	
24VDC	

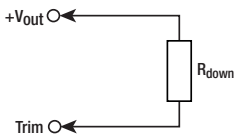
OUTPUT VOLTAGE TRIMMING

The RPMH-Series offers the feature of trimming the output voltage over a range between -20% to +10% for lower output voltages and from -40% to +10% for higher output voltages. This can be done by using external trim resistors. The values for the trim resistors in trim tables are according to standard E96 values; therefore, the specified voltage may slightly vary. Refer to **"Selection Guide"**

Trim up



Trim down



$Vout_{nom}$	= nominal output voltage	[VDC]
$Vout_{set}$	= trimmed output voltage	[VDC]
R_{up}	= trim up resistor	[Ω]
R_{down}	= trim down resistor	[Ω]
R_{HI} , R_{LO}	= internal resistors	[Ω]

$Vout_{nom}$	R_{HI}	R_{LO}
3.3VDC	100kΩ	43.2kΩ
5VDC	100kΩ	24.9kΩ
12VDC	100kΩ	9.09kΩ
15VDC	100kΩ	7.15kΩ
24VDC	100kΩ	4.32kΩ

Calculation:

$$R_{up} = \frac{R_{HI} \times R_{LO} \times Vout_{nom}}{(Vout_{set} - Vout_{nom}) \times (R_{HI} + R_{LO})}$$

$$R_{down} = R_{HI} \times \left[\frac{(Vout_{set} - Vout_{nom}) \times R_{LO} + Vout_{set} \times R_{HI}}{(Vout_{nom} - Vout_{set}) \times (R_{HI} + R_{LO})} \right]$$

Practical Example RPMH3.3-1.5, trim up

$Vout_{set}$ = 3.63VDC

$$R_{up} = \frac{100k \times 43.2k \times 3.3}{(3.63 - 3.3) \times (100k + 43.2k)} = 301.676k\Omega$$

R_{up} according to E96 ≈ **301kΩ**

Practical Example RPMH3.3-1.5, trim down

$Vout_{set}$ = 2.64VDC

$$R_{down} = 100k \times \left[\frac{(2.64 - 3.3) \times 43.2k + 2.64 \times 100k}{(3.3 - 2.64) \times (100k + 43.2k)} \right] = 249.162\Omega$$

R_{down} according to E96 ≈ **249kΩ**

continued on next page

Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

RPMH3.3-1.5

Trim up

V_{out}set =	3.4	3.45	3.5	3.63	[VDC]
R_{up} (E96) ≈	1M	665k	499k	301k	[Ω]

Trim down

V_{out}set =	3.1	3	2.8	2.64	[VDC]
R_{down} (E96) ≈	1M05	665k	365k	249k	[Ω]

RPMH5.0-1.5

Trim up

V_{out}set =	5.1	5.3	5.5	[VDC]
R_{up} (E96) ≈	1M	332k	200k	[Ω]

Trim down

V_{out}set =	4.7	4.5	4.3	4	[VDC]
R_{down} (E96) ≈	1M24	698k	475k	301k	[Ω]

RPMH12-1.5

Trim up

V_{out}set =	12.4	12.6	12.8	13	13.2	[VDC]
R_{up} (E96) ≈	249k	165k	124k	100k	82.5k	[Ω]

Trim down

V_{out}set =	10	9.6	9	8.5	8	7.7	7.2	[VDC]
R_{down} (E96) ≈	453k	357k	267k	215k	174k	154k	130k	[Ω]

RPMH15-1.5

Trim up

V_{out}set =	15.5	15.7	15.9	16.1	16.3	16.5	[VDC]
R_{up} (E96) ≈	200k	143k	110k	90k9	76k8	66k5	[Ω]

Trim down

V_{out}set =	14.5	14	13.5	13	[VDC]
R_{down} (E96) ≈	2M67	1M30	825k	604k	[Ω]

RPMH24-1.5

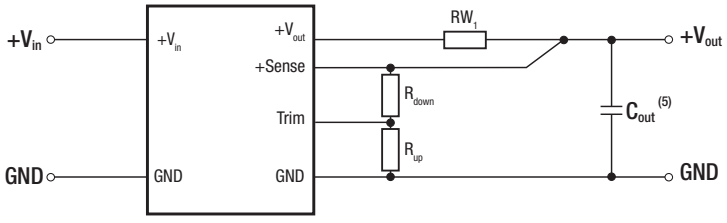
Trim up

V_{out}set =	24.5	25	25.5	26	26.5	27	28	[VDC]
R_{up} (E96) ≈	200k	100k	66k5	49k9	40k2	33k2	24k9	[Ω]

Trim down

V_{out}set =	20.1	19.6	18	17.6	17	16.5	[VDC]
R_{down} (E96) ≈	487k	422k	280k	261k	226k	205k	[Ω]

REMOTE SENSE



RW_1 ... wire losses +
R_{up} ... trim up resistor
R_{down} ... trim down resistor

The output voltage can be adjusted via the trim and sense functions. The maximum output voltage from trim and sense function combined is listed in the table below. Derating may be required when using trim and/or sense functions.

$V_{out\,nom}$	Vout max.
3.3VDC	3.63VDC
5VDC	5.5VDC
12VDC	13.2VDC
15VDC	16.5VDC
24VDC	28VDC

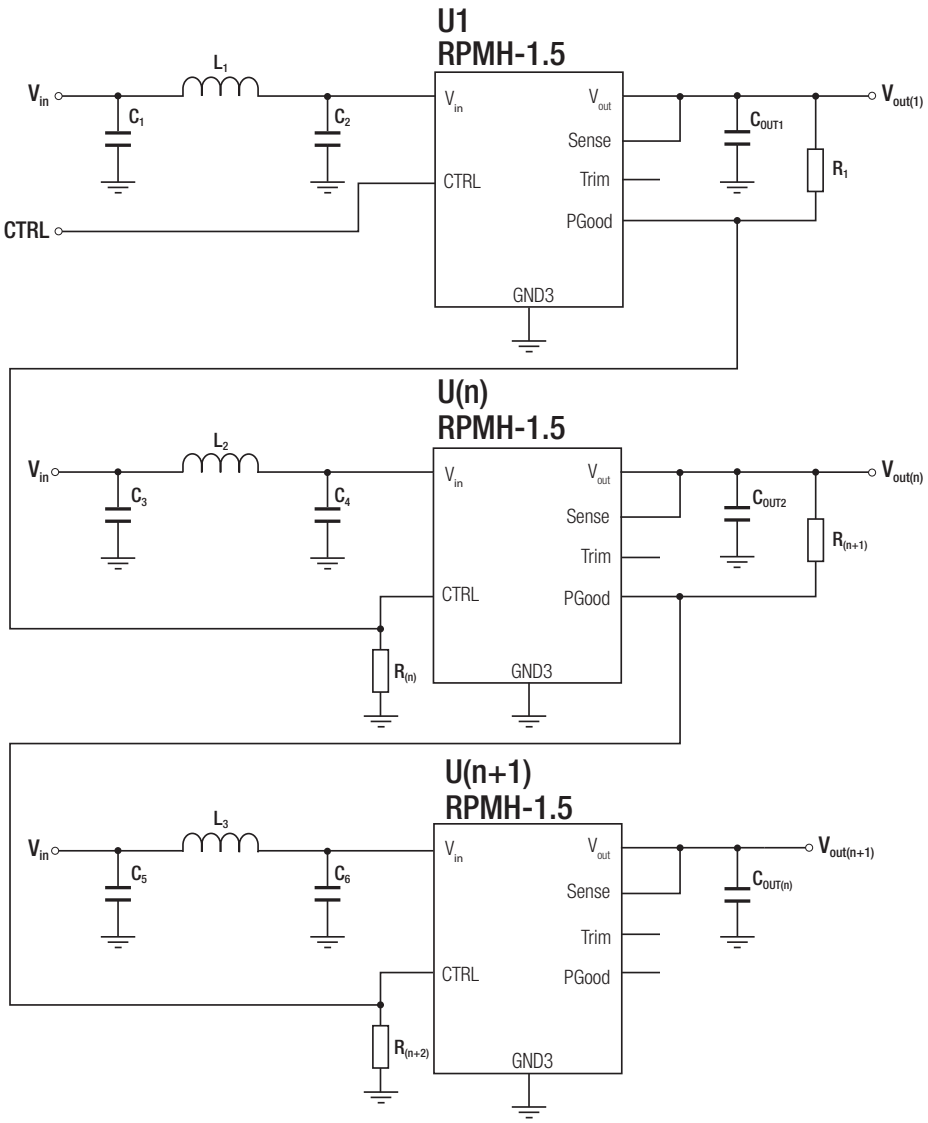
Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

REGULATIONS		
Parameter	**Condition**	**Value**
Output Accuracy		±2.0% typ. / ±4% max.
Line Regulation	low line to high line, full load	±3.0% typ.
Load Regulation	10% to 100% load	0.8% typ.
Transient Response	25% load step change	100mVp-p
	recovery time	2ms

Sequencing Multiple Modules

To sequence multiple power module, the power good (PGOOD) pad and the CTRL pad may be used. In below schematic, the U2 starts after U1 (RPMHxx-1.5) reaches its set output voltage and the power good signal is set to high which then enables U2. After U2 reaches its set output voltage, it enables next module - until U(n).

Note that by default PGOOD pad is pulled high to internal Vcc (5 VDC) and CTRL of enabled modules are pulled up to Input Voltage. Accordingly, external pull-up and pull-down resistors (R1-R(n+2)) must be used to secure proper sequencing.



Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

PROTECTIONS

Parameter	Condition		Value
Short Circuit Protection (SCP)	V_{FB} < 0.4V		hiccup mode, automatic recovery, 95-99ms
Short Circuit Input Current	without soft-start mode		15µA
Over Current Protection (OCP)	nom. Vin	3.3Vout 5Vout 12Vout 15Vout 24Vout	135% 130% 120% 110% 110%
Over Temperature Protection (OTP)	case temperature (measured on tc point)	DC-DC OFF DC-DC ON	105°C min., auto restart after cool down 100°C typ.

ENVIRONMENTAL

Parameter	Condition		Value
Operating Temperature Range [7]	@ natural convection 0.1m/s (refer to **"Derating Graph"**)		-40°C to +100°C
Maximum Case Temperature	measured on tc point (refer to **"Dimension Drawing"**)		+105°C
Temperature Coefficient	@ +60°C T_{AMB}		0.63%/K
Thermal Impedance [7]	natural convection 0.1m/s, horizontal (T_{case} to T_{AMB})		12.8K/W typ.
Operating Altitude	@ natural convection 0.1m/s		5000m
Shock	MIL-STD-810G, Method 516.6, Procedure I		40g, 11ms, saw-tooth, 3 shocks ± per axis 3 axis; unit is operating
	MIL-STD-810G, Method 516.6, Procedure IV		drop on 50mm plywood or concrete 26 times from 1 meter
Random Vibration	MIL-STD-810G, Method 514.6, Procedure I, Category 24		Category 24 - Figure 514.6E-1 - power spectral density = 0.04g²/Hz at 20Hz –1000Hz; -6dB/octave at 1000Hz – 2000Hz; 60 minutes x 3 axis; unit is operating during tests
Moisture Sensitivity Level	non-condensing		MLS 1
MTBF	according to MIL-HDBK-217F, G.B. @ full load, nom. V_{IN}= 48VDC according to MIL-HDBK-217F, G.B. @ max. load	+25°C +85°C	2021 x 10^3 hours 1410 x 10^3 hours

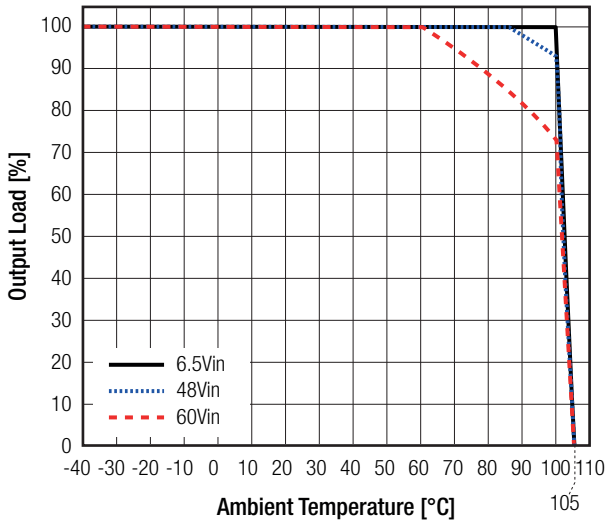
Notes:

Note7: tested with a RPMH-1.5-EVM-1 card 85.0x55.0mm 35µm copper, 4 layer

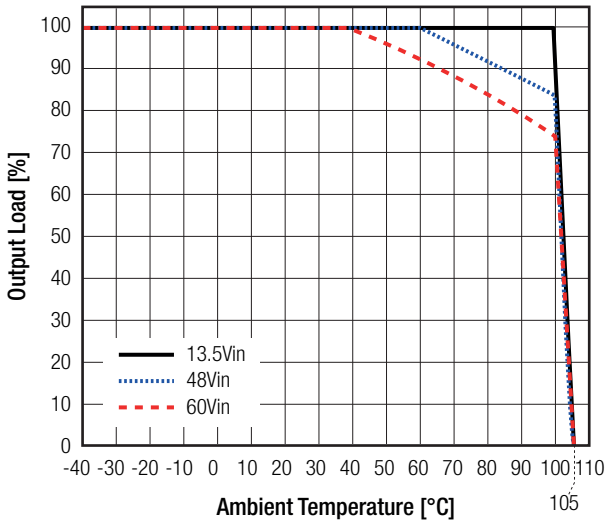
Derating Graph

(@ chamber and natural convection 0.1m/s)

RPMH3.3-1.5, RPMH5.0-1.5



RPMH12-1.5



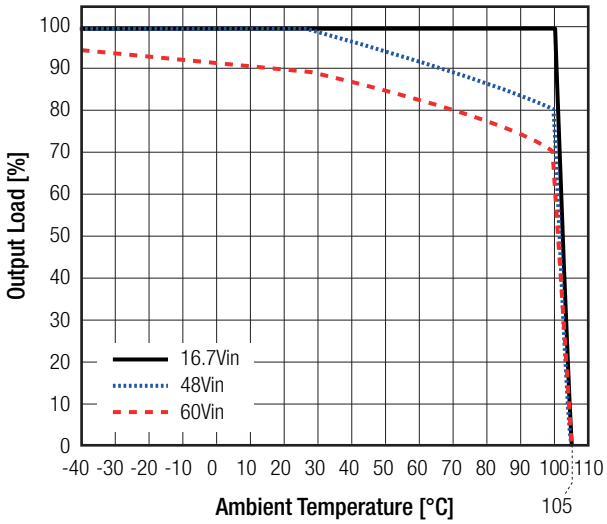
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Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

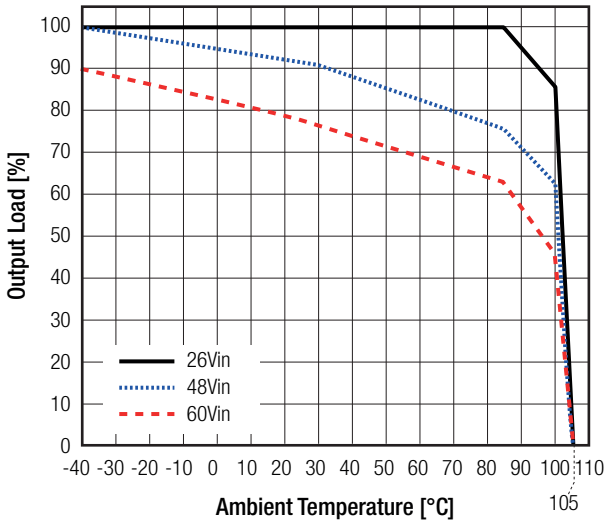
Derating Graph

(@ chamber and natural convection 0.1m/s)

RPMH15-1.5



RPMH24-1.5

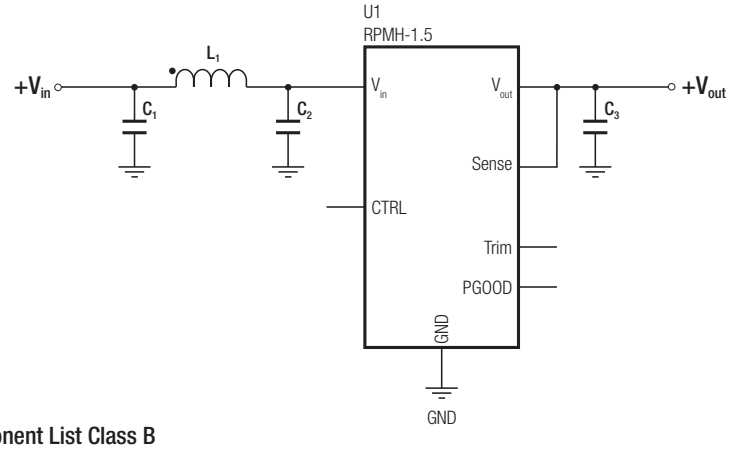


SAFETY AND CERTIFICATIONS

Certificate Type (Safety)	Report / File Number	Standard
Audio/video, information, and communication technology equipment. Safety requirements	designed to meet	EN62368-1
RoHS2		RoHS 2011/65/EU + AM2015/863

EMC Compliance	Condition	Standard / Criterion
Electromagnetic compatibility of multimedia equipment - emission requirements	with external components (refer to **"EMC filtering suggestion"** below)	EN55032, Class B

EMC filtering suggestion according to EN55032



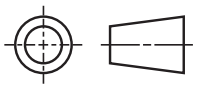
Component List Class B

U1	L1	C1	C2	C3
RPMH3.3-1.5	4.7µH 1.5A 180mΩ	3.3µF 100V X7R or X7S	2.2µF 100V X7R	-
RPMH5.0-1.5				-
RPMH12-1.5	5.6µH 1.7A 180mΩ			22µF 50V X7R
RPMH15-1.5	10µH 1.5A 180mΩ		3.3µF 100V X7R or X7S	
RPMH24-1.5		4.7µF 100V X7S		

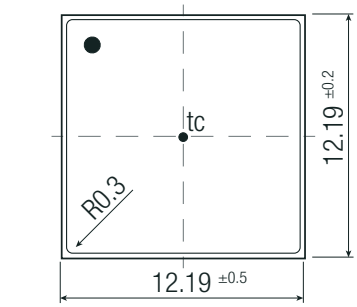
Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

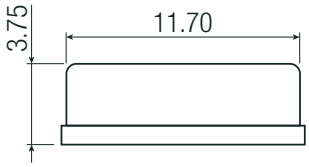
DIMENSION AND PHYSICAL CHARACTERISTICS

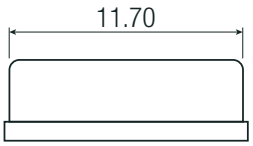
Parameter	Type	Value
Material	case PCB solder pads	metal FR4, (UL94 V-0) copper with electrolytic nickel-gold
Dimension (LxWxH)		12.19 x 12.19 x 3.75mm
Weight		1.0g typ.



Dimension Drawing (mm)







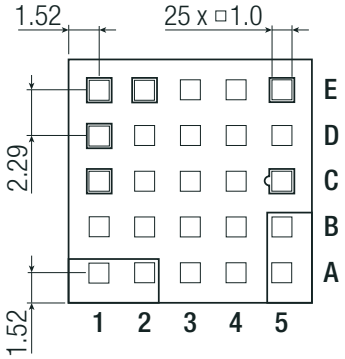
Pinning information

Pad #	Function	Description
A1, A2	Vin	Positive input voltage with respect to GND. Connect to a Vin plane for enhanced thermal performance
C1	CTRL	Active high: pull to GND to disable the device. Pull high or leave open to enable the device
A5, B5	Vout	Positive output voltage. Connect to a Vout plane for enhanced thermal performance
C5	Sense	Connect this pad to the load or directly to Vout. This pad must not be left floating
E5	Trim	Use this pad to set the output voltage (refer to **"OUTPUT VOLTAGE TRIMMING"** for different Vout)
E1, E2	NC	Not connected
D1	PGood	Output power good. High = VOUT at set level, Low = VOUT below nominal regulation. Sink current is about 0.1mA. It has a high impedance output (100kΩ connected to internal 5V Vcc). Leave floating if not used.
others	GND	Negative input voltage. Connect to GND plane(s) for enhanced thermal performance

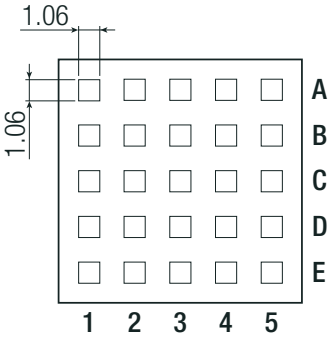
tc = case temperature measuring point
pad tolerance= ±0.05mm
case tolerance= ±0.25mm

Recommended Footprint Details

Bottom View

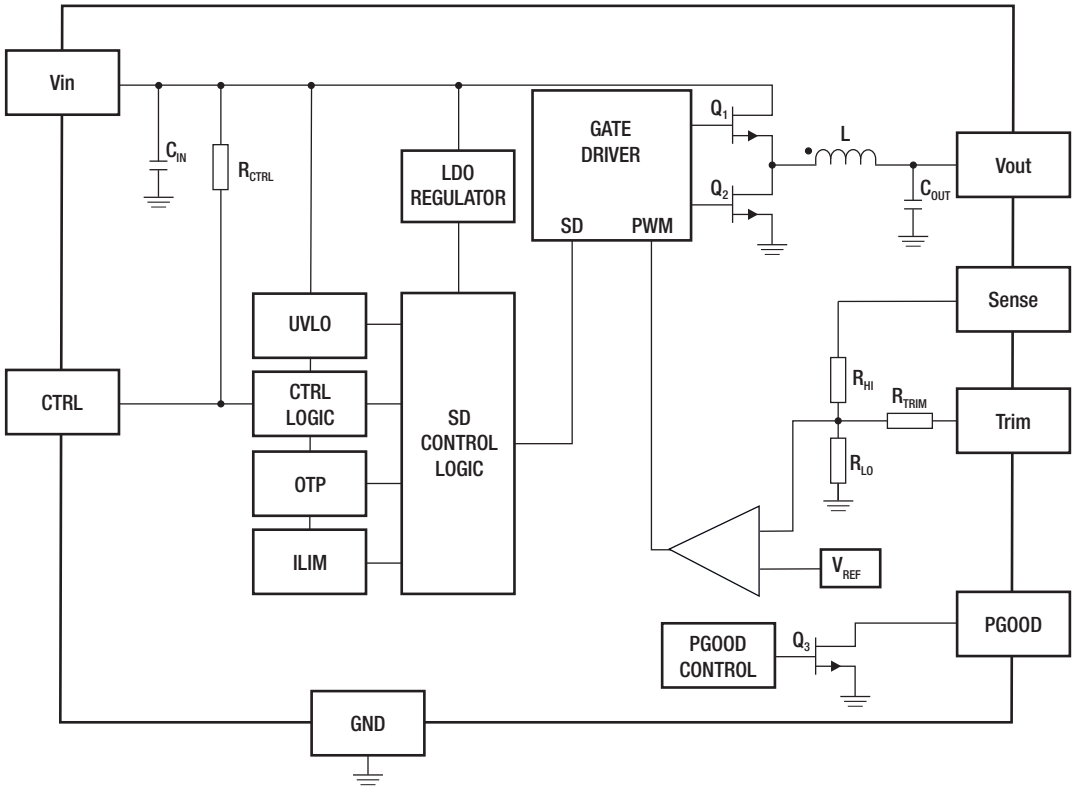


Top View



Specifications (@ Ta= 25°C, nom. Vin= 48VDC, full load, with output cap [5] after warm-up unless otherwise stated)

BLOCKDIAGRAM



Component List

$Vout_{nom}$	C_{IN}	R_{CTRL}	L	C_{OUT}	R_{HI}	R_{TRIM}	R_{LO}
3.3VDC	2µF	1MΩ	10µH	20µF	100kΩ	1kΩ	43.2kΩ
5.0VDC							24.9kΩ
12VDC				4µF			9.09kΩ
15VDC							7.15kΩ
24VDC							4.32kΩ

PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	reel (diameter + width)	Ø177.8 x 30.4mm
	tape and reel (carton)	265.0 x 240.0 x 60.0mm
	tube ("-CT")	530.0 x 30.3 x 19.2mm
Packaging Quantity	tape and reel	200pcs
	tube ("-CT")	30pcs
Tape Width		24mm
Storage Temperature Range		-55°C to +125°C
Storage Humidity	non-condensing	95% RH max.

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