

Features

Power Module

- Wide Vin 4.3 to 65VDC
- High power density (LxWxH = 12.19x12.19x3.75)
- Wide operating temperature -40°C to +95°C at full load
- Efficiency up to 89%, no need for heatsinks
- 6-sided shielding
- Thermally and EMI enhanced 25 pad LGA package
- Low profile



RPMH-0.5

0.5 Amp Single Output



EN55032 compliant

Description

The RPMH-0.5 series is a wide input voltage, 0.5A non-isolated switching regulator power module. The module accepts with up to 65VDC input and provides a trimmable output from 2.6 up to 28VDC and comes complete with a full set of features including adjustable output, sequencing, soft-start control, 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 89%, the device can operate at full load in ambient temperatures as high as +95°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

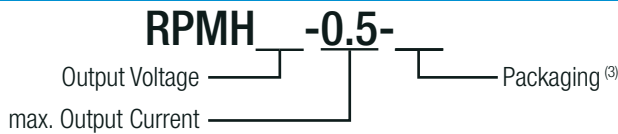
| Part Number | Input Voltage Range ⁽¹⁾ [VDC] | Output Voltage [VDC] | Vout Adjust Range [VDC] | Output Current max. [A] | Efficiency typ. [%] | Max Capacitive typ. Load ⁽²⁾ [µF] |
|-------------|--|----------------------|-------------------------|-------------------------|---------------------|--|
| RPMH3.3-0.5 | 4.3 - 65 | 3.3 | 2.64 - 3.63 | 0.5 | 72 | 80000 |
| RPMH5.0-0.5 | 6 - 65 | 5 | 4 - 5.5 | 0.5 | 77 | 50000 |
| RPMH12-0.5 | 13.5 - 65 | 12 | 7.2 - 13.2 | 0.5 | 82 | 20000 |
| RPMH15-0.5 | 16.5 - 65 | 15 | 9 - 16.5 | 0.5 | 85 | 13200 |
| RPMH24-0.5 | 25.5 - 65 | 24 | 15 - 28 | 0.5 | 89 | 9400 |

Notes:

Note1: Input voltage must be higher than desired output voltage. Check buck mode and 100% duty cycle mode

Note2: Max. Cap Load is tested at nominal input and full resistive load

Model Numbering



Notes:

Note3: Add suffix "-CT" for tube packaging for more details refer to "PACKAGING INFORMATION" without suffix, standard tape and reel packaging

Specifications @ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated

| BASIC CHARACTERISTICS | | | | | |
|--------------------------------|-------------------------------------|---|---|------|---|
| Parameter | Condition | | Min. | Typ. | Max. |
| Internal Input Filter | | | capacitor | | |
| Input Voltage Range | Buck mode | 3.3Vout 5.0Vout 12Vout 15Vout 24Vout | 4.3VDC 6VDC 13.5VDC 16.5VDC 25.5VDC | | 65VDC |
| | 100% duty cycle mode ⁽⁵⁾ | Vout= Vin - Vdrop 3.3Vout 5.0Vout 12Vout 15Vout 24Vout | 3VDC | | 4.3VDC 6VDC 13.5VDC 16.5VDC 25.5VDC |
| Absolute Maximum Input Voltage | | | | | 68VDC |
| Undervoltage Lockout (UVLO) | DC-DC ON DC-DC OFF | | 2.6VDC 2.35VDC | | 2.95VDC 2.6VDC |

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Notes:

Note4: Output capacitor required. Please refer to "Output Capacitor".

Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

| Parameter | Condition | | Min. | Typ. | Max. |
|--|--|--|---------|---|----------|
| Input Current | nom. Vin= 48VDC | 3.3Vout | | 48mA | |
| | | 5.0Vout | | 68mA | |
| | | 12Vout | | 152mA | |
| | | 15Vout | | 184mA | |
| | | 24Vout | | 281mA | |
| Quiescent Current | nom. Vin= 48VDC | 3.3Vout, 5.0Vout | | 16µA | 50µA |
| | | 12Vout, 15Vout | | 50µA | 100µA |
| | | 24Vout | | 100µA | 150µA |
| Internal Power Dissipation | nom. Vin= 48VDC | 3.3Vout | | 0.64W | |
| | | 5.0Vout | | 0.75W | |
| | | 12Vout, 15Vout | | 1.32W | |
| | | 24Vout | | 1.48W | |
| Output Voltage Trimming ⁽⁶⁾ | | | 2.64VDC | | 28VDC |
| Minimum Dropout Voltage (Vdrop) ⁽⁷⁾ | Vin min. = Vdrop + Vout | 3.3Vout, 5Vout others | | 2V/A 3V/A | |
| Minimum Load | | | 0% | | |
| Start-up Time | without using soft start function/ power up by using CTRL function | | | 1.5ms | |
| Rise-time | | | | 900µs | |
| ON/OFF CTRL | | DC-DC ON DC-DC OFF | | Open or 1.22V < V _{CTRL} < Vin Short or -0.3V < V _{CTRL} < 1.14VDC | |
| Standby Current | | DC-DC OFF | 15µA | | |
| Internal Operating Frequency | | 3.3Vout 5.0Vout 12Vout, 15Vout, 24Vout | | 300kHz 400kHz 600kHz | |
| Output Ripple and Noise ⁽⁸⁾ | 20MHz BW | 3.3Vout 5.0Vout 12Vout 15Vout, 24Vout | | 20mVp-p 35mVp-p 40mVp-p 30mVp-p | 100mVp-p |

Notes:

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

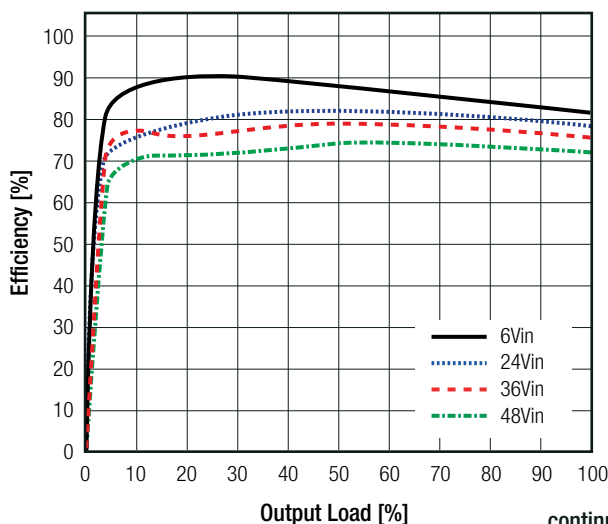
Note6: For more detailed information, please refer to **"OUTPUT VOLTAGE TRIMMING"**

Note7: Required dropout voltage per 1A output current to be within accuracy (refer to **"Dropout Voltage vs. Load"**)

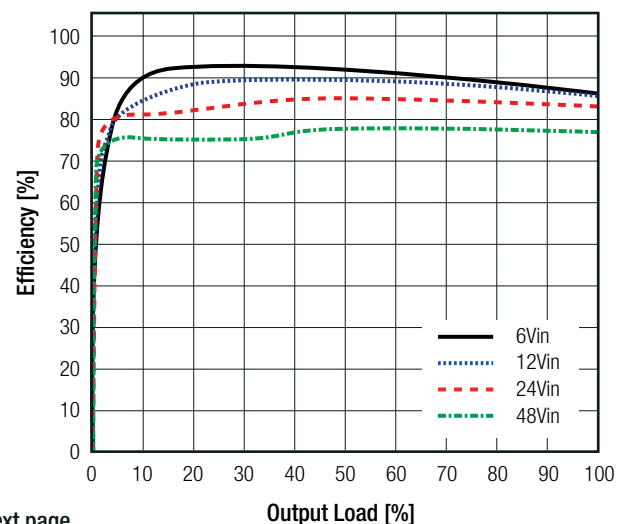
Note8: Measurements are made with a 22µF MLCC across output (low ESR)

Efficiency vs. Load

RPMH3.3-0.5

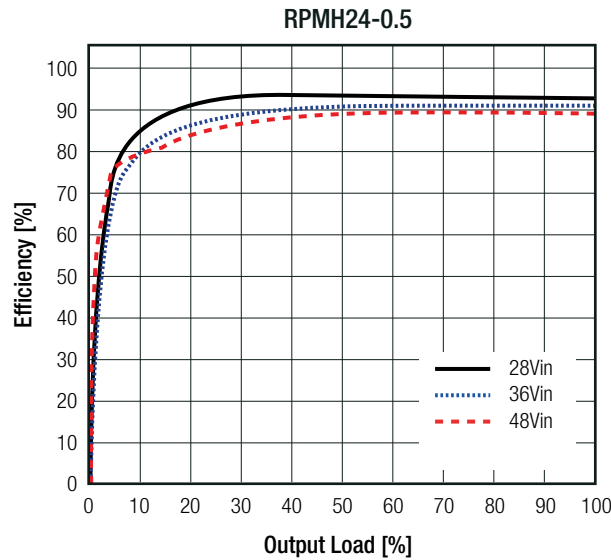
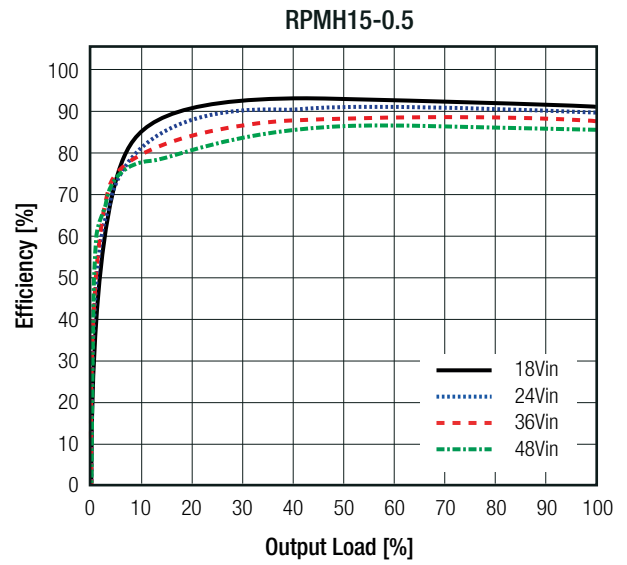
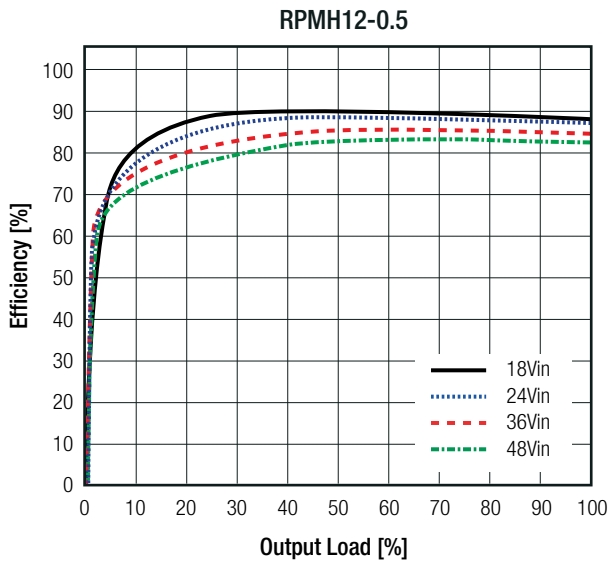


RPMH5.0-0.5

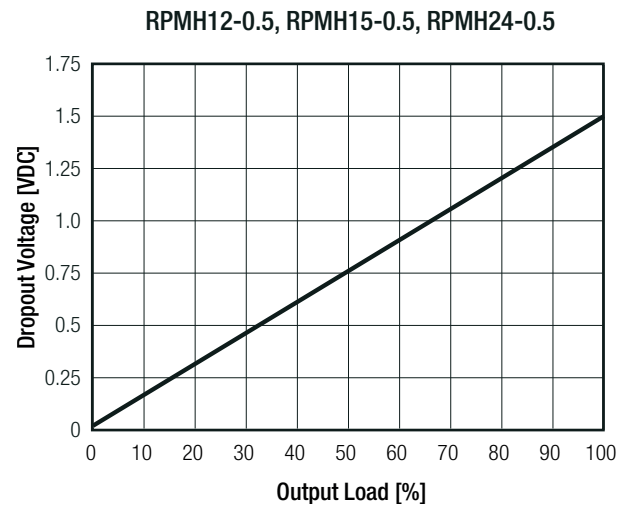
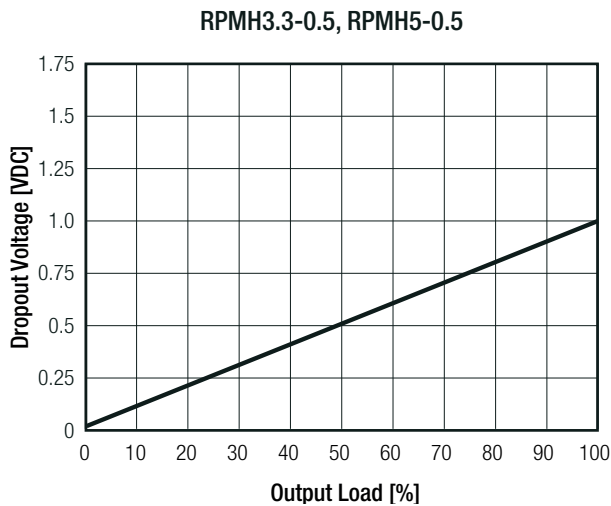


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Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)



Dropout Voltage vs. Load



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Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

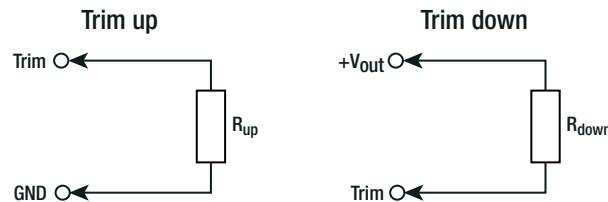
Output Capacitor

The RPMH requires MLCC output capacitors for normal operation (see table).

| Output Capacitance | |
|----------------------|-----------------------|
| V _{out_nom} | C _{OUT} |
| 3.3VDC, 5.0VDC | -- |
| 12VDC | 10uF 25V X7R 1206 |
| 15VDC | 10uF 25V X7R 1206 |
| 24VDC | 2 x 10uF 50V X7R 1210 |

OUTPUT VOLTAGE TRIMMING

The RPMH-series offers the feature of trimming the output voltage by using external trim resistors. The values for trim resistors shown in trim tables below are according to standard E96 values; therefore, the specified voltage may slightly vary. Refer to **"Selection Guide"**



V_{out_nom} = nominal output voltage [VDC]
 V_{out_set} = trimmed output voltage [VDC]
 V_{ref} = reference voltage [VDC]
 R_{up} = trim up resistor [Ω]
 R_{down} = trim down resistor [Ω]
 R_{HI}, R_{LO} = internal resistors [Ω]

| V _{out_nom} | R _{HI} | R _{LO} | V _{ref} |
|----------------------|-----------------|-----------------|------------------|
| 3.3VDC | 205kΩ | 169kΩ | 1.223VDC |
| 5.0VDC | 374kΩ | 309kΩ | |
| 12VDC | 1.22MΩ | 1MΩ | |
| 15VDC | 1.22MΩ | 1MΩ | |
| 24VDC | 1.22MΩ | 1MΩ | |

Calculation:

$$R_{up} = \left[\frac{R_{HI}}{V_{out_set} - V_{nom}} \right]$$

Practical Example RPMH3.3-0.5, trim up

$$V_{out_set} = 3.63VDC$$

$$R_{up} = \left[\frac{205k}{3.63 - 3.3} \right] = \underline{\underline{621k\Omega}}$$

R_{up} according to E96 ≈ 619kΩ

$$R_{down} = \left[\frac{(V_{out_set} - V_{ref}) \times R_{LO}}{V_{out_nom} - V_{out_set}} \right]$$

Practical Example RPMH3.3-0.5, trim down

$$V_{out_set} = 2.64VDC$$

$$R_{down} = \left[\frac{(2.64 - 1.223) \times 169k}{3.3 - 2.64} \right] = \underline{\underline{363k\Omega}}$$

R_{down} according to E96 ≈ 365kΩ

RPMH3.3-0.5

Trim up

| | | | | |
|-------------------------|------|------|------|-------|
| V _{out_set} = | 3.4 | 3.5 | 3.63 | [VDC] |
| R _{up} (E96) ≈ | 2M05 | 1M02 | 619k | [Ω] |

Trim down

| | | | | | |
|---------------------------|------|----|------|------|-------|
| V _{out_set} = | 3.1 | 3 | 2.8 | 2.64 | [VDC] |
| R _{down} (E96) ≈ | 1M58 | 1M | 536k | 365k | [Ω] |

RPMH5.0-0.5

Trim up

| | | | | |
|-------------------------|------|------|------|-------|
| V _{out_set} = | 5.1 | 5.3 | 5.5 | [VDC] |
| R _{up} (E96) ≈ | 3M74 | 1M24 | 750k | [Ω] |

Trim down

| | | | | | |
|---------------------------|------|-----|------|------|-------|
| V _{out_set} = | 4.7 | 4.5 | 4.3 | 4 | [VDC] |
| R _{down} (E96) ≈ | 3M57 | 2M | 1M33 | 845k | [Ω] |

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Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

RPMH12-0.5

Trim up

| | | | | | | |
|-------------------------|------|------|------|-----|------|-------|
| V _{out_set} = | 12.4 | 12.6 | 12.8 | 13 | 13.2 | [VDC] |
| R _{up} (E96) ≈ | 3M01 | 2M | 1M5 | 1M2 | 1M | [Ω] |

Trim down

| | | | | | | | | |
|---------------------------|------|-----|------|------|------|-----|------|-------|
| V _{out_set} = | 10 | 9.6 | 9 | 8.5 | 8 | 7.7 | 7.2 | [VDC] |
| R _{down} (E96) ≈ | 4M32 | 3M4 | 2M61 | 2M05 | 1M69 | 1M5 | 1M24 | [Ω] |

RPMH15-0.5

Trim up

| | | | | | | | |
|-------------------------|------|------|------|------|------|------|-------|
| V _{out_set} = | 15.5 | 15.7 | 15.9 | 16.1 | 16.3 | 16.5 | [VDC] |
| R _{up} (E96) ≈ | 2M4 | 1M74 | 1M33 | 1M1 | 931k | 820k | [Ω] |

Trim down

| | | | | | | | | |
|---------------------------|-----|------|-----|------|------|-----|-----|-------|
| V _{out_set} = | 12 | 11.5 | 11 | 10.5 | 10 | 9.5 | 9 | [VDC] |
| R _{down} (E96) ≈ | 3M6 | 2M94 | 2M4 | 2M05 | 1M74 | 1M5 | 1M3 | [Ω] |

RPMH24-0.5

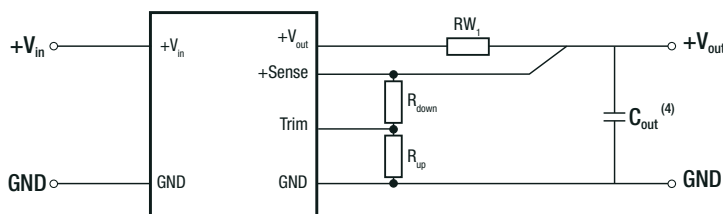
Trim up

| | | | | | | | | |
|-------------------------|------|-----|------|------|------|------|------|-------|
| V _{out_set} = | 24.5 | 25 | 25.5 | 26 | 26.4 | 27 | 28 | [VDC] |
| R _{up} (E96) ≈ | 2M43 | 1M2 | 806k | 604k | 511k | 402k | 300k | [Ω] |

Trim down

| | | | | | | | | | | |
|---------------------------|------|------|-----|------|------|------|------|------|-----|-------|
| V _{out_set} = | 19.5 | 19.2 | 18 | 17.5 | 17 | 16.5 | 16 | 15.5 | 15 | [VDC] |
| R _{down} (E96) ≈ | 3M9 | 3M74 | 2M8 | 2M49 | 2M26 | 2M | 1M82 | 1M69 | 1M5 | [Ω] |

REMOTE SENSE



RW₁ ... 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} | V _{out_max.} |
|----------------------|-----------------------|
| 3.3VDC | 3.63VDC |
| 5.0VDC | 5.5VDC |
| 12VDC | 13.2VDC |
| 15VDC | 16.5VDC |
| 24VDC | 28VDC |

Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

| REGULATIONS | | | |
|--------------------------------|-------------------------------------|--|------------|
| Parameter | Condition | Value | |
| Output Accuracy | | ±2.0% typ. / ±4.8% max. | |
| Line Regulation | low line to high line | RPMH3.3-0.5 (4.3-65VDC) | ±2.5% typ. |
| | | RPMH5.0-0.5 (6-65VDC) | ±3.0% typ. |
| | | RPMH12-0.5 (13.5-65VDC) RPMH15-0.5 (16.5-65VDC) | ±3.5% typ. |
| | | RPMH24-0.5 (25.5-65VDC) | ±3.0% typ. |
| Load Regulation ⁽⁹⁾ | 20% to 100% load step recovery time | 0.5% typ. | |
| Transient Response | 25% load step change | 100mVp-p | |
| | recovery time | 2ms | |

Note:

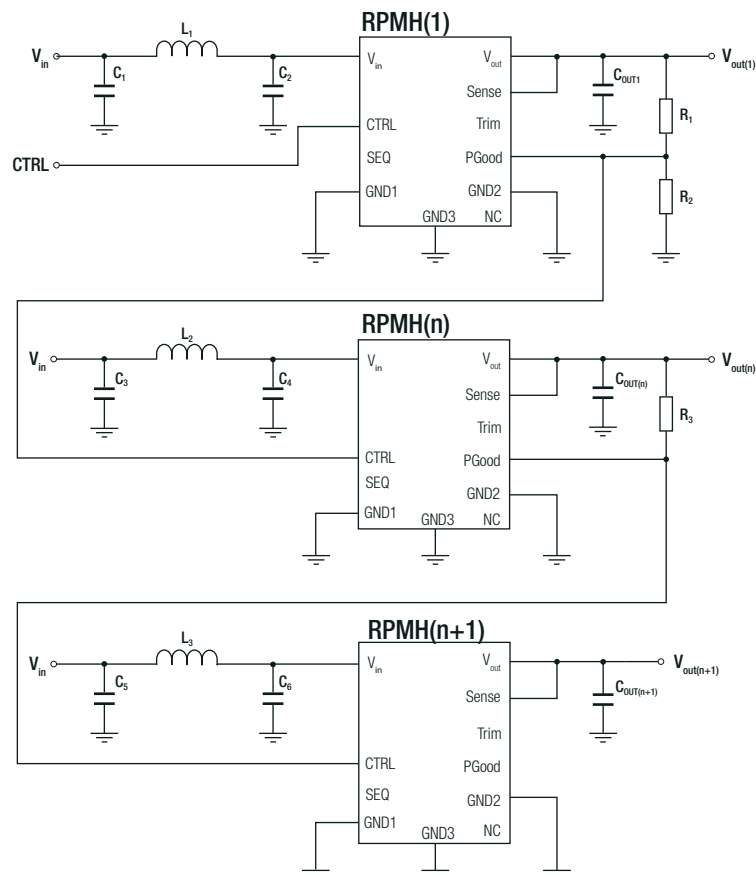
Note9: Operation below 20% load will not harm the converter, but specifications may not be met

Sequencing Multiple Modules

The SEQ pin can be used to program the rising edge of the output voltage. An internal current source charges a soft-start capacitor which is connected from the sequencing pin to GND. The following equation is used to calculate the soft-start capacitor:

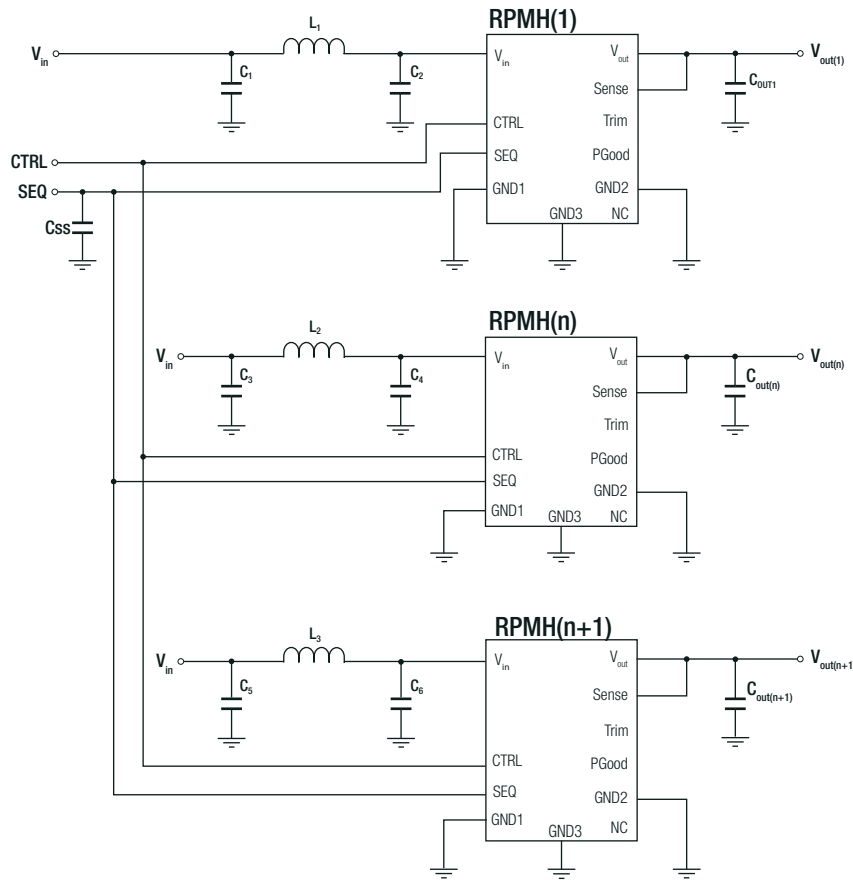
$$\begin{aligned}
 C_{ss} &= \text{soft-start capacitor} \\
 t_{ss} &= \text{required soft-start time} \\
 n &= \text{number of RPMHs} \\
 C_{ss} \text{ [nF]} &= (8.1 \times n) \times t_{ss} \text{ [ms]}
 \end{aligned}$$

To sequence multiple power module start-up times, the power good (PGood) pin and the CTRL pin may be used. In below schematic, the RPMH(n) starts after RPMH(1) reaches its set output voltage and the power good signal is set to high which then enables RPMH(n). After RPMH(n) reaches its set output voltage, it enables RPMH(n+1).



Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

To sequence multiple converters to start at the same time (set output voltage is reached at the same time), the following schematic may be used:



PROTECTIONS

| Parameter | Condition | Value |
|--------------------------------|----------------|---------------------------------|
| Short Circuit Protection (SCP) | less than 50mΩ | hiccup mode, automatic recovery |
| Over Current Protection (OCP) | | 120% min. |

ENVIRONMENTAL

| Parameter | Condition | Value |
|---|---|---|
| Operating Temperature Range ⁽¹⁰⁾ | @ natural convection 0.1m/s (refer to "Derating Graph") | -40°C to +105°C |
| Maximum Case Temperature | measured on tc point (refer to "Dimension Drawing") | +105°C |
| Temperature Coefficient | | 0.02%/K typ. |
| Thermal Impedance ⁽¹⁰⁾ | natural convection 0.1m/s, horizontal (T_{case} to T_{AMB}) | 8K/W typ. |
| Operating Altitude | @ natural convection 0.1m/s | 5000m |
| Operating Humidity | non-condensing | 5% - 95% RH |
| Shock | MIL-STD-810G, Method 516.6, Procedure I | 40g, 11ms, saw-tooth, 3 shocks \pm per axis 3 axis; unit is operating |
| | MIL-STD-810G, Method 516.6, Procedure IV | drop on 50mm plywood on 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 = 0.04g ² /Hz at 20Hz - 1000Hz; -6dB/octave at 1000Hz - 2000Hz; 60 minutes x 3 axis; unit is operating during tests |
| MTBF | according to MIL-HDBK-217F, G.B. @ full load | +25°C @ max. T_{AMB} 2.696 x 10 ³ hours 995 x 10 ³ hours |

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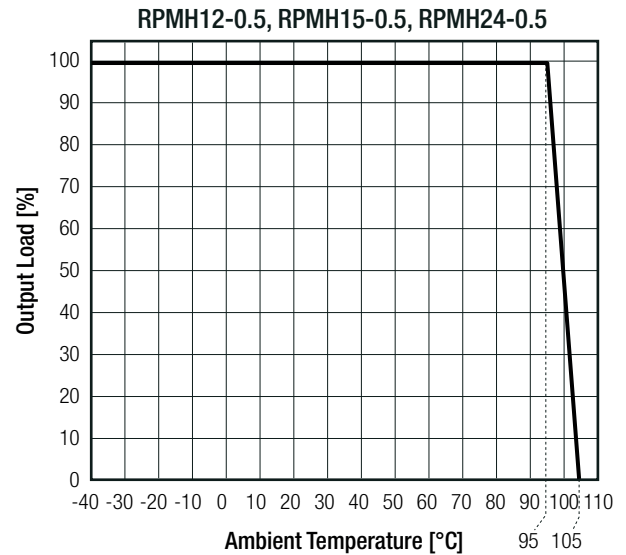
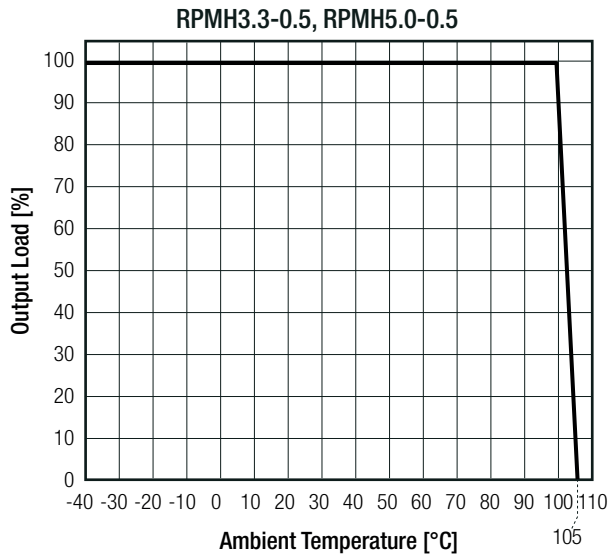
Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

Notes:

Note10: tested with a eurocard 160x100mm 70µm copper, 4 layer

Derating Graph ⁽¹⁰⁾

(@ chamber and natural convection 0.1m/s, 48Vin)

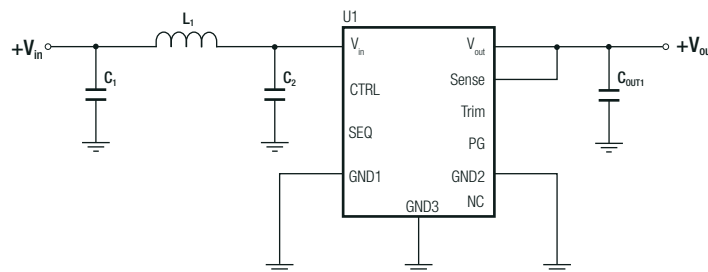


SAFETY AND CERTIFICATIONS

| Certificate Type (Safety) | Report / File Number | Standard |
|--|----------------------|------------------------------|
| Audio/video, information and communication technology equipment. Safety requirements | designed to meet | EN62368-1 |
| RoHS 2 | | 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

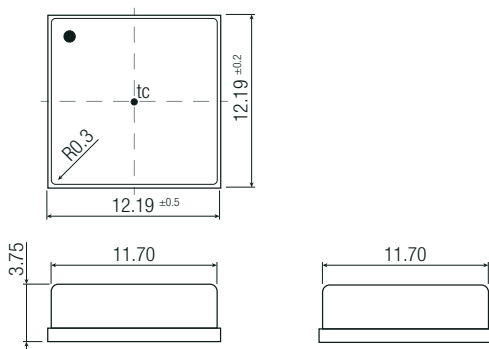
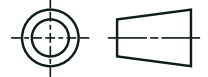
| U1 | L1 | C1 | C2 | C _{OUT1} |
|-------------|-------------------------|----------------|---------------------------|-------------------|
| RPMH3.3-0.5 | RLS-126 | 2.2µF 100V X7R | 2 x 4.7µF 100V X7R or X7S | 22µF 10V X7R |
| RPMH5.0-0.5 | | | | 22µF 25V X7R |
| RPMH12-0.5 | | | | 2 x 10µF 50V X7R |
| RPMH15-0.5 | | | | |
| RPMH24-0.5 | | | | |

Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

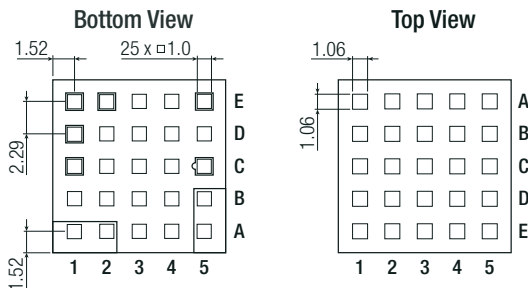
DIMENSION AND PHYSICAL CHARACTERISTICS

| 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 | | 1.1g typ. |

Dimension Drawing (mm)



Recommended Footprint Details

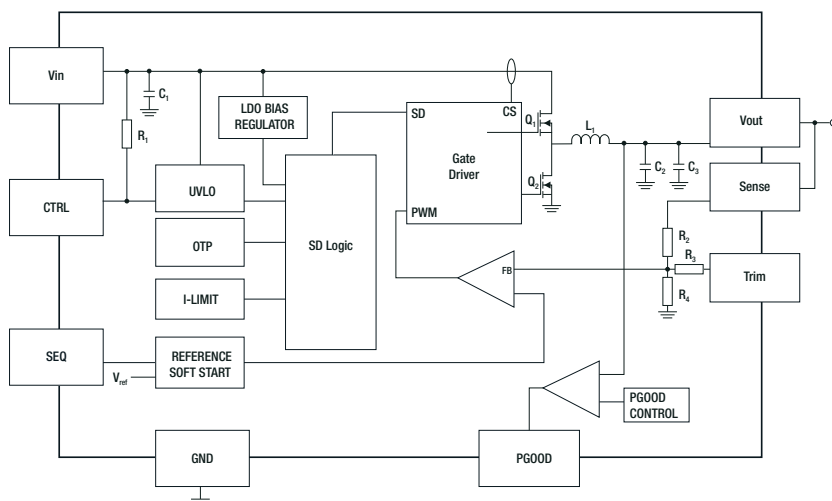


Pinning information

| 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) |
| E2 | NC | Not connected |
| E1 | SEQ | Used to sequence multiple converters or to set the startup time. Leave pad floating if not used |
| D1 | PGood | Output power good. High = Vout at set level, low = Vout below nominal regulation. Maximum sink current is about 0.1mA. It has a high impedance output (100kΩ connected to Vout), no higher than 12V. Left 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

BLOCKDIAGRAM



Component List

| Vout _{nom} | C1 | L1 | C2, C3 |
|---------------------|-------|-------|-------------------------|
| 3.3VDC | 2.2μF | 47μH | 10μF 2pcs. in parallel |
| 5.0VDC | | | |
| 12VDC | 100μH | 100μH | 4.7μF 2pcs. in parallel |
| 15VDC | | | |
| 24VDC | | | |

| Vout _{nom} | R1 | R2 | R3 | R4 |
|---------------------|------|-------|-----|--------|
| 3.3VDC | 10MΩ | 169kΩ | 1kΩ | 100kΩ |
| 5.0VDC | | 309kΩ | | 113kΩ |
| 12VDC | 10MΩ | 1MΩ | 1kΩ | 88.7kΩ |
| 15VDC | | | | 53.6kΩ |
| 24VDC | | | | |

Specifications (@ Ta= 25°C, nom. Vin, full load, with output cap ⁽⁴⁾ after warm-up unless otherwise stated)

| PACKAGING INFORMATION | | |
|-----------------------------|------------------------|------------------------|
| Parameter | Type | Value |
| Packaging Dimension (LxWxH) | tape and reel | 330.2 x 330.2 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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