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SIMPEX electronic
RECOM
DC/DC Converter

# RPM-1.0

## 1 Amp Single Output

3 YEAR Warranty

## Features

- High power density (L*W*H = 12.19*12.19*3.75)
- Wide operating temperature -40°C to +107°C at full load
- Efficiency up to 99%, no need for heatsinks
- 6-sided shielding
- Thermally and EMI enhanced 25 pin LGA package
- Compact DOSA-compatible footprint
- Low profile

## Power Module

## Description

The RPM-1.0 series is a 1A non-isolated switching regulator power module 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 99%, the device can operate at full load in ambient temperatures as high as +107°C without forced air cooling. The package is complete with 6-sided shielding for optimal EMC performance and excellent heat management.

RoHS 2+ compliant 10 from 10 — REACH compliant

EN55032 compliant

## Selection Guide

| Part Number | Input Voltage Range (1) [VDC] | Output Voltage [VDC] | Vout Adjust Range [VDC] | Output Current max. [A] | Efficiency typ. [%] | Max. Capacitive Load (2) [µF] |
|---|---|---|---|---|---|---|
| RPM3.3-1.0 (2) | 3 - 17 | 3.3 | 0.9 - 6.0 | 1 | 94 - 99 | 800 |
| RPM5.0-1.0 (2) | 3 - 17 | 5 | 0.9 - 6.0 | 1 | 92 - 99 | 800 |

**Notes:**

Note1: Refer to ***"Input Voltage Range"***

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

## Model Numbering

RPM__-1.0-

- RPM__ : Output Voltage
- -1.0- : max. Output Current
- Packaging (3)

**Notes:**

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

## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

| BASIC CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | | **Condition** | | **Min.** | **Typ.** | **Max.** |
| Internal Input Filter | | | | | | capacitor |
| Input Voltage Range | Buck mode | | 3.3Vout<br>5Vout | 3.35VDC<br>5.05VDC | 12VDC | 17VDC |
| | 100% duty cycle mode (4) | Vout= Vin - Vdrop | 3.3Vout<br>5Vout | 3VDC | | 3.35VDC<br>5.05VDC |
| Absolute Maximum Input Voltage | | | | | | 20VDC |
| Undervoltage Lockout (UVLO) | | DC-DC ON<br>DC-DC OFF | | 2.6VDC<br>2.8VDC | 2.7VDC<br>2.9VDC | 2.8VDC<br>3.0VDC |
| Input Current | | nom. Vin= 12VDC | 3.3Vout<br>5Vout | | 0.3A<br>0.45A | |
| Quiescent Current | | | | | 30µA | |
| Internal Power Dissipation | | | 3.3Vout<br>5Vout | | | 0.27W<br>0.32W |

continued on next page

EVAL BOARD available

## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

| Parameter | Condition | Min. | Typ. | Max. |
|---|---|---|---|---|
| Output Voltage Trimming [5] | | 0.9VDC | | 6VDC |
| Minimum Dropout Voltage (Vdrop) [6] | Vin min. = Vdrop + Vout | | 50mV/A | |
| Minimum Load | | 0% | | |
| Start-up Time | without using soft start function/ power up<br>using CTRL function | | 1.6ms<br>1.5ms | |
| Rise-time | | | 1.4ms | |
| ON/OFF CTRL | DC-DC ON<br>DC-DC OFF | | | Open or 0.9V<$V_{CTRL}$<Vin<br>Short or -0.3V<$V_{CTRL}$<0.45VDC |
| Input Current of CTRL Pin | DC-DC OFF | | 1.2µA | |
| Standby Current | DC-DC OFF | | 15µA | |
| Internal Operating Frequency | | | 1.25MHz | |
| Output Ripple and Noise [7] | 20MHz BW, 80Ohm @ 100MHz | | 60mVp-p | |
| Absolute Maximum Capacitive Load | below 1 second start up + $C_{ss}$ = 3700nF<br>below 1 second start up without softstart mode | | | 42000µF<br>800µF |

**Notes:**

Note4: As input approaches output voltage set point, device enters 100% duty cycle mode. in 100% duty cycle mode, Vout equals Vin minus dropout voltage (see Dropout vs. Load graph)

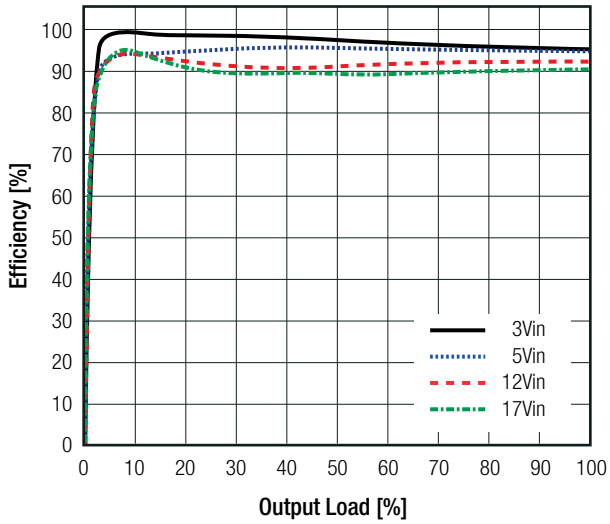
Note5: For more detailed information, please refer to trim table or calculation on page RPM-3

Note6: Required dropout voltage per 1A output current to be within accuracy (see Dropout vs. Load graph)

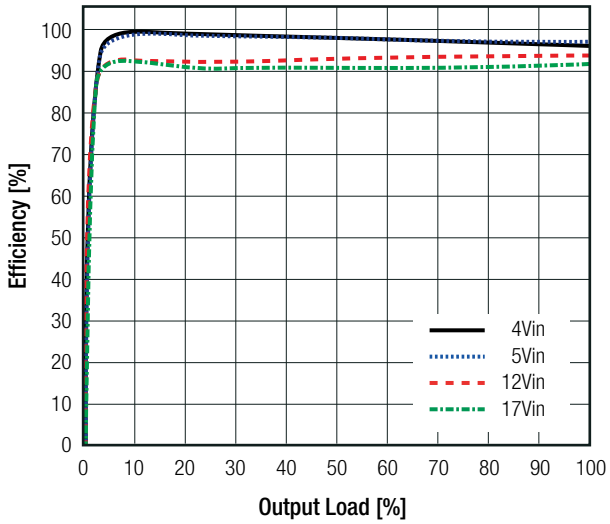
Note7: Measurements are made with a 22µF MLCC across output (low ESR)

### Efficiency vs. Load

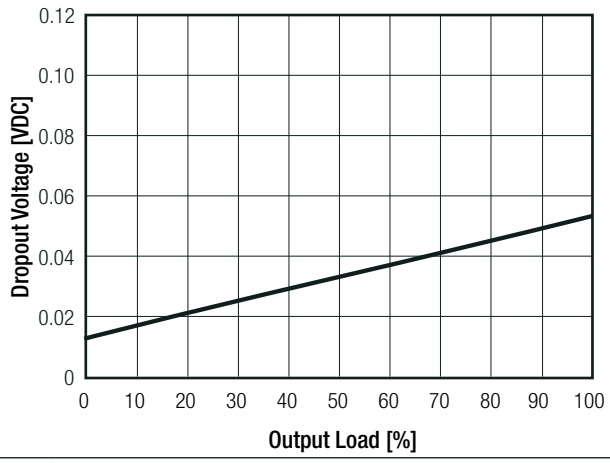
RPM3.3-1.0




RPM5.0-1.0



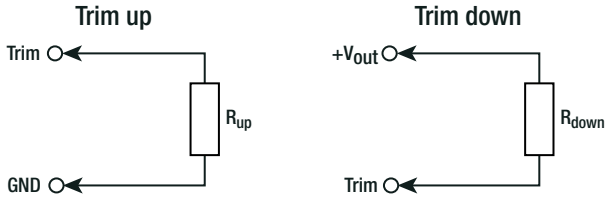

### Dropout Voltage vs. Load



## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

## OUTPUT VOLTAGE TRIMMING

The RPM series offers the feature of trimming the output voltage over a range between 0.9V and 6V 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.




| | | |
|---|---|---|
| $Vout_{nom}$ | = nominal output voltage | [VDC] |
| $Vout_{set}$ | = trimmed output voltage | [VDC] |
| $V_{ref}$ | = reference voltage | [VDC] |
| $R_{up}$ | = trim up resistor | [Ω] |
| $R_{down}$ | = trim down resistor | [Ω] |
| $R_1$, $R_2$, $R_3$ | = internal resistors | [Ω] |

| $Vout_{nom}$ | $R_1$ | $R_2$ | $R_3$ | $V_{ref}$ |
|---|---|---|---|---|
| 3.3VDC | 376kΩ | 1kΩ | 471kΩ | 0.81VDC |
| 5VDC | 344kΩ | | 431kΩ | |

**Calculation:**

$$R_{up} = \left[ \frac{R_1}{Vout_{set} - V_{nom}} \right] - R_2$$

$$R_{down} = \left[ \frac{(Vout_{set} - V_{ref}) \times R_3}{Vout_{nom} - Vout_{set}} \right]$$

**Practical Example RPM3.3-1.0:**

$$R_{up} = \left[ \frac{376k}{4.3 - 3.3} \right] - 1k = \underline{375k\Omega}$$

$$R_{down} = \left[ \frac{(1.8 - 0.81) \times 471k}{3.3 - 1.8} \right] = \underline{311k\Omega}$$

$R_{up}$ according to E96 ≈ **374kΩ**

$R_{down}$ according to E96 ≈ **309kΩ**

### RPM3.3-1.0

**Trim up**

| $Vout_{set}$ = | 3.5 | 3.7 | 3.9 | 4.1 | 4.3 | 4.5 | 4.7 | 5.0 | 5.5 | 6.0 | [VDC] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{up}$ (E96) ≈ | 1M91 | 953k | 634k | 475k | 374k | 316k | 267k | 221k | 169k | 137k | [Ω] |

**Trim down**

| $Vout_{set}$ = | 3.0 | 2.7 | 2.5 | 2.2 | 2.0 | 1.8 | 1.5 | 1.2 | 1.0 | 0.9 | [VDC] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{down}$ (E96) ≈ | 3M40 | 1M47 | 1M | 590k | 432k | 309k | 182k | 86k6 | 39k2 | 17k4 | [Ω] |

### RPM5.0-1.0

**Trim up**

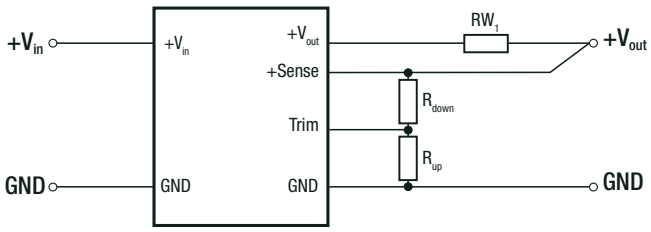
| $Vout_{set}$ = | 5.1 | 5.2 | 5.3 | 5.4 | 5.5 | 5.6 | 5.7 | 5.8 | 5.9 | 6.0 | [VDC] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{up}$ (E96) ≈ | 3M32 | 1M69 | 1M15 | 866k | 681k | 576k | 487k | 422k | 383k | 340k | [Ω] |

**Trim down**

| $Vout_{set}$ = | 4.5 | 4.0 | 3.5 | 3.3 | 2.5 | 1.8 | 1.5 | 1.2 | 1.0 | 0.9 | [VDC] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $R_{down}$ (E96) ≈ | 3M16 | 1M37 | 768k | 634k | 294k | 133k | 84k5 | 44k2 | 20k5 | 9k53 | [Ω] |

## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

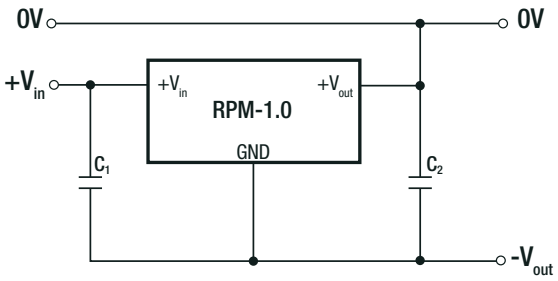
### REMOTE SENSE




The output voltage can be adjusted via the trim and sense functions.
The maximum output voltage from Trim and Sense function combined is 5.5VDC. Derating may be required when using Trim and/or sense functions.

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

### POSITIVE TO NEGATIVE




$C_1$ and $C_2$ may be added to reduced ripple and should be fitted close to the converter pins.

**Notes:**

Note8: RECOM Power Modules can also be used to convert a positive voltag into a negative voltage. Parameters such as maximum Vin, efficiency and maximum operating temperature are reduced. Please contact RECOM for further details.

### REGULATIONS

| Parameter | Condition | Value |
|---|---|---|
| Output Accuracy | | ±3.0% max. |
| Line Regulation | low line to high line, full load | 0.25% typ. / ±3.0% max. |
| Load Regulation | 0% to 100% load | 0.5% typ. / 3.0% max. |
| Soft-Start Time | | refer to soft-start capacitor calculation |
| Transient Response | 100% - 10% load step<br>recovery time | 200mV max.<br>6ms typ. |
| | 25% load step change<br>recovery time | 150mV max.<br>500µs typ. |

#### 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:

$C_{ss}$ = soft-start capacitor
$I_{ss}$ = sum of all soft-start currents of all sequenced modules
$t_{ss}$ = required soft-start time
n = number of RPMs

$$C_{ss} = \frac{t_{ss} \times I_{ss}}{1.25V} - n \times 3.3nF$$

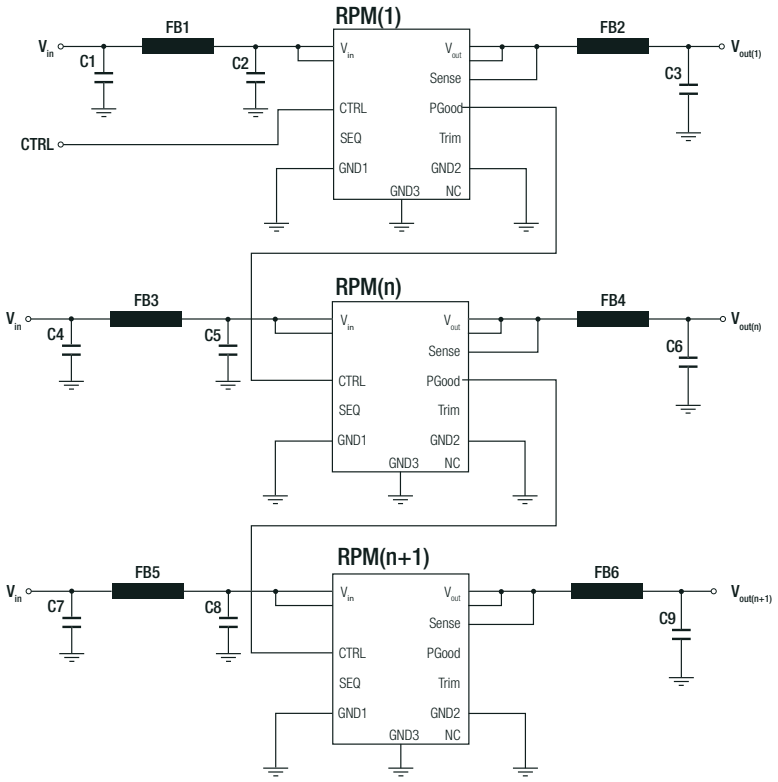
Note: there is a 3.3nF internal soft-start capacitor, and there are different constant current sources in the modules which leads to different preset soft-start times.

| $I_{ss}$ [µA] | | | Preset soft-start time [µs] | | |
|---|---|---|---|---|---|
| Min. | Typ. | Max. | Min. | Typ. | Max. |
| 4.5 | 5.0 | 5.5 | 750 | 825 | 920 |

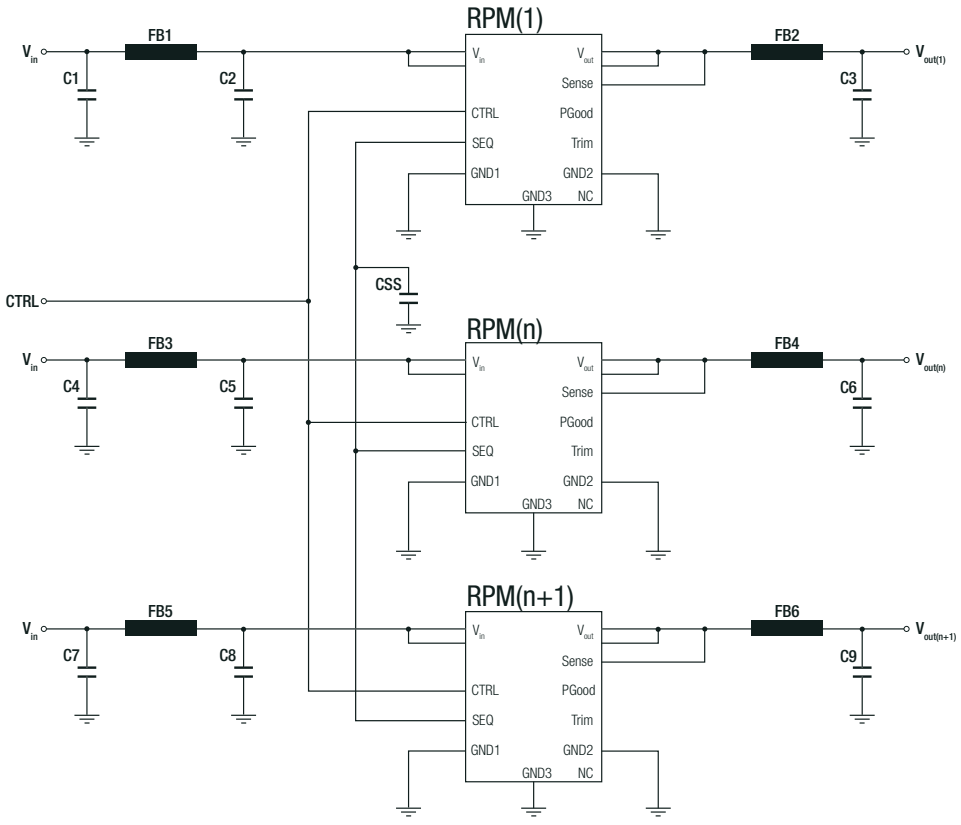
continued on next page

## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

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




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:



## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

| PROTECTIONS | | | |
|---|---|---|---|
| **Parameter** | **Condition** | | **Value** |
| Short Circuit Protection (SCP) | 50mΩ | | constant current mode |
| Short Circuit Input Current | without soft-start mode | | 75mA typ. |
| Over Current Protection (OCP) | with soft-start mode | | 120%, pulse by pulse current limitation |
| Over Temperature Protection (OTP) | case temperature (measured on tc point) | DC-DC OFF<br>DC-DC ON | 110°C, auto restart after cool down<br>100°C typ. |

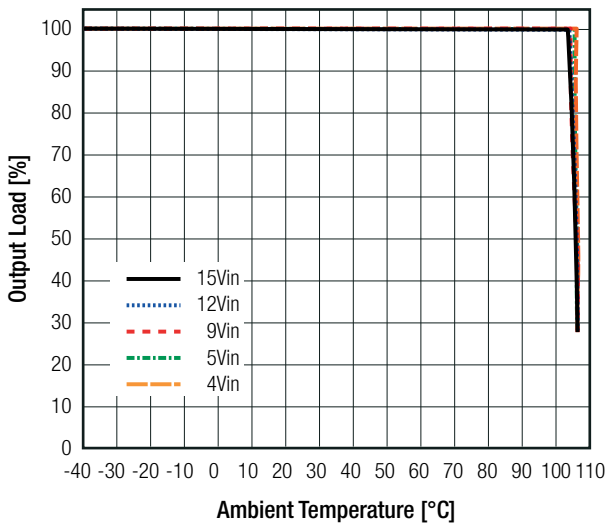
| ENVIRONMENTAL | | | |
|---|---|---|---|
| **Parameter** | **Condition** | | **Value** |
| Operating Temperature Range [9] | @ natural convection 0.1m/s (refer to derating graph) | | -40°C to +105°C |
| Maximum Case Temperature | measured on tc point (see dimension drawing) | | +110°C |
| Temperature Coefficient | @ +65°C Tamb | | 0.02%/K |
| Thermal Impedance [9] | 0.1m/s, horizontal (Tcase to Tamb) | | 8K/W |
| Operating Altitude | with derating @ natural convection 0.1m/s (refer to altitude vs. load graph) | | 5000m |
| Operating Humidity | non-condensing | | 5% - 95% RH max. |
| 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 on concrete 26 times from 1 meter |
| Temperature Cycling | MIL-STD-883F, Method 1010, Condition A | | powered -50°C to +85°C, 300 cycles |
| 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 |
| MTBF | according to MIL-HDBK-217F, G.B. @ full load | +25°C<br>+85°C | 2900 x $10^3$ hours<br>950 x $10^3$ hours |

**Notes:**

Note9: tested with a eurocard 160x100mm 70µm copper, 4 layer

### Derating Graph [9]

(@ chamber and natural convection 0.1m/s)



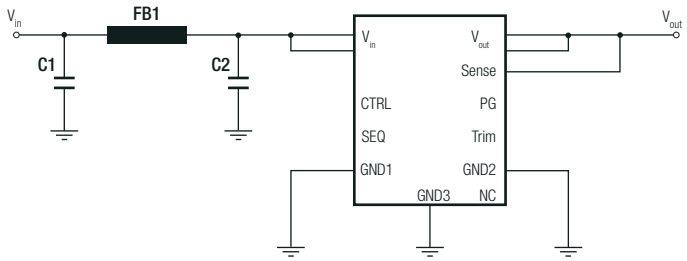
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### 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 (see filter suggestions below) | EN55032, Class A and B |

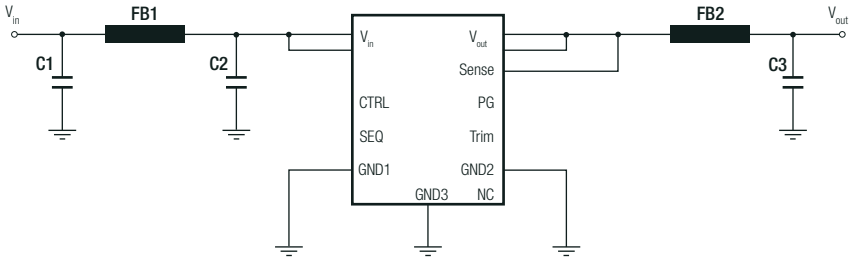
**EMC filtering suggestion according to EN55032**




**Component List Class A**

| C1 | C2 (10) | FB1 |
|---|---|---|
| 10µF 25V X7R | 10µF 25V X7R | WE ref: 742792510 |

**EMC filtering suggestion according to EN55032**




**Component List Class B**

| C1 | C2 (10) | FB1 | FB2 | C3 |
|---|---|---|---|---|
| 10µF 25V X7R | 10µF 25V X7R | WE ref: 742792510 | WE ref: 7427932 | 22µF 10V 7XR |

**Notes:**

Note10: C2 is only required below 10V input voltage

### DIMENSION AND PHYSICAL CHARACTERISTICS

| Parameter | Type | Value |
|---|---|---|
| Material | case<br>PCB<br>solder pads | metal<br>FR4, (UL94 V-0)<br>copper with electrolytic nickel-gold |
| Dimension (LxWxH) | | 12.19 x 12.19 x 3.75mm |
| Weight | | 1.1g typ. |

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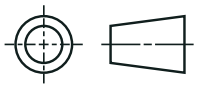
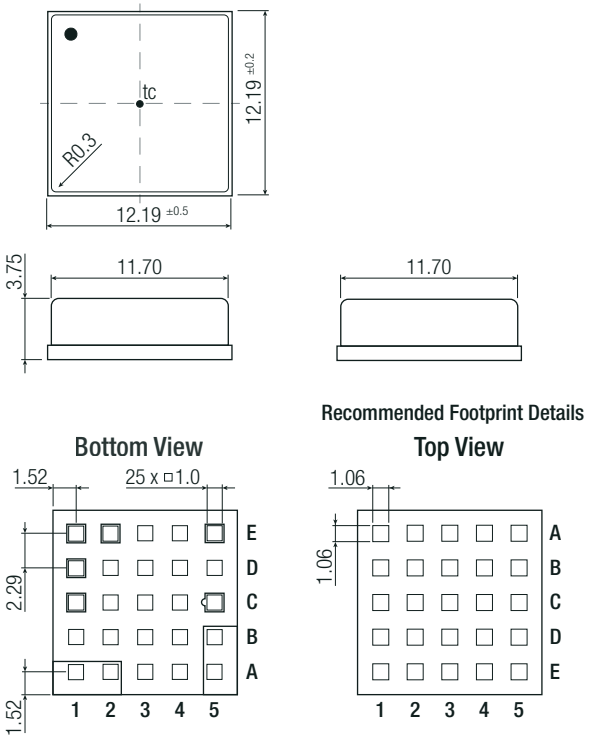
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### Dimension Drawing (mm)



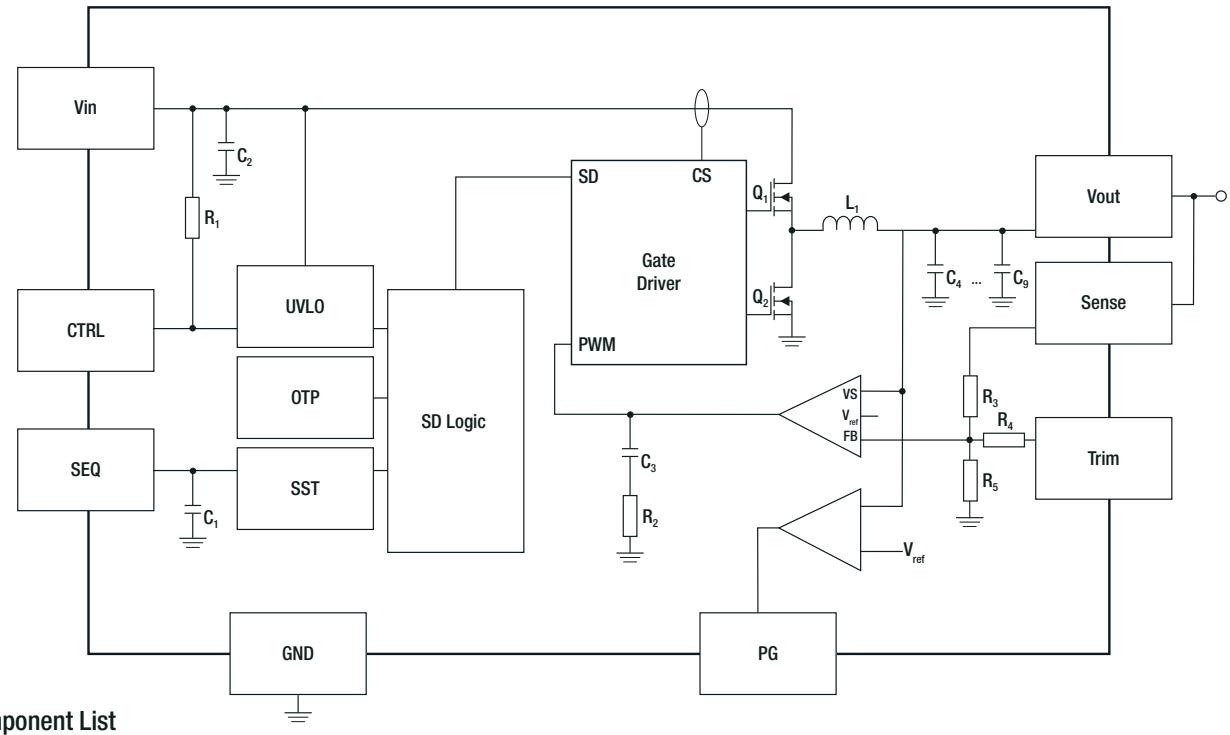



### Pinning information

| 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 | Used to set the output voltage between 0.9V and 6V |
| E2 | NC | Not connected |
| E1 | SEQ | Used to sequence multiple converters or to set the startup time. Float if not used |
| D1 | PGood | Output power good. High = Vout at set level, low = Vout below nominal regulation. Maximum sink current is 2mA. It has a high impedance output (100kΩ connected to Vout). Float if not used |
| A3, A4, B1, B2, B3, B4, C2, C3, C4, D2, D3, D4, D5, E3, E4 | 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

| | C1 | C2 | L1 | C4 - C9 | R3 | R4 | R5 |
|---|---|---|---|---|---|---|---|
| 3.3Vout | 3.3nF | 4.7µF | 2.2µH | 10µF 6pcs. in parallel | 470kΩ | 1kΩ | 150kΩ |
| 5Vout | | | | | 430kΩ | | 82kΩ |

## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

| PACKAGING INFORMATION | | |
|---|---|---|
| **Parameter** | **Type** | **Value** |
| Packaging Dimension (LxWxH) | tape and reel<br>tape and reel (carton) | 330.2 x 330.2 x 30.4mm<br>365.0 x 365.0 x 55.0mm |
| | tube ("-CT") | 530.0 x 30.3 x 19.2mm |
| Packaging Quantity | tape and reel | 500pcs |
| | tube ("-CT") | 30pcs |
| Tape Width | | 24mm |
| Storage Temperature Range | | -55°C to +125°C |
| Storage Humidity | non-condensing | 95% RH max. |