Features

Power Module

- High power density (L*W*H = 12.19*12.19*3.75)
- Wide operating temperature -40°C to +90°C at full load
- Efficiency up to 99%, no need for heatsinks
- 6-sided shielding
- Thermally and EMI enhanced 25 pad LGA package
- Compact DOSA-compatible footprint
- Low profile

RECOM
DC/DC Converter

RPM-6.0

6 Amp Single Output

3 Year Warranty

Description

The RPM-6.0 series is a 6A 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 +90°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]
RPM3.3-6.0	4 - 15	3.3	0.9 - 6.0	6.0	88 - 97	800
RPM5.0-6.0	4 - 15	5	0.9 - 6.0	6.0	91 - 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__-6.0-__

- Output Voltage
- 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 5Vout	4VDC 5.3VDC	12VDC	15VDC
	100% duty cycle mode [4]	Vout= Vin - Vdrop	5Vout	4VDC		5.3VDC
Absolute Maximum Input Voltage						17VDC
Undervoltage Lockout (UVLO)		DC-DC ON DC-DC OFF		3.8VDC 3.5VDC	3.9VDC 3.6VDC	4VDC 3.7VDC
Input Current		nom. Vin= 12VDC	3.3Vout 5Vout		1.9A 2.8A	
Quiescent Current					24µA	
Internal Power Dissipation			3.3Vout 5Vout			2.8W 3.0W

continued on next page

EVAL BOARD available

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

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 using CTRL function		1500µs 1050µs	
Rise-time			900µs	
ON/OFF CTRL	DC-DC ON DC-DC OFF			Open or 0.9V<V_{CTRL}<Vin Short or -0.3V<V_{CTRL}<0.3VDC
Input Current of CTRL Pin	DC-DC OFF		1µA	
Standby Current	DC-DC OFF		15µA	
Internal Operating Frequency			2.4MHz	
Output Ripple and Noise [7]	20MHz BW, 98Ω @ 100MHz		60mVp-p	
Absolute Maximum Capacitive Load	below 1 second start up + C_{ss} = 3700nF below 1 second start up without softstart mode			42000µF 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)

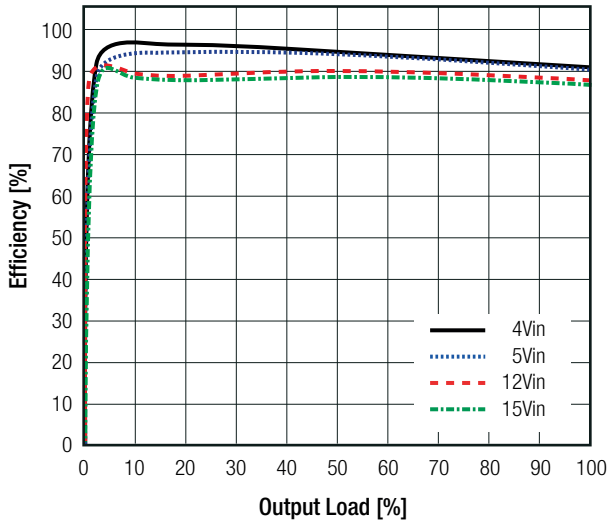
Note5: For more detailed information, please refer to trim table or calculation on page RPM-3

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

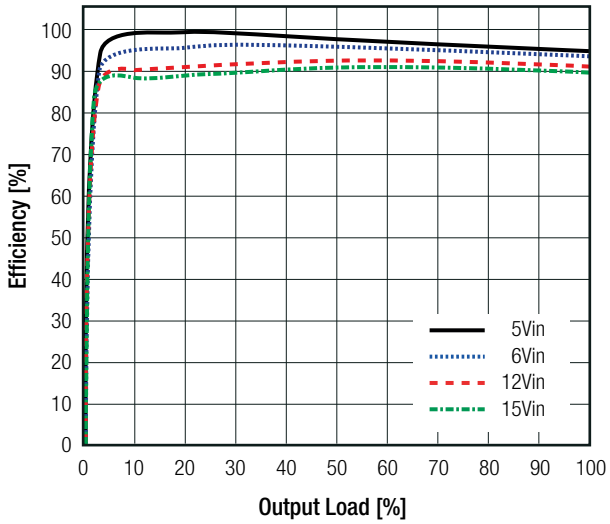
Note7: Measurements are made with a 22µF MLCC across output (low ESR)

Efficiency vs. Load

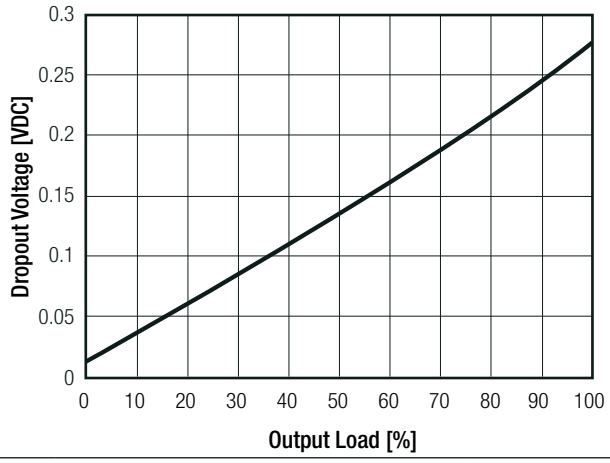
RPM3.3-6.0



RPM5.0-6.0



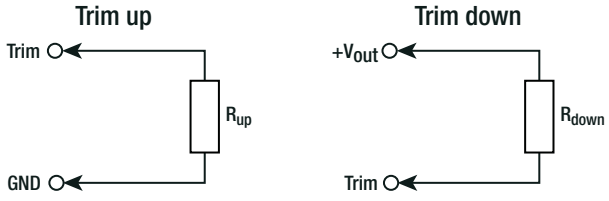
Dropout Voltage vs. Load



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 RPM3.3-6.0:

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

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

R_{up} according to E96 ≈ **374kΩ**

R_{down} according to E96 ≈ **309kΩ**

RPM3.3-6.0

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]

RPM5.0-6.0

Trim up

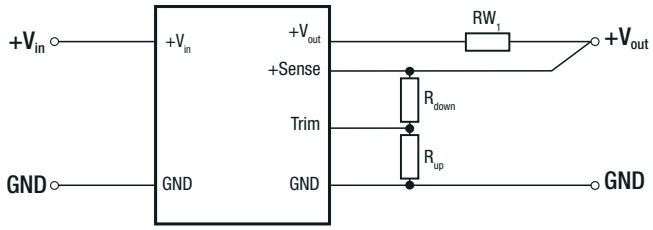
$Vout_{set}$ =	5.1	5.2	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	[VDC]
R_{up} (E96) ≈	3M32	1M69	1M15	866k	681k	576k	487k	422k	383k	340k	[Ω]

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)

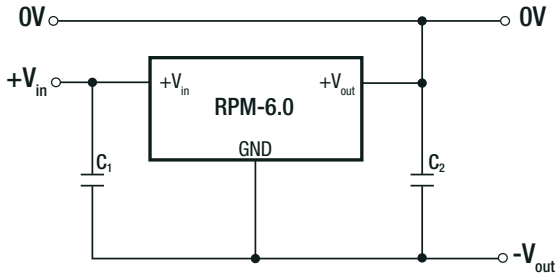
REMOTE SENSE



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	0.5% typ. / ±3.0% max.
Load Regulation	0% to 100% load	1.0% typ. / 3.0% max.
Soft-Start Time		refer to soft-start capacitor calculation
Transient Response	100% - 10% load step recovery time	200mV max. 6ms typ.
	25% load step change recovery time	150mV max. 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

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

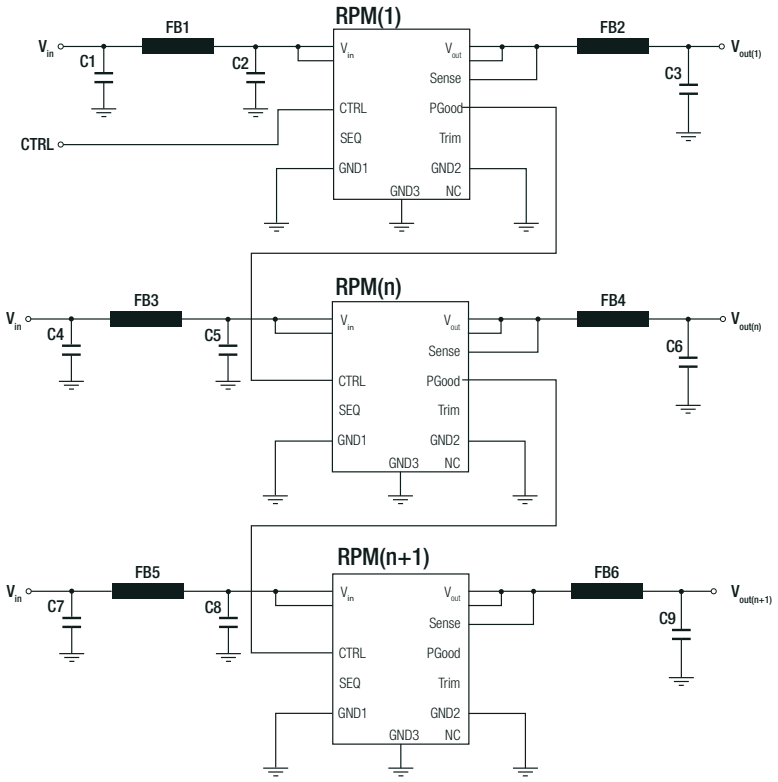
Note: there is a 3.3nF internal soft-start capacitor, and there are different constant current sources in the modules which leads to different preset soft-start times.

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

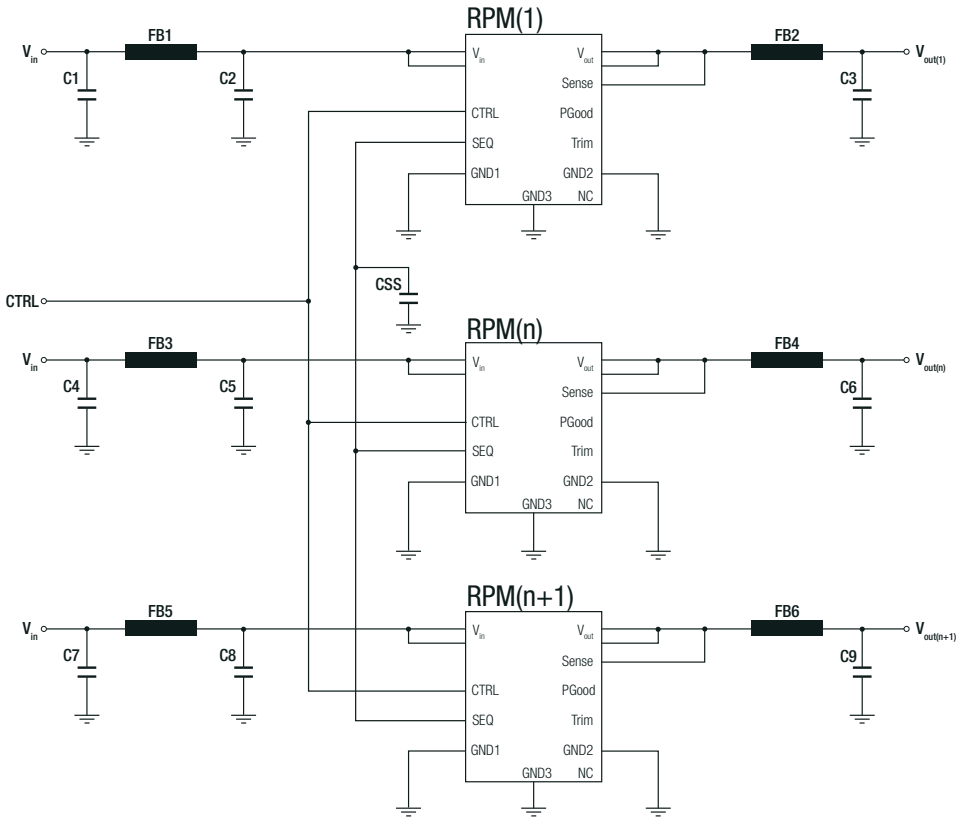
continued on next page

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		hiccup mode, automatic recovery
Short Circuit Input Current	without soft-start mode		150mA typ.
Over Current Protection (OCP)	with soft-start mode		110% - 115%, hiccup mode
Over Temperature Protection (OTP)	case temperature (measured on tc point)	DC-DC OFF DC-DC ON	110°C, auto restart after cool down 100°C typ.

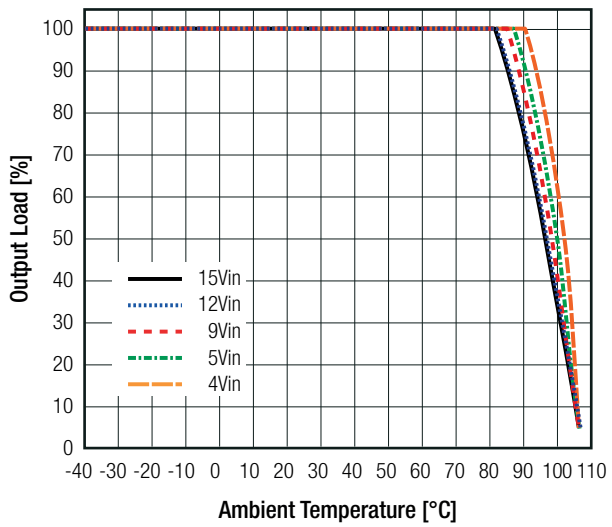
ENVIRONMENTAL			
Parameter	**Condition**		**Value**
Operating Temperature Range [9]	@ natural convection 0.1m/s (refer to derating graph)		-40°C to +85°C
Maximum Case Temperature	measured on tc point (see dimension drawing)		+110°C
Temperature Coefficient	@ +65°C Tamb		0.02%/K
Thermal Impedance [9]	0.1m/s, 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 +85°C	1800 x 10^3 hours 400 x 10^3 hours

Notes:

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

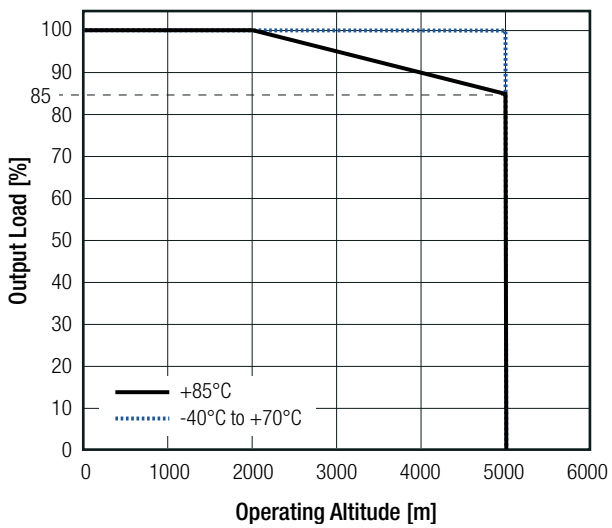
Derating Graph [9]

(@ chamber and natural convection 0.1m/s)



Operating Altitude vs Load

(@ chamber and natural convection 0.1m/s)



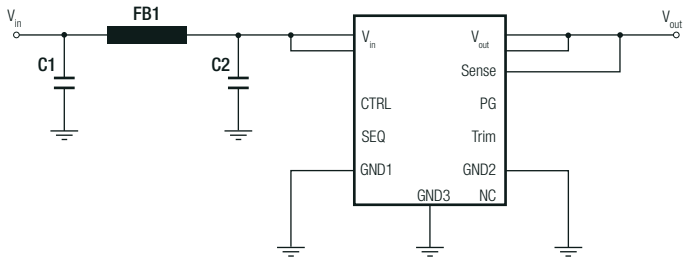
Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

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

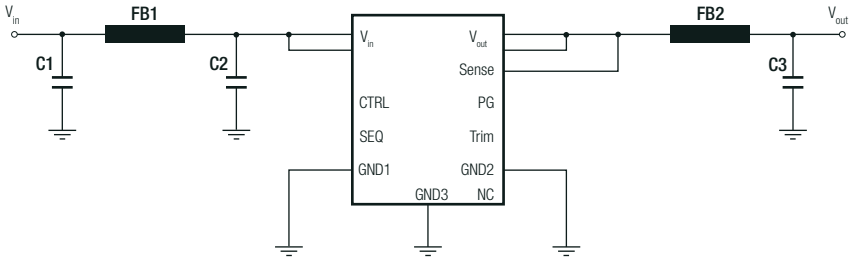
EMC filtering suggestion according to EN55032



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

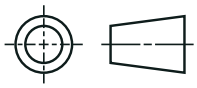
DIMENSION AND PHYSICAL CHARACTERISTICS

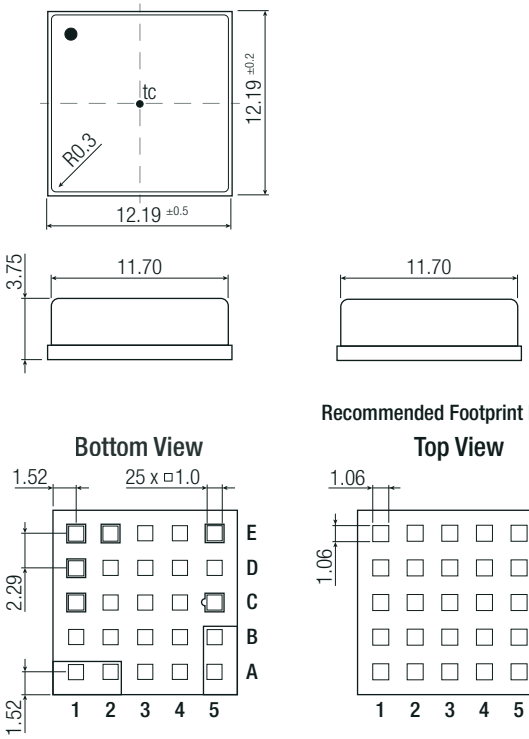
Parameter	Type	Value
Material	case PCB solder pads	metal FR4, (UL94 V-0) copper with electrolytic nickel-gold
Dimension (LxWxH)		12.19 x 12.19 x 3.75mm
Weight		1.1g typ.

continued on next page

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

Dimension Drawing (mm)



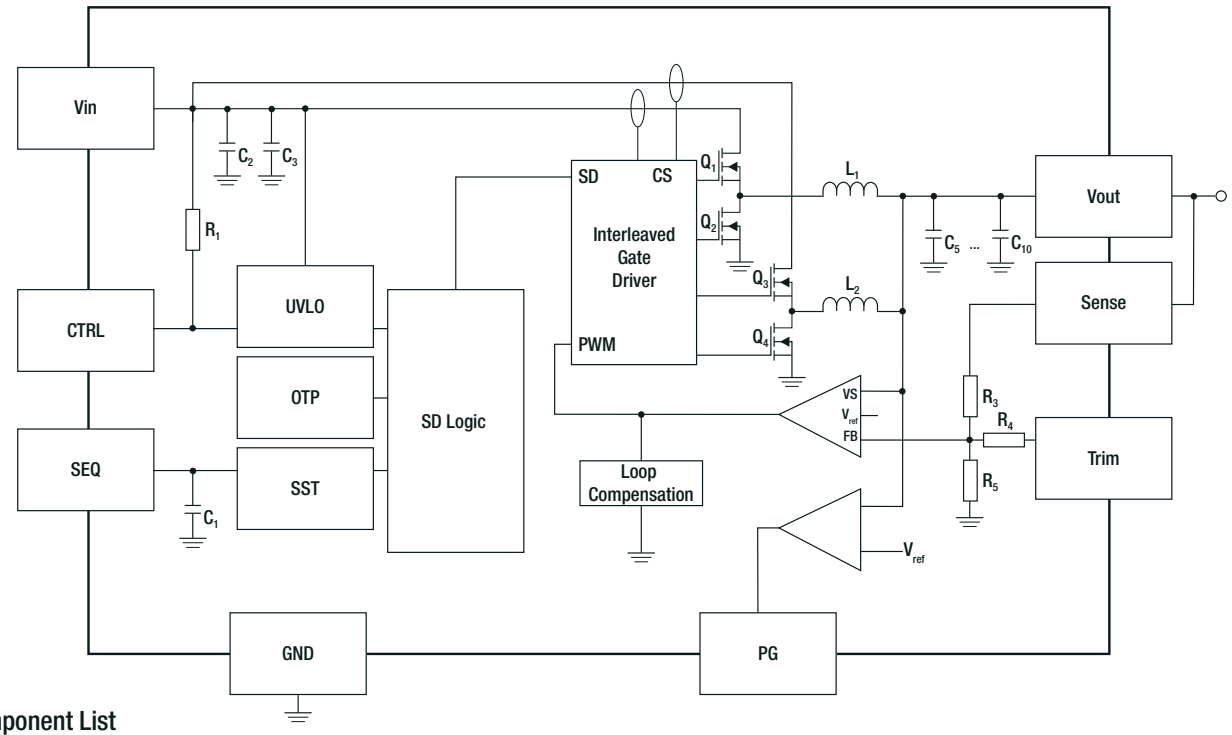


Pinning information

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, C3		R1	L1, L2	C5 - C10	R3	R4	R5
3.3Vout	3.3nF	4.7µF 2pcs. in parallel		1MΩ	1µH	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 tape and reel (carton)	330.2 x 330.2 x 30.4mm 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.