RxxC2Txx series / Power Module

2W / 21V-27VDC / 36 Pin SSOP Package

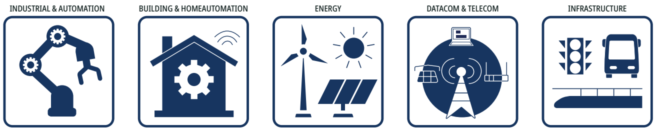
RECOM
DC/DC Converter

FEATURES

- 2W isolated DC/DC converter
- Programmable asymmetrical output voltages
- For IGBT/Si/SiC/Cascode GaN gate drive bias voltages
- High 3kVAC/1min isolation with 150kV/µs CMTI
- 1.5W at -40°C to +100°C
- Less than 3.5pF isolation capacitance
- Compact 7.5x12.83mm SMD package
- 3 years warranty

Dimensions (LxWxH): 12.83 x 7.5 x 3.55mm (0.51 x 0.30 x 0.14 inch)
0.1g (0.0032 oz)

APPLICATIONS



SAFETY & EMC

RoHS2 compliant 10 from 10

Reach compliant

DESCRIPTION

The R24C2T25 series 2W isolated DC/DC converter is a versatile solution designed for isolated gate bias voltages, particularly for transistors such as IGBTs, Si and SiC MOSFETs and Cascode GaNs. This compact converter features programmable asymmetrical output voltages, ensuring precise control and performance optimization for power electronics applications. With high 3kVAC/1min isolation, high 150kV/µs CMTI and remarkable stability up to 125°C (0.5W), it offers superior reliability, even under harsh high power, high frequency switching environments. The ultra-low isolation capacitance, less than 3.5pF, ensures minimal noise propagation across the isolation barrier. All of these exceptional features are packaged in a compact 7.5 x 12.83mm SMD form factor, making it an ideal choice for all isolated gate bias voltage needs.

SELECTION GUIDE

Part Number	Input Voltage Range [VDC]	Output Voltage Range(1) [VDC]	Output Current max. [mA]	Efficiency typ. [%]
R24C2T25	21 - 27	V_{OUT+}= 2.5 - 22.5 V_{OUT-}= (-2.5) - (-22.5) V_{TOTAL}= 18 - 25	I+= +100mA I-= -12mA	55

Note1: V_{OUT+} and V_{OUT-} can be set from 2.5VDC to 22.5VDC or -2.5VDC to -22.5VDC respectively but the total must be within the range of 18VDC to 25VDC. For more information see **„Typical Application“** below.

copyright © RECOM Power GmbH, all rights reserved

ABSOLUTE MAXIMUM RATINGS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

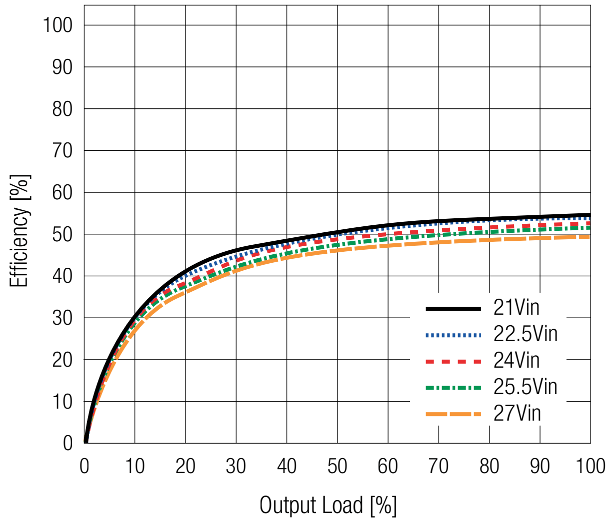
Parameter	Symbol	Min.	Typ.	Max.
Absolute maximum voltage	V_{IN} to PGND	-0.3VDC		32VDC
	CTRL, PG to PGND	-0.3VDC		7VDC
	V_{OUT+}, COM, FBV_{OUT+}, FBV_{OUT-} to V_{OUT-}	-0.3VDC		32VDC
Maximum internal power losses(2)	T_{AMB} = +25°C			2.45W
Maximum output power	V_{TOTAL}= V_{OUT+} to V_{OUT-}, T_{AMB} = +25°C			2.5W
Junction Temperature		-40°C		+150°C
Storage Temperature		-65°C		+150°C

Note2: Exceeding maximum allowable power dissipation causes the device to enter thermal shut down which protects the device from permanent damage.

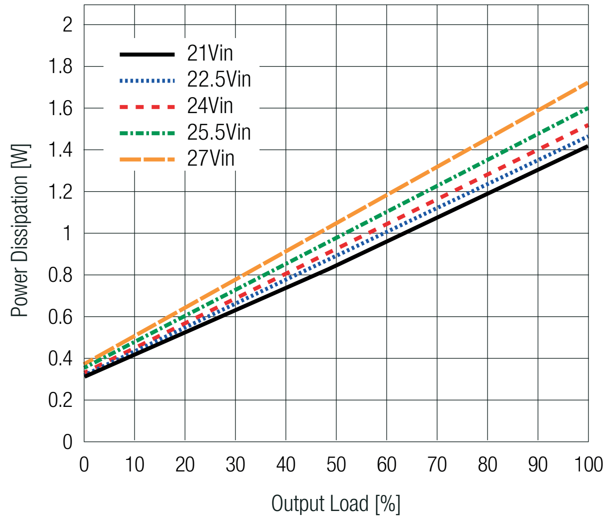
BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Parameter	Symbol	Condition	Min.	Typ.	Max.
Input Voltage Range	V_{IN}	refer to **„Derating Graph“**	21VDC	24VDC	27VDC
Under Voltage Lockout (UVLO)		rising	19VDC	20VDC	21VDC
		falling	17VDC	18VDC	19VDC
Over Voltage Lockout (OVLO)		rising	29.5VDC	31VDC	32.5VDC
		falling	27.5VDC	29VDC	30.5VDC
Soft Start Time				3ms	
Standby Current	I_Q	V_{CTRL}= 0VDC, V_{IN}= 21VDC to 27VDC			700µA
Quiescent Current		V_{CTRL}= 5VDC, V_{IN}= 21VDC to 27VDC			35mA
Power Dissipation		refer to **„Power Dissipation“**		1.7W	
Switching Frequency		V_{TOTAL}= 25VDC	11MHz	13MHz	15MHz

Efficiency vs. Output current



Power Dissipation



REGULATIONS

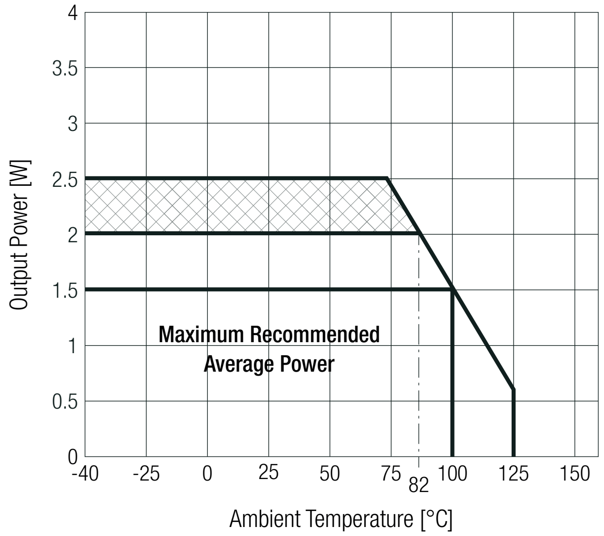
Parameter	Symbol	Condition	Min.	Typ.	Max.
Feedback Voltage(3)	V_{FB}	V_{OUT+} to V_{OUT-}	2.4675VDC	2.5VDC	2.533VDC
Feedback V_{OUT+} Hysteresis		hysteresis at the FBV_{OUT+} pin	9mV	10mV	12.3mV
Output Voltage Accuracy		0.1% of FB resistors	-1.5%		1.5%

Note3: For isolated gate driver applications, one positive and one negative output are needed. In this case, V_{OUT+} to V_{OUT-} is the total output voltage, and the middle point becomes the reference point. Because the total voltage between V_{OUT+} and V_{OUT-} is always regulated through the FBV_{OUT+} feedback, the COM pin only must regulate the middle point voltage so that it can give the correct positive and negative voltages. The COM control is achieved through FBV_{OUT-} pin as described in AGND to V_{OUT-} Voltage Regulation.

copyright © RECOM Power GmbH, all rights reserved

BASIC CHARACTERISTICS (measured @ T_{AMB}= 25°C, nom. V_{IN}, full load and after warm-up unless otherwise stated)

Derating Graph



Note4: Exceeding maximum allowable power dissipation causes device to enter thermal shutdown which protects device from permanent damage.
Note5: Keep the average power at 2W max. or peak power 2.5W for 5 seconds max.
Note6: Test with Recom 50x50mm standard EVM board with 70µm copper, double layer

ADJUSTABILITY

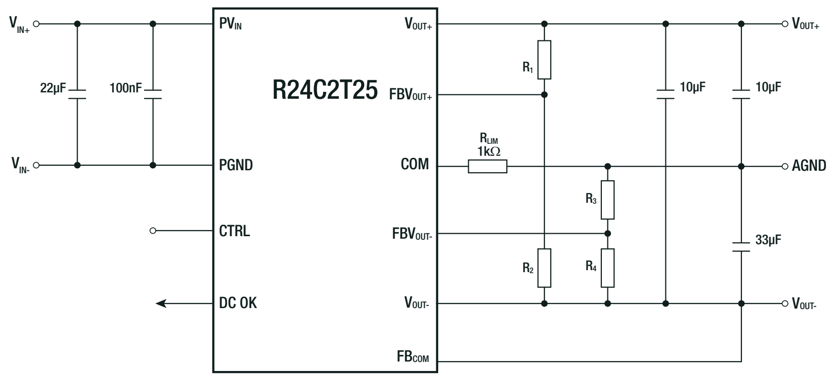
Parameter	Condition	Min.	Typ.	Max.
Output Voltage Trimming	V_{OUT+} to V_{OUT-}	18VDC		25VDC
	AGND to V_{OUT-}	2.5VDC		V_{OUT+} to V_{OUT-}

The R24C2T25 module creates two regulated outputs. It can be configured as a single output converter, V_{OUT+} to V_{OUT-} only, or a dual-output converter, V_{OUT+} to V_{OUT-} and COM to V_{OUT-}. Even though the module uses V_{OUT-} as the reference point to create two positive output voltages, the outputs can use COM as the reference point and become a positive and a negative output.

These two outputs are controlled independently through hysteresis control. Furthermore, the V_{OUT+} to V_{OUT-} is the main output, and COM to V_{OUT-} uses the main output as its input to create a second regulated output voltage.

Typical Application

V_{TOTAL}= 18-25VDC, P_{MAX}= 2 watts



Example

To set the device into dual configuration, for example to +15/-9V, start to define main output voltage as the sum of both desired voltages (|15V| + |-9V| = 24V). 24V are V_{OUT+} to V_{OUT-}. Then set the negative output.

+15/-9 V_{TOTAL}= 24VDC, V_{OUT-}= -9VDC
+20/-5 V_{TOTAL}= 25VDC, V_{OUT-}= -5VDC
+15/-3 V_{TOTAL}= 18VDC, V_{OUT-}= -3VDC
+15/-4 V_{TOTAL}= 19VDC, V_{OUT-}= -4VDC

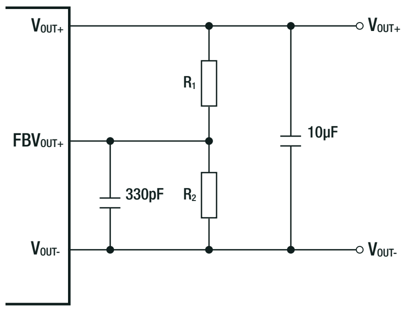
Note7: Set V_{TOTAL} first and afterwards V_{OUT-}. V_{TOTAL} must be between 18VDC and 25VDC

copyright © RECOM Power GmbH, all rights reserved

TRIM FUNCTION

Setting the main output - Single Configuration

The V_{OUT+} to V_{OUT-} output is the primary module output, regulated by the sensed voltage on FBV_{OUT+} pin. The V_{OUT+} to V_{OUT-} voltage is sensed through a voltage divider (R1 and R2). When FBV_{OUT+} voltage is below the turn-off threshold (approx. 10mV above the 2.5V reference), the power stage operates, raising the output voltage. Once the output reaches the turn-off threshold, the power stage turns off, causing the voltage to drop due to load current. When the output voltage falls below the turn-on threshold (approx. 10 mV below the 2.5V reference), the power stage is reactivated. Precise voltage reference and hysteresis control ensure accurate regulation. For enhanced noise immunity, add a 330pF capacitor between FBV_{OUT+} and V_{OUT-} pins, avoiding excessive capacitance to prevent output voltage ripple or stability issues.



Calculation

$$R_1 = \frac{(V_{OUT+} - V_{ref})}{V_{ref}} \times R_2$$

Example

$$R_1 = \frac{(18V - 2.5V)}{(2.5V)} \times 110k\Omega = \mathbf{682k}\Omega$$

Recommended resistor values for common V_{OUT+}:

V_{OUT+} [VDC]	R_2 [kΩ]	R_1 [kΩ]
18	110	682
19		726
20		770
21		814
22		858
23		902
24		946
25		990

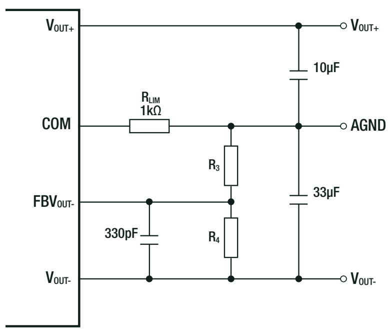
*(according to E96)

Setting the second output - Dual Configuration

For isolated gate drivers, V_{OUT+} to V_{OUT-} provides the regulated total voltage with the midpoint as the reference. The COM pin regulates the midpoint voltage for accurate positive and negative outputs based on FBV_{OUT+} feedback.

In Figure below, COM to V_{OUT-} is monitored through R3 and R4 on FBV_{OUT-}. A 330pF capacitor on FBV_{OUT-} filters noise. Charging resistor activation, controlled by FBV_{OUT-}, raises COM to V_{OUT-} voltage. After reaching the stop charging threshold, the charging resistor turns off. The discharge resistor, with a 20mV hysteresis, is then controlled by FBV_{OUT-}.

The COM to V_{OUT-} regulator protects against prolonged high-side FET activation during a COM to V_{OUT-} short. It monitors COM pin voltage, adjusting the high-side FET duty ratio. If COM pin voltage is below 0.645V while FBV_{OUT-} is under 2.48V, a 20% duty ratio control overrides normal hysteresis. When COM pin voltage exceeds 0.73V, duty ratio control is disabled, and normal operation resumes.



Calculation

$$R_3 = \frac{(V_{OUT-} - V_{ref})}{V_{ref}} \times R_4 - R_{LIM}$$

Example

$$R_3 = \frac{(5V - 2.5V)}{2.5V} \times 499k\Omega - 387\Omega = \mathbf{499k}\Omega$$

Recommended resistor values for common V_{OUT-}:

V_{OUT-} [VDC]	R_4 [kΩ]	R_{LIM} [Ω]	R_3 [kΩ]
3	499	220	100
4		301	301
5		383	499
9		715	1300

*(according to E96)

Note8: To minimize the power consumption under light loads, it is desirable to choose a resistance value of between 100kΩ and 500kΩ for R_4

Defining R_{LIM}

When the device has been configured to dual configuration, the R_{LIM} resistor is a true current limiting resistor. Set up the R_{LIM} resistor as the maximum load current (I_{OUT-_max}) needed for V_{OUT-} to COM path using following equation:

Calculation

$$R_{LIM} = \frac{V_{OUT-}}{I_{OUT-\_max}} - R_{LIM\_internal}$$

* $R_{LIM\_internal}$ = 30Ω
* I_{OUT-_max} = depends on application

Example R_{LIM} for V_{OUT-}= 5VDC

$$R_{LIM} = \frac{5V}{12mA} - 30\Omega = \mathbf{383}\Omega$$

* I_{OUT-_max} has been defined as 12mA for the target application

copyright © RECOM Power GmbH, all rights reserved

CAPACITOR SELECTION

For C_{IN} place a 10-µF and a 0.1-µF high-frequency decoupling capacitor in parallel close to V_{IN} pins. A capacitance greater than 10uF can be used to reduce the voltage ripple when the series impedance from the voltage source to the V_{IN} pins is large. For C_{OUT1} add a 2.2µF and a 100nF capacitor for high-frequency decoupling of V_{OUT+} to V_{OUT-}. Place close to the V_{OUT+} and V_{OUT-} pins. A capacitance greater than 2.2µF can be used to reduce the output voltage ripple. The selection of C_{OUT2} and C_{OUT3} is based on the gate charge requirement for the gate driver load, the charge balancing during the start-up, and the expected maximum current loading. Calculate C_{OUT2} first.

Calculation

$$C_{OUT2} = \frac{Q}{V_{out+} * \frac{V_{pp}}{100}}$$

Parameter		Unit
Q	gate charge	nC
V_{PP}	accepted Ripple	%
V_{OUT+}	output voltage +	VDC

Then calculate the C_{OUT3} value based on the output voltage ratios, the load current expected, and the variation of the output capacitors.

Calculation

$$C_{OUT3} = \frac{C_{OUT2} * V_{out+} * (I_{max} - I_{max_{Vout-}})}{V_{out-} * (I_{max} - I_{max_{Vout+}})}$$

Parameter		Unit
I_{MAX_VOUT-}	output current -	IDC
V_{OUT-}	output voltage -	VDC
I_{MAX_VOUT+}	output current +	IDC
I_{MAX}	total output current	IDC
P_{MAX}	output power	W

Example

Parameter		Value
Q	gate charge	55nC
V_{PP}	accepted Ripple	1%
V_{OUT+}	output voltage +	15VDC
I_{MAX_VOUT-}	output current -	0.012IDC
V_{OUT-}	output voltage -	9VDC
I_{MAX_VOUT+}	output current +	0.012IDC
I_{MAX}	total output current	0.0833IDC
P_{MAX}	output power	2W

CIN	min. COUT1 (VOUT+ to VOUT-)	VOUT+ to COM	min. COUT2(9)	VOUT- to COM	min. COUT3(9)
10µF + 100nF	2.2µF + 100nF	20VDC	270nF	5VDC	1µF
10µF + 100nF	2.2µF + 100nF	15VDC	390nF	9VDC	680nF
10µF + 100nF	2.2µF + 100nF	15VDC	390nF	3VDC	1.8µF
10µF + 100nF	2.2µF + 100nF	15VDC	390nF	4VDC	1.5µF

Note9: It is recommended to use about 10 times higher values than the calculated minimal values of COUT2 and COUT3. The COUT3 to COUT2 value ratio has to stay the same or be higher. Recommended procedure based on the example values +15V/-9V:
1. Calculate the minimal COUT2 value (minimal calculated COUT2=366nF).
2. Select about 10 times higher COUT2 value than the calculated COUT2 (selected COUT2=4.7µF).
3. Calculate minimal COUT3 value based on the selected COUT2 value (calulated COUT3=8.3µF)
4. Select the value of COUT3 higher than the calculated COUT3 (selected COUT3=10µF).

copyright © RECOM Power GmbH, all rights reserved

CONTROL FUNCTION

Parameter	Condition	Min.	Typ.	Max.
Control Pin Voltage	CTRL pin to PGND	0VDC		5.5VDC
ON/OFF CTRL	rising			2.1VDC
	falling	0.8VDC		
Input Current	no load			35mA
	full load			250mA
Input Current of CTRL Pin	V_{CTRL}= 5.0V		5µA	10µA

POWER GOOD OPERATING CONDITIONS

Parameter	Condition	Min.	Typ.	Max.
PowerGood threshold	PG of negated	90% of V_{FB}		110% of V_{FB}
PowerGood pin voltage	PG pin to PGND	0VDC		5.5VDC
Primary side soft start time out	Timer begins when V_{IN} > UVLO and CTRL= High and reset when Powergood pin indicates Good		16ms	

AGND REGULATIONS HYSTERESIS

Parameter	Condition	Min.	Typ.	Max.
Feedback regulation reference voltage	AGND to V_{OUT-}	2.4675VDC	2.5VDC	2.5325VDC
COM pin Short Charge comparator rising threshold to exit PWM	rising		0.73VDC	
On-Time during COM pin Short Charge PWM mode	COM pin < 0.645VDC, while FBV_{OUT-} pin < 2.48VDC		1.2µs	
Off-Time during COM pin Short Charge PWM mode	COM pin < 0.645VDC, while FBV_{OUT-} pin < 2.48VDC		5µs	

OUTPUT UNDER VOLTAGE LOCKOUT

Parameter	Condition	Min.	Typ.	Max.
UVLO rising threshold (V_{OUT+} to V_{OUT-})	Voltage at FBV_{OUT+}		0.9VDC	
UVLO hysteresis (V_{OUT+} to V_{OUT-})	Voltage at FBV_{OUT+}		0.3VDC	

OUTPUT OVER VOLTAGE LOCKOUT

Parameter	Condition	Min.	Typ.	Max.
OVLO rising threshold	Voltage from V_{OUT+} to V_{OUT-}, rising	29.45VDC	31VDC	32.55VDC
OVLO falling threshold	Voltage from V_{OUT+} to V_{OUT-}, falling	27.55VDC	29VDC	30.45VDC

COMMON MODE TRANSIENT IMMUNITY (CMTI)

Parameter	Condition	Min.	Typ.	Max.
Common Mode Transient Immunity				±150V/ns

copyright © RECOM Power GmbH, all rights reserved

PROTECTIONS

Parameter	Condition	Min.	Typ.	Max.
Over Power Protection (OPP)				latch-off
Over Temperature Protection(10) (OTP)				latch-off
Over Temperature Shutdown Setpoint			150°C±10°C	
Over Temperature Shutdown Hysteresis	cool down after latch-off before restart is enabled		20°C±5°C	

Note10: The R24C2T25 integrates power stages with over-temperature protection. If temperatures exceed limits, it stops switching and enters a latch-off protection mode.

THERMAL OPERATING CONDITIONS

Parameter	Condition	Min.	Typ.	Max.
Thermal Impedance	junction to case		16.6K/W	
	junction to board		25.9K/W	
	case to ambient, refer to note 6		30K/W	
ESD	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001			±2kV
	Charged-device model (CDM), per JEDEC specification JESD22-C101			±500V
Moisture Sensitive Level				Level 3, 260°C, 168hrs

ISOLATION CAPABILITIES

Parameter	Condition		Min.	Typ.	Max.
Comparative tracking index (CTI)	DIN EN 60112 (VDE 0303-11); IEC 60112				600VDC
Overvoltage Category	Rated mains voltage ≤ 300 VRMS				I-IV
	Rated mains voltage ≤ 600 VRMS				I-IV
	Rated mains voltage ≤ 1000 VRMS				I-III
Isolation Voltage(11)	tested in qualification tested in production				3kVAC/1min. 3.6kVAC/1sec.
Repetitive peak isolation voltage	AC voltage (bipolar)				1.2kVp
Working isolation voltage(12)	AC voltage (sine wave) Time dependent dielectric breakdown (TDDB) test				850VRMS
	DC voltage				1.2kVDC
Transient isolation voltage	tested in qualification tested in production				4.2kVp/1min. 5kVp/1sec.
Impulse voltage	waveform per IEC 62368-1				5kVp
Surge isolation voltage	waveform per IEC 62368-1				6.5kVp
Isolation Resistance	input to output	VIO= 500VDC, TA= 25°C	1000GΩ		
		VIO= 500VDC, 100°C ≤ TA ≤ 125°C	100GΩ		
		VIO= 500VDC at TS= 150°C	1GΩ		
Isolation Capacitance	input to output				3.5pF
External Clearance			8mm		
External Creepage			8mm		

Note11: High voltage isolation testing of a barrier component can degrade isolation capability. RECOM therefore strongly advises against repeated high-voltage isolation testing. If required, reduce specified retest voltage by 20%.

Note12: When the insulation in the R24C2T25 series is not used as a safety barrier, i.e. provides functional isolation only, continuous or switched voltages across the barrier up to 1.2kVp are sustainable. This is established by measuring the partial discharge inception voltage in accordance with IEC60270. Please contact techsupport@recom-power.com for further information.

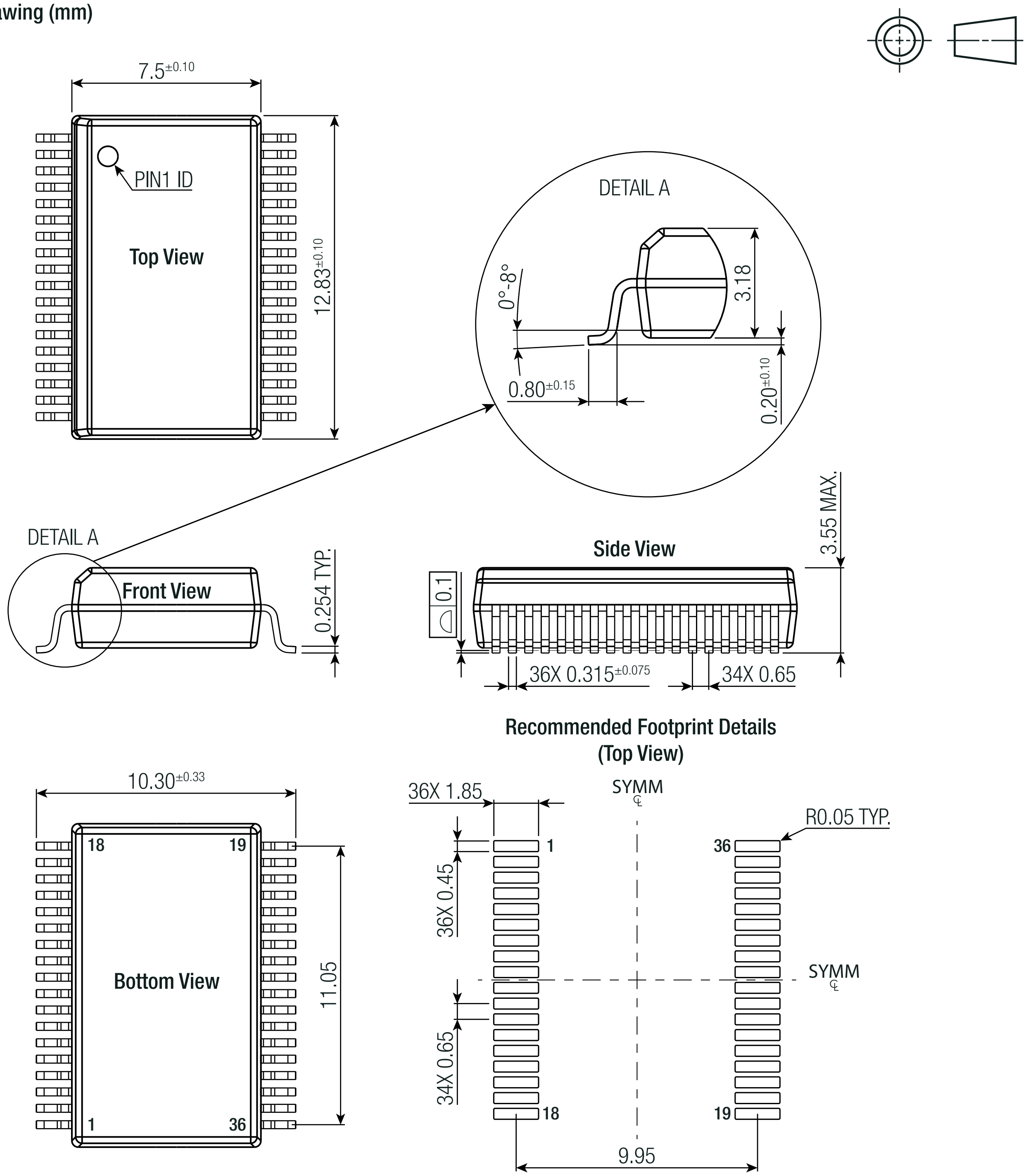
copyright © RECOM Power GmbH, all rights reserved

RECOM
DC/DC Converter

DIMENSION & PHYSICAL CHARACTERISTICS

Parameter	Type	Value
Dimension (LxWxH)		12.83 x 7.5 x 3.55mm 0.51 x 0.30 x 0.14 inch
Weight		0.1g typ. 0.0032 oz

Dimension Drawing (mm)



Tolerances:
x.x= ±0.1mm
x.xx= ±0.05mm

copyright © RECOM Power GmbH, all rights reserved

DIMENSION & PHYSICAL CHARACTERISTICS

Pad Information

Pad #	Function	Description
1, 2, 5, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18	PGND	Primary side power ground. Place several vias to copper pours for thermal relief.
3	PG	Power good open-drain output. Low when UVLO, OVLO, UVP, OVP, and OTP are not triggered.
4	CTRL	Pull high to enable the device. Leave open or connect to ground to disable the device.
6	AV_{IN}	Primary side analog input. Connect a 330pF ceramic capacitor between AV_{IN} and pin 5.
7	PV_{IN}	Primary side power input. Connect a 0.1µF and a 22µF ceramic capacitor to pin 8.
19, 20, 21, 22, 23, 24, 25, 26, 27, 30, 31, 36	V_{OUT-}	Secondary side negative output voltage.
28, 29	V_{OUT+}	Secondary side positive output voltage. Connect a 10µF and 0.1µF ceramic capacitor between V_{OUT+} and V_{OUT-}.
32	COM	Connect 1kΩ current limiting resistor to COM node of circuit. See application example.
33	FBV_{OUT-}	FBV_{OUT} Feedback (COM – V_{OUT-}) output voltage sense pin used to set the output (COM – V_{OUT-}) voltage.
34	FBV_{OUT+}	FBV_{OUT} Feedback (V_{OUT+} – V_{OUT-}) output voltage sense pin used to set the output (V_{OUT+} – V_{OUT-}) voltage.
35	FB_{COM}	Use as reference for FBV_{OUT+} and FBV_{OUT-}.

PACKAGING INFORMATION

Parameter	Type	Value
Packaging Dimension (LxWxH)	Suffix -R: tape and reel	38 x 36 x 5.5 mm 1.5 x 1.42 x 0.22 inch
	Suffix -CT: moisture barrier bag	100 x 100 x 30 mm 3.94 x 3.94 x 1.18 inch
Packaging Quantity	Suffix -R: tape and reel	750pcs
	Suffix -CT: moisture barrier bag	10pcs
Storage Temperature Range		-40°C to +125°C
Storage Humidity	non-condensing	5% - 95% RH max.

The product information and specifications may be subject to changes even without prior written notice.The product has been designed for various applications; its suitability lies in the responsibility of each customer. The products are not authorized for use in safety-critical applications without RECOM's explicit written consent. A safety-critical application is an application where a failure may reasonably be expected to endanger or cause loss of life, inflict bodily harm or damage property. The applicant shall indemnify and hold harmless RECOM, its affiliated companies and its representatives against any damage claims in connection with the unauthorized use of RECOM products in such safety-critical applications.

copyright © RECOM Power GmbH, all rights reserved