

# Features


- 2MOPP, 250VAC working voltage isolation
- Clearance and creepage distance >8mm
- Up to 10kVDC reinforced insulation
- IEC/EN/UL 60601 certified with CB Report (3rd Ed. Safety, 4th Ed. EMC)
- -40°C to +85°C operation, no derating
- 2:1 wide input range

# Regulated Converter



## REM3.5E

**3.5 Watt**  
**2:1 Input**  
**DIP24 or SMD**  
**Single & Dual**  
**Output**



### Description

The REM3.5E series of medical grade regulated DC/DC converters feature reinforced 250VAC continuous working isolation with >8mm creepage/clearance. The compact DIP24/SMD package offers industry standard pinouts with tightly regulated single/dual outputs and UVLO, SCP and OCP. The operating ambient temperature range is from -40°C to +85°C without derating. The converters are UL marked and certified to CB, IEC, EN and ANSI/AAMI 60601 3rd. Ed. Safety and 4th Ed. EMC medical standards. The low 1µA leakage current complies with medical applied part B, BF and CF limits as defined by IEC60601-1.

### Selection Guide

Part Number	nom. Input Voltage [VDC]	Output Voltage [VDC]	Output Current [mA]	Efficiency typ. <sup>(1)</sup> [%]	Max. Capacitive Load <sup>(2)</sup> [µF]
REM3.5E-xx05S/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	5	700	76 / 80 / 81 / 82	4700
REM3.5E-xx09S/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	9	388	80 / 81 / 82 / 82	3300
REM3.5E-xx12S/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	12	290	82 / 82 / 83 / 82	2200
REM3.5E-xx15S/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	15	233	83 / 82 / 84 / 83	2200
REM3.5E-xx24S/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	24	145	82 / 82 / 84 / 83	1000
REM3.5E-xx05D/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	±5	±350	76 / 80 / 81 / 82	±2200
REM3.5E-xx09D/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	±9	±194	80 / 81 / 82 / 82	±1600
REM3.5E-xx12D/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	±12	±145	82 / 82 / 83 / 82	±1000
REM3.5E-xx15D/R <sup>(3)</sup> /A <sup>(4,5)</sup>	5 / 12 / 24 / 48	±15	±117	83 / 82 / 84 / 83	±1000

#### Notes:

- Note1: Efficiency is tested at nominal input and full load at +25°C ambient  
 Note2: Max Cap Load is tested at nominal input and full resistive load



### Model Numbering



#### Notes:

- Note3: add suffix „/R8“ for 8kVDC or „/R10“ for 10kVDC isolation (DIP24 only)  
 if SMD package is used, always add suffix „/R6“ for 6kVDC isolation  
 Note4: add suffix „/CTRL“ for fitted CTRL pin (DIP24 only)  
 if SMD package is used do not add suffix „/CTRL“, CTRL pin is always mounted  
 Note5: add suffix „/X1“ for Under Voltage Lockout Option

CAN/CSA-C22.2 No. 60601-1:14 certified  
 ANSI/AAMI ES60601-1 certified  
 EN60601-1 certified  
 IEC60601-1 certified  
 IEC60601-1-2 compliant  
 EN55032 compliant

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

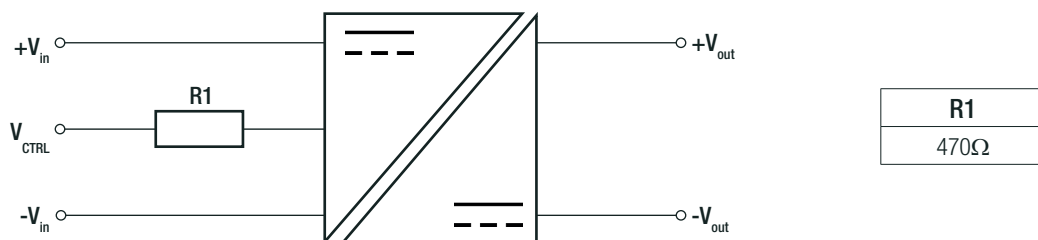
**BASIC CHARACTERISTICS**

Parameter	Condition	Min.	Typ.	Max.
Internal Input Filter				Pi-type
Input Voltage Range	nom. Vin = 5VDC nom. Vin = 12VDC nom. Vin = 24VDC nom. Vin = 48VDC	4.5VDC 9VDC 18VDC 36VDC	5VDC 12VDC 24VDC 48VDC	9VDC 18VDC 36VDC 75VDC
Under Voltage Lockout (UVLO) ("X1" version)	nom. Vin= 5VDC		DC-DC ON DC-DC OFF	4.5VDC
	nom. Vin= 12VDC		DC-DC ON DC-DC OFF	9VDC
	nom. Vin= 24VDC		DC-DC ON DC-DC OFF	18VDC
	nom. Vin= 48VDC		DC-DC ON DC-DC OFF	36VDC
Input Current	nom. Vin = 5VDC nom. Vin = 12VDC nom. Vin = 24VDC nom. Vin = 48VDC		900mA 360mA 180mA 90mA	
Quiescent Current	nom. Vin = 5VDC nom. Vin = 12VDC nom. Vin = 24VDC nom. Vin = 48VDC			50mA 20mA 5mA 2.5mA
Minimum Load <sup>(7)</sup>			10%	
Start-up time			0.6ms	
Rise time			0.45ms	
Hold-up time			0.6ms	
ON/OFF CTRL	DC-DC ON DC-DC OFF		Open or 0VDC < V <sub>CTRL</sub> < 1.2VDC Short or 4.8VDC < V <sub>CTRL</sub> < 12VDC	
Input Current of CTRL Pin	V <sub>CTRL</sub> = 5VDC		25mA	
Standby Current	DC-DC OFF			350µA
Intvernal Operating Frequency		120kHz		
Output Ripple and Noise <sup>(6)</sup>	20MHz BW			150mVp-p

**Notes:**

Note6: Measurements are made with a 0.1µF MLCC across output. (low ESR)

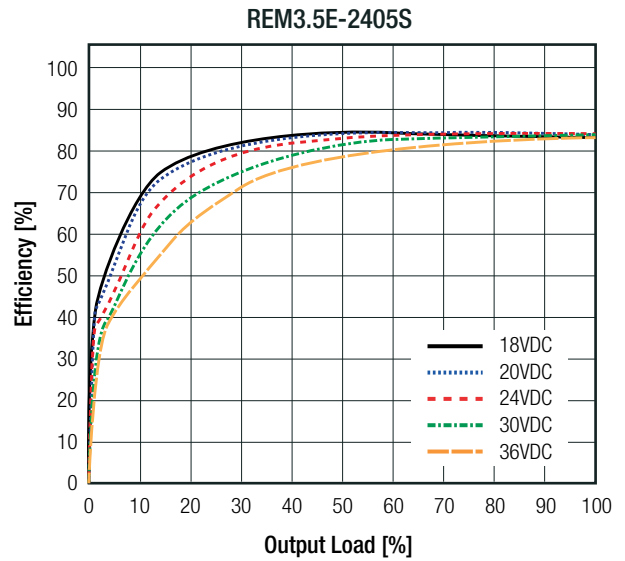
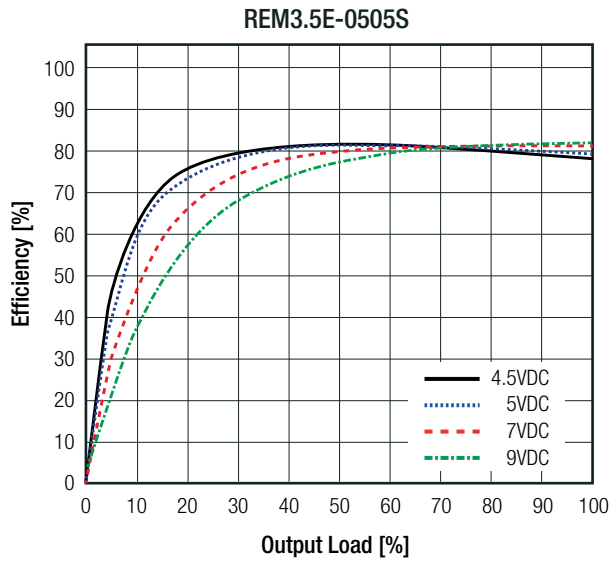
**ON/OFF CTRL Option**



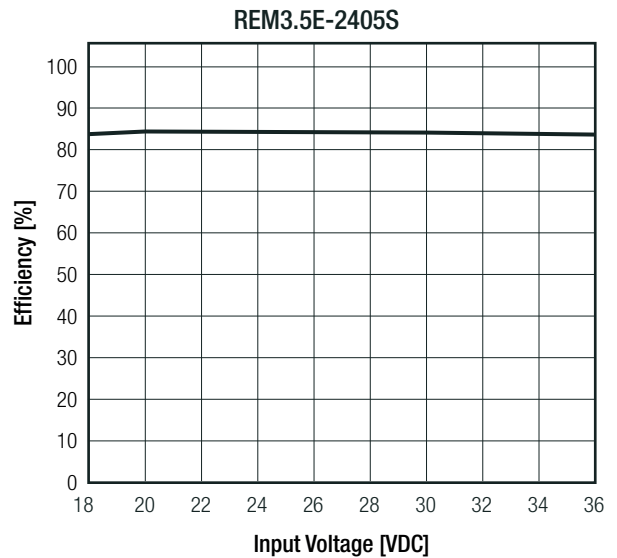
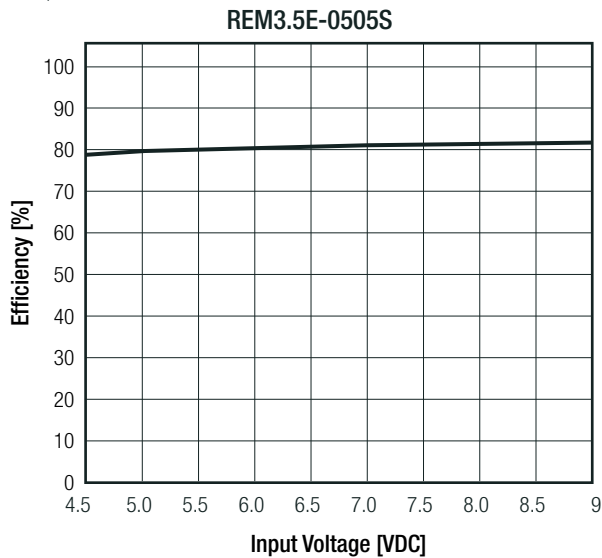
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Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

Efficiency vs. Output Load



Efficiency vs. Input Voltage  
(@ full Load)



**REGULATIONS**

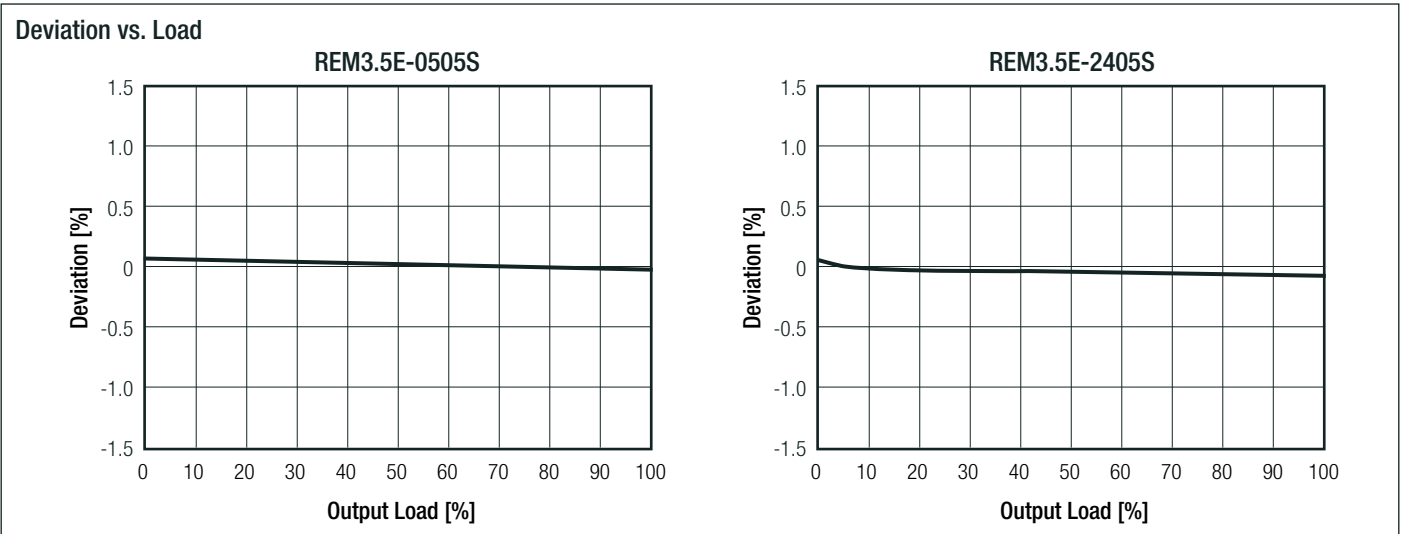
Parameter	Condition	Value
Output Accuracy		±1.5% typ.
Line Regulation	low line to high line, full load	±0.3% max.
Load Regulation <sup>(7)</sup>	10% to 100% load	0.5% typ.
Cross Regulation	dual output only	±5.0% max.
Transient Response	25% load step change	5ms

Notes:

Note7: Operation below 10% load will not harm the converter, but specifications may not be met

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



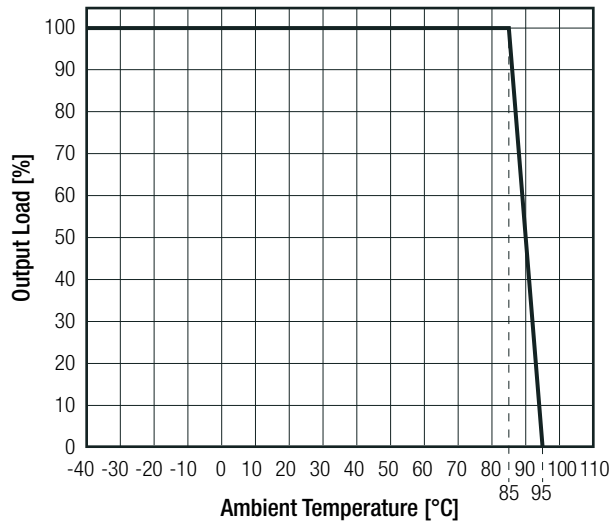
PROTECTIONS					
Parameter	Type			Value	
Short Circuit Protection (SCP)	below 100mΩ			continuous, hiccup mode, automatic recovery	
Isolation Voltage <sup>(8)</sup>	I/P to O/P	DIP24	"/R8" suffix	tested for 1 second rated for 1 minute	8kVDC 4kVAC/60Hz
			"/R10" suffix	tested for 1 second rated for 1 minute	10kVDC 5kVAC/60Hz
		SMD	"/R6" suffix	rated for 1 minute	6kVDC
Isolation Resistance				10GΩ min.	
Isolation Capacitance				20pF typ.	
Insulation Grade				reinforced	
Leakage Current				0.8μA typ. / 1μA max.	
Means of Protection	250VAC working voltage			2MOPP	
Medical Device Classification				built-in power supply	
Internal	clearance/creepage			>8mm	
External	clearance/creepage			>8mm	
<b>Notes:</b>					
Note8: For repeat Hi-Pot testing, reduce the time and/or the test voltage					
Note9: Refer to local safety regulations if input over-current protection is also required. Recommended fuse: slow blow type					

ENVIRONMENTAL			
Parameter	Condition		Value
Operating Temperature Range	full load @ natural convection 0.1m/s (see graph)		-40°C to +85°C
Maximum Case Temperature			+105°C
Temperature Coefficient			±0.02%/K typ. / ±0.05%/K max.
Thermal Impedance	0.1m/s, horizontal		20K/W
Operating Altitude			3000m
Operating Humidity	non-condensing		5% - 95% RH max.
Pollution Degree			PD2
MTBF	according to MIL-HDBK-217F, G.B.	+25°C	3600 x 10 <sup>3</sup> hours
		+85°C	450 x 10 <sup>3</sup> hours
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**Specifications** (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

**Derating Graph**

(@ Chamber and natural convection 0.1m/s)



**SAFETY AND CERTIFICATIONS**

Certificate Type (Safety)	Report / File Number	Standard
Medical Electric Equipment, General Requirements for Safety and Essential Performance	E314885	CAN/CSA-C22.2 No. 60601-1:14, 3rd Edition: 2014 ANSI/AAMI ES60601-1:2012
Medical Electric Equipment, General Requirements for Safety and Essential Performance (CB Scheme)	E314885	IEC60601-1:2005, 3rd Edition + AM1:2012
Medical Electric Equipment, General Requirements for Safety and Essential Performance	WD-SE-R-180524-A0	EN60601-1:2006 + A12:2014 IEC60601-1:2005, 3rd Edition + AM1:2012
RoHS 2		RoHS 2011/65/EU + AM2015/863

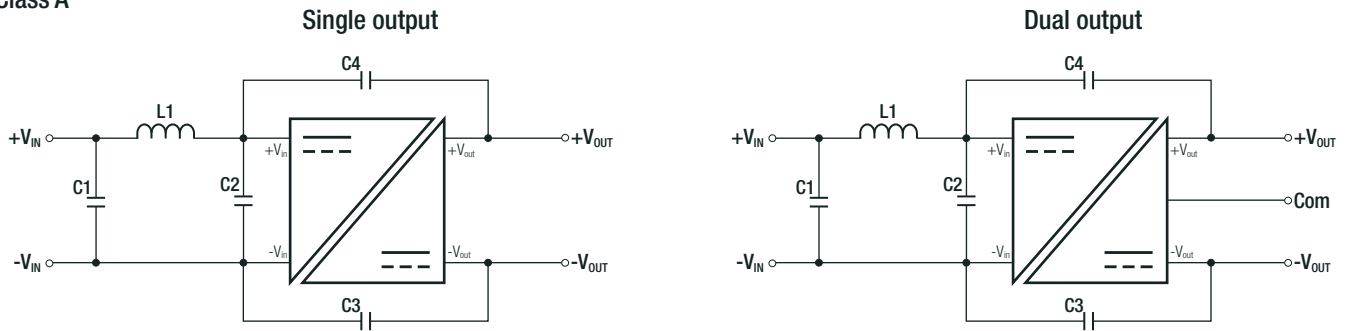
EMC Compliance	Condition	Standard / Criterion
Information technology equipment - Radio disturbance characteristics - Limits and methods of measurement	with external filter refer to <b>"EMC Filtering"</b>	EN55032, Class A and B
Information technology equipment - Immunity characteristics - Limits and methods of measurement		EN55024:2010 + A1:2015
ESD Electrostatic discharge immunity test	Air ±8kV, Contact ±4kV	IEC61000-4-2:2009, Criteria A
Radiated, radio-frequency, electromagnetic field immunity test	3V/m	IEC61000-4-3:2006 + A2:2010, Criteria A
Fast Transient and Burst Immunity	DC Power Port: ±1kV	IEC61000-4-4:2012, Criteria A
Surge Immunity	DC Power (Output) Port: ±0.5kV	IEC61000-4-5:2014 + A1:2017, Criteria A
Immunity to conducted disturbances, induced by radio-frequency fields	DC Power (Output) Port: 3V	IEC61000-4-6:2013 + C1:2015, Criteria A
Power Magnetic Field Immunity	50Hz, 1A/m	IEC61000-4-8:2010, Criteria A
Medical electrical equipment Part 1-2: Electromagnetic disturbances – Requirements and tests	with external filter	EN60601-1-2:2015 IEC60601-1-2:2014
Industrial, scientific and medical equipment – Radio frequency disturbance characteristics – Limits and methods of measurement		EN55011:2016+A1:2017, Class B
ESD Electrostatic discharge immunity test	Air ±15kV, Contact ±8kV	IEC61000-4-2:2008, EN61000-4-2:2009
Radiated, radio-frequency, electromagnetic field immunity test	10V/m	IEC61000-4-3:2006+A1:2007+A2:2010 EN61000-4-3:202006+A2:2010
Fast Transient and Burst Immunity	DC Power Port: ±2kV	IEC/EN61000-4-4:2012
Surge Immunity	DC Power (Output) Port: ±1kV	IEC/EN61000-4-5:2014+A1:2017
Immunity to conducted disturbances, induced by radio-frequency fields	DC Power (Output) Port: 3V, 6V	IEC61000-4-6:2013, EN61000-4-6:2014
Power Magnetic Field Immunity	50Hz, 30A/m	IEC61000-4-8:2009, EN61000-4-8:2010

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

### EMC Filtering Suggestions according to EN55032

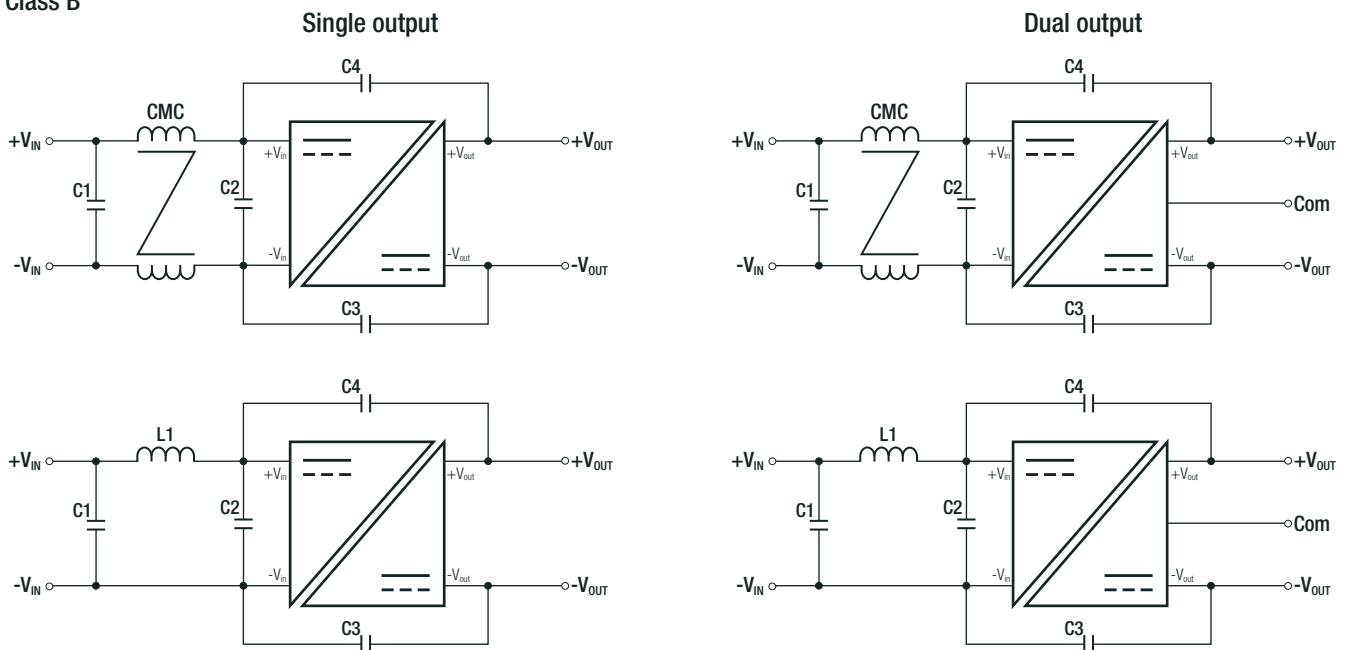
#### Class A



#### Component List Class A

MODEL	C1	C2	C3	C4	L1
REM3.5E-05xxS/R/A and REM3.5E-12xxS/R/A	4.7µF/50V	N/A	100pF/12kV	N/A	3.3µH
REM3.5E-24xxS/R/A and REM3.5E-48xxS/R/A			150pF/12kV		
REM3.5E-05xxD/R/A and REM3.5E-12xxD/R/A	10µF/100V		100pF/12kV	100pF/12kV	
REM3.5E-24xxD/R/A and REM3.5E-48xxD/R/A			150pF/12kV	150pF/12kV	

#### Class B



#### Component List Class B

MODEL	C1	C2	C3	C4	L1	CMC
REM3.5E-05xxS/R/A	4.7µF/50V	N/A	100pF/12kV	N/A	N/A	0.2mH
REM3.5E-12xxS/R/A		4.7µF/50V	220pF/12kV		50µH	N/A
REM3.5E-24xxS/R/A	10µF/100V	10µF/100V	220pF/12kV		N/A	1mH
REM3.5E-48xxS/R/A			330pF/12kV			
REM3.5E-05xxD/R/A	4.7µF/50V	N/A	100pF/12kV	100pF/12kV	N/A	0.2mH
REM3.5E-12xxD/R/A		4.7µF/50V	220pF/12kV	220pF/12kV	50µH	N/A
REM3.5E-24xxD/R/A	10µF/100V	10µF/100V	220pF/12kV	220pF/12kV		
REM3.5E-48xxD/R/A			330pF/12kV	330pF/12kV	N/A	1mH

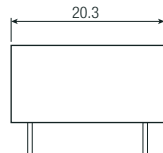
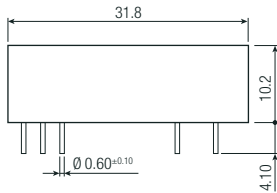
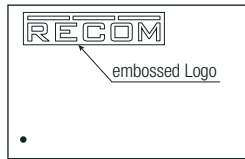
**Specifications** (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### DIMENSION and PHYSICAL CHARACTERISTICS

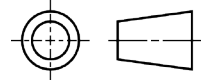
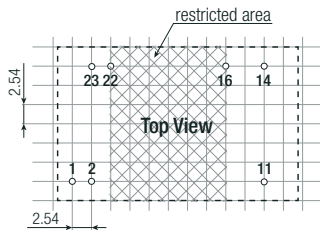
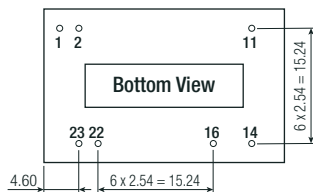
Parameter	Type	Value
Material	baseplate	non-conductive black plastic, (UL94 V-0)
	case	non-conductive black plastic, (UL94 V-0)
	potting	silicone, (UL94 V-0)
Dimension (LxWxH)	DIP24	31.8 x 20.3 x 10.2mm
	SMD	31.8 x 20.3 x 10.9mm
Weight		14g typ.

#### Dimension Drawing (mm)

##### DIP24



##### Recommended Footprint Details

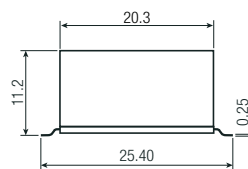
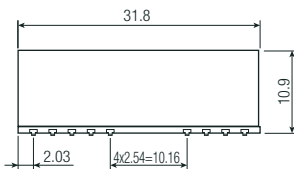
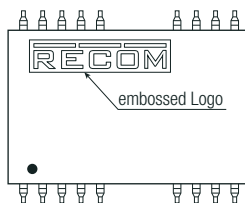


##### Pin Connections

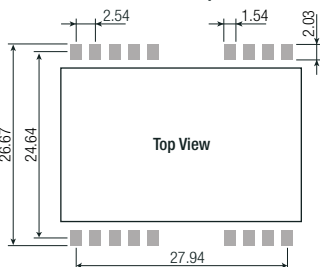
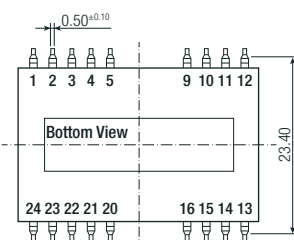
Pin #	Single	Dual
1	CTRL <sup>(4)</sup>	CTRL <sup>(4)</sup>
2	-Vin	-Vin
11	NC	-Vout
14	+Vout	+Vout
16	-Vout	Com
22	+Vin	+Vin
23	+Vin	+Vin

Tolerance:  
xx.x ± 0.5mm  
xx.xx ± 0.25mm

##### SMD



##### Recommended Footprint Details



##### Pin Connections

Pin #	Single	Dual
1	CTRL	CTRL
2	-Vin	-Vin
3, 4, 5, 9, 10	NC	NC
11	NC	-Vout
12, 13, 15	NC	NC
14	+Vout	+Vout
16	-Vout	Com
20, 21, 24	NC	NC
22	+Vin	+Vin
23	+Vin	+Vin

Tolerance:  
xx.x ± 0.5mm  
xx.xx ± 0.35mm

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

PACKAGING INFORMATION			
Parameter	Type		Value
Packaging Dimension (LxWxH)	tube	DIP24	520.0 x 22.7 x 18.3mm
		SMD	530.0 x 30.3 x 19.2mm
Packaging Quantity	tube		15pcs
Storage Temperature Range			-55°C to +125°C
Storage Humidity			95% RH max.

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