# Features

# Regulated Converter

- 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

RECOM
DC/DC Converter

# REM3.5E

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

YEAR 3 Warranty

2MOPP
250VAC

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

## 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.(1) [%] | Max. Capacitive Load (2) [µF] |
|---|---|---|---|---|---|
| REM3.5E-xx05S/R(3)/A (4,5) | 5 / 12 / 24 / 48 | 5 | 700 | 76 / 80 / 81 / 82 | 4700 |
| REM3.5E-xx09S/R(3)/A (4,5) | 5 / 12 / 24 / 48 | 9 | 388 | 80 / 81 / 82 / 82 | 3300 |
| REM3.5E-xx12S/R(3)/A (4,5) | 5 / 12 / 24 / 48 | 12 | 290 | 82 / 82 / 83 / 82 | 2200 |
| REM3.5E-xx15S/R(3)/A (4,5) | 5 / 12 / 24 / 48 | 15 | 233 | 83 / 82 / 84 / 83 | 2200 |
| REM3.5E-xx24S/R(3)/A (4,5) | 5 / 12 / 24 / 48 | 24 | 145 | 82 / 82 / 84 / 83 | 1000 |
| REM3.5E-xx05D/R(3)/A (4,5) | 5 / 12 / 24 / 48 | ±5 | ±350 | 76 / 80 / 81 / 82 | ±2200 |
| REM3.5E-xx09D/R(3)/A (4,5) | 5 / 12 / 24 / 48 | ±9 | ±194 | 80 / 81 / 82 / 82 | ±1600 |
| REM3.5E-xx12D/R(3)/A (4,5) | 5 / 12 / 24 / 48 | ±12 | ±145 | 82 / 82 / 83 / 82 | ±1000 |
| REM3.5E-xx15D/R(3)/A (4,5) | 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 resisitive load

## Model Numbering

**REM3.5E- ___ ___ ___ /R /A / ___ /**

- Output Power
- nom. Input Voltage
- Output Voltage
- Single or Dual
- Isolation (3)
- Pinning
- CTRL Option (4)
- UVLO Option (5)

**REM3.5E- ___ ___ ___ /R6/A /SMD/**

- Output Power
- nom. Input Voltage
- Output Voltage
- Single or Dual
- Isolation (3)
- Pinning
- Case Style
- UVLO Option (5)

**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

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

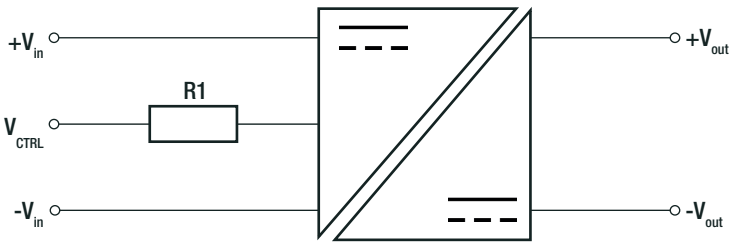
### BASIC CHARACTERISTICS

| Parameter | Condition | | Min. | Typ. | Max. |
|---|---|---|---|---|---|
| Internal Input Filter | | | | | Pi-type |
| Input Voltage Range | nom. Vin = 5VDC<br>nom. Vin = 12VDC<br>nom. Vin = 24VDC<br>nom. Vin = 48VDC | | 4.5VDC<br>9VDC<br>18VDC<br>36VDC | 5VDC<br>12VDC<br>24VDC<br>48VDC | 9VDC<br>18VDC<br>36VDC<br>75VDC |
| Under Voltage Lockout (UVLO) ("/X1" version) | nom. Vin= 5VDC | DC-DC ON<br>DC-DC OFF | | 3.9VDC | 4.5VDC |
| | nom. Vin= 12VDC | DC-DC ON<br>DC-DC OFF | | 7.9VDC | 9VDC |
| | nom. Vin= 24VDC | DC-DC ON<br>DC-DC OFF | | 16.7VDC | 18VDC |
| | nom. Vin= 48VDC | DC-DC ON<br>DC-DC OFF | | 34.3VDC | 36VDC |
| Input Current | nom. Vin = 5VDC<br>nom. Vin = 12VDC<br>nom. Vin = 24VDC<br>nom. Vin = 48VDC | | | 900mA<br>360mA<br>180mA<br>90mA | |
| Quiescent Current | nom. Vin = 5VDC<br>nom. Vin = 12VDC<br>nom. Vin = 24VDC<br>nom. Vin = 48VDC | | | | 50mA<br>20mA<br>5mA<br>2.5mA |
| Minimum Load (7) | | | | 10% | |
| Start-up time | | | | 0.6ms | |
| Rise time | | | | 0.45ms | |
| Hold-up time | | | | 0.6ms | |
| ON/OFF CTRL | DC-DC ON<br>DC-DC OFF | | Open or 0VDC<$V_{CTRL}$<1.2VDC<br>Short or 4.8VDC<$V_{CTRL}$<12VDC | | |
| Input Current of CTRL Pin | $V_{CTRL}$=5VDC | | | 25mA | |
| Standby Current | DC-DC OFF | | | | 350µA |
| Intvernal Operating Frequency | | | 120kHz | | |
| Output Ripple and Noise (6) | 20MHz BW | | | | 150mVp-p |

**Notes:**

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

### ON/OFF CTRL Option




| R1 |
|---|
| 470Ω |

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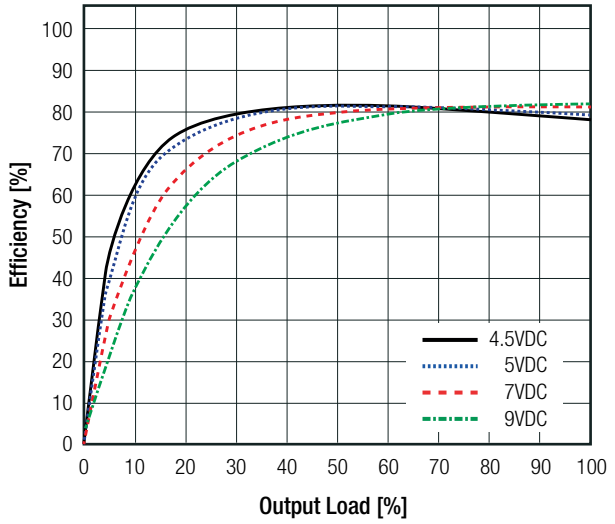
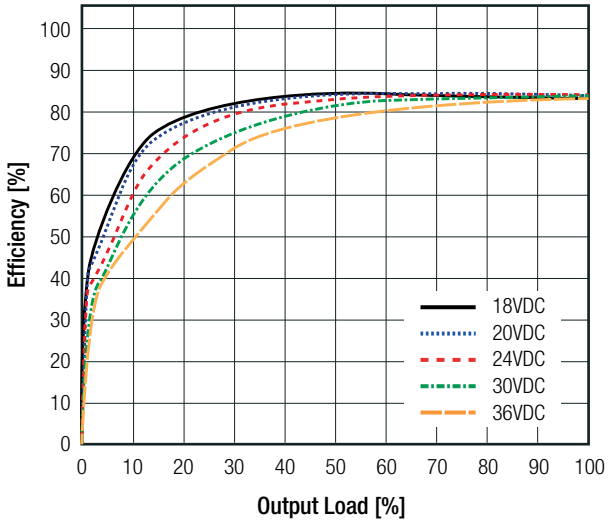
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### Efficiency vs. Output Load

REM3.5E-0505S



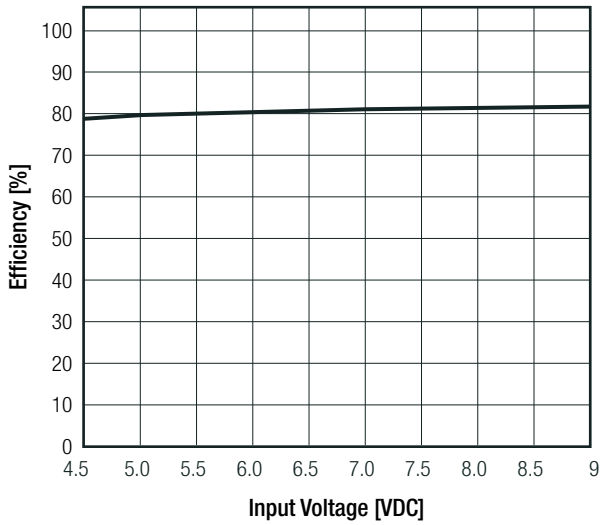

REM3.5E-2405S



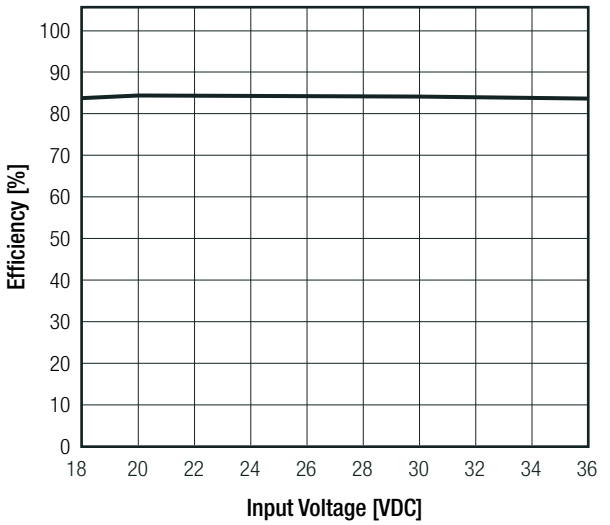

### Efficiency vs. Input Voltage

(@ full Load)

REM3.5E-0505S




REM3.5E-2405S




## REGULATIONS

| Parameter | Condition | Value |
|---|---|---|
| Output Accuracy | | ±1.5% typ. |
| Line Regulation | low line to high line, full load | ±0.3% max. |
| Load Regulation (7) | 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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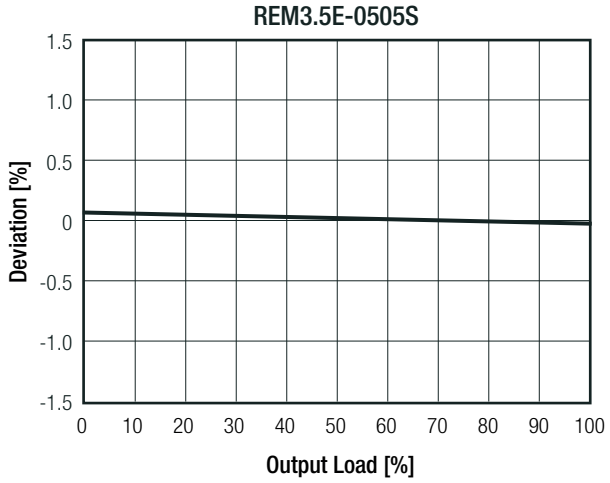
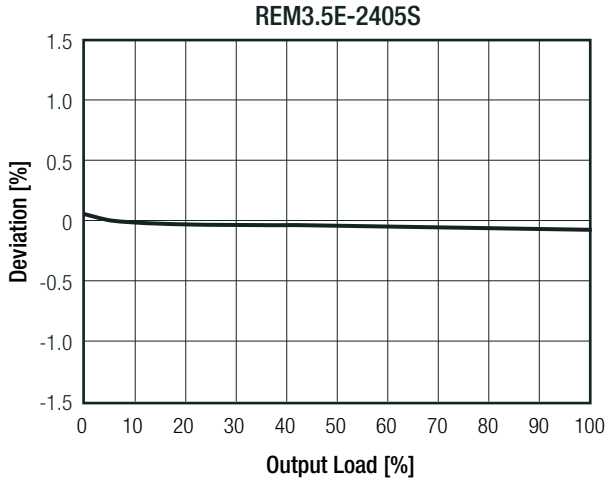
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

Deviation vs. Load




### PROTECTIONS

| Parameter | Type | | | | Value |
|---|---|---|---|---|---|
| Short Circuit Protection (SCP) | below 100mΩ | | | | continuous, hiccup mode, automatic recovery |
| Isolation Voltage [8] | I/P to O/P | DIP24 | "/R8" suffix | tested for 1 second<br>rated for 1 minute | 8kVDC<br>4kVAC/60Hz |
| | | | "/R10" suffix | tested for 1 second<br>rated for 1 minute | 10kVDC<br>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 |

**Notes:**

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<br>+85°C | 3600 x $10^3$ hours<br>450 x $10^3$ hours |

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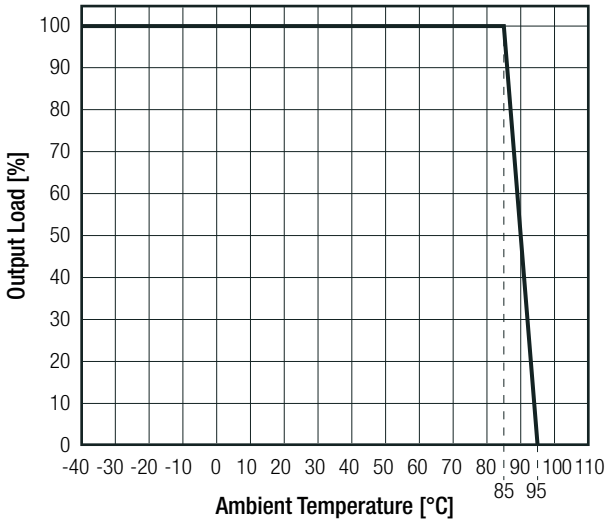
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

### 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<br>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<br>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<br>refer to ***"EMC Filtering"*** | 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<br>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<br>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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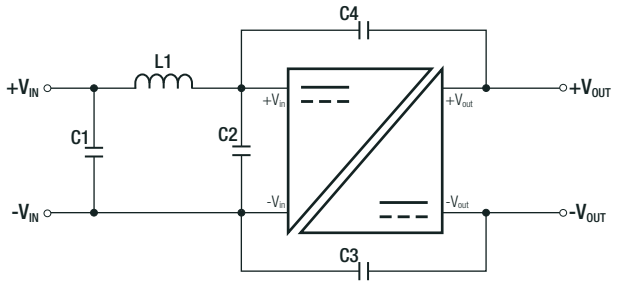
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

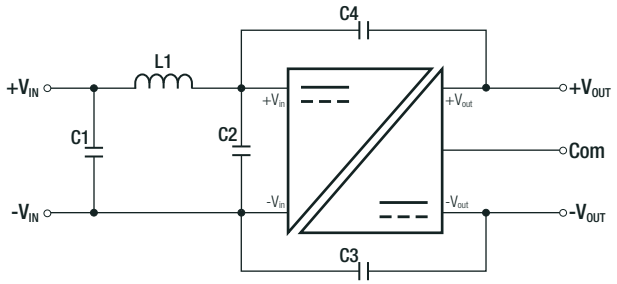
### EMC Filtering Suggestions according to EN55032

Class A

Single output




Dual output

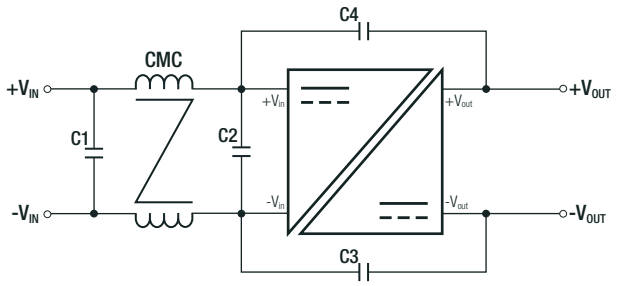



### Component List Class A

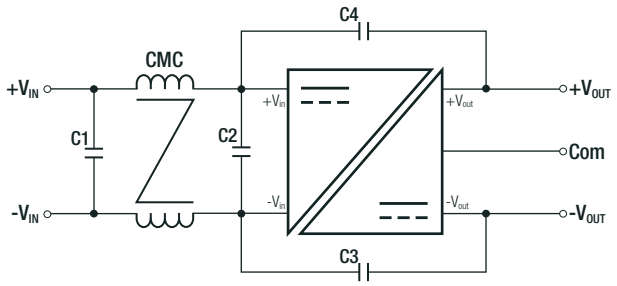
| MODEL | C1 | C2 | C3 | C4 | L1 |
|---|---|---|---|---|---|
| REM3.5E-05xxS/R/A and REM3.5E-12xxS/R/A | 4.7µF/50V | N/A | 100pF/12kV | N/A | 3.3µH |
| REM3.5E-24xxS/R/A and REM3.5E-48xxS/R/A | | | 150pF/12kV | | |
| REM3.5E-05xxD/R/A and REM3.5E-12xxD/R/A | 10µF/100V | | 100pF/12kV | 100pF/12kV | |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

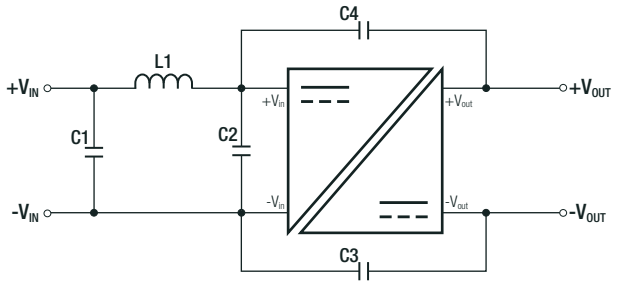
Class B

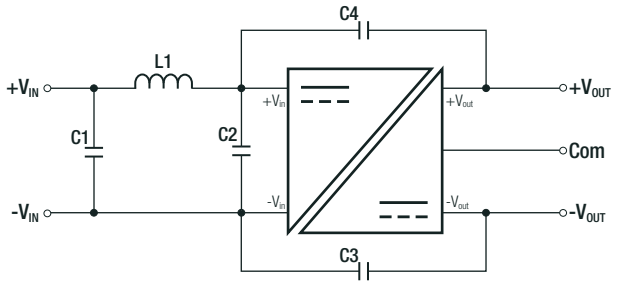
Single output




Dual output




### 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 | | | |
| REM3.5E-48xxS/R/A | | | 330pF/12kV | | N/A | 1mH |
| REM3.5E-05xxD/R/A | 4.7µF/50V | N/A | 100pF/12kV | 100pF/12kV | | 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 |

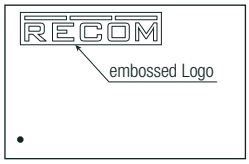
## Specifications (measured @ Ta= 25°C, nom. Vin, full load and after warm-up unless otherwise stated)

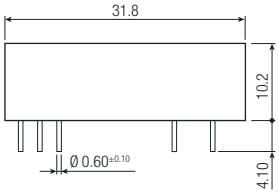
### DIMENSION and PHYSICAL CHARACTERISTICS

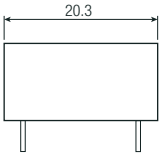
| Parameter | Type | Value |
|---|---|---|
| Material | baseplate<br>case<br>potting | non-conductive black plastic, (UL94 V-0)<br>non-conductive black plastic, (UL94 V-0)<br>silicone, (UL94 V-0) |
| Dimension (LxWxH) | DIP24<br>SMD | 31.8 x 20.3 x 10.2mm<br>31.8 x 20.3 x 10.9mm |
| Weight | | 14g typ.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

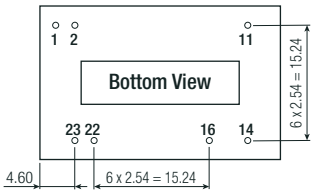
### Dimension Drawing (mm)

#### DIP24

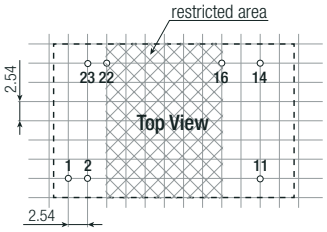



Recommended Footprint Details

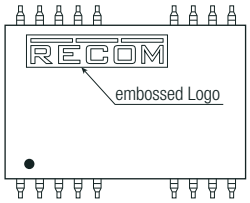


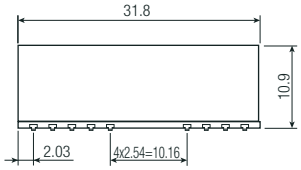

**Pin Connections**

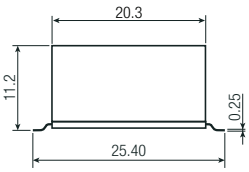
| Pin # | Single | Dual |
|---|---|---|
| 1 | CTRL (4) | CTRL (4) |
| 2 | -Vin | -Vin |
| 11 | NC | -Vout |
| 14 | +Vout | +Vout |
| 16 | -Vout | Com |
| 22 | +Vin | +Vin |
| 23 | +Vin | +Vin |

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

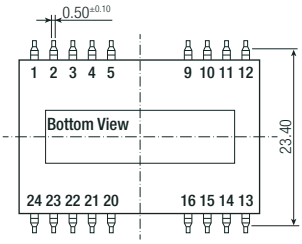
#### SMD

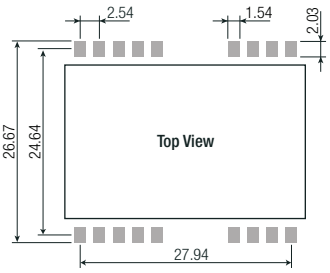



Recommended Footprint Details




**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<br>SMD | 520.0 x 22.7 x 18.3mm<br>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. |

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.

Компания «ЭлектроПласт» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Оперативные поставки широкого спектра электронных компонентов отечественного и импортного производства напрямую от производителей и с крупнейших мировых складов;
- Поставка более 17-ти миллионов наименований электронных компонентов;
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- Лицензия ФСБ на осуществление работ с использованием сведений, составляющих государственную тайну;
- Поставка специализированных компонентов (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Aeroflex, Peregrine, Syfer, Eurofarad, Texas Instrument, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits,General Dynamics и др.);

Помимо этого, одним из направлений компании «ЭлектроПласт» является направление «Источники питания». Мы предлагаем Вам помощь Конструкторского отдела:

- Подбор оптимального решения, техническое обоснование при выборе компонента;
- Подбор аналогов;
- Консультации по применению компонента;
- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.

**Как с нами связаться**

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