# Features

# Regulated Converter

- Reinforced insulation for 250VAC working voltage
- Clearance and creepage distance >8.0mm
- 5kVAC I/P to O/P 2MOPP isolation
- 2µA patient leakage current
- Industry standard pinout
- 4:1 wide input range

RECOM
DC/DC Converter

# REM20-W

## 20 Watt 4:1 Input 1.6“ x 1“ Single and Dual Output

5 YEAR warranty




2MOPP 250VAC

c UL us E314885

UL60950-1 certified
CSA/CAN C22.2 60950-1-07 certified
UL62368-1 certified
CSA/CAN C22.2 62368-1 certified
CSA/CAN C22.2 60601-01 certified
ANSI/AAMI ES60601-1 certified
EN55011 certified
CB report

## Description

The REM20-W series of medical grade regulated DC/DC converters features reinforced 5kVAC/1 minute isolation with low 2µA leakage (B, BF and CF compatible) and are 60601-1 3rd Ed. certified for 250VAC continuous working voltage isolation. The industry standard 1.6”x1” package offers tightly regulated single and dual outputs, with low output ripple and zero-load operation. The outputs are also short circuit and overload protected. The converters are certified to CB, IEC/EN and ANSI/AAMI standards and carry the UL mark.

## Selection Guide

| Part Number | Input Voltage Range [VDC] | Output Voltage [VDC] | Output Current [mA] | Efficiency typ. (1) [%] | Max. Capacitive Load (2) [µF] |
|---|---|---|---|---|---|
| REM20-2405SW (3) | 9-36 | 5 | 4000 | 87 | 5000 |
| REM20-2412SW (3) | 9-36 | 12 | 1667 | 88.5 | 850 |
| REM20-2415SW (3) | 9-36 | 15 | 1333 | 88 | 700 |
| REM20-2424SW (3) | 9-36 | 24 | 833 | 88 | 220 |
| REM20-4805SW (3) | 18-75 | 5 | 4000 | 89.5 | 2500 |
| REM20-4812SW (3) | 18-75 | 12 | 1667 | 88 | 500 |
| REM20-4815SW (3) | 18-75 | 15 | 1333 | 88 | 350 |
| REM20-4824SW (3) | 18-75 | 24 | 833 | 88.5 | 5000 |
| REM20-2405DW (3) | 9-36 | ±5 | ±2000 | 86 | ±850 |
| REM20-2412DW (3) | 9-36 | ±12 | ±833 | 88 | ±700 |
| REM20-2415DW (3) | 9-36 | ±15 | ±667 | 88 | ±220 |
| REM20-4805DW (3) | 18-75 | ±5 | ±2000 | 86 | ±2500 |
| REM20-4812DW (3) | 18-75 | ±12 | ±833 | 88.5 | ±500 |
| REM20-4815DW (3) | 18-75 | ±15 | ±667 | 88 | ±350 |

**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

**REM20-** ___ ___ **W/P**

- Output Power
- nom. Input Voltage
- nom. Output Voltage
- ***“CTRL pin option (positive logic)”***
- **W**ide Input Voltage Range (4:1)
- **S**ingle or **D**ual

**Notes:**

Note3: standard is with suffix „/P“ (CTRL pin with positive logic)
without suffix is without CTRL pin (no pin) please refer to ***“Dimension Drawing (mm)”***

**Ordering Examples:**

REM20-2412SW/P = 4:1 Input, 9-36Vin, 12Vout, with control pin positive logic
REM20-4815DW = 4:1 Input, 18-75Vin, ±15Vout, without control pin

## Specifications (measured @ Ta= 25°C, nominal input voltage. full load and after warm-up)

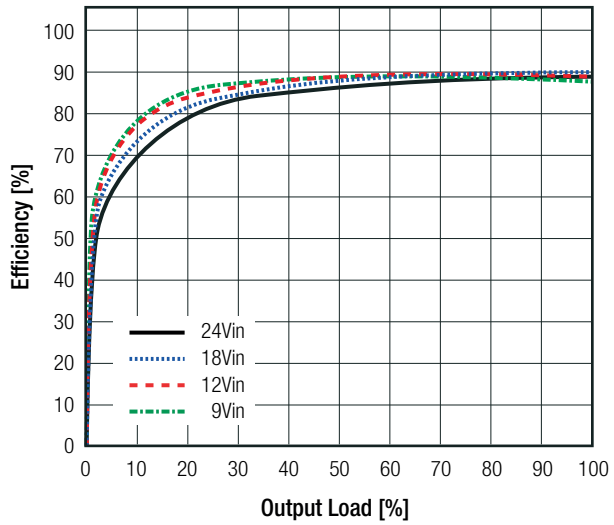
| BASIC CHARACTERISTICS | | | | | |
|---|---|---|---|---|---|
| **Parameter** | **Condition** | | **Min.** | **Typ.** | **Max.** |
| Internal Input Filter | | | | | Pi type |
| Input Voltage Range | nom. Vin= 24VDC | | 9VDC | 24VDC | 36VDC |
| | nom. Vin= 48VDC | | 18VDC | 48VDC | 75VDC |
| Input Surge Voltage | 3 second max. | nom. Vin= 24VDC | | | 50VDC |
| | | nom. Vin= 48VDC | | | 100VDC |
| Under Voltage Lockout | nom. Vin= 24VDC | DC-DC ON<br>DC-DC OFF | 7.8VDC | | 8.6VDC |
| | nom. Vin= 48VDC | DC-DC ON<br>DC-DC OFF | 15.8VDC | | 17.4VDC |
| Quiescent Current | nom. Vin= 24VDC | | | 13mA | |
| | nom. Vin= 48VDC | | | 10mA | |
| Output Voltage Trimming | 5Vout, 12Vout | | -10% | | +10% |
| | 15Vout, 24Vout | | -10% | | +20% |
| Minimum Load | | | 0% | | |
| Start-up Time | ON/OFF CTRL | | | 10ms | 60ms |
| | Power up | | | 30ms | 60ms |
| Rise Time | | | | 5ms | |
| ON/OFF CTRL [4] | DC-DC ON | | Open or 3.5VDC - 12VDC | | |
| | DC-DC OFF | | Short or 0VDC - 1.2VDC | | |
| Input Current of CTRL Pin | DC-DC ON | | -0.5mA | | 1mA |
| Standby Current | DC-DC OFF | | | 2.5mA | |
| Internal Operating Frequency | | | 220kHz | 250kHz | 300kHz |
| Output Ripple and Noise (20MHz BW) | with a 10µF X7R/MLCC | 5Vout, single and dual | | 50mVp-p | |
| | | 12 & 15Vout, single and dual | | 75mVp-p | |
| | with a 4.7µF X7R/MLCC | 24Vout single | | 100mVp-p | |

**Notes:**

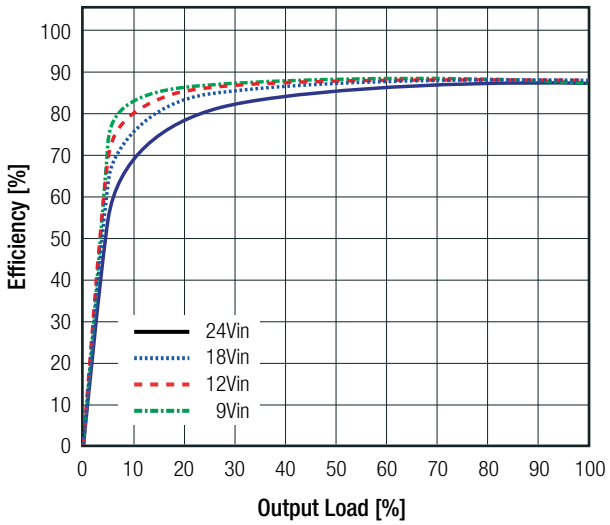
Note4: The ON/OFF control function is positive logic. The pin voltage is referenced to -Vin pin

### Efficiency vs. Load

**REM20-2405SW**




**REM20-2412SW**

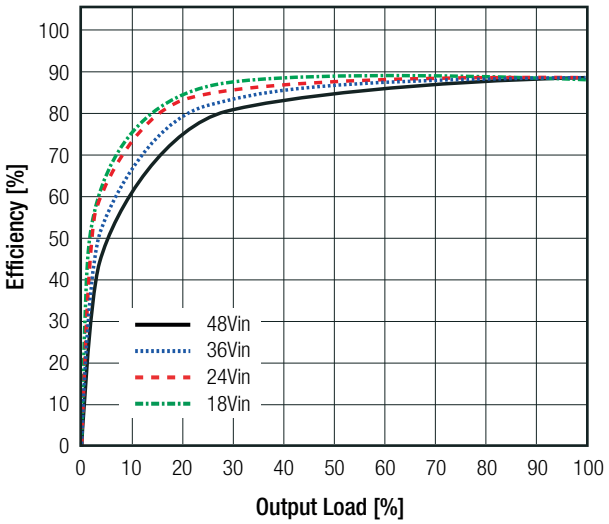



continued on next page

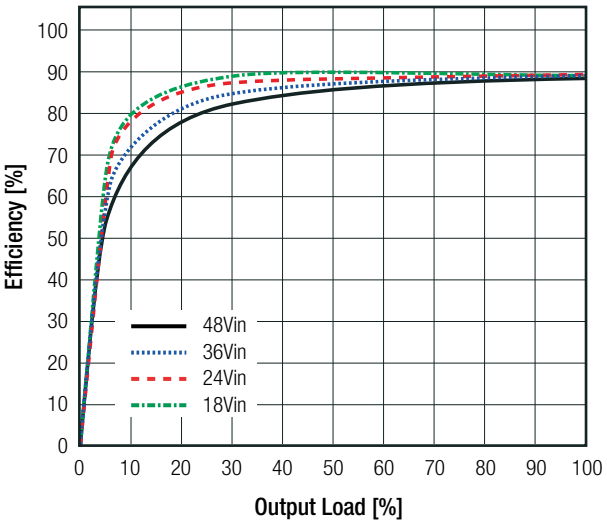
## Specifications (measured @ Ta= 25°C, nominal input voltage, full load and after warm-up)

### Efficiency vs. Load

REM20-4805SW

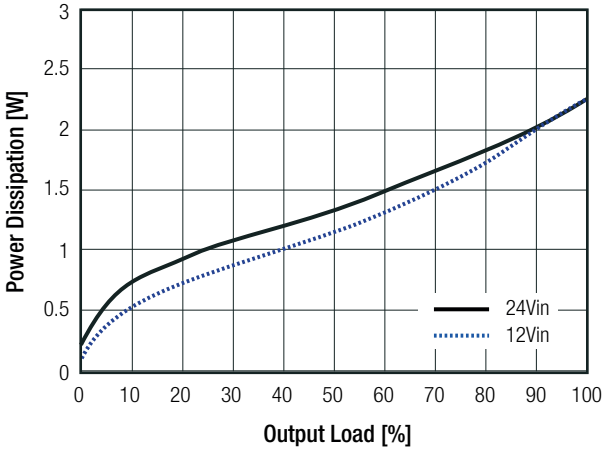



REM20-4824SW

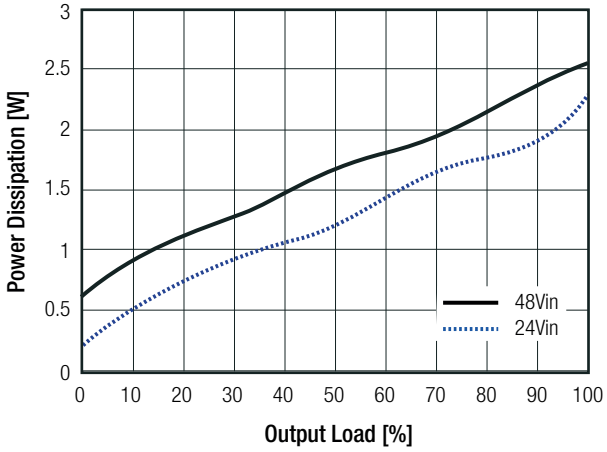



### Power Dissipation vs. Load

REM20-24xxSW



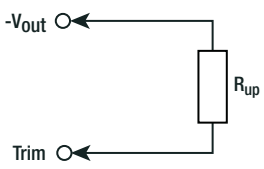

REM20-48xxSW



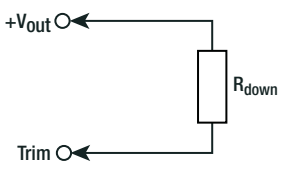

### Output Voltage Trimming

It allows the user to increase or decrease the output voltage of the module. This is accomplished by connecting an external resistor between the Trim pin and either the +Vout or -Vout pins. With an external resistor between the Trim and -Vout pin, the output voltage increases. With an external resistor between the Trim and +Vout pin, the output voltage decreases. The external Trim resistor needs to be at least 1/16W of rated. The values for trim resistors shown in trim tables below are according to standard E96 values; therefore, the specified voltage may slightly vary.

Trim up




Trim down




continued on next page

## Specifications (measured @ Ta= 25°C, nominal input voltage, full load and after warm-up)

### Trim Calculation

| | | |
|---|---|---|
| $Vout_{nom}$ | = 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] |
| $R_1$ & $R_2$ | = internal resistors | [Ω] |
| $k_u$ | = trim up factor | [ ] |

| $Vout_{nom}$ | $R_1$ | $R_2$ | $k_u$ | $V_{ref}$ |
|---|---|---|---|---|
| 5VDC | 5k1Ω | 2kΩ | 2.5 | 2.5VDC |
| 12VDC | 10kΩ | 5k1Ω | 9.5 | |
| 15VDC | 10kΩ | 5k1Ω | 12.5 | |
| 24VDC | 56kΩ | 13kΩ | 21.5 | |

### Calculation:

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

$$R_{down} = \left[ \frac{(Vout_{set} - V_{ref}) \times R_1}{Vout_{nom} - Vout_{set}} \right] - R_2$$

### Practical Example REM20-1212SW +10% / -10%:

$$R_{up} = \left[ \frac{10k \times 2.5}{13.2 - 2.5 - 9.5} \right] - 5k1 = \mathbf{15k7\Omega}$$

$$R_{down} = \left[ \frac{(10.8 - 2.5) \times 10k}{12 - 10.8} \right] - 5k1 = \mathbf{64k1\Omega}$$

$R_{up}$ according to E96 ≈ **15k8Ω**

$R_{down}$ according to E96 ≈ **64k3Ω**

#### REM20-xx05SW(/P)

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 5.05 | 5.10 | 5.15 | 5.20 | 5.25 | 5.30 | 5.35 | 5.40 | 5.45 | 5.50 | [VDC] |
| $R_{up}$ (E96) ≈ | 255k | 127k | 82k5 | 61k9 | 48k7 | 40k2 | 34k8 | 30k1 | 26k1 | 23k7 | [Ω] |

| Trim down | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 4.95 | 4.90 | 4.85 | 4.80 | 4.75 | 4.70 | 4.65 | 4.60 | 4.55 | 4.50 | [VDC] |
| $R_{down}$ (E96) ≈ | 249k | 121k | 78k7 | 56k2 | 44k2 | 35k7 | 29k4 | 24k9 | 21k | 18k2 | [Ω] |

#### REM20-xx12SW(/P)

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 12.12 | 12.24 | 12.36 | 12.48 | 12.60 | 12.72 | 12.84 | 12.96 | 13.08 | 13.20 | [VDC] |
| $R_{up}$ (E96) ≈ | 205k | 100k | 64k9 | 47k5 | 36k5 | 29k4 | 24k9 | 20k1 | 17k9 | 15k8 | [Ω] |

| Trim down | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 11.88 | 11.76 | 11.64 | 11.52 | 11.40 | 11.28 | 11.16 | 11.04 | 10.92 | 10.80 | [VDC] |
| $R_{down}$ (E96) ≈ | 768k | 383k | 249k | 182k | 143k | 118k | 97k6 | 84k5 | 73k2 | 63k4 | [Ω] |

#### REM20-xx15SW(/P)

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 15.15 | 15.30 | 15.45 | 15.60 | 15.75 | 15.90 | 16.05 | 16.20 | 16.35 | 16.50 | [VDC] |
| $R_{up}$ (E96) ≈ | 162k | 78k7 | 49k9 | 36k5 | 28k | 22k6 | 18k7 | 15k8 | 13k3 | 11k5 | [Ω] |

| Trim up | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 16.65 | 16.80 | 16.95 | 17.10 | 17.25 | 17.40 | 17.55 | 17.70 | 17.85 | 18.00 | [VDC] |
| $R_{up}$ (E96) ≈ | 10k | 8k8 | 7k6 | 6k8 | 6k | 5k3 | 4k6 | 4k1 | 3k6 | 3k2 | [Ω] |

| Trim down | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 14.85 | 14.70 | 14.55 | 14.40 | 14.25 | 14.10 | 13.95 | 13.80 | 13.65 | 13.50 | [VDC] |
| $R_{down}$ (E96) ≈ | 825K | 402k | 261k | 191k | 150k | 124k | 105k | 88k7 | 76k8 | 68k1 | [Ω] |

continued on next page

## Specifications (measured @ Ta= 25°C, nominal input voltage, full load and after warm-up)

### REM20-xx24SW(/P)

| Trim up | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 24.24 | 24.48 | 24.72 | 24.96 | 25.20 | 25.44 | 25.68 | 25.92 | 26.16 | 26.40 | [VDC] |
| $R_{up}$ (E96) ≈ | 576k | 280k | 182k | 133k | 105k | 84k5 | 69k8 | 95k3 | 52k3 | 45k3 | [Ω] |

| Trim up | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 26.64 | 26.88 | 27.12 | 27.36 | 27.60 | 27.84 | 28.08 | 28.32 | 28.56 | 28.80 | [VDC] |
| $R_{up}$ (E96) ≈ | 40k2 | 35k7 | 31k6 | 28k7 | 26k1 | 23k7 | 21k5 | 19k6 | 17k9 | 16k2 | [Ω] |

| Trim down | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | [%] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| $Vout_{set}$ = | 23.76 | 23.52 | 23.28 | 23.04 | 22.80 | 22.56 | 22.32 | 22.08 | 21.84 | 21.60 | [VDC] |
| $R_{down}$ (E96) ≈ | 4M99 | 2M43 | 1M62 | 1M18 | 931k | 768k | 649k | 562k | 487k | 432k | [Ω] |

### REGULATIONS

| Parameter | Condition | | Value |
|---|---|---|---|
| Output Accuracy | | | ±1.0% max. |
| Line Regulation | low line to high line | Single Output | ±0.2% max. |
| | | Dual Output | ±0.5% max. |
| Load Regulation | no load to full load | Single Output | 0.2% max. |
| | | Dual Output | 1.0% max. |
| Cross Regulation | assymetrical load 25% / 100% full load | only Dual Output | ±5.0% max. |
| Transient Response | recovery time | 25% load step change | 100µs typ. / 250µs max. |

### PROTECTIONS

| Parameter | Condition | | Value |
|---|---|---|---|
| Short Circuit Protection (SCP) [6] | | | continuous, auto-recovery |
| Over Load Protection (OLP) | % of Iout rated | | hiccup mode, 150% - 185% |
| Output Over Voltage Protection (OVP) | Zener diode clamp | 5Vout<br>12Vout<br>15Vout<br>24Vout | 6.2VDC typ.<br>15VDC typ.<br>20VDC typ.<br>30VDC typ. |
| Over Temperature Protection (OTP) | at tc point (refer to ***"Dimension Drawing (mm)"***) | | +115°C typ. |
| Isolation Voltage [5] | I/P to O/P<br>working voltage | tested for 1 minute<br>continuous | 5kVAC<br>250VAC |
| Isolation Resistance | | | 2GΩ min. |
| Isolation Capacitance | | | 20pF max. |
| Leakage Current | 240VAC, 60Hz | | 2µA typ. / 2.5µA max. |
| Insulation Grade | | | reinforced |
| Means of Protection | | | 2MOPP |
| Medical Device Classification | | | built-in power supply |
| Clearance/Creepage | | | >8.0mm |

**Notes:**

Note5: For repeat Hi-Pot testing, reduce the time and/or the test voltage

Note6: Refer to local safety regulations if input over-current protection is also required. Recommended fuse: slow blow type

## Specifications (measured @ Ta= 25°C, nominal input voltage, full load and after warm-up)

### ENVIRONMENTAL

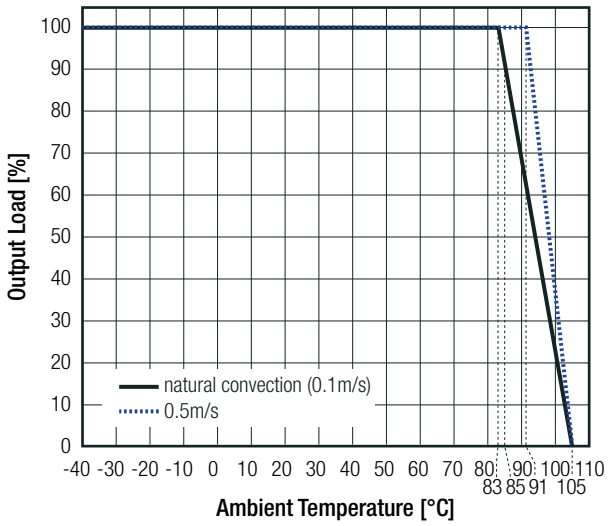
| Parameter | Condition | | | Value |
|---|---|---|---|---|
| Operating Temperature Range [7] | with derating @ natural convection 0.1m/s | | | -40°C to +105°C |
| Max. Case Temperature | | | | +110°C typ. |
| Operating Humidity | | | | 5% to 95% RH |
| Temperature Coefficient | | | | 0.02%/K |
| Thermal Impedance [7] | horizontal direction | natural convection (0.1m/s) | | 9K/W |
| | | 0.5m/s | | 6.4K/W |
| Operating Altitude | | | | 5000m |
| Pollution Degree | | | | PD2 |
| Thermal Shock | | | | according to MIL-STD-810F |
| Vibration | | | | according to MIL-STD-810F |
| MTBF | according to MIL-HDBK-217F, full load | | +25°C | 1700 x $10^3$ hours |

**Notes:**

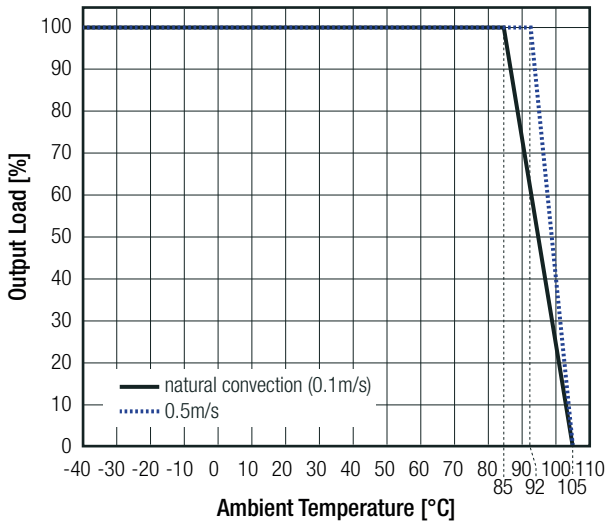
Note7: Measured with test PCB: Eurocard 160x100mm 105µm copper, double layer

**Derating Graph [7]**
(@ Chamber and nominal Vin)

REM20-24xxSW




REM20-48xxSW




### SAFETY AND CERTIFICATIONS

| Certificate Type (Safety) | Report / File Number | Standard |
|---|---|---|
| Information Technology Equipment, General Requirements for Safety | E196683 | UL60950-1, 2nd Edition, 2014<br>CAN/CSA-C22.2 No. 60950-1-07, 2nd Edition, 2014 |
| Audio/video, information and communication technology equipment. Safety requirements | | UL62368-1<br>CAN/CSA-C22.2 No. 62368-1 |
| Medical Electric Equipment, General Requirements for Safety and Essential Performance | E314885 | ANSI/AAMI ES60601-1 (2005/R2012 + A1:2012), 2012<br>CAN/CSA-C22.2 No. 60601-1:14, 3rd Edition, 2014-03 |
| Medical Electric Equipment, General Requirements for Safety and Essential Performance (CB Scheme) | 180505201 | IEC60601-1:2005, 3rd Edition + AM1:2012 |
| RoHS2+ | | RoHs 2011/65/EU + AM2015/863 |

continued on next page

## Specifications (measured @ Ta= 25°C, nominal input voltage. full load and after warm-up)

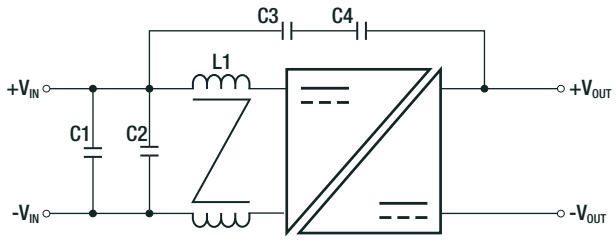
| EMC Compliance | Conditions | Standard / Criterion |
|---|---|---|
| Medical electrical equipment Part 1-2: Electromagnetic disturbances - Requirements and tests | | EN60601-1-2:2015 |
| Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement | without external filter<br>with external filter | EN55011:2009 + A1:2010, Class A<br>EN55011:2009 + A1:2010, Class B |
| | | AS/NZS CISPR11:2011 Class A, B |
| ESD Electrostatic discharge immunity test | Air: ±2, 4, 8, 15kV and<br>Contact: ±4, 6, 8kV | EN61000-4-2:2009, Criteria A<br>IEC61000-4-2:2008, Criteria A |
| Radiated, radio-frequency, electromagnetic field immunity test | 10V/m (80-2700MHz) and 9V/m,<br>27V/m, 28V/m (several frequencies) | EN61000-4-3:2006 + A2:2010, Criteria A<br>IEC61000-4-3:2007 + A2:2010, Criteria A |
| Fast Transient and Burst Immunity (8) | DC Power Port: ±0.5, 1, 2kV | IEC/EN61000-4-4:2012, Criteria A |
| Surge Immunity (8) | DC Power Port: ±0.5, 1, 2kV | IEC/EN61000-4-5:2014, Criteria A |
| Immunity to conducted disturbances, induced by radio-frequency fields | DC Power Port 10V (0.15-80MHz)<br>DC Power Port 10V (ISM bands) | EN61000-4-6:2014 + AC:2015, Criteria A<br>IEC61000-4-6:2013, Criteria A |
| Power Frequency Magnetic Field | 50Hz, 100A/m (1 min)<br>1000A/m (1 sec) | EN61000-4-8:2010, Criteria A<br>IEC61000-4-8:2009, Criteria A |

**Notes:**

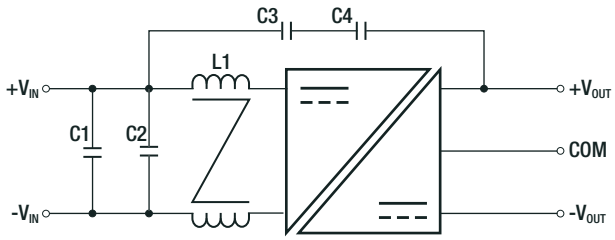
Note8: 24Vin models tested with 2pcs of Nippon chemi-con KY series (220µF/100V) MLCC and a TVS (SMDJ58A. 58V. 3000W peak pulse power) in parallel
48Vin models tested with 2pcs of Nippon chemi-con KY series (220µF/100V) MLCC and a TVS (SMDJ120A. 120V. 3000W peak pulse power) in parallel

### EMC Filtering Suggestions according to EN55011

Single output




Dual output




### Component List Class B

| nom. Vin | C1 | C2 | C3, C4 | L1 |
|---|---|---|---|---|
| 24VDC | N/A | 10µF/50V<br>1210 MLCC | 100pF/3kV | 145µH 5.2A<br>CMC |
| 48VDC | 2.2µF/100V<br>1210 MLCC | 2.2µF/100V<br>1210 MLCC | 100pF/3kV | 373µH 3A<br>CMC |

## DIMENSION and PHYSICAL CHARACTERISTICS

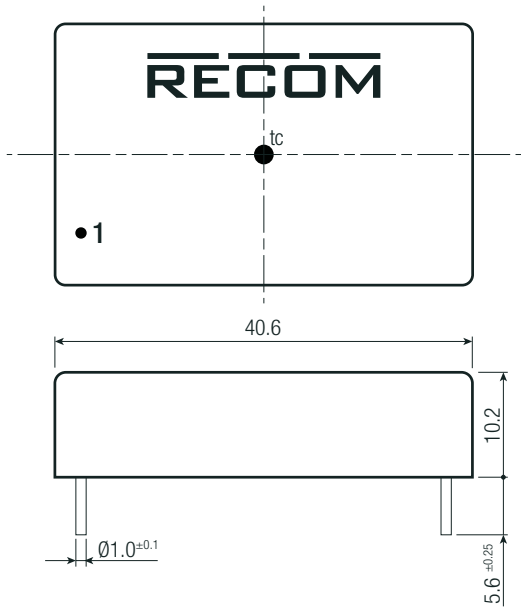
| Parameter | Type | Value |
|---|---|---|
| Material | case<br>baseplate<br>potting | non-conductive black plastic (UL94-V0)<br>non-conductive black plastic (UL94-V0)<br>silicone (UL94-V0) |
| Dimension (LxWxH) | | 40.6 x 25.4 x 10.2mm |
| Weight | | 24g typ. |

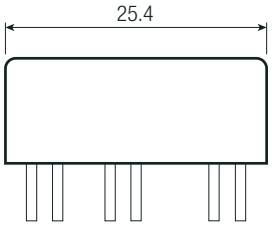
continued on next page

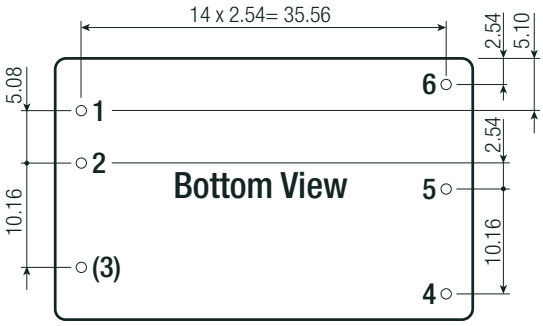
# REM20-W Series

## Specifications (measured @ Ta= 25°C, nominal input voltage. full load and after warm-up)

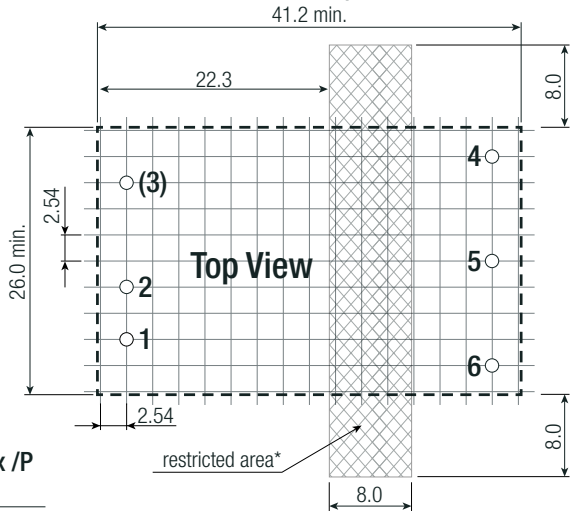
### Dimension Drawing (mm)




### Recommended Footprint Details




*A minimum of 8mm clearance and creepage is required between primary and secondary circuit to meet 2MOPP under IEC60601-1. No copper traces and/or components are allowed in this area if 2MOPP is required.

### Pin Connections with suffix /P

| Pin # | Single | Dual |
|---|---|---|
| 1 | +Vin | +Vin |
| 2 | -Vin | -Vin |
| 3 | CTRL | CTRL |
| 4 | Trim | -Vout |
| 5 | -Vout | Com |
| 6 | +Vout | +Vout |

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

### Pin Connections without suffix /P

| Pin # | Single | Dual |
|---|---|---|
| 1 | +Vin | +Vin |
| 2 | -Vin | -Vin |
| 4 | Trim | -Vout |
| 5 | -Vout | Com |
| 6 | +Vout | +Vout |

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

| PACKAGING INFORMATION | | |
|---|---|---|
| **Parameter** | **Type** | **Value** |
| Packaging Dimension (LxWxH) | tube | 290.0 x 43.5 x 19.7mm |
| Packaging Quantity | | 10 pcs |
| Storage Temperature Range | | -55°C to +125°C |
| Stoarge Humidity | non-condensing | 5% to 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.