

# Features

# Regulated Converter

- Reinforced insulation for 250VAC working voltage
- Clearance and creepage distance: 8mm
- 5kVAC I/P to O/P 2MOPP isolation
- 2µA patient leakage current
- Industry standard pinout
- 2:1 and 4:1 wide input range



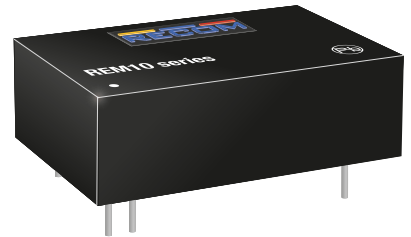
## REM10

10 Watt  
2:1 & 4:1



DIP24

Single and Dual Output



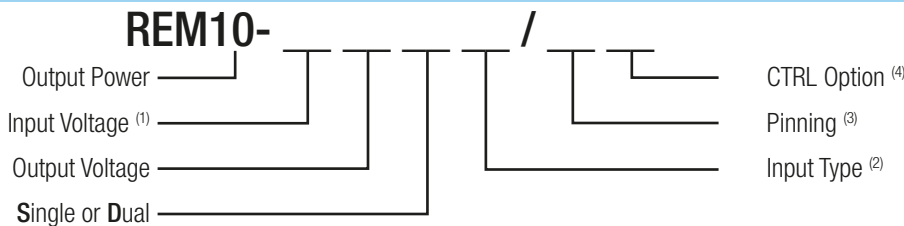
### Description

The REM10 series of medical grade regulated DC/DC converters features reinforced 5kVAC/1 minute isolation with low 2µA leakage and are 60601-1 3rd Ed. certified for 250VAC continuous working. The compact DIP24 package offers tightly regulated single and dual outputs, even under no-load conditions. The outputs are short circuit and overload protected. The converters are available in two different pinning options and optionally with an external control pin for standby consumption as low as 12.5mW. The converters are fully certified to CB, IEC/EN and ANSI/AAMI standards and carry UL mark.

### Selection Guide

Part Number	Input Voltage Range [VDC]	Output Voltage [VDC]	Output Current [mA]	Efficiency typ. [%]	Max. Capacitive Load [µF]
REM10-xx3.3S/ (3,4)	5 / 12 / 24 / 48	3.3	2500	80 / 83 / 83 / 82.5	3000
REM10-xx05S/ (3,4)	5 / 12 / 24 / 48	5	2000	84 / 85.5 / 86.5 / 86.5	2500
REM10-xx12S/ (3,4)	5 / 12 / 24 / 48	12	830	86.5 / 88 / 89 / 89	430
REM10-xx15S/ (3,4)	5 / 12 / 24 / 48	15	670	87 / 89 / 89 / 89	350
REM10-xx24S/ (3,4)	5 / 12 / 24 / 48	24	416	85.5 / 89 / 89 / 88.	125
REM10-xxx05D/ (3,4)	5 / 12 / 24 / 48	±5	±1000	83 / 84 / 85 / 85	±1440
REM10-xx12D/ (3,4)	5 / 12 / 24 / 48	±12	±416	85.5 / 89 / 89 / 88	±250
REM10-xx15D/ (3,4)	5 / 12 / 24 / 48	±15	±333	86.5 / 88 / 89 / 88	±180
REM10-xx3.3SW/ (3,4)	24 / 48	3.3	2500	83 / 82.5	3000
REM10-xx05SW/ (3,4)	24 / 48	5	2000	86.5 / 86.5	2500
REM10-xx12SW/ (3,4)	24 / 48	12	830	89 / 89	430
REM10-xx15SW/ (3,4)	24 / 48	15	670	89 / 89	350
REM10-xx24SW/ (3,4)	24 / 48	24	416	89 / 88.5	125
REM10-xx05DW/ (3,4)	24 / 48	±5	±1000	85 / 85	±1440
REM10-xx12DW/ (3,4)	24 / 48	±12	±416	89 / 88	±250
REM10-xx15DW/ (3,4)	24 / 48	±15	±333	88 / 88	±180

### Model Numbering



**Notes:**

Note1: for 4:1 Input Voltage Type add "W", see Note 2.

2:1	nom. Vin	4:1 "W"	nom. Vin
xx= 4.5-9Vin	= "05"	xx= 9-36Vin	= "24"
xx= 9-18Vin	= "12"	xx= 18-75Vin	= "48"
xx= 18-36Vin	= "24"		
xx= 36-75Vin	= "48"		

Note2: Blank for Standard 2:1 Input Voltage Range; „W" suffix for 4:1 Input Voltage Range

Note3: „A" suffix for A pinning; „C" suffix for C pinning, for more details refer to Package Style and Pinning

Note4: „CTRL" suffix for control pin option, for A pinning only, for C pinning not available

**Examples:**

REM10-0512D/A	=	2:1 Input,	4.5-9Vin,	±12Vout,	pinout „A",	without control pin
REM10-1215S/C	=	2:1 Input,	9-18Vin,	15Vout,	pinout „C",	without control pin
REM10-4815SW/A/CTRL	=	4:1 Input,	36-75Vin,	15Vout,	pinout „A" with control pin	
REM10-243.3SW/C	=	4:1 Input,	9-36Vin,	3.3Vout,	pinout „C",	without control pin



2MOPP  
250VAC

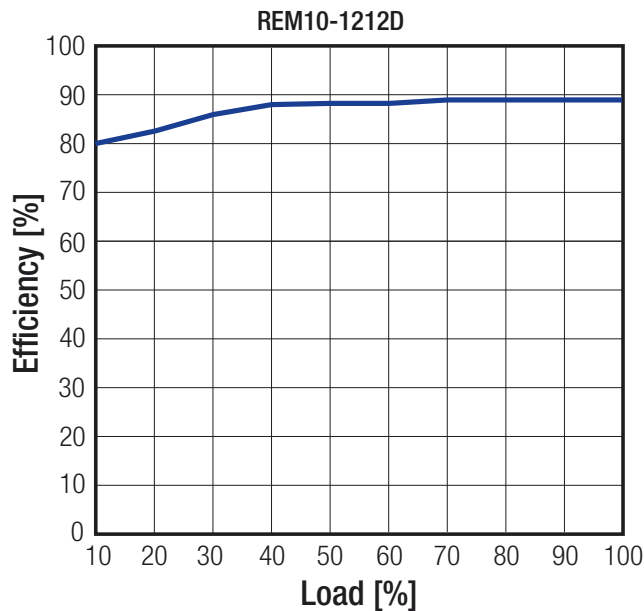
IEC/EN60601-1 certified  
CSA/CAN C22.2 60601-01 certified  
ANSI/AAMI ES60601-1 certified  
EN55011 certified

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

**BASIC CHARACTERISTICS**

Parameter	Condition	Min.	Typ.	Max.
Absolute Maximum Input Voltage ( 3sec max.)	2:1 5Vin nom. 12Vin nom. 24Vin nom. 48Vin nom.			16VDC 25VDC 50VDC 100VDC
	4:1 24Vin nom. 48Vin nom.			50VDC 100VDC
Under Voltage Lockout	2:1 5Vin nom. 12Vin nom. 24Vin nom. 48Vin nom.	4VDC 8VDC 16VDC 33VDC		4.5VDC 9VDC 18VDC 36VDC
	4:1 24Vin nom. 48Vin nom.	8VDC 16VDC		9VDC 18VDC
Start-up Time	constant resistive load, Power up or Remote ON/OFF		30ms	
Remote ON/OFF (referenced to -Vin Pin)	DC-DC ON DC-DC OFF			Open or 0-1.2VDC 2.2-12VDC
Current of CTRL Pin		-0.5mA		1mA
Remote OFF Input Current			2.5mA	
Internal Operating Frequency		270kHz	300kHz	330kHz
Output Ripple and Noise (20MHz BW limited)	10µF/25V X7R MLCC for 3.3, 5Vout 10µF/25V X7R MLCC for 12, 15Vout 4.7µF/50V X7R MLCC for 24Vout		30mVp-p 40mVp-p 50mVp-p	

**Efficiency vs. Load**



**REGULATIONS**

Parameter	Condition	Type	Value
Output Accuracy			±1.0%
Line Regulation	low line to high line	Single	±0.2%
		Dual	±0.5%
Load Regulation	no load to full load	Single	0.2%
		Dual	1.0%
Cross Regulation	asymmetrical load 25% / Full Load	only Dual Output	±5.0%
Transient Response	25% load step change		250µs

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

PROTECTIONS																			
Parameter	Condition	Type	Value																
Short Circuit Protection (SCP)			continuous, auto-recovery																
Over Load Protection (OLP)	% of Iout rated		Hiccup mode, 150% typ.																
Output Over Voltage Protection (OVP)		Single	3.3Vout	3.7VDC min. / 5VDC max.															
			5Vout	5.6VDC min. / 7VDC max.															
			12Vout	13.5VDC min. / 16VDC max.															
			15Vout	18.3VDC min. / 22VDC max.															
		Dual	24Vout	29.1VDC min. / 34.5VDC max.															
			5Vout	5.6VDC min. / 7VDC max.															
		12Vout	13.5VDC min. / 18.2VDC max.																
		15Vout	17VDC min. / 22VDC max.																
Isolation Voltage	I/P to O/P working voltage		5kVAC / 1 minute 250VAC / continuous																
Isolation Capacitance			12pF typ. / 17pF max.																
Leakage Current	240VAC, 60Hz		2µA																
Insulation Grade			reinforced																
Means of Protection			2MOPP																
Medical Device Classification			built-in power supply																
Internal Clearance and Creepage	I/P to O/P		≥8mm																
External Clearance and Creepage	I/P to O/P	"C" Pinning	>19.72mm																
		"A" Pinning	>14.64mm																
<b>Notes:</b>																			
Note5: This Power module is not internally fused. A input line fuse must be always used																			
Recommended Fuse:																			
<table border="1"> <thead> <tr> <th>2:1 Input Voltage</th> <th>Fuse (slow blow)</th> </tr> </thead> <tbody> <tr> <td>5V</td> <td>T5A</td> </tr> <tr> <td>12V</td> <td>T2A</td> </tr> <tr> <td>24V</td> <td>T1A</td> </tr> <tr> <td>48V</td> <td>T0.5A</td> </tr> </tbody> </table>		2:1 Input Voltage	Fuse (slow blow)	5V	T5A	12V	T2A	24V	T1A	48V	T0.5A	<table border="1"> <thead> <tr> <th>4:1 Input Voltage</th> <th>Fuse (slow blow)</th> </tr> </thead> <tbody> <tr> <td>24V</td> <td>T2A</td> </tr> <tr> <td>48V</td> <td>T1A</td> </tr> </tbody> </table>		4:1 Input Voltage	Fuse (slow blow)	24V	T2A	48V	T1A
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48V	T0.5A																		
4:1 Input Voltage	Fuse (slow blow)																		
24V	T2A																		
48V	T1A																		

ENVIRONMENTAL			
Parameter	Condition		Value
Maximum Case Temperature Range			-40°C to +105°C
Maximum Ambient Temperature Range			see thermal calculation below
Temperature Coefficient			0.02%/K typ.
Thermal Impedance	natural convection 0.1m/s		18K/W
Operating Altitude			5000m
Operating Humidity	non-condensing		5% - 95% RH max.
Pollution Degree			PD2
MTBF	according to MIL-HDBK-217F, G.B.	+25°C	3849 x 10 <sup>3</sup> hours
Thermal Shock			according to MIL-STD-810F standard
Vibration			according to MIL-STD-810F standard
continued on next page			

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

**Thermal Calculation:**

$$\eta_{set} = \eta_{full\ load} \times f_{\eta}$$

$$P_{diss} = \left[ \frac{P_{out\ set}}{\eta_{set}} \right] - P_{out\ set}$$

$$T_{over} = R_{th} \times P_{diss}$$

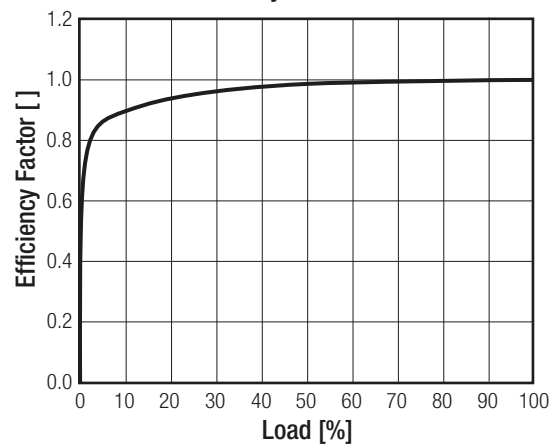
$$T_{amb} = T_{case} - T_{over}$$

$T_{case}$	= baseplate temperature	[°C]
$T_{over}$	= temperature losses	[°C]
$T_{amb}$	= ambient temperature	[°C]
$P_{out\ nom.}$	= nom. output power	[W]
$P_{out\ set}$	= output power set	[W]
$P_{diss}$	= internal losses	[W]
$R_{th}$	= thermal impedance	[K/W]
$\eta_{set}$	= efficiency set	[%]
$\eta_{full\ load}$	= efficiency @ full load	[%]
$f_{\eta}$	= efficiency factor	[ ]

**Efficiency Crosstable (%) @ full Load**

		Input Voltage					
		5	12	24	48	24W	48W
Output Voltage	3.3S	80	83	83	82.5	83	82.5
	05S	84	85.5	86.5	86.5	86.5	86.5
	12S	86.5	88	89	89	89	89
	15S	87	89	89	89	89	89
	24S	85.5	89	89	88.5	89	88.5
	05D	83	84	85	85	85	85
	12D	85.5	89	89	88	89	88
	15D	86.5	88	88	88	88	88

**Efficiency Factor vs. Load**



**Practical Example:**

Take the **REM10-1212D** with 12V Input Voltage, 50% load.  
What is the maximum ambient operating temperature?

$T_{case}$	= 105°C	$\eta_{set} = 89 \times 0.991$	<b>88.19%</b>
$P_{out\ nom.}$	= 10W	$P_{diss} = \left[ \frac{5}{0.882} \right] - 5 =$	<b>0.67W</b>
$P_{out\ set}$	= 10 x 0.5 = 5W	$T_{over} = 18 \times 0.67 =$	<b>+12.1°C</b>
$R_{th}$	= 18K/W	$T_{amb} = 105 - 12.1 =$	<b>+92.9°C</b>
$\eta_{full\ load}$	= 89% (Crosstable)		
$f_{\eta}$	= 0.991 (Graph)		

**SAFETY AND CERTIFICATIONS**

Certificate Type (Safety)	Report / File Number	Standard
Medical Electric Equipment, General Requirements for Safety and Essential Performance	E314885-A6-CB-1	CAN/CSA-C22.2 No. 60601-1:08 ANSI/AAMI ES60601-1:2005
Medical Electric Equipment, General Requirements for Safety and Essential Performance (CB Scheme)	E314885-A6-CB-1	IEC60601-1:2005 + C2:2007 3rd Edition EN60601-1:2006
EAC	RU-AT.49.09571	TP TC 004/2011 TP TC 004/2011
RoHS2+		RoHS-2011/65/EU + AM-2015/863

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

Certificate Type (Others)	Conditions	Standard / Criterion
Medical electrical equipment - Part 1-2: General requirements for basic safety and essential performance - Collateral standard: Electromagnetic compatibility - Requirements and tests		EN60601-1-2:2015
Industrial, scientific and medical equipment - Radio frequency disturbance characteristics - Limits and methods of measurement <sup>(7)</sup>		EN55011:2009 + A1:2010 Class A & B
ESD Electrostatic discharge immunity test	Air ±15kV; Contact ±8kV	EN61000-4-2:2008
Radiated, radio-frequency, electromagnetic field immunity test	10V/m (80-2500MHz) 27V/m (385MHz) 28V/m (450MHz)	EN61000-4-3:2006 + A2:2010
Fast Transient and Burst Immunity <sup>(6)</sup>	DC Port: ±2kV	EN61000-4-4:2012
Surge Immunity <sup>(6)</sup>	DC Port: ±2kV	EN61000-4-5:2005
Immunity to conducted disturbances, induced by radio-frequency fields	6Vr.m.s	EN61000-4-6:2013
Power Frequency Magnetic Field	30A/m	EN61000-4-8:2009

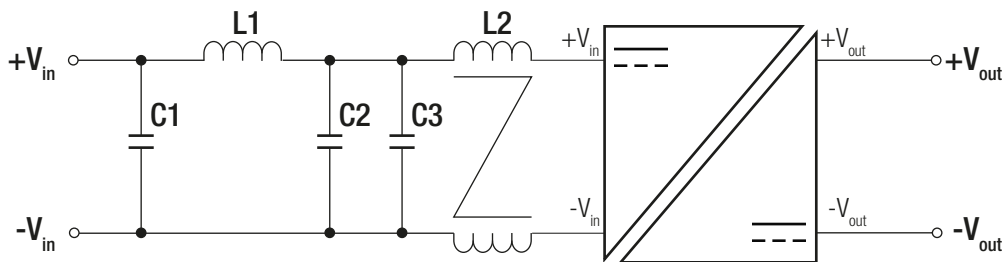
**Notes:**

Note6: An external input filter capacitor is required if the model has to meet EN61000-4-4 or/and EN61000-4-5

Recommended components: 5Vin aluminium capacitor (Nippon Chemi-con KY series, 1000µF/25V) and a reverse diode (Vishay V10P45) to connect in parallel  
12Vin, 24Vin aluminium capacitor (Nippon Chemi-con KY series, 470µF/50V)  
48Vin aluminium capacitor (Nippon Chemi-con KY series, 330µF/100V)

Note7: The whole REM10 series can meet EMI Class A with no external filter. And Class B only with external components

**EMC Filter Suggestion for Class B <sup>(8)</sup>**



MODEL	C1 <sup>(8)</sup>	C2 <sup>(8)</sup>	C3 <sup>(8)</sup>	L1 <sup>(8)</sup>	L2 <sup>(8)</sup>
REM10-05xxS_D	N/A	22µF/16V MLCC	22µF/16V MLCC	3.3µH; 3.3A SMD Inductor	52µH CMC
REM10-12xxS_D REM10-24xxS_D(W)	4.7µF/50V MLCC	4.7µF/50V MLCC	N/A	10µH; 2.3A SMD Inductor	175µH CMC
REM10-48xxS_D(W)	1µF/100V MLCC	4.7µF/100V MLCC	N/A	10µH; 2.3A SMD Inductor	419µH CMC

**Notes:**

Note8: The component values can be adapted according to customer's application

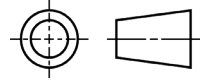
**DIMENSION and PHYSICAL CHARACTERISTICS**

Parameter	Type	Value
Material	case	non-conductive black plastic (UL94-V2)
	PCB	FR4 (UL94-V1)
	potting	silicone (UL94-V0)
Dimension (LxWxH)		31.80 x 20.30 x 10.40mm
Weight		14g

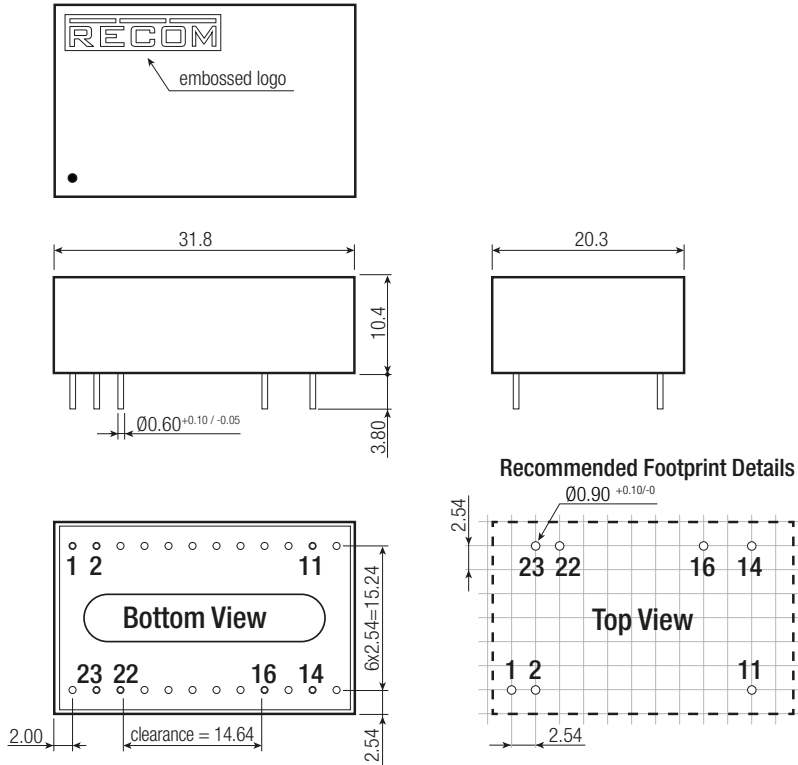
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Specifications (measured @ Ta= 25°C, nominal input voltage, full load and after warm-up)

Dimension Drawing (mm)



“A” Pinning (Standard)



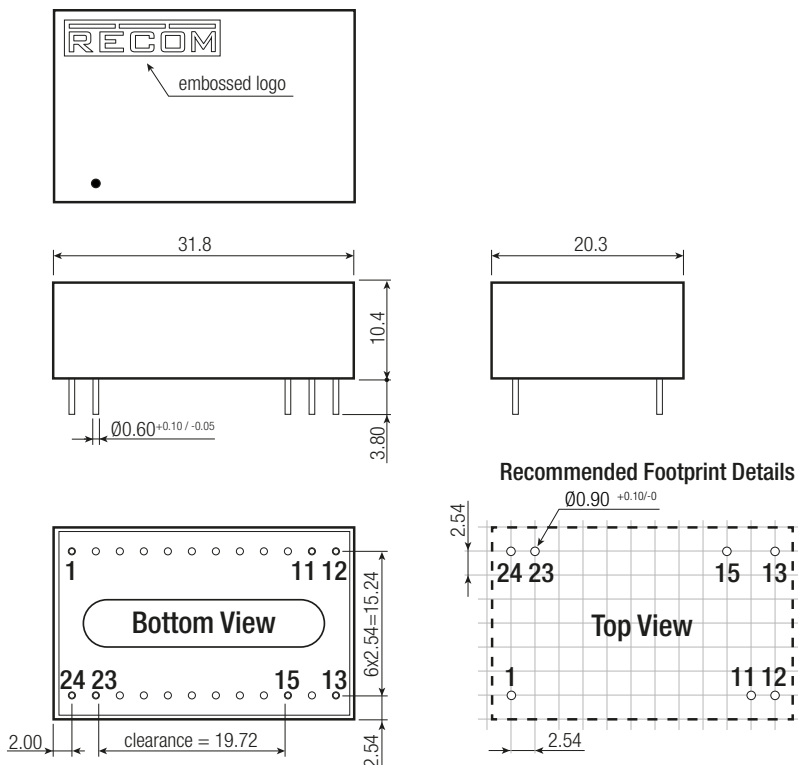
Pin Connections

Pin #	Single	Dual
1	CTRL*	CTRL*
2	-Vin	-Vin
11	NC	-Vout
14	+Vout	+Vout
16	-Vout	Com
22	+Vin	+Vin
23	+Vin	+Vin

\* If don't choose CTRL option, there is no pin on the corresponding pin number

NC= not connected  
Tolerance: xx.x= ±0.5mm  
xx.xx= ±0.25mm

“C” Pinning



Pin Connections

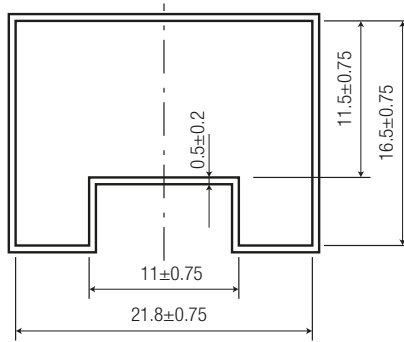
Pin #	Single	Dual
1	+Vin	+Vin
11	No Pin	Com
12	-Vout	No Pin
13	+Vout	-Vout
15	No Pin	+Vout
23	-Vin	-Vin
24	-Vin	-Vin

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

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

PACKAGING INFORMATION		
Parameter	Type	Value
Packaging Dimension (LxWxH)	tube	255 x 21.8 x 16.5mm
Packaging Quantity		7pcs
Storage Temperature Range		-55°C to +125°C
Storage Humidity	non-condensing	5% to 95% RH max.

Tube Dimension Drawing (mm)



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