



## SERIES: P78E-1000 | DESCRIPTION: NON-ISOLATED DC SWITCHING REGULATOR

### FEATURES

- 1 A of output current
- efficiency up to 96%
- industry standard SIP package
- industrial operating temp -40~+85°C
- designed to meet IEC/EN 62368-1
- drop in equivalent LM78 regulator
- no load input current of 0.2 mA
- output short circuit protection on output



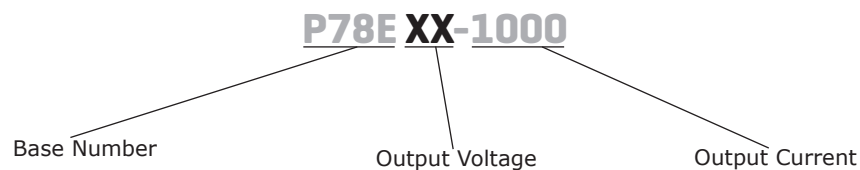
### MODEL

MODEL	input voltage <sup>1</sup>		output voltage (Vdc)	output current max (mA)	output power max (W)	ripple & noise <sup>2</sup> max (mVp-p)	efficiency <sup>3</sup> typ (%)
	typ (Vdc)	range (Vdc)					
P78E03-1000	24	6~36	3.3	1000	3.3	75	90
P78E05-1000	24	8~36	5	1000	5	75	93
	12	8~27	-5	-500	2.5	75	85
P78E09-1000	24	13~36	9	1000	9	75	94
P78E12-1000	24	16~36	12	1000	12	75	95
	12	8~20	-12	-300	3.6	75	88
P78E15-1000	24	20~36	15	1000	15	75	96
	12	8~18	-15	-300	4.5	75	87

Notes:

1. For input voltages higher than 30 Vdc, a 22  $\mu$ F / 50 V input capacitor is required.
2. Tested at nominal input, 20~100% load, 20 MHz bandwidth, with 10  $\mu$ F electrolytic and 1  $\mu$ F ceramic capacitor on the output. At loads below 20%, the max ripple and noise of the 3.3 & 5 Vdc outputs will be 100 mVp-p, and the other outputs will be 2% Vo.
3. Measured at min Vin, full load.
4. All specifications are measured at Ta=25°C, humidity < 75%, nominal input voltage, and rated output load unless otherwise specified.

### PART NUMBER KEY



## INPUT

parameter	conditions/description	min	typ	max	units
operating input voltage <sup>5</sup>	for positive output applications	6		36	Vdc
	for negative output applications	8		27	Vdc
filter	capacitor filter				
input reverse polarity protection	no				
no-load input current	positive outputs		0.3	1	mA
	negative outputs		1	4	mA

Note: 5. See Model section on page 1 for specific input voltage ranges.

## OUTPUT

parameter	conditions/description	min	typ	max	units
maximum capacitive load <sup>6</sup>	for positive output applications			680	μF
	for negative output applications			330	μF
voltage accuracy	at full load, input voltage range		±2	±4	%
	3.3 Vdc output model		±1.5	±3	%
	all other models				
line regulation	at full load, input voltage range		±0.2	±0.4	%
load regulation	at nominal input, 10~100% load		±0.4	±0.6	%
	positive output applications		±0.4	±0.8	%
	negative output applications				
switching frequency	at nominal input voltage, full load		520		kHz
transient recovery time	at nominal input voltage, 25% load step change			1	ms
transient response deviation	at nominal input voltage		±60	±200	mV
temperature coefficient	at full load			±0.03	%/°C

Note: 6. The maximum capacitive load was tested at nominal input voltage, full load.

## PROTECTIONS

parameter	conditions/description	min	typ	max	units
short circuit protection	continuous, auto recovery				

## SAFETY AND COMPLIANCE

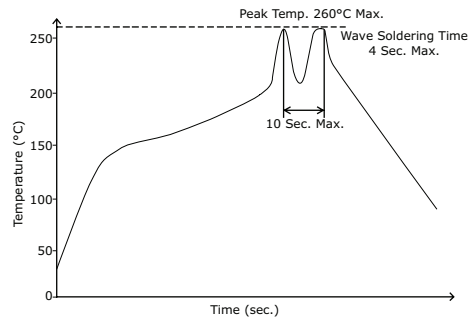
parameter	conditions/description	min	typ	max	units
safety approvals	CE				
conducted emissions	CISPR32/EN55032, class B (external circuit required, see Figure 4/5-b)				
radiated emissions	CISPR32/EN55032, class B (external circuit required, see Figure 4/5-b)				
ESD	IEC/EN61000-4-2, contact ± 4kV, class B				
radiated immunity	IEC/EN61000-4-3, 10V/m, class A				
EFT/burst	IEC/EN61000-4-4, ± 1kV, class B (external circuit required, see Figure 4/5-a)				
surge	IEC/EN61000-4-5, line-line ± 1kV, class B (external circuit required, see Figure 4/5-a)				
conducted immunity	IEC/EN61000-4-6, 3 Vr.m.s, class A				
MTBF	as per MIL-HDBK-217F, 25°C	2,000,000			hours
RoHS	yes				

## ENVIRONMENTAL

parameter	conditions/description	min	typ	max	units
operating temperature	see derating curves	-40		85	°C
storage temperature		-55		125	°C
storage humidity	non-condensing			95	%

## SOLDERABILITY

parameter	conditions/description	min	typ	max	units
wave soldering	see wave soldering profile			260	°C



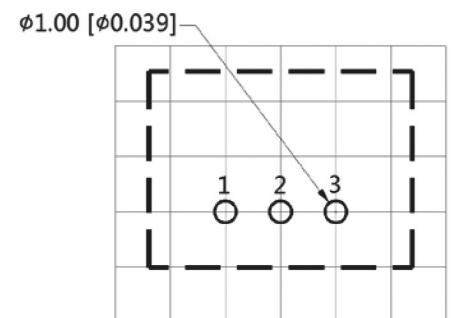
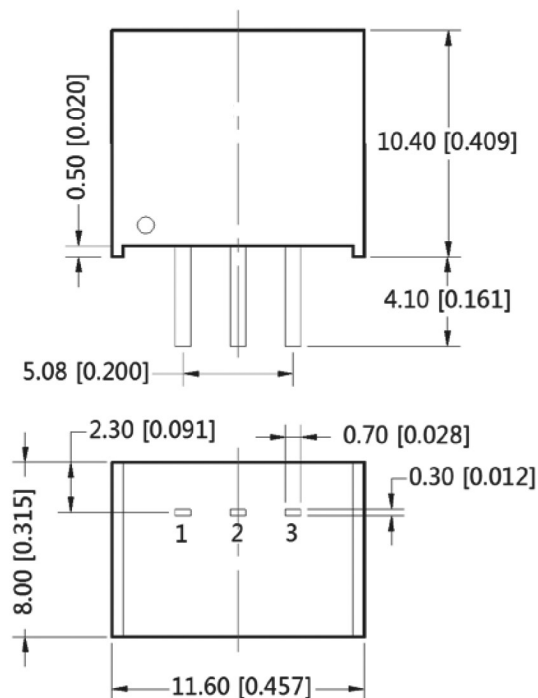
## MECHANICAL

parameter	conditions/description	min	typ	max	units
dimensions	11.6 x 8.0 x 10.40 [0.457 x 0.315 x 0.409 inch]				mm
case material	black flame-retardant and heat-resistant plastic (UL94 V-0)				
weight			1.9		g

## MECHANICAL DRAWING

units: mm [inch]  
 tolerance:  $\pm 0.50$  [ $\pm 0.020$ ]  
 pin diameter tolerance:  $\pm 0.10$  [ $\pm 0.004$ ]

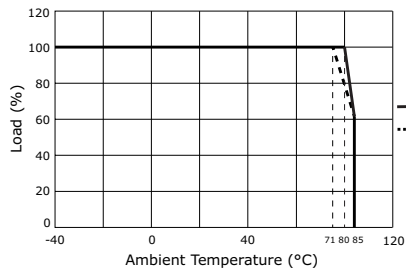
PIN CONNECTIONS		
PIN	+OUTPUT	-OUTPUT
1	+VIN	+VIN
2	GND	-VOUT
3	+VOUT	GND



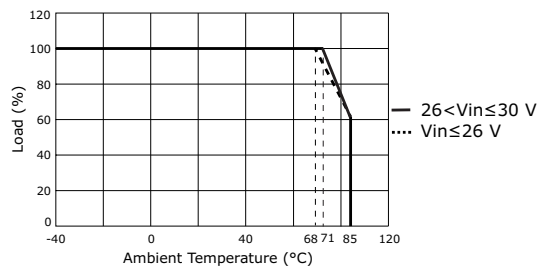
Note : Grid 2.54\*2.54mm  
 Recommended PCB Layout  
 Top View

## DERATING CURVES

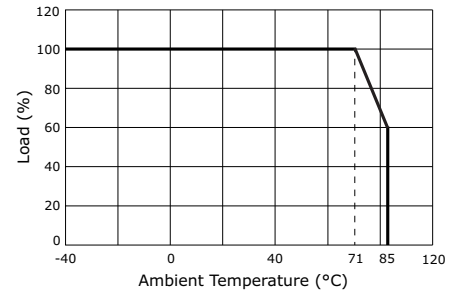
Temperature Derating Curves  
Positive 3.3, 5 Vdc Outputs  
(Natural Convection)



Temperature Derating Curves  
Positive 9, 12, 15 Vdc Outputs  
(Natural Convection)

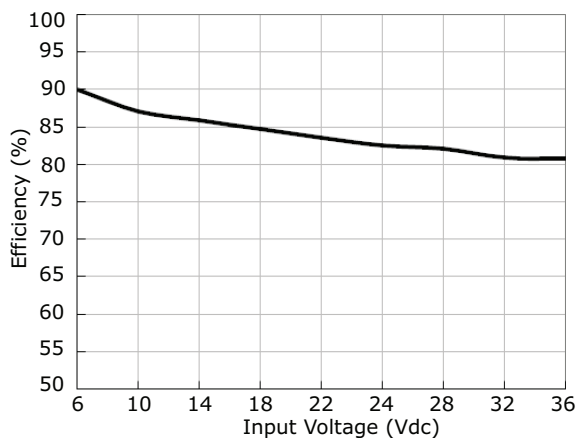


Temperature Derating Curves  
Negative Outputs  
(Natural Convection)

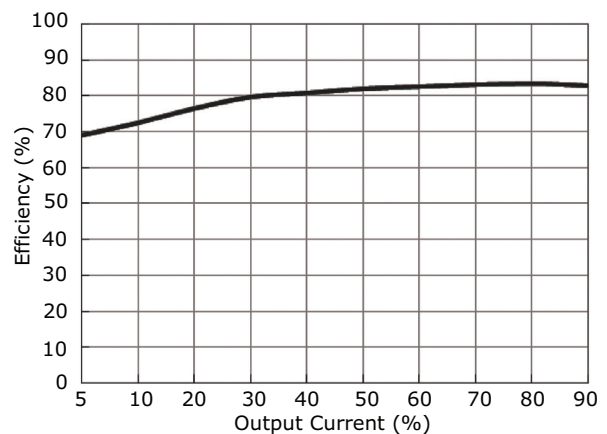


## EFFICIENCY CURVES

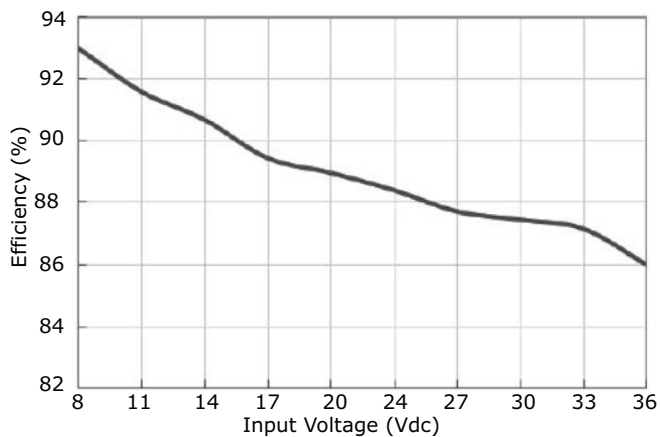
P78E03-1000 Efficiency Curve  
Positive Output, Efficiency vs. Input Voltage  
(at full load)



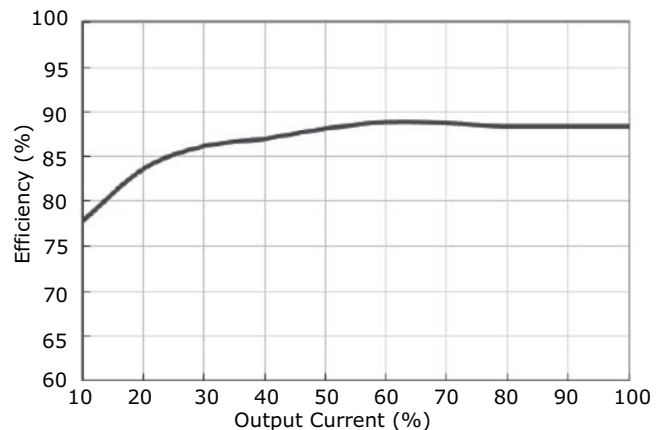
P78E03-1000 Efficiency Curve  
Positive Output, Efficiency vs. Load Current  
(at  $V_{in}$  nominal)



P78E05-1000 Efficiency Curve  
Positive Output, Efficiency vs. Input Voltage  
(at full load)

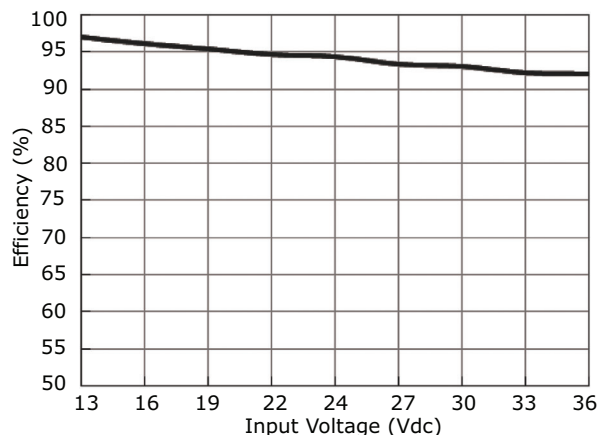


P78E05-1000 Efficiency Curve  
Positive Output, Efficiency vs. Load Current  
(at  $V_{in}$  nominal)

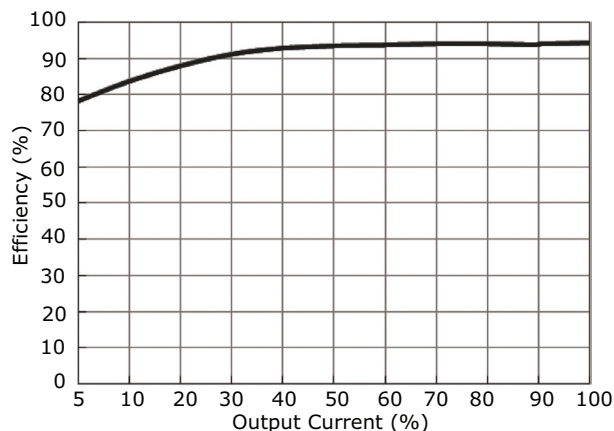


## EFFICIENCY CURVES (CONTINUED)

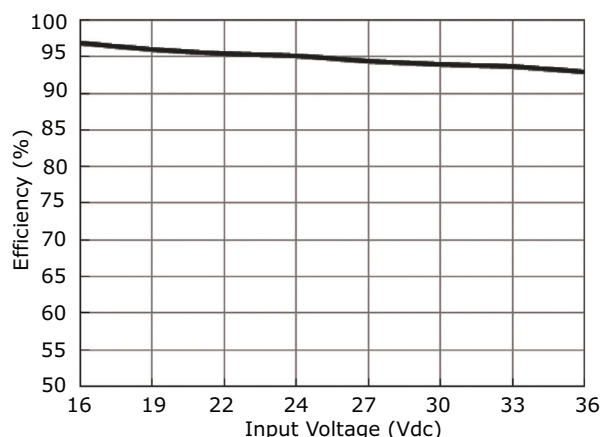
P78E09-1000 Efficiency Curve  
Positive Output, Efficiency vs. Input Voltage  
(at full load)



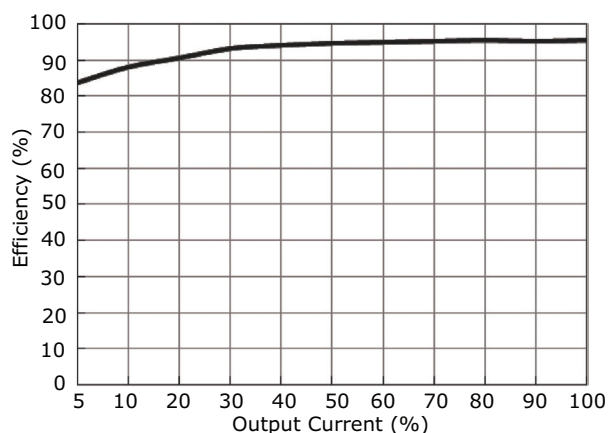
P78E09-1000 Efficiency Curve  
Positive Output, Efficiency vs. Load Current  
(at Vin nominal)



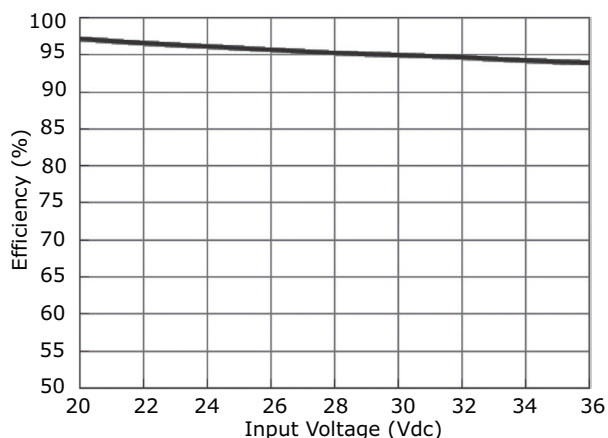
P78E12-1000 Efficiency Curve  
Positive Output, Efficiency vs. Input Voltage  
(at full load)



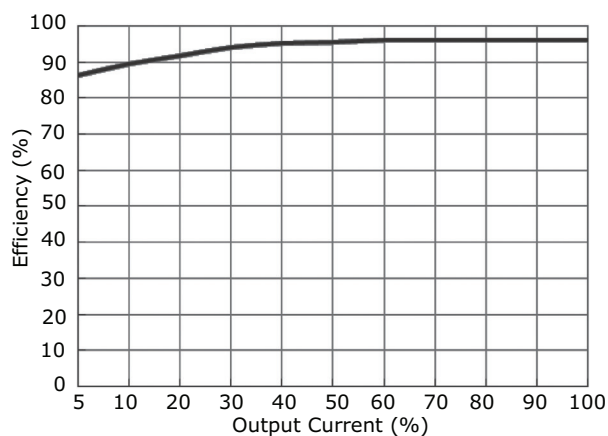
P78E12-1000 Efficiency Curve  
Positive Output, Efficiency vs. Load Current  
(at Vin nominal)



P78E15-1000 Efficiency Curve  
Positive Output, Efficiency vs. Input Voltage  
(at full load)



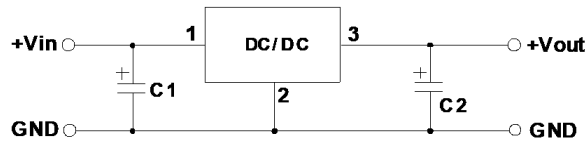
P78E15-1000 Efficiency Curve  
Positive Output, Efficiency vs. Load Current  
(at Vin nominal)



## TYPICAL APPLICATION CIRCUIT

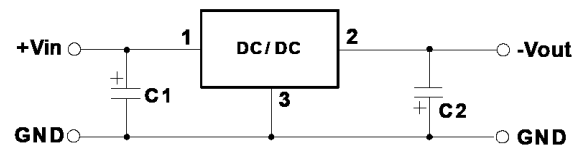
**Figure 1**

Positive Output Application Circuit



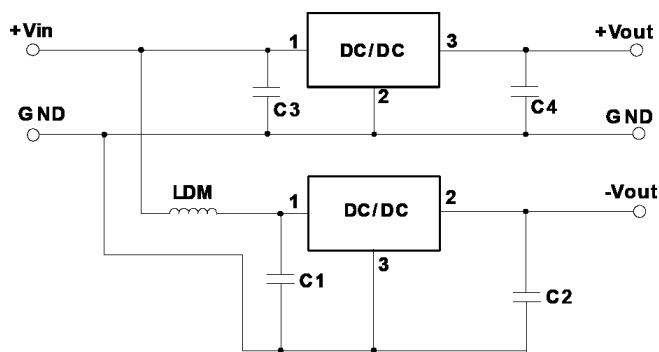
**Figure 2**

Negative Output Application Circuit



**Figure 3**

Positive and Negative Output Paralleling Application Circuit



**Table 1**

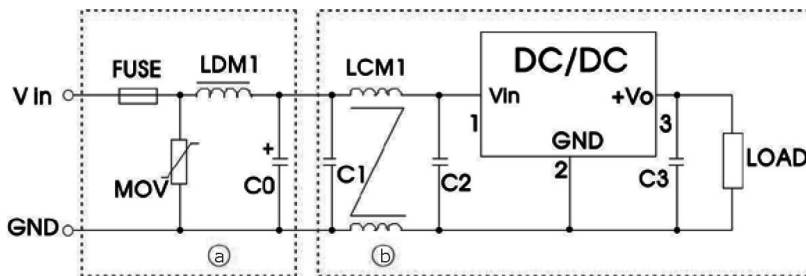
External Capacitor Table

Model Number	C1, C3 (ceramic capacitor)	C2, C4 (ceramic capacitor)
P78E03-1000	10 $\mu$ F/50 V	22 $\mu$ F/10 V
P78E05-1000	10 $\mu$ F/50 V	22 $\mu$ F/10 V
P78E09-1000	10 $\mu$ F/50 V	22 $\mu$ F/16 V
P78E12-1000	10 $\mu$ F/50 V	22 $\mu$ F/25 V
P78E15-1000	10 $\mu$ F/50 V	22 $\mu$ F/25 V

## EMC RECOMMENDED CIRCUIT

**Figure 4**

Positive output



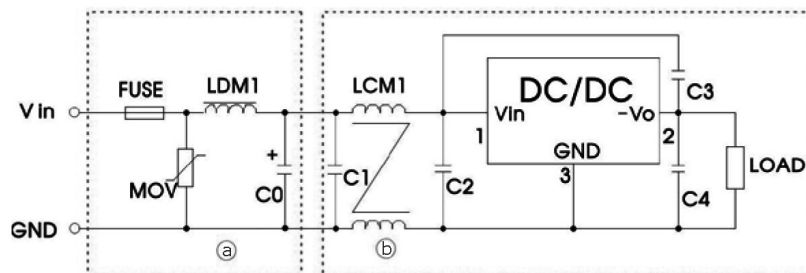
**Table 2**

Recommended external circuit components

Component	Value
FUSE	choose according to actual input current
MOV	20D470K
LDM1	82 $\mu$ H
C0	680 $\mu$ F/50 V
LCM1	4.7 mH
C1, C2	4.7 $\mu$ F/50 V
C3	10 $\mu$ F/50 V

**Figure 5**

Negative output



**Table 3**

Recommended external circuit components

Component	Value
FUSE	choose according to actual input current
MOV	20D470K
LDM1	82 $\mu$ H
C0	680 $\mu$ F/50 V
LCM1	4.7 mH
C1, C3, C4	4.7 $\mu$ F/50 V
C2	10 $\mu$ F/50 V

Note:

- C1 & C2 (C3 & C4) are required and should be connected as close to the module pins as possible.
- To reduce the output ripple further, C2 & C4 can be increased as needed and the use of tantalum or low ESR electrolytic capacitors would be recommended.
- When using application circuit in Figure 3, a 10  $\mu$ H LDM component is recommended to reduce the interference.

## PACKAGING

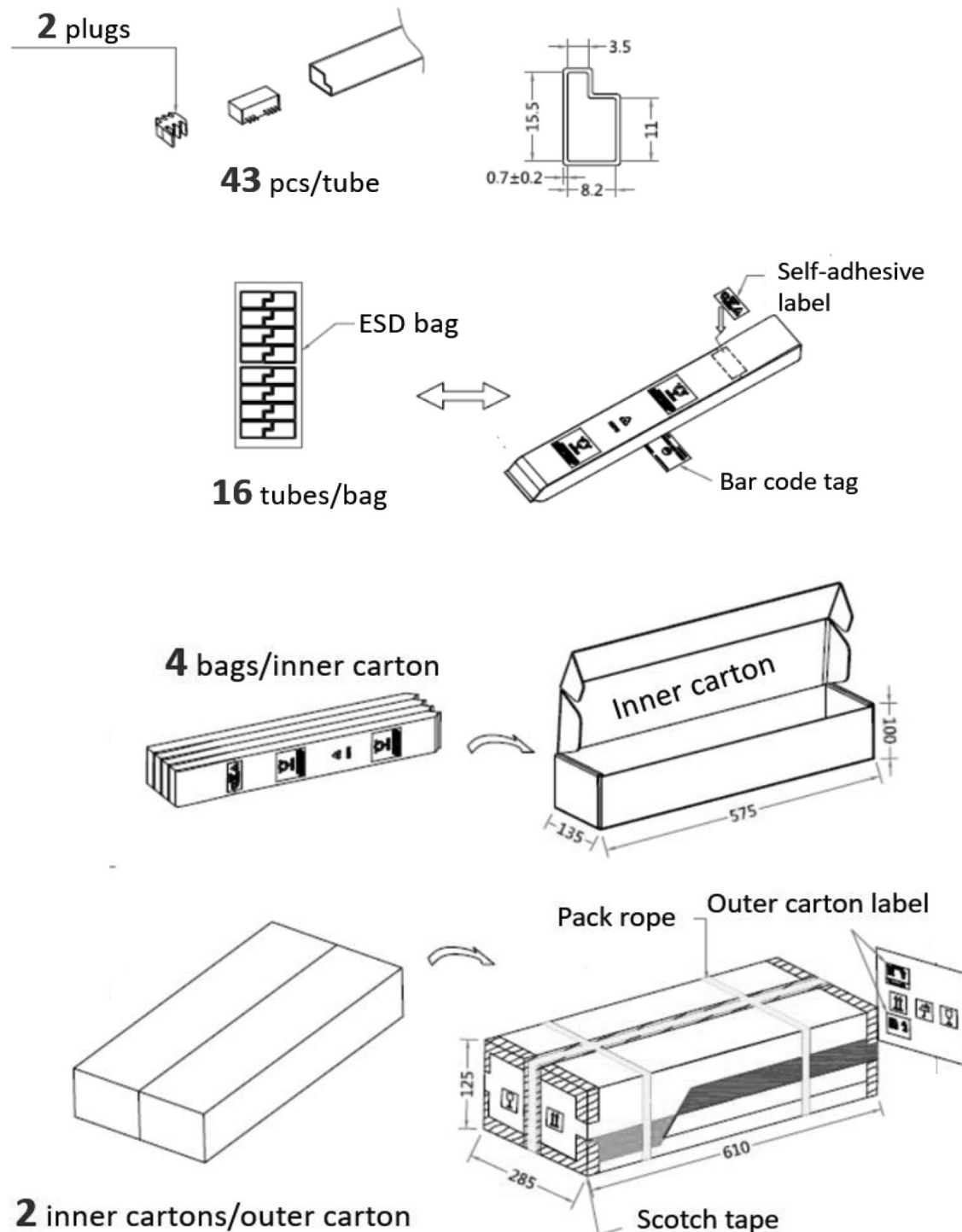
units: mm

Tube Size: 9.6 x 16.9 mm

Tube QTY: 43 pcs per tube

Carton Box Size: 285 x 125 x 610 mm

Carton Box QTY: 5,504 pcs per carton box



## REVISION HISTORY

rev.	description	date
1.0	initial release	09/12/2018

The revision history provided is for informational purposes only and is believed to be accurate.



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