350W AC-DC Power Supply with PFC
CFM351M Series
APPLICATION NOTE

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CFM351M Series

Application Note V10

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CFM351M Series

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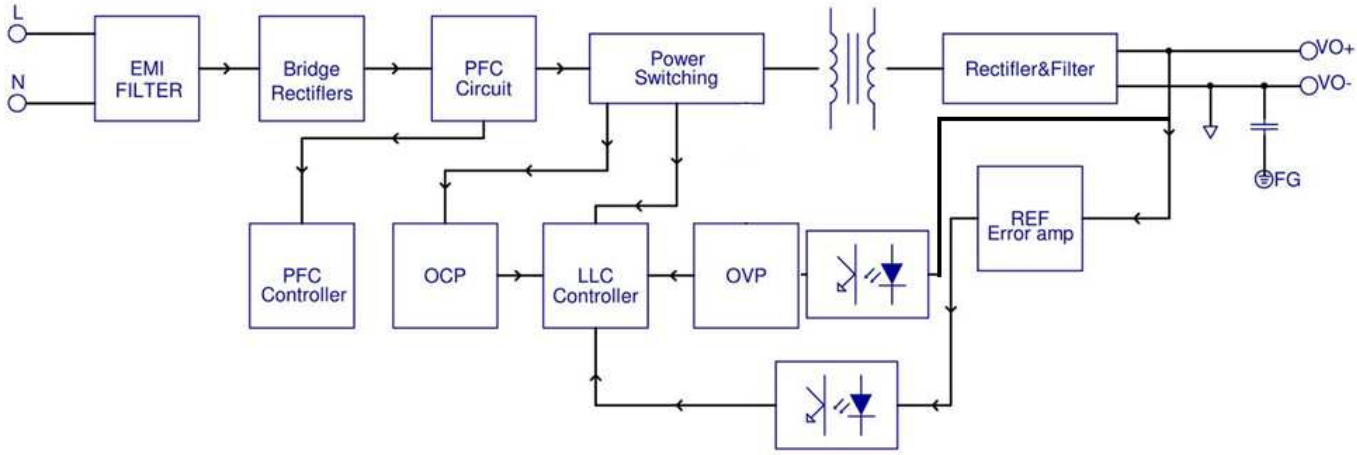
1. Introduction

This application note describes the features and functions of Cincon's CFM351M series of open frame switching AC-DC medical power module. These are highly efficient, reliable, compact, high power density AC/DC medical power modules. The module is fully protected against short circuit and over-voltage conditions. Cincon's world class automated manufacturing methods, together with an extensive testing and qualification program, ensure that the CFM351M series power module is extremely reliable.

2. CFM351M Series Features

- Universal Input Range 90 ~ 264V_{ac}
- Meets EN60601-1 and EN55011 Class B
- 350W with Free Air Convection @ 220V_{ac}
- Active PFC Meets EN61000-3-2 Class D
- High Efficiency up to 93% Typical
- Active PFC Meets EN61000-3-2
- Remote Voltage Sense
- PS On/Off Remote Control
- +5V Stand-by Output Power
- 12V Fan Output
- Meets 2MOPP

3. Electrical Block Diagram



4. Technical Specifications

(All specifications are typical at nominal input, full load at 25℃ unless otherwise noted.)

ABSOLUTE MAXIMUM RATINGS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input Voltage		All	90 120		264 370	V_{ac} V_{dc}
Operating Temperature	See Derating Curve	All	-20		+70	℃
Storage Temperature		All	-40		+85	℃

INPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Voltage Range		All	100		240	V_{ac}
Input Frequency Range		All	47		63	Hz
Maximum Input Current	100% Load, Vin=100V_{ac}	All			5	A
Leakage Current	Vin=264V_{ac},60HZ	All			300	uA
Inrush Current	Vin=230V_{ac}, cold start at 25℃	All			50	A

OUTPUT CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	Vin=Nominal Vin, Io=Io .max, Tc=25℃	CFM351M050 CFM351M120 CFM351M240 CFM351M480	4.95 11.88 23.76 47.52	5 12 24 48	5.05 12.12 24.24 48.48	V_{dc}
Operating Output Current Range		CFM351M050 CFM351M120 CFM351M240 CFM351M480			60 29.2 14.6 7.3	A
Holdup Time	Vin=115V_{ac}	All		16		ms
Output Voltage Regulation						
Load Regulation	60% load to 60%±40% load	All			±1.0	%
Line Regulation	Vin=High line to low line	All			±0.5	%
Over Current Protection		All	120	135	150	%
Over Voltage Protection		CFM351M050 CFM351M120 CFM351M240 CFM351M480		6.2 15 30 56		V_{dc}
Output Ripple and Noise	1. Add a 0.1uF ceramic capacitor and a 47uF aluminum electrolytic capacitor to output. 2. Oscilloscope is 20MHz band width. 3. Ambient temperature=25℃	CFM351M050 CFM351M120 CFM351M240 CFM351M480			100 120 150 150	mVp-p
Load Capacitance	1. V_{in}=115V_{ac} and 230V_{ac} 2. Output is 100% full load 3. Ambient temperature=25℃	CFM351M050 CFM351M120 CFM351M240 CFM351M480			60000 30000 14560 3600	uF

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Efficiency	1. V_{in}=230V_{ac} 2. Output is 100% full load 3. Ambient temperature=25℃	CFM351M050 CFM351M120 CFM351M240 CFM351M480		88 92 93 93		%

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Input to Output	1 Minute	All			5656	V_{dc}
Input to Earth (Ground)	1 Minute	All			2121	V_{dc}
Output to Earth (Ground)	1 Minute	All			710	V_{dc}
Isolation Resistance		All	100			MΩ

FEATURE CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Switching Frequency	Pout=max. rated power	All		55		kHz
Output Voltage Adjustment	Pout=max. rated power	All	-5		+5	%

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	Io=100%; Ta=25℃ per MIL-HDBK-217F	All	100			k hours
Weight		All		640		g
Safety	Class I, ANSI/AAMI ES60601-1, EN/IEC 60601-1					
EMC Emission	EN55011 Class B, FCC CFR 47 Part 15, IEC 61000-3-2:2014, IEC 61000-3-3:2013					
Conducted Disturbance	EN55011, FCC CFR 47 Part 15 Class B					
Radiated Disturbance	EN55011, FCC CFR 47 Part 15 Class B					
Harmonic Current Emissions	IEC 61000-3-2:2014					
Voltage Fluctuations & Flicker	IEC 61000-3-3:2013					
EMC Immunity	EN60601-1-2:2015, IEC61000-4-2, 3, 4, 5, 6, 8, 11					Ed 4.0
Electrostatic Discharge (ESD)	IEC 61000-4-2:2008					
Radio-Frequency, Continuous Radiated Disturbance	IEC 61000-4-3:2010					
Electrical Fast Transient (EFT)	IEC 61000-4-4:2012					
Surge	IEC 61000-4-5:2014					
Conducted Disturbances, Induced by RF Fields	IEC 61000-4-6:2013					
Power Frequency Magnetic Field	IEC 61000-4-8:2009					
Voltage Dips	IEC 61000-4-11:2004					
Voltage Interruptions	IEC 61000-4-11:2004					

5. Main Features and Functions

5.1 Operating Temperature Range

The highly efficient design of Cincon's CFM351M series power modules has resulted in their ability to operate within ambient temperature environments from -200℃ to 700℃. Due consideration must be given to the de-rating curves when ascertaining the maximum power that can be drawn from the module. The maximum power which can be drawn is influenced by a number of factors, such as:

- Input voltage range
- Permissible output load (per derating curve)
- With 10CFM air flow

5.2 Over Voltage Protection

All different voltage models have a full continuous over voltage protection. The power module will supply up to 125% of rated voltage. In the event of an over voltage converter will shut down. In order to resume operation, the AC input voltage should be removed

5.3 Over Current Protection

The power modules provide full continuous short-circuit protection. The unit will auto recover once the short circuit is removed. To provide protection in a fault condition, the unit is equipped with internal over-current protection. The unit will operate normally once the fault condition is removed. The power module will go to hiccup mode if the output current is set from 120% to 150% of rated current.

6. EMC & Safety

■ Emission and Immunity

EN60601-1-2:2015 ed. 4.0, EN55011 Class B

FCC Part15 Class B

IEC61000-3-2, 3, IEC61000-4-2, 3, 4, 5, 6, 8, 11

■ Safety

IEC60601-1:2005+A1

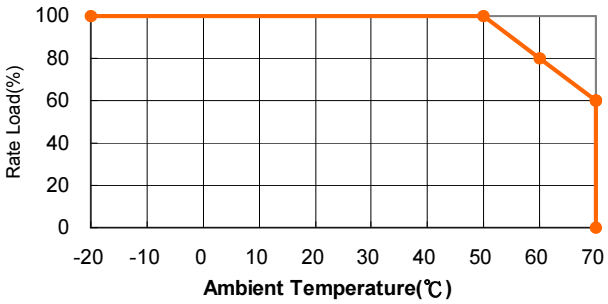
EN60601-1:2006+A11:2011+A1+A12,

UL ANSI/AAMI ES60601-1:2005

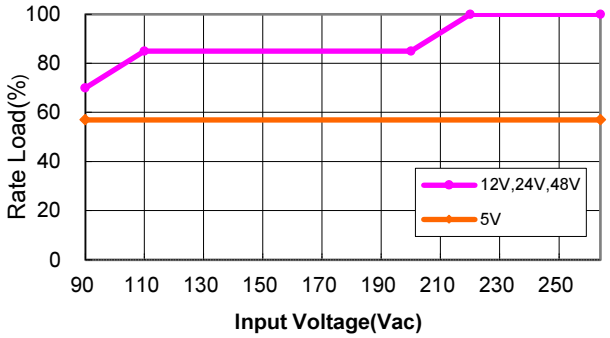
7. Applications

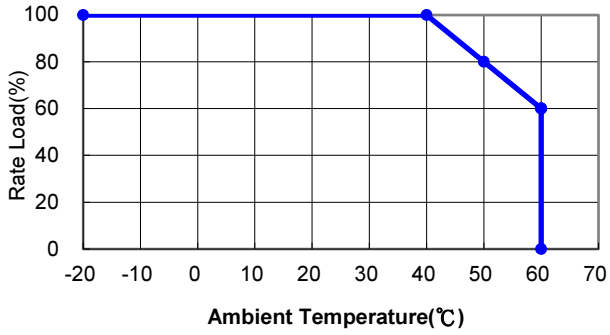
7.1 Power De-Rating Curve

350 with 10CFM Air Flow



350W With Natural Convection





7.2 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure 1. When testing the Cincon's CFM351M series under any transient conditions, please ensure that the transient response of the source is sufficient to power the equipment under test. We can calculate the

- Efficiency
- Load regulation and line regulation

The value of efficiency is defined as:

$$\eta = \frac{Vo \times Io}{Pin} \times 100\%$$

Where:

Vo is output voltage

Io is output current

Pin is input power

The value of load regulation is defined as:

$$Load\ reg. = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where:

V_{FL} is the output voltage at 60% load

V_{NL} is the output voltage at 60%±40% load

The value of line regulation is defined as:

$$Line\ reg. = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where:

V_{HL} is the output voltage of maximum input voltage at full load.

V_{LL} is the output voltage of minimum input voltage at full load.

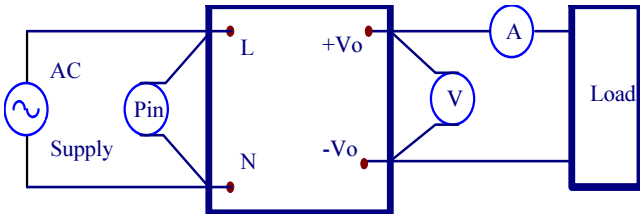


Figure 1. CFM351M Series Test Setup

7.3 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 2. Measured method:

Add a C2=0.1uF ceramic capacitor and a C1=47uF electrolytic capacitor to output at 20 MHz Band Width.

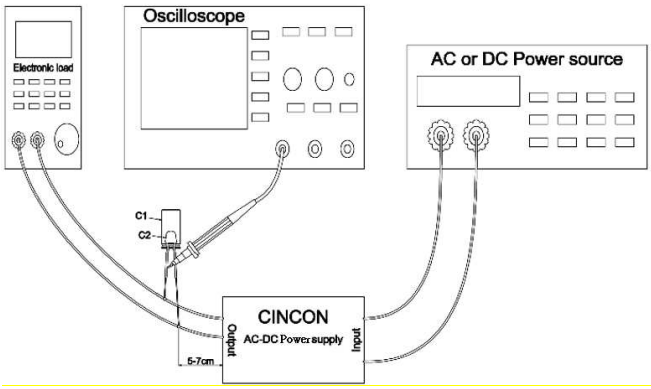
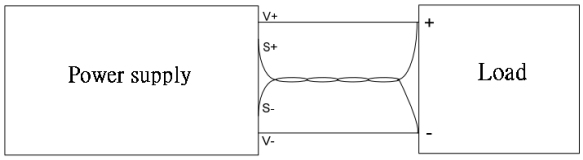


Figure 2. Output Voltage Ripple and Noise Measurement Set-Up

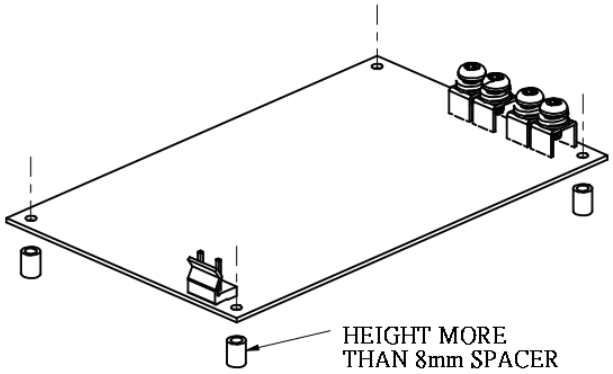
7.4 Remote Sense

The CFM351M series has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the CFM351 series. Sense+&- can not be reversed

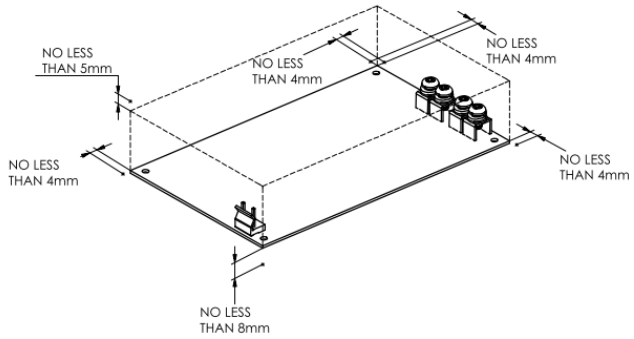


7.5 Installation Instruction

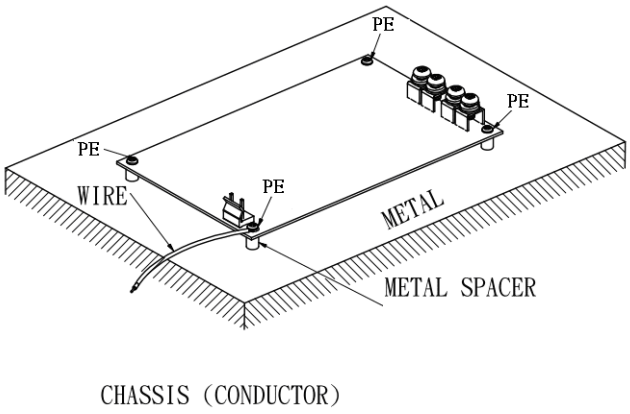
The CFM351M series has four 3.5mm diameter mounting holes. Please use the mounting holes as follows:
Insert the spacer (6mm diameter max.) of 8mm height or more to mount the unit. The vibration specification applies when the unit is mounted on 8mm spacers



Please allow 4mm side clearance from the components and all side of the PCB. Allow 5mm clearance above the highest parts on the PCB. Be especially careful to allow 8mm between the solder side of the PCB and the mounting surface. If the clearances are not sufficient, the specifications for isolation and withstand will not be valid.

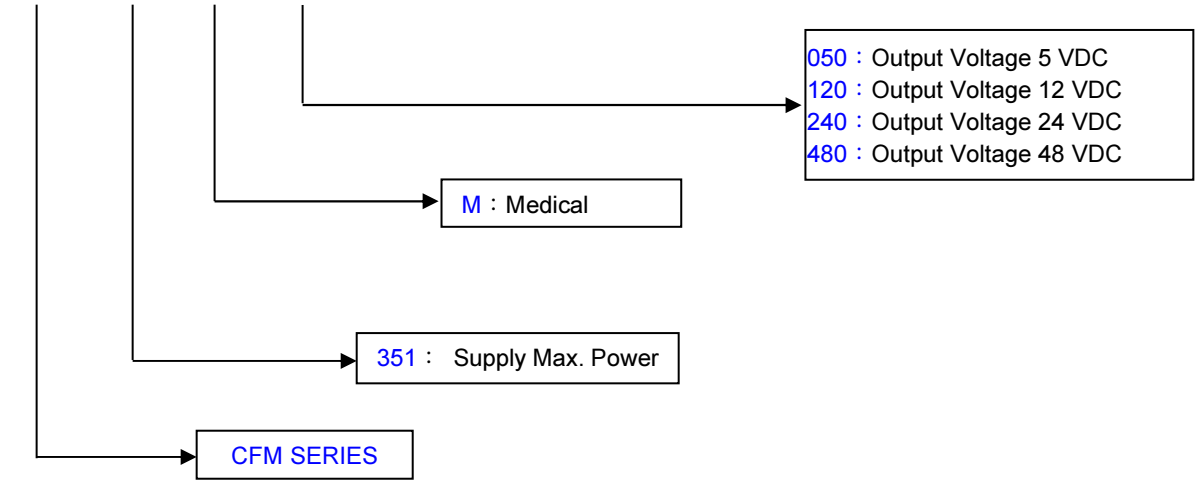


PE should be connected to the earth (ground) terminal of the apparatus. If not, the conducted noise and output noise will increase.



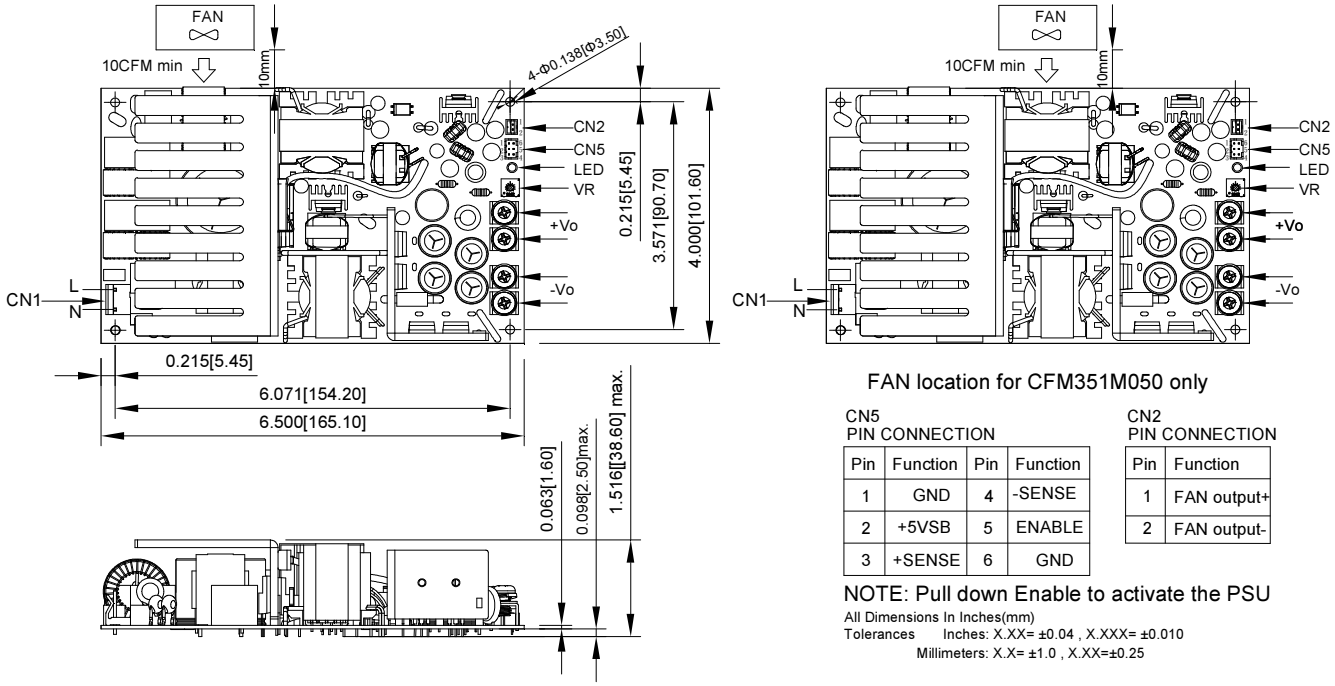
8. Part Number

CFM 351 M XXX



9. Mechanical Outline Diagrams and Packing Information

9.1 Mechanical Outline Diagrams



CN5
PIN CONNECTION

Pin	Function	Pin	Function
1	GND	4	-SENSE
2	+5VSB	5	ENABLE
3	+SENSE	6	GND

CN2
PIN CONNECTION

Pin	Function
1	FAN output+
2	FAN output-

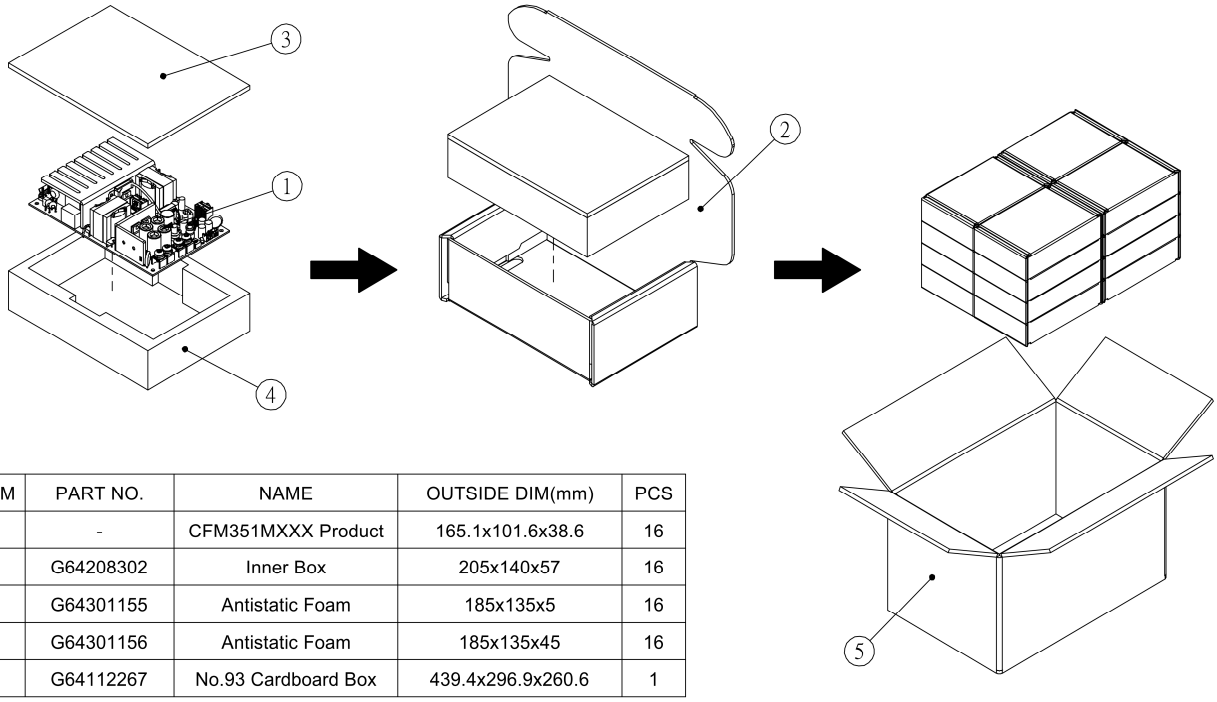
NOTE: Pull down Enable to activate the PSU

All Dimensions In Inches(mm)
Tolerances Inches: X.XX= ±0.04 , X.XXX= ±0.010
Millimeters: X.X= ±1.0 , X.XX=±0.25

Figure 3. CFM351M series Mechanical Outline Diagram

9.2 Packing Information

The packing information for CFM351M SERIES is showing as follows:



ITEM	PART NO.	NAME	OUTSIDE DIM(mm)	PCS
1	-	CFM351MXXX Product	165.1x101.6x38.6	16
2	G64208302	Inner Box	205x140x57	16
3	G64301155	Antistatic Foam	185x135x5	16
4	G64301156	Antistatic Foam	185x135x45	16
5	G64112267	No.93 Cardboard Box	439.4x296.9x260.6	1

Each Box Packaging 16 PCS Products
Gross weight Ref. 12 Kg

CFM351M 16Pcs a box, including the total weight of package material about 12Kg

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