FM05D200P
FM05D200P DC FILTER MODULE

Approved By:

Department	Approved By	Checked By	Written By
Research and Development Department	Enoch	Astray Jacky	Astray
Quality Assurance Department	Ryan	Benny	

Content

FM05D200P DC FILTER MODULE

Application Note V10 November 2019

1. Introduction

FM05D200P filter module is created to accommodate the need to meet Railway standards of EN55015 standard, and Fire & Smoke EN45545-2. This standard filter simplifies the process of meeting the necessary requirements for Railway applications. The filter module is designed to reduce common mode and differential mode noise of the DC converter. The FM05D200P filter module offers maximum current rating of 5A and maximum rated voltage up to 200V.

It has industry Quarter-Brick size and pinouts. Allowing case operating temperature range of –40°C to 110°C. An optional heat sink is available to extend the full power range of the unit. The filter module provides excellent thermal performance. FM05D200P is designed primarily for common railway applications and also suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. Features

* Quarter-Brick Size Meet Industrial Standard
* PCB Mount
* 5A Filter Module
* 200VDC Input Voltage Maximum
* All Capacitors are Multi-Layer Ceramic Inside
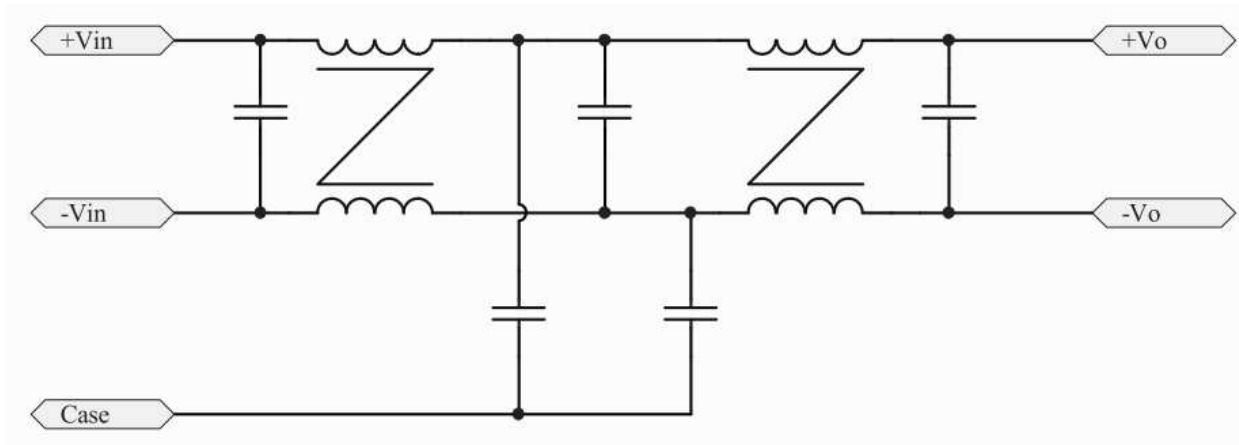* Fire & Smoke Meets EN45545-2

3. Electrical Circuit Diagram

Figure1 Internal Schematic for FM05D200P Module

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						
Continuous		All			200	V_{dc}
Transient	1 second	All			250	V_{dc}
Operating Temperature	see derating curve	All	-40		+110	℃
Storage Temperature		All	-55		+125	℃

ELECTRICAL CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Operating Voltage Range		All	0		200	V_{dc}
Operating Current Range		All	0		5	A
Input Surge Voltage	1 second	All			250	V_{dc}
DC Resistance	+Input to +Output.	All		34	38	mΩ
	-Input to –Output	All		34	38	mΩ

ISOLATION CHARACTERISTICS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Isolation Voltage	1 minute; input to case, output to case	All			2250	V_{dc}
					1500	V_{ac}
Isolation Resistance	500Vdc, input to case, output to case	All	100			MΩ
Isolation Capacitance	input to case, output to case	All		4000		pF

GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
Weight		All		59		grams
Case Material	Plastic, DAP					
Base plate Material	Aluminum					
Potting Material	UL 94V-0					
Shock/Vibration	Meets EN50155 (EN61373)					
Humidity	95% RH max. Non Condensing					
Thermal Shock	Meets MIL-STD-810F					
Fire & Smoke	Meets EN45545-2					

5. Main Features and Functions
5.1 Operating Temperature Range
The FM05D200P filter module has resulted in their ability to operate within ambient temperature environments from -40℃ to 110℃. The derating curve was drawn from the FM05D200P module.

- Output load current
- Forced air or natural convection
- Heat sink optional

5.2 Insertion Loss
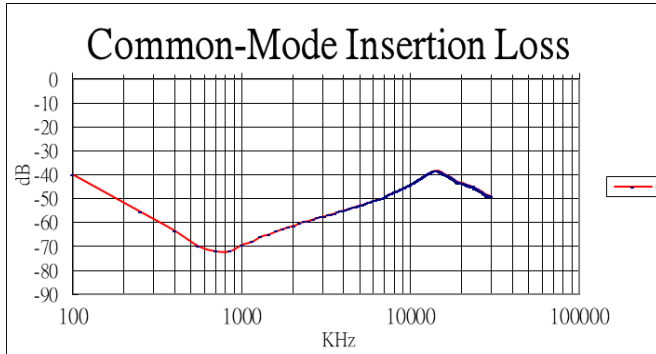The filter module is designed to reduce common mode and differential mode noise of the DC converter. The typical characteristics see below.

Figure 2. Typical Common-Mode Insertion Loss
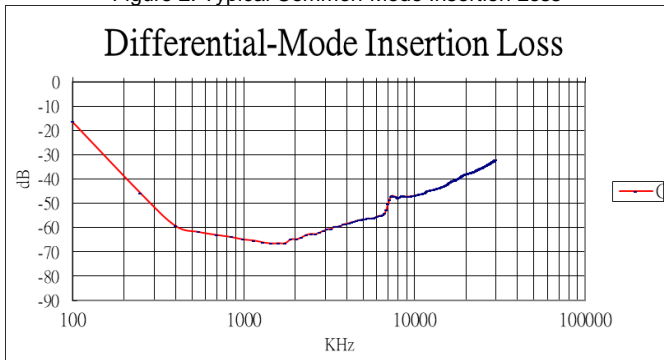
Figure 3. Typical Differential-Mode Insertion Loss

6. Applications
6.1 Recommend Layout, PCB Footprint and Soldering Information
The system designer or end user must ensure that metal and other components in the vicinity of the module meet the spacing requirements for which the system is approved. Low resistance and inductance PCB layout traces are the norm and should be used where possible. Due consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended soldering profile and PCB layout are shown below.

Lead Free Wave Soldering Profile
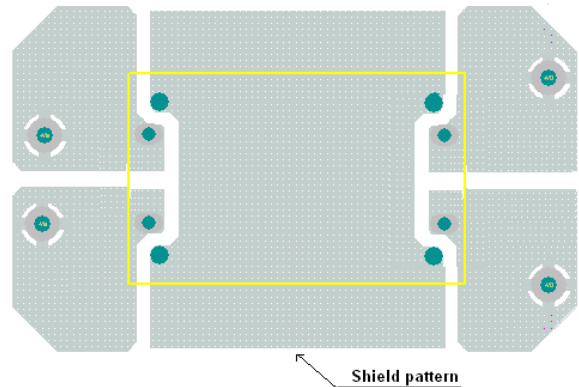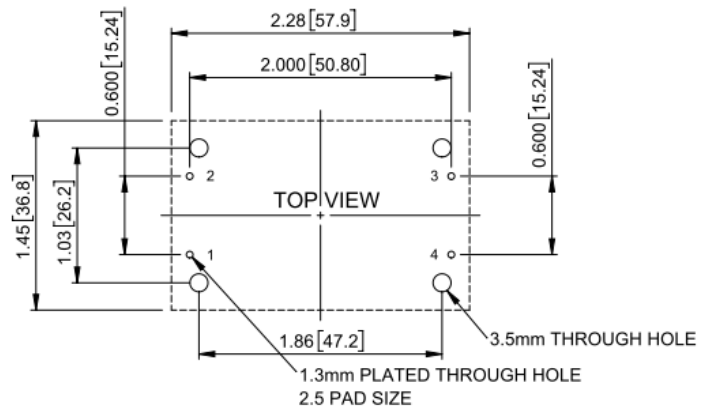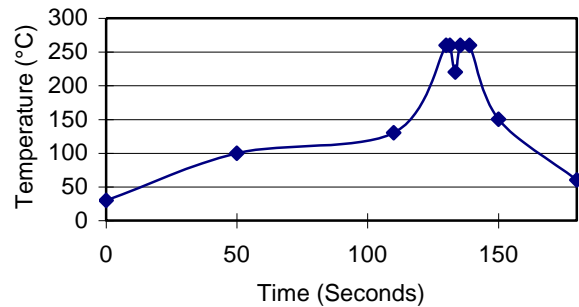
6.2 Thermal Considerations
The module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The example is presented in **section 6.3**. The current output of the module should not be allowed to exceed rated current.

6.3 Power Derating

The operating case temperature range of FM05D200P is -40°C to +110°C. When operating the FM05D200P, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed 110°C.

The following curve is the de-rating curve of FM05D200P without heat sink.

Power Dissipated vs Ambient Temperature and Air Flow without heatsink
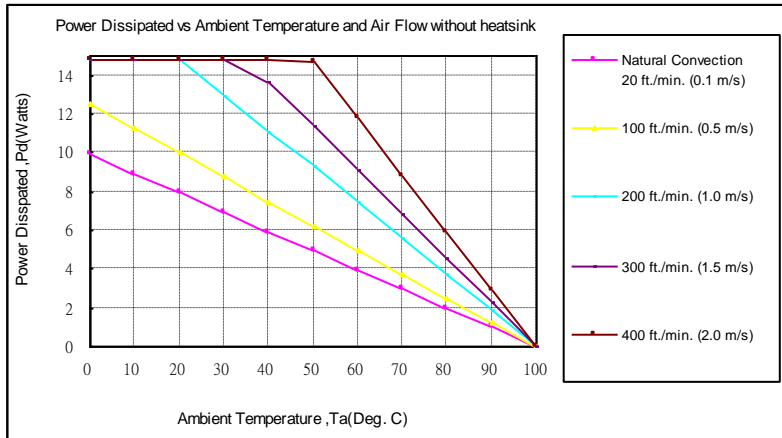
AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	10.1 ℃/W
100 ft./min. (0.5m/s)	8.0 ℃/W
200 ft./min. (1.0m/s)	5.4 ℃/W
300 ft./min. (1.5m/s)	4.4 ℃/W
400 ft./min. (2.0m/s)	3.4 ℃/W

Example:

What is the minimum airflow necessary for a FM05D200P operating at output current of 5A, and a maximum ambient temperature of 80°C?

Solution:

Given:

I_o=5A

Determine Power dissipation (P_d):

$P_d = I_o \times I_o \times DCR$

P_d =5A×5A×(34mΩ+34mΩ)=1.7Watts

Determine airflow:

Given: P_d =1.7W and T_a=80°C

Check *Power Derating* curve:

Minimum airflow= 20 ft./min.

Verify:

Maximum temperature rise is

$\Delta T = Pd \times Rca$=1.7W×10.1=17.17°C

Maximum case temperature is

Tc=Ta+ΔT=97.17°C<110°C

Where:

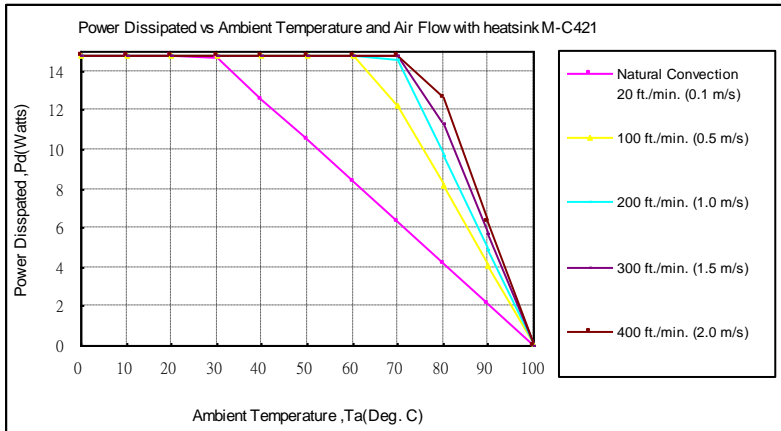The Rca is thermal resistance from case to ambient environment.

Ta is ambient temperature and Tc is case temperature.

Power Dissipated vs Ambient Temperature and Air Flow with heatsink M-C421

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	4.78 ℃/W
100 ft./min. (0.5m/s)	2.44 ℃/W
200 ft./min. (1.0m/s)	2.06 ℃/W
300 ft./min. (1.5m/s)	1.76 ℃/W
400 ft./min. (2.0m/s)	1.58 ℃/W

Example with heat sink QBT210 (M-C421):

What is the minimum airflow necessary for a FM05D200P operating at output current of 5A, and a maximum ambient temperature of 100℃?

Solution:

Given:

Io=5A

Determine Power dissipation (P_d):

$P_d = I_o \times I_o \times DCR$

P_d =5A$\times$5A$\times$(34mΩ+34mΩ)=1.7Watts

Determine airflow:

Given: Pd=1.7W and Ta=100℃

Check above Power de-rating curve:

Minimum airflow= 100 ft./min

Verify:

Maximum temperature rise is△T = P_d × R_{ca}=1.7$\times$2.44=4.15℃

Maximum case temperature is Tc=Ta+△T=104.15℃<110℃

Where:

The Rca is thermal resistance from case to ambient environment.

Ta is ambient temperature and Tc is case temperature.

6.4 Quarter Brick Heat Sinks:
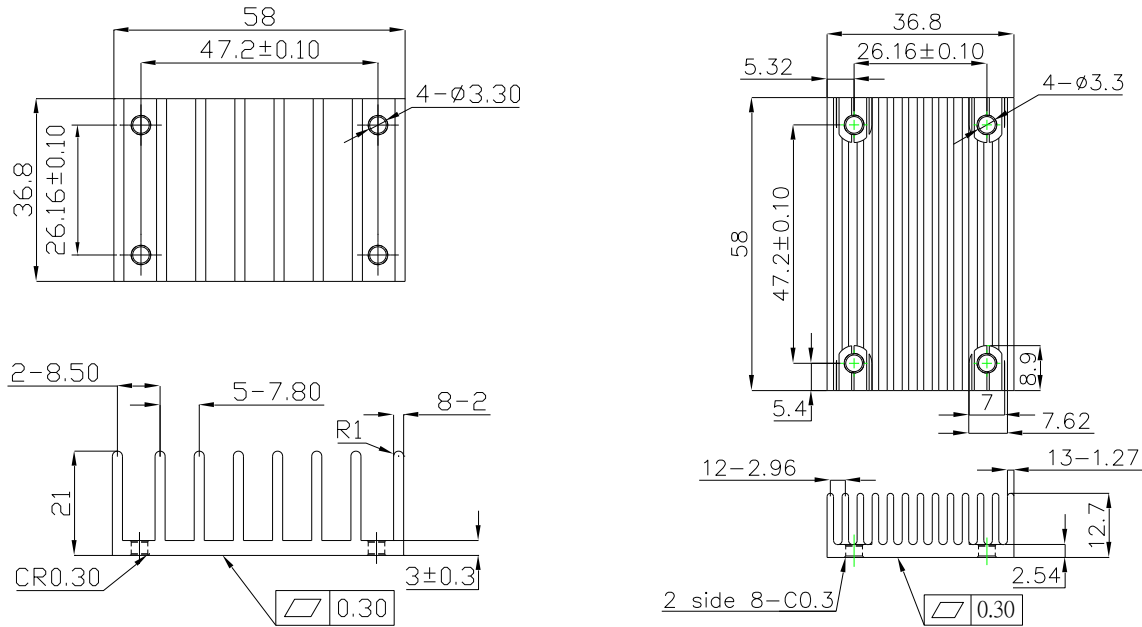
All Dimensions in mm

QBT210 (M-C421): G6620510201
Transverse Heat Sink

Rca: 4.78°C/W (typ.), At natural convection
    2.44°C/W (typ.), At 100LFM
    2.06°C/W (typ.), At 200LFM
    1.76°C/W (typ.), At 300LFM
    1.58°C/W (typ.), At 400LFM

QBL127 (M-C448): G6620570202
Longitudinal Heat Sink

Rca: 5.61°C/W (typ.), At natural convection
    4.01°C/W (typ.), At 100LFM
    3.39°C/W (typ.), At 200LFM
    2.86°C/W (typ.), At 300LFM
    2.49°C/W (typ.), At 400LFM
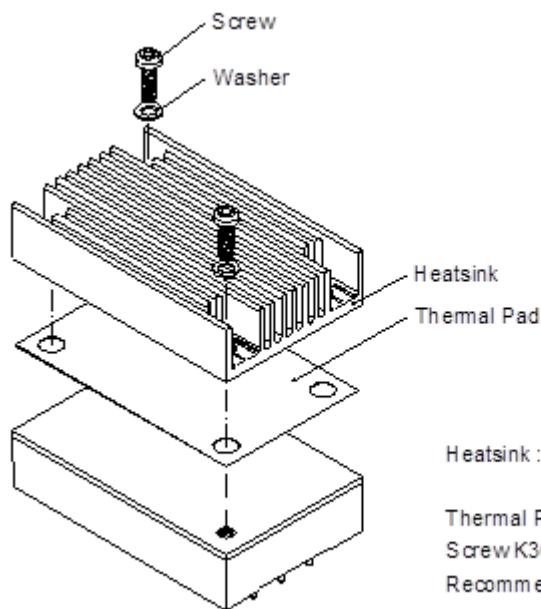
Heatsink : QBL127 (M-C448)
             QBT210 (M-C421)
Thermal Pad PQ01: SZ35.8x56.9x0.25mm
Screw K308W: SMP+SW M3x8L
Recommended torque 3 Kgf-cm

Figure 4 Installation Drawing

7. Connection for Standard Use

7.1 Recommended Schematic

EMI performance is affected by a variety of external factors, such as PCB construction, circuit layout, and more. Therefore, in some applications, components other than filters may be required to fully comply with the specified standards. For railway application, the FM30R080P output filter is required for output conducted noise to meet EN50155 : EN50121-3-2:2015.

FM05D200P have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a 7A time delay fuse for all models.
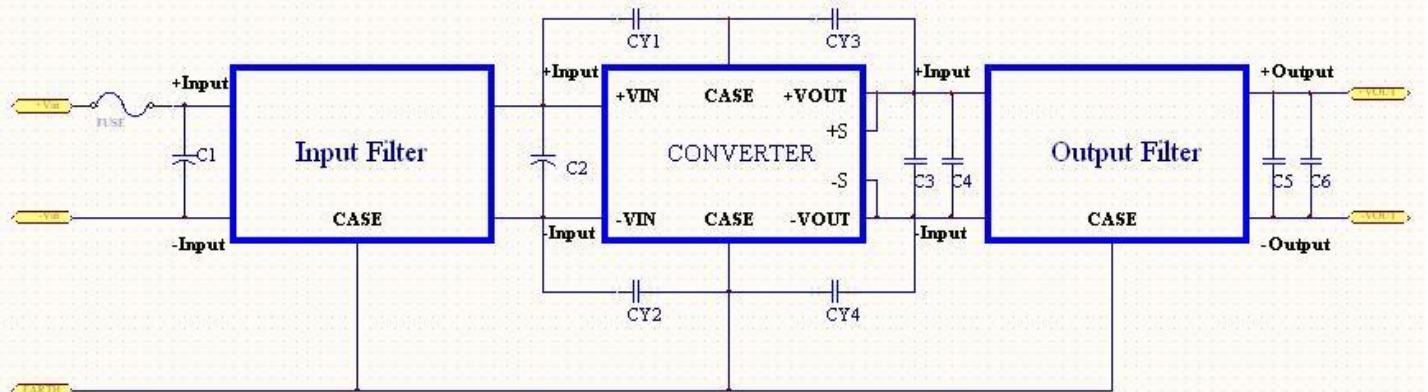
Note:
CY1-CY4 Select the voltage rating to meet input-to-output isolation requirements.
C2 should be the recommended value indicated in the power module datasheet.
Note:
If the impedance of input line is high, Input capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

7.2 EMC Considerations

EMI Test standard: EN55032/EN55022/EN50121-3-2 Class A Conducted Emission
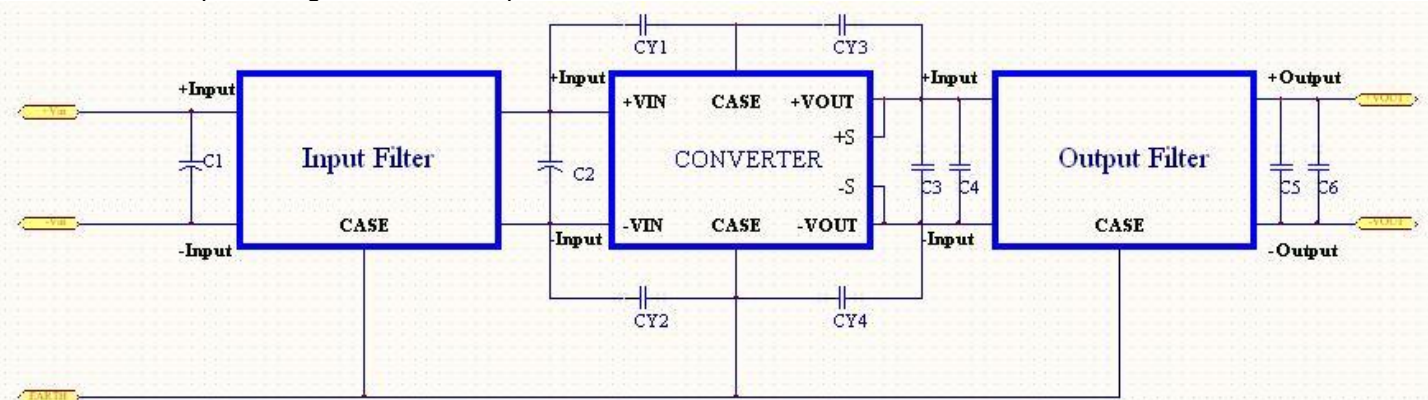Test Condition: Input Voltage: Nominal, Output Load: Full Load

Figure1 Connection circuit for conducted EMI Class A testing

Input Filter Module	DC-DC Converter Model No.	Output Filter Module	C1	C2	C3	C4	CY1	CY2	CY3	CY4
FM05D200P	CQB150W-110S3V3 CQB150W-110S05 CQB150W-110S15 CQB150W-110S48 CQB100W-110S05 CQB100W-110S15 CQB100W-110S48	FM30R080P	220uF	220uF	10uF	1uF	2200pF	2200pF	1000pF	1000pF
	CQB150W-110S12 CQB150W-110S24 CQB150W-110S28 CQB100W-110S12 CQB100W-110S24 CQB100W-110S28						1500pF	1500pF	680pF	680pF

Note: C1, C2 are CHEMICON 220uF/200V KXJ series aluminum capacitors,
    C3, C4 are ceramic capacitor
    C5, C6 are NC.
    CY1, CY2, CY3, CY4 are TDK Y1 capacitors or equivalent.
    Bead Core SN030 T2.8*1.7*1.2 SM For CY1,CY2.
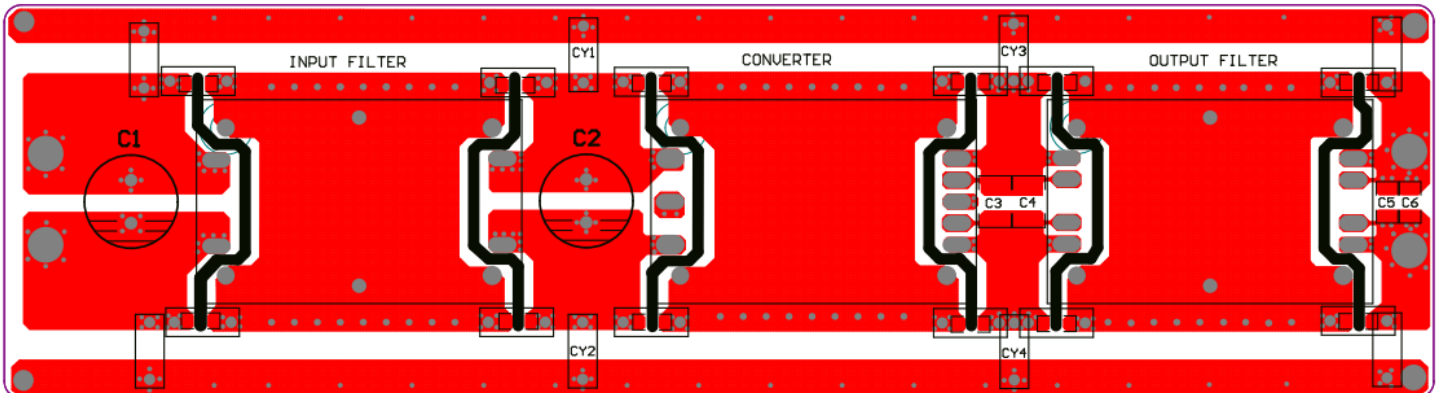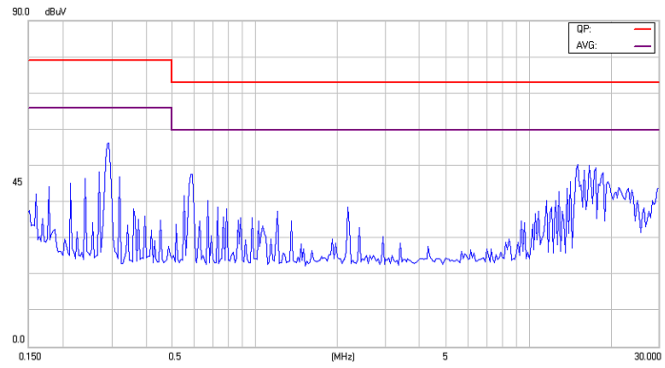

EMI test board top side
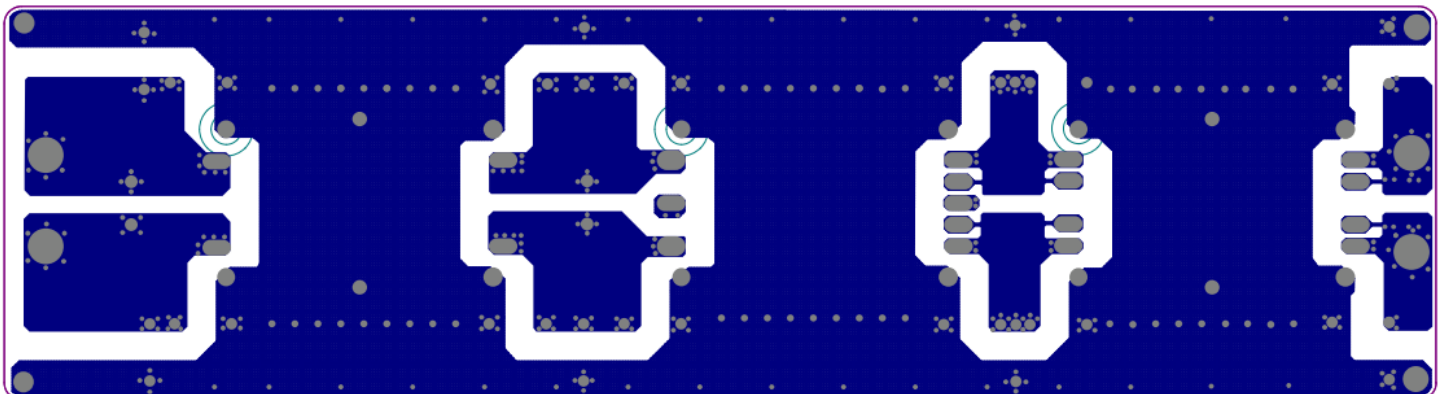
EMI test board bottom side

(1) EMI input conducted noise to meet EN55011/EN55032/EN50155 :
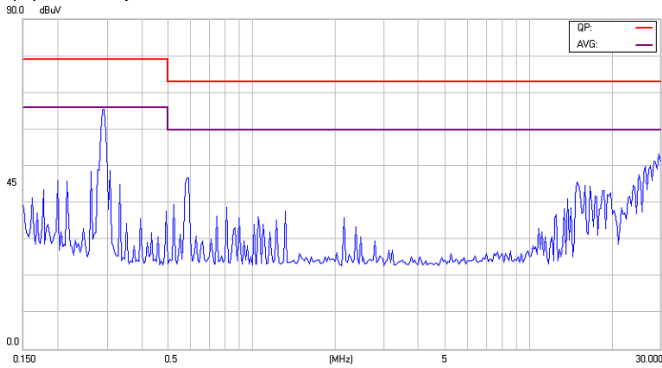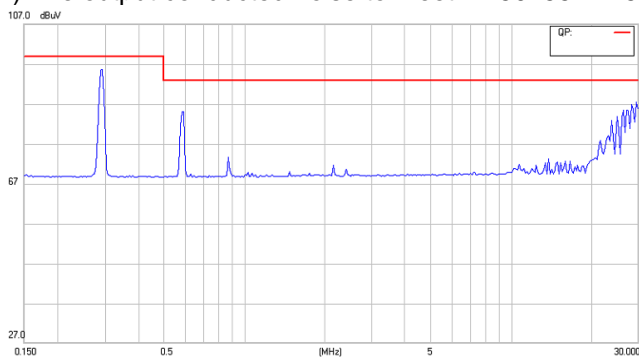
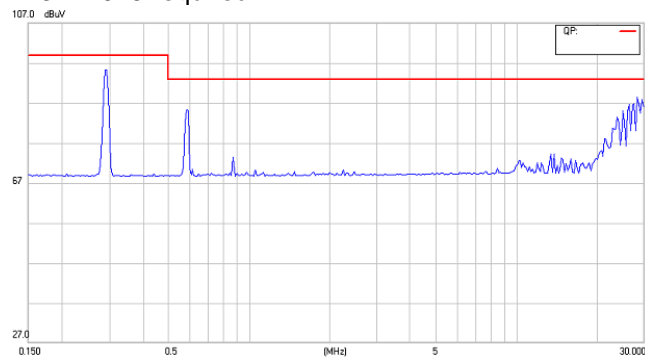

Conducted EN55032 Class A of CQB150W-110S24
Line

Conducted EN55032 Class A of CQB150W-110S24
Nature

(2) The output conducted noise to meet EN50155: EN50121-3-2:2015 required:
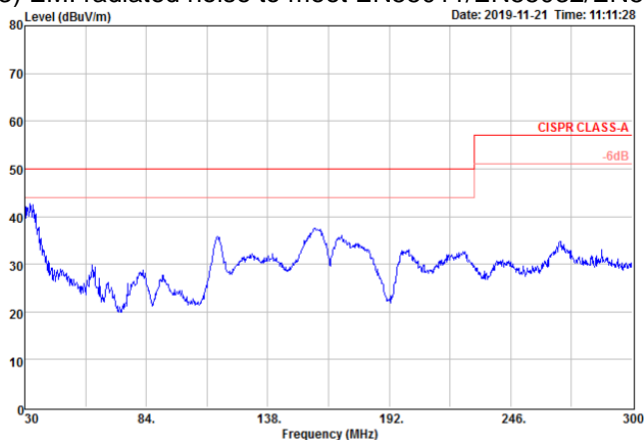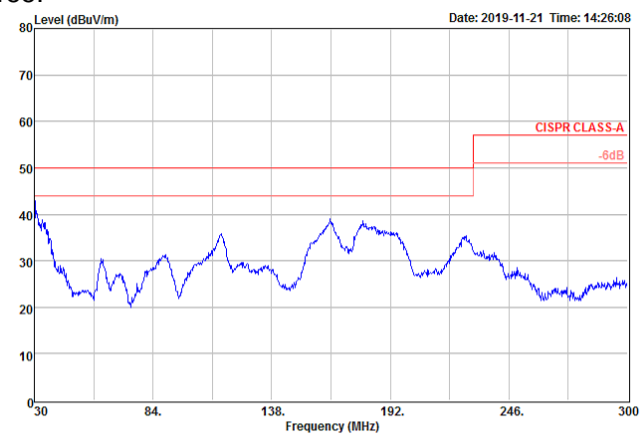

CQB150W-110S24 Positive

CQB150W-110S24 Negative

(3) EMI radiated noise to meet EN55011/EN55032/EN50155:

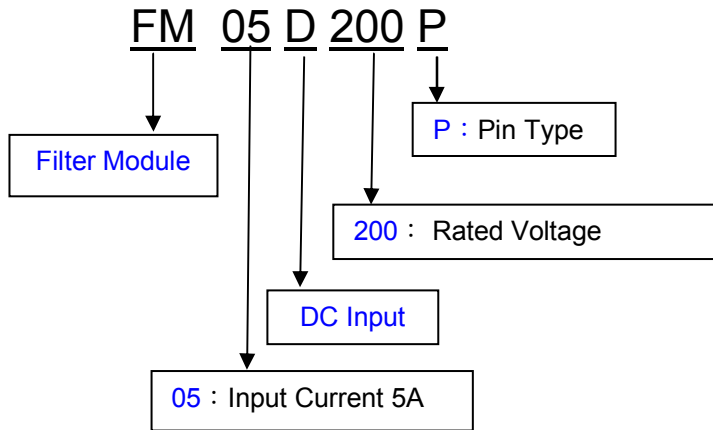Radiated EN55032 Class A of CQB150W-110S24
Vertical

Radiated EN55032 Class A of CQB150W-110S24
Horizontal

8. Part Number

FM 05 D 200 P

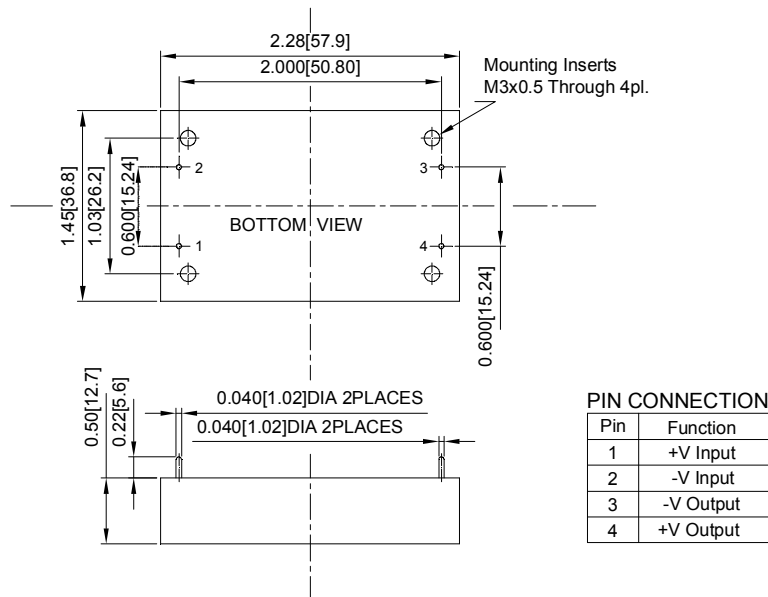Filter Module

P : Pin Type

200 : Rated Voltage

DC Input

05 : Input Current 5A

9. Mechanical Outline Diagrams
9.1 FM05D200P Mechanical Outline Diagrams

All Dimensions In Inches (mm)
Tolerance Inches: X.XX= ±0.02 , X.XXX= ±0.010
Millimeters: X.X= ±0.5 , X.XX=±0.25

2.28[57.9]
2.000[50.80]

Mounting Inserts
M3x0.5 Through 4pl.

1.45[36.8]
1.03[26.2]
0.600[15.24]

2
3

BOTTOM VIEW

1
4

0.600[15.24]

0.50[12.7]
0.22[5.6]

0.040[1.02]DIA 2PLACES
0.040[1.02]DIA 2PLACES

PIN CONNECTION

Pin	Function
1	+V Input
2	-V Input
3	-V Output
4	+V Output

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