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│   **AC-DC Switching Power Module**   │
│   **CBM70S SERIES**   │
│   **APPLICATION NOTE**   │
│   │
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Approved By:

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Contents

CBM70S Series
Application Note V11

1. Introduction

This application note describes the features and functions of Cincon's CBM70S series, switching AC-DC power module. These are highly efficient, reliable, compact, high power density, single output AC/DC 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 CBM70S series power module is extremely reliable.

2. Pin Function Description
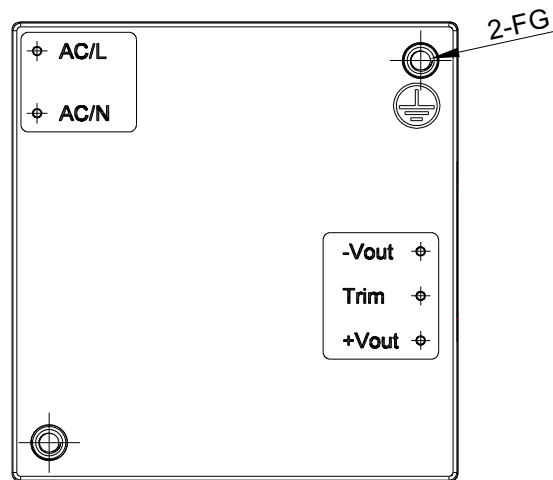
No	Label	Function	Description
1	AC/L	AC Line	Positive Supply Input
2	AC/N	AC Neutral	Negative Supply Input
3	+Vout	+V Output	Positive Power Output
4	Trim	Trim	External Output Voltage Adjustment
5	-Vout	-V Output	Negative Power Output
--	--	Mounting Insert	Mounting Insert (FG)

Note: Base plate can be connected to FG through M3 threaded mounting insert. Recommended torque 3Kgf-cm.

3. Electrical Block Diagram
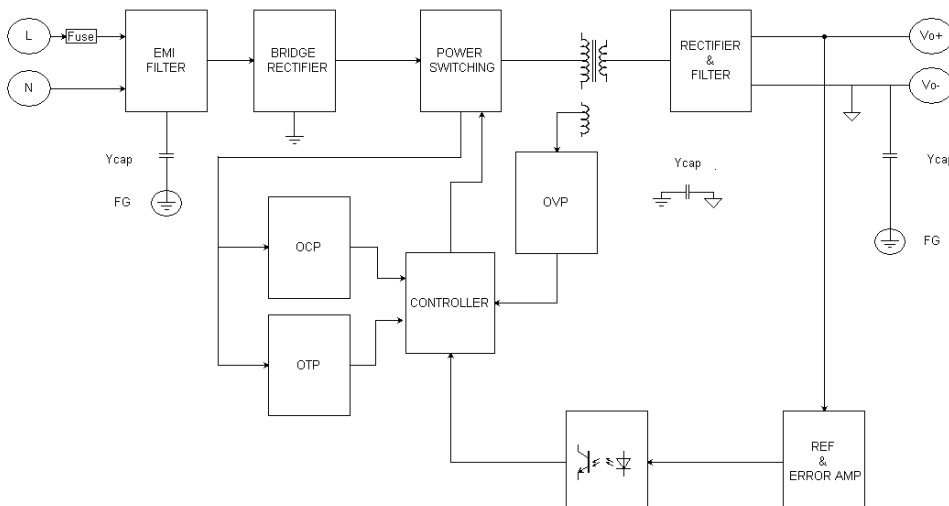
4. Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure 1. When testing the Cincon's CBM70S 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:

- Efficiency
- Load regulation and line regulation.

The value of efficiency is defined as:

$$\eta = \frac{V_o \times I_o}{V_{in} \times I_{in}} \times 100\%$$

Where:

V_o is output voltage,

I_o is output current,

V_{in} is input voltage,

I_{in} is input current.

The value of load regulation is defined as:

$$Load\ reg. = \frac{V_1 - V_2}{V_2} \times 100\%$$

Where:

V_1 is the output voltage at 60% load.
V_2 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.

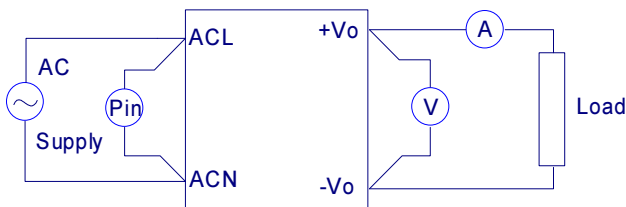V_{LL} is the output voltage of minimum input voltage at full load.

Figure 1. CBM70S Series Test Setup

5. Features and Functions

5.1 Over Current Protection

All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into hiccup mode protection.

5.2 Over Voltage Protection

All different voltage models have a fully continuous over voltage protection. The power module will supply OVP.In the event of happen the OVP, the converter will shut down, the converter will go into hiccup mode protection.

5.3 Over Temperature Protection

These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of the center part of aluminum base plate
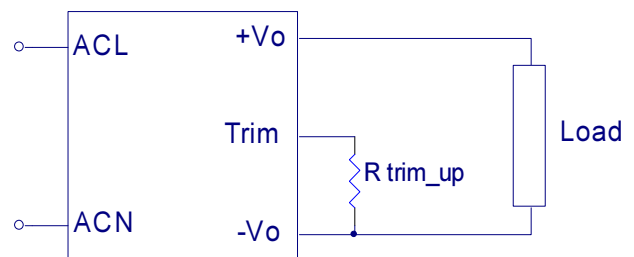
5.4 Output Voltage Adjustment

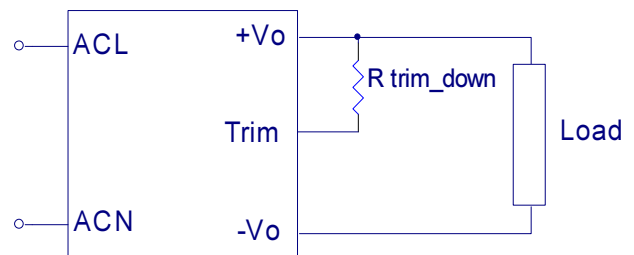Output may be externally trimmed (-10% to +10%) with a fixed resistor. Po≦max rated power ,Io≦Io_max.

Trim up/down is extra features，changing the output voltage will cause some electrical properties to be substandard.

EX:

Output voltage ±1%,etc.

Trim-up Voltage Setup

Trim-down Voltage Setup

The value of R$_{trim\_up}$ defined as:

$$R_{trim\_up}$$
$$= \left[\frac{(R3 \times Vr \times \frac{(R1+R2)}{R1})}{(Vout - \left(Vr \times \frac{(R1+R2)}{R1}\right) - \left(\frac{(Vr \times R3)}{R1}\right))} \right]$$
$$- Rt(K\Omega)$$

Where:

R$_{trim\_up}$ is the external resistor in KΩ.

V$_{o, nom}$ is the nominal output voltage.

V$_o$ is the desired output voltage.

R1, R2, R3, Rt and Vr are internal to the unit and are defined in Table 1.

Table 1 – Trim up and Trim down Resistor Values

Model Number	Output Voltage(V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	Rt (KΩ)	Vr (V)
CBM70S120	12.0	6.82	10	16	51	2.5
CBM70S240	24.0	6.82	22.6	36.33	130	2.5
CBM70S360	36.0	6.82	39	52.81	200	2.5
CBM70S480	48.0	6.82	56	68.51	240	2.5

For example, to trim-up the output voltage of 12V module (CBM70SS120) by 10% to 13.2V, R$_{trim\_up}$ is calculated as follows:

R1=6.82KΩ, R2=10KΩ, R3=16KΩ, Rt=51KΩ, Vr=2.5V, Vo=13.2V, Vo, nom=12V

$$R_{trim_{up}} =$$

$$\left[\frac{16 \times 2.5 \times ((6.82+10)/6.82)}{13.2 - \left(\frac{2.5X(6.82+10)}{6.82}\right) - \left(\frac{2.5X16}{6.82}\right)} \right] - 51$$

$$= 33.3742 \ (K\Omega)$$

Because R1,R2,R3 round off to the 2nd decimal place. R$_{trim\_up}$& R$_{trim\_down}$ have error value.

The typical value of R$_{trim\_up}$

Trim up (%)	12V	24V	36V	48V
	R$_{trim\_up}$ (KΩ)			
1%	1087.46	2831.31	4318.89	4595.59
2%	426.42	922.50	1394.74	1717.02
3%	251.04	509.98	768.22	986.75
4%	169.90	329.77	495.12	653.38
5%	123.12	228.75	342.19	462.48
6%	92.69	164.13	244.42	338.80
7%	71.31	119.23	176.52	252.16
8%	55.47	86.23	126.62	188.07
9%	43.27	60.94	88.40	138.75
10%	33.57	40.95	58.18	99.63

The value of R$_{trim\_down}$ defined as:

$$R_{trim_{down}} =$$

$$\left[\frac{(Vout - Vr \times \frac{R1+R2}{R1}) \times R3}{(\left(\frac{Vr \times R3}{R1}\right) - \left(Vout - Vr \times \frac{(R1+R2)}{R1}\right))} \right] - Rt(K\Omega)$$

Where:

R$_{trim\_down}$ is the external resistor in KΩ.

V$_{o, nom}$ is the nominal output voltage.

V$_o$ is the desired output voltage.

R1, R2, R3, Rt and Vr are internal to the unit and are defined in Table 1.

For example: to trim-down the output voltage of 12V module (CBM70S120) by 10% to 10.8V, R$_{trim\_down}$ is calculated as follows:

R1=6.82KΩ, R2=10KΩ, R3=16KΩ, Rt=51KΩ, Vr=2.5V, Vo=10.8V, Vo, nom=12V

$$R_{trim_{down}} =$$

$$\left(10.8 - 2.5 * \frac{6.82+10}{6.82}\right) * 16/(2.5 * \frac{16}{6.82}$$
$$- \left(10.8 - 2.5 * \frac{6.82+10}{6.82}\right)) - 51$$
$$= 9.24 \ (K\Omega)$$

The typical value of R$_{trim\_down}$

Trim down (%)	12V	24V	36V	48V
	R$_{trim\_down}$ (KΩ)			
1%	545.17	1225.67	1699.95	2407.42
2%	276.41	657.18	904.41	1236.83
3%	171.64	418.39	569.43	771.39
4%	115.86	286.95	384.85	521.42
5%	81.21	203.76	267.95	365.42
6%	57.60	146.37	187.27	258.79
7%	40.48	104.39	128.23	181.29
8%	27.50	72.34	83.16	122.42
9%	17.31	47.08	47.63	76.18
10%	9.11	26.66	18.89	38.91

6. Input / Output Considerations

6.1 Output Ripple and Noise Measurement

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

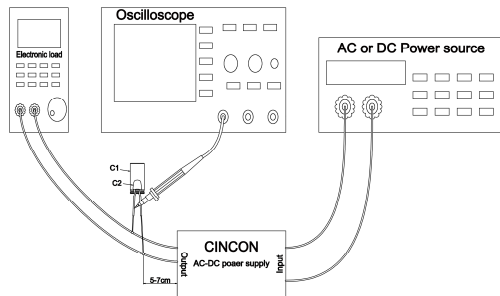Add a C2=0.1uF ceramic capacitor and a C1=10uF electrolytic capacitor to output at 20 MHz bandwidth.

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

7. Thermal Design

7.1 Operating Temperature Range

The highly efficient design of Cincon's CBM70S series power modules has resulted in their ability to operate within ambient temperature environments from -40°C to +85°C.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)
- Forced air or natural convection
- Heat sink (optional)

7.2 Convection Requirements for Cooling

To predict the approximate cooling needed for the half brick module, refer to the power derating curves in **section 7.4**. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed 85°C as measured at the center of the top of the case (thus verifying proper cooling).

7.3 Thermal Considerations

The power 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 7.4**. The power output of the module should not be allowed to exceed rated power (V_{o_set} x I_{o_max}).

7.4 Power Derating

The operating case temperature range of CBM70S series is -40°C to +85°C. When operating the CBM70S series, proper derating or cooling is needed. (at 115VAC & 230VAC)
The maximum case temperature under any operating condition should not exceed 85°C.
The following curve is the derating curve of CBM70S series without heatsink.

Note: Pd is calculated after 1 minute of burn-in

Pd vs Ta and Air Flow without heatsink
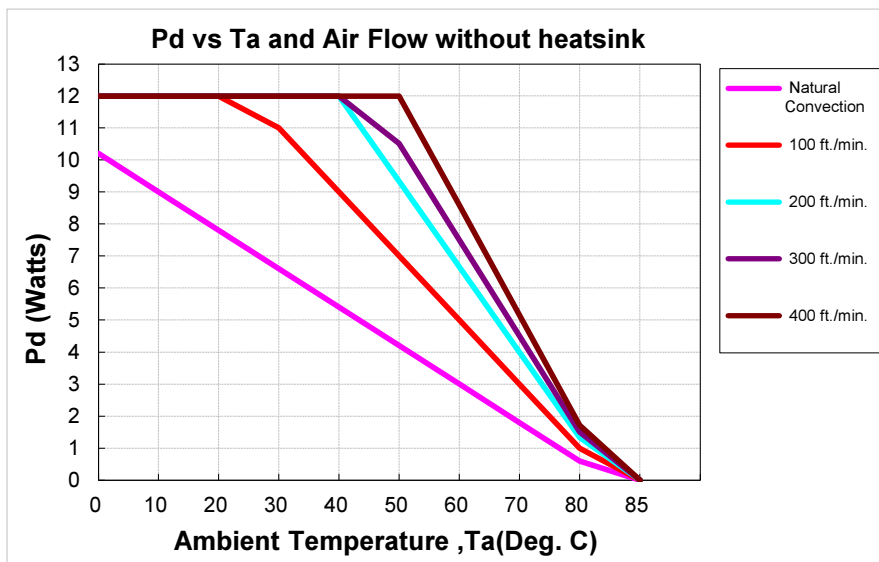
AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection	8.33℃/W
100 ft./min. (0.5m/s)	5.0℃/W
200 ft./min. (1.0m/s)	3.75℃/W
300 ft./min. (1.5m/s)	3.33℃/W
400 ft./min. (2.0m/s)	2.91℃/W

Example without heatsink:

What is the minimum airflow necessary for a CBM70S120 operating at 230VAC, an output current of 5.83A, and a maximum ambient temperature of 35°C without heatsink?

Solution:

Given: V_{in}=230VAC, V_o=12V_{dc}, I_o=5.83A

Determine Power dissipation (P_d): P_d= P_i-P_o= P_o(1-η)/η, P_d= 12V×5.83A×(1-0.88)/0.88=9.54Watts

Determine airflow: Given: P_d= 9.54W and T_a= 35°C

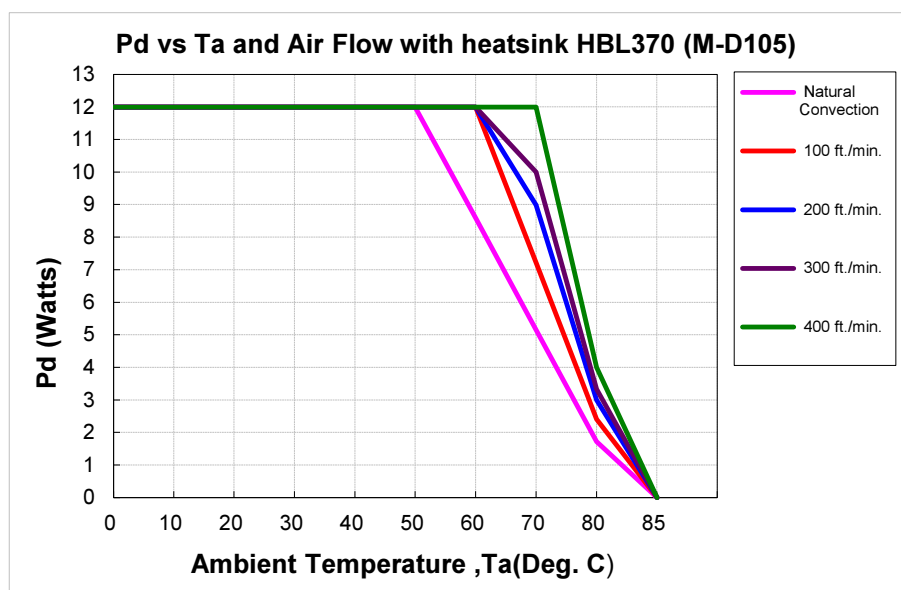**Check *Power Derating* curve:** Minimum airflow= 100 ft./min.

Verify:

Maximum temperature rise is ΔT= P_d × R_{ca} = 9.54×5= 47.7°C

Maximum case temperature is T_c = T_a +ΔT= 82.7°C<85°C

Where:

The R_{ca} is thermal resistance from case to ambient environment.

T_a is ambient temperature and T_c is case temperature.

Pd vs Ta and Air Flow with heatsink HBL370 (M-D105)

AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection	2.91℃/W
100 ft./min. (0.5m/s)	2.08℃/W
200 ft./min. (1.0m/s)	1.67℃/W
300 ft./min. (1.5m/s)	1.50℃/W
400 ft./min. (2.0m/s)	1.25℃/W

Example with heatsink HBL370 (M-D105)**:**

What is the minimum airflow necessary for a CBM70S120 operating at 230VAC, an output current of 5A, and a maximum ambient temperature of 60°C with heatsink HBL370 (M-D105).

Solution:

Given: V_{in}=230VAC, V_o=12V_{dc}, I_o=5A

Determine Power dissipation (P_d): P_d= Pi-Po= Po(1-η)/η, P_d= 12V×5A×(1-0.88)/0.88=8.18Watts

Determine airflow: Given: P_d= 8.18W and T_a = 60℃

Check above Power de-rating curve: Minimum airflow= Natural Convection
Verify:

Maximum temperature rise is ΔT= P_d × R_{ca}= 8.18×2.91= 23.8℃
Maximum case temperature is T_c= T_a +ΔT= 83.8℃<85℃

Where:
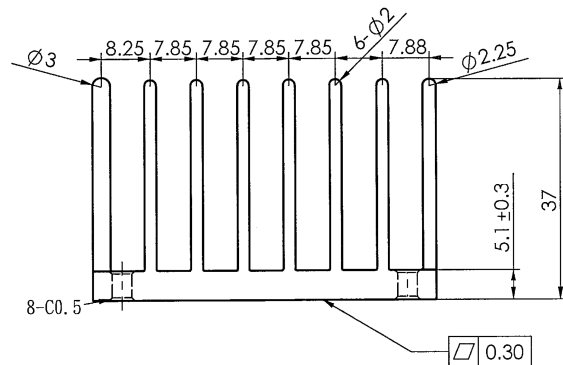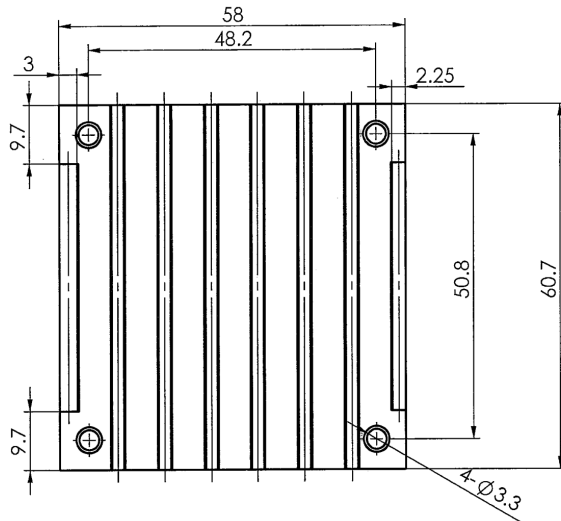
The R_{ca} is thermal resistance from case to ambient environment.
T_a is ambient temperature and T_c is case temperature.

7.5 Half Brick Heat Sinks

All Dimensions in mm
HBL370 (M-D105) Heat Sink G6620710201 60.7*58*37mm
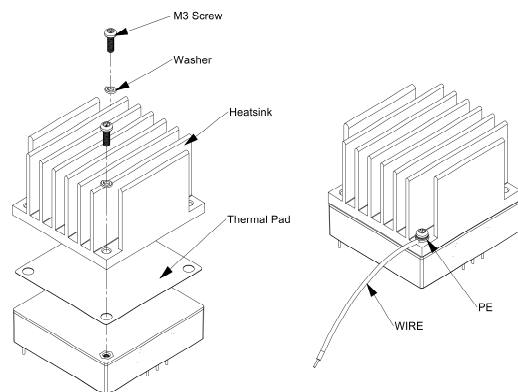Rca: 2.91°C/W (typ.), At natural convection
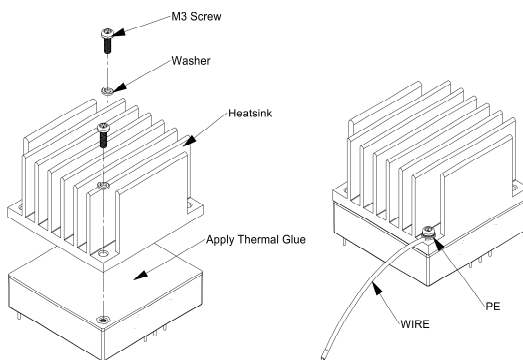   2.08°C/W (typ.), At 100LFM
    1.67°C/W (typ.), At 200LFM
    1.50°C/W (typ.), At 300LFM
    1.25°C/W (typ.), At 400LFM

Heat Sink HBL370 (M-D105): 60.7*58*37mm (G6620710201)
Thermal Pad: 56.9*60*0.25mm(G6135041091)
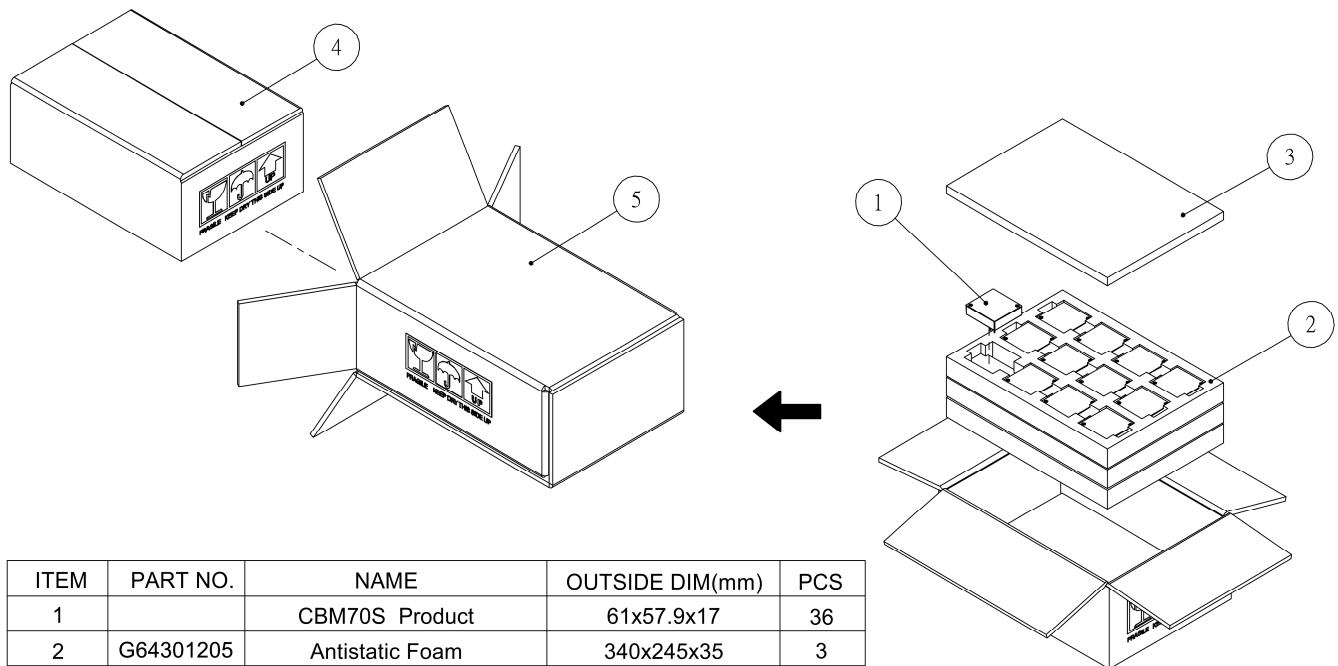Screw: K310W SMP+WS M3*0.5 10mm (G75A1300332)

Heat Sink HBL370 (M-D105): 60.7*58*37mm (G6620710201)
Thermal Glue: Thermal Conductivity 3.5W/(m*K)
Screw: K310W SMP+WS M3*0.5 10mm (G75A1300332)

8. Packing Information

The packing information for CBM70S SERIES is showing as follows:

ITEM	PART NO.	NAME	OUTSIDE DIM(mm)	PCS
1		CBM70S Product	61x57.9x17	36
2	G64301205	Antistatic Foam	340x245x35	3
3	G64308319	Antistatic Foam	340x245x15	2
4	G64112339	No.59 Cardboard Box	360.6x257.6x148.5	1
5	G64112270	No.95 Cardboard Box	390.9x284.8x175.7	1

Each Box Packaging 36 PCS Products
Net weight Ref. 4.9 Kg
Gross weight Ref. 6.1 Kg

CBM70S 36 PCS a box, including the total weight of package material about 6.1Kg

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