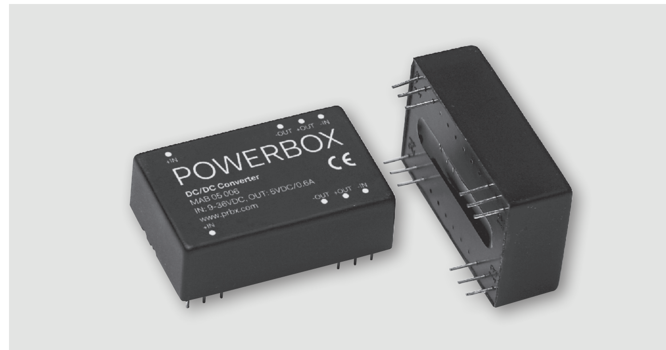
P R
B X

POWERBOX Industrial Line
MAB05 Series
3W 4:1 Single and Dual Output
DC/DC Converter
Manual V10



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1. Introduction

The MAB05 series offer 2-3 watts of output power in a 24 pin DIP and SMD copper package. The MAB series has a 4:1 wide input voltage range of 9-36VDC and 18-72VDC, and provides a precisely regulated output. This series has features such as high efficiency, 500VDC,1500VDC, 3KVDC of isolation and allows an ambient operating temperature range of –25°C to 71°C (de-rating above 71 °C). The modules are fully protected against output short circuit. All models are very suitable for distributed power architectures, telecommunications, battery operated equipment and industrial applications.

2. DC/DC Converter Features

- 2-3W isolated output
- DIP-24 / SMD package
- Efficiency up to 77%
- 4:1 input range
- Regulated outputs
- Pi Input filter
- Continuous short circuit protection

3. Electrical Block Diagram

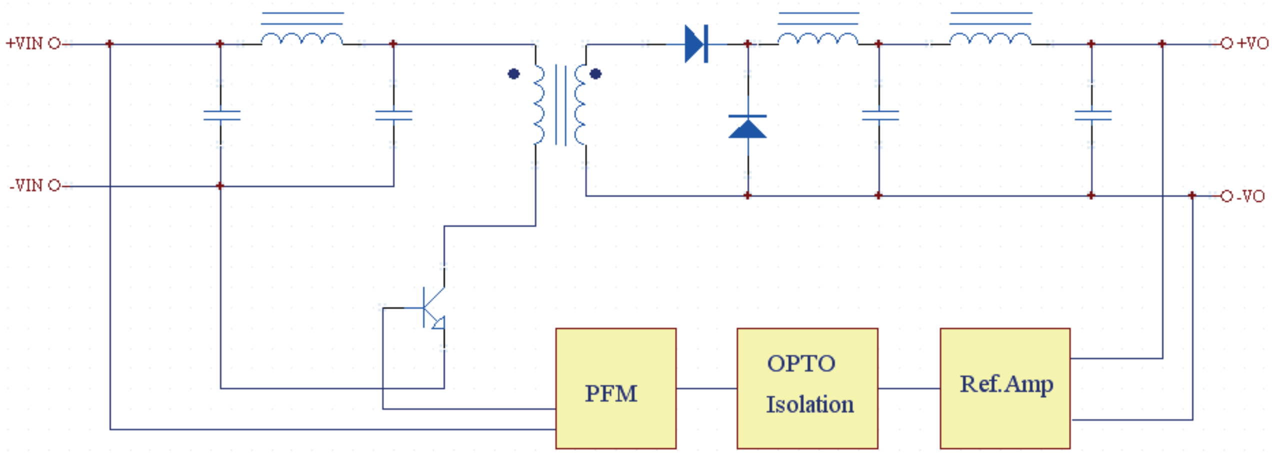


Figure 1 Electrical Block Diagram of single output module

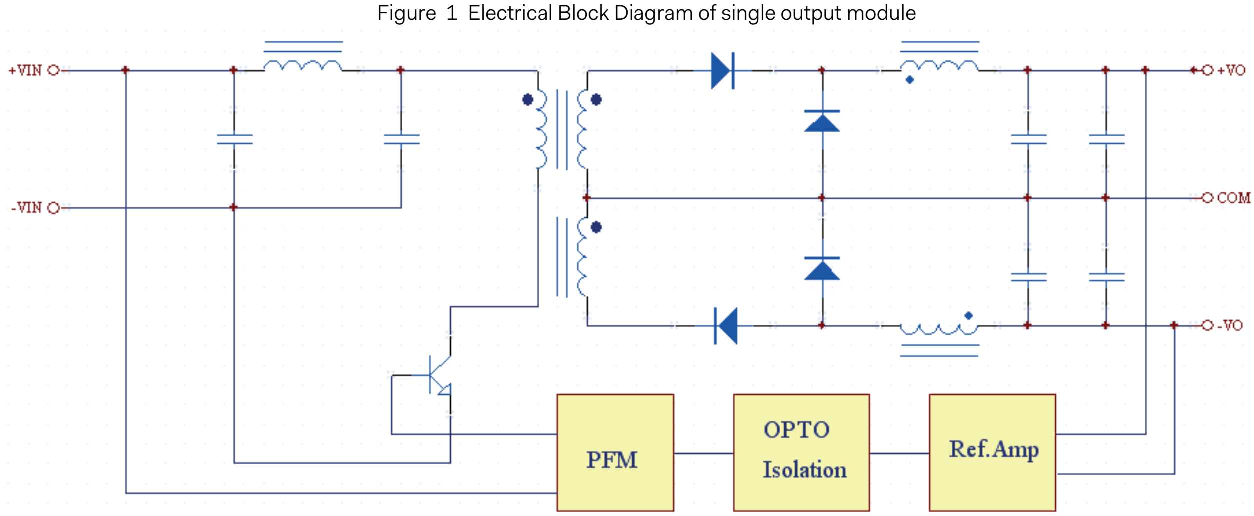


Figure 2 Electrical Block Diagram of dual output module

4. Technical Specifications

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

Absolute Maximum Ratings

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Input voltage						
Continuous		24Vin	-0.3		36	VDC
		48Vin	-0.3		72	VDC
Transient	100ms	24Vin			50	VDC
		48Vin			100	VDC
Operating ambient temperature	De-rating, above 71 °C	All	-25		+71	°C
Case temperature	Plastic case	All			95	°C
	Copper case	All			100	°C
Storage temperature		All	-40		+100	°C
Input/output isolation voltage	1 minute (M/S)	MAB 05 XXX	500			VDC
	(H)	MAB 05 XXX	3K			VDC
	(HM/HMS)	MAB 05 XXX	1.5K			VDC

Input Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Operating input voltage		24Vin	9	24	36	VDC
		48Vin	18	48	72	VDC
Maximum input current	Full load, Vin=9V	24Vin		470		mA
	Full load, Vin =18V	48Vin		240		mA
No-load input current	Vin=24V	Vo=3.3VDC		15		mA
		Vo=5VDC		15		mA
		Vo=12VDC		15		mA
		Vo=15VDC		25		mA
		Vo=±5VDC		25		mA
		Vo=±12VDC		25		mA
		Vo=±15VDC		15		mA
	Vin=48V	Vo=3.3VDC		7.5		mA
		Vo=5VDC		7.5		mA
		Vo=12VDC		7.5		mA
		Vo=15VDC		12		mA
		Vo=±5VDC		12		mA
		Vo=±12VDC		12		mA
		Vo=±15VDC		7.5		mA

Output Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Output voltage set point	Vin=Nominal input, Io = Iomax2.5VDC	Vo=3.3VDC	3.234	3.3	3.366	VDC
		Vo=5VDC	4.9	5	5.1	VDC
		Vo=12VDC	11.76	12	12.24	VDC
		Vo=15VDC	14.7	15	15.3	VDC
		Vo=±5VDC	±4.9	±5	±5.1	VDC
		Vo=±12VDC	±11.76	±12	±15.3	VDC
		Vo=±15VDC	±14.7	±15	±15.3	VDC
Output voltage balance	Vin nominal, input, Io=Iomax	Dual			±1.0	%
Output voltage regulation						
Load regulation	Io=full Load to 10% load	Single			±0.5	%
	Io=full Load to 25% load	Dual			±1.0	%
Line regulation	Vin=low line to high line, full load	All			±0.5	%
Temperature coefficient	Ta=-25°C to 71°C	All			±0.05	%/°C
Output voltage ripple and noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Vin=nominal input, Io=full load	Vo=3.3VDC			100	mV
	(with 0.1uF MLCC for SMD package)	Vo=5VDC			100	mV
		Vo=12VDC			100	mV
		Vo=15VDC			100	mV
		Vo=±5VDC			100	mV
		Vo=±12VDC			120	mV
		Vo=±15VDC			150	mV
Operating output current range		Vo=3.3VDC			600	mV
		Vo=5VDC			600	mV
		Vo=12VDC			250	mV
		Vo=15VDC			200	mV
		Vo=±5VDC			±300	mV
		Vo=±12VDC			±125	mV
		Vo=±15VDC			±100	mV
Output DC current limit inception	Vo=90% Vo, nominal	All	120			%

Dynamic Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Turn-on delay and rise time						
Turn-on delay time, from input	Vin, nominal to 90%Vo, set	Vo=3.3&5V		0.5	1.2	ms
		Others		4	12	ms
Output voltage rise time	10%Vo, set to 90%Vo, set	Vo=3.3&5V		0.5	1.2	ms
		Others		4	12	ms

Efficiency

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
100% load	Vin=24V	MAB 05 006		72		%
		MAB 05 009		76		%
		MAB 05 012		76		%
		MAB 05 015		70		%
		MAB 05 018		72		%
		MAB 05 021		72		%
		MAB 05 003		70		%
	VIN=48V	MAB 05 027		72		%
		MAB 05 030		77		%
		MAB 05 033		77		%
		MAB 05 036		71		%
		MAB 05 039		72		%
		MAB 05 042		72		%
		MAB 05 024		70		%

Isolation Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Isolation voltage	Input to output, 1 minute	MAB 05 XXX (M/MS)	500			VDC
		MAB 05 XXX (H)	3K			VDC
		MAB 05 XXX (HM/HMS)	1.5K			VDC
Isolation resistance	Input to output	All	1000			MΩ
Isolation capacitance	Input to output	MAB 05 XXX (H)		300		pF
		Others		600		pF

Feature Characteristics

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
Switching frequency		All	100			KHz

General Specifications

Parameters	Notes and Conditions	Device	Min	Typical	Max	Units
MTBF	Io=100% of Io, max: Ta=25°C per MIL-HDBK-217F	All		2800		Khours
Weight		All		12.5		grams

5. Main Features and Functions

5.1 Operating Temperature Range

The MAB05 series converters can be operated by a wide ambient temperature range from -25°C to 71°C (de-rating above 71°C). The standard models case temperature should not be exceeded 100°C at normal operating (detail see content 6.2).

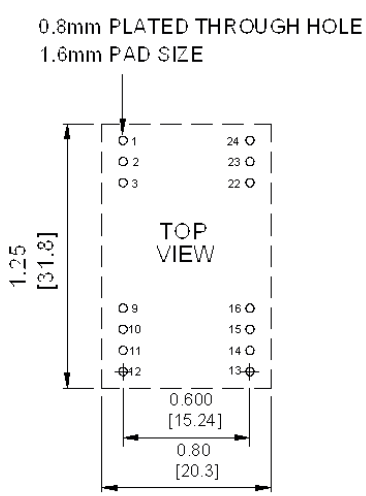
5.2 Over Current Protection

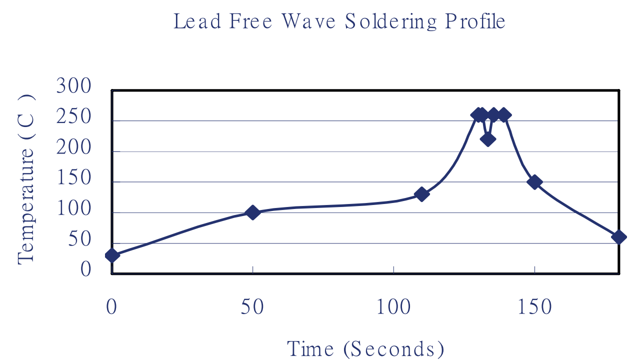
All models have internal over current and continuous short circuit protection. The unit operates normally once the fault condition is removed. At the point of current limit inception, the converter will go into over current protection.

6. Applications

6.1 Recommended Layout, PCB Footprint and Soldering Information

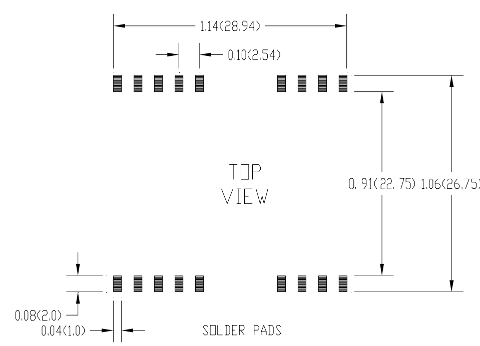
The system designer or the end user must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces are the norm and should be used where possible. Due consideration must also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

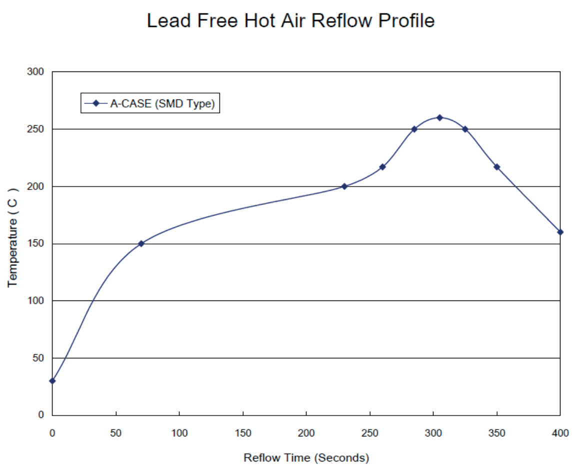




Note:

1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4°C/Sec (From 50°C to 100°C)
3. Soaking temperature: 0.5°C/Sec (From 100°C to 130°C), 60±20 seconds
4. Peak temperature: 260°C, above 250°C3~6 Seconds
5. Ramp up rate during cooling: -10.0°C/Sec (From 260°Cto 150°C)



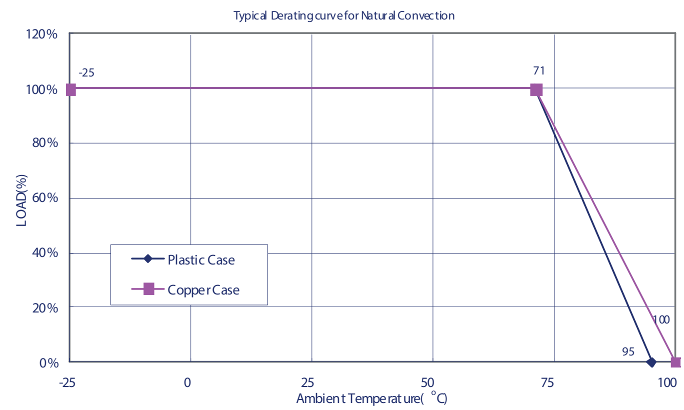


Note:
1. Soldering Paste: SHENMAO PF610-P (Sn/Ag/Cu)
2. Ramp up rate during preheat: 1.71°C/Sec (From 30°C to 150°C)
3. Soaking temperature: 0.31°C/Sec (From 150°C to 200°C), 160±10 seconds
4. Ramp up rate during reflow: 0.96°C/Sec (From 217°C to 260°C)
5. Peak temperature: 260°C, above 217°C 90 Seconds
6. Ramp up rate during cooling: -1.2°C/Sec (From 260°Cto 160°C)

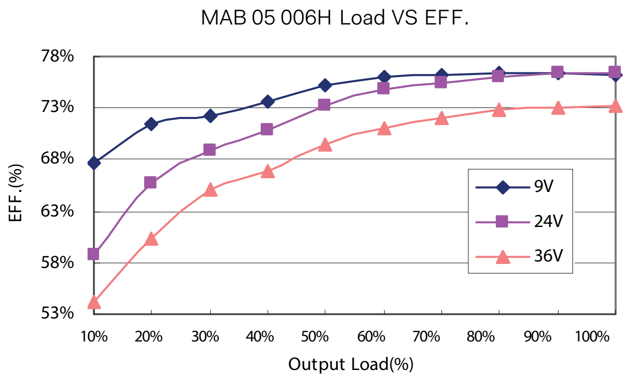
Figure 3 Recommended PCB Layout Footprints and Wave Soldering Profiles for DIP-24 and SMD packages

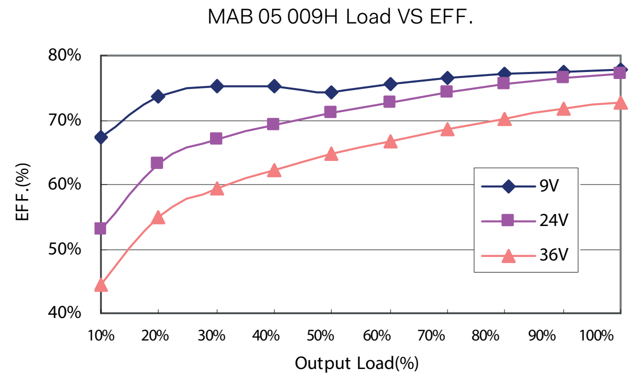
6.2 Power De-Rating Curves

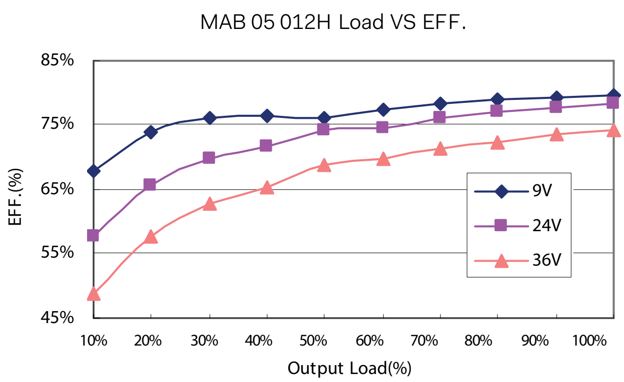
Operating Ambient temperature Range: -25°C ~ 71°C with de-rating above 71°C.
Maximum case temperature under any operating condition should not exceed 95°C (Plastic Case), 100°C (Copper Case).

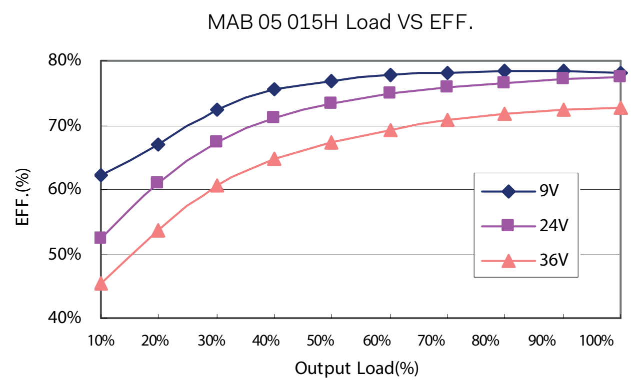


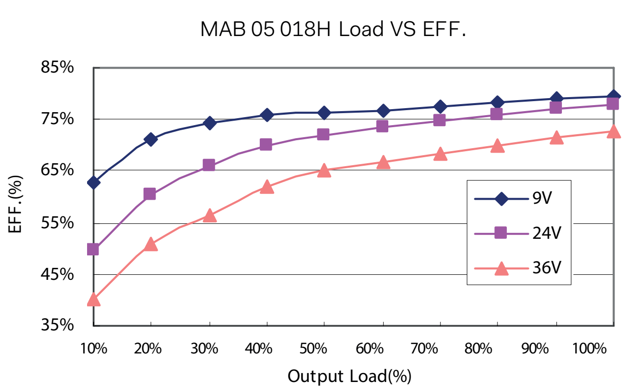
6.3 Efficiency VS. Load

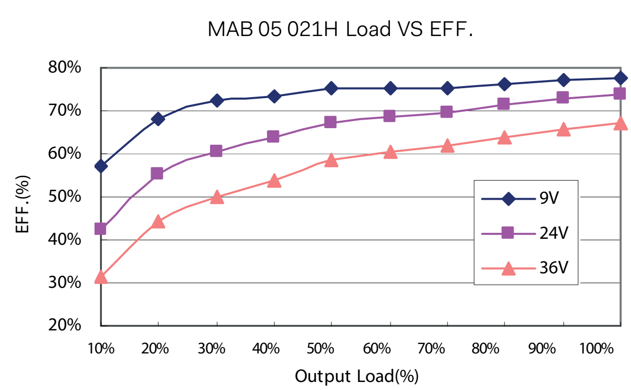


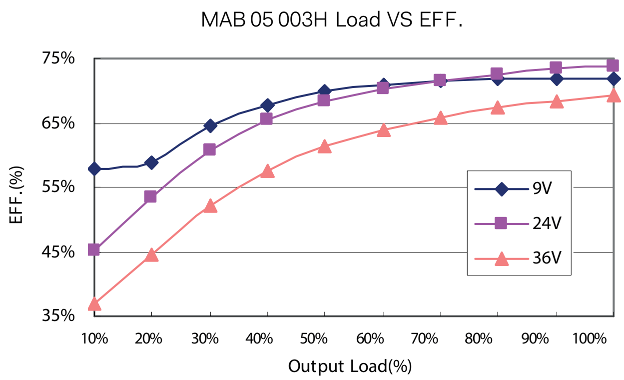


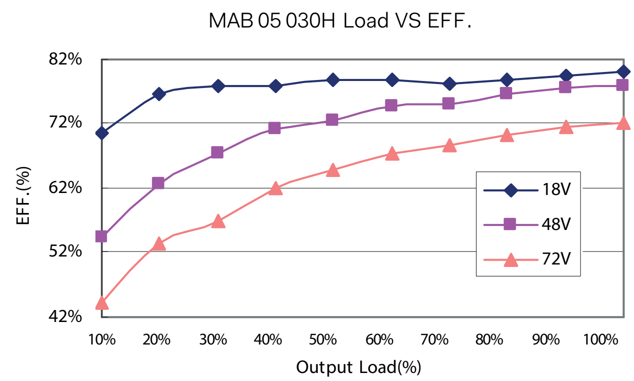


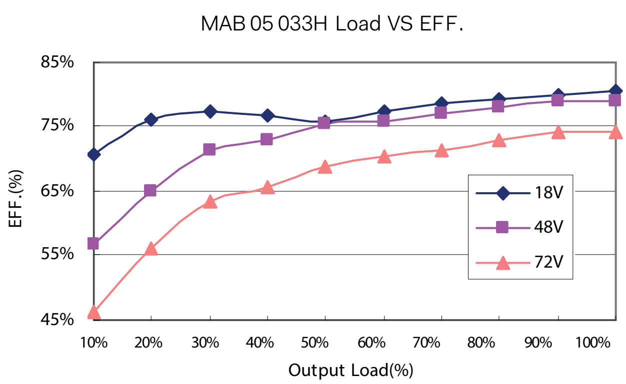







MAB 05 003H Load VS EFF.
75%
65%
55%
45%
35%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
9V
24V
36V


MAB 05 030H Load VS EFF.
82%
72%
62%
52%
42%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


MAB 05 033H Load VS EFF.
85%
75%
65%
55%
45%
EFF.(%)
10%
20%
30%
40%
50%
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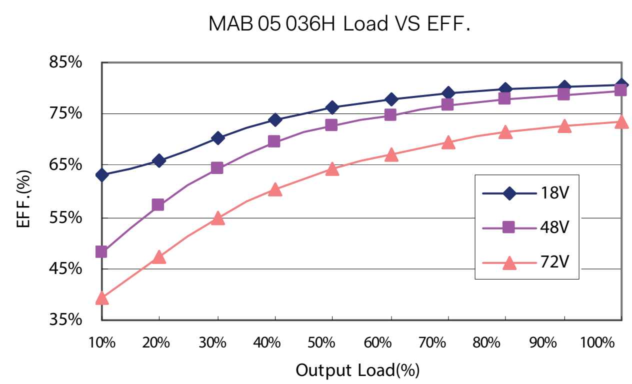
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


MAB 05 036H Load VS EFF.
85%
75%
65%
55%
45%
35%
EFF.(%)
10%
20%
30%
40%
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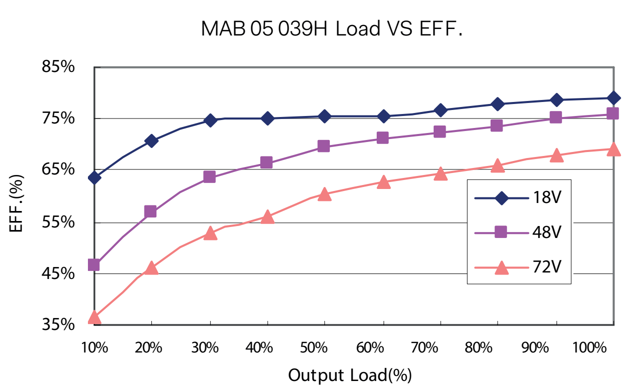
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V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75%
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35%
EFF.(%)
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40%
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60%
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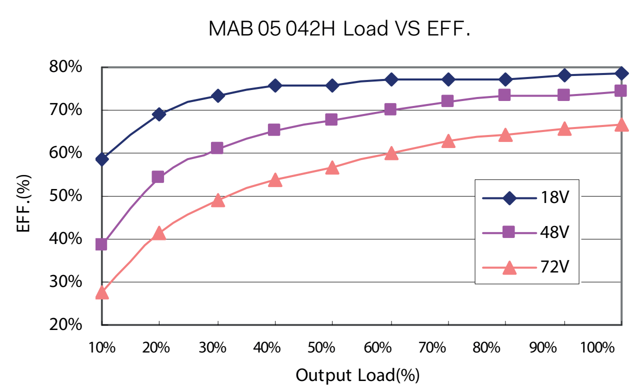
80%
90%
100%
Output Load(%)
18V
48V
72V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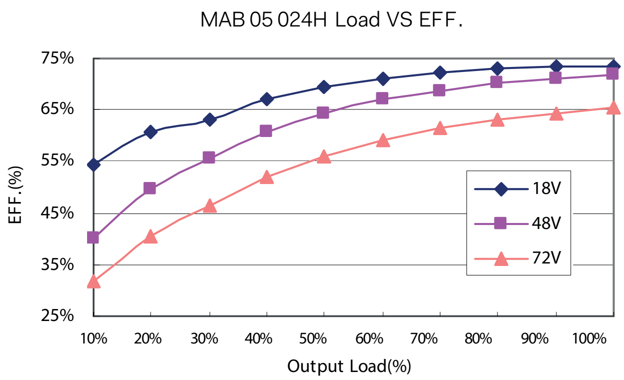
80%
70%
60%
50%
40%
30%
20%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V


MAB 05 024H Load VS EFF.
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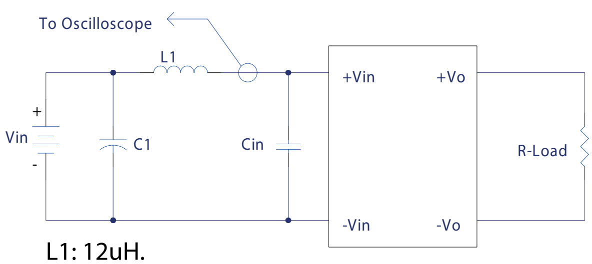
65%
55%
45%
35%
25%
EFF.(%)
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
Output Load(%)
18V
48V
72V

6.4 Input Capacitance at the Power Module

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown in Figure 4 represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).



L1: 12uH.
C1: 220uF ESR <0.1 Ω @ 20 ℃, 100KHz.
Cin: None

Figure 4 Input Reflected-Ripple Test Setup

6.5 Test Set-Up

The basic test set-up to measure parameters such as efficiency and load regulation is shown in Figure 5. When testing the modules 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:

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

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:

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

Where:
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at 10% load (Single output)
VNL is the output voltage at 25% load (Dual output)

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.

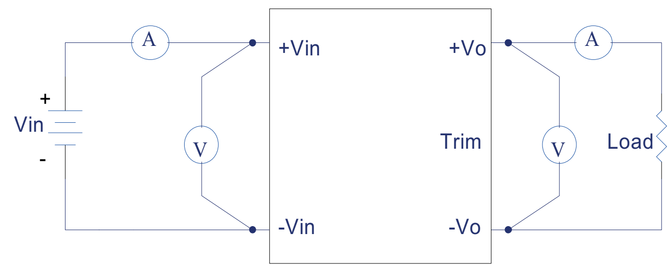
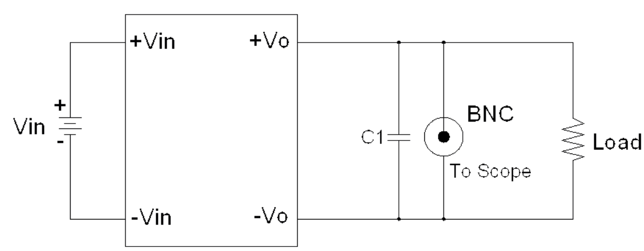


Figure 5 Test Setup

6.6 Output Ripple and Noise Measurement

The test set-up for noise and ripple measurements is shown in Figure 6 and 7. A coaxial cable was used to prevent impedance mismatch reflections disturbing the noise readings at higher frequencies. Measurements are taken with output appropriately loaded and all ripple/ noise specifications are from 5Hz to 20MHz Band Width.



Note: C1: 0.1uF Ceramic capacitor for SMD Models Only

Figure 6 Using BNC to Measure Output Ripple and Noise

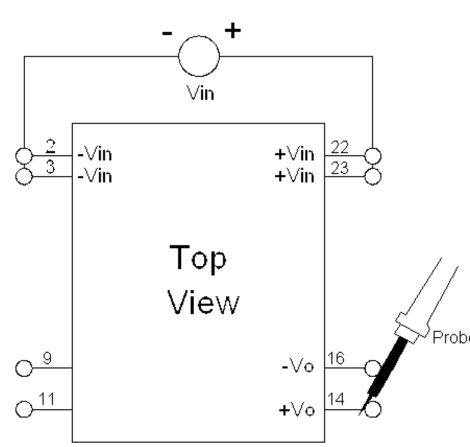


Figure 7 Using Probe to Measure Output Ripple and Noise

6.7 Output Capacitance

The MAB05 series converters provide unconditional stability with or without external capacitors. For good transient response low ESR output capacitors should be located close to the point of load. These series converters are designed to work with load capacitance to see technical specifications.

7. Safety & EMC

7.1 Input Fusing and Safety Considerations

The MAB05 series converters have not an internal fuse. However, to achieve maximum safety and system protection, always use an input line fuse. We recommended a active fast fuse 0.63A for 24Vin models and 0.3A for 48Vin models. Figure 8 circuit is recommended by a transient voltage suppressor diode across the input terminal to protect the unit against surge or spike voltage and input reverse voltage.

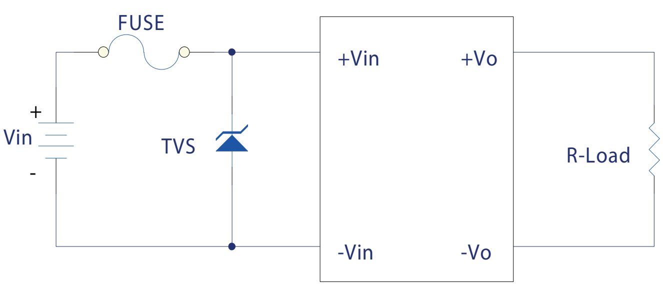


Figure 8 Input Protection

7.2 EMC Considerations

EMI Test standard: EN55022 Class A

Test Condition: Input Voltage: Nominal, Output Load: Full Load

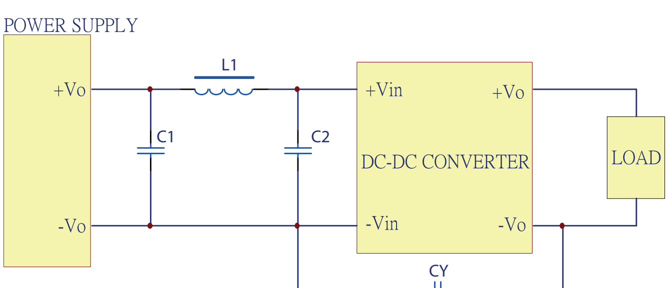
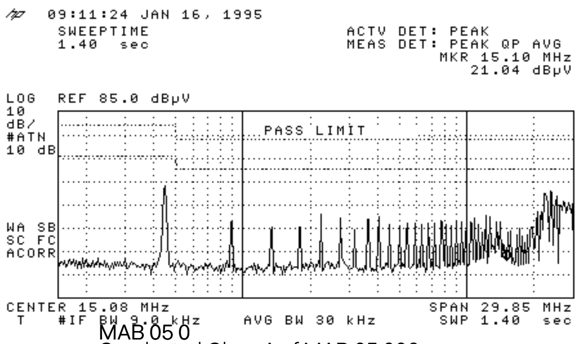


Figure 9 Connection circuit for conducted EMI testing

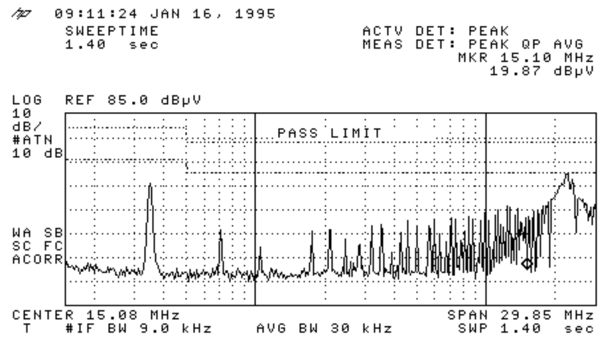
EN55022 Class A

Model No.	C1	C2	L1	CY
MAB 05 006	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 009	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 012	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 015	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 018	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 021	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 003	NC	47uF/50V ESR<0.17Ω	Short	NC
MAB 05 027	NC 4	7uF/100V ESR<0.17Ω	Short	NC
MAB 05 030	NC	7uF/100V ESR<0.17Ω	Short	NC
MAB 05 033	NC	47uF/100V ESR<0.17Ω	Short	NC
MAB 05 036	NC	47uF/100V ESR<0.17Ω	Short	NC
MAB 05 039	NC	47uF/100V ESR<0.17Ω	Short	NC
MAB 05 042	NC	47uF/100V ESR<0.17Ω	Short	NC
MAB 05 024	NC	47uF/100V ESR<0.17Ω	Short	NC

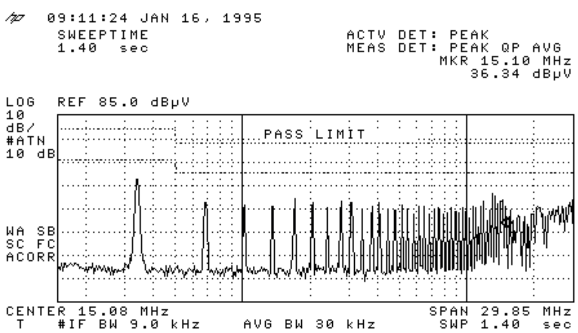
Note: The C2 is KY series aluminum capacitors.



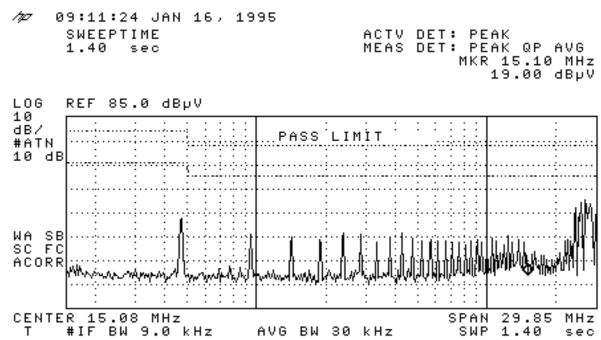
MAB 05 0
Conducted Class A of MAB 05 006



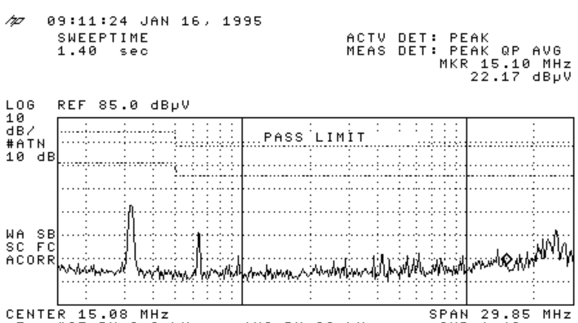
Conducted Class A MAB 05 009



Conducted Class A MAB 05 012



Conducted Class A MAB 05 015



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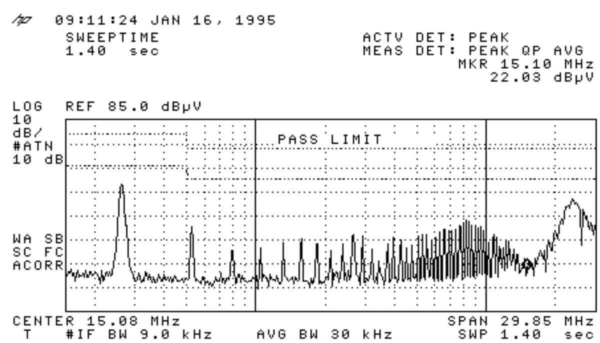
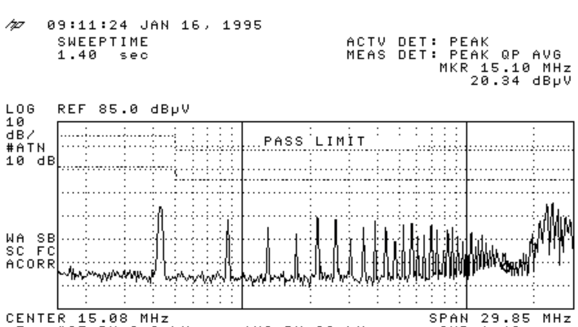
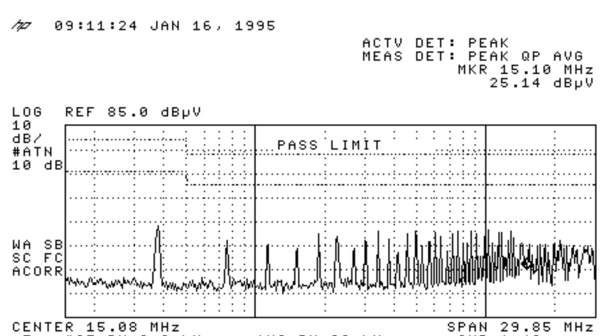


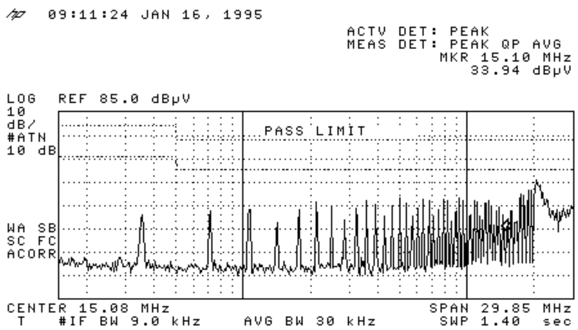
Conducted Class B MAB 05 021



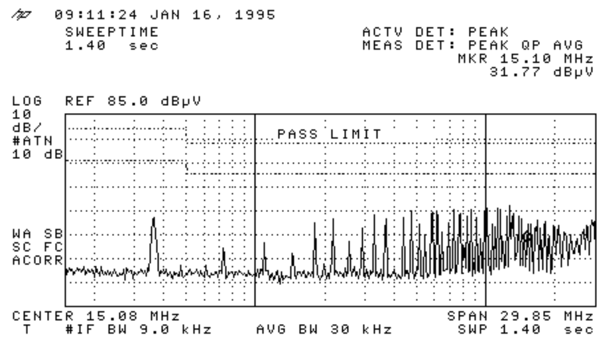
Conducted Class A MAB 05 003



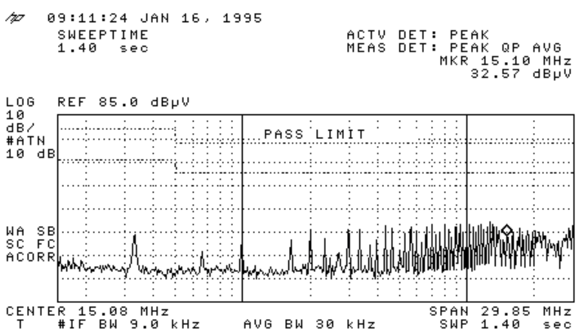
Conducted Class MAB 05 027



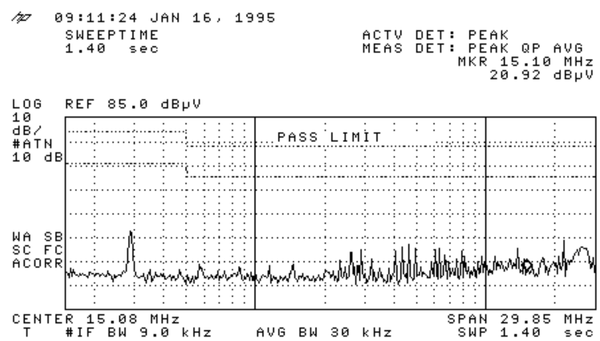
Conducted Class A of MAB 05 030



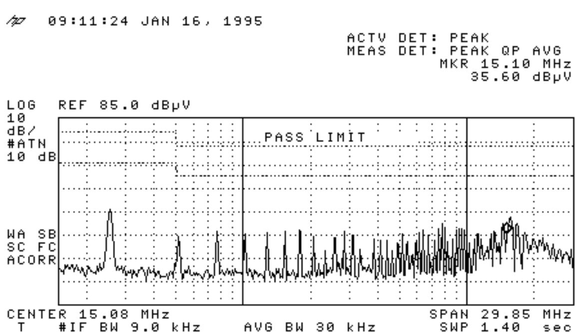
Conducted Class A of MAB 05 033



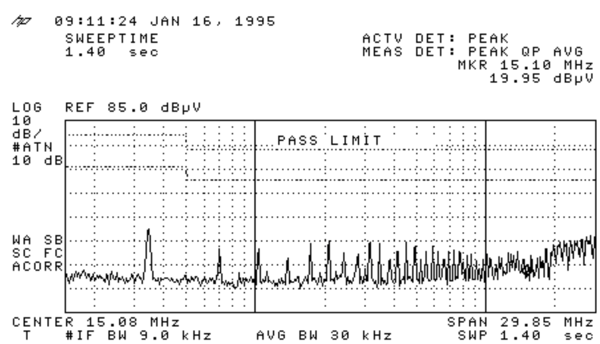
Conducted Class A of MAB 05 036



Conducted Class A of MAB 05 039



Conducted Class A of MAB 05 042



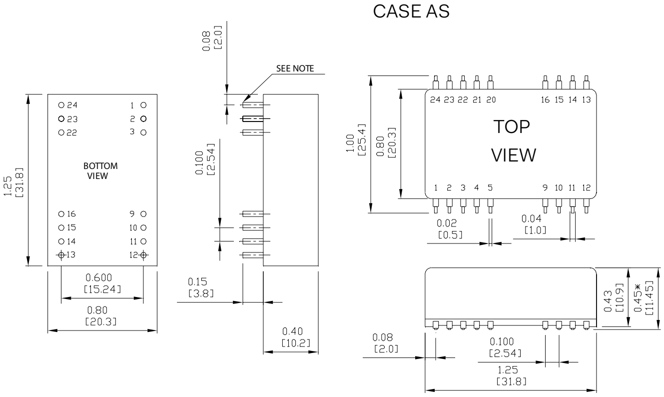
Conducted Class A of EMAB 05 024

8. Mechanical Specifications

8.1 Mechanical Outline Diagrams

NOTE:Pin Size is 0.02 ±0.002 Inch (0.5±0.05 mm)DIA
All Dimensions In Inches (mm)
Tolerances Inches: X.XX= ±0.02 , X.XXX= ±0.010
Millimeters: X.X= ±0.5 , X.XX=±0.25

CASE AS



PIN CONNECTION									
500 VDC					1.5K & 3K VDC				
Pin	Single Output		Dual Output		Pin	Single Output		Dual Output	
	DIP	SMD	DIP	SMD		DIP	SMD	DIP	SMD
1,24	+V Input		+V Input		1,24	NP	NC	NP	NC
2,23	NC		-V Output		2,3	-V Input		-V Input	
3,22	NC		Common		4,5	NP	NC	NP	NC
4	NP	NC	NP	NC	9	NC		Common	
5	NP	NC	NP	NC	10,15	NC		NC	
9	NP	NC	NP	NC	11	NC		-V Output	
10,15	-V Output		Common		12,13	NP	NC	NP	NC
11,14	+V Output		+V Output		14	+V Output		+V Output	
12,13	-V Input		-V Input		16	-V Output		Common	
16	NP	NC	NP	NC	20,21	NP	NC	NP	NC
20,21	NP	NC	NP	NC	22,23	+V Input		+V Input	

* NP-NO PIN
* NC-NO CONNECTION WITH PIN