

1) Introduction

Increasingly power supplies used in applications such as home appliance, office automation, communications and industrial area need to operate on the main AC line 100V and 200V as products are manufactured for global markets.

Traditionally power supplies have been designed to operate on either 100V or 200V AC mains, as products were manufactured for local markets.

The MK-series permits the use of 100V and 200V AC line source by automatic sensing of the main AC line.

This application guide describes the MK-series, its electrical circuit design, mounting procedure and applications.

2) The MK-series

2-1 General description

MK-series is designed to operate with input range 90-132 Volts AC and 180-276 Volts AC with output power capability of 50-150 Watts (higher output power can be achieved by using external triac together with the MK series)

The MK-series automatically determines whether the input voltage level is 100V or 200V, and will switch accordingly to voltage doubler mode or full wave bridge rectification mode. The rectified voltage level for both modes is similar. The switching between the voltage doubler mode and the full wave bridge rectification mode is done by built-in triac, so minimising use of external components.

The MK-series is housed in a 7 pin single in line package which is light weight, compact and ideal for portable equipment.

2-2 Benefits/Features

- a) Power supply damage caused by selecting wrong rectification mode in manually operated 100V/200V switch is eliminated together with reduced possibility of inductive noise on electrical line.
- b) Power transformer does not have to be designed for full range input voltage, hence the power output is increased.
- c) Few external components required, simplifying design and improved efficiency.
- d) Fully mold package with insulation voltage resistance AC 2KV/1 minute. The internal thickness of the mold is $>0.71\text{mm}$.
- e) Built-in protective device prevent damage resulting from instantaneous outages and voltage drops. (MK1210)
- f) Doubler voltage rectification mode can be delayed using external capacitor on the MK1210.

Absolute Maximum Ratings

Item	Symbol	Conditions	Ratings	Units
Storage Temp.	Tstg		-30 - 125	°C
Operating Temp.	Top	Case Temp.	-10 - 100	°C
Junction Temp.	Tj		125	°C
Peak off-state voltage	VDRM	Tc=25°C	500	V
RMS on-state Current	IT(RMS)	Tc=66°C	10	A
Surge On-state Current	ITSM	Tj=125°C	100	A
Current Square time	I2T	Tc=25°C 2ms ≤ t < 10ms	10	A2S
Power dissipation	PD	Ta=25°C Tc=100°C	2.4 6.0	W
Dielectric Strength	Vdis	1 minute	2	KV
Isolation Resistance	Ris	500V	100	Mohms

Electrical Characteristics (Tc=25°C)

Item	Symbol	Conditions	Ratings	Units	
T R I A C	Off-state Current	IDRM	VDRM=500V	MAX 100	uA
	On-state voltage	VTM	ITM=10A	MAX 1.6	V
	Thermal Resistance	Ojc	Junction to case	MAX 4.1	°C/W
D 1	Reverse Current	IR	VR=800V	MAX 10	uA
	Forward Voltage	VF	IF=0.1A	MAX 1.7	V
Starting Voltage of voltage doubler	Vs(AC) Vs(DC)	pin 3-7	MAX 70 MAX 90	V(AC) V(DC)	
Switch-over voltage	Vc(AC) Vc(DC)	pin 3-7	145-165 195-220	V(AC) V(DC)	
Temp. Coefficient of switch-over voltage	Kt	Tc=-10 to +100°C	TYP -30	mV(AC)/°C	

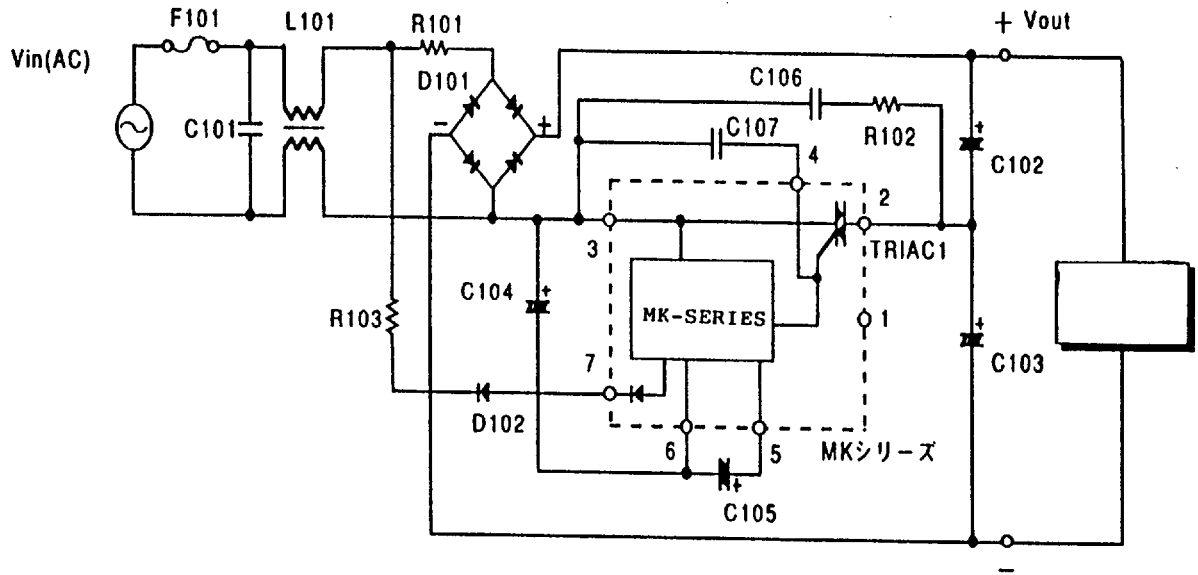
MK1210 Electrical Characteristics
 Absolute Maximum Ratings

Item	Symbol	Conditions	Ratings	Units
Storage Temp.	Tstg		-30 -+125	°C
Operating Temp.	Top	Case Temp.	-10 -+100	°C
Junction Temp.	Tj		+125	°C
Peak off-state voltage	VDRM	Tc=25 °C	500	V
RMS on-state Current	IT(RMS)	Tc=66 °C	10	A
Surge On-state Current	ITSM	Tj=125°C	100	A
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Electrical Characteristics (Tc=25°C)

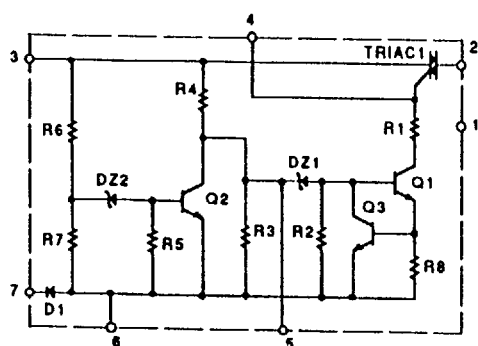
Item	Symbol	Conditions	Ratings	Units
T R I A C	Off-state Current	IDRM	VDRM=500V	MAX 100 uA
	On-state voltage	VTM	ITM=10A	MAX 1.6 V
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Starting Voltage of voltage doubler	Vs(AC) Vs(DC)	pin 3-7	MAX 70 MAX 90	V(AC) V(DC)
Switch-over voltage	Vc(AC) Vc(DC)	pin 3-7	145-165 195-220	V(AC) V(DC)
Temp.Coefficient of switch-over Voltage	Kt	Tc=-10 to +100°C	TYP -30	m(VAC)/°C
Cancel voltage of full wave rect.	VuL	pin 3-7	TYP 25	V(DC)

2-4 Typical Application Example

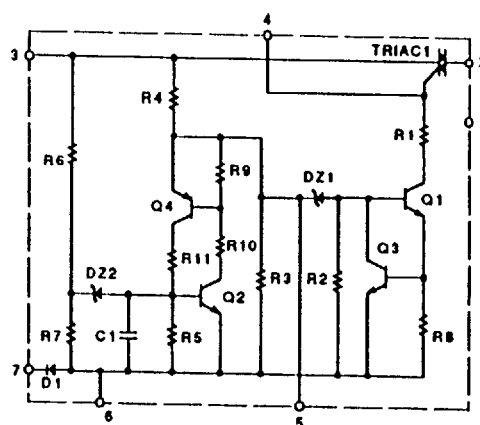


2-5 Equivalent Circuits

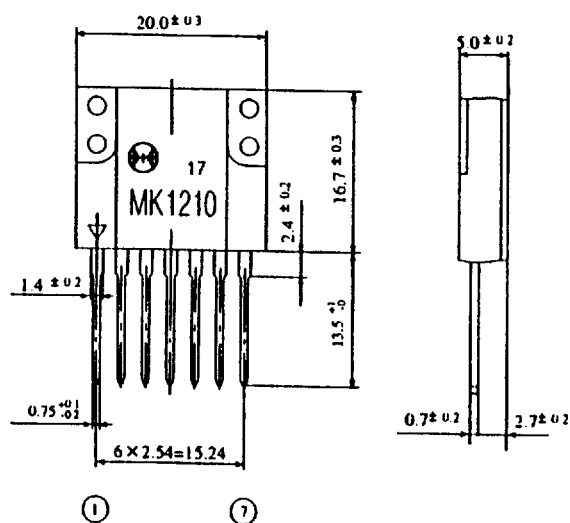
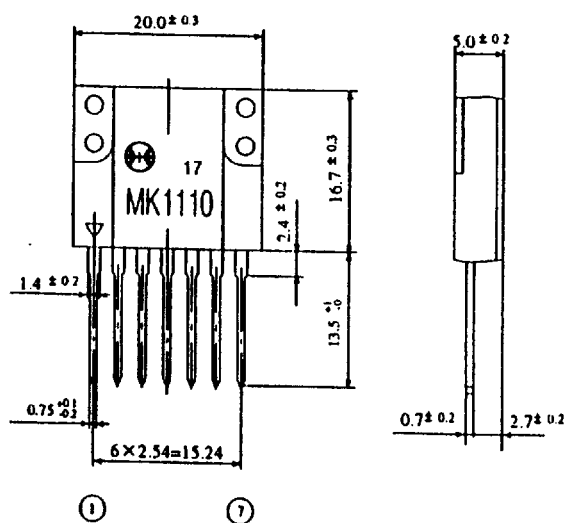
★ MK1110



★ MK1210



2-6 Package information



3) Functional description

3-1 Operation of the Voltage doubler and the Full wave rectification modes.

The MK-series uses voltage doubler rectification when operating at 100V and full wave bridge rectification when operating at 200V. Figures 3a and 3d show the 100V to the 200V mode switching stage.

a) Voltage doubler rectification

In the 100V mode, the Triac is ON. Positive half cycle charge capacitor C1 as shown by ----- line in figure 3a. The negative half cycle charge capacitor C2 as shown by - - - - - line in figure 3a.

The applied 100V voltage results in a peak voltage of 142V across C1 and C2. Note as an approximation whenever the input voltage is at instantaneous minimum, one capacitor is at its minimum, but the other capacitor is half way between peak and the minimum voltage. These rectified voltages result in a ripple wave having an average value of 240V.

b) Full wave bridge rectification

In the 200V mode, the Triac is OFF. Capacitors C1 and C2 in series are charged to peak line voltage each half cycles as shown by ----- and - - - - - lines in figure 3b. The applied 200V results in a peak voltage of 282V across the series capacitors C1 and C2. These rectified voltage results in a ripple wave having an average value of 260V.

3-2 MK-series functional description

When the mains is applied the Triac is in the OFF state. As the mains voltage level rises, typically at 50V the Triac is turned ON as a result of transistor Q1 biased ON via the resistor ladder R3, R4 and zener diode DZ1 (see section 2-5, MK1110 and MK1210 equivalent circuits). At this instant the voltage doubler mode starts.

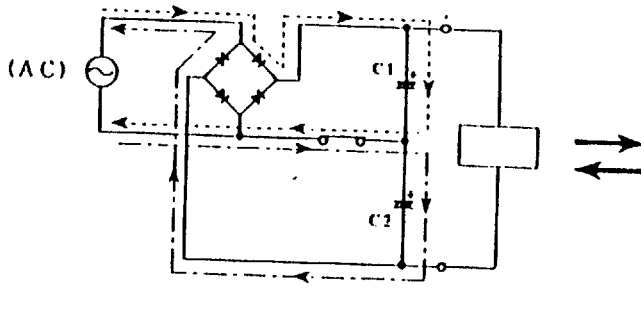
When the input voltage reaches typically 155V, transistor Q2 is biased ON via resistor ladder R6, R7 and zener DZ2 which pulls low the R4 and DZ1 connection switching OFF transistor Q1 in-turn switching Triac OFF. At this point the MK-series pulls out of voltage doubler rectification mode and full wave bridge rectification mode starts, refer to figure 3e.

The MK1210 has built-in protection function to latch into the full wave rectification mode. During full wave rectification transistors Q2 and Q4 are biased ON, keeping Triac OFF. If mains voltage drop or there is mains failure, the MK1210 transistors Q2 and Q4 function as a latch in the ON state thereby not allowing Triac to turn ON. The rectified voltage drops linearly, refer to figure 3f.

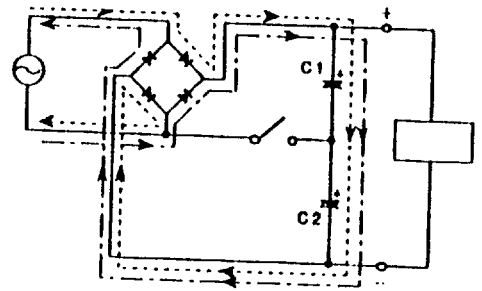
When the mains is reinstated and has not dropped below typically 50VAC, transistors Q2 and Q4 stay latched ON, not allowing MK1210 to drop into voltage doubler mode and continue to function as full wave bridge rectification. Only when the mains is dropped below 50VAC transistor Q2 and Q4 are biased OFF turning Triac ON allowing voltage doubler rectification.

The MK1210 has a delay time function. By means of capacitor (value dependent), refer to section 4-2-2, connected across pin 5 and pin 6, delay can be set from switch ON (mains applied) to MK1210 dropping into voltage doubler mode.

100V/200V Manually Operated Switch

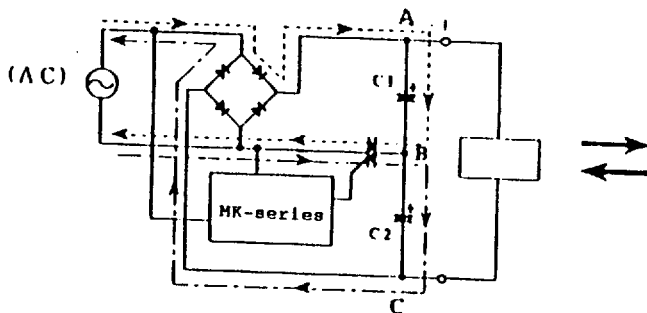


3a (100V)

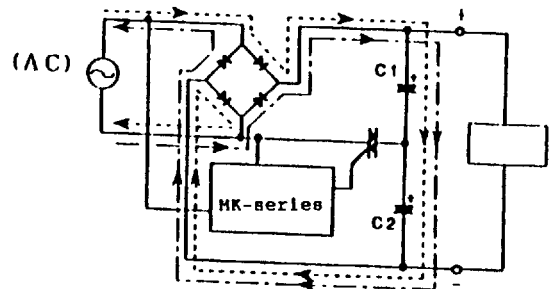


3b (200V)

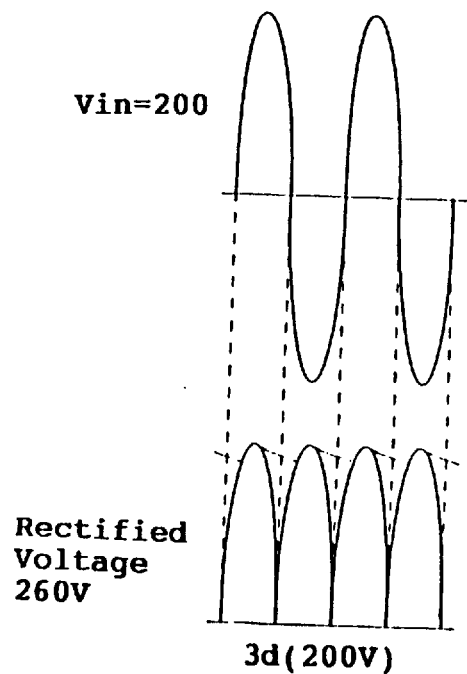
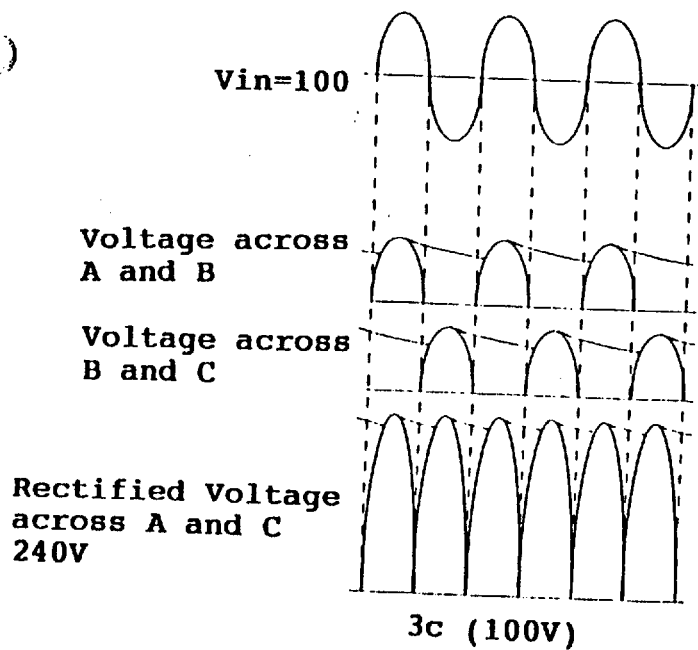
MK-Series



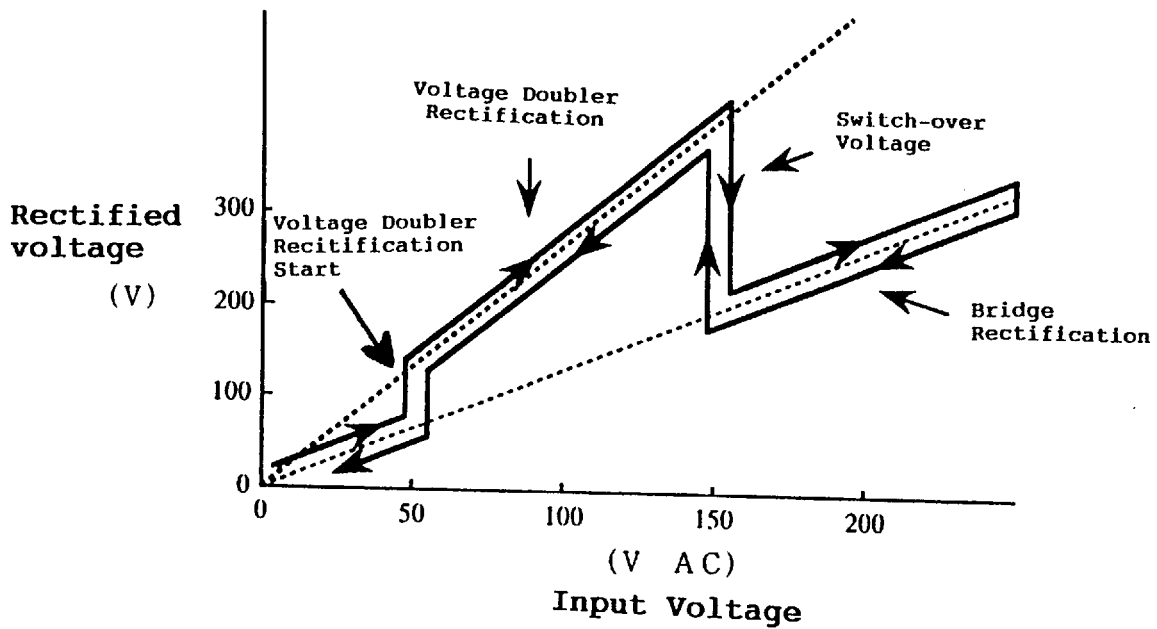
Voltage Doubler Mode



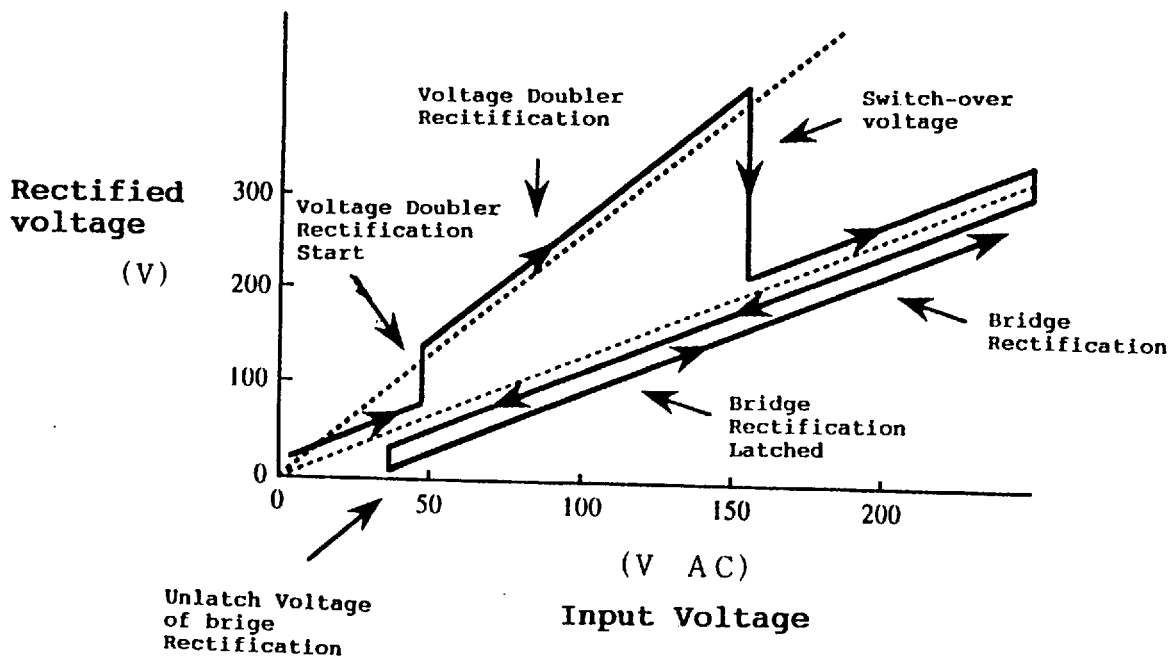
Full wave bridge rectification



NOTE: Triac is built-in the MK-series,
for clarity shown externally



3 e MK 1110

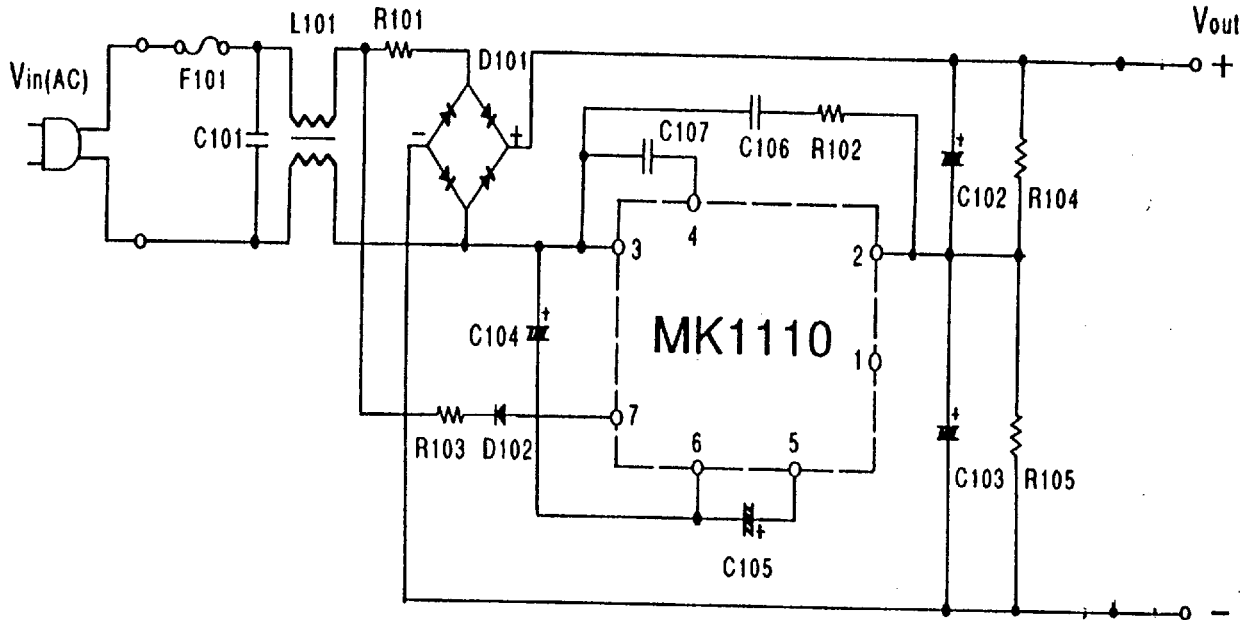


3 f MK 1210

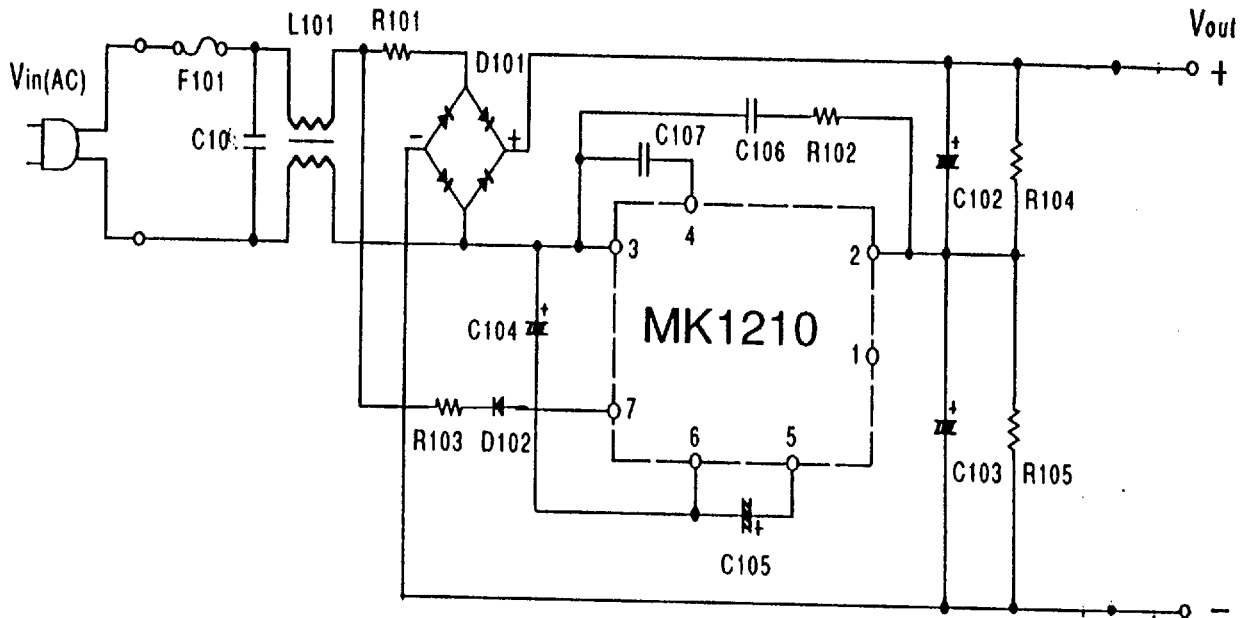
4) Application circuit examples

4-1 Circuit and parts list

4-1-1 MK1110



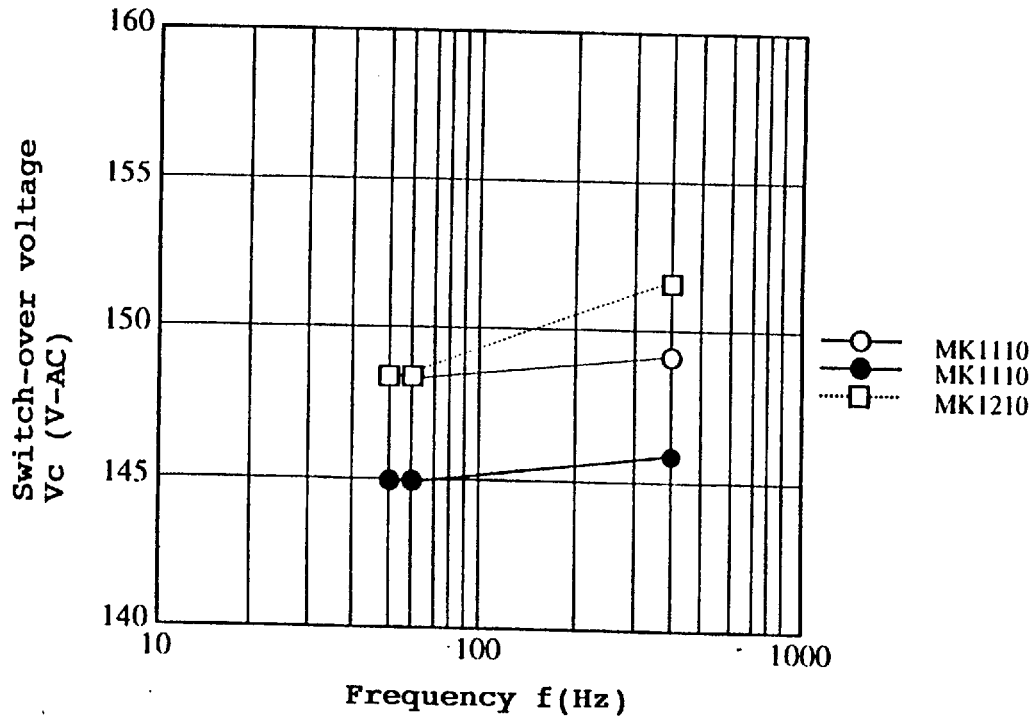
PART No.	TYPE	RATINGS
R102	Metal film resistor	30 ohms 3W
R103	Winding resistor	15 ohms 2W
R104	Metal film resistors	100K ohms 2W
R105	"	100K ohms 2W
C102	Electrolytic capacitor	390uF 250V
C103	"	390uF 250V
C104	"	4.7uF (*) 400V
C105	"	100uF (*) 16V
C106	Film capacitor	0.047uF AC250V
C107	"	0.1uF 50V
D101	Bridge diode	D3SB60
D102	Diode	1KV 1A
* C104 and C105 acts as power source during total power failure to keep MK-series internal cct. powered		



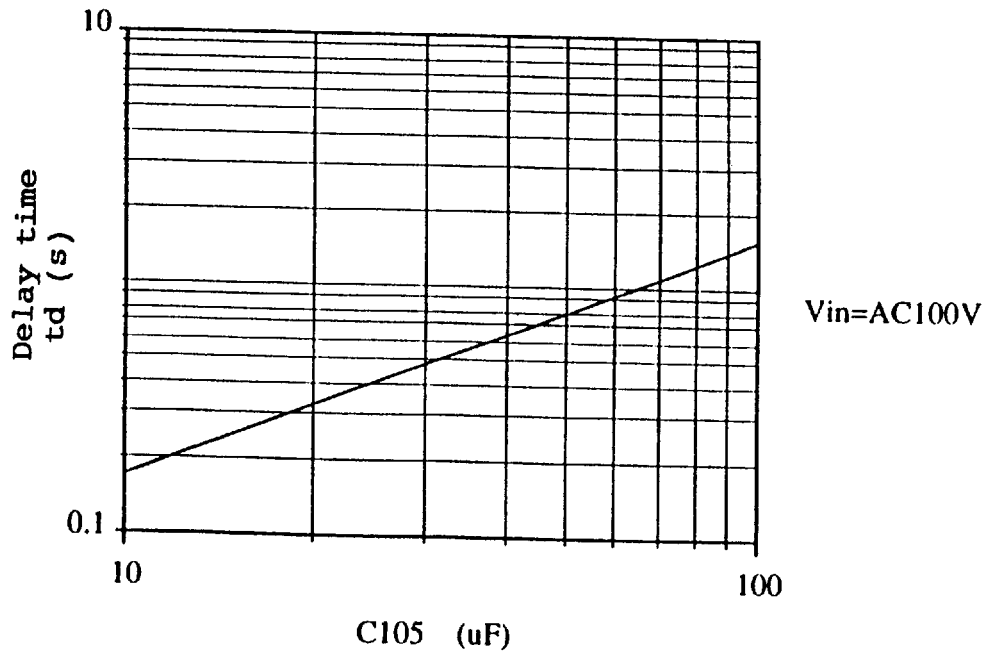
PART No.	TYPE	RATINGS
R102	Metal film resistor	30 ohms 3W
R103	Winding resistor	15 ohms 2W
R104	Metal film resistors	100K ohms 2W
R105	"	100K ohms 2W
C102	Electrolytic capacitor	390uF 250V
C103	"	390uF 250V
C104	"	4.7uF (*2) 400V
C105	"	100uF (*2) 16V
C106	Film capacitor	0.047uF AC250V
C107	"	0.1uF 50V
D101	Bridge diode	D3SB60
D102	Diode	1KV 1A

4-2 Special characteristics

4-2-1 Characteristics of Switch-over voltage versus frequency



4-2-2 MK1210 Voltage double delay time versus capacitor value



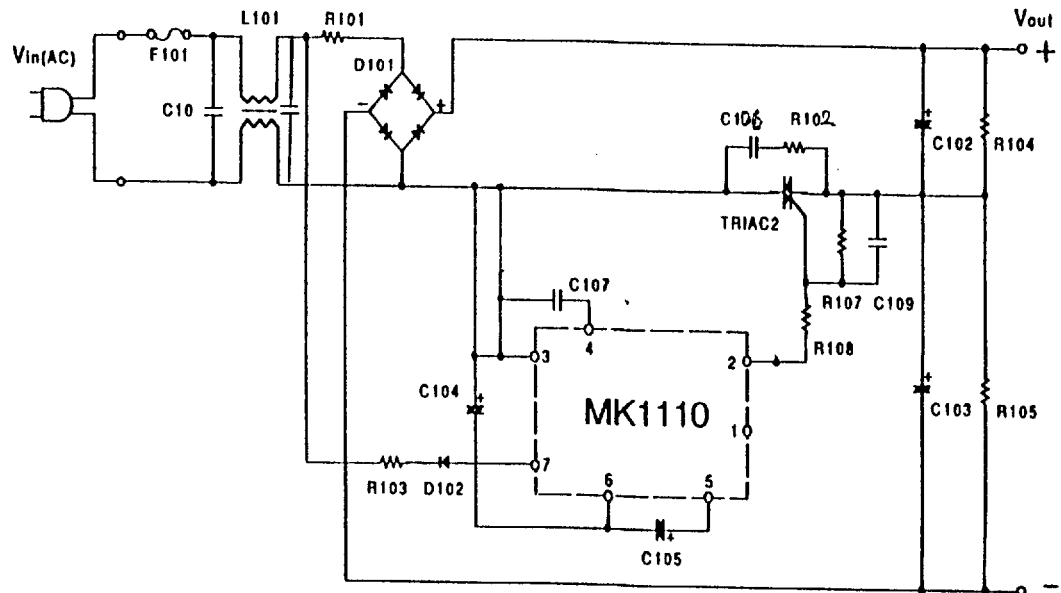
(MK1110 has no time delay function)

5) Miscellaneous

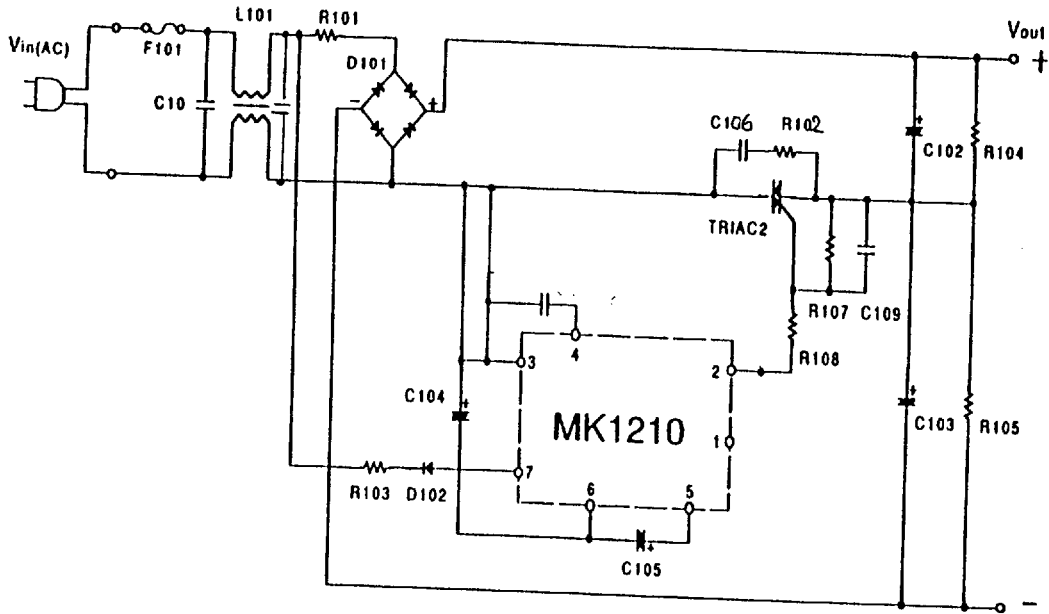
5-1 MK-series high power application circuit example

For high power application external Triac can be used together the MK-series pin 2 which acts as a Triac current gate drive. Section 5-1-1 and 5-1-2 shows application with MK1110 and MK1210 respectively.

5-1-1 MK1110

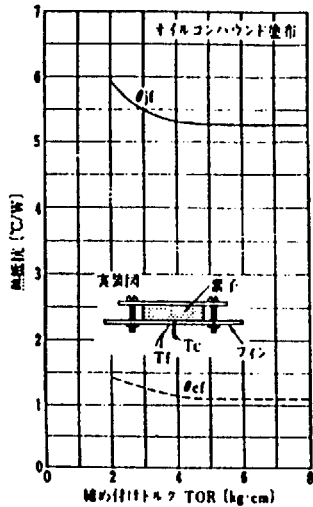


PART No.	TYPE	RATINGS
R102	Metal film resistor	30 ohms 3W
R103	Winding resistor	15 ohms 2W
R104	Metal film resistors	100K ohms 2W
R105	"	100K ohms 2W
R107	Carbon resistors	100 ohms 1/2W
R108	Metal film resistors	100 ohms 1W
C102	Electrolytic capacitor	390uF 250V
C103	"	390uF 250V
C104	"	4.7uF (*) 400V
C105	"	100uF (*') 16V
C106	Film capacitor	0.047uF AC250V
C107	"	0.1uF 50V
C109	"	0.1uF 50V
D102	Diode	1KV 1A

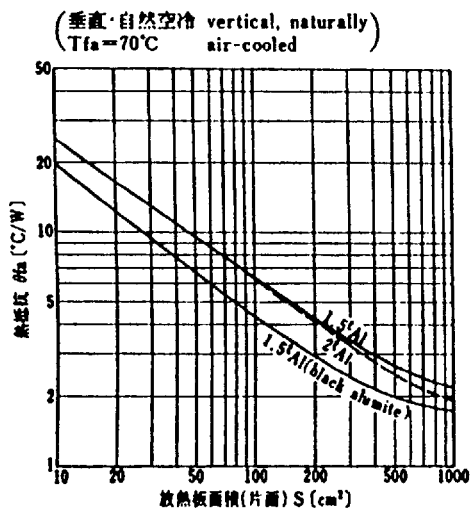


PART No.	TYPE	RATINGS
R102	Metal film resistor	30 ohms 3W
R103	Winding resistor	15 ohms 2W
R104	Metal film resistors	100K ohms 2W
R105	"	100K ohms 2W
R107	Carbon resistors	100 ohms 1/2W
R108	Metal film resistors	100 ohms 1W
C102	Electrolytic capacitor	390uF 250V
C103	"	390uF 250V
C104	"	4.7uF (*1) 400V
C105	"	100uF (*1) 16V
C106	Film capacitor	0.047uF AC250V
C107	"	0.1uF 50V
C109	"	0.1uF 50V
D102	Diode	1kV 1A

5-2 接触熱抵抗 θ_{jf} , θ_{cf}

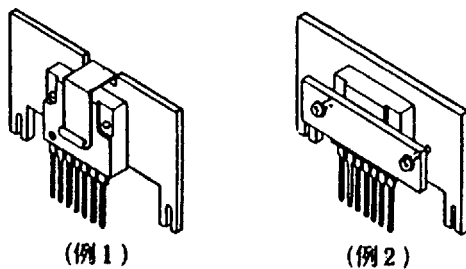


5-3 放熱板面積と熱抵抗



5-4 推奨実装例

放熱フィンへの実装は下記の方法を推奨します。



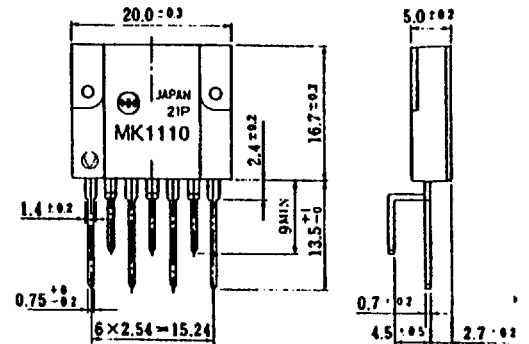
- ※1 例1は小出力の場合に推奨します。それ以上の場合は、例2のような2点締めによる確実な実装を推奨します。
なお、例1で使用する取付クリップはオプション部品として用意してあります。
- ※2 接触熱抵抗を少なくするためにオイルコンパウンドの使用をお勧めします。
- ※3 フィンはバリ等のない平坦なものを使用してください。

※4 プリント基板への挿入はリードのストッパーまでにしてください。

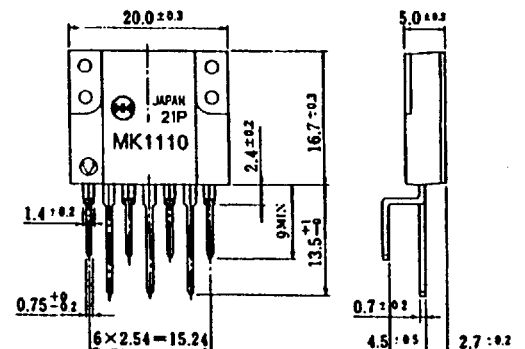
5-5 オプション

(1) フォーミング

●コード番号 4104



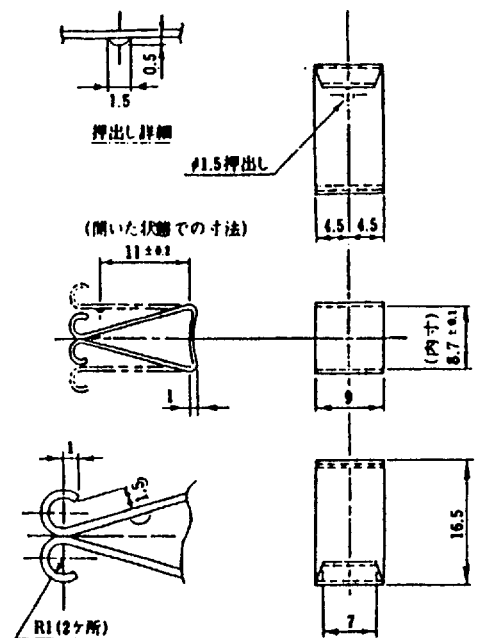
●コード番号 4105



注) フォーミングのご注文の際はモジュールの品名の後にスペースをあげコード番号をご指定ください。

例. MK1110 4104

(2) クリップ

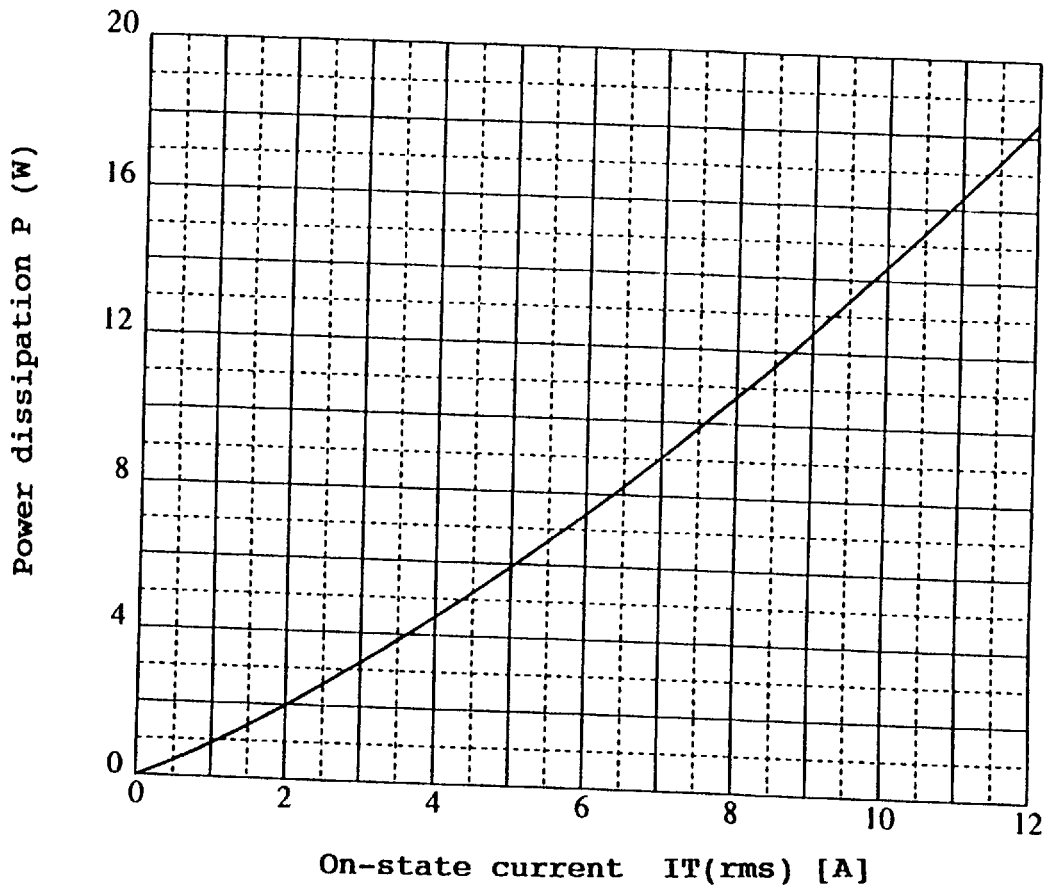


注) クリップ添付でご注文の際はモジュールの品名の後にスペースをあげコード番号4150とご指定ください。

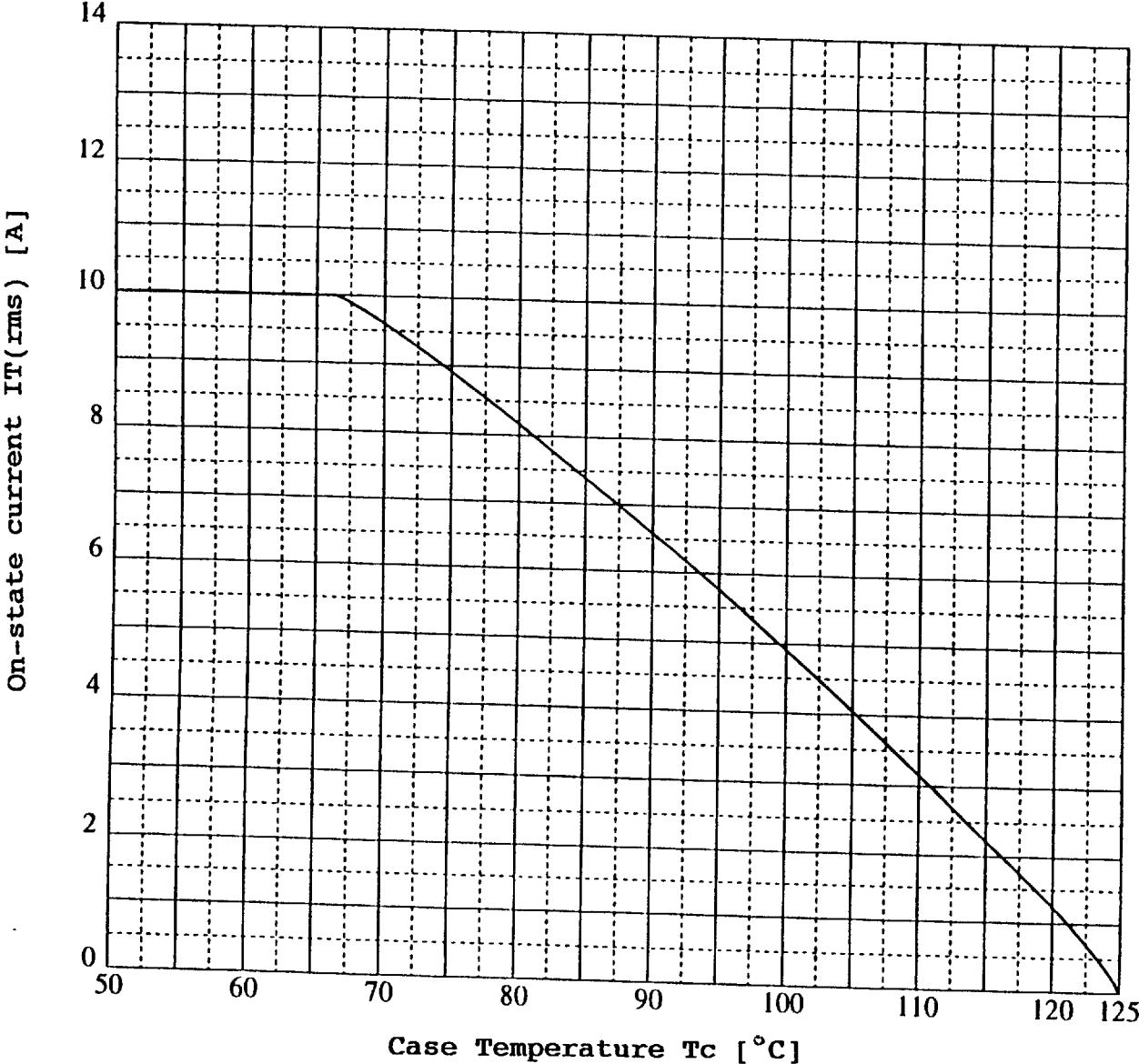
5-6 Triac characteristics

MK1110/MK1210 Power dissipation

$T_j = 125^\circ\text{C}$



MK1110/MK1210 Derating Curve



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6 Reliability

Shindengen makes every effort to maintain and improve the design, quality and reliability of all products. The MK-series uses diodes, transistors and other parts manufactured by Shindengen. All parts have been individually tested to ensure quality and reliability.

1 Test method and conditions

No.	Test Item	Conditions	Period	No. of samples	Failures
1	High Temp. storage	Ta=125°C	1000h	10	0
2	Moisture resistance	Ta=85°C, RH=85%	1000h	10	0
3	High Temp. No o/p with I/P applied	Ta=100°C I/P=200VAC Io=0A	1000h	10	0
4	As above with moisture	Ta=85°C, RH=85% I/P= 200VAC Io=0A	1000h	10	0
5	Temp. cycle	-30°C ~RT~ +125°C (30m)(15m)(30m)	30 cycle	10	0
6	Soldering heat	260°C +/- 5°C 1 - 1.5mm from body	10 sec	10	0
7	Terminal tension	weight 1.0Kg	30 sec	10	0
8	Terminal bending	weight 0.5Kg	2 times	10	0
9	Solderability	230°C +/- 5°C 1 - 1.5mm from body	5 sec	10	0

2 Criteria for passing the test

No	Test item	Conditions	Criteria
1	Starting voltage of voltage doubler (Vs)		MAX 90V(DC)
2	Switch-over Voltage (Vc)		195-220V(DC)
3	Off-state current	VDRM=500V	MAX 200uA
4	On-state voltage	ITM=10A	MAX 1.8V