

Data Sheet

Customer: _____

Product: Metal Film Precision MELF Resistor - MM / MML Series _____

Size : 0102/0204/0207 _____

Issued Date: 25-Aug.-2023 _____

Edition: Ver. 3 _____

Record of change

Date	Ver.	Description	Page
17-Jul.-2017	1		
17-Jan.-2018	2	Revise ohmic range, add surge curve	2,6~10
25-Aug.-2023	3	Revise ohmic range & derating curve	2,6~10

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Prepared by	Checked by	Approved by	Accepted by (customer)
25-Aug.-2023	25-Aug.-2023	25-Aug.-2023	
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Metal Film Precision MELF Resistor

MM/MML Series

■ Features

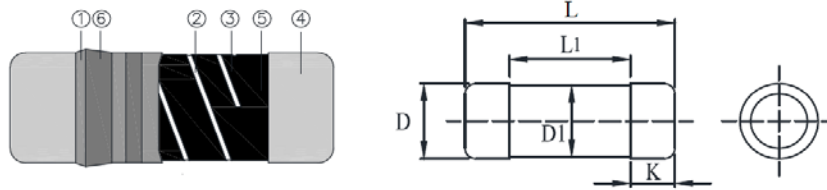
- Excellent overall stability
- Tight tolerance down to $\pm 0.1\%$
- Extremely low TCR down to $\pm 5 \text{ PPM}/^\circ\text{C}$
- High power rating up to 1 Watts



■ Applications

- Telecommunication
- Medical Equipment
- Measurement/Testing Equipment

■ Construction and Dimension



Type	L (mm)	L _{1 min.} (mm)	∅D (mm)	∅D ₁ (mm)	K (mm)
MM102	2.20±0.1	1.1	1.10±0.1	D +0/-0.15	0.45±0.05
MML102	2.20±0.1	1.1	1.10±0.1	D +0/-0.15	0.45±0.05
MM204	3.50±0.2	1.7	1.40±0.15	D +0/-0.2	0.8±0.1
MML204	3.50±0.2	1.7	1.40±0.15	D +0/-0.2	0.8±0.1
MM207	5.90±0.2	2.9	2.20±0.2	D +0/-0.2	1.3±0.1
MML207	5.90±0.2	2.9	2.20±0.2	D +0/-0.2	1.3±0.1

■ Part Numbering

<u>MM204</u>	<u>F</u>	<u>E</u>	-	<u>100KR</u>
Type	Tolerance	TCR(ppm/°C)		Ohmic value
MM102	B= $\pm 0.1\%$	A= ± 5		10R=10Ω
MM204	C= $\pm 0.25\%$	B= ± 10		120R=120Ω
MML204	D= $\pm 0.5\%$	C= ± 15		1K2R=1.2KΩ
MM207	F= $\pm 1\%$	D= ± 25		1MR=1MΩ
MML207	J= $\pm 5\%$	E= ± 50		
		F= ± 100		

Metal Film Precision MELF Resistor

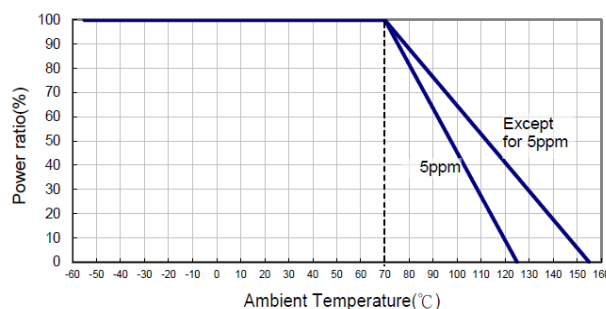
MM/MML Series

■ General Specification

Item Type	Power Rating at 70°C	Operating Temperature Range	Max. Operating Voltage	Max. Overload Voltage	Resistance Range					TCR (PPM/°C)	
					±0.1%	±0.25%	±0.5%	±1%	±5%		
MM102	1/8W	-55 ~ +155°C	150V	300V	100Ω-56KΩ			--		±15	
					100Ω-82KΩ	49.9Ω-200KΩ	49.9Ω-390KΩ	--		±25	
					--		1Ω-1MΩ			±50	
					--			1Ω-1MΩ		±100	
MML102	1/5W	-55 ~ +155°C	200V	400V	100Ω-56KΩ			--		±15	
					100Ω-82KΩ	49.9Ω-200KΩ	49.9Ω-390KΩ	--		±25	
	--				1Ω-1MΩ			±50			
	--				1Ω-1MΩ		±100				
MM204	1/4W	-55 ~ +125°C	200V	400V	10Ω-332KΩ	--			±5		
		-55 ~ +155°C	200V	400V	10Ω-20KΩ			±10			
					10Ω-300KΩ			±15			
					10Ω-1MΩ	10Ω-3.4MΩ	1Ω-4.7MΩ	±25			
					10Ω-1MΩ	1Ω-3.4MΩ	0.2Ω-10MΩ	±50			
					--		0.1Ω-10MΩ		±100		
Jumper:2A	--			0Ω(<15mΩ)		--					
MML204	2/5W	-55 ~ +125°C	200V	400V	10Ω-332KΩ	--			±5		
		-55 ~ +155°C	200V	400V	10Ω-20KΩ			±10			
					10Ω-300KΩ			±15			
					10Ω-1MΩ	10Ω-3.4MΩ	1Ω-4.7MΩ	±25			
					10Ω-1MΩ	1Ω-3.4MΩ	0.2Ω-10MΩ	±50			
					--		0.1Ω-10MΩ		±100		
--			0Ω(<15mΩ)		--						
MM207	1/2W	-55 ~ +125°C	300V	600V	10Ω-332KΩ	--			±5		
		-55 ~ +155°C	300V	600V	10Ω-20KΩ			±10			
					10Ω-300KΩ			±15			
					10Ω-1MΩ	10Ω-3.4MΩ	1Ω-4.7MΩ	±25			
					10Ω-1MΩ	1Ω-3.4MΩ	0.2Ω-10MΩ	±50			
					--		0.1Ω-10MΩ		±100		
Jumper:4A	--			0Ω(<15mΩ)		--					
MML207	1W	-55 ~ +125°C	300V	600V	10Ω-332KΩ	--			±5		
		-55 ~ +155°C	300V	600V	10Ω-20KΩ			±10			
					10Ω-300KΩ			±15			
					10Ω-1MΩ	10Ω-3.4MΩ	1Ω-4.7MΩ	±25			
					10Ω-1MΩ	1Ω-3.4MΩ	0.2Ω-10MΩ	±50			
					--		0.1Ω-10MΩ		±100		

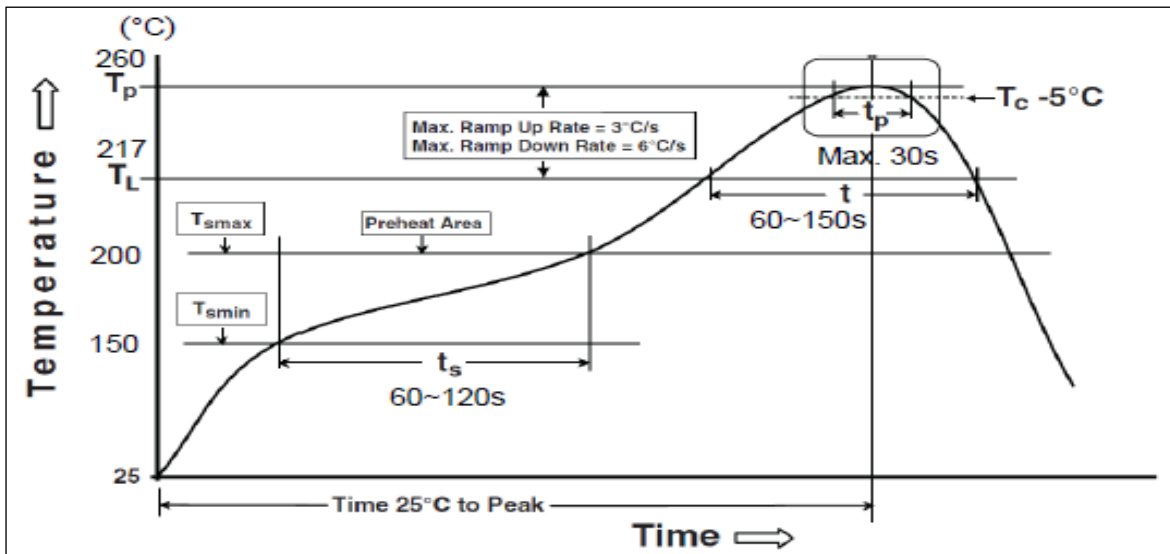
- Operating Voltage= $\sqrt{P * R}$ or Max. Operating Voltage listed above, whichever is lower.
- Overload Voltage= $2.5 * \sqrt{P * R}$ or Max. Overload Voltage listed above, whichever is lower.

■ Derating Curve



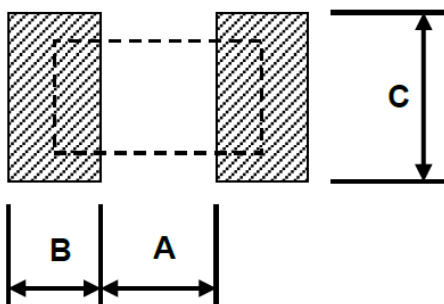
Metal Film Precision MELF Resistor MM/MML Series

■ Soldering Condition (Ref. IPC/JEDEC J-STD-020 & J-STD-002)



Reflow Profiles	
Profile Feature	Pb-Free Assembly
Preheat	
Min. Temperature (T _{smin})	150 °C
Max. Temperature (T _{smax})	200 °C
Preheating time (t _s) from (T _{smin} to T _{smax})	60-120 seconds
Ramp-up rate (T _L to T _p)	3 °C/second max.
Liquidous temperature (T _L)	217 °C
Time (t _L) maintained above T _L	60-150 seconds
Min. Peak temperature (T _p min)	235°C
Max. Peak temperature (T _p max)	260°C
Time (t _p) within 5 °C of the specified classification temperature (T _c)	30 seconds max.
Ramp-down rate (T _p to T _L)	6 °C/second max.
Time 25 °C to peak temperature	8 minutes max.

■ Recommend Land Pattern



Type	A (mm)	B (mm)	C (mm)
MM/MML102	1.0	0.8	1.5
MM/MML204	1.6	1.2	1.6
MM/MML207	3.0	1.7	2.4

Metal Film Precision MELF Resistor MM/MML Series

■ Environmental Characteristics

Item	Requirement		Test Method
	5% and Below	Jumper	
Temperature Coefficient of Resistance (T.C.R.)	As Spec		JIS-C-5201-1 4.8 IEC-60115-1 4.8 At 25°C /-55°C and 25°C /+125°C, 25°C is the reference temperature 5ppm: At 25°C /-10°C and 25°C /+85°C, 25°C is the reference temperature
Short Time Overload	±(0.15%+0.05Ω) 5ppm: ±(0.05%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.13 IEC-60115-1 4.13 RCWV*2.5 or Max. Overload Voltage whichever is lower for 5 seconds
Insulation Resistance	≥ 10G		JIS-C-5201-1 4.6 IEC-60115-1 4.6 Max. Overload Voltage for 1 minute
Endurance	±(0.5%+0.05Ω) 5ppm: ±(0.25%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.25 IEC-60115-1 4.25.1 70±2°C, RCWV for 1000 hrs with 1.5 hrs "ON" and 0.5 hr "OFF"
Damp Heat with Load	±(1.0%+0.05Ω) 5ppm: ±(0.25%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.24 IEC-60115-1 4.24 40±2°C, 90~95% R.H., RCWV for 1000 hrs with 1.5 hrs "ON" and 0.5 hr "OFF"
Dry Heat	±(1.0%+0.05Ω) 5ppm: ±(0.25%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.23 IEC-60115-1 4.23.2 at +125°C /+155°C for 1000 hrs
Bending Strength	±(0.5%+0.05Ω) 5ppm: ±(0.1%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.33 IEC-60115-1 4.33 Bending once for 5 seconds with 2mm
Solderability	95% min. coverage		JIS-C-5201-1 4.17 IEC-60115-1 4.17 245±5°C for 3 seconds
Resistance to Soldering Heat	±(0.5%+0.05Ω) 5ppm: ±(0.05%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.18 IEC-60115-1 4.18 260±5°C for 10 seconds
Voltage Proof	No breakdown or flashover		JIS-C-5201-1 4.7 IEC-60115-1 4.7 1.42 times Max. Operating Voltage for 1 minute
Leaching	Individual leaching area ≤ 5% Total leaching area ≤ 10%		JIS-C-5201-1 4.18 IEC-60068-2-58 8.2.1 260±5°C for 30 seconds
Rapid Change of Temperature	±(0.5%+0.05Ω) 5ppm: ±(0.2%+0.01Ω)	<15mΩ	JIS-C-5201-1 4.19 IEC-60115-1 4.19 -55°C to +125°C /+155°C, 5 cycles

** RCWV(Rated Continuous Working Voltage)= $\sqrt{(P * R)}$ or Max. Operating Voltage whichever is lower.

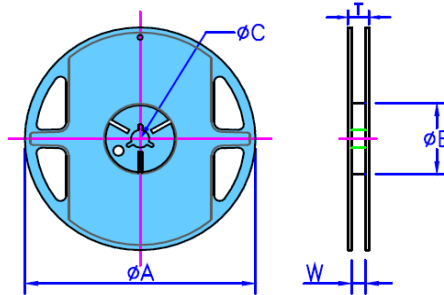
■ **Storage Temperature: 15~28°C; Humidity <80%RH**

■ **Shelf Life: 2 years from production date.**

Metal Film Precision MELF Resistor MM/MML Series

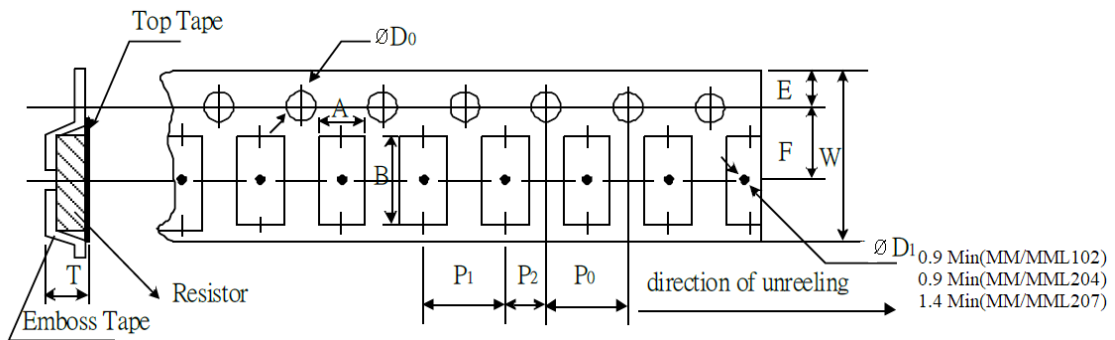
■ Packaging

Packaging Quantity & Reel Specifications :



Type	Reel Diameter	ΦA (mm)	ΦB (mm)	ΦC (mm)	W (mm)	T (mm)	Emboss Plastic Tape (EA)
MM/MML102	7 inch	178.5±1.5	60.0+1.0	13.0±0.2	9.0±0.5	12.5±0.5	3,000
MM/MML204	7 inch	178.5±1.5	60.0+1.0	13.0±0.2	9.0±0.5	12.5±0.5	3,000
MM/MML207	7 inch	178.5±1.5	60.0+1.0	13.0±0.5	13.0±0.5	15.5±0.5	2,000

Emboss Plastic Tape Specifications :



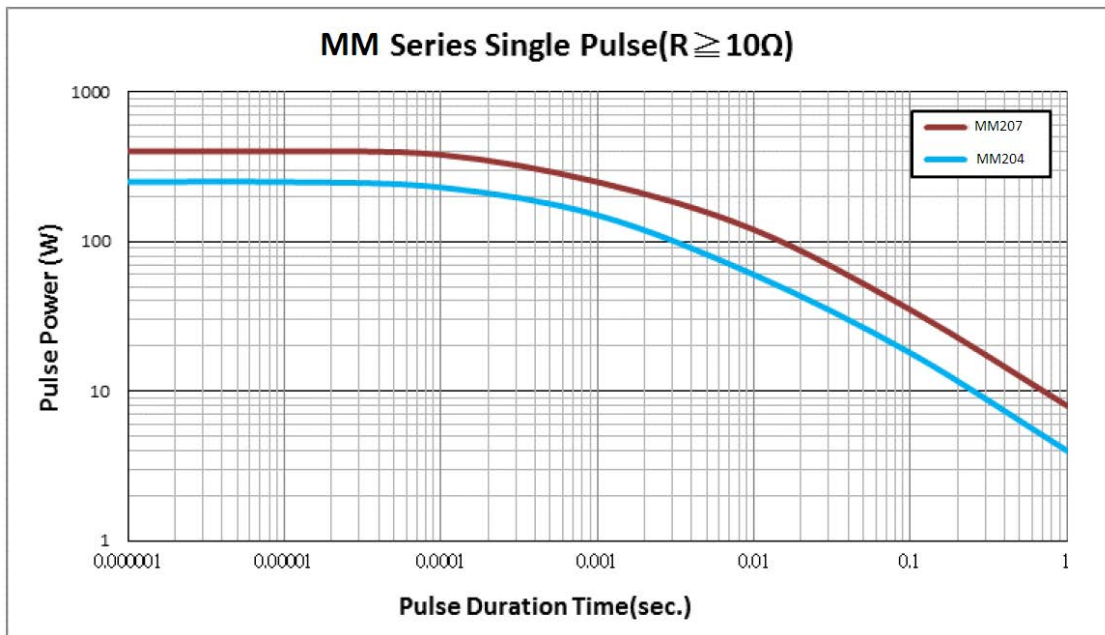
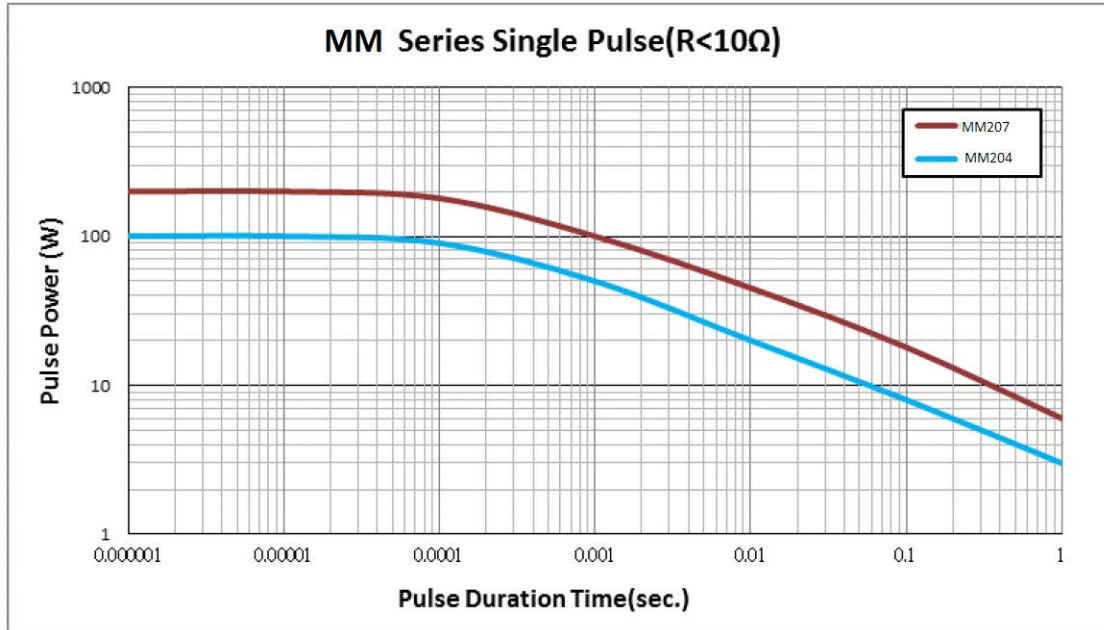
Type	A (mm)	B (mm)	W (mm)	E (mm)	F (mm)	P0 (mm)	P1 (mm)	P2 (mm)	ΦD0 (mm)	T (mm)
MM/MML102	1.30±0.20	2.40±0.20	8.0±0.10	1.75±0.10	3.50±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.50+0.10	1.50±0.10
MM/MML204	1.55±0.20	3.65±0.20	8.0±0.10	1.75±0.10	3.50±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.50+0.10	1.80±0.10
MM/MML207	2.40±0.10	6.15±0.10	12.0±0.10	1.75±0.10	5.50±0.05	4.00±0.10	4.00±0.10	2.00±0.05	1.50+0.10	2.70±0.10

Metal Film Precision MELF Resistor

MM/MML Series

■ Pulse withstanding capacity

The single impulse graph is the result of the impulse of rectangular shape applied. The limit of acceptance was a shift in resistance of less than 1% from the initial value. The power applied was subject to the restrictions of the maximum permissible impulse voltage graph shown.

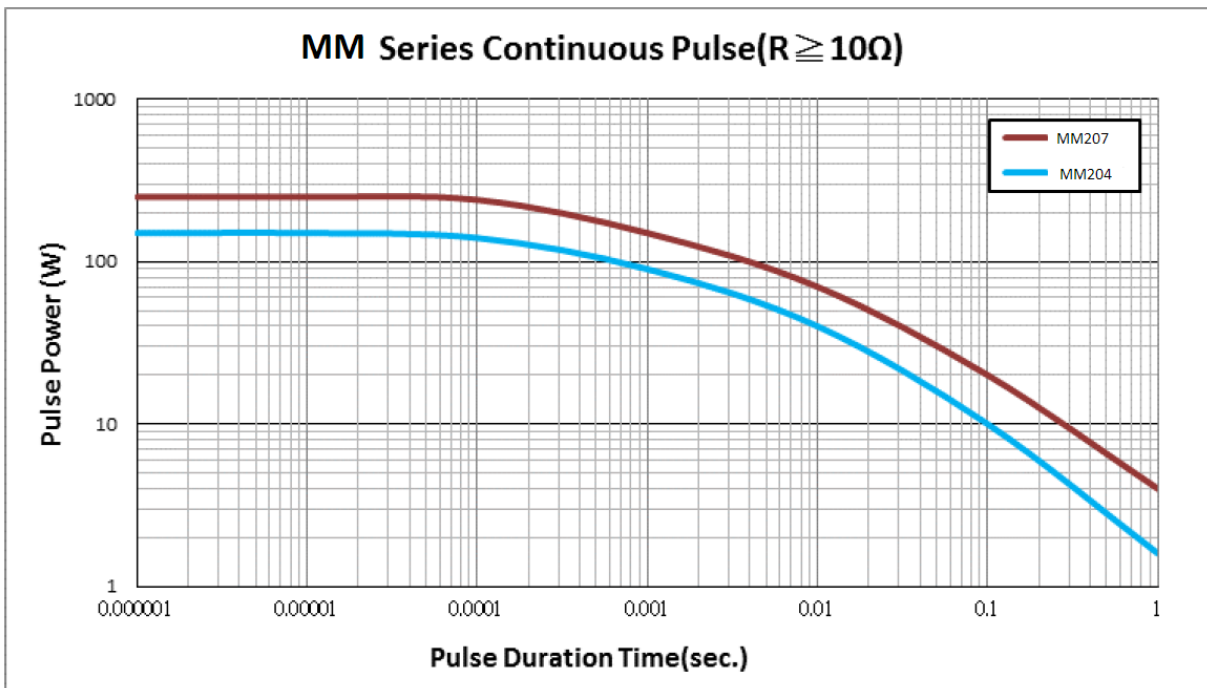
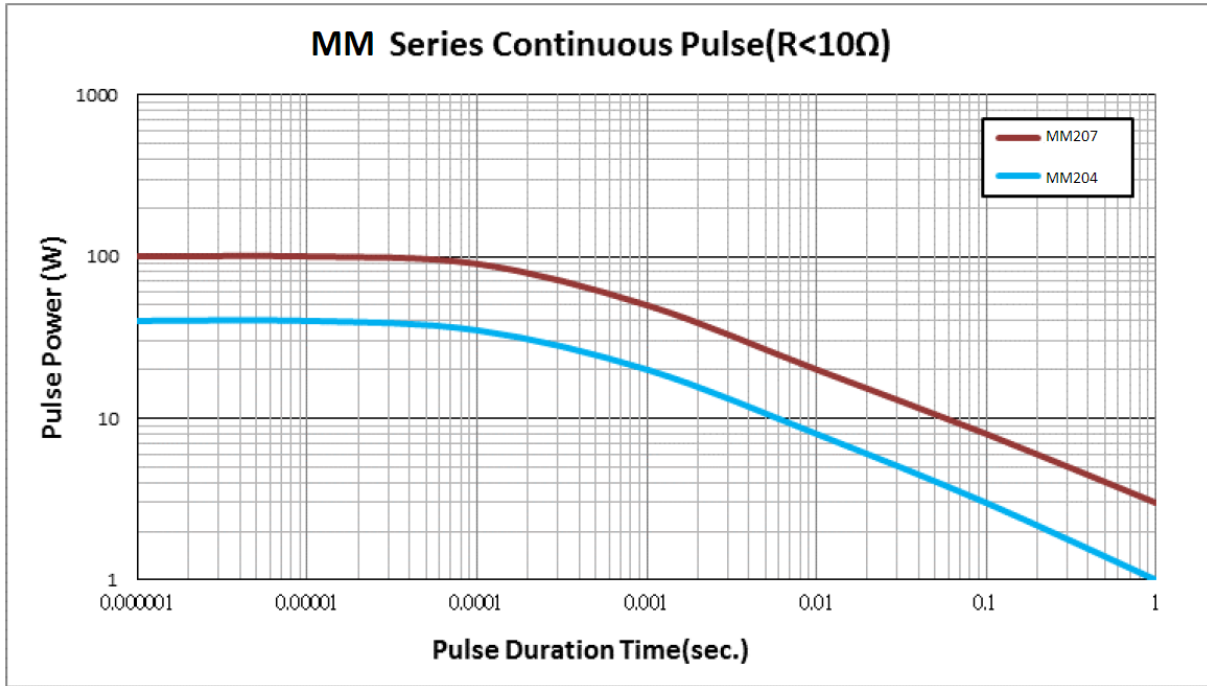


Metal Film Precision MELF Resistor

MM/MML Series

■ Continuous Pulse

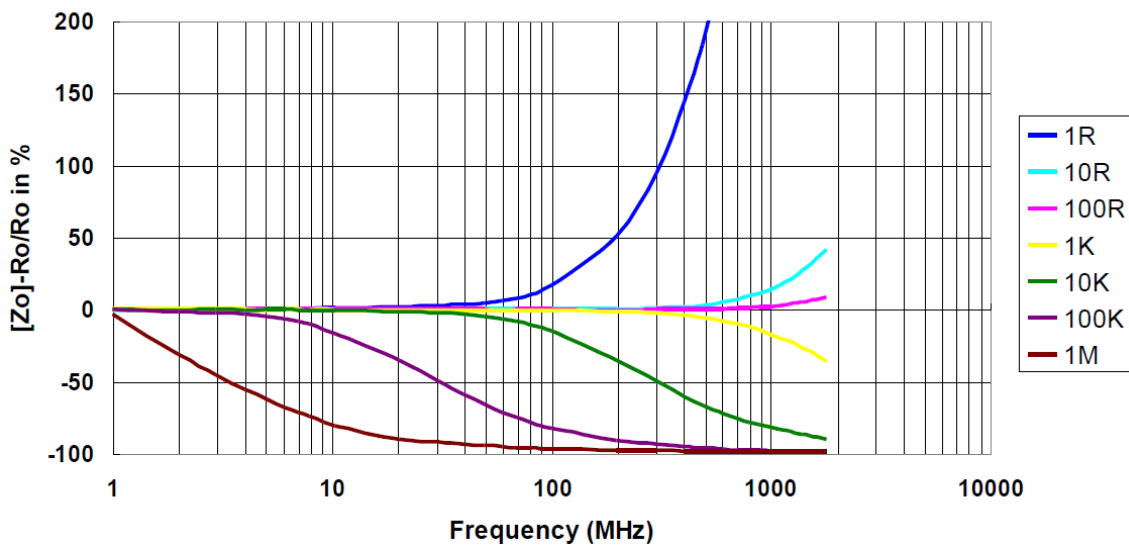
The continuous load graph was obtained by applying repetitive rectangular pulses where the pulse period was adjusted so that the average power dissipated in the resistor was equal to its rated power at 70°C. Again the limit of acceptance was a shift in resistance of less than 1% from the initial value.



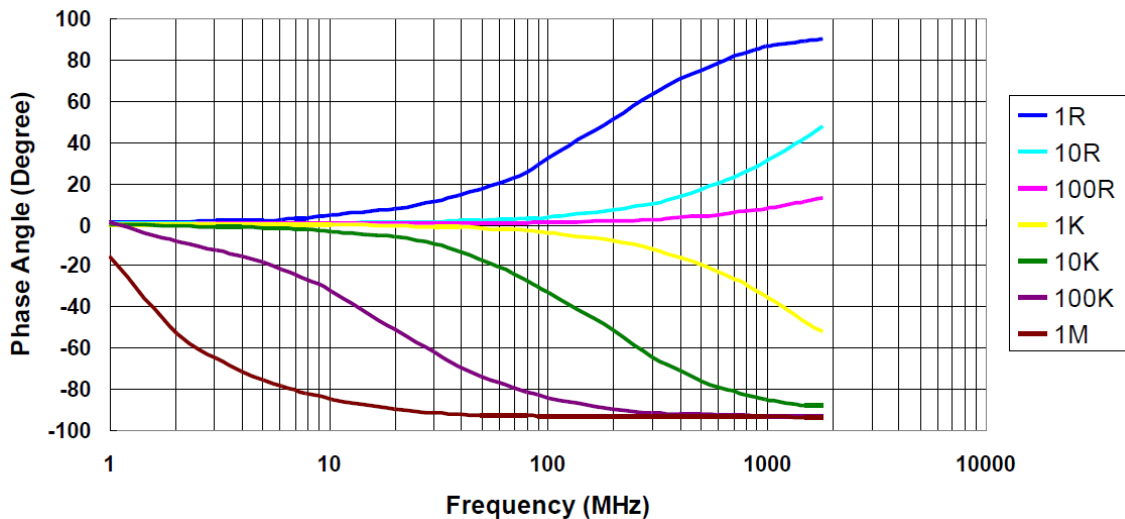
■ **Frequency behavior**

Resistors are designed to function according to ohmic laws. This is basically true of resistors for frequencies up to 100kHz. At higher frequencies, there is an additional contribution to the impedance by an ideal resistor switched in series with a coil and both switched parallel to a capacitor. The values of the capacitance and inductance are mainly determined by the dimensions of the terminations and the conductive path length. The environment surrounding components has a large influence on the behavior of the component on the printed-circuit board.

**Frequency vs. Impedance
MM Series (MM204)**



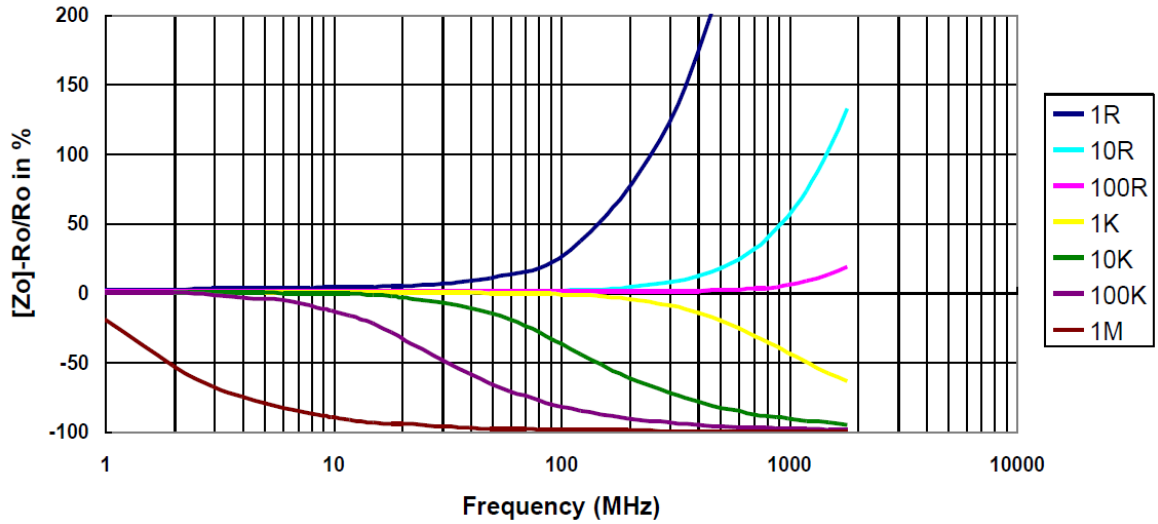
**Frequency vs. Phase Angle
MM Series (MM204)**



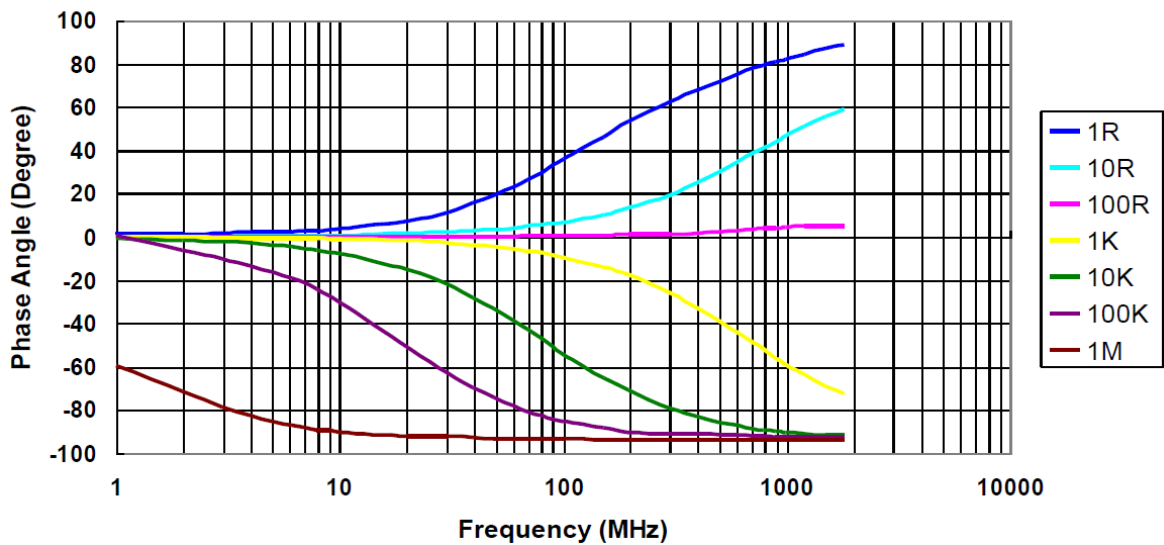
Metal Film Precision MELF Resistor

MM/MML Series

Frequency vs. Impedance
MM Series (MM207)



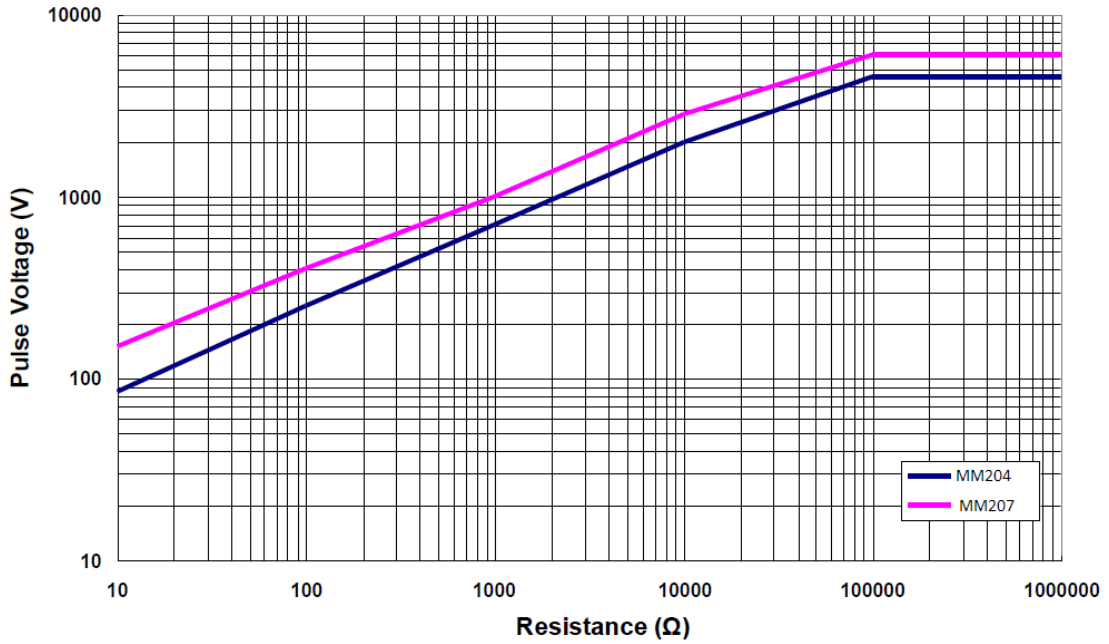
Frequency vs. Phase Angle
MM Series (MM207)



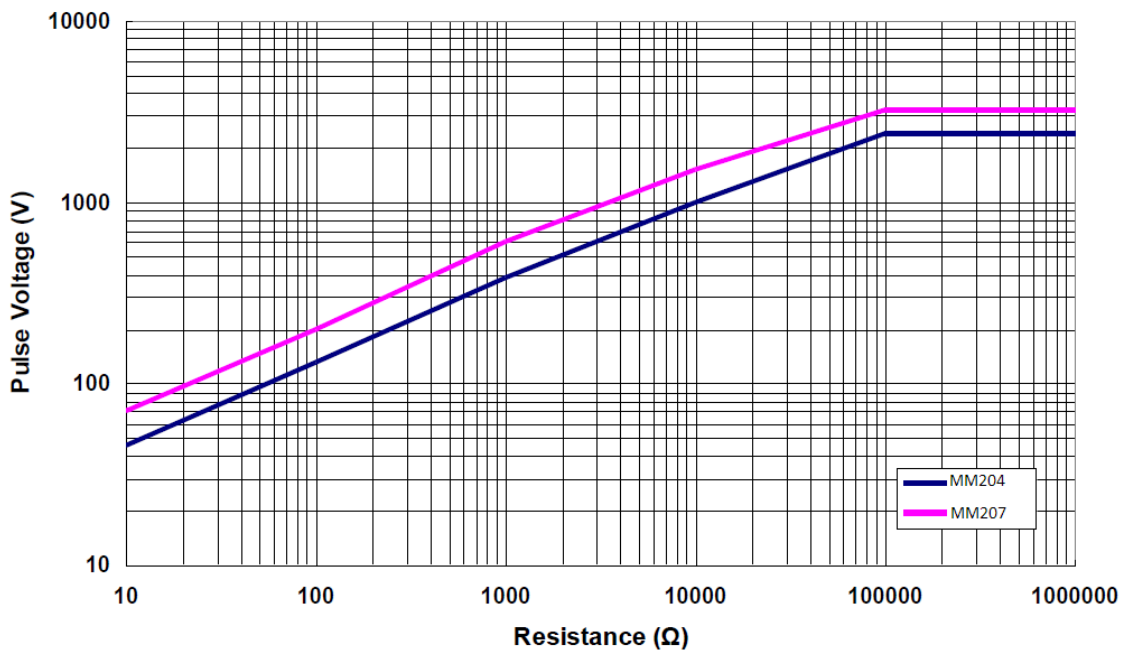
■ **Lightning Surge**

Resistors are tested in accordance with IEC 60 115-1 using both 1.2/50us and 10/700us pulse shapes. The limit of acceptance is a shift in resistance of less than 0.5% from the initial value.

1.2/50µs Lightning Surge



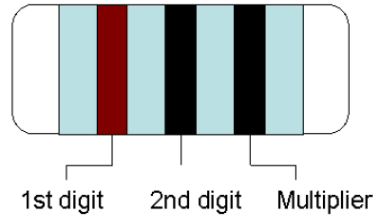
10/700µs Lightning Surge



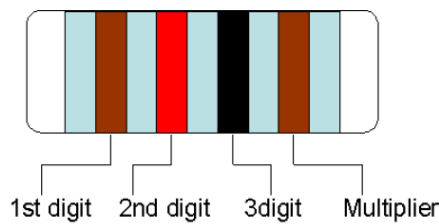
Metal Film Precision MELF Resistor

MM/MML Series

■ Marking & Resistance Tolerance



±5%	E-24	1.0	1.1	1.2	1.3	1.5	1.6	1.8	2.0	2.2	2.4	2.7	3.0	3.3	3.6	3.9	4.3	4.7	5.1	5.6	6.2	6.8	7.5	8.2	9.1
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±1%	E-96	1.00	1.02	1.05	1.07	1.10	1.13	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.37	1.40	1.43	1.47	1.50	1.54	1.58	1.62	1.65	1.69	1.74
		1.78	1.82	1.87	1.91	1.96	2.00	2.05	2.10	2.15	2.21	2.26	2.32	2.37	2.43	2.49	2.55	2.61	2.67	2.74	2.80	2.87	2.94	3.01	3.09
		3.16	3.24	3.32	3.40	3.48	3.57	3.65	3.74	3.83	3.92	4.02	4.12	4.22	4.32	4.42	4.53	4.64	4.75	4.87	4.99	5.11	5.23	5.36	5.49
		5.62	5.76	5.90	6.04	6.19	6.34	6.49	6.65	6.81	6.98	7.15	7.32	7.50	7.68	7.87	8.06	8.25	8.45	8.66	8.87	9.09	9.31	9.53	9.76
±0.5% ±0.25% ±0.1%	E-192	10.0	10.1	10.2	10.4	10.5	10.6	10.7	10.9	11.0	11.1	11.3	11.4	11.5	11.7	11.8	12.0	12.1	12.3	12.4	12.6	12.7	12.9	13.0	13.2
		13.3	13.5	13.7	13.8	14.0	14.2	14.3	14.5	14.7	14.9	15.0	15.2	15.4	15.6	15.8	16.0	16.2	16.4	16.5	16.7	16.9	17.2	17.4	17.6
		17.8	18.0	18.2	18.4	18.7	18.9	19.1	19.3	19.6	19.8	20.0	20.3	20.5	20.8	21.0	21.3	21.5	21.8	22.1	22.3	22.6	22.9	23.2	23.4
		23.7	24.0	24.3	24.6	24.9	25.2	25.5	25.8	26.1	26.4	26.7	27.1	27.4	27.7	28.0	28.4	28.7	29.1	29.4	29.8	30.1	30.5	30.9	31.2
		31.6	32.0	32.4	32.8	33.2	33.6	34.0	34.4	34.8	35.2	35.7	36.1	36.5	37.0	37.4	37.9	38.3	38.8	39.2	39.7	40.2	40.7	41.2	41.7
		42.2	42.7	43.2	43.7	44.2	44.8	45.3	45.9	46.4	47.0	47.5	48.1	48.7	49.3	49.9	50.5	51.1	51.7	52.3	53.0	53.6	54.2	54.9	55.6
		56.2	56.9	57.6	58.3	59.0	59.7	60.4	61.2	61.9	62.6	63.4	64.2	64.9	65.7	66.5	67.3	68.1	69.0	69.8	70.6	71.5	72.3	73.2	74.1
		75.0	75.9	76.8	77.7	78.7	79.6	80.6	81.6	82.5	83.5	84.5	85.6	86.6	87.6	88.7	89.8	90.9	92.0	93.1	94.2	95.3	96.5	97.6	98.8

Color	Digit	Multiplier
Silver	-	10 ⁻²
Gold	-	10 ⁻¹
Black	0	10 ⁰
Brown	1	10 ¹
Red	2	10 ²
Orange	3	10 ³
Yellow	4	10 ⁴
Green	5	10 ⁵
Blue	6	10 ⁶
Violet	7	10 ⁷
Grey	8	10 ⁸
White	9	10 ⁹

※ Resistance more than two significant figures(<1R) or more than three significant figures(>1R) will not provide color code