No. P-JAA-001
DATE 2007-01

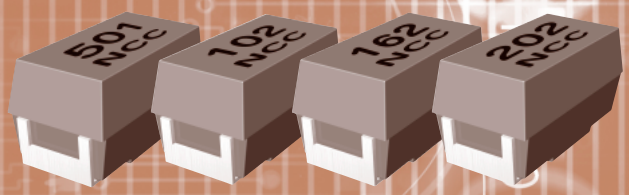
PRODUCTS DATA SHEET

CIRCUIT PROTECTOR

Type JAA

RoHS COMPLIANT

Size 3216



MATSUO ELECTRIC CO., LTD.

Type JAA circuit protection is designed for fuse function against excessive current around battery in portable electronic equipment because the demand for high capacity batteries is increasing.
Since it is designed as chip type, it is compact and the best suitable for portable use.
Also, the ecology design of Type JAA is gentle because of elimination of lead from terminals.

FEATURES

1. Low fusing point element that is newly developed is applied.
   Has excellent fusing and cutting characteristics.
2. Surface temperature rise is 100°C or less when applying 200% rated current for fusing. This offers less influence on the peripheral units.
3. Size 3216 (3.2 × 1.6 × 1.6 mm), using resin mold and precision case
4. Suitable for automatic mounting
5. Precise dimensions allows high-density mounting and symmetrical construction of terminals provide “Self-Alignment”.
6. Resistance to soldering heat : Reflow or flow soldering 10 seconds at 260°C
7. Standard package : 8 mm width tape carrier.
8. LEAD FREE and RoHS Compliant

RATING

Item	Ratings
Category Temperature Range	-40 ~ +125°C
Rated Current	0.5–0.63–0.8–1.0–1.25–1.6–2.0 A
Rated Voltage	24 VDC
Voltage Drop	Refer to the list of standard products.
Insulation Resistance (between terminals and case)	1000 MΩ or more
Fusing Characteristics	Fusing within 2 minute if the current is 200% of rated current.

ORDERING INFORMATION

J A A　2 4 0 2　1 0 2　N A　0 1 0

Type	Code	RV
JAA	2402	24 V

Code	Rated current
501	0.5 A
631	0.63 A
801	0.8 A
102	1.0 A
132	1.25 A
162	1.6 A
202	2.0 A

Code	Package type
NA	ϕ180 Reel
ND	ϕ330 Reel

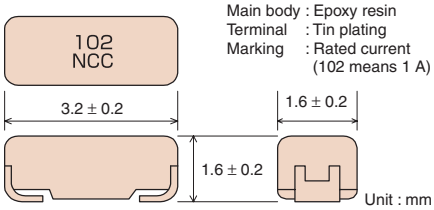
Special product code
010

CATALOG NUMBERS AND RATING

Catalog number	Rated current A	Internal resistance mΩ (Typical)	Voltage drop mV (Max.)	I^2t* A^2s (Typical)	Rated voltage VDC
JAA 2402 501 □□010	0.5	154	100	0.026	24
JAA 2402 631 □□010	0.63	110	100	0.043	
JAA 2402 801 □□010	0.8	82	100	0.090	
JAA 2402 102 □□010	1.0	63	100	0.14	
JAA 2402 132 □□010	1.25	50	100	0.25	
JAA 2402 162 □□010	1.6	39	100	0.35	
JAA 2402 202 □□010	2.0	30	100	0.68	

*Reference I^2t is defined as the value when 10 times rated current is applied.

DIMENSIONS



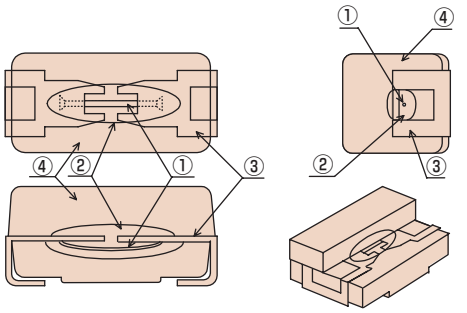
Main body : Epoxy resin
Terminal : Tin plating
Marking : Rated current
(102 means 1 A)

Unit : mm

MARKING

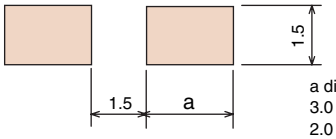
Code	Rated current
501	0.5 A
631	0.63 A
801	0.8 A
102	1.0 A
132	1.25 A
162	1.6 A
202	2.0 A

CONSTRUCTION



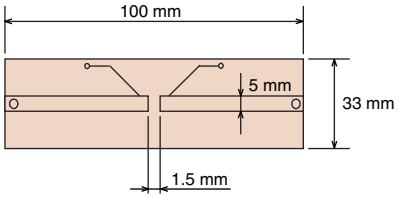
Number	Name	Material etc.
①	Fuse element	Lead alloy
②	Arc extinction material	Silicone resin
③	Terminal	Tin plating
④	Body	Epoxy resin

RECOMMENDED PAD DIMENSIONS



a dimension
3.0 (flow)
2.0 (reflow)

STANDARD TEST BOARD

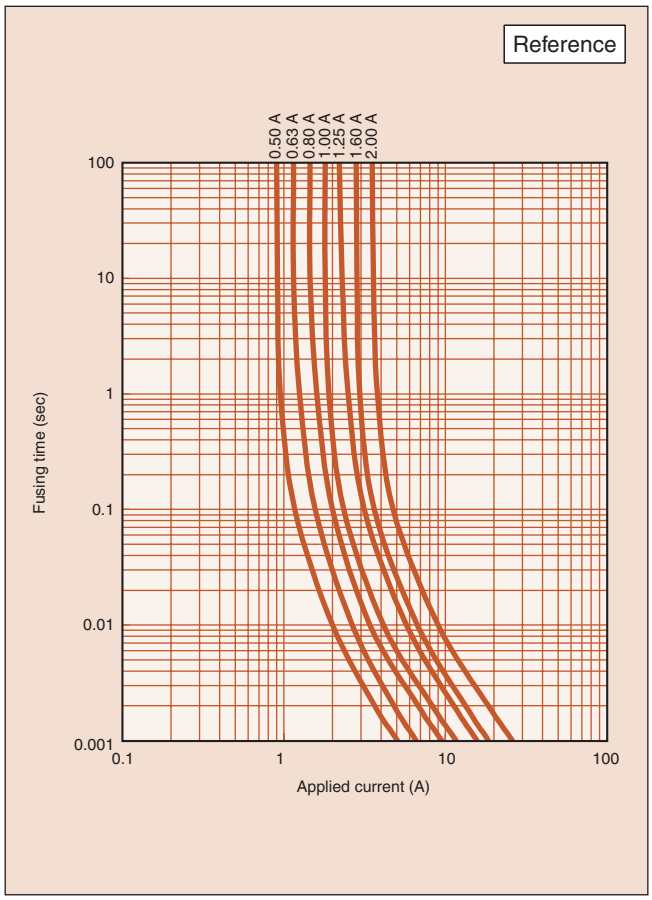


Glass epoxy on one side
Thickness : 1.6 mm
Copper layer : 35 µm

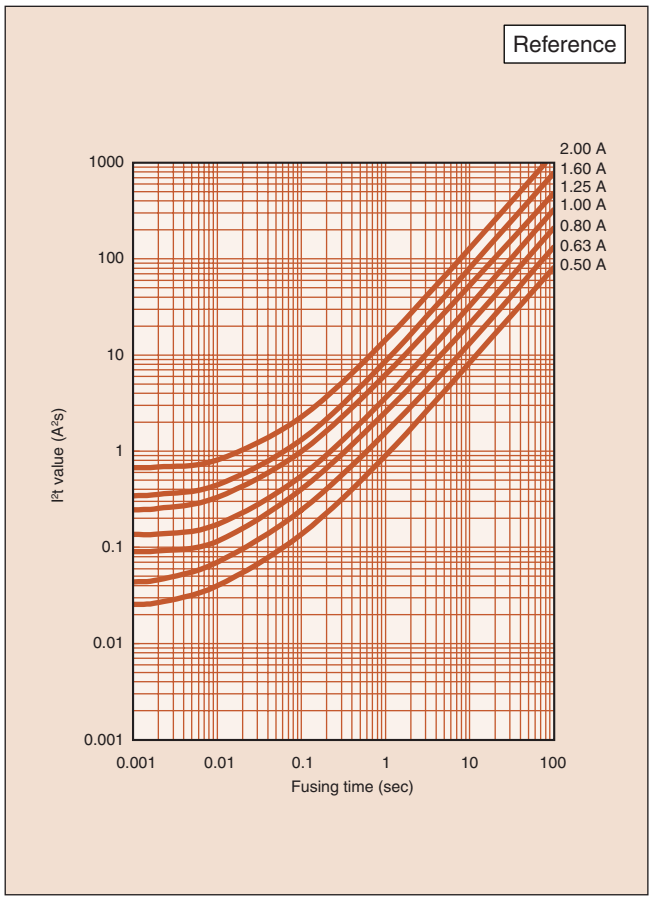
PERFORMANCE

Item	Performance	Test method
Temperature rise	Temperature rise shall not exceed 40°C.	Apply rated current.(Ambient temperature : 10 – 30°C)
Current-carrying capacity	Shall not open.	Apply 125% of rated current.
Clearing characteristics	Arc shall not be continued. Crack shall not initiate in peripheral case.	Breaking voltage : 24 V Breaking current : 50 A
Voltage drop	Voltage drop is below the value specified in CATALOG NUMBERS AND RATING.	Apply rated current using 24 V power supply.
Fusing characteristics	Fusing within 2 minutes	Apply 200% of rated current.
Insulation resistance	1000 MΩ or more	Insulation resistance between terminals and mold case
Electrode strength (Flexibility)	No mechanical damage. Shall meet the electric performance.	Board supporting width : 90 mm Bending speed : Approx. 0.5 mm/sec Duration : 30 sec Bending : 3 mm
Solderability	95% or more terminal surface shall be covered with new solder.	Dipping : 3 sec Temperature : 245 ± 3°C Solder : Sn – 3Ag – 0.5Cu
		Dipping : 3 sec Temperature : 230 ± 2°C Solder : Conforms to JISZ3282 (solder) H60A, H60S, H63A
Resistance to soldering heat	Marking shall be legible. No mechanical damage. Shall meet the electric performance.	Flow Preconditioning : 100 ~ 150°C, 60 sec Temperature : 260 ± 5°C, 10 ± 1 sec Reflow soldering Preconditioning : 1 ~ 2 min, 180°C or less Peak : 250 ± 5°C, 5 sec Holding : 230 ~ 250°C, 20 ~ 40 sec Cooling : more than 2 min Manual soldering Iron edge temperature : higher than 400°C Duration : 3 ~ 4 sec
Thermal shock	No mechanical damage. Voltage drop after the test shall be less than the value specified in CATALOG NUMBERS AND RATING.	-55 ± 3°C : 30 min Room temperature : 2 ~ 3 min or less 125 ± 2°C : 30 min Room temperature : 2 ~ 3 min or less Repeat above step for 10 cycles
Moisture resistance		Temperature : 85 ± 3°C Humidity : 85 ± 3% RH Duration : 1000 $\pm^{48}_{0}$ hours
Load life		Temperature : 85 ± 3°C Applied current : 125% of rated current Duration : 1000 $\pm^{48}_{0}$ hours
Stability		Temperature : 125 ± 3°C Duration : 1000 $\pm^{48}_{0}$ hours

FUSING CHARACTERISTICS

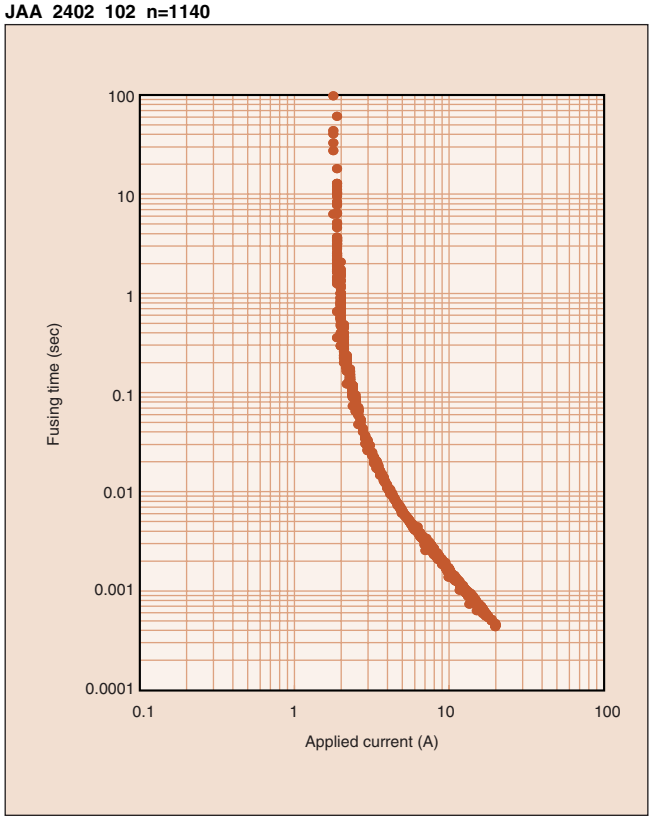


I^2T–T CHARACTERISTICS



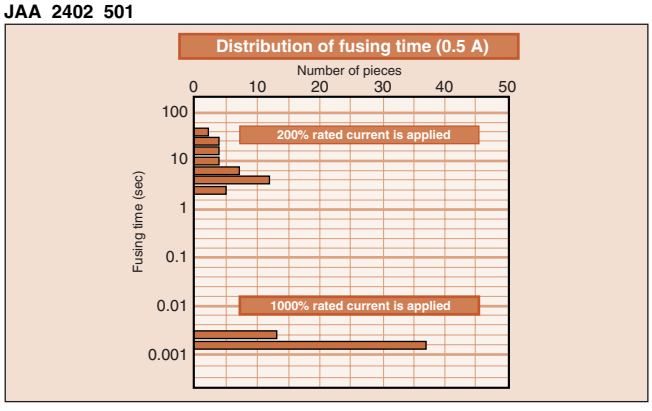
DISTRIBUTION OF FUSING CHARACTERISTICS

JAA 2402 102 n=1140

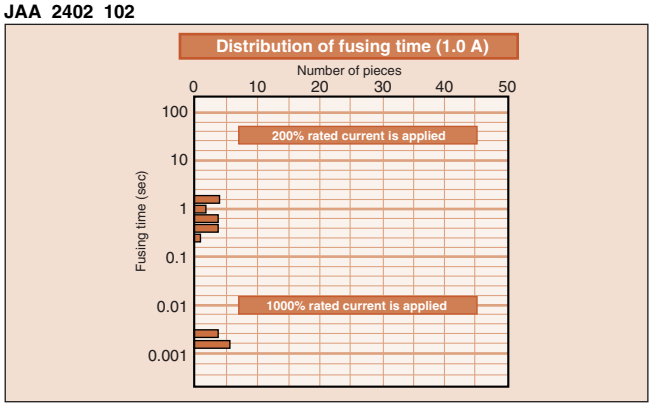


DISTRIBUTION OF FUSING TIME

JAA 2402 501



JAA 2402 102



DETERMINATION OF RATED VALUE AND SELECTION OF CIRCUIT PROTECTION ELEMENT (TYPE JAA)

Determine the rated value of circuit protection element, and select the correct circuit protection element for your circuit. If you select the correct circuit protection element, safety of your circuit can be ensured.
How to determine the rated value of the circuit protection element is described below :

■ Flow for fuse selection

1. Measurement of circuit values using actual device	Measure the circuit values, such as operating current of the circuit
2. Calculation from operating current	From the obtained operating current and the category temperature, calculate the minimum rated value to determine the applicable fuse.
3. Calculation from overload current	From the obtained overload current, calculate the maximum rated value to determine the applicable fuse.
4. Calculation from inrush current	From the inrush current, calculate the minimum rated value to determine the applicable fuse.
5. Final determination of rated value	From the calculation results of steps 2 through 4, determine the rated value.
6. Operation check using actual device	After selecting the rating, confirm if the device works properly under the pre-determined conditions.

■ Fuse selection

1. Measurement of circuit values using actual device

Before determining the rated value of the fuse, preliminarily measure the following using the actual device.

1–1 Operating current
Using an oscilloscope or equivalents, measure the operating current of the circuit.

1–2 Overload current
Using an oscilloscope or equivalents, measure the overload current that needs to break the circuit.

1–3 Inrush current
Using an oscilloscope or equivalents, measure the inrush current of the circuit at power-on or power-off. In addition, determine the number of inrush current applied.

1–4 Category temperature
Measure the ambient temperature of the fuse circuit.

EXAMPLE TO SELECT RATINGS OF TYPE JAA
<Fuse selection>
Effective operating current : 1.2 A
Effective overload current : 6.0 A
Inrush current waveform : Fig. A
(Pulse width : 1 ms, Wave height : 20 A)
Numbers to withstand inrush current : 100,000 times
Category temperature : 85°C

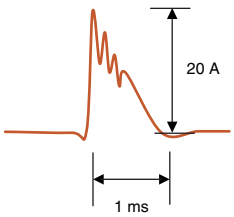


Fig. A : Inrush current waveform

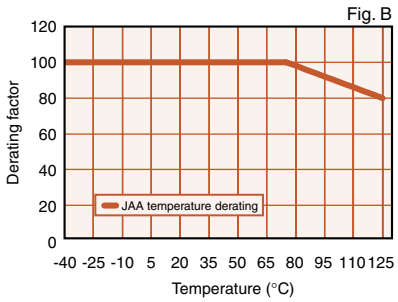
2. Calculation from operating current

2–1 Measurement of operating current
Using an oscilloscope or equivalents, measure operating current (effective current) of the actual circuit.
Example : Effective operating current = 1.2 A

2–2 Derating
①Temperature derating factor
Using Fig. B, find the temperature derating factor correspond to the temperature.
②Rated derating factor
Rated derating factor = 1.0 (Constant irrespective of temperature)

Use Formula 1 to calculate the rated current of the fuse to be used for the circuit.
Rated current of fuse ≥ Operating current/ (① × ②) ... Formula 1

Example : Category temperature = 85°C, Operating current = 1.2 A
①Temperature derating factor = 0.96 (Refer to Fig. B.)
②Rated derating factor = 1.0 (Constant irrespective of temperature)
Calculation using Formula 1 :
Rated current ≥ 1.2/ (0.96 × 1.0) = 1.25 A



The above calculation result shows that the fuse with rated current of 1.25 A or more should be selected for this circuit.
Type JAA, with rated current of 1.25 A or more can be selected.

3. Calculation from overload current

3–1 Measurement of overload current

Using oscilloscope or equivalents, measure the overload current that needs to break the circuit.
Example : Effective overload current = 6.0 A

3–2 Calculation from overload current

Determine the rated current so that the overload current can be 2 times larger than the rated current.
Use Formula 2 to calculate the rated current of the fuse.

Rated current of fuse ≤ Overload current/2.0 ... Formula 2

Example : Overload current = 6.0 A
Use Formula 2 to calculate the rated current.
Rated current ≤ 6.0/2.0 = 3.0 A

The above calculation result shows that the fuse with rated current of 3.0 A or less should be selected for this circuit.

Type JAA, with rated current of 2.0 A or less can be selected.

4. Calculation from inrush current

4–1 Measurement of inrush current waveform

Using an oscilloscope or equivalent, measure the waveform of the inrush current of the actual circuit.

4–2 Creation of approximate waveform

Generally, the waveform of inrush current is complicated. For this reason, create the approximate waveform of inrush current as shown on Fig. C to simplify calculation.

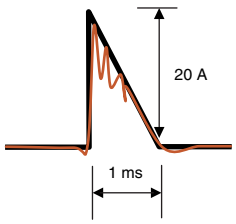


Fig. C : Inrush current waveform
Red line : Actual measurement waveform
Black line : Approximate waveform

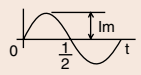
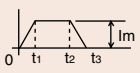
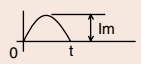
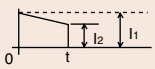
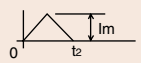
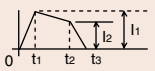
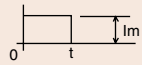
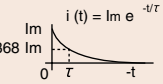
4–3 Calculation of I^2t of inrush current

Calculate I^2t (Joule integral) of the approximate waveform.
The formula for this calculation depends on the approximate waveform.
Refer to Table A.

Example : Pulse applied = 1 ms, Peak value = 20 A
Approximate waveform = Triangular wave
Since the approximate waveform is a triangular wave, use the following formula for calculation.
I^2t of rush current = $1/3 \times Im^2 \times t$ ... Formula 3
(Im : Peak value, t : Pulse applying time)
Use Formula 3 to calculate I^2t of the rush current :
$I^2t = 1/3 \times 20 \times 20 \times 0.001 = 0.13\ (A^2s)$

JOULE-INTEGRAL VALUES FOR EACH WAVEFORM

Table A

Name	Waveform	I^2t	Name	Waveform	I^2t
Sine wave (1 cycle)		$\frac{1}{2} Im^2 t$	Trapezoidal wave		$\frac{1}{3} Im^2 t_1 + Im^2(t_2 - t_1) + \frac{1}{3} Im^2(t_3 - t_2)$
Sine wave (half cycle)		$\frac{1}{2} Im^2 t$	Various wave 1		$I_1 I_2 t + \frac{1}{3}(I_1 - I_2)^2 t$
Triangular wave		$\frac{1}{3} Im^2 t$	Various wave 2		$\frac{1}{3} I_1^2 t_1 + \{I_1 I_2 + \frac{1}{3}(I_1 - I_2)^2\}(t_2 - t_1) + \frac{1}{3} I_2^2(t_3 - t_2)$
Rectangular wave		$Im^2 t$	Charge/ discharge waveform		$\frac{1}{2} Im^2 \tau$

✻ Following formula is generally used for calculation of I^2t as i(t) equal to current.

$$I^2t = \int_0^t i^2(t)dt$$

4–4 Search of load ratio

①Set up the number of cycles to withstand. (generally 100,000 times)

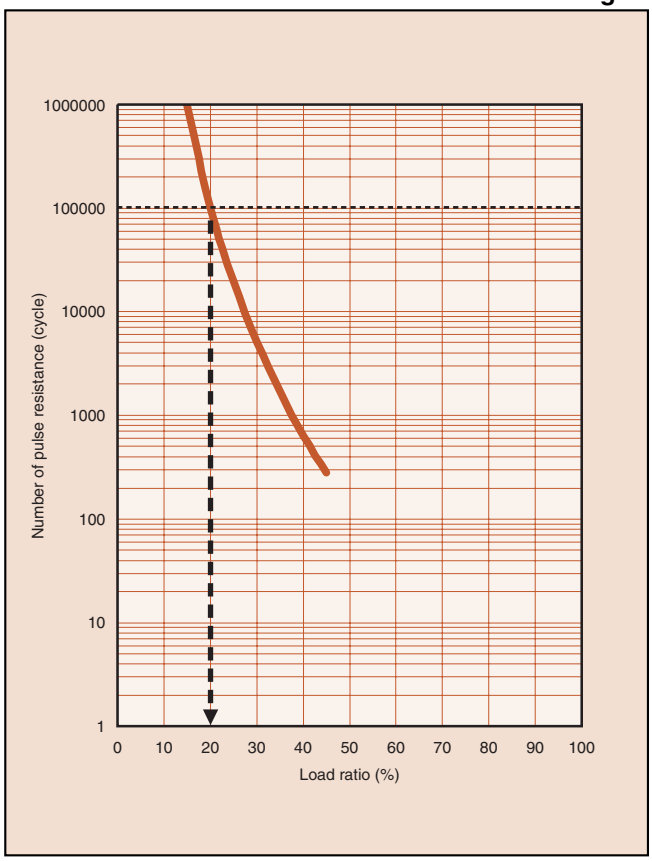
②Obtain the load ratio from Pulse resistance characteristics. (Fig. D)

Example : 100,000 times is required against inrush current applied.

The load ratio is 20% or less from Fig. D.

PULSE RESISTANCE CHARACTERISTICS

Fig. D



4–5 Calculation from Joule integral and load ratio

Use Formula 4 to calculate the standard I^2t for the fuse to be used.

Standard I^2t of fuse > (I^2t of inrush current/load ratio)..... ..... Formula 4

Example : I^2t of pulse = 0.13 A^2s,
Pulse applied = 1 ms, Required load ratio = 20%

From Formula 4,
Standard I^2t of fuse > 0.13/0.2 = 0.65 (A^2s)

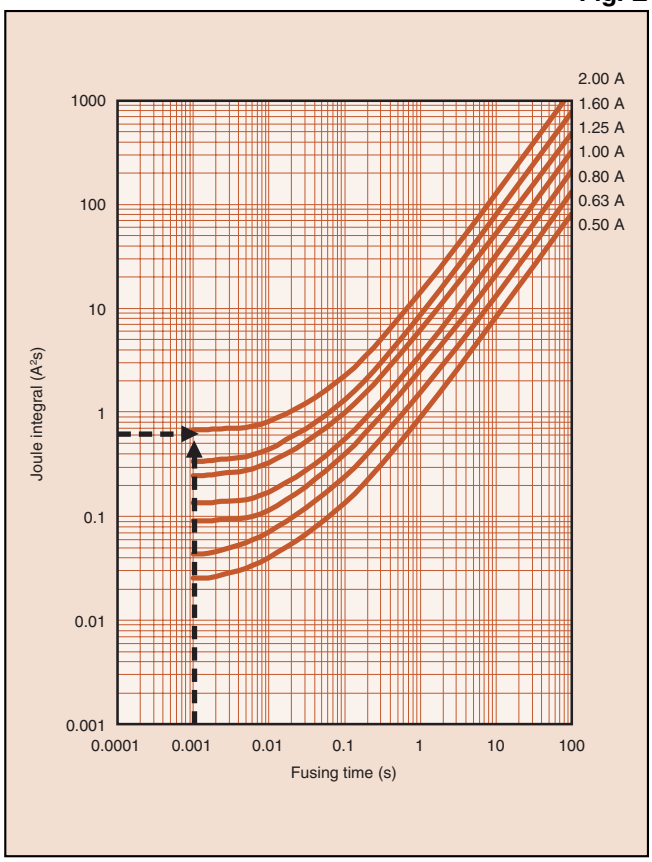
The standard I^2t of the fuse should be 0.65 (A^2s) or more.

Since the rush pulse applied is 1 ms, obtain the intersection of 1 ms (horizontal axis) and 0.65 A^2s (vertical axis) from Fig. E (refer to the arrow shown in Fig. E).

Select a fuse whose curve is above the intersection. Type JAA, with rated current of 2.0 A or more should be selected.

JOULE INTEGRAL VS. FUSING TIME

Fig. E



5. Final determination of rated value

Determine the rated current of the circuit protection element. The rated current should meet all the calculation results.

Example : 2.0 A meet the all requirement.

6. Operation check using actual device

After selecting the rating, confirm if the device works properly under the pre-determined conditions.

⚠Application Notes for Circuit Protector

1. Circuit Design

Circuit Protector should be designated only after confirming operating conditions and the Circuit Protector performance characteristics.
When determining the rated current, be sure to observe the following items :

(1) Circuit Protector should always be operated below the rated current (the value considered in the temperature derating rate) and voltage specifications.
(2) Circuit Protector should always be operated below the rated voltage.
(3) Circuit Protector should be selected with correct rated value to be fused at overload current.
(4) When Circuit Protector are used in inrush current applications, please confirm sufficiently inrush resistance of Circuit Protector.
(5) Please do not apply the current exceeding the breaking current to Circuit Protector.
(6) Use Circuit Protector under the condition of category temperature.
(7) Circuit Protector should not be used in the primary power source.

Circuit Protector should be selected by determining the operating conditions that will occur after final assembly, or estimating potential abnormalities through cycle testing.

2. Assembly and Mounting

During the entire assembly process, observe Circuit Protector body temperature and the heating time specified in the performance table. In addition, observe the following items :

(1) Mounting and adjusting with soldering irons are not recommendable since temperature and time control is difficult.
In case of emergency for using soldering irons, be sure to observe the conditions specified in the performance table.
(2) Circuit Protector body should not have direct contact with a soldering iron.
(3) Once Circuit Protector mounted on the board, they should never be remounted on boards or substrates.
(4) During mounting, be careful not to apply any excessive mechanical stresses to the Circuit Protector.

3. Solvents

For cleaning of Circuit Protector, immersion in isopropyl alcohol for 90 seconds (at 20 ~ 30°C liquid temp.) will not be damaged.
If organic solvents (Pine Alpha™, Techno Care™, Clean Through™, etc.) will be applied to the Circuit Protector, be sure to preliminarily check that the solvent will not damage the Circuit Protector.

4. Ultrasonic Cleaning

Ultrasonic cleaning is not recommended for Circuit Protector.
This may cause damage to the Circuit Protector such as broken terminals which results in electrical characteristics effects, etc. depending on the conditions.
If Ultrasonic cleaning process must be used, please evaluate the effects sufficiently before use.

5. Caution During Usage

(1) Circuit Protector with electricity should never be touched. Circuit Protector with electricity may cause burning due to the Circuit Protector high temperature. Also, in case of touching Circuit Protector without electricity, please check the safety temperature of Circuit Protector.
(2) Protective eyeglasses should always be worn when performing fusing tests. However, there is a fear that Circuit Protector will explode during test. During fusing tests, please cover particles not to fly outward from the board or testing fixture. Caution is necessary during usage at all times.

6. Environmental Conditions

(1) Circuit Protector should not be operated in acid, alkali, or active gas atmosphere.
(2) Circuit Protector should not be vibrated, shocked, or pressed excessively.
(3) Circuit Protector should not be operated in a flammable or explosive atmosphere.
(4) After mounting Circuit Protector on a board, covering Fuses with resin may affect to the electric characteristics of the Circuit Protector. Please be sure to evaluate it in advance.

7. Emergency

In case of fire, smoking, or offensive odor during operation, please cut off the power in the circuit or pull the plug out.

8. Storage

(1) Circuit Protector should be stored at room temperature (-10°C ~ +40°C) without direct sunlight. Direct sunlight may cause decolorization and deformation of the exterior and taping. Also, there is a fear that solderability will be remarkably lower in high humidity.
(2) If the products are stored for an extended period of time, please contact Matsuo Sales Department for recommendation. The longer storage term causes packages and tapings to worsen. If the products are stored for longer term, please contact Matsuo Sales Department for advice.
(3) The products in taping, package, or box should not be given any kind of physical pressure. Deformation of taping or package may affect automatic mounting.

9. Disposal

When Circuit Protector are disposed of as waste or “scrap”, they should be treated as “industrial waste”. Circuit Protector contain various kinds of metals and resins.

10. Samples

Circuit Protector received as samples should not be used in any products or devices in the market. Samples are provided for a particular purpose such as configuration, confirmation of electrical characteristics, etc.

MATSUO ELECTRIC CO., LTD.

Please feel free to ask our sales department for more information on the Circuit Protector.

Overseas Sales Dep. :	5-3, 3-Chome, Sennari-cho, Toyonaka-shi, Osaka 561-8558, Japan	Tel : 06-6332-0883	Fax : 06-6332-0920
USA :	Matsuo Electronics of America, Inc. 2134 Main Street, Suite 200, Huntington Beach, CA 92648	Tel : 714-969-2491	Fax : 714-960-6492
Head Office :	5-3, 3-Chome, Sennari-cho, Toyonaka-shi, Osaka 561-8558, Japan	Tel : 06-6332-0871	Fax : 06-6331-1386
URL :	http://www.ncc-matsuo.co.jp/		