Identification File of Type ZE64G23
for use in oil

CONTENTS

<table>
<thead>
<tr>
<th></th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Category</td>
<td>1</td>
</tr>
<tr>
<td>2. Structure</td>
<td>1</td>
</tr>
<tr>
<td>3. Manufacturing process</td>
<td>2</td>
</tr>
<tr>
<td>4. Manufacturing control</td>
<td>2</td>
</tr>
<tr>
<td>5. Shop and acceptance test</td>
<td>3</td>
</tr>
<tr>
<td>6. Electrical characteristics</td>
<td>5</td>
</tr>
<tr>
<td>7. Other information</td>
<td>6</td>
</tr>
<tr>
<td>Fig.1 Power consumption - temperature characteristic</td>
<td>7</td>
</tr>
<tr>
<td>Fig.2 Resistive current - temperature characteristics</td>
<td>7</td>
</tr>
<tr>
<td>Fig.3 Total leakage current - temperature characteristic</td>
<td>8</td>
</tr>
<tr>
<td>Fig.4 Accelerated ageing test result</td>
<td>8</td>
</tr>
<tr>
<td>Fig.5 Residual voltage ratio - discharge current characteristics</td>
<td>9</td>
</tr>
<tr>
<td>Fig.6 Protective characteristics</td>
<td>9</td>
</tr>
<tr>
<td>Fig.7 Absorbed energy - discharge current characteristic</td>
<td>10</td>
</tr>
<tr>
<td>Fig.8 Discharge current - operation times characteristic</td>
<td>10</td>
</tr>
</tbody>
</table>

April, 2005

MEIDENSHA CORPORATION
Identification File

1. Category

Zinc oxide block described in this file is applied to the arrester for use in oil.

2. Structure

(a) General

The side surface of block is covered with high resistance layers. The both contact surfaces are spray coated with aluminum.

(b) Dimension and reference number

<table>
<thead>
<tr>
<th>Reference Number</th>
<th>Dimension (mm)</th>
<th>Volume (cm$^3$)</th>
<th>Weight (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Diameter</td>
<td>Thickness</td>
<td></td>
</tr>
<tr>
<td>ZE64G23</td>
<td>64.5</td>
<td>22.5</td>
<td>73.6</td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>1.0</td>
<td>5.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>407</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>36</td>
</tr>
</tbody>
</table>

(c) Indication

Following figures are indicated on each block.

Year 2005, Month May, Lot code 01, Range of V1mA (dc)

(Note)

1. The month of October, November and December are indicated as X, Y, and Z respectively.

2. Range of V1mA (dc) is shown as follows.

<table>
<thead>
<tr>
<th>Type</th>
<th>V1mA (dc) (kV)</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>ZE64G23</td>
<td>4.28 ~ 4.32</td>
<td>L4</td>
</tr>
<tr>
<td></td>
<td>4.33 ~ 4.37</td>
<td>L3</td>
</tr>
<tr>
<td></td>
<td>4.38 ~ 4.42</td>
<td>L2</td>
</tr>
</tbody>
</table>
Construction

The block consists of the following parts:

- Aluminum electrode
- Non linear resistor (ZnO)
- High resistance layer (Ceramics)
- Outer layer (Glass)

### 3. Manufacturing process

Zinc oxide, additives of Bi\textsubscript{2}O\textsubscript{3}, Co\textsubscript{3}O\textsubscript{4}, MnO\textsubscript{2}, Cr\textsubscript{2}O\textsubscript{3}, Sb\textsubscript{2}O\textsubscript{3}, etc. and pure water are mixed and granulated. After granulation, press forming and sintering were performed. The manufacturing flow is as follows:

<table>
<thead>
<tr>
<th>Additives</th>
<th>mixing</th>
<th>Granulation</th>
<th>Press forming</th>
<th>Presintering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure water</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zinc oxide</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Organic binder</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- First insulation coating
- Second insulation coating

<table>
<thead>
<tr>
<th>Inspection</th>
<th>Metalize</th>
<th>Grinding</th>
<th>Second insulation coating</th>
<th>Sintering</th>
</tr>
</thead>
</table>

### 4. Manufacturing control

The quality system meets the requirements laid down in the International Standard ISO 9001.
5. Shop and acceptance test

5.1 Test procedure

(a) Dimension and appearance test
   This test shall be carried out in the in-process inspection.

(b) Reference voltage test
   Reference voltage defined as terminal voltage across ZnO block when d.c. 1mA begins to flow.
   This test shall be carried out promptly in order to avoid heat generation of blocks and this test shall be made at a block temperature of 20 to 25°C.

(c) Residual voltage test
   Residual voltage at current impulse with 8/20us, 10kA shall be measured.

(d) Discharge current withstand capability
   (I) High current impulse
      The current impulse with 4/10us, 100kA shall be applied to the block for 2 times.
      The interval between impulses shall be long enough for the block to be cooled down to the ambient temperature.
   (ii) Rectangular current impulse
      The 2ms rectangular current impulse with 1,000A shall be applied to the block for 20 times. These divided into 4 groups of 5 impulses. The interval between impulses shall be 50 to 60 seconds and the interval between groups shall be long enough for the block to be cooled down to the ambient temperature.

5.2 Sampling procedure

Sampling procedure shall be carried out in accordance with MIL-STD-105E.

<table>
<thead>
<tr>
<th>Test item</th>
<th>Number of samples</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reference voltage and external appearance</td>
<td>all blocks</td>
<td>In process inspection</td>
</tr>
</tbody>
</table>
| Residual voltage ratio at a specified current value | 5 blocks / lot    | MIL-STD-105E, S-2
                                                          Double sampling plan
                                                          AQL = 6.5 %               |
| High current impulse withstand     | 5 blocks / lot    | MIL-STD-105E, S-2
                                                          Double sampling plan
                                                          AQL = 6.5 %               |
| Rectangular current impulse withstand | 5 blocks / lot    | MIL-STD-105E, S-2
                                                          Double sampling plan
                                                          AQL = 6.5 %               |
| Dimension check                    | 50 blocks / lot   | MIL-STD-105E, S-4
                                                          Single sampling plan
                                                          AQL = 1.0 %               |

- 3 -
The double sampling plan shall be as follows.

### First sampling test

<table>
<thead>
<tr>
<th>Good</th>
<th>No good</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0</td>
<td>Acceptable</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Re-sampling</td>
</tr>
<tr>
<td>0 - 3</td>
<td>2 – 5</td>
<td>Not acceptable</td>
</tr>
</tbody>
</table>

### Re-sampling test (total)

<table>
<thead>
<tr>
<th>Good</th>
<th>No good</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>1</td>
<td>Acceptable</td>
</tr>
<tr>
<td>4 - 8</td>
<td>2 – 6</td>
<td>Not acceptable</td>
</tr>
</tbody>
</table>

The single sampling plan shall be as follows.

### Sampling test

<table>
<thead>
<tr>
<th>Good</th>
<th>No good</th>
<th>Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>49 - 50</td>
<td>0 - 1</td>
<td>Acceptable</td>
</tr>
<tr>
<td>0 - 48</td>
<td>2 - 50</td>
<td>Not acceptable</td>
</tr>
</tbody>
</table>

### Note

1. Reference voltage test and external appearance check shall be carried out on each ZnO block in the in process inspection.

2. The number of samples shall be based on 5,000 blocks.
6. Electrical characteristics

(a) Rated discharge current                      10 kA crest

(b) MCOV in oil up to 110 °C                   1.6 kV r.m.s.

(c) Reference voltage (at 25 °C)
   V1mA (ac)                                    4.13 ~ 4.42 kV crest
   [ V1mA (dc)                                  4.28 ~ 4.42 kV crest ]

(d) Power consumption at MCOV (at 90 °C)
   Average                                      0.27 w
   Max.                                          0.41 w

   Power consumption (average) - Temperature characteristic Refer to Fig.1

(e) Resistive current at MCOV (at 90 °C)
   Average                                      0.27 mA crest
   Max.                                          0.41 mA crest

   Resistive current (average) - Temperature characteristic Refer to Fig.2

(f) Total leakage current at MCOV (at 90 °C)
   Average                                      0.67 mA rms
   Max.                                          1.00 mA rms

   Total leakage current (average) - Temperature characteristic Refer to Fig.3

(g) Life cycle

   Accelerated ageing test result               Refer to Fig.4

(h) Residual voltage ratio at 10 kA
   Average                                      1.65 ( - )
   Max.                                          1.69 ( - )

   Residual voltage ratio - discharge current characteristics Refer to Fig.5

   Protective characteristics (Average value)    Refer to Fig.6

(i) High current withstand capability           100 kA crest – 2 shots

(j) Rectangular current withstand capability    1,000 A – 20 shots

   Absorbed energy – discharge current characteristic Refer to Fig.7

   Discharge current – applicable number characteristic Refer to Fig.8
7. Other information

7.1 Minimum contact pressure of blocks

The minimum contact pressure of blocks shall be 10 kg.

7.2 Working capability

The working capability of blocks are defined by the weight of granulation powder at Meidensha.

The working capability of Meidensha is about 600 tons per year (as of August 1993).
Fig. 1  Power consumption - temperature characteristic of ZE64G23 type block

Fig. 2  Resistive current - temperature characteristic of ZE64G23 type block
Fig.3  Total leakage current - temperature characteristic of ZE64G23 type block

Fig.4  Accelerated ageing test result of ZE64G23 type block

Oil in oven: 120°C
Applied voltage ratio: 80%
Fig. 5 Residual voltage ratio - discharge current characteristics of ZE64G23 type block

Discharge current (kA crest) vs. Residual voltage ratio (-)

- 8/20us waveform (max. value)
- 8/20us waveform (mean value)

- 8/20us waveform (max. value)
- 8/20us waveform (mean value)

V0.25kA : 1.35
V0.5kA : 1.39
V1kA : 1.43
V2kA : 1.51
V5kA : 1.59
V10kA : 1.69
V20kA : 1.83
V40kA : 2.00

Fig. 6 Protective characteristics (Average value) of ZE64G23 type block

Discharge current (kA crest) vs. Residual voltage ratio (-)

- Lightning (8/20us, current wave)
- Steep (1/2.5us, current wave)
- Switch (30/80us, current wave)
- Lightning (4/10us, current wave)
Fig. 7  Absorbed energy - discharge current characteristic of ZE64G23 type block

- 2ms rectangular current (Average value)

Fig. 8  Discharge current - operation times characteristic (withstand) of ZE64G23 type block