What’s going on? – 1.2/50-8/20 surge current parameters

Abstract

This is an advanced level tutorial on the 1.2/50-8/20 impulse (surge) generator used in test Standards and ITU-T Recommendations. The critical surge current parameters of the 1.2/50-8/20 impulse generator are given together with examples of the generator interaction with Ethernet ports.

The document content is of a general nature only and is not intended to address the specific circumstances of any particular individual or entity; nor be necessarily comprehensive, complete, accurate or up to date; nor represent professional or legal advice.

Copyright © 2017 M J Maytum. All rights reserved.
Contents

1. Introduction ........................................................................................................................................... 1

2. Surge current parameters ......................................................................................................................... 1

3. 1.2/50-8/20 surge generator values ......................................................................................................... 1

4. Comments ................................................................................................................................................. 2

Annex A (informative) USA Ethernet port differential testing ........................................................................ 3

A.1 Introduction ........................................................................................................................................... 3

A.2 Current surge parameters ....................................................................................................................... 3
What’s going on? – 1.2/50-8/20 surge current parameters

1. Introduction

In past standards meetings I have noticed that people tend to only talk about the surge voltage levels. In the case of Ethernet common-mode surge testing this is correct, but for differential mode testing the surge current parameters are more important. The document quantifies the surge current parameters for the 1.2/50-8/20 surge generator used in ITU-T Recommendations K.20, K.21, K.44 and K.45.

2. Surge current parameters

The current parameters characterised and their significance are shown below:

- peak current, \( I_{PP} \)—peak current can mechanically stress wire-termination connections
- \( di/dt \)—controls the peak secondary winding current at core saturation
- \( i^2t \)—primary wiring heating, can lead to conductor fusing or insulation damage
- \( Q \)—defines voltage clamp energy rating and capacitor voltage change
- waveshape designation—Together with \( I_{PP} \) is the top-level waveform definition

3. 1.2/50-8/20 surge generator values

Using the ITU-T Recommendation K.44 circuit, the output current parameters were characterised for external resistance, \( R_{EXT} \), values of 0, 1 \( \Omega \), 2 \( \Omega \), 5 \( \Omega \), 6 \( \Omega \), 10 \( \Omega \), 20 \( \Omega \) and 50 \( \Omega \), see Figure 1. The charging voltage was standardised at 1 kV, which produces a peak open-circuit output voltage of about 940 V. The resulting peak short-circuit current becomes 940 V/ 2 \( \Omega \) = 470 A. Table 1 shows the surge current parameters, where \( di/dt \) is the maximum value occurring during the front time and not the average front time value and \( Q \) is the summation of positive and negative charge.
Table 1—Current waveform parameters for 1 kV charging voltage

<table>
<thead>
<tr>
<th>$R_{\text{EXT}}$ Ω</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>5</th>
<th>6</th>
<th>10</th>
<th>20</th>
<th>50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$I_{\text{PP}}$ A</td>
<td>465</td>
<td>320</td>
<td>243</td>
<td>138</td>
<td>121</td>
<td>80.2</td>
<td>43.5</td>
<td>18.2</td>
</tr>
<tr>
<td>waveshape</td>
<td>7.9/20</td>
<td>6.5/20</td>
<td>5.5/20</td>
<td>3.8/24</td>
<td>3.6/25</td>
<td>2.8/29</td>
<td>2.1/35</td>
<td>1.5/43</td>
</tr>
<tr>
<td>$\frac{\text{di/dt}}{\text{A/µs}}$</td>
<td>91.7</td>
<td>88.4</td>
<td>85.2</td>
<td>77.0</td>
<td>74.6</td>
<td>66.3</td>
<td>51.9</td>
<td>31.5</td>
</tr>
<tr>
<td>$Q$ mC</td>
<td>11.2</td>
<td>5.89</td>
<td>4.86</td>
<td>3.98</td>
<td>3.76</td>
<td>3.06</td>
<td>2.07</td>
<td>1.05</td>
</tr>
<tr>
<td>$\bar{I}t$ A²s</td>
<td>3.05</td>
<td>1.33</td>
<td>0.808</td>
<td>0.326</td>
<td>0.263</td>
<td>0.136</td>
<td>0.0485</td>
<td>0.0102</td>
</tr>
</tbody>
</table>

For different charging voltages, the values of Table 1 can be modified by multiplying the $I_{\text{PP}}$, $\frac{\text{di/dt}}{\text{A/µs}}$ and $Q$ values by the charging voltage in kV and $\bar{I}t$ by the square of the charging voltage in kV. Table 2 shows an example for an $R_{\text{EXT}}$ of 5 Ω and a charging voltage of 6 kV with multipliers of 6 and 36.

Table 2—Current values for 6 kV charging and $R_{\text{EXT}} = 5$ Ω

<table>
<thead>
<tr>
<th>$R_{\text{EXT}}$ Ω</th>
<th>$I_{\text{PP}}$ A</th>
<th>waveshape</th>
<th>$\frac{\text{di/dt}}{\text{A/µs}}$</th>
<th>$Q$ mC</th>
<th>$\bar{I}t$ A²s</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>828</td>
<td>3.6/25</td>
<td>462</td>
<td>23.9</td>
<td>11.7</td>
</tr>
</tbody>
</table>

4. Comments

Common-mode surge testing of transformer isolated ports should be done with a defined voltage impulse. If the Ethernet port may contain voltage limiting components two test configurations should be used. To test for possible current hogging by one of the voltage limiting components all the port signal and powering conductors should be joined together and fed by a single resistor from the surge generator, see K.44 (2017/05) Figure A.6.7-3a – Ethernet port longitudinal/common mode withstand test circuit. To test for possible common-mode to differential mode conversion each conductor should be fed by a separate current sharing resistor, see K.44 (2017/05) Figure A.6.7-4 – Ethernet port longitudinal/common mode surge test circuit.

Differential-mode surge testing of transformer isolated ports should be done with a defined current impulse as in differential-mode the pair voltage will be relatively low. Each signal twisted pair and powering pairs should be tested.
Annex A
(informative)

USA Ethernet port differential testing

A.1 Introduction

In the USA there are two popular differential mode test configurations. One uses a <2/>10, 800 V and 100 A generator. The so called “alternative generator” is a 1.2/50-8/20, 800 V generator with an external series resistance of 6 Ω. Both generators deliver 800 V open-circuit and 100 A short circuit, but in practice their current stress levels are very different because of the current waveshapes.

A.2 Current surge parameters

Table 3 compares the current surge parameters for the two generators.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>&lt;2/&gt;10</th>
<th>1.2/50-8/20</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{\text{EXT}}$ Ω</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>$I_{\text{PP}}$ A</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>waveshape</td>
<td>1.8/12</td>
<td>3.6/25</td>
</tr>
<tr>
<td>$di/dt$ A/µs</td>
<td>120</td>
<td>60</td>
</tr>
<tr>
<td>$Q$ mC</td>
<td>1.09</td>
<td>3.00</td>
</tr>
<tr>
<td>$\bar{F}t$ A²s</td>
<td>0.0882</td>
<td>0.168</td>
</tr>
</tbody>
</table>

Clearly the <2/>10 generator current is considerably less stressful in terms of $Q$ and $\bar{F}t$. The <2/>10 generator current is considerably more stressful in terms of $di/dt$ and this results in a higher secondary winding surge current than the 1.2/50-8/20 generator, see Figure 3. The generators maybe listed as alternatives, but they are not equivalent for testing.

![Figure 3—Secondary winding surge current difference dependent on surge generator](image-url)