Network Responses to Coupled Current by Electrical Fast Transient Disturbances to UTP Cable

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Abstract—In order to study susceptibility of a computer network by using an Electrical Fast Transient/Burst (EFT/B) test method, we composed a simple computer network and tested it experimentally. The test setup consisted of two hubs, three Unshielded Twisted Pair (UTP) cables, and two desktop Personal Computers (PCs). By using a ping utility at the PC1, states of network signal transmission were monitored during the EFT/B generator's execution time. A Capacitive Coupling Clamp (CCC) was introduced to wrap the UTP cable between hub1 and hub2, as described in the international standard IEC 61000-4-4. Pulsed current coupled by the CCC was picked up by using high-frequency current sensors and recorded by an oscilloscope. For the test, 1 kV, 2 kV, 4 kV, 6 kV, and 7 kV of the EFT/B generator's open voltages were arbitrarily selected. At the 4 kV and 6 kV of the open voltages, coupled peak current on the UTP wire reached 2.8 A and 4 A, respectively, and network data losses were displayed but not for all the test shots. Moreover, there was no data loss at 7 kV even though lower voltages did induce data losses. The probable reason for these results is that the EFT/B was not effectively synchronized with the moments when the pings were sent and received in the Ethernet system.

Keywords-electrical fast transient; burst; network hub; conducted susceptibility

I. INTRODUCTION

EFT/B test method is widely used for Electromagnetic Compatibility tests and spreads to Intentional Electromagnetic Interference (IEMI) Conducted Susceptibility (CS) test area. This paper describes EFT/B test and results for a simple network including network hubs with UTP cables and PCs.

II. EXPERIMENTAL SETUP

Figure 1 shows the block diagram of the experimental setup. The CCC was driven by the Haefely PEFT8010 EFT/B generator. Then length of each UTP cable is 10 meters. The signals traveled along PC1 - hub1 - hub2 - PC2, and returned through the round-trip path so that they can be monitored by the PC1. The current, shown in Figure 2, was measured at three points; the +3.3 V DC power line inside the hub1, the ground line inside the hub1, and the first wire among the eight wires of UTP cable just behind the hub1 connector.

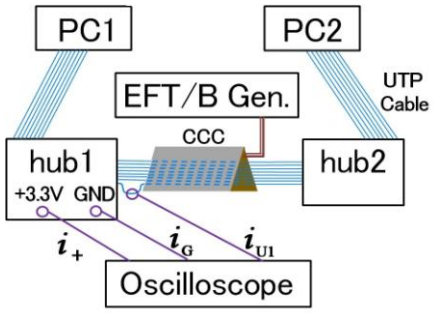

Figure 1. Test Setup Block Diagram.

III. TEST and RESULTS

TABLE I. EFT/B Gen.'s Spike and Burst Selections

Selec-tions	Spike Frequency [kHz]	Burst Duration [ms]	Burst Period [ms]	Execution Time [s]	Num. of Total Spikes
{a}	0.001	0.01	1000	10	10
{b}	0.01	100	1000	10	100
{c}	0.1	500	1000	10	500
{d}	5	15	300	10	2500

TABLE II. Measured Current Peak vs. EFT/B Gen. Voltages

EFT/B Gen. Open voltage	i_+	i_G	i_{U1}
1 kV	16 mA	40 mA	700 mA
2 kV	30 mA	90 mA	1500 mA
4 kV	70 mA	180 mA	2800 mA
6 kV	110 mA	290 mA	4000 mA
7 kV	130 mA	310 mA	4000 mA

TABLE III. Responses

EFT/B Gen. Open Voltage	Spike and Burst Selection	Data - no loss / √ loss
1 kV	{a}-{d}	-
2 kV	{c}-{d}	-
4 kV	{c}	-
4 kV	{d}	√
	{d}	-
6 kV	{d}	√
	{d}	-
7 kV	{d}	-
	{d}	-

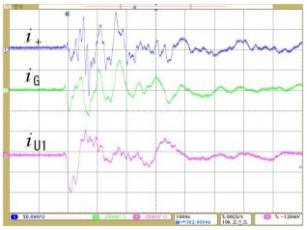

Figure 2. Measured Current of Selection {d} at 6 kV
(i_+ : 50 mA/div,
i_G : 200 mA/div,
i_{U1}: 2000 mA/div,
Time: 100 ns/div).