Reliability & Quality Assurance - ESD Online Continuous Monitoring System

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Abstract

Despite a great deal of effort during the past decade, Electrostatic Discharge (ESD) still affects production yields, manufacturing costs, product quality, product reliability, and profitability. Industry experts have estimated average product losses 8-33% due to electrostatic as shown in figure-1. The cost of damaged devices themselves ranges from only a few cents for a simple diode to several hundred dollars for complex hybrids. When associated costs of repair and rework, shipping, labor, and overhead are included, clearly the opportunities exist for significant improvements against ESD.

![Figure 1: Informal Summary of Static Losses by Level](image)

Source: White Paper on Electrostatic Discharge (ESD) Phenomena

LIMITATIONS AND TRENDS

ESD Associates standards state that ESD protection is now prerequisite at each area in the electronic industries. An ESD Control Program decreases unidentified field failures and latent defect field failures. Reducing latent effect field failure is what allows companies to report return on investments of 10:1 from their ESD Control Programs. Leading companies use continuous monitors as a cost effective component in satisfying the paragraph 6.1.3 Compliance Verification Plan requirements of ANSI/ESD S20.20.

Barco Electronic Systems Limited is ANSI/ESD S20.20/IEC61340-5-1 certified, follows the ESD control program. Barco has their own setup of ESD monitoring for various workstations. ESD Online Continuous Monitoring System provides 100% monitoring for both the operator and the work surface. This unit provides continuous monitoring of one user wearing a wrist strap and also functions to ensure the grounding integrity of ESD protected work surfaces. This device will continuously monitor the user until the wrist strap or work surface becomes dysfunctional or unsafe according to accepted industry standards, at which point the monitor will issue an audible signal notifying the user of a problem. The ESD Online Continuous Monitoring System also verifies whether an outlet ground is good or bad.
Introduction

Barco’s ESD Online Continuous Monitoring System provides the 100% ESD protection for each workstation of module line, PCBA line & Test & Repair lines. Instead of periodic testing, Barco are utilizing workstation continuous monitoring system to ensure that their products are manufactured in a complete ESD safe environment. Full time workstation continuous monitoring is the better monitoring than periodic testing, and can save a significant amount of money in testing costs and rejected products.

Periodic testing detects failures after ESD susceptible products have been manufactured. The costs of dealing with the resulting catastrophic or latent defects can be considerable. ESD Online Continuous Monitors eliminate the need for users to test wrist straps and log the results; by their function, these monitors satisfy the ISO 9000 and ANSI/ESD S20.20 Paragraph 6.2.2.2 and test logging requirements. ESD Online Continuous Monitoring System gives the protection for complete workstation (mat ground, ground point & wrist strap). General description of setup of workstations and work surfaces

Workstations and Work surfaces:

![Workstation and Work Surfaces with ESD protection](image)

Figure 2: WorkStation and Work Surfaces with ESD protection

An ESD Protective workstation refers to the work area of a single individual that is constructed and equipped with materials and equipment to limit damage to ESD sensitive items. It may be a stand-alone station in a stockroom, warehouse, or assembly area, or in a field location such as a computer bay in a commercial aircraft.

The workstation provides a means for connecting all work surfaces, fixtures, handling equipment, and grounding devices to a common point ground. In addition, there may be provision for connecting additional personal grounding devices, equipment, and accessories such as constant ground monitors and ionizers.

![Earthing connection from earth pit to Common Plate](image)

Figure 3: Earthing connection from earth pit to Common Plate

![Wrist Strap](image)

Figure 4: Wrist Strap

Electrostatic protective work surfaces with a resistance to ground of 10^6 to 10^9 provide a surface that is at the same electrical potential as other ESD protective items in the workstation. They also provide an electrical path to ground for the controlled dissipation of any static potential on materials that contact the surface. The work surface also helps define a specific work area in which ESD sensitive devices may be safely handled. The work surface is connected to the common point ground.
**Wrist Straps**

Typically, wrist straps are the primary means of controlling static charge on personnel. When properly worn and connected to ground, a wrist strap keeps the person wearing it near ground potential. Because the person and other grounded objects in the work area are at or near the same potential, there can be no hazardous discharge between them. In addition, static charges are safely dissipated from the person to ground and do not accumulate.

Wrist straps as shown in Figure 4 have two major components, the cuff that goes around the person’s wrist and the ground cord that connects the cuff to the common point ground. Most wrist straps have a current limiting resistor molded into the ground cord head in the end that connects to the cuff. The resistor most commonly used is a one mega ohm, 1/4 watt with a working voltage rating of 250 volts. Wrist straps should be tested on a regular basis. Daily testing or continuous monitoring is recommended.

**Layout of ESD online continuous monitoring system:**

![Block Diagram of ESD online continuous monitoring system in Barco Electronics system Limited, Noida, India](image)

**Figure 5:** Block Diagram of ESD online continuous monitoring system in Barco Electronics system Limited, Noida, India

![Block Diagram of ESD Online Continuous Monitoring System in Barco Electronics system Limited, Noida, India](image)

**Figure 6:** Block Diagram of ESD Online Continuous Monitoring System in Barco Electronics system Limited, Noida, India
Features of ESD Online Continuous Monitoring System:

The Most challenging part is to continuous monitor the performance of the wrist strap and the mats. Normally it is practice that wrist straps and mats are checked periodically but this will not ensure 100% safety. ESD Online Continuous Monitoring System ensures 100% ESD safe working environment. The main features of this complete setup are:

- Real time feedback for each workstation (continuous check the wrist strap, mat and ground)
- Easy to track the faulty workstation
- Centralized monitoring system
- Real Time status available on Network
- Visual and audio signals for the failure
- Modular Design and extendibility
- Software- Fetch health status of all units and stores in Database
- Ease to configure and maintain of the complete setup
- Centralized Data storage on SQL server

Hardware Requirement:

- Wrist Strap Master Controller
- Wrist Strap Slave Units (max. 32)
- Wrist Strap
- System with Windows XP/Windows 7
- RS-232 port
- LAN & Daisy chain setup

Software Requirement:

- C-WSM software
- NI Lab View 9.0
- Lab view Run Time Engine Installer
- SQL Server Database access
- PC with Windows 7 or XP

Hardware & Software Explanation

1. Wrist Strap Master Controller

The ESD Continuous Workstation Monitor (CWM) is a microcontroller (P89LPC938, 8-bit microcontroller with accelerated two-clock 80C51 core 8 kB 3 V byte-erasable Flash with 10-bit A/D converter) based system used for continuous monitoring of the status of ESD mats, and ESD earthing connections. It also validates the ESD wrist straps. Main components are required for complete monitoring setup.

ESD host Unit (Figure 5) which has the capability to control maximum 32 Workstation Monitor Units. This master unit communicates with all 32 units in a Daisy chain.

Master Controller specification & Features:

- 12V/5A adaptor’s output to “Power” port of the ESD Host.
- DB9-DB9 cross cable from RS232 port of ESD Monitoring PC, to the RS232 port of ESD Host
- RJ45-RG45 straight cable from ESD Host unit to the first ESD CWM of the daisy chain.
- All units are connected in daisy chain manner with RJ45 cable.
- Host Unit provides power to next ESD CWM unit. Power distribution is just like a daisy chain.
- FMW using keil software and downloaded with flash magic.
2. **Wrist Strap Slave Units (max. 32)** Each CWM has a unique identification and communicates with host unit.

Wrist Strap Slave Unit features:

- Wrist strap LED (red, yellow or green indication)
- Wrist strap mat LED
- Wrist strap power LED Easy to be programmed to append a new unit in daisy chain.

3. **Wrist Strap, Mat & Earthing connection**

Complete hardware monitors the resistance of wrist strap. It continuously monitors the wrist strap to detect loss of continuity between operator and monitor. Conditions such as broken coils cords and improper contact with the skin are detected instantly to alert the operator before serious and expensive ESD damage can occur.

The **Resistance of Wrist Band** is sum of the following resistances-1. Wrist Band chord, 2. Contact resistance between wrist and conductive elastic band, 3. Wrist to figure tip

The **Resistance of Mat** is resistance between the two punches on the mat and represents the intactness of Earth connection with MAT (and do not represents mat surface resistance). The CWM unit checks the two connections on the ESD mat by continuously monitoring the resistance across it. If a resistance of >20M Ohm is read, the “MAT” RED LED goes ON. Also a continuous beep sound is generated.
**Grounding or earthing connection** is connected to common ground plate where the resistance shall not be greater than 25 ohms. If there is broken between ground cables this unit detects and alarm.

The CWM unit continuously monitors the ESD Ground by sensing a signal from the ESD Host unit. If this signal is not found for >10s, the “WRIST BAND” and “MAT” LED are blinked in RED. Also a corresponding beep ON-OFF is generated.

**How to use wrist strap monitor unit at workstation:**

1. Connect the lead of ESD wrist strap to the “Wrist Strap” socket of CWM unit. The wrist-strap LED will glow RED (as shown in Figure 10), indicating that the presence of the strap has been sensed but it has not yet been validated.

2. To validate the wrist-strap, wear it and press the metal push-button on the CWM (as shown in Figure 11) until a beep is heard (Max time 5 seconds). If the wrist-strap is found OK, the Wrist-Strap LED goes GREEN and a beep is heard. If this is not observed, the wrist-band is not good and should be replaced.

4. **ESD monitoring system Software**

   This is also designed and developed in house, it continuously acquire data for all installed monitoring units and log the same in database. This Software displays health of all workstations.

   It shows status of each station: Green status indicates that workstation is active and ESD compliance, yellow status indicates workstation is not registered, red status indicates work station is not ESD compliance. Software is having different features like Login, Configuration and Maintenance. Only Authorize user can access these feature.

   Work Station monitoring system is completely developed in NI LabVIEW 9.0 and data stores is in SQL database. It continuously acquires data for all installed monitoring units and logs the same in database as well as text file on monitoring computer.

**Software Installation requirement:** NI LabView 9.0; Run Time Engine Installer; SQL Server Database access; PC with Windows 7 or XP

The final release software is installed at the Specified stations (PCBA line etc.). The station logon, this software will also start. Stations must not be shut down/Logoff until it’s in maintenance condition or updating condition otherwise the data will not be updated in Database.

When the first time install the setup then administrator has to configure the setup .the complete daisy line should be configured once at first time.
**Figure 10:** Front Panel of ESD Online Continuous Work Station Monitor System

**Figure 11:** View of Work Station Monitoring Unit with description

**Front Panel Controls:** There are controls which can be used to change/edit/view various parameters. Features of all controls are as given below:

<table>
<thead>
<tr>
<th>Controls</th>
<th>Features</th>
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<tbody>
<tr>
<td>Login/Logoff</td>
<td>Administrator login to enable configure and Maintenance button Ref -Figure 11</td>
</tr>
<tr>
<td>View Status</td>
<td>Status of all ESD Monitoring units (1-32) Ref-Figure 12</td>
</tr>
<tr>
<td>Configure</td>
<td>Configuration of serial port setting, database connection, wrist strap resistance and mat resistance (as given ESD 20.20 standards)</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Check Communication of each unit check under maintenance. Ref Figure 11</td>
</tr>
<tr>
<td>Help</td>
<td>This button is used to open this document from the GUI</td>
</tr>
<tr>
<td>Exit</td>
<td>This button is used to exit the GUI or shutdown the GUI. When the exit button is pressed then there will not be any monitoring of Continuous WSM system</td>
</tr>
<tr>
<td>ESD 20.20 document</td>
<td>This button is used to open the ESD 20.20.2007 pdf Document.</td>
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**Conclusion:** In this paper there is an overview of the ESD online continuous monitoring system which is in house development of Barco Electronic Systems Limited, Noida India. This complete setup reduces the latent failure and also helps to increase the productivity.

**About the Author:**

Ms Pratima Mehta did Bachelor degree in Electrical Engineering (honors) from Jai Narayan University, Jodhpur (Rajasthan) in 2003.
She joined Bhabha Atomic Research Center (RRCAT, Indore) as Scientific Officer (2003-2006), joined with Free Electron Laser Group where she contributed in automation of electron beam line.
Then she joined Eicher Engineering Solutions (2006-2009) as Labview Analyst where she contributed in enhancement of automobile industry and gained automation experience.
She joined telecom industry Fibcom India pvt. Limited as Senior Engineer (2009-2010)
She is currently working in Barco Electronic Systems Private Limited, Noida (2010-Current) as a Senior Engineer in Test Engineering and Industrialization Department. Her contribution is in Hardware Testing & Test Solution for production and her experience is in Boundary Scan -JTAG, Lab view, Test stand.