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# PRACTICAL EARTHING, BONDING, LIGHTNING AND SURGE PROTECTION



## YOU WILL LEARN HOW TO:

- Develop a sound working knowledge of earthing and harmonics
- Do a step-by-step site analysis on power quality and harmonics
- Gain practical knowledge on surge and transient protection
- Troubleshoot electrical and electronic systems for power quality and harmonic problems
- Identify, design correctly and fix EMC/EMI problems
- Know why and how to earth a circuit effectively
- Effectively design to filter at MHz frequencies
- Understand how to minimise the four noise coupling mechanisms
- Understand the function of the signal earth versus the signal return
- Select cables appropriately
- Know when to shield and when to filter
- Effectively earth mixed analogue and digital signals
- Reduce emission and susceptibility problems

## WHO SHOULD ATTEND:

- Instrumentation and Control Engineers
- Electronics and Systems Engineers/Technicians
- Consulting Engineers
- Electrical Engineers
- Power System Protection and Control Engineers
- Electrical and Instrumentation Technicians
- Mechanical Engineers
- Printed Circuit Board Designers
- Logic Designers
- Signal Integrity Specialists
- CAD Managers
- EMC Specialists
- Design Engineers
- Building Service Designers
- Data Systems Planners and Managers
- Test Engineers
- Technical Managers

## The Workshop

On day one of this interactive, practical workshop we review the fundamentals of power quality and the procedures for design and installation for earthing and neutral systems. You will cover the common misconceptions, problems and solutions of noise and harmonics in power systems, as well as surge and transient protection.

The second day of this workshop will help you identify, design, prevent and fix common EMC/EMI problems, with a focus on earthing and shielding techniques. Learning how to fix earthing and shielding problems on the job can be very expensive and frustrating, although it must be noted that most of the principles involved are simple. This workshop will give you the tools to approach earthing and shielding issues in a logical and systematic way. The overall focus is on useful design and systems issues; not about regulations and standards. The idea is that you will take this material back with you to your work and apply the key principles immediately to your design and troubleshooting challenges.

## Practical Sessions

This is a practical, hands on workshop enabling you to work through practical exercises which reinforce the concepts discussed.

**Including 8 demonstrations and 3 practical exercises**

- Demonstration of power quality and harmonics problems
- Analysis of waveforms to identify problems
- Simple harmonic, power quality and earthing calculations

*To gain full value from this workshop, please bring your laptop/notebook computer.*

## The Program

### DAY ONE

#### INTRODUCTION

- What is power quality and EMC?
- IEC/IEEE and FIPS standards
- Interfacing with electrical utilities

#### RECOMMENDED DESIGN AND INSTALLATION PRACTICE

- Wiring, earthing and distribution systems
- Dedicated and derived neutral systems
- Earthing and bonding equipment

#### EARTHING AND NOISE CONTROL

- Site auditing for noise control
- Misconceptions in performance earthing
- "Single Point" vs "Multi Point" techniques
- Noise and the zero signal reference grid

#### SURGE AND TRANSIENT PROTECTION

- Lightning phenomena
- Power system faults and switching surges
- Mitigation techniques - case study

#### HARMONICS IN POWER SYSTEMS

- Principles of harmonic analysis
- Harmonic phase angle and sequence
- Control of harmonic pollution
- Converters and inverters
- Theoretical and practical values of harmonic currents
- Effect on conductors and neutral Overloading
- Harmonic filter design
- Protection of capacitor banks
- Inverters design for low harmonic output

#### HARMONIC SITE ANALYSIS PROCEDURES

- Harmonic analysers
- Measurement - voltage or current?
- Measurement fundamentals and true RMS/predictive analysis
- Harmonic order and sequences and resonance
- Voltage and current waveforms (signatures)
- Harmonic interaction auditing

#### CASE STUDIES

- Checklist for powering, earthing and communications
- Commercial buildings
- Manufacturing and process control
- Medical facilities
- Computers and data processing environments
- Telecommunications

### DAY TWO

#### INTRODUCTION

- Fundamentals
- Interference sources
- EMI/EMC regulations

#### BASIC PRINCIPLES OF NOISE REDUCTION

- Importance of wiring inductance
- Noise coupling examples
- Common and differential modes
- Balanced circuits and common mode rejection

#### PRINCIPLES OF EARTHING

- What is electrical earthing?
- Function of an earth
- Analogue and digital earthing
- Single point, multipoint and hybrid earths
- Earth grid technique
- Isolated earthing technique

#### DIAGNOSIS OF NOISE PROBLEMS

- Relating symptoms to causes
- Ringing, rounding and reflections
- Practical methods of diagnosis
- Noise coupling examples

#### NOISE REDUCTION TECHNIQUES

- Minimisation of bandwidth
- Best place to earth cable shield
- Reducing mutual inductance

#### POWER CIRCUITS AND POWER SUPPLIES

- Power quality and EMI
- Filters and transient protection
- Switch mode power supply design

#### INDUCTIVE AND CAPACITIVE SHIELDING

- Materials and limitations
- Openings and penetrations
- Magnetic fields
- Shielding design guidelines

#### REDUCTION OF ELECTROMAGNETIC COUPLING

- EM shielding of cables
- Shielding for ESD and RF
- To shield or to filter?

#### SELECTION OF THE RIGHT CABLE AND CONNECTOR

- Cable earthing and crosstalk
- Cable shielding and connectors

#### CIRCUIT BOARD EARTHING ISSUES

- Identification of critical circuits
- Embedded controllers and EMC
- Component placement

#### TYING IT ALL TOGETHER

