# Entrance to EMI

#### Scan Measurement Mode







### What is EMC/EMI



- EMC has verified / classified by its characteristics and the co-relation with EUT
- This presentation is concentrated on CE of EMI, especially for CM and DM in CE

EUT(DUT) = Equipment Under Test (Device Under Test)

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### What is EMI

![](_page_2_Figure_2.jpeg)

- The Classification of EMC is done by frequency range
- The range is being changed by introducing new EUT, day by day
- World-wide and/or each country has the regulation/standard of EMC/EMI related and any of EUT has controlled by such regulation/standard
- Mostly familiar regulation/standard are
  - CISPR(The International Special Committee On Radio Interference)
  - EN (European Norm)
  - FCC (Federal Communications Commission)
  - IEC (International Electrotechnical Commission)

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## What CE and CM / DM

![](_page_3_Figure_2.jpeg)

- CE -- Noise moved through the line(s) to EUT
- CM : Common-Mode Noise
  = Noise Line to Ground

• DM : Differential-Mode Noise = Noise Line to Line

![](_page_3_Figure_6.jpeg)

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## Measurement of the Noise(s)

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- Measurement is done by EMI Receiver Occasionally done by Spectrum Analyzer, but not recommended
- Basic equipment are EMI receiver and LISN(Line Impedance Stabilization Network)
- Configuration and Setup of Measurement equipment be decided / done by
  - -- what kind of EUT to be measured
  - -- which regulation/standard is applied
- LISN has various models, according to the power condition(of EUT), like 16A to 200A, 1ph to 3ph
- Measurement is recommended to select/choose a place, having minimized outer noise influence, like in chamber or mini-shield room.

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## Measurement of the Noise(s)

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![](_page_5_Picture_3.jpeg)

![](_page_5_Picture_4.jpeg)

![](_page_5_Figure_5.jpeg)

![](_page_6_Picture_0.jpeg)

![](_page_6_Figure_2.jpeg)

#### <u>Solution = Debugging is to reduce/control the noise under the limit lines.</u>

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#### How to Reduce the Noise(s)

Various way of methods can be considered/applied to reduce the noise(s) Below are some of mostly used method/consideration Recommended the Filter should be the LAST solution

- Pattern
- The Ideal approach
- To achieve most recommended EMI Solution/Debugging, EMI consideration/design should be started at the same time of EUT design
- ♦ Wiring
- Do not do the wire twisted
- Allocate wires be separated, as far as possible
- Position
- Filter should be located at the "just" entrance of power input
- Shielding
- Shield any components, causing noises,
- Separate the components with shielding materials

### Filters : The Last & Final Solution = Debugging

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Actual in the field

- = EMI Solution/Debugging is the last,
  - after EUT design is finished

![](_page_7_Picture_20.jpeg)

![](_page_8_Picture_0.jpeg)

#### Why EMI Debugging is Difficult - Filter Design

#### Measured Noise = Total Noise = CM + DM

![](_page_8_Figure_4.jpeg)

Measured results

Total Noise = CM + DM

Filter is consisted with two types of components

![](_page_8_Figure_8.jpeg)

Common-Mode Group -- CM Coil and Y-Capacitor

Differential-Mode Group -- DM Coil and X-Capacitor

![](_page_8_Figure_11.jpeg)

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Why EMI Debugging is Difficult - Filter Design

• How to determine the noise is CM or DM, from the measured noise, total noise ???

Experience **Know-How** 

• How to select the components ???

Know-How **Experience** 

• How fast the components selection can be done ???

Experience Know-How

• How to be sure the selected components are accurate & exact size for the solution ???

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Summary of EMI Solution = Debugging = EMI Filter Design

- Analysis and Measurement of Exact Noise by mode, CM and DM
- EMI Solution = Debugging is finalized by EMI Filter (EMI Filter Design)
- Understanding more and more about the components being used on EMI Filter
- Design EMI Filter, using smaller Components and less Quantity

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### <u>Successful EMI Debugging = Good & Fast Filter Design</u>

![](_page_10_Picture_9.jpeg)

### <u>COST SAVING = COMPETITIVENESS</u>

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Consideration to make EMI Debugging as EASY WORK

MEASURE the noises by mode, CM and DM, respectively

![](_page_11_Picture_4.jpeg)

SELECT the components in exact size and performance, mode by mode

![](_page_11_Picture_6.jpeg)

SIMULATE the performance of the components and the filter

![](_page_11_Picture_8.jpeg)

APPLY the selected components as "Primary" filter to EUT

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![](_page_12_Figure_2.jpeg)

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![](_page_13_Figure_2.jpeg)

- Simulate the performance of the selected components and also the designed filter
- Apply selected components as "Primary" filter to EUT

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DM Mode Noise

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#### Basic System Configuration – EA-2100

- Basic System consist of EMI Receiver, EMI Analyzer(EA-2100), and LISN
- EA-2100 consists of main body and Filter Test Kit(FTK-05)
- > Available to supply the item in individual unit and also as package
- > Mini Shield Room should be a good option for effective and economical test environment

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#### Preparation – System Set Up

- Set up the system = EMI Receiver + EA-2100 + FTK-05 + LISN
- Set up EMI Receiver as your selected measurement condition

Most EMI Receiver has EMI software which set up the limit lines, frequency ranges, and etc, by only selecting the regulation/standard, like CISPR14..

![](_page_15_Figure_6.jpeg)

- Check the ground of each unit/item = **Good ground condition is Important**
- Power Line Filters shall be recommended to protect any outer noise influence

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#### Preparation – System Check

- Check the system with EMI Receiver and/or with Reference Source(CRS-1530)
- Measure L1, or L2 of EUT
- Change the Attenuation level on EMI Receiver and measure again
- Compare the results ;
  - 1<sup>st</sup> Highest Noise point should be at same frequency point

Only Noise level should be changed matching with the selected attenuation Level

![](_page_16_Picture_9.jpeg)

CRS-1530

![](_page_16_Figure_11.jpeg)

- Measurement is for certain frequency range ONLY
- The noise is not only within the range, existing before and after the selected frequency range
- In case, any of big noise(energy) is existed in lower frequency range, it can cause wrong measurement results.

![](_page_17_Picture_0.jpeg)

204 kHz 90.50 dBuV

107.0 dBuV

LOG 10 dB/

10 dB

Measurement - Initial

- Measure L1, and L2 with EMI Receiver EA-2100 is on "TEST" Mode
- Select one of them, L1 or L2, the higher noise measured
- Select "ANALYSIS" Mode ; Default is "LOW" and "CM[ON]"
- Measure CM Mode Only

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Components Selection -CM Mode - Understanding the components

- Impedance is the Key of Component
- Using minor(hidden) factors of Components
- Achieve good design by considering/using such minor factors

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![](_page_18_Figure_7.jpeg)

![](_page_18_Figure_8.jpeg)

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Components Selection –CM Mode

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- Select any of CM Mode Components you have
- Apply it(them) on FTK
- Measure the results.

![](_page_19_Figure_8.jpeg)

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Components Selection – DM Mode – Understanding the components

- Impedance is the Key of Component
- Using minor(hidden) factors of Components
- Achieve good design by considering/using such minor factors

![](_page_20_Figure_6.jpeg)

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#### X-Capacitor + DM Choke Coil

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Components Selection –DM Mode

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- Select any of DM Mode Components you have
- Apply it on FTK
- Measure the results.

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#### **Measurement - Final**

![](_page_22_Figure_3.jpeg)

Line 1

![](_page_22_Figure_5.jpeg)

#### Solved=debugged

![](_page_22_Figure_7.jpeg)

![](_page_22_Picture_8.jpeg)

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#### Extended Function of EA-2100 / Radiated Disturbance(RE)

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- Radiated Disturbance(RE) is from 30MHz to 1.1GHz
- In the most cases, RE noise is detected below 300MHz
- EA-2100 has function "HIGH" to measure and analyze the noise up to 300MHz, mode by mode
- Noise Pattern measured through this has almost same shape/pattern of actual RE noise
- Through this, catch RE noise source and how to control/reduce RE noise under the regulation/standard

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