Pre-Compliance Measurements according to SAE J1752-3 with ESDEMC TEM Cells

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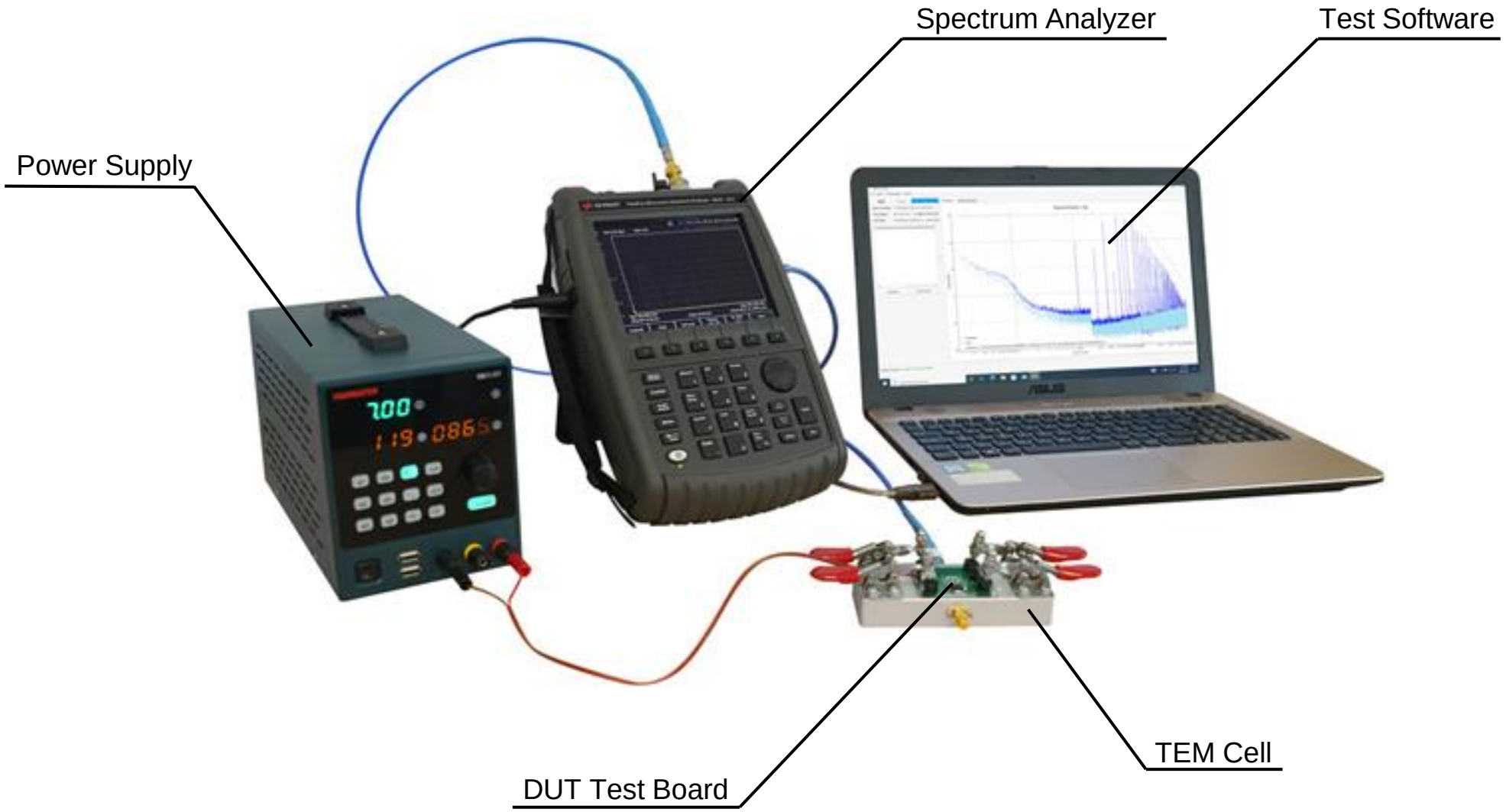
Background

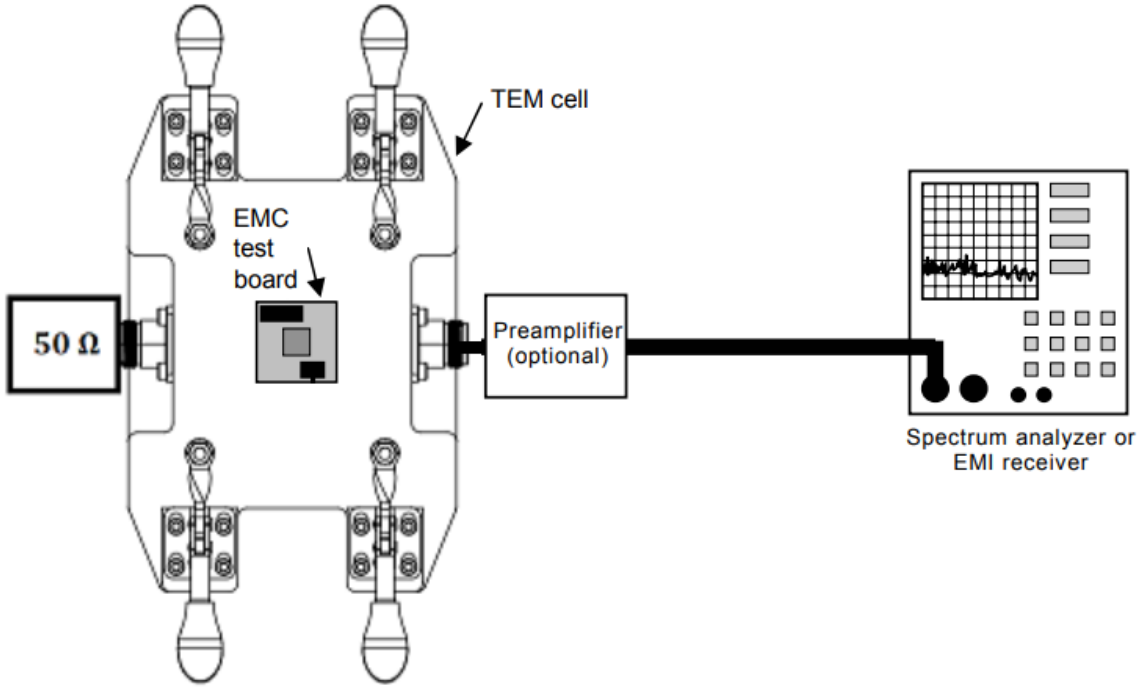
- TEM Cell Overview:
  - Transverse-electromagnetic-mode (TEM) is an electromagnetic field pattern of radiation where both E and H fields are perpendicular to the direction of the radiation propagation
  - A TEM Cell is an expanded coaxial transmission line (septum) that propagates TEM waves (within a cavity)
  - E and H field are approximately uniform between the septum and cavity ceiling
  - Approximately simulates a planar field in free space (377Ω far-field wave impedance)
  - E field strength at the mid-point between the septum and cavity ceiling is related to the RF voltage between septum and cavity GND, and the septum to cavity ceiling height
- SAE J1752-3 Standard:
  - The SAE J1752-3 standard defines a method for measuring EM radiation of an integrated circuit (IC) using a TEM Cell
- ESDEMC TEM Cell Products:
  - Specially designed to satisfy the requirements of the following standards:
    - SAE J1752-3
    - IEC 61967-8
    - IEC 61967-2
  - Software solution is available for J1752-3 compliant RE testing and emissions level classification

SAE J1752-3 Test System



SAE J1752-3 Test Conditions

- IC device-under-test (DUT) is mounted to a test board
- DUT test board is mated to the ceiling of the TEM cell cavity, acting as a TEM Cell wall
- DUT shall be powered-on in an operating mode specified by the manufacturer
- The test frequency range is determined by the TEM Cell in use



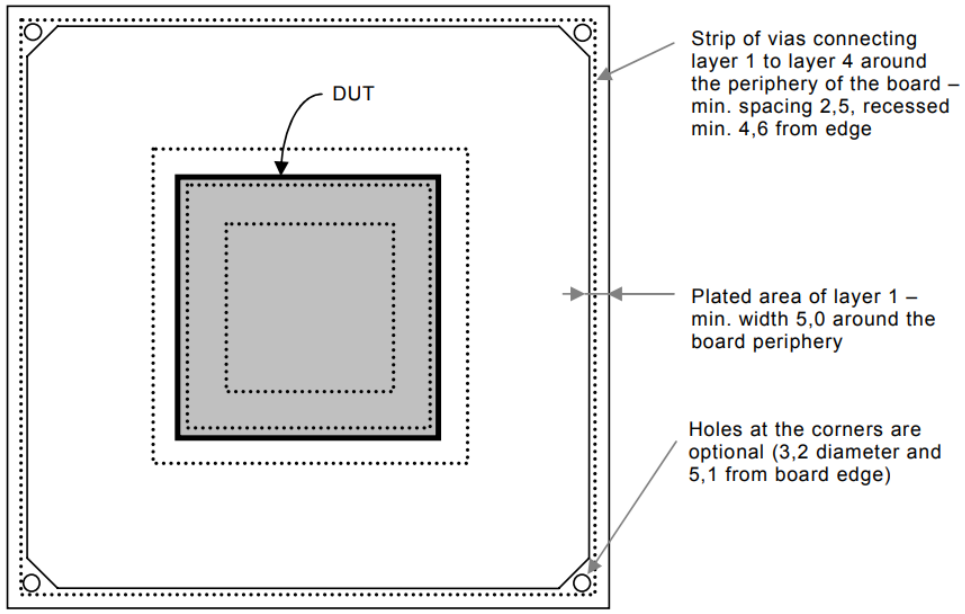
Test Setup

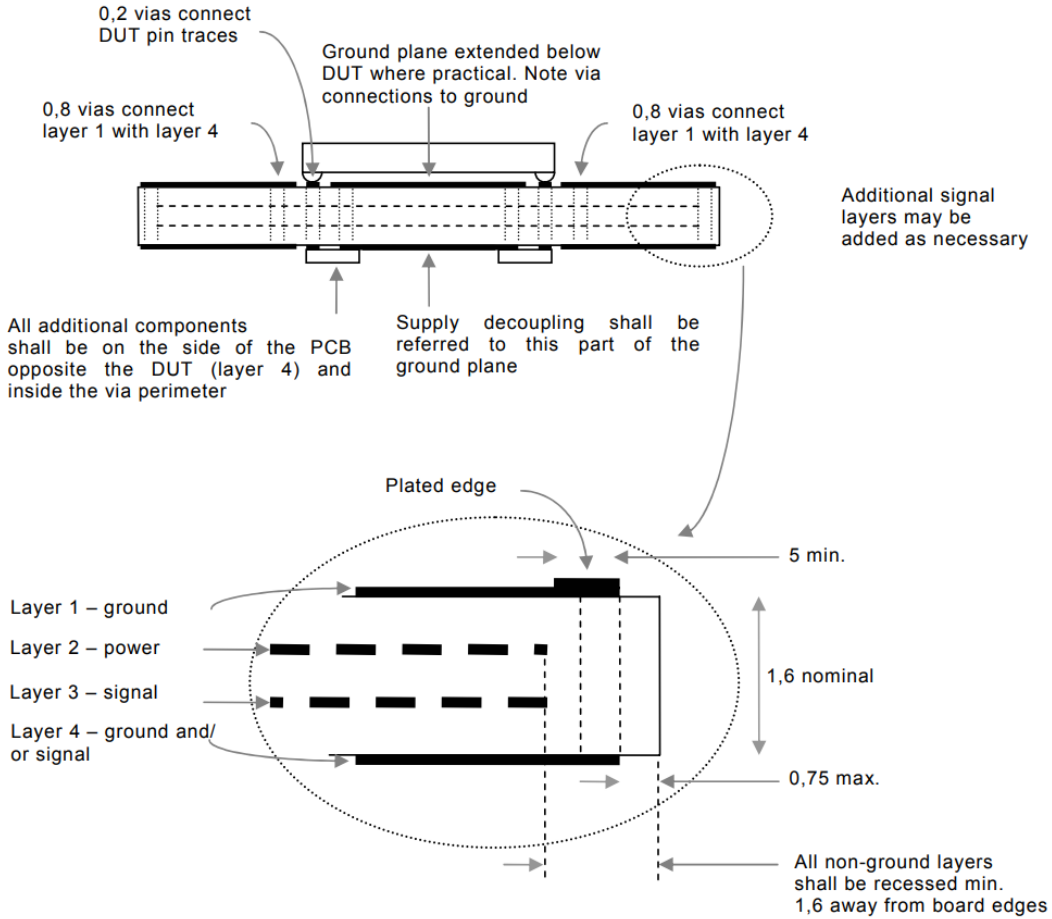
- System Gain:
  - Double-shielded or semi-rigid coaxial cable is required
  - A low-noise preamplifier of 20 to 30 dB nominal gain is typically used
  - Gain accuracy of +/- 0.5 dB is required
  - Gain magnitude shall remain within a 6 dB envelope of full frequency range
- RF Measurement Settings:
  - Frequency: 150 kHz – 8 GHz
  - RBW: 9 kHz or 10 kHz
  - VBW: 3*RBW
  - Detector Type: Peak
  - Sweep Mode: Max Hold

- TEM Cell
  - Port opposite of measurement shall be terminated with 50 Ω load (VSWR < 1.1)
  - PCB test board properly mated to ceil the TEM Cell cavity
  - VSWR < 1.4
  - Septum Width > .91*DUT package width
  - Septum-to-Wall Height < 2*DUT package height

Test Setup Continued

- DUT Test Board PCB:
  - Clear description of PCB layout design requirements (J1752-3 Section 6.2):



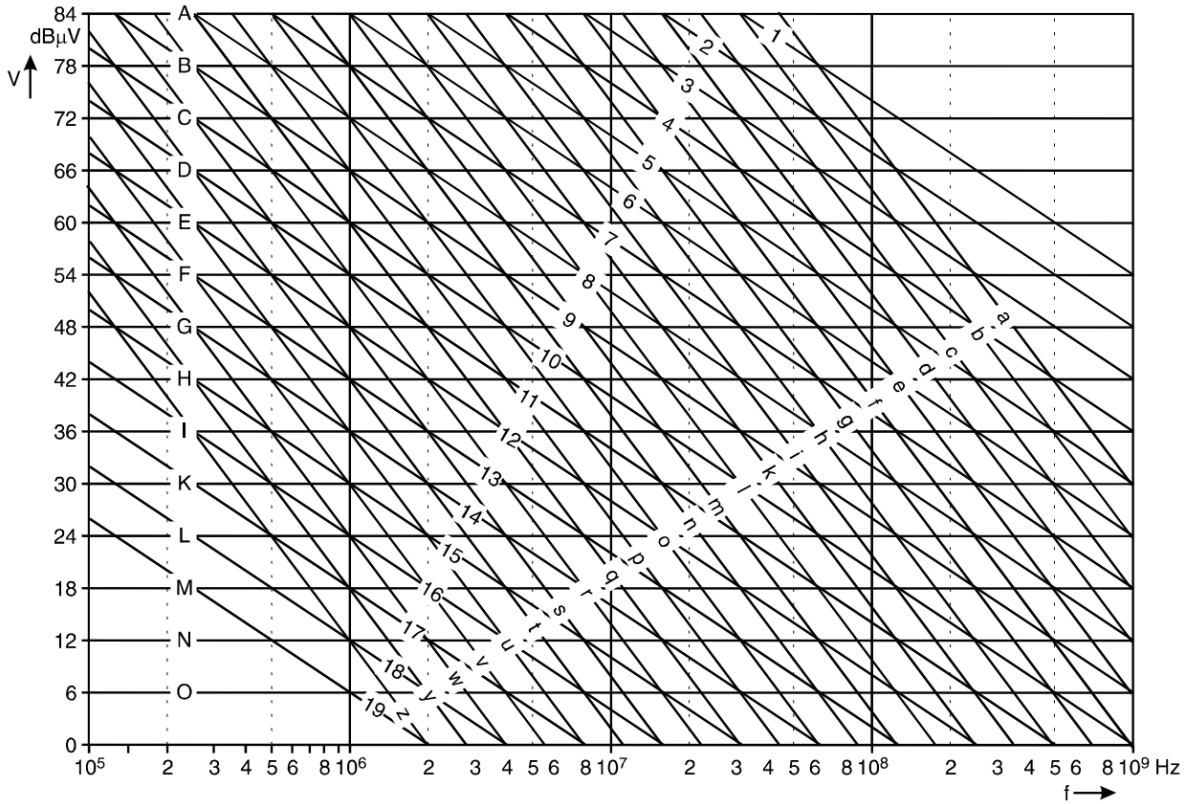


Procedure

- Ambient Measurement
  - Measured ambient levels shall be 6 dB below the target reference level
    - Emissions measurement results are only considered reliable when at least 6 dB above the noise floor
  - If necessary, tests shall be conducted within a shielded chamber
- DUT Operational Check
  - With the IC test board energized, complete an operational check to verify the proper function of the device and the IC test mode software
- DUT Measurement
  - Operational check to verify proper DUT test mode
  - While DUT is in test mode, measure RF emissions accumulating 3 sweeps on max hold
    - Individual sweep time should be greater than the full length of a test mode software loop cycle
  - Two measurements shall be taken:
    - 0˚ PCB position
    - 90˚ PCB position

Results Presentation

- Emissions Classifications
  - The classification describes the maximum measured emission level
  - Two letters and one number are used
  - Characters represent one of three separate slopes
    - 0 dB / decade slope: ‘A’ - ‘O’
    - -20 dB / decade slope: ‘1’ - ‘19’
    - -40 dB / decade slope: ‘a’ - ‘z’



ESDEMC TEM Cell Products & Solutions

- All ESDEMC TEM Cells may be used for SAE J1752-3 testing

TEM Cell Model	Insertion Loss (1dB Bandwidth)	VSWR	Max DUT Width	Max DUT Height	Max CW Input Power	Max CW Input Voltage	RF Connector Type
EM601-6	DC-6GHz	< 1.5	37.5mm	6.2mm	57dBm	44dBV	Type-N
EM601-6a	DC-6GHz	< 1.4	37.5mm	6.2mm	57dBm	44dBV	Type-N
EM601-8	DC-8GHz	< 1.4	24.0mm	4.0mm	53dBm	40dBV	SMA
EM602-10	DC-10GHz	< 1.5	37.5mm	0.8mm	48dBm	35dBV	SMA
EM603-8	DC-8GHz	< 1.4	24.0mm	4.0mm	53dBm	40dBV	SMA
EM603-10	DC-10GHz	< 1.5	18.9mm	3.2mm	53dBm	40dBV	SMA
EM603-12	DC-12GHz	< 1.5	15.1mm	2.5mm	53dBm	40dBV	SMA
EM603-14	DC-14GHz	< 1.5	12.2mm	2.0mm	53dBm	40dBV	SMA

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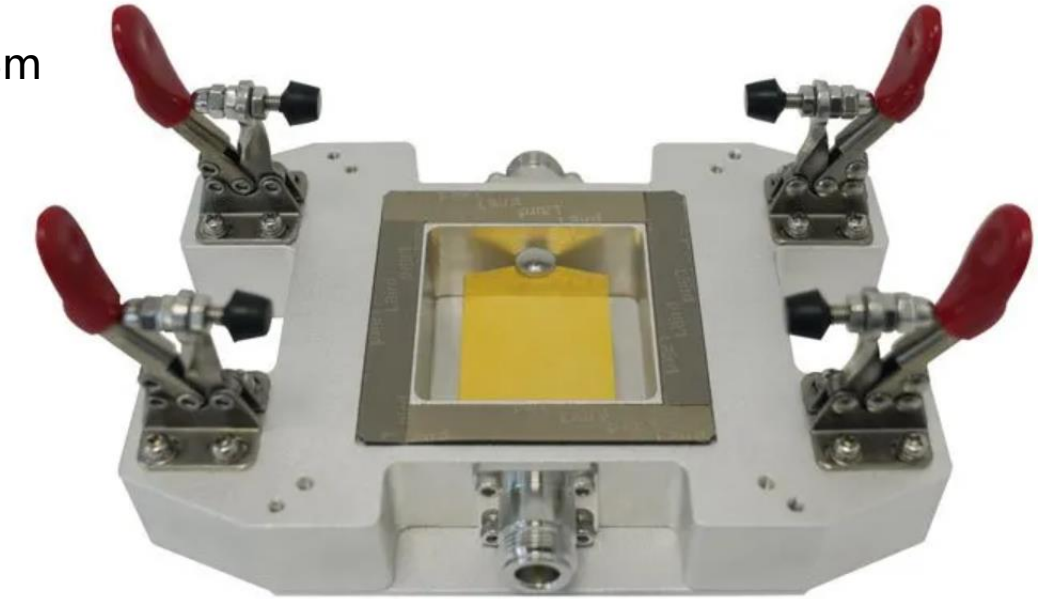
- EM601-6:
  - Frequency Range: 150 kHz – 6 GHz
  - Septum-to-Wall Height: 12.5mm
  - Septum Width: 34mm
  - VSWR: < 1.5
  - Max Input Power: 57dBm



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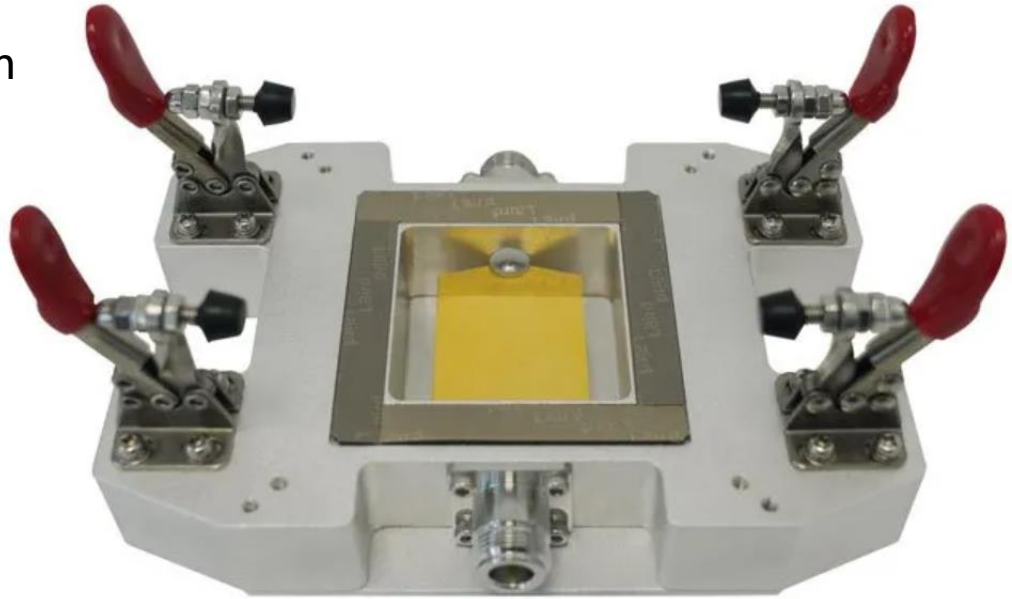
- EM601-6a:
  - Frequency Range: 150 kHz – 6 GHz
  - Septum-to-Wall Height: 12.5mm
  - Septum Width: 34mm
  - VSWR: < 1.4
  - Max Input Power: 57dBm



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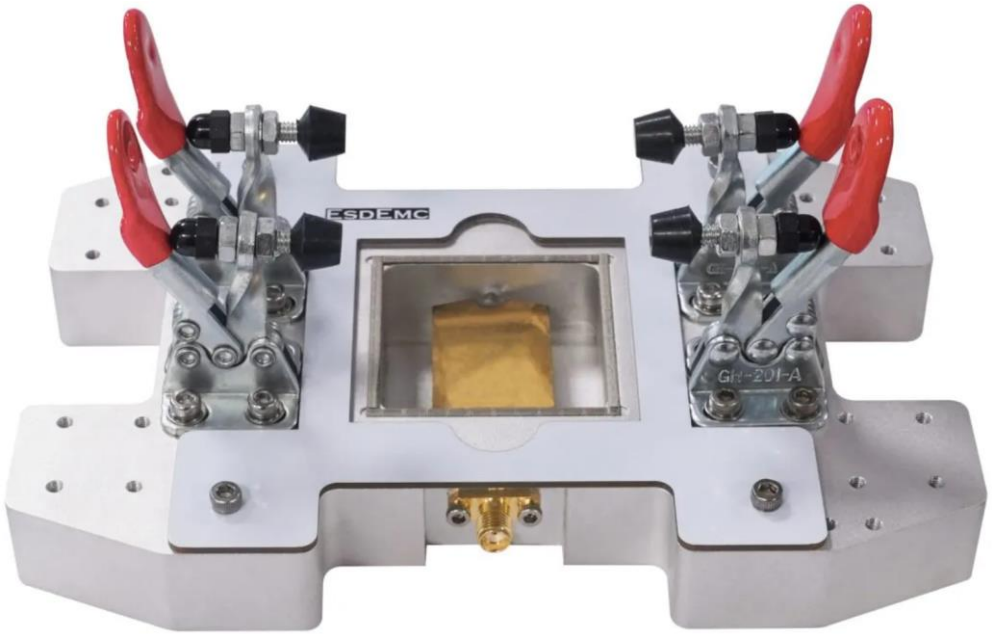
- EM601-8:
  - Frequency Range: 150 kHz – 8 GHz
  - Septum-to-Wall Height: 8mm
  - Septum Width: 22mm
  - VSWR: < 1.4
  - Max Input Power: 53dBm



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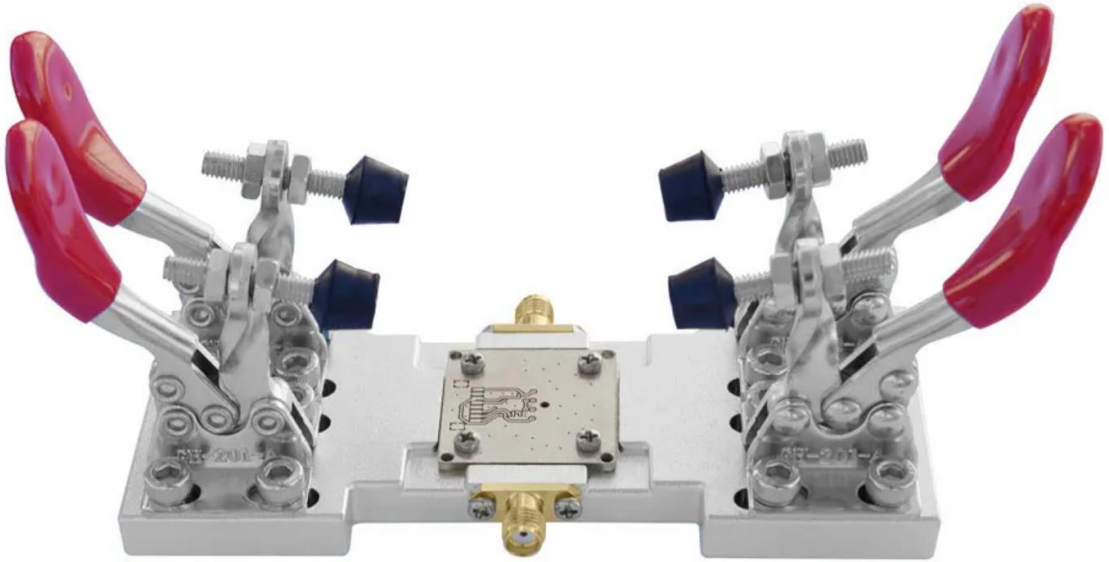
- EM602-10:
  - Frequency Range: 150 kHz – 8 GHz
  - Septum-to-Wall Height: 8mm
  - Septum Width: 22mm
  - VSWR: < 1.5
  - Max Input Power: 48dBm



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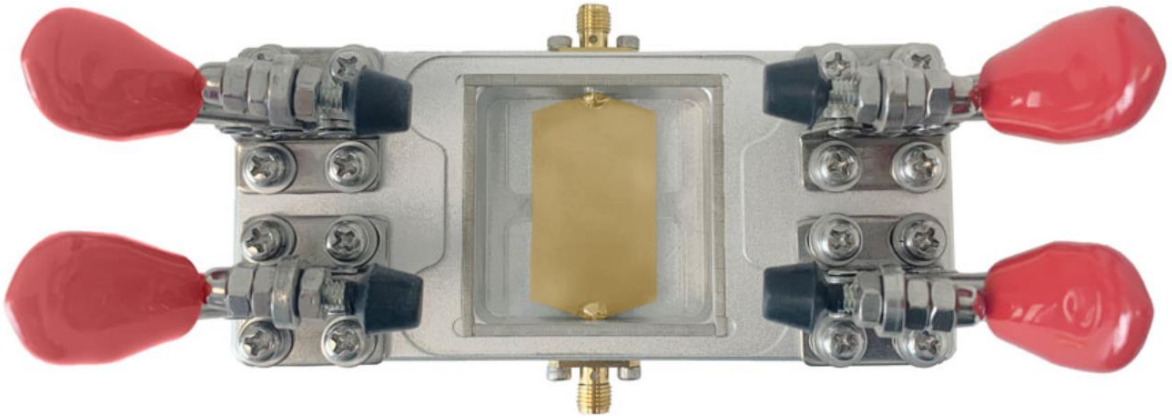
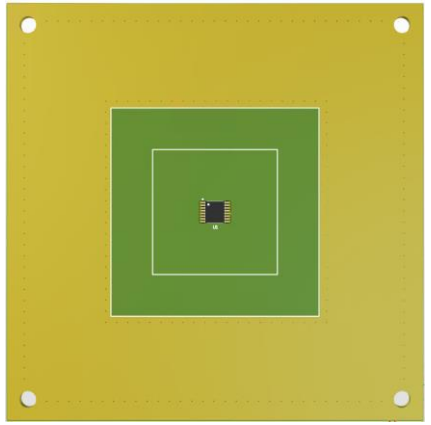
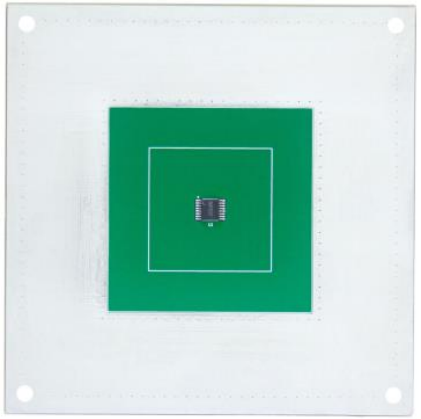
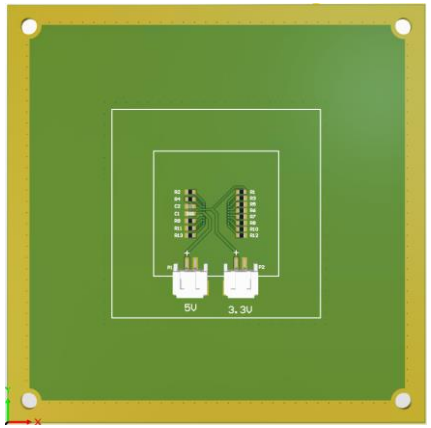
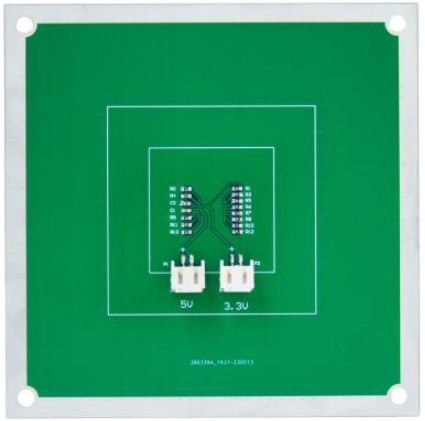
- EM603-8:
  - Frequency Range: 150 kHz – 8 GHz
  - Septum-to-Wall Height: 8mm
  - Septum Width: 22mm
  - VSWR: < 1.4
  - Max Input Power: 53dBm



ESDEMC TEM Cell Products & Solutions

- IC Test Board Layout Solutions

Design	Manufacture
	
	

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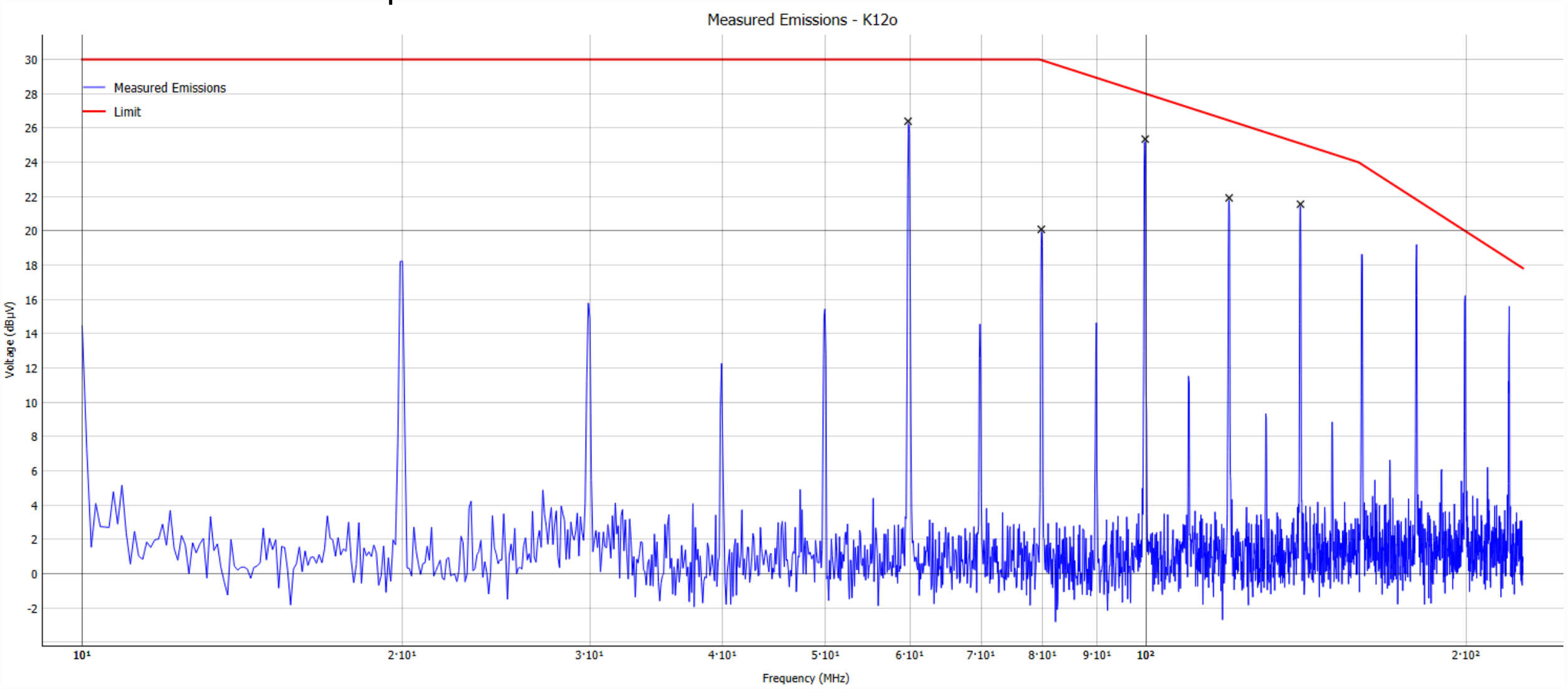
- Test Software Example 1



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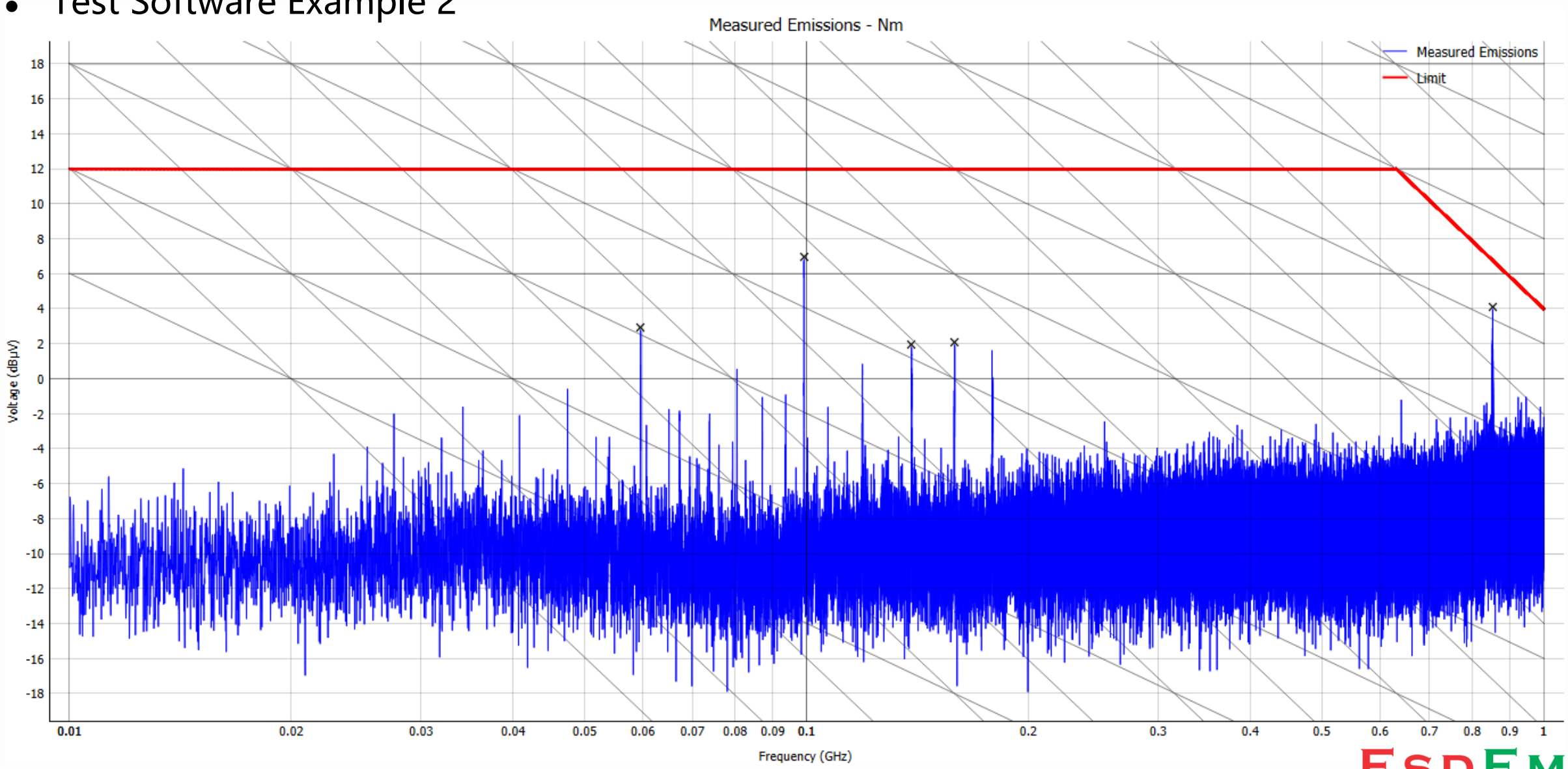
- Test Software Example 2



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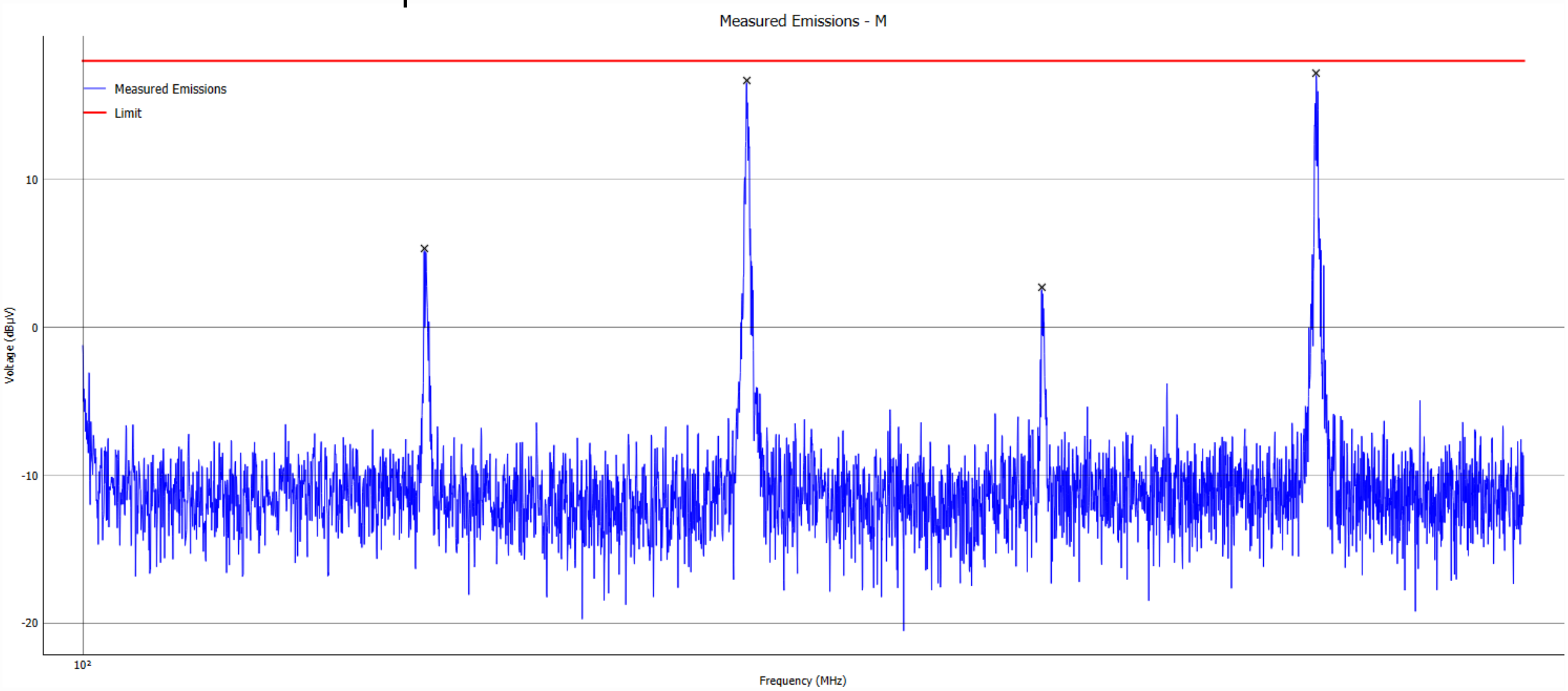
- Test Software Example 3



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