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Successfully Performing an IEC 61000-4-3 Field Calibration

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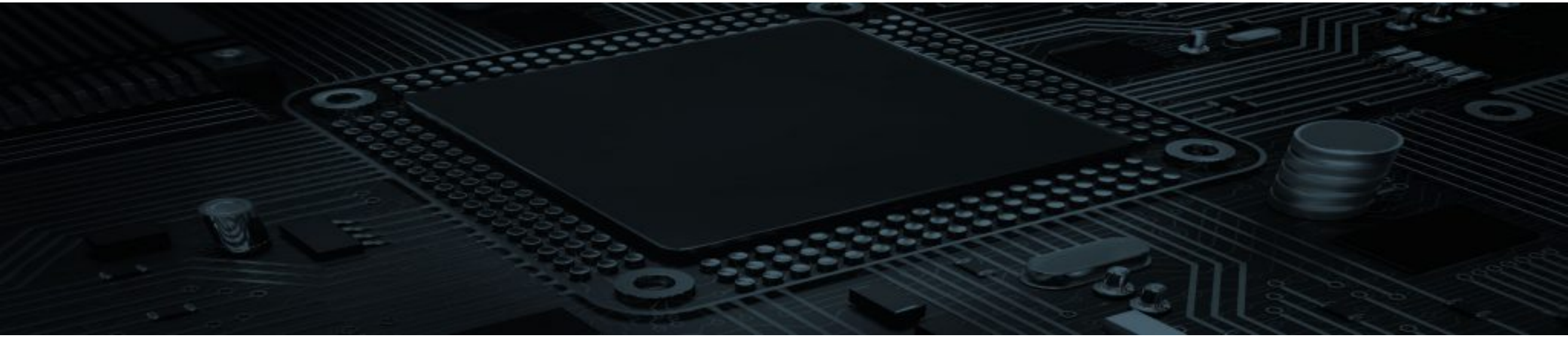


Dean Landers

Applications Engineer, Amplifier Research

Short Bio: Dean Landers is an Applications Engineer for Amplifier Research. He is actively engaged in new application and product development, system development and integration, customer support, and training with hardware demonstrations for both customers and AR personnel. Prior to working at Amplifier Research, Dean spent 9 years as an EMC Test Engineer at Retlif Testing Laboratories, managing military, commercial aviation, and commercial test programs, writing customer test procedures, and working with customers to help them understand their compliance needs and requirements. He also serves on the IEEE EMC Society Executive Committee and is the current chair.

Topics Covered

- Introduction to IEC 61000-4-3
- Test levels and how the modulation used during test affects the calibrated test level
- Discuss different types of calibration under IEC 61000-4-3
- Physical layouts of test areas and rooms
- Equipment needed to perform the calibration and testing
- Performing the calibration and understanding the data presented
- Calculating the standard power after calibration has been performed
- Linearity Check
- Mitigation tactics if the calibration fails
- How to ensure the test is performed the same way every time

Introduction to IEC 61000-4-3

- Basic Radiated Immunity test method utilized by harmonized standards within the EMC Directive (2014/30/EU)
- Simulates a continuous RF environment
- Test levels are determined by committees who develop product family standards
- Test levels typically do not exceed 30 V/m
- Performance Criteria is typically Performance Criteria A (which means that the EUT must operate within the manufacturer's specifications with no deviation)
- The Continuous Wave (CW) signal is typically amplitude modulated (AM) by 80% with a 1 kHz repetition rate
- Two types of uniform field area (UFA) calibration can be performed: Constant Power and Constant Field Strength
- Calibration should be performed on an annual basis, or any time changes are made to equipment or the test area

Test Levels and Calibration

Level	Test field strength V/m
1	1
2	3
3	10
4	30
x	Special
NOTE x is an open test level and the associated field strength may be any value. This level may be given in the product standard.	

Source: Table 1 of IEC 61000-4-3:2008

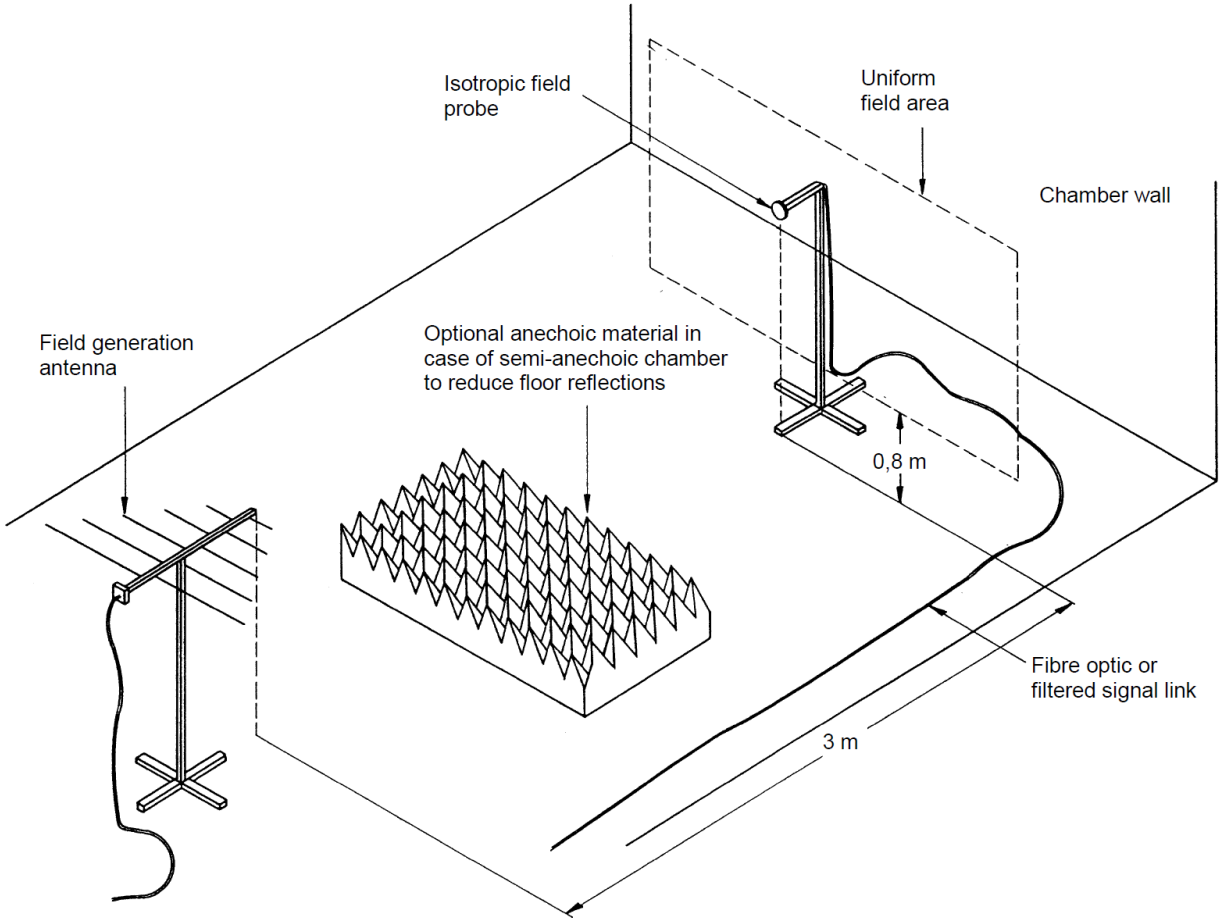
Test Levels and Calibration (cont'd)

1. Calibration is performed via a 16-point grid.
2. Two types of calibration are described within the test standard: **Constant Field Strength** and **Constant Power**

Test Levels and Modulation

- Calibration is performed at a level higher than that of the highest test level
- This is due to the effects of modulation during test
- For Amplitude Modulation at 80%, the field level will reach a level 80% higher than the CW field level (CW Level + 80% = 1.8x)
- For example, a 30 V/m test level shall be calibrated at 54 V/m (30 V/m x 1.8 = 54 V/m)

Physical Layouts of Test Areas



Source: Figure 3 of IEC 61000-4-3:2008

Physical Layouts of Test Areas (cont'd)

- The three-meter test distance shown is preferred.
- The anechoic material shown may be ferrite tiles, foam absorber, hybrid absorber, or a combination of ferrite tiles and foam absorber.
- The anechoic material is typically a square or rectangle
- Be sure to remove the table during UFA calibration
- May want to add small pickup device (such as a stub antenna) for field validation, placed in an area outside of the field to validate field during test
- Antenna(s)

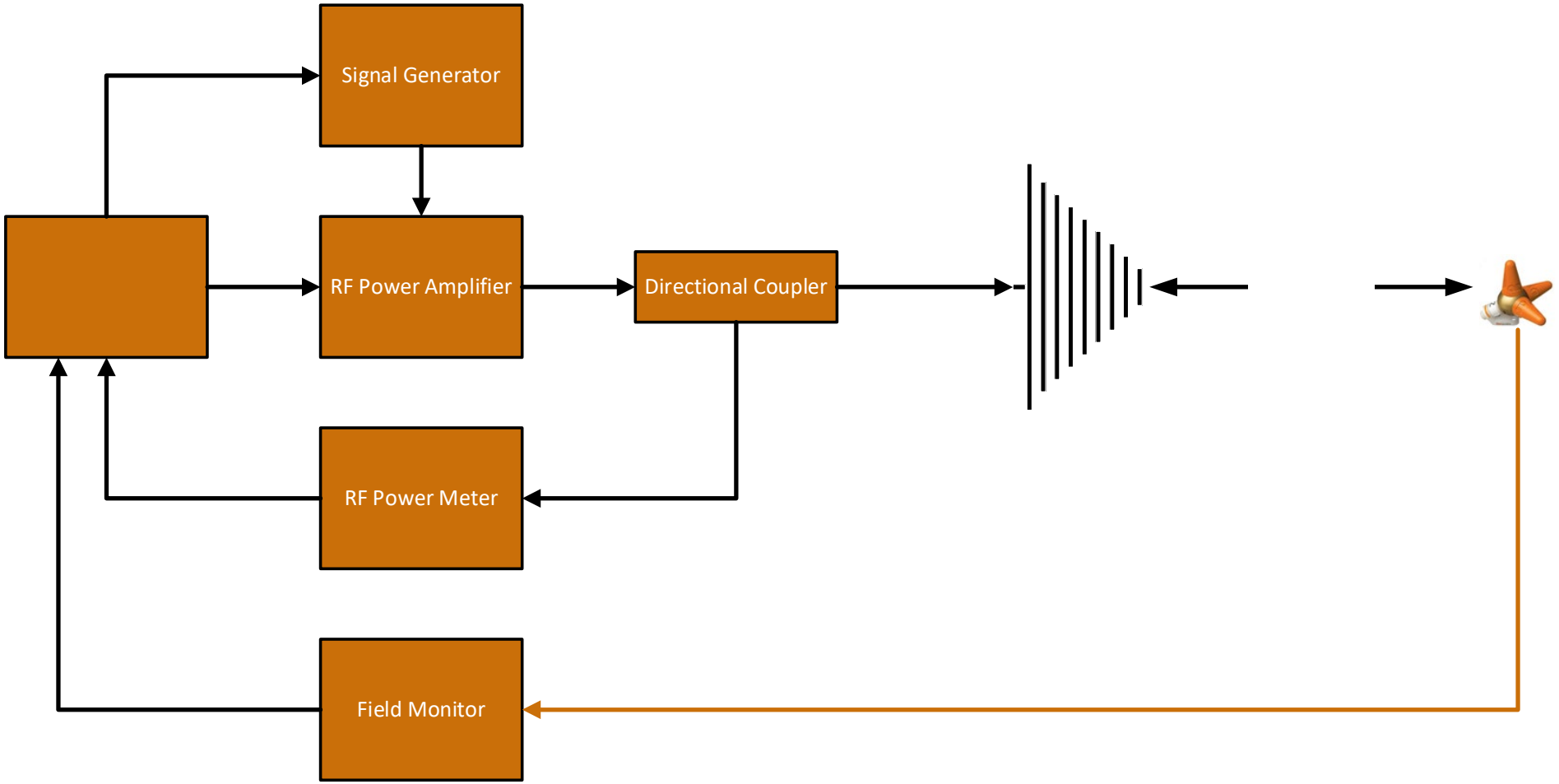
Test Equipment

- Semi-Anechoic Chamber
- Signal Generator(s)
- RF Power Amplifier(s)
- Directional Coupler(s)
- RF Power Meter
- RF Power Sensor(s)
- Field Probe
- Field Monitor

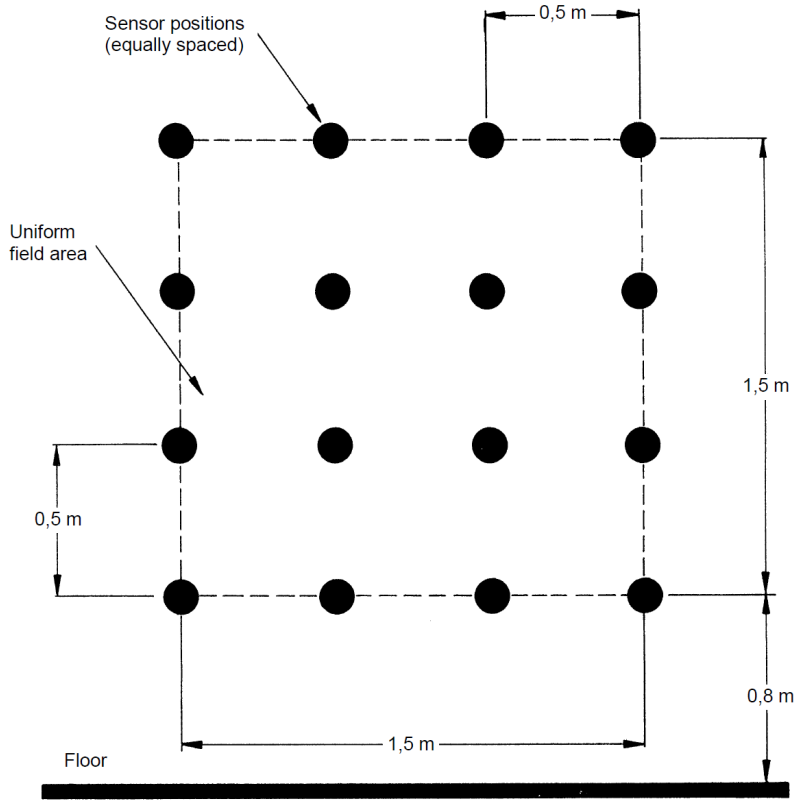
Optional Test Equipment

- Probe Positioner
- Multiple Field Probes
- RF Switch

Test Equipment Configuration



16 Point Field Grid

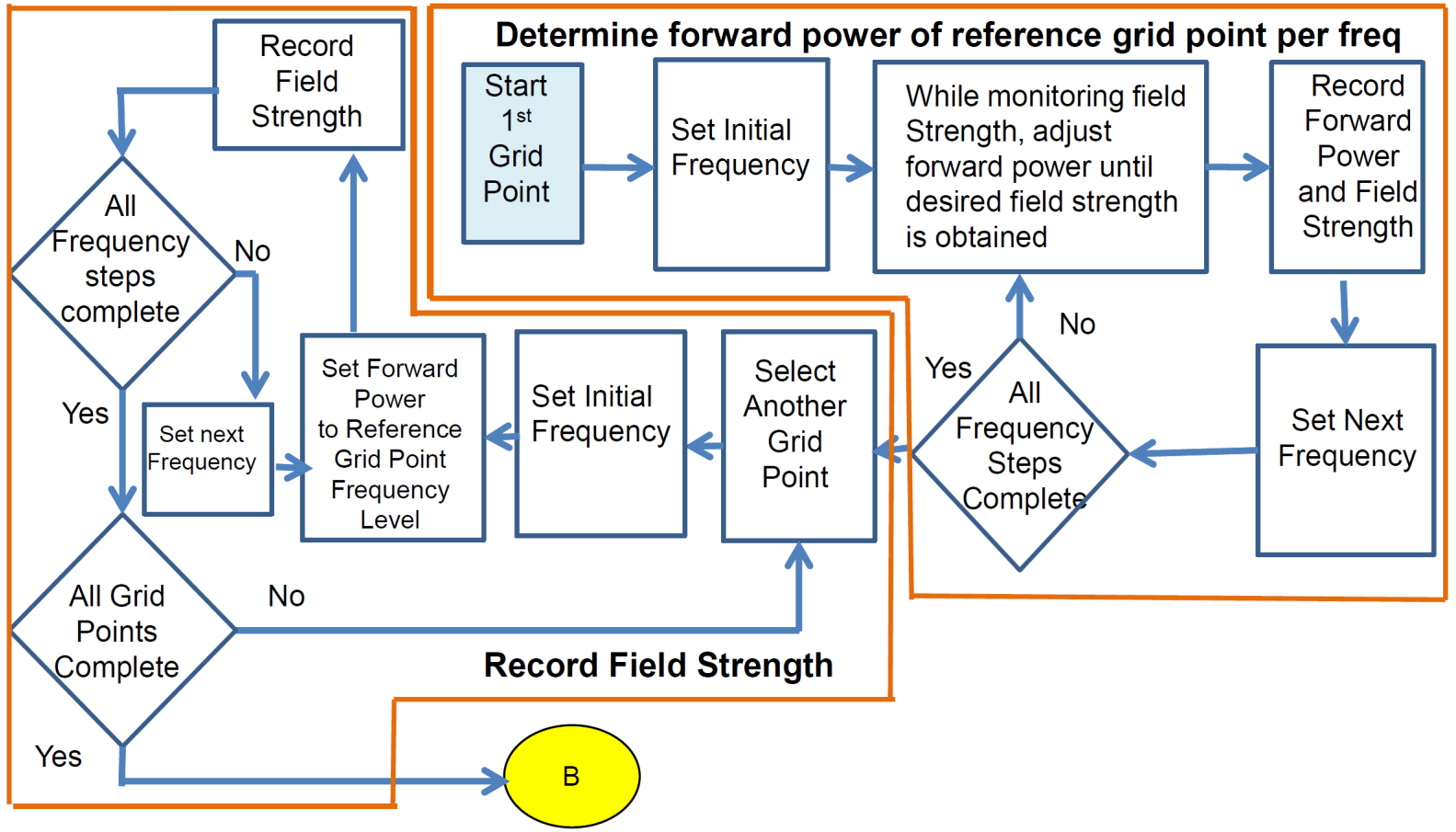


Source: Figure 4 of IEC 61000-4-3:2008

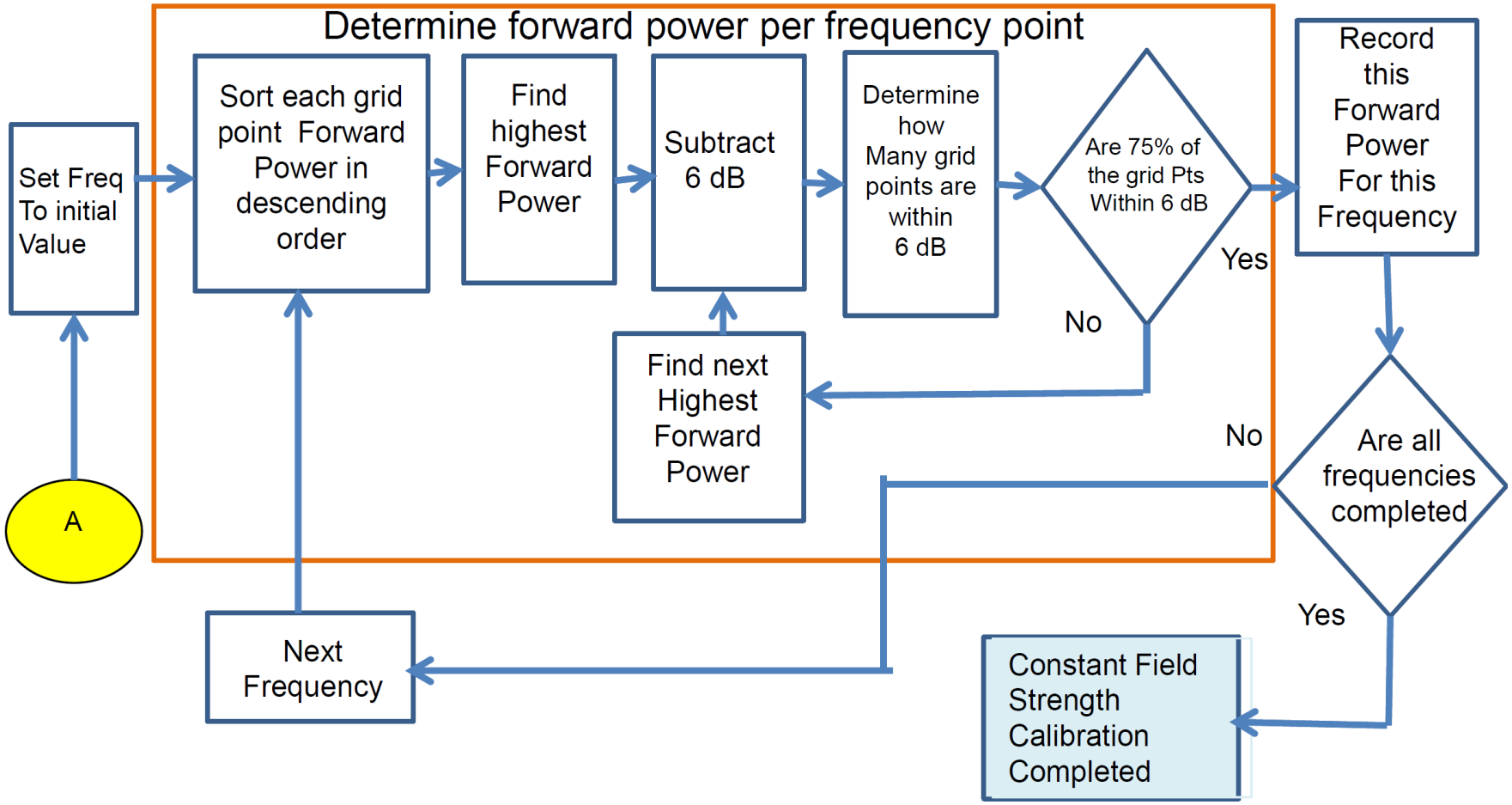
Performing the Calibration – Initial Steps

1. Identify the Test Level (30 V/m x 1.8 = 54 V/m)
2. Identify the frequency range (typically 80 MHz to 6 GHz)
3. Identify the frequency steps (typically 1%)
4. Set the field probe into position 1

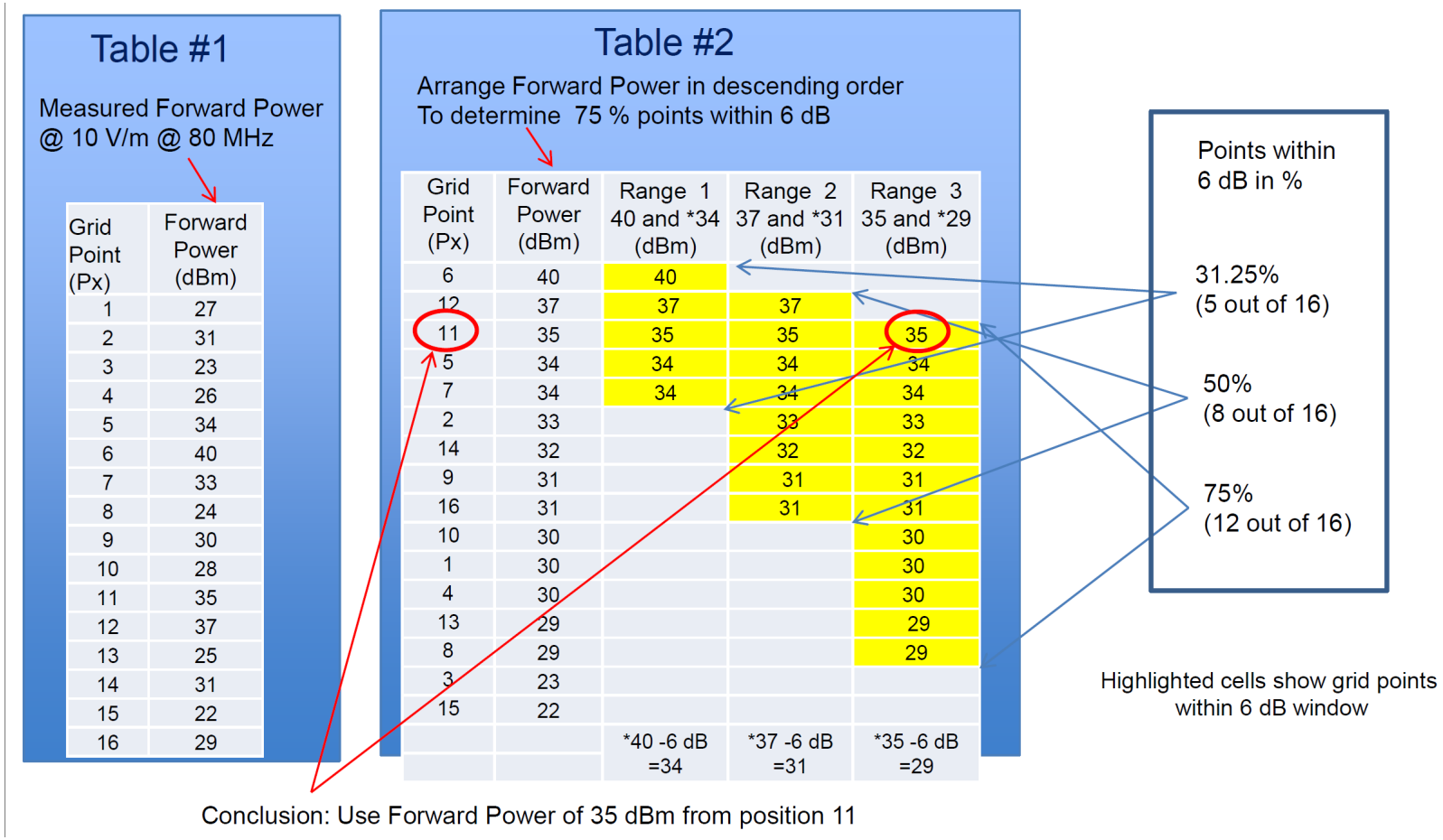
Performing the Calibration – Constant Power



Performing the Calibration – Constant Field Strength



Evaluating the Data from the Constant Field Strength Method



Checking for Linearity/Saturation

1. Once the forward power numbers are known, the linearity of the amplifier must be evaluated. For each frequency step, apply the forward power obtained during calibration
2. Record this forward power
3. Decrease the output of the signal generator by 5.1 dB
4. Record the new forward power applied to the antenna
5. Subtract the new forward power from the original forward power
6. Verify that the difference is between 3.1 and 5.1 dB.

How to Ensure Repeatability

1. It's important to ensure that the test is performed correctly at every execution
2. Utilizing a small pickup device installed during calibration, connect it to a spectrum analyzer or power meter
3. Apply the forward power at the first frequency step for each of the individual test levels that will be tested
4. Record the spectrum analyzer trace or power meter reading of the output of the pickup device for each individual test level
5. Prior to performing the test, verify that the level measured on the spectrum analyzer is within +/- 1 dB of the level measured just after calibration

Mitigation – What to do when the calibration or linearity check fails?

- Evaluate the test area, and ensure that your test setup is optimized
- Ensure that the equipment (antennas, amplifiers, absorber) is appropriate for the test (construction, dimensions, etc.)
- Move the antenna closer than the 3 meter distance
- Change the height of the antenna.
- Consider adding floor absorber
- When using automated routines, verify that the software is performing the math correctly.

Summary

- IEC 61000-4-3 requires UFA calibration prior to testing
- Calibration should be performed annually, or when changes are made to the environment or (potentially) equipment
- The IEC 61000-4-3 calibration can be performed with either Constant Power or Constant Field Strength methods
- The calibration must be performed at 1.8x the highest test level that will be tested
- The maximum UFA, currently, is 1.5 meters by 1.5 meters
- Mitigation can be performed if the calibration or linearity/saturation check fails

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Thank you for attending!

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