Introduction

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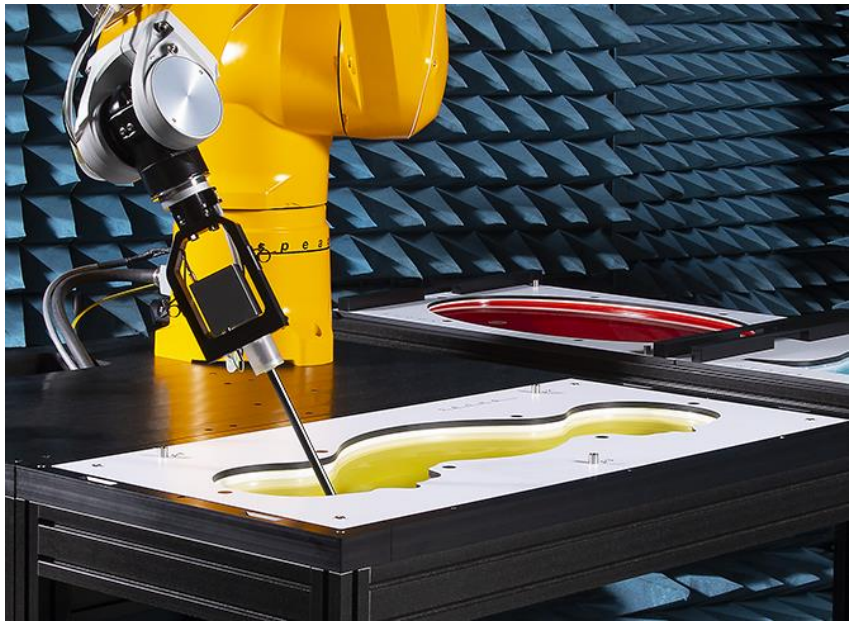
Today's Discussion

- Definitions
  - Portable
- RF Exposure Limits and Exemptions
  - FCC Limits
  - EU Limits
  - FCC Exemption Calculations
  - EU Exemption Calculations
- Mobile Phone Testing
  - Discuss the differences between the EU requirements and FCC requirements
    - Next to Head
    - Next to Body
    - Hotspot Testing Requirements
    - KDBs Test Requirements by Technology
    - EU Test Requirements by Technology
- WiFi 6E Testing Requirements
  - FCC Testing Requirements
  - EU Testing Requirements



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RF Exposure Definition

- Portable definition
  - Evaluation of devices operating with in 20 cm of the human body general population limits
    - Extremities (hands, wrist, ankles, feet, pinnae) limit is 4.0 W/kg averaged over 10 grams of tissue for both the FCC and EU
    - Body and Head limit is 1.6 W/kg averaged over 1 gram of tissue for the FCC and 2.0 W/kg averaged over 10 grams of tissue for the EU
  - Evaluation of devices operating with in 20 cm of the human body controlled/ occupational limits
    - Extremities (hands, wrist, ankles, feet, pinnae) limit is 20.0 W/kg averaged over 10 grams of tissue for both the FCC and EU
    - Body and Head limit is 8.0 W/kg averaged over 1 gram of tissue for the FCC and 10.0 W/kg averaged over 10 grams of tissue for the EU
      - This limit is not to be used on a consumer device or band defined as consumer use for the FCC
        - For example, a PTT for occupational use has a WiFi module installed. The LMR band is assessed to the occupational limit and the WiFi is assessed to the general population limit
    - Above 6 GHz you use the MPE Limits for assessment for the FCC and once 62209-1528 is approved by the EU you can test SAR to 10 GHz and MPE above 10 GHz

FCC Exemption Thresholds

- Option A
  - Applies to all frequencies and all distances
    - It can be used for both SAR test exemptions and MPE test exemptions
    - $P \leq 1$ mW
    - There is one limitation that most be met for the exclusion to be fully valid
      - When there are multiple transmitters in a device, ALL simultaneously transmitters must meet the 1 mW maximum power
      - This is explained further in 1.1307(b)(3)(i)(A) and 1.1307 (b)(3)(ii)(A)

FCC Exemption Thresholds (Continued)

- Option B
  - Applies to the frequency range of 300 MHz – 6GHz with distances from 5 mm to 40 cm
    - This option is for SAR exclusions
    - Lower limit is being discussed to be reduced
  - The maximum time-averaged power or ERP, whichever is greater, must be $\leq P_{th}$
    - P_{th} is calculated based on the separation distance in cm from the transmitter to the user for the device operating at f GHz

      P_{th} (mW) = ERP_{20cm} $(d/20)^x$ for distances $d \leq 20$cm

      P_{th} (mW) = ERP_{20cm} for distances $20cm < d \leq 40cm$

      $x = -\log 10\left(\frac{60}{ERP_{20cm}\sqrt{f}}\right)$

      ERP_{20cm} (mW) 0.3 GHz ≤ f < 1.5 GHz = 2040 f

      ERP_{20cm} (mW) 1.5 GHz ≤ f ≤ 6 GHz = 3060

EU Exemption Thresholds

- Many general standards and product specific standards
  - Primarily use EN 62311, EN 62479, EN62209, EN 50566, EN50360
  - EU has a 2 different exclusion levels based on power or distance
    - The power exclusion is 10 times the limit in mW
      - For head and body general population SAR, the limit 2.0 W/kg so the exclusion is 20 mW
      - For extremity general population SAR, the limit is 4.0 W/kg so the exclusion is 40 mW
      - For head and body occupational SAR, the limit 10.0 W/kg so the exclusion is 100 mW
      - For extremity occupational SAR, the limit is 20.0 W/kg so the exclusion is 200 mW

EU Exemption Thresholds (Continued)

- Formula based exclusion level
  - The following formulas are used to determine the exclusion power level

$$P_{max}' = \exp\left[As + Bs^2 + C\ln(BW) + D\right] \quad \text{(B.1)}$$

For compliance with the SAR limit of SAR_{max} = 2 W/kg averaged over m = 10 g in ICNIRP Guidelines [1] and IEEE Std C95.1-2005 [3], use Equations (B.2) to (B5) in Equation (B.1):

$$A = \left(-0{,}4588f^3 + 4{,}407f^2 - 6{,}112f + 2{,}497\right)/100 \quad \text{(B.2)}$$

$$B = \left(0{,}1160f^3 - 1{,}402f^2 + 3{,}504f - 0{,}4367\right)/1000 \quad \text{(B.3)}$$

$$C = \left(-0{,}1333f^3 + 11{,}89f^2 - 110{,}8\text{f} + 301{,}4\right)/1000 \quad \text{(B.4)}$$

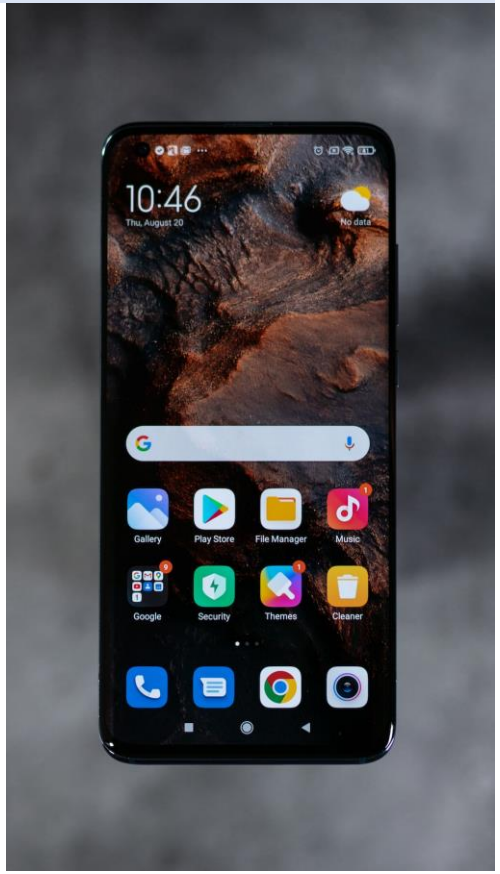
$$D = -0{,}03540f^3 + 0{,}5023f^2 - 2{,}297f + 6{,}104 \quad \text{(B.5)}$$

For other values of SAR_{max} using an averaging mass of m = 10 g, multiply the final P_{max}' value by SAR_{max} / 2 W/kg.

  - s is the separation distance, BW is the free space antenna bandwidth and f is in GHz

RF Exposure Mobile Phone KDBs

- Technology Specific for Mobile Phones
  - There are many technology specific KDBs for SAR
    - Use these KDBs to use test reduction to further help limit the amount of testing on a device
      - Guidance is available for 802.11, LTE, 3G HSPA, HSPA+, 5G Sub 6
      - Used for Head, Body and Extremity SAR test reductions
      - The guidance limits the number of channels/operating modes tested based on output power and SAR value
    - Array systems for testing
      - Can use to determine the highest SAR value in each band
      - Test the highest value with SAR system in each band and all values above 1.2 W/kg
      - Only applicable to WWAN bands
    - Test Requirements
      - Test 1 RB highest power configuration then adjacent based on value measured
      - Test 50% RB highest power configuration then adjacent based on value measured



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EU Mobile Phone Standards

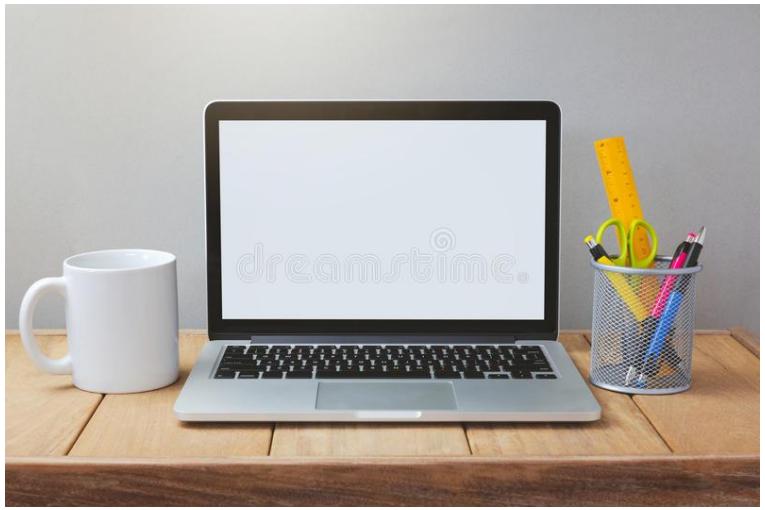
- Product Specific Standards
  - EN50361 General System Requirements
    - Describes the system parameters for testing
  - EN50360 Transmitters Used in Close Proximity to the Ear
    - Test requirements for mobile phones
    - Test configurations listed in EN62209-1
  - EN50566 Transmitters Used in Close Proximity to the Body
    - Test requirements for mobile phones
    - Test configurations listed in EN62209-2

Testing Differences for Mobile Phones

- Testing is required for Head, Body and Extremity
  - Head Measurements
    - The FCC and EU are harmonized for head measurements
    - Test Left, Right, Touch and Tilt for all bands and Technologies
  - Body Measurements
    - This is where the two economies diverge
    - FCC Requirements Testing of All Bands and Technologies
      - Non-hotspot mobile phone test with less than 25 mm gap on the back of the phone
      - This is from the 90's when all mobile phones had belt clips due to the large size
      - Hotspot mobile phone test with less than or equal to 10 mm gap on all sides
    - EU Requirements of All Bands and Technologies
      - Test all sides with a 0 mm gap
  - Extremity Measurements
    - The FCC and EU are harmonized for extremity measurements
    - Test all Bands and Technologies on all Sides at 0 mm Gap

RF Exposure Procedures for WiFi 6E

- Testing portable devices with transmitters above 6 GHz
  - WiFi 6E at present require testing for both SAR and Power Density
    - FCC is requiring testing of both for the time being until they can determine the accuracy of the power density measurements
    - Power density measurements are conducted in the near field at the appropriate distance based on use case
    - All measurements must be conducted using a calibrated probe for near field measurements at the frequency band of test
    - Testing is conducted with the probe on a robot arm such as the Dasy system
    - For devices above 6 GHz other then WiFi 6E, power density measurements are all that is required
    - A PAG is required for Power Density devices



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Testing Requirements for FCC

- The following steps are required for FCC testing of WiFi 6E
  - Measure the spatial peak SAR for 5 channels in the 6 GHz band
  - If the system supports, give the Absorbed Power Density (APD)
  - Scale to the upper end of the tune up tolerance
  - Evaluate the Incident Power Density (IPD) for the 5 channels
  - Scale to the upper end of the tune up tolerance

Testing Requirements for EU

- Measurements are conducted for MPE only
  - The EU requires testing above 6 GHz to be conducted for PD
  - Conduct measurements per 63195-1
  - Conduct computational evaluation per 63195-2
  - No SAR measurements are conducted
  - 62209-1528 extends SAR to 10 GHz
  - Waiting for the EU to approve 62209-1528
  - Once approved, SAR measurements will be conducted for WiFi 6E

Questions

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