SAR Evaluation Considerations for Handsets with Multiple Transmitters & Antennas

FCC / OET

Laboratory Division

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TCB Workshop

Issues

- current TCB requirements:
  - non-dominant transmitters in handsets that transmit simultaneously cannot be approved by TCB when output is > 5 mW
  - these have to be submitted to the FCC for approval
- SAR procedures for simultaneous transmission have not been standardized among SAR systems
  - the high level recommendations in draft standards are insufficient and testing is very time consuming at multiple frequencies
  - procedures on how to determine 1-g SAR for simultaneous transmission are unclear
  - simultaneous SAR tests are often problematic and done incorrectly
- measurement issues in tight regions of the SAM phantom

Procedures Overview

- the procedures in KDB 648474 will allow:
  - manufacturers to minimize or avoid complex tests when satisfying certain SAR and antenna separation requirements while products are developed
- TCB can approve these when <u>simultaneous SAR tests are not required</u>
  - consumer cellphones with multiple transmitters & antennas
    - Part 22H, 24E, 27L (AWS) & 90 SMR
      - with 802.11 a/b/g and Bluetooth
- stand-alone SAR tests
  - routine evaluation applies to licensed transmitters
  - test reduction applies to unlicensed devices
- simultaneous transmission test exclusion applies when
  - the sum of stand-alone 1-g SAR is within SAR limit
  - SAR to antenna separation ratio of antenna pair is low
- when simultaneous transmission test is required
  - test only highest SAR configuration in stand-alone evaluation

Stand-alone Test Requirements

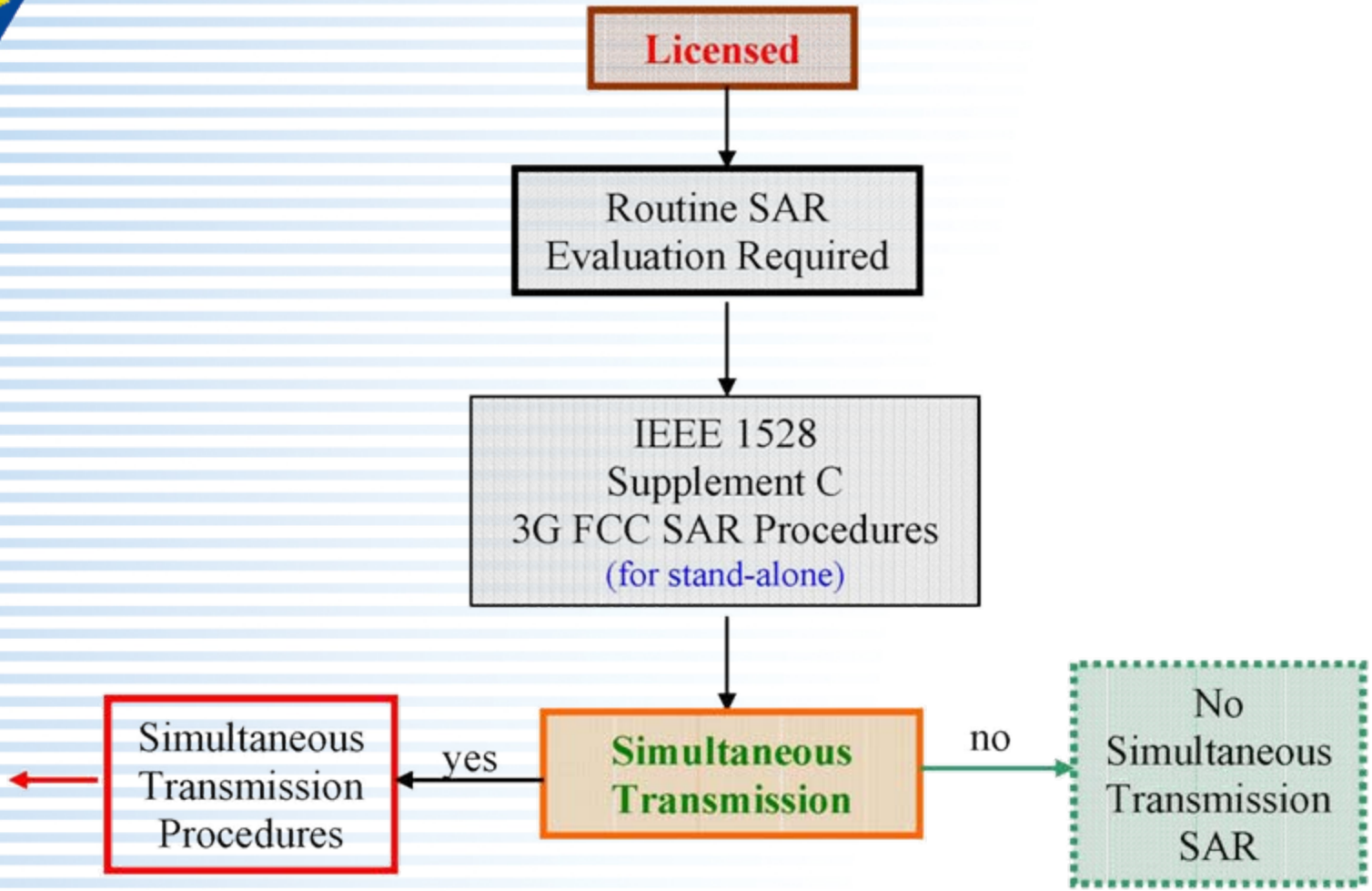
- licensed transmitters: IEEE-1528, Supplement C, 3G procedures
  - routine SAR required
- unlicensed transmitters: Supp. C, 802.11 & 3-6 GHz procedures
  - output $\leq 60/f_{(GHz)}$ mW – SAR evaluation is generally not required (see flowchart)
  - output $> 60/f_{(GHz)}$ mW – test according to multiples of P_{Ref}
    - SAR not required for certain antenna separation & power
    - test highest output channel only if SAR is $\leq$ 0.8 W/kg
    - test all required channels if SAR is > 0.8 W/kg (50% of limit)

	2.45	5.15 – 5.35	5.47 – 5.85	GHz
P_{Ref}	12	6	5	mW
Values for P_{Ref} are derived from $\frac{1}{2} \cdot 60/f_{(GHz)}$ Device output power should be rounded to the nearest mW to compare with values specified in this table.				

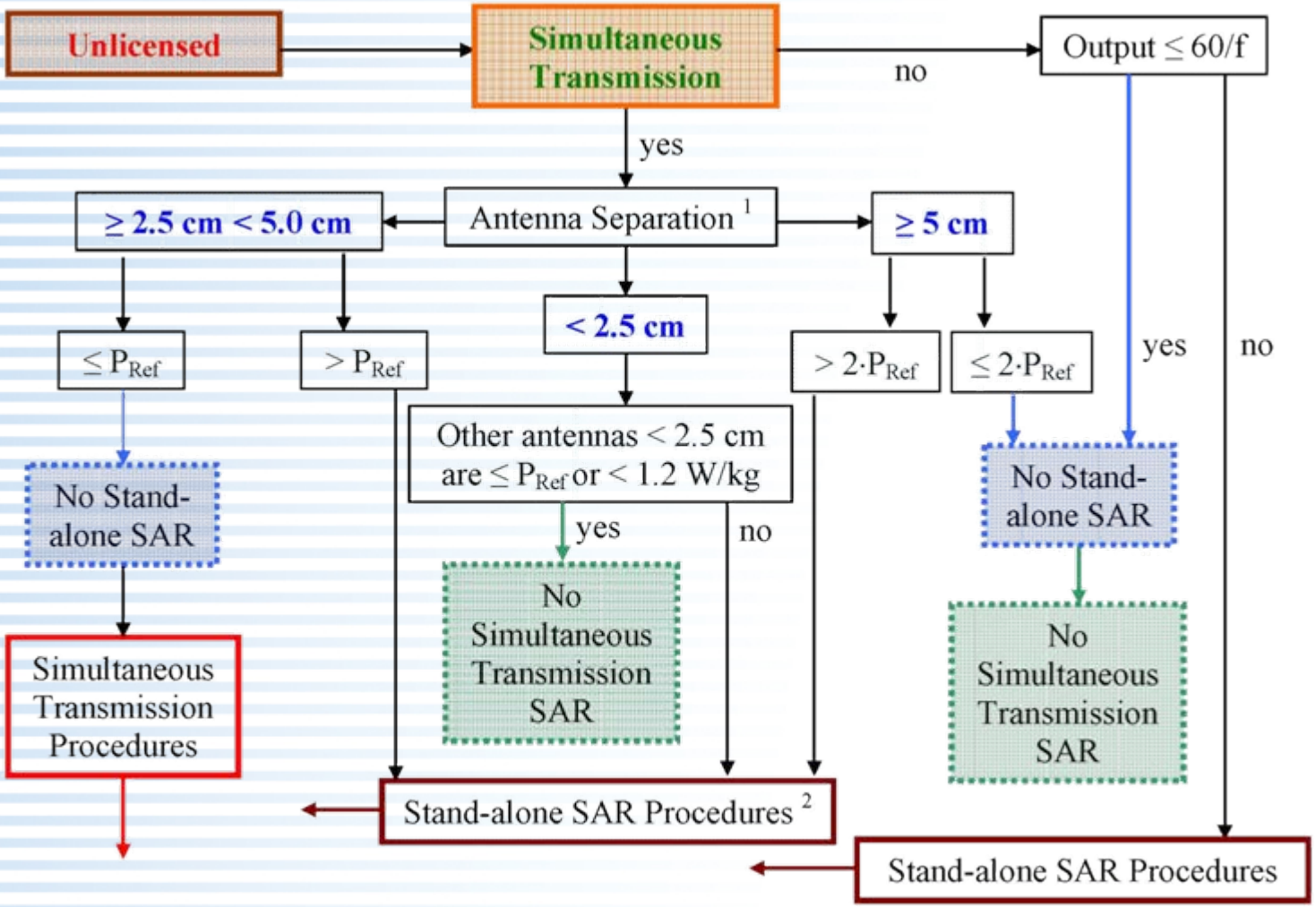
Simultaneous Transmission SAR - General

- simultaneous transmission: overlapping transmissions
  - except when maximum network handoff time is < 30s
- unlicensed transmitters: SAR is not required when
  - antenna is ≥ 5 cm from other antennas and stand-alone SAR is not required (i.e. $\leq 2 \cdot P_{Ref}$, see flow charts)
- all transmitters in a cellphone:
  - SAR is not required when
    - sum of 1-g SAR is < 1.6 W/kg (SAR limit) or
    - SAR to antenna separation ratio for antenna pair is < 0.3
  - SAR is required when
    - SAR to antenna separation ratio for antenna pair is ≥ 0.3
      - test only highest SAR configuration in stand-alone mode
- simultaneous transmission SAR requirements for head and body can be different; especially for clam-shell phones

Licensed Transmitters

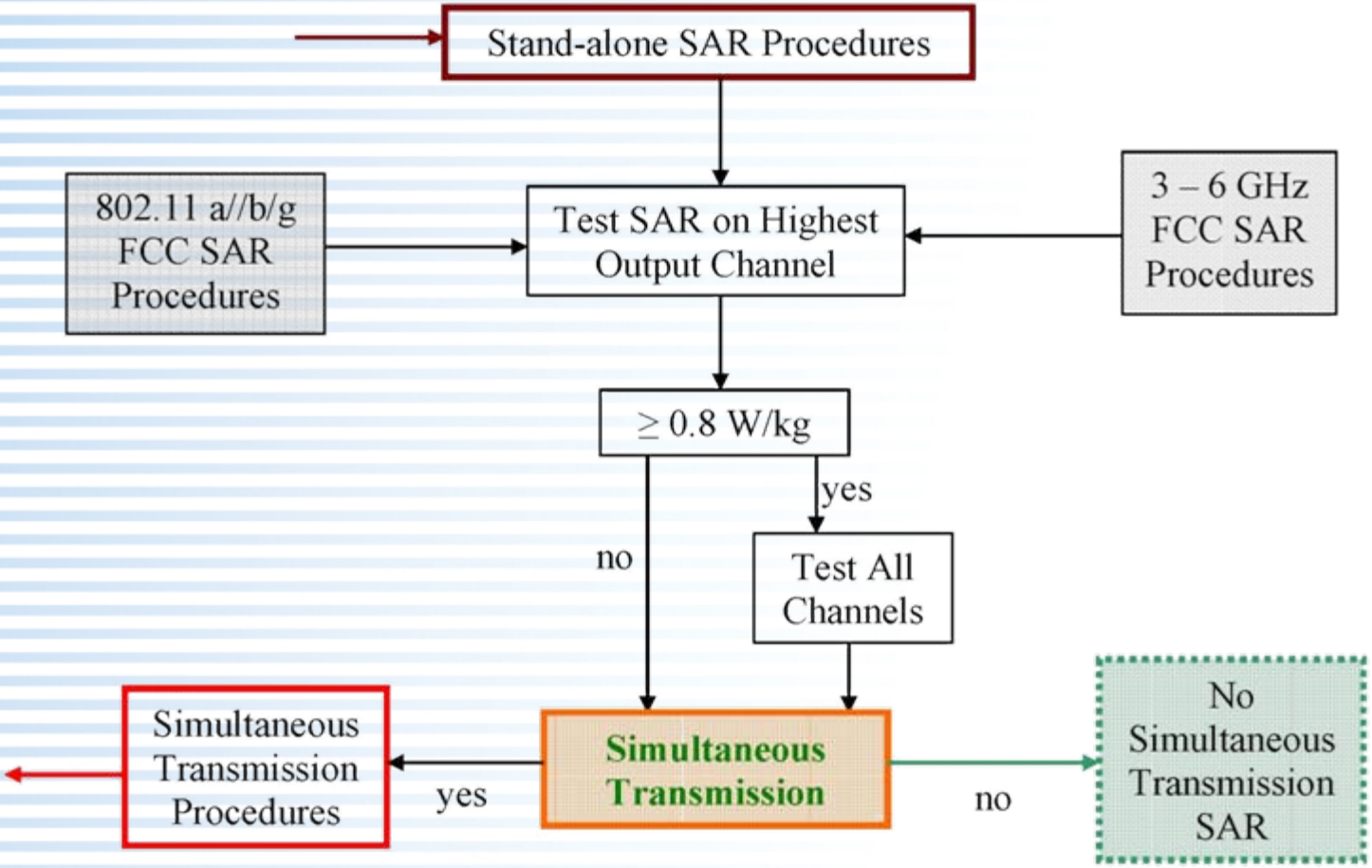


Unlicensed Transmitters

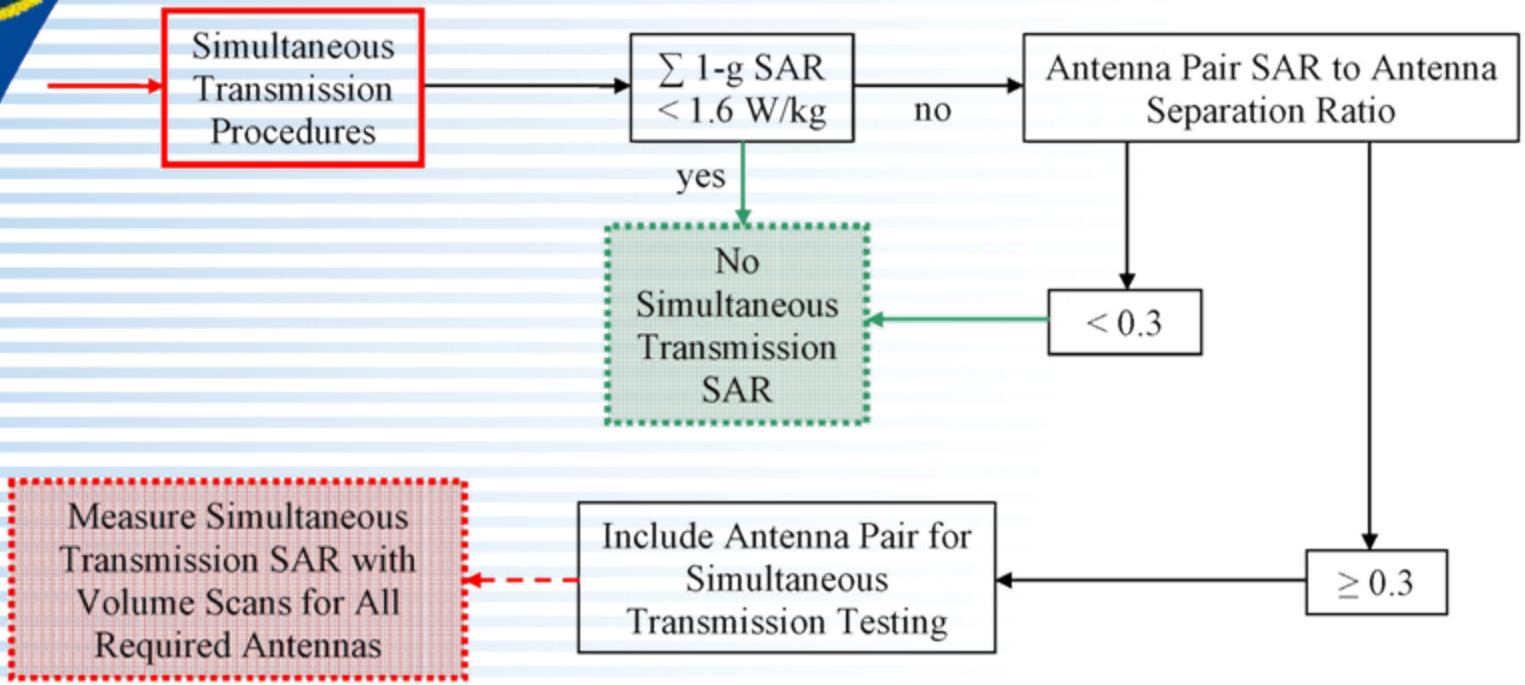


[1] Antenna separation is determined by the closest distance between antennas
[2] When simultaneous transmission applies, reduced antenna separations may require SAR at ≤ 60/f

Unlicensed Stand-alone Procedures



Simultaneous Procedures



Note: Simultaneous transmission exposure conditions for head and body can be different for certain style phones; therefore, different test requirements may apply. For example, clam-shell phones in open and folded operating configurations.

Examples: rectangular phones

- upper center (patch antenna) - 250 mW PCS
  - routine stand-alone SAR
  - simultaneous SAR if $\sum$ 1-g $\geq$ 1.6 W/kg and SAR to antenna ratio $\geq$ 0.3
- bottom edge – 50 mW 802.11 b/g, simultaneous with PCS only
  - $\geq$ 5 cm (PCS only) and > $2 \cdot P_{Ref}$ - test stand-alone SAR
    - on highest output channel and test all channels if SAR $\geq$ 0.8 W/kg
  - simultaneous SAR if $\sum$ 1-g $\geq$ 1.6 W/kg or SAR to antenna ratio $\geq$ 0.3
- lower left edge – 5 mW Bluetooth, simultaneous with PCS only
  - $\geq$ 5 cm (PCS only) and $\leq 2 \cdot P_{Ref}$
    - no stand-alone SAR and no simultaneous SAR

	2.45	5.15 – 5.35	5.47 – 5.85	GHz
P_{Ref}	12	6	5	mW

Examples: clam-shell phones

- right hinge (stub antenna) – 300 mW PCS
  - routine stand-alone SAR
  - simultaneous SAR if $\sum$ 1-g $\geq$ 1.6 W/kg and SAR to antenna ratio $\geq$ 0.3
- bottom edge – 20 mW 802.11 a/b/g
  - $\geq$ 5 cm (PCS & Bluetooth)
    - 802.11 b/g $\leq 2 \cdot P_{Ref}$ – no stand-alone SAR and no simultaneous SAR
    - 802.11a $> 2 \cdot P_{Ref}$ – test stand-alone SAR
      - on highest output channel and test all channels if SAR $\geq$ 0.8 W/kg
      - simultaneous SAR if $\sum$ 1-g $\geq$ 1.6 W/kg or SAR to antenna ratio $\geq$ 0.3
- top edge – 25 mW Bluetooth
  - $\geq$ 5 cm (PCS & 802.11 a/b/g) and $> 2 \cdot P_{Ref}$ – test stand-alone SAR
    - on highest output channel and test all channels if SAR $\geq$ 0.8 W/kg
  - simultaneous SAR if $\sum$ 1-g $\geq$ 1.6 W/kg or SAR to antenna ratio $\geq$ 0.3
- when body-worn exposure conditions apply
  - simultaneous transmission exposure conditions for head and body are different for 802.11 and Bluetooth

Simultaneous Measurements

- simultaneous transmission at different frequencies
  - require different tissue liquids and probe calibrations
  - separate measurements are necessary
- require measured raw data to be summed
  - on identically registered measurement grids
  - with all simultaneous transmitting antennas enclosed in identical measurement volumes for each measurement
  - to enable the extrapolation and interpolation procedures to determine the aggregate 1-g SAR in post-processing
- volume scans are quite time-consuming
  - difficulties and constrains should be expected

SAR in Mouth Region of SAM

- measurement difficulties in tight regions of SAM
  - mouth, jaw, nose and similar partially enclosed regions
  - measurement accuracy & probe accessibility issues
  - SAM configuration issues – horizontal vs. up-right
- measure SAR with flat phantom
  - when measurement is not feasible with SAM or results can be questionable due to probe calibration and orientation issues
  - position phone with lower edge at a fixed distance determined by smallest separation in cheek touching position using SAM
    - rectangular phones with ERP at ½ cm from flat phantom
    - clam-shell phones with hinge against smooth edge of flat phantom and upper half unfolded beyond side wall
- contact FCC for interim guidance on
  - other clam-shell phone positioning issues (variable gap with SAM)
  - simultaneous transmission SAR measurement requirements