



**Federal Communications Commission  
Office of Engineering and Technology  
Laboratory Division**

October 23, 2015

**3G SAR MEASUREMENT PROCEDURES**

**1. INTRODUCTION**

The SAR test guidance in this document provides uniform operating procedures for testing the SAR of third generation (3G) 3GPP and 3GPP2 devices incorporated in typical consumer devices. The SAR procedures for 4G LTE Rel. 8 and Rel. 10 are described in KDB Publication 941225 D05 and D05A, respectively, to address the test requirements of more recent evolving technologies. The fundamental SAR measurement guidance, SAR test procedures for handsets, laptop computers, tablets and other product platform and wireless technology specific requirements are described in the different KDB publications identified in KDB Publication 447498 D01.<sup>1</sup>

3GPP and 3GPP2 have specified test mode configurations for product conformance evaluation. Some of these test modes and device operating configurations can be adapted for SAR measurements. The wireless test configurations described in this document are required to minimize SAR measurement variations and to facilitate SAR test reduction. The maximum power and tolerance specified for production units and power measured for test samples are used to reduce the number of SAR tests in each frequency band for wireless modes with equivalent transmission characteristics, such as different combinations of data rate and modulation. Depending on the *reported* SAR, operating characteristics and exposure conditions of the individual device, additional SAR measurements may be required for certain test configurations.<sup>2</sup>

A communication test set or basestation simulator is required to configure 3G devices through an air link with call processing to perform SAR measurements. When carrier aggregation applies; for example, in DC-HSDPA and Ev-Do Rev. B, multiple basestation simulators are used to establish the required test configurations. If Factory Test Mode (FTM) is used to configure a device with non-standard features or implementation requirements to measure SAR, a KDB inquiry is required to determine the test configurations. FTM usually requires proprietary software operating on a computer to establish the necessary device operating parameters through a USB port. A basestation simulator or additional test equipment is also necessary to keep the test conditions stable. Regardless of whether call processing or FTM is used, the test device output conditions must be closely monitored with applicable equipment, such as a communication test set, spectrum analyzer and power meter etc., to ensure the required RF and physical channel parameters are unchanged during SAR measurement. The device operating parameters and test procedures must be fully documented in test reports to support the test results.

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<sup>1</sup> See Introduction section of KDB Publication 447498 D01.

<sup>2</sup> See KDB Publication 447498 D01 for *reported* SAR.

## 2. GENERAL SAR TEST REDUCTION CONSIDERATIONS FOR 3G DEVICES

When the same transmitter and antenna are used by wireless modes with similar or equivalent transmission characteristics, the SAR measured in one of the wireless modes may be scaled according to the maximum output power of equivalent modes to facilitate SAR test reduction. It is generally unacceptable to apply SAR results across frequency bands or exposure conditions (test configurations or positions); therefore, the SAR procedures must be applied independently to the exposure conditions in each frequency band.

### 2.1 3G SAR Test Reduction Procedure

In the following procedures, the mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. When the maximum output power and tune-up tolerance specified for production units in a secondary mode is  $\leq \frac{1}{4}$  dB higher than the primary mode or when the highest *reported* SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is  $\leq 1.2$  W/kg, SAR measurement is not required for the secondary mode.<sup>3</sup> This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

## 3. 3GPP2 CDMA 2000

### 3.1 1x RTT Handsets

The following procedures apply to CDMA 2000 Release 0 and Release A single carrier (1x RTT) handsets operating with Mobile Protocol Revision 6 or 7 (MOB\_P\_REV 6 or 7)<sup>4</sup>. The default test configuration is to measure SAR in RC3 with an established radio link between the handset and a communication test set. SAR in RC1 is selectively confirmed according to the 3G SAR test reduction procedure with RC3 as the primary mode. The forward and reverse links are configured with the same RC for SAR measurement. Maximum output power is verified by applying the procedures defined in 3GPP2 C.S0011 and TIA-98-E. SAR must be measured according to these maximum output conditions and requirements in KDB Publication 447498 D01.

#### 3.1.1 Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures in section 4.4.5.2 of 3GPP2 C.S0011/TIA-98-E. Results for at least steps 3, 4 and 10 of the power measurement procedures are required in the SAR report. Steps 3 and 4 are measured using Loopback Service Option SO55 with power control bits in “All Up” condition. TDSO/SO32 may be used instead of SO55 for step 4. Step 10 is measured using TDSO/SO32 with power control bits in the “Bits Hold” condition (i.e. alternative Up/Down Bits). All power measurements defined in C.S0011/TIA-98-E that

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<sup>3</sup> For example, when the *reported* SAR of a primary mode is 1.4 W/kg and the maximum output power specified for the primary and secondary modes are 250 mW and 200 mW, the scaled SAR would be  $1.4 \times (200/250) = 1.12$  W/kg; therefore, SAR is not required for the secondary mode.

<sup>4</sup> A KDB inquiry is required for other CDMA 2000 1xRTT releases and Mobile Protocol revisions.

are inapplicable to the handset or cannot be measured due to technical or equipment limitations must be clearly identified in the test report.<sup>5</sup>

### 3.1.2 Head SAR

SAR for next to the ear head exposure is measured in RC3 with the handset configured to transmit at full rate in SO55. The 3G SAR test reduction procedure is applied to RC1 with RC3 as the primary mode; otherwise, SAR is required for the channel with maximum measured output in RC1 using the head exposure configuration that results in the highest reported SAR in RC3.<sup>6</sup>

### 3.1.3 Body-Worn Accessory SAR

Body-worn accessory SAR is measured in RC3 with the handset configured in TDSO/SO32 to transmit at full rate on FCH only with all other code channels disabled. The body-worn accessory procedures in KDB Publication 447498 D01 are applied. The 3G SAR test reduction procedure is applied to the multiple code channel configuration (FCH+SCH<sub>n</sub>), with FCH only as the primary mode. Otherwise, SAR is required for multiple code channel configuration (FCH + SCH<sub>0</sub>), with FCH at full rate and SCH<sub>0</sub> enabled at 9600 bps, using the highest reported SAR configuration for FCH only.<sup>7</sup> When multiple code channels are enabled, the transmitter output can shift by more than 0.5 dB and may lead to higher SAR drifts and SCH dropouts.<sup>8</sup>

The 3G SAR test reduction procedure is applied to body-worn accessory SAR in RC1 with RC3 as the primary mode.<sup>9</sup> Otherwise, SAR is required for RC1, with SO55 and full rate, using the highest reported SAR configuration for body-worn accessory exposure in RC3.<sup>10</sup>

### 3.1.4 Handsets with built-in Ev-Do

For handsets with Ev-Do capabilities, the 3G SAR test reduction procedure is applied to Ev-Do Rev. 0 with 1x RTT RC3 as the primary mode to determine body-worn accessory test requirements. Otherwise, body-worn accessory SAR is required for Rev. 0, at 153.6 kbps, using the highest reported SAR configuration for body-worn accessory exposure in RC3.

The 3G SAR test reduction procedure is applied separately to Rev. A and Rev. B, with Rev. 0 as the primary mode to determine body-worn accessory SAR test requirements. When SAR is not required for Rev. 0, the 3G SAR test reduction is applied with 1x RTT RC3 as the primary mode. Otherwise, SAR is

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<sup>5</sup> Certain measurement difficulties may require a KDB inquiry.

<sup>6</sup> The highest reported head SAR for the left & right side, in touch & tilt positions, for the antenna configuration tested in RC3.

<sup>7</sup> The highest reported body-worn accessory SAR for the antenna configuration in RC3 with FCH only, using TDSO/SO32.

<sup>8</sup> The output power and operating conditions for FCH+SCH<sub>0</sub> are adjusted according to procedures in section 4.4.5.2 of 3GPP2 C.S0011/TIA-98-E. Depending on the design of an individual handset, the maximum output power condition may drift; therefore, code domain power must be monitored to ensure SCH does not dropout during the SAR measurement. When applicable, it may be desirable to consider using FTM (Factory Test Mode) to configure the transmitter if more stable operating conditions can be achieved for the SAR measurement; however, basestation support and monitoring is still required.

<sup>9</sup> RC3 channels include both the FCH only and FCH+SCH<sub>0</sub> configurations for the antenna configuration.

<sup>10</sup> The highest reported SAR for a body-worn accessory for the antenna configuration tested in RC3 with FCH only and FCH+SCH<sub>0</sub>.

required for Rev. A or Rev. B, with a Reverse Data Channel payload size of 4096 bits and a Termination Target of 16 slots defined for Subtype 2 and 3 Physical Layer configurations, using the highest reported SAR configuration for body-worn accessory exposure in Rev. 0 or RC3, as appropriate.

A Forward Traffic Channel data rate corresponding to the 2-slot version of 307.2 kbps with ACK Channel transmitting in all slots is configured in the downlink for Rev. 0, Rev. A and Rev. B.<sup>11</sup>

### 3.2 1x Ev-Do Data Devices

The following procedures apply to Access Terminals (AT) operating under CDMA 2000 High Rate packet Data, 1x Ev-Do Rev. 0, Rev. A and Rev. B. SAR is required for devices with Ev-Do capabilities in body-worn accessory and other body exposure conditions, such as handsets, laptops, tablets and data modems operating in various consumer electronic devices. When VOIP is supported by Ev-Do devices for next to the ear use, head exposure SAR is required.<sup>12</sup> The default test configuration is to measure SAR with an established radio link between the AT and a communication test set, according to 3GPP2 Test Application Protocols (TAP); FTAP/RTAP for Rev. 0, FETAP/RETAP for Rev. A and FMCTAP/RMCTAP for Rev. B<sup>13</sup>. The code channel power levels, RF channel output power (with All Bits Up) and other operating parameters should be actively monitored and controlled by the communication test set during SAR measurement. The use of FTM should be avoided.<sup>14</sup> Maximum output power is verified by applying the procedures defined in 3GPP2 C.S0033 and TIA-866. SAR must be measured according to these maximum output conditions and requirements in KDB Publication 447498 D01.

#### 3.2.1 Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures in section 3.1.2.3.4 of 3GPP2 C.S0033-0/TIA-866 for Rev. 0, section 4.3.4 of 3GPP2 C.S0033-A for Rev. A and section 4.3.4 of 3GPP2 C.S0033-C for Rev. B. Maximum output power is measured for Rev. 0 and Rev. A in Subtype 0/1 and Subtype 2 Physical Layer configurations, respectively. For Rev. B, maximum output power is measured according to power back-off requirements using Subtype 3 Physical Layer with “test 2” and “test 3” configurations. Power is measured using “test 2” with two carries in the maximum frequency separation condition and “test 3” for N-adjacent carriers; where N is the maximum number of carriers supported by the device. Both “test 2” and “test 3” configurations are measured with the channels centered within the transmit frequency band. The device operating configurations under TAP/ETAP/MCTAP must be clearly documented in the test report; including power control, code channel and RF channel output power conditions. The measurement results are required in the SAR report with any measurement difficulties and equipment limitations clearly identified.

#### 3.2.2 SAR Measurement

SAR is measured using the F/R TAP configurations required for Rev. 0, Rev. A and Rev. B. The AT is tested with a Reverse Data Channel rate of 153.6 kbps in Subtype 0/1 Physical Layer configurations. A Reverse Data Channel payload size of 4096 bits and Termination Target of 16 slots are used for Subtype 2 and 3. FTAP, FETAP and FMCTAP are all configured with a Forward Traffic Channel data rate

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<sup>11</sup> The procedures in the 1x Ev-Do Data Devices section should be applied to configure the handset for SAR measurements.

<sup>12</sup> 1x Ev-Do Rev. A and Rev. B may support VOIP operations.

<sup>13</sup> See 3GPP2 C.S0029-0, C.S0029-A and C.S0029-C, Test Application Specification (TAS), for details on FTAP/RTAP, FETAP/RETAP and FMCTAP/RMCTAP operations.

<sup>14</sup> A KDB inquiry is required to address measurement requirements.

corresponding to the 2-slot version of 307.2 kbps with ACK Channel transmitting in all slots. AT power control is in “All Bits Up” conditions for the TAP/ETAP/MCTAP.

Body-worn accessory and other body SAR are measured using Subtype 0/1 Physical Layer configurations for Rev. 0. The 3G SAR test reduction procedure is applied to Rev. A, Subtype 2 Physical layer configuration, with Rev. 0 as the primary mode; otherwise, SAR is measured for Rev. A using the highest *reported* SAR configuration for body-worn accessory exposure in Rev. 0. SAR is required for Rev. B, Subtype 3; it is measured by applying both the “test 2” and “test 3” configurations used for power measurement. Head SAR is required for Ev-Do devices that support next to the ear use according to the required handset test configurations; for example, with VOIP in Subtype 2 or Subtype 3 Physical Layer configurations.<sup>15</sup>

### 3.2.3 1x RTT Support

For Ev-Do data devices that also support 1x RTT voice and/or data operations, the 3G SAR test reduction procedure is applied to 1x RTT RC3 and RC1 with Ev-Do Rev. 0, Rev. A and Rev. B as the respective primary modes.<sup>16</sup> Otherwise, the ‘Body-Worn Accessory SAR’ procedures in the ‘3GPP2 CDMA 2000 1x Handsets’ section are applied.

## 3.3 1x-Advanced

Maximum output power is verified for 1x-Advanced by applying the 1x RTT power measurement procedures using SO75, with RC 8 in the uplink and RC11 in the downlink. Smart blanking must be disabled. The test device is configured with Forward Power Control Mode = 000 and Reverse Power Control = 400 bps; that is, 400 kHz for both uplink and downlink power control. The power measurement results must be included in the SAR report to satisfy power requirements in KDB Publication 447498 D01 and to qualify for SAR test exclusion or to support the SAR test setup and results.

The 3G SAR test reduction procedure is applied to 1x-Advanced with 1x RTT RC3 as the primary mode. When SAR measurement is required, the 1x-Advanced power measurement configurations are used. The 1x Advanced SAR procedures are applied separately to head, body-worn accessory and other exposure conditions.

## 4. 3GPP UMTS

### 4.1 WCDMA Handsets

The following procedures are applicable to 3GPP Release 99, Release 5 and Release 6 UMTS/WCDMA handsets.<sup>17</sup> The default test configuration is to measure SAR with an established radio link between the handset and a communication test set using a 12.2 kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH & DPDCH<sub>n</sub>), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Uplink and downlink are both configured with the same RMC and required AMR. SAR for Release 5 HSDPA and Release 6 HSPA are measured

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<sup>15</sup> See KDB Publication 648474 D04 for VOIP SAR testing considerations.

<sup>16</sup> When SAR is not required for Ev-Do Rev. A, only Rev. 0 and Rev. B need consideration.

<sup>17</sup> HSPA<sup>+</sup> is discussed separately in this document. LTE procedures are in separate KDB publication.

respectively using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified by applying the applicable versions of 3GPP TS 34.121. SAR must be measured according to these maximum output conditions and requirements in KDB Publication 447498 D01. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.<sup>18</sup>

#### 4.1.1 Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1’s” for WCDMA/HSDPA or by applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCH<sub>n</sub> and spreading codes, HSDPA, HSPA) are required in the SAR report. All configurations that are not supported by the handset or cannot be measured due to technical or equipment limitations must be clearly identified.

#### 4.1.2 Head SAR

SAR for next to the ear head exposure is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to AMR configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for 12.2 kbps AMR in 3.4 kbps SRB (signaling radio bearer) using the highest reported SAR configuration in 12.2 kbps RMC for head exposure.<sup>19</sup>

#### 4.1.3 Body-Worn Accessory SAR

SAR for body-worn accessory configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCH<sub>n</sub> configurations supported by the handset with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured using an applicable RMC configuration with the corresponding spreading code or DPDCH<sub>n</sub>, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When more than 2 DPDCH<sub>n</sub> are supported by the handset, it may be necessary to configure additional DPDCH<sub>n</sub> using FTM (Factory Test Mode) or other chipset based test approaches with parameters similar to those used in 384 kbps and 768 kbps RMC.<sup>20</sup>

#### 4.1.4 Handsets with Release 5 HSDPA

The 3G SAR test reduction procedure is applied to HSDPA body-worn accessory configurations with 12.2 kbps RMC as the primary mode.<sup>21</sup> Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures in the “Release 5 HSDPA Data Devices” section of this document, for the highest reported SAR body-worn accessory exposure configuration in 12.2 kbps RMC. Handsets with both HSDPA and HSUPA are tested according to Release 6 HSPA test procedures.

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<sup>18</sup> See 3GPP TS 25.214, section 5.1.2.6 for E-MPR.

<sup>19</sup> The highest reported head SAR for the left & right side, in touch & tilt positions, for the antenna configuration tested on a channel in 12.2 kbps RMC.

<sup>20</sup> The highest data rate defined for RMC is 768 kbps, which contains 2 DPDCH<sub>n</sub>. When a communication test set is not used, a KDB inquiry is required to determine the test setup requirements.

<sup>21</sup> HSDPA is tested with FRC. See ‘Release 5 HSDPA Data Devices’ section for output power measurement and FRC configurations requirements.

#### 4.1.5 Handsets with Release 6 HSPA (HSDPA/HSUPA)

The 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body-worn accessory configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures in the “Release 6 HSPA Data Devices” section of this document, for the highest reported body-worn accessory exposure SAR configuration in 12.2 kbps RMC. When VOIP is applicable for next to the ear head exposure in HSPA, the 3G SAR test reduction procedure is applied to HSPA with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body-worn accessory measurements is tested for next to the ear head exposure.

#### 4.2 **Release 5 HSDPA Data Devices**

The following procedures are applicable to HSDPA data devices operating under 3GPP Release 5.<sup>22</sup> SAR is required for devices in body-worn accessory and other body exposure conditions, including handsets and data modems operating in various electronic devices. HSDPA operates in conjunction with WCDMA and requires an active DPCCH. The default test configuration is to measure SAR in WCDMA with HSDPA remain inactive, to establish a radio link between the test device and a communication test set using a 12.2 kbps RMC configured in Test Loop Mode 1. SAR for HSDPA is selectively measured using the highest reported SAR configuration in WCDMA, with an FRC in H-set 1 and a 12.2 kbps RMC.<sup>23</sup> SAR is selectively confirmed for other physical channel configurations (DPCCH & DPDCH<sub>n</sub>) according to exposure conditions, device operating capabilities and maximum output power specified for production units, including tune-up tolerance by applying the 3G SAR test reduction procedures. Maximum output power is verified according to the applicable versions of 3GPP TS 34.121. SAR must be measured based on these maximum output conditions and requirements in KDB Publication 447498 D01, with respect to the UE Categories, and explained in the SAR report. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.

##### 4.2.1 Output Power Verification

Maximum output power is verified on the high, middle and low channels according to Release 5 procedures described in section 5.2 of 3GPP TS 34.121, using an FRC with H-set 1 and a 12.2 kbps RMC with TPC set to all “1’s”. When HSDPA is active, output power is measured according to requirements for HS-DPCCH Sub-test 1 - 4.<sup>24</sup> Results for all applicable physical channel configurations (DPCCH, DPDCH<sub>n</sub> and spreading codes, HS-DPCCH etc.), with and without HSDPA active, are required in the SAR report. All configurations that are not supported by the test device or cannot be measured due to technical or equipment limitations must be clearly identified.

##### 4.2.2 SAR Measurement

When voice transmission in next to the ear head exposure conditions is applicable to a WCDMA/HSDPA data device, head SAR is measured according to the ‘Head SAR’ procedures in the ‘WCDMA Handsets’ section of this document. SAR for body exposure configurations is measured according to the ‘Body-Worn Accessory SAR’ procedures in the ‘WCDMA Handsets’ section. The 3G SAR test reduction

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<sup>22</sup> Due to Cubic Metric (CM) and Maximum Power Reduction (MPR) requirements, Release 6 HSPA devices should be tested according to Release 6 HSPA configurations and procedures.

<sup>23</sup> HSDPA is a primary mode of operation for data devices; SAR is selectively verified according to SAR levels.

<sup>24</sup> See TS 34.121 Tables C.10.1 – C.10.4 for setup requirements.

procedure is applied to *HSDPA body SAR* with 12.2 kbps RMC as the primary mode.<sup>25</sup> Body SAR for HSDPA is measured using an FRC with H-Set 1 in Sub-test 1 and a 12.2 kbps RMC configured in Test Loop Mode 1, for the highest *reported* SAR configuration in 12.2 kbps RMC without HSDPA.<sup>26</sup>

HSDPA is configured according to the applicable UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HARQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission conditions, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4 ms and a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. DPCCH and DPDCH gain factors ( $\beta_c$ ,  $\beta_d$ ), and HS-DPCCH power offset parameters ( $\Delta_{ACK}$ ,  $\Delta_{NACK}$ ,  $\Delta_{CQI}$ ) are set according to values indicated in Table 1.<sup>27</sup> The CQI value is determined by the UE category, transport block size, number of HS-PDSCHs and modulation used in the H-set.<sup>28</sup>

**Table 1**

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}^{(1)}$	CM (dB) <sup>(2)</sup>
1	2/15	15/15	64	2/15	4/15	0.0
2	12/15 <sup>(3)</sup>	15/15 <sup>(3)</sup>	64	12/15 <sup>(3)</sup>	24/15	1.0
3	15/15	8/15	64	15/8	30/15	1.5
4	15/15	4/15	64	15/4	30/15	1.5

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$   
Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ .  
Note 3: For subtest 2 the  $\beta_c/\beta_d$  ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 11/15$  and  $\beta_d = 15/15$ .

### 4.3 Release 6 HSPA Data Devices

The following procedures are applicable to HSPA (HSUPA/HSDPA) data devices operating under 3GPP Release 6.<sup>29</sup> SAR is required for devices in body-worn accessory and other body exposure conditions, including handsets and data modems operating in various electronic devices. HSUPA operates in conjunction with WCDMA and HSDPA. SAR is initially measured in WCDMA test configurations with HSPA remain inactive. The default test configuration is to establish a radio link between the test device and a communication test set to configure a 12.2 kbps RMC in Test Loop Mode 1. SAR for HSPA is

<sup>25</sup> A KDB inquiry is required to address test and approval requirements when the maximum output power measured in HS-DPCCH Sub-test 2 – 4 is higher than Sub-test 1.

<sup>26</sup> The  $\beta$  values for 12.2 kbps RMC are set according to Table C.10.1.4 of TS 34.121; also see Table C.10.1.1.

<sup>27</sup> In order to achieve maximum output,  $\beta_c/\beta_d < 1$  should be maintained to avoid triggering any power setback required by higher  $\beta$  ratios.

<sup>28</sup> Many of the operating parameters are automatically checked and set by a communication test set to ensure conflicts do not exist in the HS-DPCCH setup. In addition to the specific uplink HSDPA parameters, many of the downlink parameters that do not affect UE transmitter operations must also be set accordingly to ensure proper HSDPA operation. See Annex C.10.1, C.8.1.1 and Table C.10.1.4 of TS 34.121 for HSDPA setup requirements.

<sup>29</sup> Test conditions and requirements should be established according to procedures in applicable versions of 3GPP documents, including TS 34.108, TS 34.109 and TS 34.121 etc. Unless published KDB guidance is available, additional considerations may be necessary for higher release HSPA that may require case-by-case consideration.

selectively measured with HS-DPCCH, E-DPCCH and E-DPDCH, all enabled, along with a 12.2 kbps RMC using the highest *reported* SAR configuration in WCDMA with 12.2 kbps RMC only.<sup>30</sup> An FRC is configured according to HS-DPCCH Sub-test 1 using H-set 1 and QPSK.<sup>31</sup> HSPA is configured according to E-DCH Sub-test 5 requirements. SAR for other HSPA sub-test configurations is confirmed selectively according to exposure conditions, E-DCH UE Category and maximum output power of production units, including tune-up tolerance by applying the 3G SAR test reduction procedure. Maximum output power is verified according to procedures in applicable versions of 3GPP TS 34.121. SAR must be measured based on these maximum output conditions and requirements in KDB Publication 447498 D01, with respect to the UE Categories for HS-DPCCH and HSPA, and explained in the SAR report. When Maximum Power Reduction (MPR) applies, the implementations must be clearly identified in the SAR report to support test results according to Cubic Metric (CM) and, as appropriate, Enhanced MPR (E-MPR) requirements.

#### 4.3.1 Output Power Verification

Maximum output power is verified on the high, middle and low channels according to Release 6 procedures in section 5.2 of 3GPP TS 34.121, using the appropriate RMC, FRC and E-DCH configurations. When E-DCH is not active, TPC is set to all “1’s”; otherwise, inner loop power control with power control algorithm 2 is required to maintain E-TFCI requirements. When HSPA is active output power for the applicable HSPA modes should be measured for E-DCH Sub-test 1 - 5.<sup>32</sup> Results for all applicable physical channel configurations (DPCCH, DPDCH and spreading codes, HS-DPCCH, E-DPCCH, E-DPDCH<sub>k</sub>) are required in the SAR report. All configurations that are not supported by the test device or cannot be measured due to technical or equipment limitations must be clearly identified.

#### 4.3.2 SAR Measurement

When voice transmission in next to the ear head exposure conditions is applicable to a WCDMA/HSPA data device, head SAR is measured according to the ‘Head SAR Measurements’ procedures in the ‘WCDMA Handsets’ section of this document. SAR for body exposure configurations is measured according to the ‘Body-Worn Accessory SAR’ procedures in the ‘WCDMA Handsets’ section. The 3G SAR test reduction procedure is applied to HSPA body SAR with 12.2 kbps RMC as the primary mode. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 and power control algorithm 2, according to the highest *reported* body SAR configuration in 12.2 kbps RMC without HSPA.<sup>33</sup> When VOIP applies to head exposure, the 3G SAR test reduction procedure is applied with 12.2 kbps RMC as the primary mode; otherwise, the same HSPA configuration used for body SAR measurements are applied to head exposure testing.

Due to inner loop power control requirements in HSPA, a communication test set is required for output power and SAR tests.<sup>34</sup> The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSPA are configured according to the  $\beta$  values indicated in Table 2 and other applicable procedures described in the ‘WCDMA Handset’ and ‘Release 5 HSDPA Data Devices’ sections of this document.

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<sup>30</sup> HSPA should be configured according to the HSDPA and HSUPA UE categories of the test device.

<sup>31</sup> See TS 34.121 Tables C.10.1 – C.10.4 for setup requirements.

<sup>32</sup> Applicable HSPA modes are determined by the E-DCH UE category. Test only modes supported by the device.

<sup>33</sup> A KDB inquiry is required to determine test and approval requirements when the maximum output power measured in E-DCH Sub-test 2 – 4 is higher than Sub-test 5.

<sup>34</sup> When test mode must be used, a KDB inquiry is required to address measurement and approval requirements.

**Table 2**

Sub-test	$\beta_c$	$\beta_d$	$\beta_d$ (SF)	$\beta_c/\beta_d$	$\beta_{hs}^{(1)}$	$\beta_{ec}$	$\beta_{ed}$	$\beta_{ed}$ (SF)	$\beta_{ed}$ (codes)	CM <sup>(2)</sup> (dB)	MPR (dB)	AG <sup>(4)</sup> Index	E-TFCI
1	11/15 <sup>(3)</sup>	15/15 <sup>(3)</sup>	64	11/15 <sup>(3)</sup>	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	$\beta_{ed1}: 47/15$ $\beta_{ed2}: 47/15$	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 <sup>(4)</sup>	15/15 <sup>(4)</sup>	64	15/15 <sup>(4)</sup>	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1:  $\Delta_{ACK}$ ,  $\Delta_{NACK}$  and  $\Delta_{CQI} = 8 \Leftrightarrow A_{hs} = \beta_{hs}/\beta_c = 30/15 \Leftrightarrow \beta_{hs} = 30/15 * \beta_c$ .

Note 2: CM = 1 for  $\beta_c/\beta_d = 12/15$ ,  $\beta_{hs}/\beta_c = 24/15$ . For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference.

Note 3: For subtest 1 the  $\beta_c/\beta_d$  ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 10/15$  and  $\beta_d = 15/15$ .

Note 4: For subtest 5 the  $\beta_c/\beta_d$  ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signaled gain factors for the reference TFC (TF1, TF1) to  $\beta_c = 14/15$  and  $\beta_d = 15/15$ .

Note 5: Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g.

Note 6:  $\beta_{ed}$  cannot be set directly; it is set by Absolute Grant Value.

#### 4.4 HSPA, HSPA<sup>+</sup> and DC-HSDPA SAR Guidance

SAR test exclusion may apply to 3GPP Rel. 6 HSPA, Rel. 7 HSPA<sup>+</sup> and Rel. 8 DC-HSDPA. When SAR measurement is required for HSPA, HSPA<sup>+</sup> or DC-HSDPA, a KDB inquiry is required to confirm that the wireless mode configurations in the test setup have remained stable throughout the SAR measurements.<sup>35</sup> Without prior KDB confirmation to determine the SAR results are acceptable, a PAG is required for equipment approval.

SAR test exclusion for HSPA, HSPA<sup>+</sup> and DC-HSDPA is determined according to the following:

- a) The HSPA procedures are applied to configure 3GPP Rel. 6 HSPA devices in the required sub-test mode(s) to determine SAR test exclusion.
- b) SAR is required for Rel. 7 HSPA<sup>+</sup> when SAR is required for Rel. 6 HSPA; otherwise, the 3G SAR test reduction procedure is applied to (uplink) HSPA<sup>+</sup> with 12.2 kbps RMC as the primary mode.<sup>36</sup> Power is measured for HSPA<sup>+</sup> that supports uplink 16 QAM according to configurations in Table C.11.1.4 of 3GPP TS 34.121-1 to determine SAR test reduction.
- c) SAR is required for Rel. 8 DC-HSDPA when SAR is required for Rel. 5 HSDPA; otherwise, the 3G SAR test reduction procedure is applied to DC-HSDPA with 12.2 kbps RMC as the primary mode. Power is measured for DC-HSDPA according to the H-Set 12, FRC configuration in Table C.8.1.12 of 3GPP TS 34.121-1 to determine SAR test reduction. A primary and a secondary serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.
- d) Regardless of whether a PAG is required, the following information must be verified and included in the SAR report for devices supporting HSPA, HSPA<sup>+</sup> or DC-HSDPA:
  - 1) The output power measurement results and applicable release version(s) of 3GPP TS 34.121.
    - i) Power measurement difficulties due to test equipment setup or availability must be resolved between the grantee and its test lab.

<sup>35</sup> E-TFCI and AG index may change due to transmission and propagation conditions during the SAR measurement.

<sup>36</sup> The procedures for Rel. 6 HSPA are more conservative than Rel. 7 HSPA<sup>+</sup>, which provide the basis for further HSPA<sup>+</sup> relaxation.

- 2) The power measurement results are in agreement with the individual device implementation and specifications. When Enhanced MPR (E-MPR) applies, the normal MPR targets may be modified according to the Cubic Metric (CM) measured by the device, which must be taken into consideration.
  - 3) The UE category, operating parameters, such as the  $\beta$  and  $\Delta$  values used to configure the device for testing, power setback procedures described in 3GPP TS 34.121 for the power measurements, and HSPA/HSPA<sup>+</sup> channel conditions (active and stable) for the entire duration of the measurement according to the required E-TFCI and AG index values.
- e) When SAR measurement is required, the test configurations, procedures and power measurement results must be clearly described to confirm that the required test parameters are used, including E-TFCI and AG index stability and output power conditions.<sup>37</sup>

## 5. GSM, GPRS AND EDGE

The following procedures may be considered for each frequency band to determine SAR test reduction for devices operating in GSM/GPRS/EDGE modes to demonstrate RF exposure compliance. GSM voice mode transmits with 1 time slot. GPRS and EDGE may transmit up to 4 time slots in the 8 time-slot frame according to the multislot class implemented in a device. For Class A devices with Dual Transfer Mode (DTM) capability that support simultaneously transmission using both circuit switched (CS) and packet switched (PS) connections, the aggregate time slots must be considered in the applicable exposure conditions to determine SAR compliance. Unless it is clearly explained in the SAR report that DTM is not feasible or does not apply to a device, DTM SAR results are expected for Class A GSM/(E)GPRS devices to demonstrate SAR compliance. When enhanced EDGE mode with additional time slots or higher order modulations (QAM) applies, until procedures are available, a KDB inquiry is necessary to determine the configurations required for SAR testing. The SAR test reduction procedures for GSM/(E)GPRS devices may be considered in conjunction with the applicable SAR test reduction provisions in KDB Publication 447498 D01. Regardless of whether DTM applies to a GSM/(E)GPRS device, operating parameters such as device Class, (E)GPRS multislot class, DTM multislot class and the maximum time-slot burst averaged conducted output power must be clearly identified in the SAR report to support the test configurations and measurement results. A summary of the specific procedures and test configurations applied to the SAR measurements must be clearly described in the SAR report to support the test results.

### 5.1 Dual Transfer Mode

Class A GSM/(E)GPRS devices operate in DTM can transmit simultaneously using both circuit switched (CS) and packet switched (PS) connections defined by the DTM multislot classes (see 3GPP TS 43.055 and TS 45.001). Mobile stations operating in DTM configurations are required to have one allocated CS time-slot for voice and additional PS slots for packet data. The total number of downlink and uplink time slots is defined by the DTM multislot class. DTM devices may operate according to earlier GSM requirements using two transceivers or the more recent 3GPP requirements using a single transceiver to transmit CS and PS data in consecutive time-slots within the same GSM frame. Furthermore, additional DTM multislot classes and enhanced DTM configurations have also been considered in recent and on-going revisions of the 3GPP/GSM requirements, which may require further considerations for SAR testing.

For Class A devices, the SAR evaluation must take into account the maximum CS and PS time slots defined by the DTM multislot class for the device, with respect to head body-worn accessory and other near body operating configurations and exposure conditions. SAR may be evaluated for DTM with the

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<sup>37</sup> See footnote 35.

device operating in DTM using one CS plus the number of PS time-slots that result in the highest source-based time-averaged maximum output or by summing the single time-slot CS and highest maximum output multislot PS SAR.<sup>38</sup> A communication test set with DTM support is necessary to configure the test device for SAR measurement in DTM mode. Alternatively, the single slot CS GSM/GMSK voice mode SAR for each applicable exposure condition can be added respectively to the PS (E)GPRS multislot data-mode SAR to demonstrate SAR compliance for DTM.

## 5.2 General Reporting Requirements

The following information is required in the SAR report to identify the required test configurations for supporting the results.

- a) Device class - A, B or C
- b) Identify the GPRS/EDGE multislot class, including the maximum number of downlink, uplink and total time slots per frame
- c) For Class A devices with DTM capability, identify the DTM multislot class and include the maximum number of downlink, uplink and total time slots per frame for DTM operations; i.e. CS and PS time-slots
- d) The maximum output power specified for production units, including tune-up tolerance, within the time-slot burst for each operating mode – GMSK/8-PSK in CS/GSM and PS/(E)GPRS configurations
- e) Descriptions of the test device and communication test set configurations used in the DTM SAR measurements or procedures applied to sum DTM SAR for the required operating configurations and exposure conditions, with respect to maximum measured time-slot burst averaged conducted output power and maximum number of time slots defined by the DTM multislot class for the device

## 5.3 SAR Test Reduction

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested. GSM voice and GPRS data use GMSK, which is a constant amplitude modulation with minimal peak to average power difference within the time-slot burst. For EDGE, GMSK is used for MCS 1 – MCS 4 and 8-PSK is used for MCS 5 – MCS 9; where 8-PSK has an inherently higher peak-to-average power ratio. The GMSK and 8-PSK EDGE configurations are considered separately for SAR compliance. The GMSK EDGE configurations are grouped with GPRS and considered with respect to time-averaged maximum output power to determine compliance. The 3G SAR test reduction procedure is applied to 8-PSK EDGE with GMSK GPRS/EDGE as the primary mode.<sup>39</sup>

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<sup>38</sup> When different maximum output power applies to GSM voice or GPRS/EDGE time slots, GSM voice and GPRS/EDGE time slots should be tested separately to determine compliance by summing the corresponding *reported* SAR. Detailed explanation must be included in the SAR report to substantiate the test configurations with respect to the maximum output power applicable to each time-slot mode and configuration to support the SAR results.

<sup>39</sup> In addition to different maximum power specifications for the time slot configurations, some devices may have different maximum output power specified for GMSK and 8-PSK in EDGE mode, which must be taken into consideration to determine SAR test reduction and measurement requirements.

## Change Notice

**10/16/2014:** 941225 D01 3G SAR Procedures v03 replaces 941225 D01 SAR test for 3G devices v02 and consolidates and replaces previous attachments KDB 941225 D02 HSPA and 1x Advanced v02r02, 941225 D03 SAR Test Reduction GSM GPRS EDGE vo1, and 941225 D04 SAR for GSM E GPRS Dual Xfer Mode v01 into a single document to provide SAR measurement guidance for 3G wireless technologies. It includes updates to align the procedures with recent changes to other RF exposure KDB publications.

**10/23/2015:** 941225 D01 3G SAR Procedures v03r01 replaces 941225 D01 SAR test for 3G devices v03. Replaced PBA with PAG and corrected two typos.