

SAR Analysis Report

(Based upon upper bound transmission duty factor)

E-Reader

FCC ID: 2AOAJ-2679

Apr. 25, 2019

360 Engine Burns LLC

400 West Capitol Avenue, Suite 1700 Little Rock, Arkansas, 72201

Rev. A

Contents

1. Product Description	3
2. Network Connection on a typical eBook purchase	3
3. Referenced FCC Guideline	5
4. Conservative Approach in Upper Bound Transmission Duty Factor	5
5. Available Content for E-Reader Download	6
6. File Size Distribution for Each Content Type	7
7. Downlink and Uplink Throughput.....	7
8. Rationale in calculating Upper Bound Transmission Duty Factor	8
9. HSDPA Analysis	10
10. WCDMA Analysis	19
11. GPRS Analysis.....	20
12. EDGE Analysis	21
13. WLAN & Bluetooth Analysis	22
14. LTE Analysis.....	23
15. RF Conducted Power	32
16. SAR Analysis	35

1. Product Description

- a. Radio Capabilities
 - i. Frequency Band :
 - GSM 850: 824.2-848.8 MHz;
 - GSM 1900: 1850.2 -1909.8 MHz;
 - WCDMA Band V: 826.4 – 846.6 MHz;
 - WCDMA Band II: 1852.4 – 1907.6 MHz;
 - LTE Band 2: 1850.7 – 1909.3 MHz;
 - LTE Band 4: 1710.7 – 1754.3 MHz;
 - LTE Band 12: 729.7 -745.3 MHz
 - ii. WWAN portion: GSM/GPRS(Class 10)/EDGE(Class 10)/WCDMA/HSDPA/HSUPA/LTE
 - iv. WLAN portion: 802.11 b/g/n (WLAN and WWAN will not operate simultaneously unless it is transitioning from WLAN to WWAN or WWAN to WLAN. Network handover period is less than 60 seconds and so it's not subject to rf exposure evaluation.)
 - v. BT4.0 including EDR/LE
- b. External connector:
 - i. USB port
- c. Model S8IN4N is an E-reader. The primary use of this device is to download the eBook and periodical offering from the content provider. Model S8IN4N does not support voice transmission. The wireless radios are only used to send and receive data (electronic article) for this e- reader and does not support wireless file transfer to/from other devices.

The UBTF for this e-reader is exactly same as the previous filing with FCC ID: 2AJZA-9266

2. Network Connection on a typical eBook purchase RX-TX sequence via cellular network

- a. Step #1 Initial wireless power-up and pairing request

When a customer switches on the eBook reader, a link of 1kB data size is sent to the content provider website via carrier towers in conjunction with a proprietary Data network. This is also called a pairing request for connections, as defined in the Data network terminology.

There is an uplink activity. Its uplink duration is 0.5 seconds. Entire process will take 30 seconds based upon the most conservative estimate (shortest).

- b. Step #2 Launch store application: this is download activity only. Application will be launched about 30 seconds based upon the most conservative estimate (shortest).

- c. Step #3 Search for content: Majority time spent in this process is during browsing the store content in making the decision on which category of electronic article and specific title to be purchased. The duration of event can be varied from one user to the other. The most conservative estimate is based upon the shortest browsing time of 40 seconds and entering multiple selections by the end user (transmitting) of 8 seconds.
- d. Step #4 Review search result: This is receiving activity only. Before making the final decision on download the electronic article, estimating the end user will take time in reviewing the content summary before making the purchasing decision. The most conservative estimate that the end user will take about 150 seconds in reviewing the search result.
- e. Step #5 New search and review result: To anticipate the end user will be making multiple selections (to purchase multiple books) at the same time but less time will be spent in browsing the contents and reviewing the selections. The most conservative duration is 90 seconds with less selections entered by the end user of 7 seconds.(transmitting).
- f. Step #6 Over-the-air book purchase request

The customer then browses the eBook reader and sends a purchase request to the content provider website through the carrier tower through Data network. The data size of this request is approximately 1kB. The data contains the customer's credit card information and the book information.

There is an uplink activity. The uplink duration is 0.5 second. The duration of time for the end user in entering the credit card information is estimating of 30 seconds (shortest).

- g. Step #7 Over-the-air book purchase confirmation including download information exchange.

The content provider sends a purchase confirmation to the eBook reader. The data size of this confirmation is approximately 1kB. The purchase confirmation #, the credit card authorization/receipt, and the delivery confirmation are contained this purchase confirmation. This confirmation is preceded by the wireless delivery of the ordered item to the eBook reader.

There is an uplink activity. The uplink duration is 0.5 seconds and the duration of time takes about 20 seconds.

- h. Step #8 Over-the-air book delivery

The content provider sends the ordered book to the requesting device through carrier network via Data network. The data size of this delivery is typically 500kB based on the book purchased.

In GPRS/EDGE/WCDMA mode of operation, this is a downlink activity. The downlink duration varies based on the book size.

In HSDPA and HSUPA mode of operation, this is downlink/uplink activity due to HSDPA/HSUPA requires the pilot signal to be active during the entire duration of the download. HARQ and CQI transmissions are transmitted as code channels in conjunction with the pilot signal. The downlink duration varies based on the book size and the uplink data rate (HSUPA or CDMA) signal has no effect on the download time so an analysis for HSDPA covers standard and HSUPA uplink speeds.

- i. For magazine or newspaper subscription delivery, it will consist of 1 and 8 steps described above
- j. Proprietary Notes:
 - Data network controls the signal transmission. The uplink duration will not be dictated by the carrier to which the eBook is connected.
 - The Data network is a proprietary “cloud” that handles all traffic between this e-Reader and the content provider who implemented Data network. It handles handshakes, authentication, purchase transmission, book download. It also provides a books management system whereby a customer can keep their place or content across e-Reader hardware and other mobile device.
 - The connection flow description above will not vary from one operator to another. In other words, the wireless operations are operator-independent.

3. Referenced FCC Guideline

- a. “Information requirements for FCC consideration of relevant upper bound transmission duty factor to qualify e-book devices/e-reader for SAR test exclusions” Dated Jan 07, 2010
- b. “RF Exposure procedure review : e-Reader – estimating a conservative transmission duty factor”
- c. TCB council workshop presentation dated April 28, 2010 c. “Greater than 10 MB using HSPA” Dated June 17, 2010
- d. KDB 447498 D01 General RF Exposure Guidance v06

4. Conservative Approach in Upper Bound Transmission Duty Factor

Our calculation of RF exposure for the purpose of SAR analysis is based on conservative product or network usage.

The frequency and duration of transmission time are based on nominal use, and the transmission time reported in this waiver request is done in seconds.

In addition, e-reader uses the following techniques for conservative approach in assessing RF exposure impact

- 1) Our primary connection is WiFi, not WAN. WAN is activated if and only if the e-Reader is not used in a WiFi-enabled hot spot location.

- 2) Our WAN modem is automatically powered down via power management inside the device when the WAN modem is not in use.
- 3) The 700 kbps worst-case data rate (in HSDPA mode) used in our calculation is significantly less than what can be measured in real-time data rates. 3G speeds in excess of 1Mbps are not uncommon based on our network observations.
- 4) For WCDMA, GPRS, and EDGE mode of operation, since there is little or no transmission during download for these wireless modes, the analysis is based on the longest uplink transmission and shortest downlink transmission.
 - a. For WCDMA mode of operation, 384 kbps data rate/ fastest download is used and 64 kbps /slowest data rate is used for uplink.
 - b. For GPRS mode of operation, 40 kbps data rate / fastest download and 8 kbps data rate / slowest uplink are used.
 - c. For EGPRS mode of operation, 118.5 kbps data rate / fastest download and 8 kbps data rate/slowest uplink are used.
- 5) For WiFi mode of operation, since there is little or no transmission during the download, the analysis is based on the shortest downlink data rate of 2000 kbps. We schedule delivery of subscriptions at times we expect that users will be less likely to be holding the device.

5. Available Content for E-Reader Download

Table 1	
Publication Category	% of total download
Books	30
Newspapers	30
Magazines	20
Internet Content	20

Table 1 presents the data of content distribution in each of category based upon data gathered with expected future content distributions in the most conservative way to ensure continued compliance.

6. File Size Distribution for Each Content Type

Table 2 / Monthly Download Metric				
A	B	C	D	E
File Size (Mbyte)	Books % Distribution	Newspapers % Distribution	Magazine % Distribution	Internet Content % Distribution
< 0.5MB	52.8	10	22	45
0.5 - 1	29.3	9	7	30
1 - 5	15.2	59	47	20
5 - 10	1.1	19	19	4
10 - 20	0.7	3	5	0
20 - 30	0.4	0	0	0
30 - 40	0.2	0	0	1
40 - 50	0.3	0	0	0

Table 2 presents download metrics based upon available store content download file size in each category and future expectations provided by the content store for the device. This usage/content was updated in September 2014 and was re-evaluated recently in April 2019 to be the same.

7. Downlink and Uplink Throughput

Table 3				
Protocol	Downlink Throughput*		Uplink**	
	Low (kbps)	Max (kbps)	Low (kbps)	Max (kbps)
LTE	2,000	10,000	5,000	
HSDPA	700	14,400	384	
WCDMA	230	384	128	
EGPRS	100	118.5	8.8 (1slot)	
GPRS	28	40	8(1 slot)	

Note 1: 700kbps is used for HSDPA calculations in this document to ensure Upper Bound limitations are being stressed (and takes into account network overhead)
Model CW96BW is primarily a downlink focused device- the only uplink information will be packet acknowledgements during network connections.

Note 2: For WCDMA mode, the max download data rate is 384 kbps. Allowing a 50% derating factor for network and protocol overhead, $384 \text{ kbps} \times 50\% = 192 \text{ kbps}$ is used in table 10 calculation.

Note 3: For EGPRS/EDGE mode, the max download data rate is 237 kbps. Allowing a 50% derating factor for network and protocol overhead, $237 \text{ kbps} \times 50\% = 118.5 \text{ kbps}$ is used in table 12 calculation.

Note 4: For GPRS mode, the max download data rate is 80 kbps. Allowing a 50% derating factor for network and protocol overhead, $80 \text{ kbps} \times 50\% = 40 \text{ kbps}$ is used in table 11 calculation.

Note 5: For LTE mode, 2000 kbps is used for LTE calculation in this document to ensure Upper Bound limitations are being stressed and takes into account network overhead.

8. Rationale in calculating Upper Bound Transmission Duty Factor

- a. Step 1: Define the percentage of distribution based upon category defined.
 - i. Table 1: Based upon the category defined in content download store and data center database structure. Four content categories have been defined as eBook, Newspaper, Magazine and internet content.
- b. Step 2: Grouping the file size and provide the percentage for each group of file size in each category. For file size larger than 10 MB, the increment of grouping should not be less than 5 MB or greater than 20 MB (June 17, 2000 FCC guidance).
 - i. Table 2: The max. file size is 50 MB,
- c. Step 3: Define what air-data rate to be used based upon wireless technology
 - i. Table 3: LTE=2000kbps; HSDPA= 700kbps; WCDMA=384kbps, GPRS=40kbps; EGPRS=118.5kbps
- d. Step 4: Category type download duration for each file size grouping for each mode of operation
 - i. HSDPA Analysis

1. Weighted Composite Download Time for each Category and total for all file sizes and category. (Table 4 and 5)
2. Adjusted for large file size download (Table 6,7, and 8)
3. Event Process Durations and UBTDF percentage (Table 9)
- ii. WCDMA Analysis
 1. Event Process Durations based upon fastest download time and UBTDF percentage (Table 10)
- iii. GPRS Analysis
 1. Event Process Durations based upon fastest download time and UBTDF percentage (Table 11)
- iv. EDGE Analysis
 1. Event Process Durations based upon fastest download time and UBTDF percentage (Table 12)
- v. WiFi & Bluetooth Analysis
 1. Event Process Durations and UBTDF percentage (Table 13)
- vi. LTE Analysis
 1. Weighted Composite Download Time for each Category and total for all file sizes and category. (Table 14 and 15)
 2. Adjusted for large file size download (Table 16,17, and 18)
 3. Event Process Durations and UBTDF percentage (Table 19)
- e. Step 5: Based upon RF conducted output power and antenna-to-user separation distance in calculating the SAR test Exclusion threshold.
- f. Step 6: Adjusted RF conducted output with UBTDF Vs. SAR test exclusion threshold.

9. HSDPA Analysis

Table 4 (Based upon Jan 07, 2010/ FCC eReader guideline, item 4(b)) Download Size Distribution before adjusting for large download > 10 MB									
A	B	C	D	E	F	G	H	I	J
File Size (Mbyte)	TX Duration (s)	Books % Distribution	Ebook Download Duration (s)	Newspaper % Distribution	Newspaper Download Duration (s)	Magazine % Distribution	Magazine Download Duration (s)	Blog % Distribution	Internet Content Download Duration (s)
< 0.5MB	5.85	52.8	3.09	10	0.59	22	1.29	45	2.63
0.5 - 1	11.7	29.3	3.43	9	1.05	7	0.82	30	3.51
1 - 5	58.51	15.2	8.89	59	34.52	47	27.5	20	11.7
5 - 10	117.03	1.1	1.29	19	22.24	19	22.24	4	4.68
10 - 20	234.06	0.7	1.64	3	7.02	5	11.7	0	0
20 - 30	351.09	0.4	1.4	0	0	0	0	0	0
30 -40	468.11	0.2	0.94	0	0	0	0	1	4.68
40 -50	585.14	0.3	1.76	0	0	0	0	0	0
Total weighted composite download Time for each category=			22.44		65.42		63.55		27.2
Note1:	HSDPA Worst case data rate of 700 Kbps				Upper Bound Download Duration = Size(in Mbyte)*1024 (Kbyte/Mbyte) *8 (Bit/Byte)/700 Kbps				
Note 2:	All content size in store will not exceed 50 Mbytes								

Calculation (for example: Column A : file size less than 0.5MB)

1. Column B: ((the upper file size in Mbyte in column A) *1024 (kbyte/Mbyte)* 8(bit/byte))/700 kbps
 - a. $0.5\text{MB} \times 1024 \times 8 / 700 = 5.85$ seconds. – calculate the download time needed based upon 0.5 MB file size with 700 kbps data rate.
2. Column C/ eBook: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 /
column B = 52.8%
3. Column D/ Weighted eBook download percentage :(column B * column C)
 - a. 5.85 seconds *

$$52.8\%=3.09 \text{ seconds}$$

4. Column E/ Newspaper: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2/column C=10%
 - a. $5.85 \text{ seconds} * 10\%=0.59 \text{ seconds}$
6. Column G / Magazine : Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 / column D=22%
 - a. $5.85 \text{ seconds} * 22\%=1.29 \text{ seconds.}$
8. Column I / Internet content: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 / column E: 45%
 - a. $5.85 \text{ seconds} * 45\%=2.63 \text{ seconds.}$
10. Weighted total composite download time: sum (weighted download time for each category for all file size)
 - a. Weighted total (eBook / Column D) = $3.09+3.43+8.89+1.29+1.64+1.4+0.94+1.76=22.44 \text{ seconds.}$
 - b. Weighted total (newspaper/Column F)= $0.59+1.05+34.52+22.24+7.02+0+0+0=65.42 \text{ seconds}$
 - c. Weighted total (Magazine/Column H)= $1.29+0.82+27.5+22.24+11.7+0+0+0=63.55 \text{ seconds}$
 - d. Weighted total (Internet content / Column J) = $2.63+3.51+11.7+4.68+0+0+4.68+0=27.20 \text{ seconds.}$

Table 5/ Content Category Distribution before adjusted for large file size (>10MB)			
A	B	C	D
Content	Weighted Total time to download (s)/ From Table 4/column D/F/H/J	% of total download / from Table 1	Weighted composite Download time per category (s)
EBook	22.44	30	6.73
Newspapers	65.42	30	19.63
Magazines	63.55	20	12.71
Internet Content	27.20	20	5.44
Total Weighted Composite Download Time (s)			44.51

Exposure concerns may arise for infrequent occurrences of continuous transmissions more than a couple minutes; especially when user may not be aware of such circumstances with respect to wireless modes, data rates, expected transmission durations etc. To address such concerns, the frequency of occurrences for downloads larger than 10 MB should be limited.

The download time is computed according to the slowest download rate (700kbps for HSDPA) and the upper range of each download file size. This download time is independent of uplink data rate.

This transmission time is weighted by the frequency of occurrences for the download size and content category.

For each download size range, the combined frequency of occurrences for all content categories for download sizes larger than 10 MB should be limited. The percentage of occurrences for download size is multiplied by the percentage of occurrences for the corresponding content category in each download size range and summed across all content categories for the download size range. The aggregate percentage across all content categories for each download size range should be less the maximum percentage computed by the equation below. The weighted download duration is also adjusted according to the ratio of the actual download size (MB_{range}) to a 10 MB download to qualify for SAR exclusion.

$$\text{Max. \% (large downloads) = } \frac{\frac{10 \text{ second}}{MB_{range} * 1024 * 8}}{700 \text{ kbps}} * \frac{10 \text{ MB}}{MB_{range}} * 100\%$$

The maximum percentages calculated using the above equations for selected MB_{range} are listed below. A download size step range of 10 MB is typically appropriate; however, it should not be less than 5 MB or larger than 20 MB. For conservativeness, only the high end of each range (MB_{range}) should be used in the calculations.

Table 6 (Max. Allowed % for large file size Vs Sum of actual download % for each category)			
A	B	C	D
MB (range)	Un-weighted time (second)	Actual %	Max. Allowed (%)
20	234.06	2.11%	2.14
30	351.09	0.12%	0.95
40	468.11	0.26%	0.53
50	585.14	0.9%	0.34
The sum of actual percentage for each download size range should be less than the max. allowed percentage shown in above to qualify for SAR exclusion.			

Column B / un-weighted time= (MB (range) * 1024 *8) / 700 kbps.

Column C / Actual %:

For example:

Step 1: Column A: for file size in the range of 10 – 20 MB size, use upper file size which is 20 MB

Step 2: As indicated in table 2, 0.7% of eBook download is for file size in 10 -20 MB range. As indicated in table 1, eBook content distribution percentage is 30%.

Step 3: Combined %=download % *content %; = 0.007 x 0.3= 0.21%

Step 4 : repeat the same steps as indicated above to calculate combined % for newspaper/magazine and internet content.

Step 5: Sum the combined % for all category for specific file range.

Column C = 0.3/ebook+0.3/newspaper+0.2/magazine= 0.8%

Table 7 Adjusted for large download									
A	B	C	D	E	F	G	H	I	J
File Size (Mbyte)	TX Duration (s)	Books % Distribution	Weighted EBook Download Duration (s)	Newspaper % Distribution	Weighted Newspaper Download Duration (s)	Magazine % Distribution	Weighted Magazine Download Duration (s)	Internet Content % Distribution	Weighted Internet Content Download Duration (s)
< 0.5MB	5.85	50	2.	35	2.0	95	5.56	45	2.63
0.5 - 1	11.7	15	1.	35	4.1	2	0.23	30	3.51
1 - 5	58.51	25	14.	25	14.6	1	0.59	20	11.7
5 - 10	117.03	6	7.	4	4.6	1	1.17	4	4.68
For download sizes > 10 MB: Combined download size and content category distributions are indicated in (); where combined %=download % *content %; for example, 0.007 * 0.3=0.0021=0.21%. The sum of these for each download size range should be less than the max. allowed percentage shown in Table 6 to qualify for SAR exclusion. The weighted duration is adjusted by the ratio of download size and 10 MB; unadjusted values are shown in ().									
10 – 20	234.06	0.7 (0.21%)	1.64 3.28	3 (0.9%)	7.02 14.04	5 (1%)	11.7 23.4	0	0
20 – 30	351.09	0.4 (0.12%)	1.4 4.2	0	0	0	0	0	0
30 -40	468.11	0.2 (0.06%)	0.94 3.76	0	0	0	0	1 (0.2%)	4.68 18.72
40 -50	585.14	0.3 (0.09)	1.76	0 3	0	0 5	0	0	0 0
			36.74		72.44		75.25		41.24

Table 8 / Content Category Distribution adjusted for large download sizes > 10 MB			
A	B	C	D
Content	Weighted Total time to download (s)	% of total download	Weighted composite Download time per category (s)
EBook	36.74	30	6.73
Newspaper	72.44	30	19.63
Magazines	75.25	20	12.71
Internet Content	41.24	20	5.44
Weighted Composite Download Time (s)			56.05

Table 9 / Upper bound transmission duty factor based upon weighted composite download			
A	B	C	D
Step time line	Description	Duration (s)	Tx Duration (s)
P1	Power up & Register to the network	30	10
P2	PDP Context establishment	6	6
T0	Download information exchange	3	3
T1	Download content	56.05	56.05
T2	Time between Content and index download (Note1)	90	0
T3	Index download	14.01	14.01
T4	Wait to Deactivate PDP (Note1)	570	0
T5	PDP Deactivate	1	1
Note1: this time is fixed in the software design		Total	770.06
			90.06
Composite Duty Factor %			11.7

Power up & Register to the network: a link of 1kB data size is sent to the content provider via cellular network provider in conjunction with content provider's proprietary network with carrier. The content provider sends an authentication confirmation of approximately 1kb data size to the requesting device through proprietary network to acknowledge its presence and confirm its readiness for any new request.

Definition (Refer to Figure 1)

Authentication: Verification at the Data network about the authenticity of the user who is intending to make a transaction

Book Download: The process of Data network sending book to the device – This may or may not include authentication depending on whether the user was already authenticated. The plot shows the case where the authentication was included

Full Transaction Cycle: From the moment the user initiates a book download to the time when the PDP context is deactivated. (See below for definition of PDP context deactivation)

Go Dormant: A colloquial term which translates, in 3GPP terms, to "Device goes from RRC connected state to RRC Idle state". In RRC connected state, the device is allowed to transmit. In RRC Idle state, the device can not transmit without going through the 3GPP defined access procedure

Index Download: The process of Data sending "key" words to the device. The index helps the user search the book for specific words. This is optional and not always done.

PDP Context: a 3GPP term (Packet Data Protocol Context), where the core network provides access to external IP network by providing an address to the device. In the case of e-Reader, PDP context provides a means (via an IP address) for the Data Network to send data to device. Please note: Active PDP context does not imply a constant transmission from the device.

PDP Context Activation: When the data pipe from device to the Data exists and hence the Data Network can send data to the device

PDP Context deactivation: The Data Network can NOT send any user data (such as books, blogs, newspaper) to the device

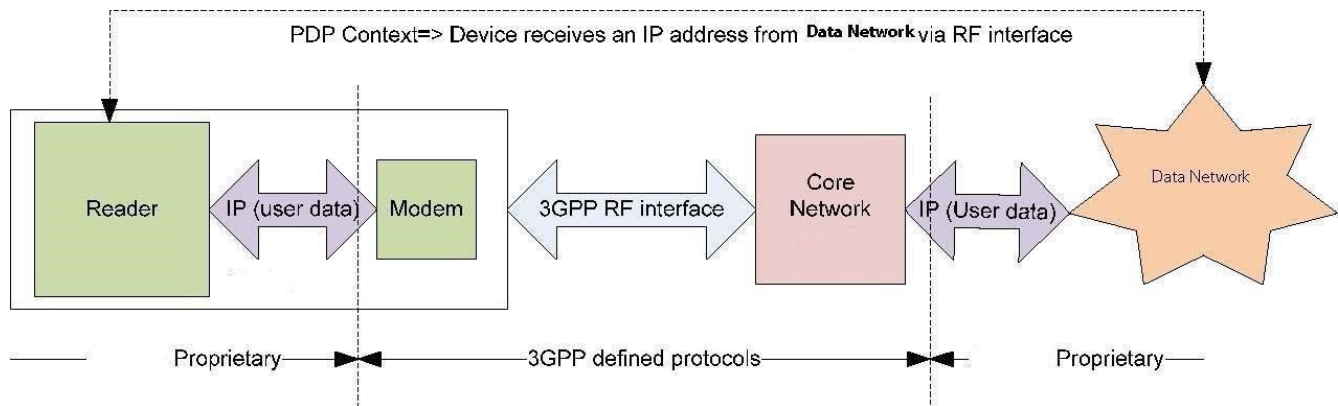


Figure 1 End to End Protocol view

Clarifications Case 1: Single Book Download

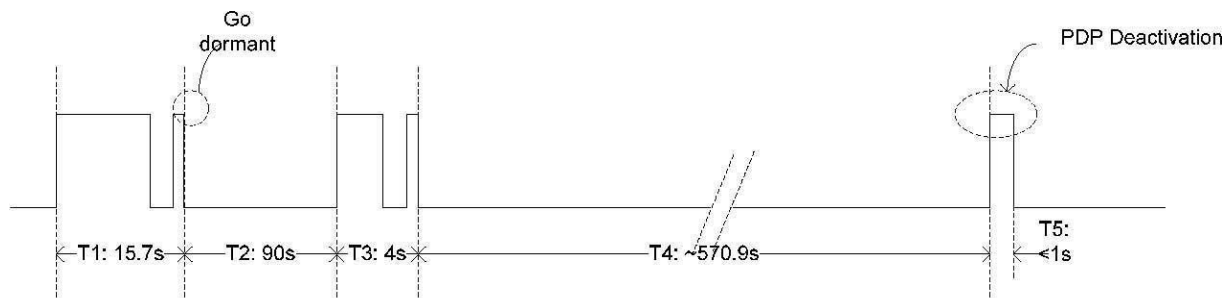


Figure 2 Spectrum Analyzer Plot

The figure 2 represents the spectrum analyzer plot. It is represented here as a line plot so that it can be annotated and described. The Figure 2 shows four time intervals T1, T2, T3 and T4. Each of them is defined and described below

T1: This is the time for book download. The book download finishes and the device goes dormant. The time shown in the figure is the time it had taken, on cellular network, to download a book of size 1MByte at a rate of 512Kbps. This time will depend on the size of the book and the data rate. In the calculation of T1 time, 700kbps data rate was used for each of file size including 4 seconds idle period.

T2: This is a fixed time designed into the software (proprietary). This time does not depend on the size of the book or the data rate offered by the cellular network

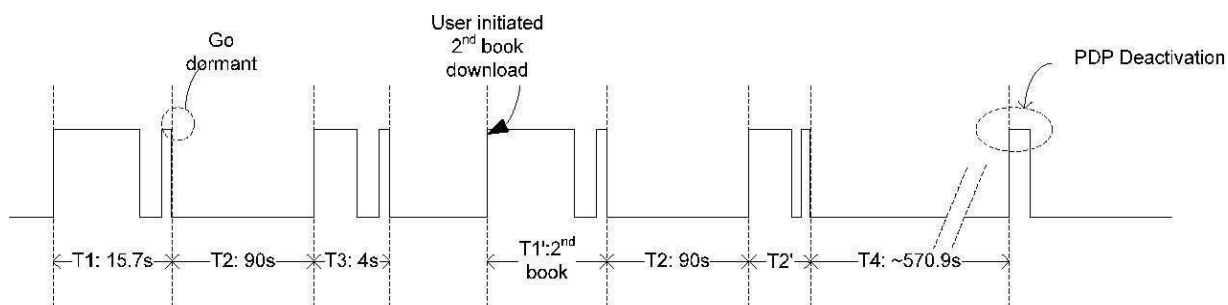
T3: This is the time to download the index. This is always done once after the book is downloaded. The duration depends on the size of the index and the data rate. Here the data rate is still 700Kbps. The size of the index is dependent on the book size. In the calculation, estimate $\frac{1}{4}$ of T1 time is needed including 4 seconds idle period.

T4: This is the idle time that determines when the PDP context is deactivated. The minimum idle time is 570s before the PDP is activated as per the proprietary software design. This is noted in the figure and this happens when the user downloads the book and does not touch any keys on the reader for about 910 min.

If the user is reading a book in this time by turning pages, the PDP context stays activated (without any Transmission from the device) and the time T4 increases. This time does not depend on the book size but only on the user activity. The user can, for example, initiate a second book download in this period. Please refer to Use case 2. In order to present the most conservative approach in assessing the transmitting-on time Vs the duration of transaction, T4 time is not counted in the calculating the duty cycle.

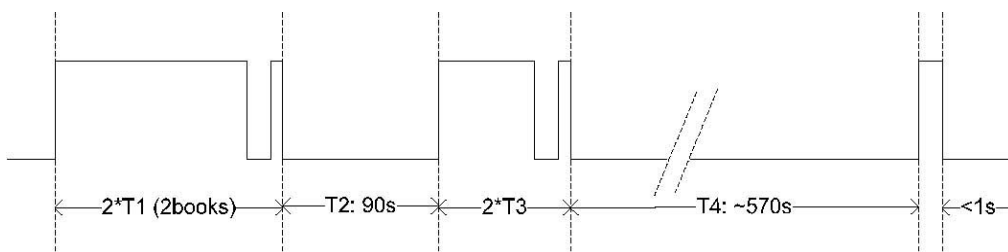
T5: This is the PDP deactivation as defined in 3gPP. The Transmission time is <1s in this period and is not dependent on book size.

Case 2: User chooses to buy another book during the idle time T4



In this case the user initiated a 2nd transaction to download another 1MByte book. The time periods, T1' and T2' will be same (assuming same network load) as T1 and T2 respectively to download the 2nd book and its index respectively.

Case 3: User chooses to download 2 books bundled together



In this case, the Book1 and book2 are downloaded together. After time period T2 (min 90s), the indices for book 1 and book2 are downloaded. The figure assumes no user activity during the idle period T4.

10. WCDMA Analysis

Since there is little or no transmission during download in WCDMA mode of operation, WCDMA analysis is based on the longest uplink transmission and shortest downlink transmission. As indicated in table 2 (data size distribution), using 0.5 MB file size with highest download data rate will maximize UBTDF when the download duration is minimized. (Based upon Jan 07, 2010/ FCC eReader guideline, item 4(a))

As provided in table 3, note 2, the max download speed is 384 kbps. Allowing 50% derating factor for network and protocol overhead, download speed of 192 kbps is used to calculate the download time.

Download Duration (second) = $((0.5 \text{ MB}) * 8 \text{ (bits/byte)} * 1024 \text{ (Kbytes/MB)}) / (384 \text{ (kbps)} * 0.5) = 21.3$ seconds

Network connection and registration always occur at the same data rate, and always exchanges the same information, so this event will always take the same amount of time.

Table 10/ Upper bound transmission duty factor based upon weighted composite download			
A	B	C	D
Step time line	Description	Duration (s)	Tx Duration (s)
1	Initial wireless power up & Register to the network	30	0.5
2	Launch Store Application	30	0
3	Search for content	40	8
4	Review search result	150	0
5	New search and review result	90	7
6	Over-the-air purchase request	30	0.5
7	Over-the-air purchase confirmation including download 7 information exchange	20	3
8 (T1)	Download content	21.3	0
8 (T2)	Time between Content and index download (Note1)	90	0
8 (T3)	Index download	9.33	0
8 (T4)	Wait to Deactivate PDP (570 seconds, not use in the calculation)	0	0
8 (T5)	PDP Deactivate	1	1
Note1: Fixed time-proprietary software		Total	511.63
		Composite Duty Factor %	3.9

11. GPRS Analysis

Similar to WCDMA mode of operation, there is little or no transmission during download in GPRS mode of operation, GPRS analysis is based on the longest uplink transmission and shortest downlink transmission (Based upon Jan 07, 2010/ FCC eReader guideline, item 4(a)). As indicated in table 2 (data size distribution), using 0.5 MB file size with highest download data rate will maximize UBTDF when the download duration is minimized.

As provided in table 3 note 4, the max download speed is 80 kbps. Allowing 50% derating factor for network and protocol overhead, download speed of 40 kbps is used to calculate the download time.

Download Duration (second) = $((0.5 \text{ MB}) * 8 \text{ (bits/byte)} * 1024 \text{ (Kbytes/MB)}) / (80 \text{ (kbps)} * 0.5) = 102.4$ seconds

Network connection and registration always occur at the same data rate, and always exchanges the same information, so this event will always take the same amount of time.

Table 11/ Upper bound transmission duty factor based upon weighted composite download			
A	B	C	D
Step time line	Description	Duration (s)	Tx Duration (s)
1	Initial wireless power up & Register to the network	30	0.5
2	Launch Store Application	30	0
3	Search for content	40	8
4	Review search result	150	0
5	New search and review result	90	7
6	Over-the-air purchase request	30	0.5
7	Over-the-air purchase confirmation including download 7 information exchange	20	3
8 (T1)	Download content	102.4	0
8 (T2)	Time between Content and index download (Note1)	90.00	0
8 (T3)	Index download	25.6	0
8 (T4)	Wait to Deactivate PDP (570 seconds, not use in the calculation)	0	0
8 (T5)	PDP Deactivate	1.00	0.13
Note1: Fixed time-proprietary software		Total	609
		Composite Duty Factor %	3.14

12. EDGE Analysis

Similar to WCDMA mode of operation, there is little or no transmission during download in EDGE mode of operation, EDGE analysis is based on the longest uplink transmission and shortest downlink transmission (Based upon Jan 07, 2010/ FCC eReader guideline, item 4(a)). As indicated in table 2 (data size distribution), using 0.5 MB file size with highest download data rate will maximize UBTDF when the download duration is minimized.

As provided in table 3, note 3, the max download speed is 4 slots * 59.25 kbps/slot =237 kbps. Allowing 50% derating factor for network and protocol overhead, download speed of 118.5 kbps is used to calculate the download time.

Download Duration (second) = ((0.5 MB) * 8 (bits/byte) * 1024 (Kbytes/MB)) / (237 (kbps) *0.5) = 34.6 seconds

Network connection and registration always occur at the same data rate, and always exchanges the same information, so this event will always take the same amount of time.

Table 12/ Upper bound transmission duty factor based upon weighted composite			
A	B	C	D
Step time line	Description	Duration (s)	Tx Duration (s)
1	Initial wireless power up & Register to the network	30	0.5
2	Launch Store Application	30	0
3	Search for content	40	8
4	Review search result	150	0
5	New search and review result	90	7
6	Over-the-air purchase request	30	0.5
7	Over-the-air purchase confirmation including download 7 information exchange	20	3
8 (T1)	Download content	34.6	0
8 (T2)	Time between Content and index download (Note1)	90.00	0
8 (T3)	Index download	8.65	0
8 (T4)	Wait to Deactivate PDP (570 seconds, not use in the calculation)	0	0
8 (T5)	PDP Deactivate	1.00	0.13
Note1: Fixed time-proprietary software		Total	524.25
			19.13
Composite Duty Factor %			3.65

13. WLAN & Bluetooth Analysis

Within the WiFi network, this client device (eBook reader) shall establish the network connection and authenticated with master device (hot spot). The step timeline is similar to GPRS. EDGE and WCDMA, the transaction duration is similar to HSDAP. During the download process, the client device is constantly sending the acknowledgement back to master device to check the number of packet received.

Within the WiFi network, the UBTDF is max. when the download data rate is the slowest in term to have longest transmitting –on time. A 0.5 MB file size is used in the calculation due to 0.5 MB size has higher download percentage across all four categories and 2MBPs data rate is used.

Sample calculation: $(0.5 \text{ MB} * (8\text{bits}/\text{byte}) * (1024\text{Kbytes}/\text{MB})) / 2000\text{kbps} = 2.048 \text{ seconds}$

Table 13/ Upper bound transmission duty factor based upon weighted composite download

A	B	C	D
Step	Event	Event Duration (in sec)	Transmission on- time(in sec)
1	Power up & register on network	30	0.5
2	Launch store application	30	0
3	Search for content	40	8
4	Review search results	150	0
5	New search and review result	90	7
6	Over-the-air purchase request	30	0.5
7	Over-the-air purchase confirmation	20	2.5
8	Download archived content (0.5MB)	2.048	2.048
9	Purchase completed (Modem inactive)	5.0	0
Totals		397.05	20.55
Duty Factor		5.18%	

Bluetooth operation supports audio streaming. The UBTF is max. when the packet transmissions extend to 5 slots combined with 1 receiving slot. The max. duty factor for Bluetooth is $5/6 = 83.3\%$.

14. LTE Analysis

Table 13 (Based upon Jan 07, 2010/ FCC eReader guideline, item 4(b)) Download Size Distribution before adjusting for large download > 10 MB									
A	B	C	D	E	F	G	H	I	J
File Size (Mbyte)	TX Duration (s)	Books % Distribution	Ebook Download Duration (s)	Newspaper % Distribution	Newspaper Download Duration (s)	Magazine % Distribution	Magazine Download Duration (s)	Blog % Distribution	Internet Content Download Duration (s)
< 0.5MB	2.05	52.8	1.08	10	0.21	22	0.45	45	0.92
0.5 - 1	4.10	29.3	1.20	9	0.37	7	0.29	30	1.23
1 - 5	20.48	15.2	3.11	59	12.08	47	9.63	20	4.10
5 - 10	40.96	1.1	0.45	19	7.78	19	7.78	4	1.64
10 - 20	81.92	0.7	0.57	3	2.46	5	4.10	0	0.00
20 - 30	122.88	0.4	0.49	0	0.00	0	0.00	0	0.00
30 -40	163.84	0.2	0.33	0	0.00	0	0.00	1	1.64
40 -50	204.8	0.3	0.61	0	0.00	0	0.00	0	0.00
Total weighted composite download Time for each category=			7.85		22.90		22.24		9.52
Note1:	LTE Worst case data rate of 2000 Kbps				Upper Bound Download Duration = Size(in Mbyte)*1024 (Kbyte/Mbyte) * 8 (Bit/Byte)/2000 Kbps				
Note 2:	All content size in store will not exceed 50 Mbytes								

Calculation (for example: Column A : file size less than 0.5MB)

- Column B: (the upper file size in Mbyte in column A) *1024 (kbyte/Mbyte)* 8(bit/byte))/2000 kbps
 - $0.5\text{MB} * 1024 * 8 / 2000 = 2.05$ seconds.
– calculate the download time needed based upon 0.5 MB file size with 2000 kbps data rate.
- Column C/ eBook: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 / column B = 52.8%
- Column D/ Weighted eBook download percentage :(column B * column C)
 - $2.05.85 \text{ seconds} * 52.8\% = 1.08 \text{ seconds}$

4. Column E/ Newspaper: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2/column C=10%
 - a. 2.05 seconds * 10%=0.21 seconds
5. Column F/ Weighted Newspaper download percentage: (column B*column E)
 - a. 2.05 seconds * 10%=0.21 seconds
6. Column G / Magazine : Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 / column D=22%
 - a. 2.05 seconds * 22%=0.45 seconds.
7. Column H / Weighted Magazine download percentage: (column B * column G)
 - a. 2.05 seconds * 22%=0.45 seconds.
8. Column I / Internet content: Percentage of distribution for each category for data size < 0.5 MB as indicated in table 2 / column E: 45%
 - a. 2.05 seconds * 45%=0.92 seconds.
9. Column J / weighted Internet content download percentage: (column B*column I)
 - a. 2.05 seconds * 45%=0.92 seconds.
10. Weighted total composite download time: sum (weighted download time for each category for all file size)
 - a. Weighted total (eBook / Column D) = 1.08+1.20+3.11+0.45+0.57+0.49+0.33+0.61=7.85 seconds.
 - b. Weighted total (newspaper/Column F)=0.21+0.37+12.08+7.78+2.46+0+0+0=22.90 seconds
 - c. Weighted total (Magazine/Column H)=0.45+0.29+9.63+7.78+4.1+0+0+0=22.24 seconds
 - d. Weighted total (Internet content / Column J) =0.92+1.23+4.10+1.64+0+0+1.64+0=9.52 seconds

Table 14/ Content Category Distribution before adjusted for large file size (>10MB)			
A	B	C	D
Content	Weighted Total time to download (s)/ From Table 13/column D/F/H/J	% of total download / from Table 1	Weighted composite Download time per category (s)
EBook	7.85	30	2.36
Newspapers	22.9	30	6.87
Magazines	22.24	20	4.45
Internet Content	9.52	20	1.90
Total Weighted Composite Download Time (s)			15.58

Exposure concerns may arise for infrequent occurrences of continuous transmissions more than a couple minutes; especially when user may not be aware of such circumstances with respect to wireless modes, data rates, expected transmission durations etc. To address such concerns, the frequency of occurrences for downloads larger than 10 MB should be limited.

The download time is computed according to the slowest download rate (2000kbps for LTE) and the upper range of each download file size. This download time is independent of uplink data rate.

This transmission time is weighted by the frequency of occurrences for the download size and content category.

For each download size range, the combined frequency of occurrences for all content categories for download sizes larger than 10 MB should be limited. The percentage of occurrences for download size is multiplied by the percentage of occurrences for the corresponding content category in each download size range and summed across all content categories for the download size range. The aggregate percentage across all content categories for each download size range should be less than the maximum percentage computed by the equation below. The weighted download duration is also adjusted according to the ratio of the actual download size (MB_{range}) to a 10 MB download to qualify for SAR exclusion.

$$\text{Max. \% (large downloads)} = 10 \text{ second} / (\text{MB}_{\text{range}} * 1024 * 8 / 2000 \text{ kbps}) * (10 \text{ MB} / \text{MB}_{\text{range}}) * 100\%$$

The maximum percentages calculated using the above equations for selected MB_{range} are listed below. A download size step range of 10 MB is typically appropriate; however, it should not be less than 5 MB or larger than 20 MB. For conservativeness, only the high end of each range (MB_{range}) should be used in the calculations.

Table 15 (Max. Allowed % for large file size Vs Sum of actual download % for each category)			
A	B	C	D
MB (range)	Un-weighted time (second)	Actual %	Max. Allowed (%)
20	81.92	2.11%	6.10
30	122.88	0.12%	2.71
40	163.84	0.26%	1.53
50	204.8	0.09%	0.98
The sum of actual percentage for each download size range should be less than the max. allowed percentage shown in above to qualify for SAR exclusion.			

Column B / un-weighted time= (MB_{range} * 1024 * 8) / 2000 kbps.

Column C / Actual %:

For example:

Step 1: Column A: for file size in the range of 10 – 20 MB size, use upper file size which is 20 MB

Step 2: As indicated in table 2, 0.7% of eBook download is for file size in 10 -20 MB range. As indicated in table 1, eBook content distribution percentage is 30%.

Step 3: Combined %=download % *content %; = 0.007 x 0.3= 0.21%

Step 4 : repeat the same steps as indicated above to calculate combined % for newspaper/magazine and internet content.

Step 5: Sum the combined % for all category for specific file range.

Column C = 0.3/ebook+0.3/newspaper+0.2/magazine= 0.8%

Table 16 Adjusted for large download									
A	B	C	D	E	F	G	H	I	J
File Size (Mbyte)	TX Duration (s)	Books % Distribution	Weighted EBook Download Duration (s)	Newspaper % Distribution	Weighted Newspaper Download Duration (s)	Magazine % Distribution	Weighted Magazine Download Duration (s)	Internet Content % Distribution	Weighted Internet Content Download Duration (s)
< 0.5MB	2.05	50	1.03	35	0.72	95	1.95	45	0.92
0.5 - 1	4.1	15	0.62	35	1.44	2	0.08	30	1.23
1 - 5	20.48	25	5.12	25	5.12	1	0.20	20	4.10
5 - 10	40.96	6	2.46	4	1.64	1	0.41	4	1.64
For download sizes > 10 MB: Combined download size and content category distributions are indicated in (); where combined %=download % *content %; for example, 0.007 * 0.3=0.0021=0.21%. The sum of these for each download size range should be less than the max. allowed percentage shown in Table 15 to qualify for SAR exclusion. The weighted duration is adjusted by the ratio of download size and 10 MB; unadjusted values are shown in ().									
10 – 20	81.92	0.7 (0.21%)	0.57 0.17	3 (0.90%)	2.46 0.74	5 (1%)	4.10 0.82	0	0 0
20 – 30	122.88	0.4 (0.12%)	0.49 0.15	0	0	0	0.00 0.00	0	0 0
30 -40	163.84	0.2 (0.06%)	0.33 0.10	0	0	0	0.00 0.00	1 (0.20%)	1.64 0.33
40 -50	204.8	0.3 (0.09%)	0.61 0.18	0	0	0	0.00	0	0 0
			11.82		12.11		7.56		9.85

Table 17 / Content Category Distribution adjusted for large download sizes > 10 MB			
A	B	C	D
Content	Weighted Total time to download (s)	% of total download	Weighted composite Download time per category (s)
EBook	11.82	30	3.55
Newspaper	12.11	30	3.63
Magazines	7.56	20	1.51
Internet Content	9.85	20	1.97
Weighted Composite Download Time (s)			10.66

Table 18 / Upper bound transmission duty factor based upon weighted composite download			
A	B	C	D
Step time line	Description	Duration (s)	Tx Duration (s)
P1	Power up & Register to the network	15	15
P2	EPS Bearer establishment	8	8
T0	Download information exchange	3	3
T1	Download content	10.66	10.66
T2	Time between Content and index download (Note1)	90	0
T3	Index download	2.67	2.67
T4	Wait to Deactivate PDP (Note1)	570	0
T5	PDP Deactivate	1	1
Note1: this time is fixed in the software design		Total	700.33
			40.33
Composite Duty Factor %			5.76

Power up & Register to the network: a link of 1kB data size is sent to the content provider via cellular network provider in conjunction with content provider's proprietary network with carrier. The content provider sends an authentication confirmation of approximately 1kb data size to the requesting device through proprietary network to acknowledge its presence and confirm its readiness for any new request.

Definition (Refer to Figure 1)

Authentication: Verification at the Data network about the authenticity of the user who is intending to make a transaction

Book Download: The process of Data network sending book to the device – This may or may not include authentication depending on whether the user was already authenticated. The plot shows the case where the authentication was included

Full Transaction Cycle: From the moment the user initiates a book download to the time when the device is detached. (See below for definition of the device detach)

Go Dormant: A colloquial term which translates, in 3GPP terms, to "Device goes from RRC connected state to RRC Idle state". In RRC connected state, the device is allowed to transmit. In RRC Idle state, the device can not transmit without going through the 3GPP defined access procedure

Index Download: The process of Data sending "key" words to the device. The index helps the user search the book for specific words. This is optional and not always done.

EPS bearer establishment: a 3GPP term (EPS bearer establishment), where the core network provides access to external IP network by providing an address to the device. In the case of e-Reader, EPS bearer establishment provides a means (via an IP address) for the Data Network to send data to device. Please note: Active EPS bearer does not imply a constant transmission from the device.

Dedicated Bearer Establishment: When the data pipe from device to the Data exists and hence the Data Network can send data to the device

The device Detach: The Data Network can NOT send any user data (such as books, blogs, newspaper) to the device.

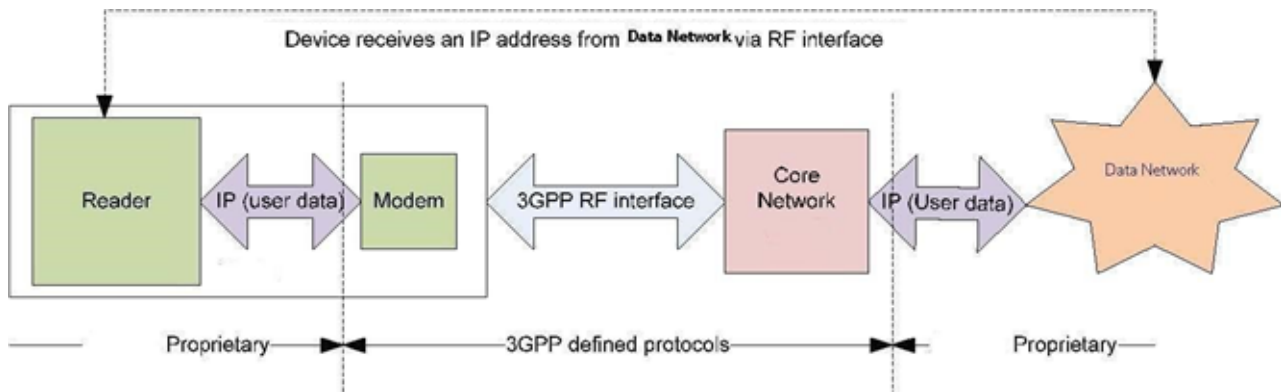


Figure 1 End to End Protocol view

Clarifications Case 1: Single Book Download

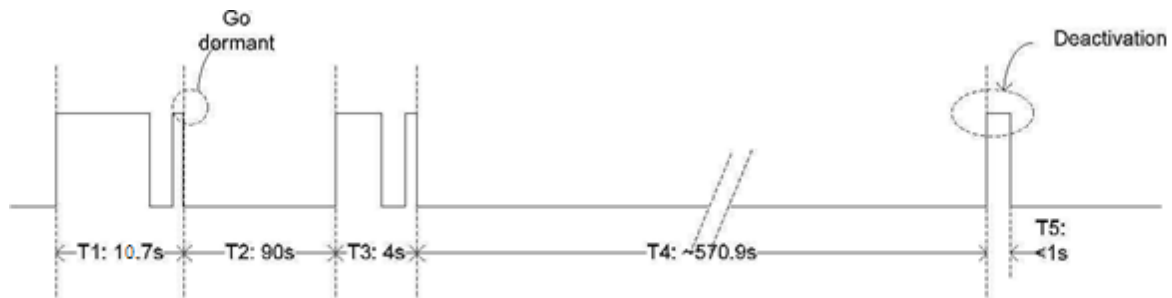


Figure 2 Spectrum Analyzer Plot

The figure 2 represents the spectrum analyzer plot. It is represented here as a line plot so that it can be annotated and described. The Figure 2 shows four time intervals T1, T2, T3 and T4. Each of them is defined and described below

T1: This is the time for book download. The book download finishes and the device goes dormant. The time shown in the figure is the time it had taken, on cellular network, to download a book of size 1MByte at a rate of 512Kbps. This time will depend on the size of the book and the data rate. In the calculation of T1 time, 2000kbps data rate was used for each of file size including 4 seconds idle period.

T2: This is a fixed time designed into the software (proprietary). This time does not depend on the size of the book or the data rate offered by the cellular network

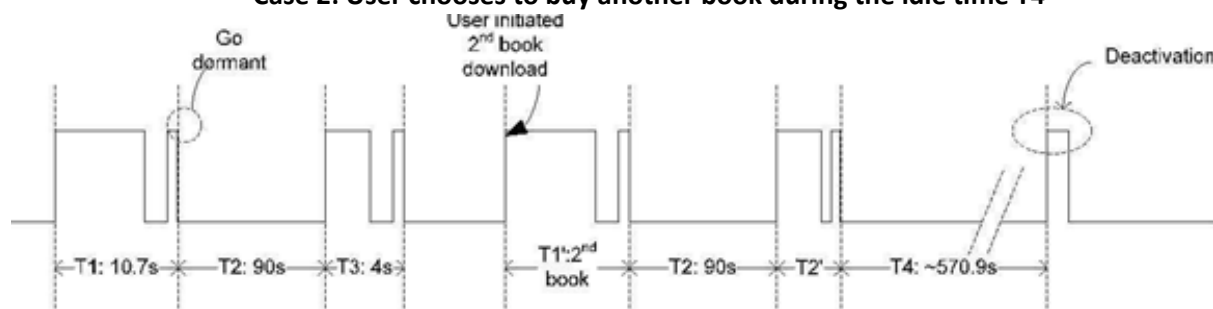
T3: This is the time to download the index. This is always done once after the book is downloaded. The duration depends on the size of the index and the data rate. Here the data rate is still 2000Kbps. The size of the index is dependent on the book size. In the calculation, estimate $\frac{1}{4}$ of T1 time is needed including 4 seconds idle period.

T4: This is the idle time that determines when the dedicated EPS bearer is deactivated. The minimum idle time is 570s before the EPS bearer is activated as per the proprietary software design. This is noted in the figure and this happens when the user downloads the book and does not touch any keys on the reader for about 910 min.

If the user is reading a book in this time by turning pages, the default EPS bearer stays activated (without any Transmission from the device) and the time T4 increases. This time does not depend on the book size but only on the user activity. The user can, for example, initiate a second book download in this period. Please refer to Use case 2. In order to present the most conservative approach in assessing the transmitting-on time Vs the duration of transaction, T4 time is not counted in the calculating the duty cycle.

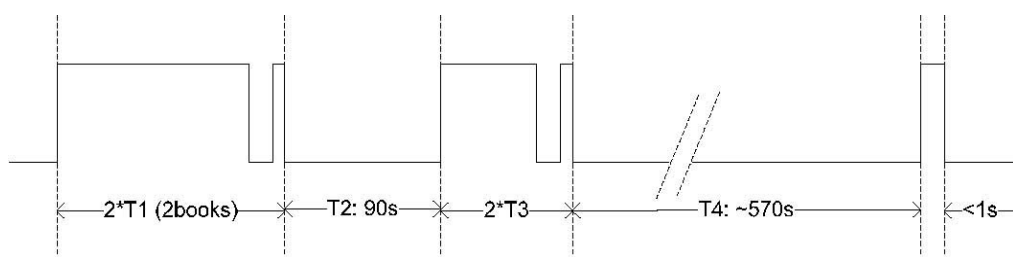
T5: This is the EPS bearer deactivation as defined in 3GPP. The Transmission time is <1s in this period and is not dependent on book size.

Case 2: User chooses to buy another book during the idle time T4



In this case the user initiated a 2nd transaction to download another 1MByte book. The time periods, T1' and T2' will be same (assuming same network load) as T1 and T2 respectively to download the 2nd book and its index respectively.

Case 3: User chooses to download 2 books bundled together



In this case, the Book1 and book2 are downloaded together. After time period T2 (min 90s), the indices for book 1 and book2 are downloaded. The figure assumes no user activity during the idle period T4.

15. RF Conducted Power

Max. Target average Power Based upon Tune up Procedure

The maximum output power, including tune up tolerances are detailed in the tables below. Measurement data included in the application filing are within the tune-up nominal power and tolerances described in the tune up procedure documentation.

Nominal Target Burst Average power for Production Unit

Mode	Antenna 1 / 2	
	GSM 850	GSM 1900
	Burst Average power(dBm)	
GSM/GPRS (GMSK, 1 Tx slot)	31.0 ±1	29.0 ±1
GPRS (GMSK, 2 Tx slots)	28.0 ±1	26.0 ±1
EDGE (8PSK, 1 Tx slot)	26.0 ±1	25.0 ±1
EDGE (8PSK, 2 Tx slots)	23.0 ±1	22.0 ±1

Power unit: dBm

Note-GPRS and EDGE powers are burst powers. The frame power (*source based average power) can be calculated by applying a 10log (1/8) duty factor (-9.03 dB) for single slot, 10log (2/8) duty factor (-6.02dB) for 2-slot operations

<WCDMA>

Mode	Antenna 1 / 2	
	WCDMA Band V	WCDMA Band II
AMR / RMC 12.2K	22 ± 1	22 ± 1
HSDPA Subtest-1	22 ± 1	22 ± 1
HSDPA Subtest-2	22 ± 1	22 ± 1
HSDPA Subtest-3	21.5 ± 1	21.5 ± 1
HSDPA Subtest-4	21.5 ± 1	21.5 ± 1
HSUPA Subtest-1	22 ± 1	22 ± 1
HSUPA Subtest-2	20 ± 1	20 ± 1
HSUPA Subtest-3	21 ± 1	21 ± 1
HSUPA Subtest-4	20 ± 1	20 ± 1
HSUPA Subtest-5	22 ± 1	22 ± 1

<FDD LTE>

Antenna 1 / 2							
LTE_B2	Channel bandwidth / Transmission bandwidth configuration [RB]						Power (dBm)
	1.4	3	5	10	15	20	
	MHz	MHz	MHz	MHz	MHz	MHz	
QPSK	1	1	1	1	1	1	22+1/-1 dB
QPSK	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	22+1/-1 dB
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	21+1/-1 dB
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	21+1/-1 dB
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	20+1/-1 dB

Antenna 1 / 2							
LTE_B4	Channel bandwidth / Transmission bandwidth configuration [RB]						Power (dBm)
	1.4	3	5	10	15	20	
	MHz	MHz	MHz	MHz	MHz	MHz	
QPSK	1	1	1	1	1	1	22+1/-1 dB
QPSK	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	22+1/-1 dB
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	21+1/-1 dB
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	21+1/-1 dB
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	20+1/-1 dB

Antenna 1 / 2					
LTE_B12	Channel bandwidth / Transmission bandwidth configuration [RB]				Power (dBm)
	1.4	3	5	10	
	MHz	MHz	MHz	MHz	
QPSK	1	1	1	1	22+1/-1 dB
QPSK	≤ 5	≤ 4	≤ 8	≤ 12	22+1/-1 dB
QPSK	> 5	> 4	> 8	> 12	21+1/-1 dB
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	21+1/-1 dB
16 QAM	> 5	> 4	> 8	> 12	20+1/-1 dB

WLAN 2.4GHz	Max Target Power (dBm)		
Channel	11b	11g	HT20
Ch1	20.5	17.0	17.0
Ch6	22.0	21.5	22.0
Ch11	21.0	17.5	17.0
Ch12	19.0	15.0	16.0
Ch13	12.5	2.0	-1.0

Channel	Average Power (dBm)		
	BR / EDR		
	1M	2M	3M
CH00	8	5	5
CH39	8	5	5
CH78	8	5	5

Channel	Average Power (dBm)	
	LE	
	1M	
CH00	6	
CH39	6	
CH78	6	

16. FCC SAR Analysis

a. SAR Exclusion Threshold: KDB 447498 Section 4.3.1

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [f(\text{GHz})] \leq 3.0$$
 for 1-g SAR.

- $f(\text{GHz})$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Antenna	Tx	Freq. (MHz)	UBDTF Duty Cycle (Note 1)	Output power			Separation distance (mm) (note 4)	Threshold Value (Note 5)
				dBm (Note 2)	mW (Note 2)	mW (Note 3)		
2G	GPRS 1TX Slot	850	3.14%	23	199.5	6.3	5	1.2
2G	GPRS 2TX Slot	850	3.14%	23	199.5	6.3	5	1.2
2G	EDGE 1TX Slot	850	3.65%	18	63.1	2.3	5	0.4
2G	EDGE 2TX Slot	850	3.65%	18	63.1	2.3	5	0.4
2G	GPRS 1TX Slot	1900	3.14%	21	125.9	4.0	5	1.1
2G	GPRS 2TX Slot	1900	3.14%	21	125.9	4.0	5	1.1
2G	EDGE 1TX Slot	1900	3.65%	17	50.1	1.8	5	0.5
2G	EDGE 2TX Slot	1900	3.65%	17	50.1	1.8	5	0.5
3G	WCDMA	850	3.90%	23	199.5	7.8	5	1.4
3G	HSDPA/ HSUPA	850	11.70%	23	199.5	23.3	5	4.3
3G	WCDMA	1900	3.90%	23	199.5	7.8	5	2.1
3G	HSDPA/ HSUPA	1900	11.70%	23	199.5	23.3	5	6.4
4G	LTE B2	1900	5.76%	23	199.5	11.5	5	3.2
4G	LTE B4	1800	5.76%	23	199.5	11.5	5	3.1
4G	LTE B12	700	5.76%	23	199.5	11.5	5	1.9
WLAN	802.11b/g/n	2480	5.18%	22	158.5	8.2	5	2.6
BT	EDR	2480	83.30%	8	6.3	5.3	5	1.7

Note 1: the low transmission duty factor

Note 2: Maximum output power including tune-up/manufacturing tolerances. GPRS and EGPRS values are frame average powers, calculated from the maximum burst average power corrected for source-based duty cycle (for 2-slot use correction = $\frac{1}{4}$).

Note 3: Maximum power adjusted for UBTDF (see note 1) and rounded to closest mW as per KDB 447498 procedures.

Note 4: Minimum test separation distance between enclosure and person is 0mm per KDB 941225 D07 UMPC device test procedures.

Note 5: To exclude the device from SAR testing the threshold value must be less than 3.0.

For this e-reader device, the test separation distance is 0mm therefore 5mm is used in the equation. For each of the technologies the maximum output power (nominal power plus tune-up tolerance), corrected for both source- based duty cycle and UBDTF duty cycle calculated in this document, is used in the equation above to determine if SAR is excluded (value is 3.0 or less) or required (value exceeds 3.0). The table on the following page shows the results – thresholds with a green background meet the exclusion criteria, those in red do not.

SAR testing is required to cover LTE operation in band 2 and band 4; HSDPA/HSUPA operations in both 850MHz and 1900MHz bands. Testing was performed using RMC 12.2kbps uplink to cover all possible WCDMA uplink speeds as this has the highest maximum rated power in both bands.

17. IC SAR Analysis

SAR Exclusion Threshold: RSS102-Issue 5 Section 2.5.1

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in Table 1.

Table 1: SAR evaluation – Exemption limits for routine evaluation based on frequency and separation distance^{4,5}

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

Remark:

1. The exemption limits in Table 1 are based on measurements and simulations of half-wave dipole antennas at separation distances of 5 mm to 25 mm from a flat phantom
2. Output power level shall be the higher of the maximum conducted or equivalent isotropically radiated power (e.i.r.p.) source-based, time-averaged output power.
3. For test separation distance less than 5 mm, the exemption limits for a separation distance of 5 mm can be applied to determine if a routine evaluation is required.
4. For limb-worn devices where the 10 gram value applies, the exemption limits for routine evaluation in Table 1 are multiplied by a factor of 2.5

Band	Tx	Freq. (MHz)	UBTDF Duty Cycle Note 1	Output power			Antenna Gain dBi ^{Note 3}	Antenna Gain Numeric ^{Note 3}	EIRP mW ^{Note 4}	Exempt Level mW
				dBm	mW	mW ^{Note 2}				
2G	GPRS 1TX Slot	850	3.14%	23	199.5	6.27	-4.3	0.4	2.3	17
2G	GPRS 2TX Slot	850	3.14%	23	199.5	6.27	-4.3	0.4	2.3	17
2G	EDGE 8PSK 1TX Slot	850	3.65%	18	63.1	2.30	-4.3	0.4	0.9	17
2G	EDGE 8PSK 2TX Slot	850	3.65%	18	63.1	2.30	-4.3	0.4	0.9	17
2G	GPRS 1TX Slot	1900	3.14%	21	125.9	3.95	2.26	1.7	6.7	7
2G	GPRS 2TX Slot	1900	3.14%	21	125.9	3.95	2.26	1.7	6.7	7
2G	EDGE 8PSK 1TX Slot	1900	3.65%	17	50.1	1.83	2.26	1.7	3.1	7
2G	EDGE 8PSK 2TX Slot	1900	3.65%	17	50.1	1.83	2.26	1.7	3.1	7
3G	WCDMA	850	3.90%	23	199.5	7.78	-4.3	0.4	2.9	17
3G	HSDPA / HSUPA	850	11.70%	23	199.5	23.34	-4.3	0.4	8.7	17
3G	WCDMA	1900	3.90%	23	199.5	7.78	2.26	1.7	13.1	7
3G	HSDPA / HSUPA	1900	11.70%	23	199.5	23.34	2.26	1.7	39.3	7
4G	LTE B2	1900	5.76%	23	199.5	11.49	2.26	1.7	19.3	7
4G	LTE B4	1800	5.76%	23	199.5	11.49	1.98	1.6	18.1	8
4G	LTE B12	700	5.76%	23	199.5	11.49	-1	0.8	9.1	25
WLAN	802.11b/g/n	2480	5.18%	22	158.5	8.21	0.5	1.1	9.2	4
BT	EDR	2480	83.30%	8	6.3	5.26	0.5	1.1	5.9	4

Note 1: UBTDF duty factor calculated in this document.

Note 2: Maximum power adjusted for UBTDF (see note 1) and rounded to closest mW.

Note 3: Peak antenna gain.

Note 4: EIRP=Antenna gain * Maximum power adjusted for UBTDF

18. Conclusion

In conclusion, WCDMA B5/B2, LTE B2/B4, WLAN 2.4 GHz and Bluetooth band are with power levels (i.e. the higher of the conducted or radiated (e.i.r.p.) source-based, time-averaged output power) that is higher than the low power threshold requirements by utilizing Upper Bound Transmission Duty Factor. Therefore, for this wireless mode, SAR testing is required for RF exposure compliance for the e-Reader.