Barnes&Noble Nook eBook Reader

SAR EVALUATION
USING
UPPER BOUND TRANSMISSION DUTY FACTOR (UBTDF)

FOR

MODEL NUMBER: BNRZ100-01

FCC ID: XHHBNRZ100-1
IC: 8961A-BNRZ10001

REPORT NUMBER: 10U13105-4, Revision B

ISSUE DATE: JULY 16, 2010

Prepared for
BARNES AND NOBLE
400 HAMILTON AVENUE
PALO ALTO, CA 94301, U.S.A.

Prepared by
COMPLIANCE CERTIFICATION SERVICES
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

Revision History

Rev.	Issue Date	Revisions	Revised By
---	07/7/10	Initial Issue	M. Heckrotte
A	07/12/10	Corrected Typos	M. Heckrotte
B	07/16/10	Corrected HSDPA Conducted Power	M. Heckrotte

Table of Contents

1. Executive Summary

This document serves to explain Barnes&Noble's analysis supporting a SAR test exclusion for the nook eBook reader. Guidelines from the FCC Jan. 7th document titled "Information requirements for FCC considerations of relevant upper bound transmission duty factors to qualify e-book devices/e-readers for SAR test exclusions' were used as a basis for this SAR test exclusion.

2. Product Overview

This FCC SAR evaluation provides the data needed to present the case for using the 'Upper Bound Transmission Duty Factor (UBTDF for the Barnes&Noble nook eBook reader, M/N BNRZ100-01, Figure 1.

Figure 1 - Barnes&Noble nook eBook Reader

The nook is a hand-held content reader. The primary content are the book and periodical offerings found in the Barnes&Noble eBook catalogue. The nook has a large black and white display for reading and a smaller, color touch screen for navigation.

The nook connects to the Barnes&Noble server wirelessly using WiFi or 3G radio (WiFi and 3G radio will not transmit simultaneously). Content can also be loaded from a PC though a USB connection. The internet access is solely used to connect to the Barnes&Noble catalogue and servers. The nook cannot browse the internet.

3. Wireless Technology

The nook, M/N BNRZ100-01 uses the Sierra Wireless MC8201V wireless modem in a data only mode. For WiFi it uses the M/N PW621-M chipset from Cybertan. The device does not support voice transmission. The wireless interface is only used to send and receive data for the eBook Reader.

4. Radio Protocols

The nook supports the following radio protocols:

1. WiFi
   a. 802.11b
   b. 802.11g
2. GSM
   a. GPRS
   b. EGPRS (EDGE)
3. UMTS WCDMA / HSDPA
   a. FDD Band II
   b. FDD Band V

In addition to RF connectivity the nook has a USB port and can receive content by a wired connection to a computer.

WiFi is always the preferred radio access technology. The nook will connect through its USB port or by WiFi before connecting to the cellular network through any of the RF protocols it supports. If a supported WiFi WLAN is not found, the nook will register and authenticate to the cellular network while continuing to search for WLAN access points at regular intervals. However, in no case will the nook use more than one radio access technology at a time.

As will be shown, for the purposes of the UBTDF analysis HSDPA is the worst case protocol. HSDPA is worse than the other radio protocols because the transmitter can be on continually during the data download process, resulting in a source-based time-averaging duty factor of 100%. Therefore, the testing reported and this document focused on the HSDPA.

In summary, the nook uses USB wired or WiFi as the default means of connection and if the USB and WiFi are not available it will use the cellular network.

5. Network Connection and Data Rates

Data flow is dominated by downloaded publications to the nook. The nook only transmits inquiry information, limited data for searches and ordering, signal quality and packet acknowledgement data.

The nook is capable of communicating using GSM with GPRS or EDGE or with UMTS (WCDMA) with HSDPA. The HSDPA is of particular interest because its protocol requires regular acknowledgements from a device receiving data. In the other modes the receiving device largely has its transmitter off when receiving large data downloads. Hence, HSDPA is the worst case because the nook's transmitter will be on for the highest percentage of time during a transmission when using this mode.

AT&T states its network performance for HSDPA as:

> *HSDPA's …. peak theoretical rate is 14.4 Mbps. AT&T has engineered its network so that most users experience ….downlink throughput rates of 700 kbps to 1.7 Mbps, with bursts over 1 Mbps. …Uplink rates are 500 kbps to 1.2 Mbps.*
>
> *These throughput rates are about five times as high as EDGE and ten times as high as GPRS. (Note that actual user throughputs depend on many factors, including signal quality and network loading.)*
>
> *Current HSDPA devices commonly support peak rates of 3.6 or 7.2 Mbps….*
>
> *When operating on a UMTS network that does not support HSDPA, peak speeds are 384 kbps with ….throughput speeds of 220 to 320 kbps*[1].

Data rates vary, based on network connectivity quality. Table 1 lists the data rates for the RF protocols supported by the nook. For the purposes of this filing HSDPA will be the worst case because the nook transmitter will be on for the largest percentage of time in this mode. In GSM with either GPRS or EDGE the nook's transmitter will be usually off during a download because the device is receiving data, not sending it. The same is true for WCDMA (UMTS) except in HSDPA mode. For the purposes of the calculations in this document a rate of 700 kbps will be used. This is the lower end of the rate AT&T has engineered their network to deliver to users and will result in longer download times than an assumption of a faster rate would. Measurement made on live networks experience a range of data speeds but confirm that 700 kbps is a conservative estimate of the experienced rate, as is reported later in this document. As will be seen in the data reported, 700 kbps is a worst case as it is the lower end of the range AT&T has designed its HSDPA network to deliver.

[1] AT&T developer documentation.

Table 1 – Network Protocol Data Rates (low, high and maximum)

Data Service		Maximum Data Rate	Data Rate (kbps)	
		(kbps)	Low End	High End
GPRS	Uplink		8 (1 slot)	
	Downlink	80	28	60
EDGE	Uplink		8.8 (1 slot)	
	Downlink	237	100	140
UMTS	Uplink		128	
	Downlink	384	220	320
HSDPA	Uplink		N/A	
	Downlink	14,400	700	1700

6. Software Connection Manager

The nook contains a Software Connection Manager which prioritizes the connectivity to be used when downloading content. The user can load content through the USB wired connection. When using a wireless connection the following priorities are used when content is requested:

1. By WiFi, if a WLAN is available.
2. By the cellular network if USB and WiFi are not available.

All wireless radios are powered down as much as possible to save battery life.[2] When a connection is required the connection manager will seek to service the request using the order of priority listed above. In a transaction, using conservative estimates, immediately after completion of the download request the nook disconnects from the network and powers down the active wireless radio.

With the Connection Manager is a Download Manager that manages the download process. If a file size larger than 10 MB is requested the user will be required to use either a wired USB or WiFi connection. The maximum transmission time for a 10 MB download using the HSDPA low-end data rate of 700 kbps is 2 minutes.

[2] The modem may be powered down or placed in a low-power Idle state, in which it is not actively transmitting but maintains its data context with the network. From the idle state each new request does not require registration onto the network, which reduces the transmission and battery power required. The modem may remain powered but inactive while the user has the Store application open, for example. To save battery power the modem will be powered off in the Reader or Library function when there are no active download requests.

7. Intended Use Cases

The nook uses its wireless functionality to allow an end user to:

1. Search for content at Barnes&Noble eBookstore
2. Purchase and download content from eBookstore
3. Synchronize local content library with user's own online library
4. Download device software update

In order to provide a conservative evaluation the combination search and then purchase transaction is selected for in-depth treatment. This combination is consider both the most frequency and worst case use case for the purposes of this analysis.

The nook is a data only device and does not support voice communications.

8. Measured vs Calculated Download Speed

Table 2 presents a representative sample of file sizes used to compare measured and calculated download results for HSDPA. The calculations are based on a 700 kbps data rate which is at the low end of network speeds on the AT&T system.

The measurements were taken on live 3G networks using the Barnes&Noble download server. Each book was downloaded multiple times from several locations. The following table reports both measured and calculated download times. Most of the measurements were determined using the time records in the transmission logs for multiple downloads, which were then averaged. The calculated download times assumed a 700 kbps download speed, which is at the lower end of the range for the AT&T network. In the future higher rates can be expected. Often users will experience rates of up to 1.7 Mbps, which will shorten download times. See Section 5 for a more detailed discussion of both uplink and downlink data rates.

Table 2 - Calculated vs Measured Download Times

Book	File Size (MB)	Measured (Sec)	Calculated (Sec)
Tipping Point	0.25	10.18	2.90
The Heart of a Woman	0.33	10.54	3.80
Feeling Strong	0.48	11.12	5.59
Britannia in Brief	0.61	10.76	7.17
Dracula	0.64	11.97	7.49
Pride and Prejudice	0.65	11.05	7.60
Little Women	0.98	14.51	11.48
Miracle Ball	1.32	19.36	15.40
Allergies	4.05	49.03	47.39

The impact of authentication and protocol overhead can be seen in the longer times measured for the smaller books versus those calculated. The data is graphed in Figure 2, which presents the download time, calculated and measured vs book size. The scales in Figure 2 are linear. The overhead of the setup and tear down is also seen in a relatively constant offset between the measured times and the calculated times. This is because, beyond the time required to download a book there is a fixed setup and tear down time. However, for the larger books the measured transmission times are consistent with the calculated values.

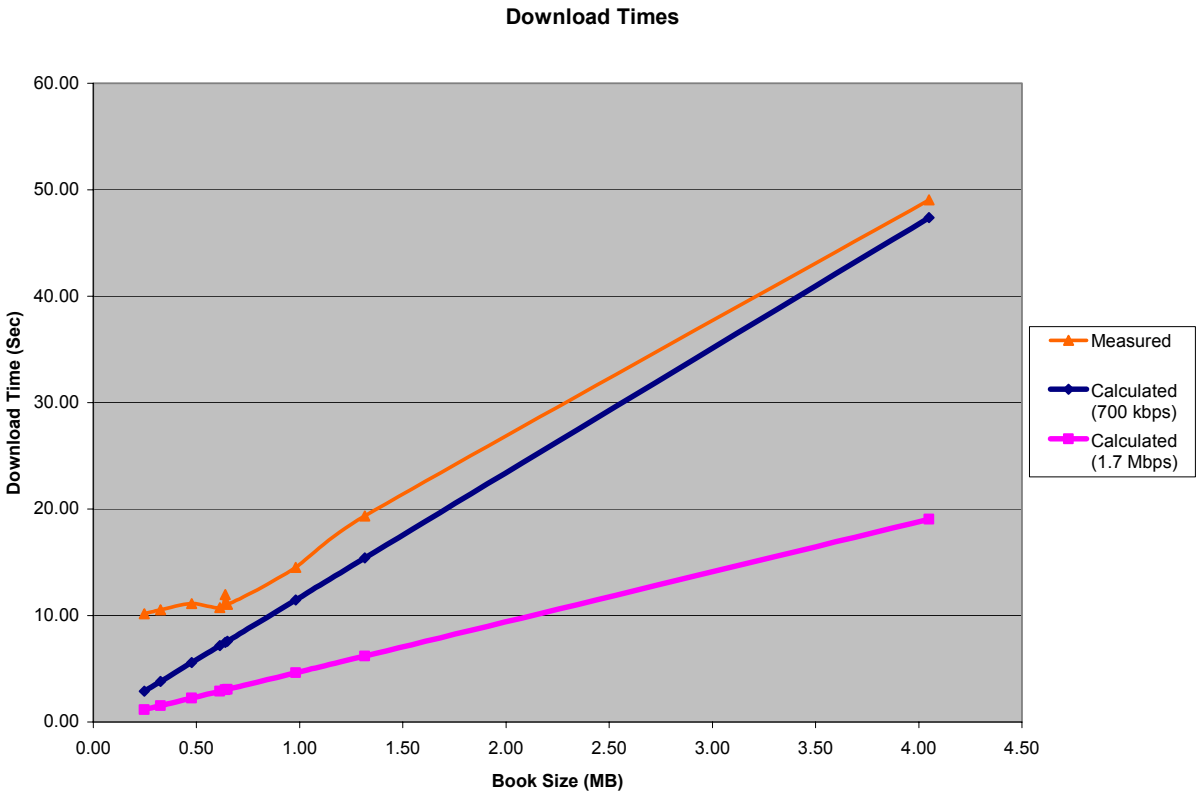

Figure 2 - Calculated vs Measured Download times

The data in Table 2 and Figure 2 was obtained from the transmission log files on the nook. To confirm this data scope photos were taken, monitoring the power amplifier on the device, Figure 4.

Measurement of file downloads support the AT&T representation that 700 kbps is on the low end of the range for downlink speed. The average downlink speed appears to be close to 1 Mbps.

9. HSDPA Data Calculations for Upper Bound Transmission Duty Factor (UBTDF)

This section presents an 8 step process to present data and calculations used in determining the Upper Bound Transmission Duty Factor (UBTDF).

9.1 Publication Categories

A study was conducted of the Barnes&Noble.com file and download sizes for its books and periodicals. Data was gathered from Barnes&Noble's database of electronic book orders and downloads using the following categories:

- eBooks
- Newspapers
- Magazines

Barnes&Noble does not offer web publications and so blogs and RSS feeds are not offered for the nook. Therefore such category of web publications is not applicable for this product.

The data was then analyzed for percentage of orders by publication file size and is presented in Table 3.[3] The data presented in Table 3 is expected to be representative of future trends during product life cycle.

[3] The data presented was gathered using actual eBook sales by Barnes&Noble.com over the last 6 months.

9.2 8 Step UBTDF Calculation

Step 1: File Size Categories, Transmission Durations and Publication Distributions

Step 1.1 – Define 5 file size categories (shown in Column A of Table 3)

Step 1.2 – Calculate the transmission durations for the maximum file size in each category (700 kbps is used for these calculations).

Column B of Table 3, transmission duration is calculated using 700 kbps, the slower speed expected for an HSDPA download. The equation is:

Transmission Duration =

(Maximum File Size (MB)) / (700 kbps Transmission Speed) * 1024 Kbytes/MB * 8 bits/byte

Step 1.3 – List the distribution percentages by file size category for each type of publication (Columns C, D, & E).

Table 3 –Distribution by File Size

A	B	C	D	E
File Size (MB)	**Upper Bound Transmission Duration (Sec)**	**eBook Distribution (%)**	**Newspapers Distribution (%)**	**Magazines Distribution (%)**
< 0.5	**5.9**	**42.7%**	**12.5%**	**28.6%**
0.5 - 1	**11.7**	**32.9%**	**4.2%**	**42.9%**
1 - 2	**23.4**	**17.8%**	**45.8%**	**28.5%**
2 - 5	**58.5**	**6.0%**	**37.5%**	**0.0%**
5 - 10	**117.0**	**0.6%**	**0.0%**	**0.0%**

Step 2: Publication Type Download Durations for Each File Size Category

In step 2 the download durations are calculated for each publication category and file size.

Step 2.1 – Add a 2nd column for each publication category to calculate total download durations for each publication type (shown in Columns D, F, H of Table 4**)**

Step 2.2 – Calculate the download durations for each publication type category for every file size (shown in Columns D, F, H of Table 4**)**

Column D Calculation (Table 4):

(UBTD (Column B) * Distribution % (Column C) = Weighted Duration (Column D)

Table 4 –Distribution by File Size

A	B	C	D	E	F	G	H
File Size (MB)	Upper Bound Transmission Duration (Sec)	eBook Distribution (%)	Weighted Duration (Sec)	Newspapers Distribution (%)	Weighted Duration (Sec	Magazines Distribution (%)	Magazines Distribution (%)
< 0.5	5.9	42.7%	2.5	12.5%	0.7	28.6%	1.7
0.5 - 1	11.7	32.9%	3.9	4.2%	0.5	42.9%	5.0
1 - 2	23.4	17.8%	4.2	45.8%	10.7	28.5%	6.7
2 - 5	58.5	6.0%	3.5	37.5%	21.9	0.0%	0.0
5 - 10	117.0	0.6%	0.7	0.0%	0.0	0.0%	0.0
		Totals →	14.7		33.9		13.4

Step 3: System Publication Distribution Forecast

The frequency of downloads is different for different publication categories. The UBTDF needs to be weighted by the anticipated frequency of downloads. Table 5 presents the distribution of downloads over the three categories of publications.

Step 3.1 – Based on experience to date the distribution of downloads by publication category is presented in Table 5.

Step 3.2 – The distributions of downloads is reviewed against current experience with Barnes&Noble installed base.

Step 3.3 – Table 5 presents the distribution based on actual experience.

Table 5 –Distribution of Downloads by Type of Publication

A	B
Publication Category	**Percentage of Total Downloads (%)**
eBooks:	**89.6**
Newspapers:	**8.6**
Magazines:	**1.8**

Step 4: Weighted Composite Download Time by Publication Type, with Total for all File Sizes and Publication Types

Step 4.1 – List the cumulative totals for each publication type calculated in Table 4 and place them in Column B of Table 6.

Step 4.2 – Record the distribution of publications from Column B of Table 5 in Column C of Table 6.

Step 4.3 – Calculate the weighted composite download time by publication category by multiplying Column B by Column C in Table 6 and record the result in Column D of Table 6.

Weighted Composite Download Time Calculation (Column D of Table 6)

Weighted Time by File Size (Column B) * Download Distribution % (Column C)

= Weighted Composite Download Time (Column D)

Table 6 –Weighted Composite Download Time by Type of Publication and Total for all File Sizes

A	B	C	D
Publication Category	**Weighted Time by File Size (Sec)**	**Percentage of Total Downloads (%)**	**Weighted Composite Download Time (Sec)**
eBooks:	**14.7**	**89.6**	**13.2**
Newspapers:	**33.9**	**8.6**	**2.9**
Magazines:	**13.4**	**1.8**	**0.3**
Weighted Composite Download Time ⟶			**16.3**

Summary: The weighted composite download time for all file sizes and publication types = 16.3 seconds, which is used in Table 7, Step 5, Column D below.

Step 5: Event Process Durations and UBTDF Duty Factor

Detailed steps for conservative user scenario of power-up, browse, purchase and download content include:

1. Power up device
2. Open store application
3. Select category to browse/search
4. Review search results
5. Repeat steps 3&4
6. Select item for purchase
7. Purchase transaction
8. Download content
9. Complete transaction – power down modem

User Interactions

Device and network controlled aspects of the search and download process can be measured reliably because these are automated processes. The user interactions are more difficult to determine because they are dependent on individual users and their specific situation when negotiating a transaction. The amount of time a user takes to review search results, the number of iterations required before an item is selected and the decision making speed in selecting a publication are highly variable. In addition to this variability the service time to deliver search results will depend on network loading both at the store server and also on the cellular network, particularly at the cell tower being used. The durations selected have been chosen to maintain conservativeness in these calculations. At the end of a transaction cycle an indefinitely long delay occurs. This will often extend to hours or even days. This is particularly true for users that normally have WiFi available or connect through the USB port. For these users connection over the cellular network may be rare. No allowance is made for the duration between transactions because of its high variability.

Table 7 lists the events with their duration and transmitter on-time. At the end of the table the UBTDF is calculated.

Step 5.1 – List the steps required for the total transaction (Column B of Table 7).
Step 5.2 – List conservative event duration time (Column C of Table 7).
Step 5.3 – List the transmitter on-time for each event (Column D of Table 7).
Step 5.4 – For Event 8, Download Content, insert the weighted composite download time from the bottom of Column D of Table 6 (Step 8 Column D of Table 7).
Step 5.5 – For Step 8, Download Content, add 8 seconds to the weighted composite download time for the PDP content to end (Step 8 Column C of Table 7).
Step 5.6 – Sum the event durations to get the total transaction duration (Bottom of Column C of Table 7).
Step 5.7 – Sum the transmitter on-time durations to get the total transmitter on-time for the transaction (Bottom of Column D of Table 7).
Step 5.8 – Calculate the UBTDF (Bottom of Column D of Table 7).

UBTDF Calculation (Column D Table 7):

Total transmitter on-time (Total of Column D) / Total Event Duration (Total of Column C)

= UBTDF (Bottom of Column D)

Table 7 –HSDPA Event Process Duration and UBTDF Duty Factor

A	B	C	D
#	Event	Event Duration (Sec)	Transmitter On-Time (Sec)
1	Power up & register on network	17.0	5.2
2	*Launch store application**	20.0	0.0
3	Search for content	30.0	12.5
4	*Review search results**	150.0	0.0
5	*New search and review results**	90.0	7.2
6	*Select an item for purchase**	30.0	4.2
8	*Purchase Transaction**	20.0	10.1
8	Download content**	24.3	16.3
9	Purchase completed (Modem off)	15.0	0.0
	Totals →	396.3	55.5
	UBTDF →		14.0%

**Requires user interaction*

***Includes 8 second for PDP content to end*

Summary: UBTDF for HSDPA = 14.0%.

Step 6: HSDPA Maximum RF Power

Step 6.1 – The maximum RF power measured during certification testing is reported in Table 8.

Table 8 – Maximum RF Conducted RF power for HSDPA mode

HSDPA			
Mode	**Channel**	**Subtest**	**Power (dBm)**
FDD II HSDPA	**9262**	**1**	**22.33**
		2	**22.32**
		3	**22.05**
		4	**21.84**
	9400	**1**	**22.3**
		2	**22.12**
		3	**21.9**
		4	**22.12**
	9538	**1**	**22.51**
		2	**22.35**
		3	**22.12**
		4	**22.76**
FDD V HSDPA	**4132**	**1**	**23.00**
		2	**23.25**
		3	**22.85**
		4	**22.72**
	4180	**1**	**22.22**
		2	**22.18**
		3	**22.20**
		4	**21.87**
	4230	**1**	**22.45**
		2	**22.33**
		3	**22.35**
		4	**22.04**

Summary: The maximum average output power for HSDPA Band V is 23.25 dBm and was found on 826.4 MHz (channel 4132).

The maximum average output power for HSDPA Band II is 22.76 dBm and was found on 1907.6 MHz (channel 9538).

Step 7: RF Exposure Average Power

Step 7.1 –Apply the UBTDF value from Table 7 Column D, expressed in dB, to the RF average power from Table 8 to determine the adjusted average power (Column C of Table 9).

Step 7.2 – Calculate the RF low power threshold using the 60/f (GHz) equation (Column C of Table 10).

UBTDF Adjusted RF Power Calculation (Column C Table 9):

Average Output Power (dBm) - UBTDF (dB)

= UBTDF Adjusted Average Power (Column C)

Table 9 – Resulting Adjusted Maximum RF Average Power

A	B	C
Category	**UBTDF Power (dBm)**	**Adjusted Average Power (mW)**
HSDPA Band V	**23.25 dBm – 8.53 dB = 14.72 dBm**	**29.6 mW**
HSDPA Band II	**22.76 dBm – 8.53 dB = 14.23 dBm**	**26.5 mW**

Table 10 – RF Low Power Threshold Requirements (60/*f*)

A	B	C
Category	**60/f (mW)**	**Low Power Threshold (mW)**
HSDPA Band V	**60/0.8365 mW**	**71.73 mW**
HSDPA Band II	**60/1.8825 mW**	**31.87 mW**

Step 8: HSDPA UBTDF Calculation Summary

Summary: Since both HSDPA Band II and Band V adjusted average power (Column C Table 9) are less than the low power threshold values (Column C Table 10) this device qualifies for SAR test exclusion.

10. HSDPA Transaction Plots

10.1 Modem/Radio power-up and network registration

Figure 3 shows the power-up and network registration sequence in HSDPA mode.

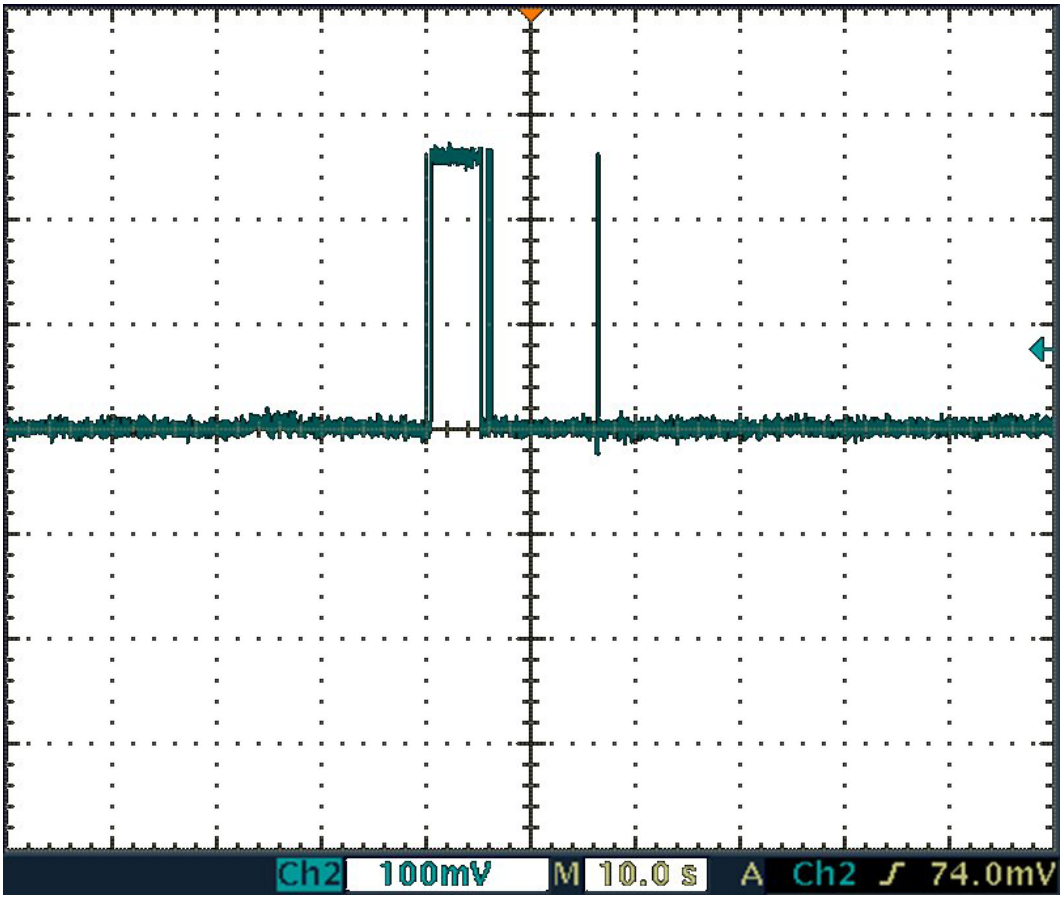

Figure 3 - Power-up and network registration

The total transaction takes ~17 sec. and the transmitter on time is ~5.2 sec.

10.2 HSDPA Content Downloads

Figure 4 presents a live network download of a 1 MB file using HSDPA.

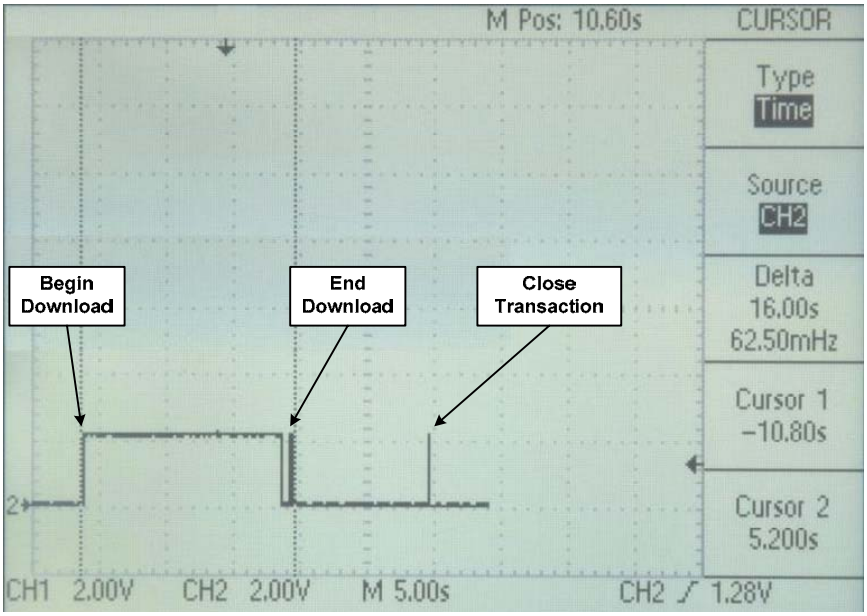

Figure 4 - Nook transmission time for a 0.98 MB file download

The plot shows the file download, a pause before the final acknowledgement and then an 8 second pause while the PDP content to ends, before the final conclusion of the sequence with the network. The 8 second pause while the PDP content ends is used in step 5.5 as part of the calculation. The duration of the download is only an example. The duration will change based on file size, as shown in Section 5, by measurement and calculation.

11. Summary

This document presents the analysis supporting an exclusion from SAR testing for routine evaluation of RF exposure compliance. The analysis addresses the most conservative scenarios and a positive control mechanism is implemented to assure that no files over 10 MB will be downloaded using HSDPA.

There are a number of reasons why the nook will have low levels of transmitter on-time. Some of these are:

1. The modem is powered down to save battery, when not in use.
2. When using a wireless connection the nook gives priority to its WiFi connection and will only connect to the cellular network if WiFi not available.
3. The nook does not support voice communication.
4. The majority of downloads are under 1 MB.
5. The most conservative usage scenario is to download a single item and then start to read it.

Conclusion: The Upper Bound Transmission Duty Factor (UBTDF) calculation has shown that the nook meets the 60/*f (GHz)*.

12. Annex – GSM (GPRS/EDGE)

GPRS and EDGE protocols have inherently low transmission duty cycles. As will be demonstrated in this annex, operation in this mode will always be under the low power threshold.

The transaction sequence for either GPRS or EDGE is very similar that listed in Table 7, however protocol differences vary the transmitter on-time.

Table 11 and Table 12 specify the values for GPRS and EDGE.

The download speed is calculated assuming 4 downlink slots at 20 kbps/slot, 1 uplink slot at 8 kbps and a 50% derating for network and protocol overhead. The formula for download time is then:

Download Duration (s) =

File Size (bits) / {(number of slots) * (rate/slot) * (1-derating factor)}

GPRS Example:

$$\frac{0.5\ MB * 8\ \frac{bits}{byte} * 1024\ \frac{Kbytes}{MB}}{4\ slots * 20\ \frac{kbps}{slot} * (1 - 0.5)} = 102.4\ \text{seconds}$$

EDGE Example:

$$\frac{0.5\ MB * 8\ \frac{bits}{byte} * 1024\ \frac{Kbytes}{MB}}{4\ slots * 59.25\ \frac{kbps}{slot} * (1 - 0.5)} = 34.6\ \text{seconds}$$

With GSM the UBTDF is maximized when the download time is minimized. A 0.5 MB file size is used in the calculations as a conservative estimate based on the download distribution data presented in Table 3.

Table 11 – GPRS Event Process Duration and UBTDF Duty Factor

A	B	C	D
Step	**Event**	**Event Duration (Sec)**	**Transmitter On-Time (Sec)**
1	Power up & register on network	17.0	6.5
2	*Launch store application**	20.0	0.0
3	Search for content	30.0	15.6
4	*Review search results**	150.0	0.0
5	*New search and review results**	90.0	9.0
6	*Select an item for purchase**	30.0	5.3
8	*Purchase Transaction**	20.0	0.0
8	Download content	102.4	0.0
9	Purchase completed (Modem off)	15.0	0.0
	Totals →	474.4	36.4
	UBTDF →		7.7%

**Requires user interaction*

Table 12 – EDGE Event Process Duration and UBTDF Duty Factor

A	B	C	D
Step	**Event**	**Event Duration (Sec)**	**Transmitter On-Time (Sec)**
1	Power up & register on network	17.0	6.5
2	*Launch store application**	20.0	0.0
3	Search for content	30.0	15.6
4	*Review search results**	150.0	0.0
5	*New search and review results**	90.0	9.0
6	*Select an item for purchase**	30.0	5.3
8	*Purchase Transaction**	20.0	0.0
8	Download content	34.6	0.0
9	Purchase completed (Modem off)	15.0	0.0
	Totals →	406.6	36.4
	UBTDF →		8.9%

**Requires user interaction*

The conducted RF power measured for the nook is listed in Table 13 and the source-based time average power is listed in Table 14.

Table 13 – GPRS & EDGE Maximum Conducted Burst RF Power

RF Conducted Burst Power Measurements						
Band	**GSM 850 (dBm)**			**GSM 1900 (dBm)**		
Channel	**128**	**190**	**251**	**512**	**661**	**810**
GPRS/Class 8	**32.15**	**32.15**	**32.05**	**28.39**	**28.68**	**28.76**
GPRS/Class 10	**31.95**	**31.91**	**31.80**	**28.22**	**28.51**	**28.61**
EDGE/Class 8	**27.26**	**27.21**	**27.30**	**25.45**	**25.50**	**25.70**
EDGE/Class 10	**27.18**	**27.15**	**27.17**	**25.40**	**25.28**	**25.60**

Table 14 – Source-Based Time Average Power

Source-Based Time Averaging						
Band	**GSM 850 / Average / dBm**			**GSM 1900 / Average / dBm**		
Channel	**128**	**189**	**251**	**512**	**661**	**810**
GPRS 8/12.5%	**23.12**	**23.12**	**23.02**	**19.36**	**19.65**	**19.73**
GPRS 10/25%	**25.93**	**25.89**	**25.78**	**22.20**	**22.49**	**22.59**
EDGE 8/12.5%	**18.23**	**18.18**	**18.27**	**16.42**	**16.47**	**16.67**
EDGE 10/25%	**21.16**	**21.13**	**21.15**	**19.38**	**19.26**	**19.58**

Table 15 calculates the UBTDF adjusted RF power. Table 16 calculates the applicable 60/*f* threshold. Comparing the UBTDF adjusted RF power to the 60/*f* low power threshold shows that this device is below the threshold in this band and qualified for SAR testing exclusion.

Table 15 – Resulting RF Exposure Average Power

A	B	C
Category	**UBTDF Power (dBm)**	**Adjusted Average Power (mW)**
GPRS – 850	**25.93 dBm – 11.15 dB = 14.78dBm**	**30.1mW**
GPRS – 1900	**22.59 dBm – 11.15 dB = 11.44 dBm**	**13.9 mW**
EDGE – 850	**21.16 dBm – 10.48 dB = 10.68 dBm**	**11.7 mW**
EDGE – 1900	**19.58 dBm – 10.48 dB = 9.10 dBm**	**8.1 mW**

Table 16 – RF Low Power Threshold Requirements (60/*f*)

A	B	C
Category	**60/f (mW)**	**Low Power Threshold (mW)**
GPRS – 850	**60/0.8365 mW**	**71.73 mW**
GPRS – 1900	**60/1.8825 mW**	**31.87 mW**
EDGE – 850	**60/0.8365 mW**	**71.73 mW**
EDGE - 1900	**60/1.8825 mW**	**31.87 mW**

13. Annex – WCDMA (UMTS)

The evaluation for WCDMA (UMTS) (not using HSDPA) is presented in this section.

As with GPRS and EDGE, the transaction sequence is very similar that for HSDPA, however protocol differences vary the transmitter on-time. Table 17 specifies the values for WCDMA.

As provided in Table 1 the maximum download speed is 384 kbps. Allowing a 50% derating factor for network and protocol overhead, the formula for download time is then:

Download Duration (s) =

File Size (bits) / {(384 kbps) * (.50)}

UMTS Example:

$$\frac{0.5\ MB * 8\ \frac{bits}{byte} * 1024\ \frac{Kbytes}{MB}}{384\ kbps * (1 - 0.5)} = 21.3\ \text{sec}onds$$

With WCDMA (not using HSDPA) the UBTDF is maximized when the download time is minimized. A 0.5 MB file size is used in the calculations as a conservative estimate based on the download distribution data presented in Table 3.

Table 17 – Total Transaction and Transmitter On Time

A	B	C	D
Step	**Event**	**Event Duration (Sec)**	**Transmitter On-Time (Sec)**
1	**Power up & register on network**	17.0	4.7
2	***Launch store application****	20.0	0.0
3	**Search for content**	30.0	11.3
4	***Review search results****	150.0	0.0
5	***New search and review results****	90.0	6.5
6	***Select an item for purchase****	30.0	3.8
8	***Purchase Transaction****	20.0	0.0
8	**Download content**	21.3	0.0
9	**Purchase completed (Modem off)**	15.0	0.0
		Totals → 393.3	26.2
		UBTDF →	6.7%

****Requires user interaction***

The conducted RF power is presented in Table 18.

Table 18 – Conducted RF power in UMTS mode

UMTS		
Mode	**Channel**	**Power (dBm)**
UMTS FDD Band II	**9262**	**22.40**
	9400	**22.19**
	9538	**22.56**
UMTS FDD Band V	**4132**	**23.04**
	4180	**22.75**
	4230	**22.96**

Table 19 calculates the UBTDF adjusted RF power. Table 20 calculates the applicable 60/*f* threshold. Comparing the UBTDF adjusted RF power to the 60/*f* low power threshold shows that this device is below the threshold in this band and qualified for SAR testing exclusion.

Table 19 – Resulting RF Exposure Average Power

A	B	C
Category	**UBTDF Power (dBm)**	**Adjusted Average Power (mW)**
UMTS Band V	**23.04 dBm – 11.77 dB = 11.34 dBm**	**13.6 mW**
UMTS Band II	**22.56 dBm – 11.77 dB = 10.79 dBm**	**12.0 mW**

Table 20 – RF Low Power Threshold Requirements (60/*f*)

A	B	C
Category	**60/f (mW)**	**Low Power Threshold (mW)**
UMTS Band V	**60/0.8365 mW**	**71.73 mW**
UMTS Band II	**60/1.8825 mW**	**31.87 mW**

14. Annex - WiFi

The evaluation for WiFi is presented in this section.

As with GPRS, EDGE and WCDMA, the transaction sequence is very similar to that HSDPA, however protocol differences vary the transmitter on-time.

With WiFi the UBTDF is maximized when the download time is minimized. A 1.0 MB file size is used in the calculations shown in Table 21 as a conservative estimate based on the download distribution data presented in Table 3.

The download time for a 1 MB file is calculated as:

Download Duration (s) =

File Size (bits) / 2 Mbps

WiFi (Slower – 2 Mbs) Example:

$$\frac{1.0\ MB * 8\ \frac{bits}{byte} * 1024\ \frac{Kbytes}{MB}}{2000\ kbps} = 4.1\ \text{sec}onds$$

WiFi (Faster – 11 Mbs) Example:

$$\frac{1.0\ MB * 8\ \frac{bits}{byte} * 1024\ \frac{Kbytes}{MB}}{11000\ kbps} = 0.7\ \text{sec}onds$$

The slower data rate for older 802.11 is used because this results in a conservative estimate of the transaction time. During this period the nook will acknowledge packets but for this purpose it is assumed to be continually transmitting.

Table 21 – Total Transaction and Transmitter On Time

A	B	C	D
Step	**Event**	**Event Duration (Sec)**	**Transmitter On-Time (Sec)**
1	**Power up & register on network**	**35.0**	**4.6**
2	***Launch store application****	**20.0**	**0.0**
3	**Search for content**	**20.0**	**3.5**
4	***Review search results****	**150.0**	**0.0**
5	***New search and review results****	**90.0**	**4.0**
6	***Select an item for purchase****	**20.0**	**3.5**
8	***Purchase Transaction****	**20.0**	**2.5**
8	**Download content**	**4.1**	**4.1**
9	**Purchase completed (Modem off)**	**5.0**	**0.0**
	Totals →	**364.1**	**22.2**
		UBTDF →	**6.1%**

****Requires user interaction***

The conducted RF power is presented in Table 22.

Table 22 – Maximum Conducted RF power for WiFi

Mode	Channel	Frequency (MHz)	RF Conducted Power (dBm)
802.11b	1	2412	15.13
	6	2437	15.18
	11	2462	15.46
802.11g	1	2412	13.27
	6	2437	13.46
	11	2462	13.62

The UBTDF calculation is in Table 21. With WiFi the nook's transmitter will be largely off during a download, the nook will only send short acknowledgement transmissions (ACKs) that a WLAN client sends back to the access point during a download, and therefore the UBTDF will never exceed the value calculated for WCDMA/HSDPA mode.

Table 23 calculates the UBTDF adjusted RF power. Table 24 calculates the applicable 60/*f* threshold. Comparing the UBTDF adjusted RF power to the 60/*f* low power threshold shows that this device is below the threshold in this band and qualified for SAR testing exclusion.

Table 23 – Resulting RF Exposure Average Power

A	B	C
Category	UBTDF Power (dBm)	Adjusted Average Power (mW)
WiFi	15.46 dBm – 12.15 dB = 3.31 dBm	2.1 mW

Table 24 – RF Low Power Threshold Requirements (60/*f*)

A	B	C
Category	60/f (mW)	Low Power Threshold (mW)
WiFi	60/2.4418 mW	24.57 mW