Plastic Logic
QUE™ proReader

SAR Evaluation
Using
Upper Bound Transmission Duty Factor (UBTDF)

Revision 1.8 – Feb 25th 2010

FCC ID: WXP-PLR002

Description:	Plastic Logic QUE™ proReader
Model Name:	QUE™ proReader
Model Number:	PLR002

Plastic Logic
650 Castro St. Ste 500
Mt. View, CA. 94041

Submitted by
Plastic Logic

1. Table of Contents

2. Executive Summary

This document serves to explain our analysis to qualify the Plastic Logic QUE proReader for SAR test exclusion. Guidelines from the FCC Jan. 7th document titled 'Information requirements for FCC considerations of relevant upper bound transmission duty factors to qualify e-book' were used as a basis for this SAR test exclusion.

3. Product Overview

Figure 1 - Plastic Logic's QUE proReader

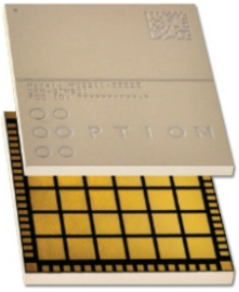
This FCC SAR evaluation provides the data needed to present the case for using the 'Upper Bound Transmission Duty Factor (UBTDF) for the Plastic Logic QUE™ proReader. (Figure 1)

QUE™ is a hand-held content reader aimed at the high-end mobile professional. The content will include work documents (MS Word, Excel, PowerPoint, PDF, etc.) e-books, web publications, (i.e., blogs which are received as static documents) newspapers and magazines. It is approximately 8.5" x 11" x .3" in size, similar to an 8.5x11 notepad, and weighs roughly 1 lb. The device has a large touch screen on the front of the device which is used to navigate the User Interface and the content. The Black & White reflective display has 8 levels of grayscale.

QUE™ connects wirelessly to the Internet via WLAN or 3G (WLAN and 3G radio will not transmit simultaneously) to allow access to the content users need. This Internet access is used solely for the download of content, no Internet browsing is supported on the QUE™. QUE™ will be sold online and in selected retail stores.

4. Wireless Technology

QUE™ proReader uses the GTM501 3G wireless module manufactured by Option. The module is used in data only mode and has all voice functionality disabled. The wireless interface supports 2G (GPRS/EDGE), UMTS, WCDMA and HSDPA modes, with theoretical transfer speeds of up to 7.2Mbps in HSDPA mode. The module is used only to send and receive data. The GTM501 is an LGA package with multimode support to allow high speed access over 3G networks but is also backwards compatible with 2G networks.



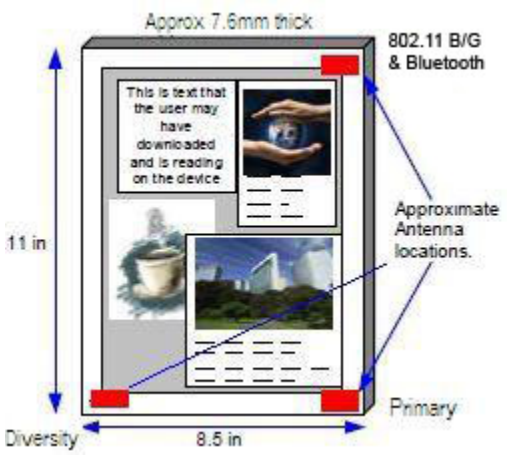
5. Radio Protocols

The device includes multiple transmitters, 3G, Bluetooth & WLAN (802.11B/G in 2.4GHz ISM band), however there are no RF exposure collocation issues. The transmit antennas are spaced greater than 20cm apart and simultaneous transmission is prevented in software.

The QUE™ provides the following RF protocols:

1. GSM (Compliant to Part 22E & 24H)
    a. GPRS (Class 10, Class 12)
    b. EGPRS/EDGE (Class 10, Class12)
2. UMTS, WCDMA /HSDPA
    a. FDD Band II
    b. FDD Band V
3. WLAN
    a. 802.11b (18.2dBm)
    b. 802.11g (21.3dBm)
4. Bluetooth v2.0 (3.74dBm)

Figure 2 - Antenna Locations



WLAN is always the default and preferred wireless method of connecting to the Internet. Once a request for content has been received, the device will always check for a wired USB connection to a computer first, if that is not available it will look for an available WLAN access point first – if no USB or WLAN connections are found, the device will then initiate a 3G data connection. The QUE™ software only allows one RF connection at a time.

The Bluetooth radio is designed to receive content only from Blackberry phones (no other phones are supported) to the QUE so end users can view it on their QUE proReader. The Bluetooth implementation for QUE is as a slave device only and does not serve any other function.

HSDPA is the worst case protocol for the purposes of the proposed UBTDF approach by comparing to GPRS/EDGE and WLAN, and because the HSDPA is continually transmitting during the data download process. This 'always-transmitting' mode is due in part to the use of HARQ, or 'Hybrid Automatic Repeat Request' and results in a source-based time averaging duty factor of 100%.

6. Network Connection and Data Rates

The QUE™ proReader will operate on the ATT 3G Network in the USA and Puerto Rico and will have no international roaming support. This SAR analysis is based on using this specific ATT network configuration.

Real data rates while on the network are dependent on many factors such as proximity to cell tower, number of simultaneous users in a cell site, etc., and will vary considerably. Calculations in this document are based on a download data rate of 700kbps which is documented by ATT to be on the low-end of their real-world usage on a live 3G network as referenced by this paragraph taken from the ATT website on Feb 25th, 2010: '*HSDPA is the highest-performance cellular-data technology ever deployed. Its peak theoretical rate in 14.4 Mbps. AT&T has engineered its network so that most users experience typical downlink throughput rates of 700 kbps to 1.7 Mbps, with bursts over 1 Mbps. Typical uplink rates are 500 kbps to 1.2 Mbps'*. (Note that initial real-world testing is showing consistently higher data rates.) This 700kbps data rate is the rate available to our application, not the over-the-air data rate and accounts for network and protocol overhead. We use this low-end data rate of 700kbps through-out this document to ensure that we are always stressing the upper bound limitations critical for a conservative SAR evaluation.

Table 1: Network Protocol Data Rates (Low, High & Real-world)

Data Protocol	Uplink**	Downlink		
	Low-End Data Rate (kbps)	Low-End Data Rate (kbps)	High-End Data Rate (kbps)	Real-world Data Rates (kbps)
GPRS	14	28	80	40-60
EDGE	60	100	237	100-140
UMTS/WCDMA	128	220	384	220-320
HSDPA	NA	**700***	7200	700-1700

** 700kbps is used for HSDPA calculations in this document to ensure Upper Bound limitations are being stressed (and takes into account network overhead)*

*** Note that QUE is primarily a downlink focused device - the only uplink information will be packet acknowledgements during network connections.*

7. Software Connection Manager

The device contains a Software Connection Manager which has a pre-defined algorithm to prioritize how the content will be downloaded to the device as listed here:

1. Via USB cable from a paired computer
2. Via WLAN if within range of an access point
3. Via 3G if within range of the 3G network (reverts to 2G if needed)

All of the wireless radios will be powered down as their default state. Once a request has been received to download content – either from a pre-determined scheduled delivery (for to newspapers, magazines and web publications) or by the user's request via the user interface, the Connection Mgr will run through the above listed process to establish a connection and download the content. Immediately after completing the download the radio disconnects from the network and powers down the active radio.

The QUE Connection Manager software, in conjunction with the online store, will determine the size of any file to be downloaded before the download starts. If the file size is larger than 10MB, the user will be required to use either a WLAN or wired USB connection for the download and will not be permitted to download the file using a HSDPA connection. The maximum transmission time for a 10MB download using the HSDPA low-end data rate of 700kbps is 2 minutes.

8. Intended Use Cases

QUE™ proReader allows the user to connect wirelessly to a network (3G or WLAN) to do one or more of the following:

1. Search for content on the QUE™ store using a dedicated on-device application. (This on-device store application is not a browser – when a browse/search session is initiated, it gets the text, icons, data from the on-line store server and presents the data in the application view)
2. From the device: browse the store (#1 above), purchase and download content. Select a piece of content to buy from the store, go through the purchase process and have that purchased content downloaded to the device for reading.
3. Synchronize/Download content purchased from a paired computer and/or a scheduled download. The QUE user can purchase content from a PC and then pair the computer with the QUE to download the purchased content to the device via USB cable using the QUE desktop software. The purchased content can also be scheduled to be downloaded at pre-determined times.
4. From the device, manually check for newly purchased content (either from the device or from a PC) for download. If there is content available the content is downloaded using the preferred wireless connection as defined in the Connection Manager section above.

The device does not have any Internet browsing capabilities. (Note that we support the downloading of blog pages from the Internet, but these are translated into ePub format before downloading them as static documents onto the QUE. This is no different than downloading a PDF document)

9. Data Transaction Durations and Frequency

Table 2 below reflects a representative sample of minimum, average and maximum file sizes used to generate both real-world and calculated conservative download results for HSDPA. The calculated times are based on a 700kbps data rate which is at the low end of real-world expectations for the Option 501 module running on the ATT network.

The measurements below were taken on a live 3G network using an external FTP server. Each result is generated using an automated script that logs transmission times and is the average of 5 downloads for each sample.

Table 2: Calculated Vs. Measured Download Times

Content	Category	File Size (in KBs)	Calculated* (700kbps)	Measured** (in Sec)
Forbes Investors Guide	Magazine	555	6.34	5.80
Anna Karenina	Book	723	8.26	9.20
The Count of Monte Cristo	Book	999	11.42	11.40
Test File	Test	1,666	19.04	16.42
Test File	Test	5,120	58.51	51.20
Test File	Test	10,240	117.03	100.80

* *Calculated times are derived by dividing the File Size column by 700kbps which will reflect upper bound transmission times and accounts for normal network overhead.*

** *Measured times derived by taking the average duration of 5 real-world downloads performed in the Plastic Logic labs.*

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

This section goes through an 8 step process to present the data and calculations used in determining our Upper Bound Transmission Duty Factor.

Publication Categories

Plastic Logic will use the Barnes & Noble store to provide on-line content to the QUE. QUE content falls into four major content categories:

- eBooks
- Newspapers
- Magazines
- Web Publications

We have detailed data on eBook download file sizes from our store partner which is representative of what will be sent the QUE and reflected in the eBook column C of Table 3. All other content categories reflect the latest information culled from our research over the last 6 months and represent our best estimates at this time. (Since this is our first release of our QUE product and it's not on the market yet, we don't have real, hard data for these categories) This data reflects conservative or upper bounds limits for download file sizes.

Step 1: File Size Categories, Upper Bounds Transmission Durations and Publication Type Distribution Percentages

1.1 Define 5 different categories for file sizes as shown in Column A of Table 3

1.2 We use 700kbps as the upper bound data rate to calculate transmission durations for each file size category. (using max size for each category)

Column B Calculation (Table 3):

$$\frac{Max\ file\ size\ of\ category\ X}{Upper\ Bound\ data\ rate} = Upper\ bound\ Transmission\ duration$$

$$Example\ for\ 1-2MB\text{:}\ \frac{2MBytes * \frac{1024Kbytes}{Mbyte} * \frac{8bits}{byte}}{700Kbps} = 23.41\ seconds$$

1.3 Distribution percentage's by file size for each publication type category (columns C, D, E & F)

1.4 Percentage in column's C, D, E & F were generated by PL market research over the last 6 months

Table 3: File Size Categories & Publication Type Distribution Percentages

A	B	C	D	E	F
File Size (MB)	Upper Bound Transmission Duration	eBooks % Distribution per file size	Newspapers % Distribution per file size	Magazines % Distribution per file size	Web Pub % Distribution per file size
> .5	5.85	19.56	8.00	0.88	95.00
0.5 - 1	11.70	76.40	28.00	19.12	3.00
1 - 2	23.41	3.04	50.60	54.00	1.55
2 - 5	58.51	0.70	12.40	24.00	0.45
5 - 10	117.03	0.30	1.00	2.00	0.00

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

2.1 Add 2nd column for each publication type category to calculate total download durations for each publication type: Table 4; column D = eBooks, column F = Newspapers, column H = Magazines, column J = Web Publications

2.2 Calculate download durations for each publication type category for every file size. Columns D, F, H & J (highlighted)

Column D Calculation (Table 4):

*'UB Transmission Duration X (column B)' * 'eBook % Distribution per file size X (column C)' = 'eBook Download Durations (column D)'*

$$Example\ for\ 1-2\ MB\ File\ Size: \quad 23.41\,\text{sec} * 3.04\% = 0.71 sec$$

Table 4: Publication Type Category Download Durations

A	B	C	D	E	F	G	H	I	J
File Size (MB)	Upper Bound Transmission Duration	eBooks % Distribution per file size	eBooks Download Durations (sec)	Newspapers % Distribution per file size	Newspapers Download Durations (sec)	Magazines % Distribution per file size	Magazines Download Durations (sec)	Web Pub % Distribution per file size	Web Pubs Download Durations (sec)
> .5	5.85	19.56	1.14	8.00	0.47	0.88	0.05	95.00	5.56
0.5 - 1	11.70	76.40	8.94	28.00	3.28	19.12	2.24	3.00	0.35
1 - 2	23.41	3.04	0.71	50.60	11.84	54.00	12.64	1.55	0.36
2 - 5	58.51	0.70	0.41	12.40	7.26	24.00	14.04	0.45	0.26
5 - 10	117.03	0.30	0.35	1.00	1.17	2.00	2.34	0.00	0.00
		Totals ->	**11.56**		**24.01**		**31.31**		**6.54**

Step 3: System Publication Distribution Forecast

The daily delivery of a newspaper subscription will likely outnumber the times a user will buy a book, so we need to calculate our expected maximum file size by applying a weighted factor to reflect the expected distribution between the four publication type categories as shown in Table 5.

3.1 Current and Future projections for distribution of all system publication types (Table 5, column A)

3.2 Current forecasts are based on internal research along with input from our online store partner and reflect the most aggressive usage scenarios

3.3 Table 5 data considers all available usage statistics

Table 5: System Publication Type Distribution Forecast

	A % of Total of Downloads (Conservative Estimate)
eBooks:	6%
Newspapers:	58%
Magazines:	2%
Web Publications:	34%
Totals:	100%

Summary: Table 5, Column A is used for System Publication Type Distribution Percentage calculations in the remainder of this document.

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

4.1 List cumulative totals for each publication type category for Weighted Time per File Size (Table 6, Column A)

4.2 Use Table 5, column A '% of Total Downloads' for Table 6 column B

4.3 Calculate total Weighted Composite Download Time per Publication Category (column C) by multiplying column A * column B

Column C Calculation (Table 6):

*'Totals: Weighted Time per File Size (column A)' * '% of Total Downloads (column B)' = 'Weighted Composite Download Time per Publication Category' (column C)*

*Example: (eBooks, Table 6) 11.56sec * 6% = 0.69sec (column C)*

Table 6: Weighted Composite Download Time for each Publication Type and Total for all File Size and Publication Types

	A	B	C
	Totals: Weighted Time per File Size	% of Total Downloads (Table 5)	Weighted Composite Download Time per Publication Category
eBooks:	11.56	6%	0.69
Newspapers:	24.01	58%	13.93
Magazines:	31.31	2%	0.63
Web Publications:	6.54	34%	2.22
	Weighted Composite Download Time ->		**17.47**

Summary: Weighted Composite Download Time for all file sizes and publication types = 17.47 seconds, which is used in Table 7, Step 8, 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 (books, newspapers, etc)
4. Review search results
5. Repeat steps 3 & 4
6. Select item for purchase
7. Purchase Transaction
8. Download content
9. Transaction complete – power down modem

Aspects of User Interaction

There are many aspects of the search and download process we can measure consistently and reliably, but there are also many variables that come into play in determining a viable duty cycle approach. The amount of time the user takes to review search results, the number of iterations it takes the user to find what they are looking

for, proximity to a cell tower, and the number of simultaneous users on a given cell site will all affect the overall session duration time. These durations have been used to maintain conservativeness in our calculations. Indefinite or long delays occurring at the end of a transaction cycle are not included. In consideration of the above, the times used below in Table 7 reflect conservative scenarios in order to ensure stressing the upper bound limitations.

5.1 List 9 step process for event durations and transmitter on-time (Table 7, column B)
5.2 Show conservative event duration numbers (column C)
5.3 Event Duration numbers (column C) are derived from extensive user research and beta program testing and reflect conservative usage durations to ensure upper bounds limitations are being tested
5.4 Sum all event duration numbers in Column C
5.5 Step 8, column C adds an averaged duration of 8 seconds to 'end the PDP Context' to the total of the column D total (refer to Figures 4,5 & 6)

***Column C, Step 8 Calculation (Table 7):*
'Transmission on-time (column D)' + '8 Seconds for PDP context to end' = 'Download Content (column C)'
Example: 17.47sec + 8sec = 25.47 Sec

5.6 Sum all 'Transmission on-Time' numbers (column D)
5.7 Step 8, column D is taken from the 'Weighted Composite Download Time per Publication Category Totals' cell from Table 6, column C
5.8 Calculate UBTDF percentage duty factor

Column D 'UBTDF Duty Factor' Calculation:
'Transmission on-time Total' / 'Event Duration Total' = 'UBTDF Duty Factor'

$$Example\ \frac{46.47sec}{415.47sec} = 11.18\%$$

Table 7: HSDPA Event Process Durations and UBTDF Duty Factor

A	B	C	D
Step	Event	Event Duration (in Sec)	Transmission on-time (in Sec)
1	Power up & Register on Network	45	9
2	*Launch Store Application**	20	0
3	Search for content	30	8
4	*Review search results**	150	0
5	*New search and review results**	90	7
6	*select an item for purchase**	30	5
7	purchase transaction	20	0
8	Download content**	25.47	17.47
9	Purchase Completed (Modem off)	5	0
	Totals:	415.47	46.47
		UBTDF Duty Factor ->	**11.18%**

**Requires user interaction (refer to 'Aspects of User Interaction' on page 12)*

*** Includes 8 seconds in Event Duration column for PDP context to end*

Summary: UBTDF Duty Factor for HSDPA = 11.18%

Step 6: HSDPA Conducted Power Output

6.1 Conducted power tables as measured during certification lab testing.

Table 8: Conducted Powers for HSDPA mode

HSDPA

Band	Mode	UL Ch No.	DL Ch No.	f (MHz)	O/P Power (dBm)
					Average
UMTS850 (Band V)	Subtest 1	4132	4357	826.4	22.30
		4183	4408	836.6	22.50
		4233	4458	846.6	22.30
	Subtest 2	4132	4357	826.4	21.70
		4183	4408	836.6	21.90
		4233	4458	846.6	21.70
	Subtest 3	4132	4357	826.4	21.80
		4183	4408	836.6	21.90
		4233	4458	846.6	21.70
	Subtest 4	4132	4357	826.4	21.70
		4183	4408	836.6	21.90
		4233	4458	846.6	21.70
UMTS1900 (Band II)	Subtest 1	9262	9662	1852.4	21.10
		9400	9800	1880.0	22.40
		9538	9938	1907.6	21.80
	Subtest 2	9262	9662	1852.4	20.70
		9400	9800	1880.0	21.90
		9538	9938	1907.6	21.20
	Subtest 3	9262	9662	1852.4	20.70
		9400	9800	1880.0	21.90
		9538	9938	1907.6	21.25
	Subtest 4	9262	9662	1852.4	20.70
		9400	9800	1880.0	21.85
		9538	9938	1907.6	21.10

Summary: The maximum average output power for UMTS Band V is 22.50 dBm @836.6MHz
Summary: The maximum average output power for UMTS Band II is 22.40 dBm @1880.0 MHz

Step 7: RF Exposure Average Power

7.1 Apply the UBTDF value of 11.18% (from Table 7, column D Total) to the RF Exposure Average Power to get 'Adjusted Average Power' (Table 9, column C)

7.2 Calculations for UBTDF power numbers

Column C Calculations (Table 9):

'Average Output Power' + '10log(DF)' = 'Adjusted Average Power'

Example: 22.50dBm + 10log(11.18%) = 12.98dBm

Table 9: Resulting RF Exposure Average Power

A	B	C
Category	UBTDF Power	Adjusted Ave Power
UMTS Band V	22.50dBm – 9.52 dB = 12.98 dBm	19.88 mW
UMTS Band II	22.40dBm - 9.52 dB = 12.88 dBm	19.43 mW

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

A	B	C
Category	60/f	Low Power Threshold
UMTS Band V	60/0.836	71.77 mW
UMTS Band II	60/1.88	31.91 mW

Step 8: HSDPA UBTDF Calculations Summary:

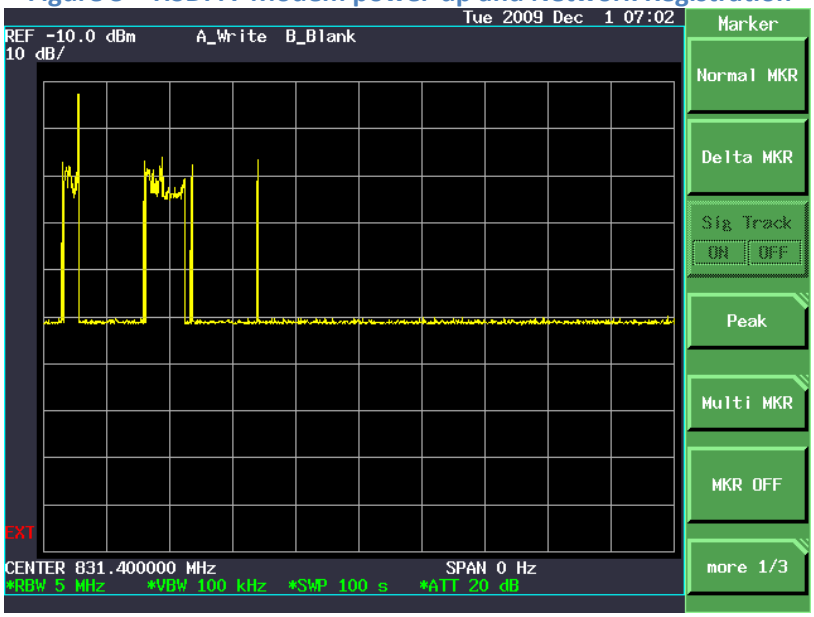
Since both Band II and Band V Adjusted Average Power (Table 9, column C) are less than the Low Power Threshold values (Table 10, column C) **we believe this device qualifies for SAR test exclusion.**

11. HSDPA Power and Download Plots

Modem/Radio power-up and network registration

The following plot show common wireless power-up and network registration sequences for HSDPA:

Figure 3 – HSDPA Modem power-up and Network Registration

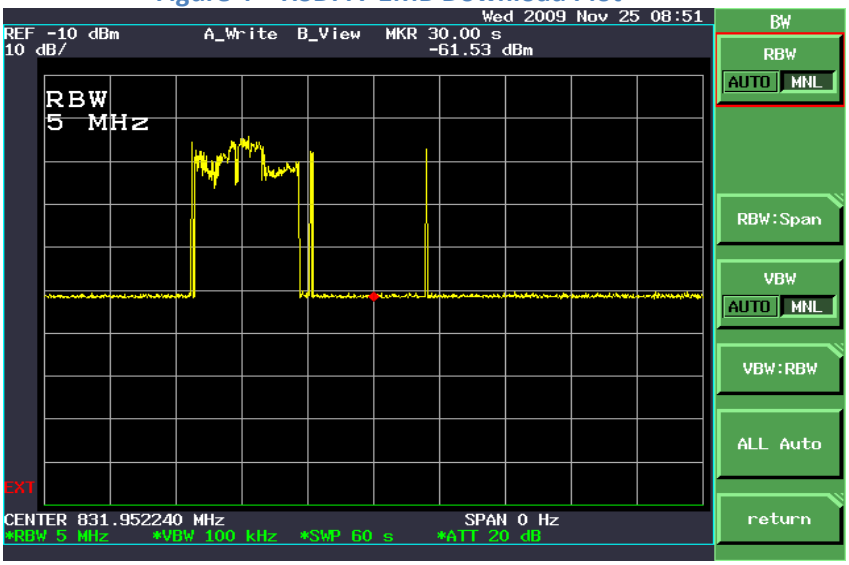


The HSDPA plot in Figure 3 shows a total measurement time of 100 seconds (from beginning to end of plot, 10 seconds per division) with total transmission time of 8.89 seconds. This is a conservative estimate of the Network Registration Transmission time.

HSDPA Content Downloads

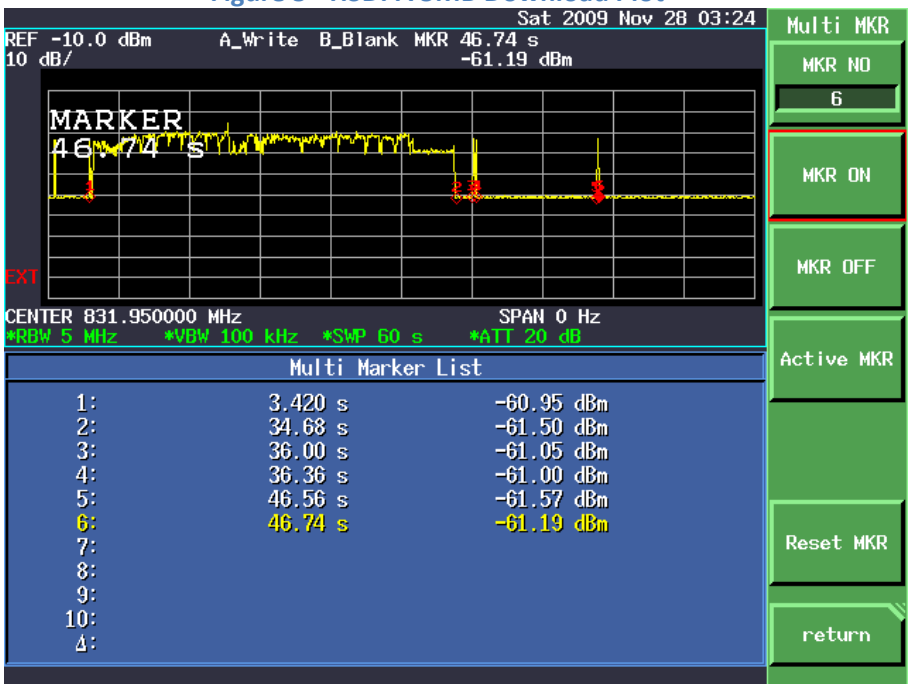
The following plots show a live network download sequence of 1MB, 5MB & 10MB files using HDSPA. Note that these Transmitter vs. Time plots show all RF energy transmitted from the product for a complete file download. With the time scales used in these plots, individual transmit packets (ACKs/NACKs) cannot be resolved.

Figure 4 – HSDPA 1MB Download Plot



This plot reflects a total measurement time of 60 seconds with 11.45 second of transmission time. (Note the 11.45 duration is very close to the theoretical worst-case of 11.70 seconds for a 1MB file using a data rate of 700kbps)

Figure 5 - HSDPA 5MB Download Plot



The plot in Figure 5 shows a total measurement time of 60 seconds with 31.80 seconds of transmission. (This duration of 31.80 seconds is considerably faster than the calculated time of 58.51 seconds using a data rate of 700kbps as shown in Table 2, thus ensuring we are stressing the upper bounds limitations in our calculations)

Figure 6 - HSDPA 10MB Download Plot

Figure 6 above shows a total measurement time of 100 seconds with 50.7 seconds of transmission. (This duration of 50.7 seconds is considerably faster than the calculated time of 117.03 seconds using a data rate of 700kbps as shown in Table 2, thus ensuring we are stressing the upper bounds limitations in our calculations)

12. Summary

An analysis of RF exposure for the purpose of waiving SAR evaluation should account for most conservative usage and not be based purely on a statistical approach. In comparison to many other popular RF devices, the frequency and duration of transmission times for the QUE™ proReader are minimal. (i.e., Transmission times are measured in seconds, not minutes or hours) Furthermore, as the network bandwidth continues to increase over time these transmissions will become even shorter, thereby reducing the RF exposure even more.
There are many techniques that QUE uses to further minimize potential SAR impact, some of which are reflected in the following list:

1) The modem will always be powered down when not in use
2) 3G will be used only when a USB or WLAN connection is not available
3) The 700kbps data rate used for real-world testing is way below what we've been seeing at multiple locations (we commonly see up to 1.8Mbps) and accounts for normal overhead involved with data transactions.
4) Many newspaper and magazine subscriptions will be delivered during non-peak hours, a period when users aren't likely to be holding the device

In conclusion, by using the Upper Bound Transmission Duty Factor to adjust the measured power, the UMTS Band V and Band II are well below SAR low power threshold requirements. Thus, SAR testing is not required to address RF exposure compliance for this hand-held device.

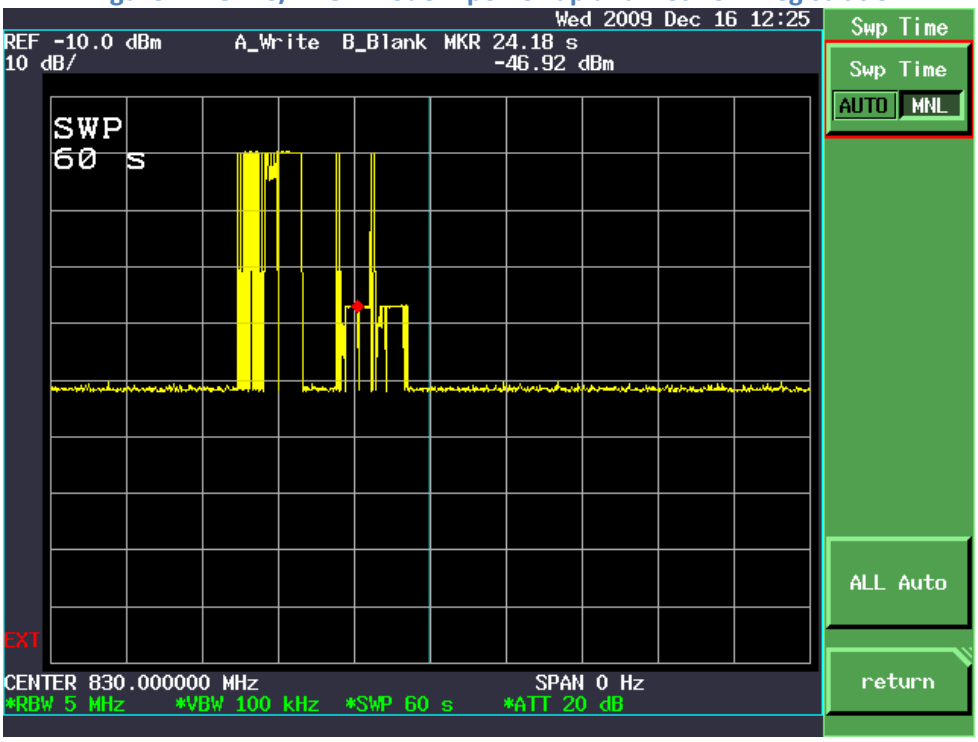
13. Appendix A: GPRS/EDGE

The GPRS and EDGE protocols inherently have low transmit duty cycles while downloading files, which means when the wireless is operated in this mode the average output power will always be below the 60/f mW low power threshold.

GPRS/EDGE Modem/Radio power-up and network registration

The following plot show a normal wireless power-up and network registration sequences for GPRS/EDGE. (Note that the UE transmit pattern for GPRS network registration is the same as the pattern for EDGE network registration)

Figure 7 – GPRS/EDGE Modem power-up and Network Registration



The GPRS/EDGE power-up and registration sequence shows a measurement time of 60 seconds with 11.04 seconds of active transmissions.

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.

GPRS/EDGE & WCDMA Power Output

Table 11: Conducted Powers for GPRS/EGPRS mode

GPRS (GMSK) - Coding Scheme: MCS4

Band	Ch No.	f (MHz)	Conducted output power (dBm)											
			1 slot			2 slot			3 slot			4 slot		
			Avg	Frame Avg Pwr	Pk	Avg	Frame Avg Pwr	Pk	Avg	Frame Avg Pwr	Pk	Avg	Frame Avg Pwr	Pk
GSM850	128	824.2	31.60	22.60	31.70	28.60	22.60	28.70	26.70	22.44	26.80	25.50	22.50	25.70
	190	836.6	31.60	22.60	31.70	28.60	22.60	28.70	26.70	22.44	26.80	25.50	22.50	25.70
	251	848.8	31.60	22.60	31.70	28.60	22.60	28.70	26.70	22.44	26.80	25.50	22.50	25.70
GSM1900	512	1850.2	28.20	19.20	28.30	25.30	19.30	25.50	23.50	19.24	23.60	22.30	19.30	22.40
	661	1880	28.10	19.10	28.30	25.20	19.20	25.40	23.40	19.14	23.50	22.20	19.20	22.30
	810	1909.8	28.00	19.00	28.10	25.10	19.10	25.30	23.30	19.04	23.50	22.10	19.10	22.20

EGPRS (8PSK) - Coding Scheme: MCS9

Band	Ch No.	f (MHz)	Conducted output power (dBm)											
			1 slot			2 slot			3 slot			4 slot		
			Avg	Frame Avg Pwr		Avg	Frame Avg Pwr	Pk	Avg	Frame Avg Pwr	Pk	Avg	Frame Avg Pwr	Pk
GSM850	128	824.2	25.80	16.80	28.90	23.70	17.70	26.70	21.70	17.44	24.70	20.40	17.40	23.40
	190	836.6	25.80	16.80	28.90	23.70	17.70	26.70	21.70	17.44	24.70	20.40	17.40	23.40
	251	848.8	25.80	16.80	28.90	23.70	17.70	26.70	21.70	17.44	24.70	20.40	17.40	23.40
GSM1900	512	1850.2	24.50	15.50	27.60	22.30	16.30	25.40	20.20	15.94	23.30	19.00	16.00	22.10
	661	1880	24.70	15.70	27.80	22.60	16.60	25.80	20.60	16.34	23.80	19.30	16.30	22.50
	810	1909.8	24.70	15.70	27.80	22.50	16.50	25.70	20.50	16.24	23.60	19.10	16.10	22.30

Table 12: GPRS/EDGE Multi-Slot Rated Power

GPRS/EDGE Multi-Slot Rated Power				
	UL 1x Slot	**UL 2x Slot**	**UL 3xSlot**	**UL 4xSlot**
Power Back-Off	0 dBm	3 dBm	4.8 dBm	6 dBm
850 MHz /GPRS Target Power	32 dBm	29 dBm	27.2 dBm	26 dBm
850 MHz / EDGE Target Power	26 dBm	23 dBm	21.2 dBm	20 dBm
1900 MHz / GPRS Target Power	29 dBm	26 dBm	24.2 dBm	23 dBm
1900 MHz / EDGE Target Power	26 dBm	23 dBm	21.2 dBm	20 dBm

The Maximum Frame Average power for the GSM850 Band is 22.60 dBm @836.6 MHz.
The Maximum Frame Average power for the GSM1900 Band is 19.30 dBm @1850.2 MHz.
The Maximum Frame Average power for the EGPRS850 Band is 17.70 dBm @836.6 MHz.
The Maximum Frame Average power for the EGPRS1900 Band is 16.60 dBm @1880.0 MHz.

GPRS/EDGE Duty Cycle

Tables 13 and 14 show the Event duration times, transmit-on time and final duty factor numbers for GPRS (Table 13) and EDGE (Table 14). Higher duty factors occur when the GPRS or EDGE network configures the UE to operate with the highest number of downlink slots at the highest data rate, the lowest number of uplink slots at the lowest data rate, and with smaller file sizes. The download duration in Table 12 is based upon these conditions: 0.5MB file size, 4 downlink slots at 20kbps per slot, 1 uplink slot at 8kbps, and a derating of 50% to account for network and protocol overhead.

Calculations for GPRS/EDGE Duty Factor:

*Download Content Duration (s) = [file size (bits)] / [(number of slots) * (fastest rate per slot) * (1 – derating factor)]*

$$GPRS\ Example: \quad \frac{0.5Mbyte * \frac{8bits}{byte} * \frac{1024Kbytes}{1Mbyte}}{4slots * \frac{20Kbit/sec}{slot} * (1 - 0.5)} = 102.4\ seconds$$

Table 13: Event Process Durations for GPRS

Event	Class 10		Class 12	
	Duration (in Sec)	TX (in Sec)	Duration (in Sec)	TX (in Sec)
Power up & Register on Network	45	11	45	11
Launch Store Application*	20	0	20	0
Search for content	30	10	30	10
Review search results*	150	0	150	0
New search and review results*	90	9	90	9
select an item for purchase*	30	7	30	7
purchase transaction	20	0	20	0
Download content (.5MB)	102	0	102	0
Purchase Completed (Modem off)	5	0	5	0
Total Time	492	37	492	37
Duty Factor:	7.52%		7.52%	

**requires user interaction (refer 'Aspects of User Interaction on page 12)*

The download duration for table 13 is based upon these conditions: 0.5MB file size, 4 downlink slots at 59.2kbps per slot, 1 uplink slot at 8.8kbps, and a derating of 50% to account for network and protocol overhead.

Table 14: Event Process Durations for EDGE

Event	Class 10		Class 12	
	Duration (in Sec)	TX (in Sec)	Duration (in Sec)	TX (in Sec)
Power up & Register on Network	45	11	45	11
Launch Store Application*	20	0	20	0
Search for content	30	10	30	10
Review search results*	150	0	150	0
New search and review results*	90	9	90	9
select an item for purchase*	30	7	30	7
purchase transaction	20	0	20	0
Download content (.5MB)	35	0	35	0
Purchase Completed (Modem off)	5	0	5	0
Total Time	425	37	425	37
Duty Factor:	8.71%		8.71%	

**requires user interaction (refer 'Aspects of User Interaction' on page 12)*

GPRS/EDGE Adjusted Power Output

Table 15: GPRS Adjusted Power Output & Low-Power Threshold Limits

A	B	C	D
Category	Adjusted power (dBm)	Adjusted power (mW)	Limit
Band V, GPRS, Class 10	22.6dBm -11.24dB = 11.36dBm	13.68mW	71.77mW
Band V, GPRS, Class 12	22.6dBm -11.24dB = 11.36dBm	13.68mW	71.77mW
Band II, GPRS, Class 10	19.3dBm -11.24dB = 8.06dBm	6.4mW	31.91mW
Band II, GPRS, Class 12	19.2dBm -11.24dB = 7.96dBm	6.26mW	31.91mW

Table 16: EDGE Adjusted Power Output and Low-Power threshold Limits

A	B	C	D
Category	Adjusted power (dBm)	Adjusted power (mW)	Limit
Band V, EDGE, Class 10	17.7dBm -10.6dB = 7.1dBm	5.13mW	71.77mW
Band V, EDGE, Class 12	16.8dBm -10.6dB = 6.2dBm	4.17mW	71.77mW
Band II, EDGE, Class 10	16.6dBm -10.6dB = 6dBm	3.98mW	31.91mW
Band II, EDGE, Class 12	15.7dBm -10.6dB = 5.1dBm	3.23mW	31.91mW

Summary: Since the Adjusted Power output for both GPRS and EDGE in all Bands and Classes (Columns C in Tables 15 & 16) are lower than the low-power threshold requirements (Columns D in Tables 15 & 16) we believe this device qualifies for SAR test exclusion.

14. Appendix B: WCDMA (Release 99)

The WCDMA protocol inherently has low transmit duty cycles while downloading files, which means when the wireless is operated in this mode the average output power will always be below the 60/f low power threshold.

For a mode where the UE is not transmitting during data download, the worst case duty factor occurs at the fastest data rate, which is what we use for Table 16 calculations.

Calculations used for WCDMA Duty Factor:

*Download Content Duration (s) = [file size (bits)] / [(fastest data rate) * (1 – derating factor)]*

$$Example: \quad \frac{0.5MB * \frac{1024Kbytes}{MByte} * \frac{8\ bits}{byte}}{384kbps * (1 - 0.5)} = 21.3seconds$$

Table 17: Event Process Durations for WCDMA

Event	WCDMA Full OTA Rate***		WCDMA Best Usable Rate****	
	Duration (in Sec)	TX (in Sec)	Duration (in Sec)	TX (in Sec)
Power up & Register on Network	45	11	45	11
Launch Store Application*	20	0	20	0
Search for content	30	10	30	10
Review search results*	150	0	150	0
New search and review results*	90	9	90	9
select an item for purchase*	30	7	30	7
purchase transaction	20	0	20	0
Download content (0.5MB)**	21	0	26	0
Purchase Completed (Modem off)	5	0	5	0
Total Time	411	37	416	37
Duty Factor	**9.00%**		**8.89%**	

**requires user interaction (refer 'Aspects of User Interaction' on page 12)*

***based on a 0.5MB download file size and 50% derating factor*

****based on 384kbps data rate*

*****based on 320kbps data rate*

Summary: WCDMA Full OTA Rate Duty Factor = 9.00%

WCDMA Best Usable Rate Duty Factor = 8.89%

WCDMA Conducted Power

Table 18: Conducted Power for WCDMA (Release 99 – 12.2kbps RMC)

Band	Mode	UL Ch No.	DL Ch No.	f (MHz)	O/P Power (dBm)
					AVE
UMTS850 (Band V)	Rel 99 12.2kps RMC	4132	4357	826.4	22.30
		4183	4408	836.6	22.60
		4233	4458	846.6	22.30
UMTS1900 (Band II)	Rel 99 12.2kps RMC	9262	9662	1852.4	21.11
		9400	9800	1880.0	22.50
		9538	9938	1907.6	22.00

WCDMA Adjusted Power Output

Table 19: Adjusted Power Output and Low-Power Threshold Limits for WCDMA

A	B	C	D
Category	Adjusted power (dBm)	Adjusted power (mW)	Limit
Band V, WCDMA (Rel 99), full OTA	22.6dBm -10.46dB = 12.14dBm	16.38mW	71.77mW
Band V, WCDMA (Rel 99), best usable	22.6dBm -10.51dB = 12.09dBm	16.18mW	71.77mW
Band II, WCDMA (Rel 99), full OTA	22.5dBm -10.46dB = 12.04dBm	16.01mW	31.91mW
Band II, WCDMA (Rel 99), best usable	22.5dBm -10.51dB = 11.99dBm	15.82mW	31.91mW

Summary: Since the adjusted power output for all WCDMA bands (Table 19, column C) are lower than the low-power threshold requirements (Table 19, column D), we believe this device qualifies for SAR test exclusion.

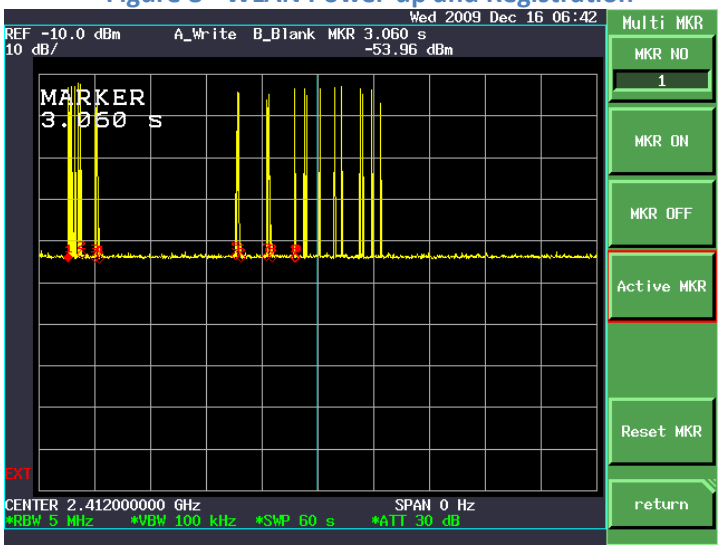
15. Appendix C: WLAN & Bluetooth

The WLAN protocol inherently has low transmit duty cycles while downloading files, which means when the wireless is operated in this mode the average output power will always be below the 60/f low power threshold.

WLAN Modem/Radio power-up and network registration

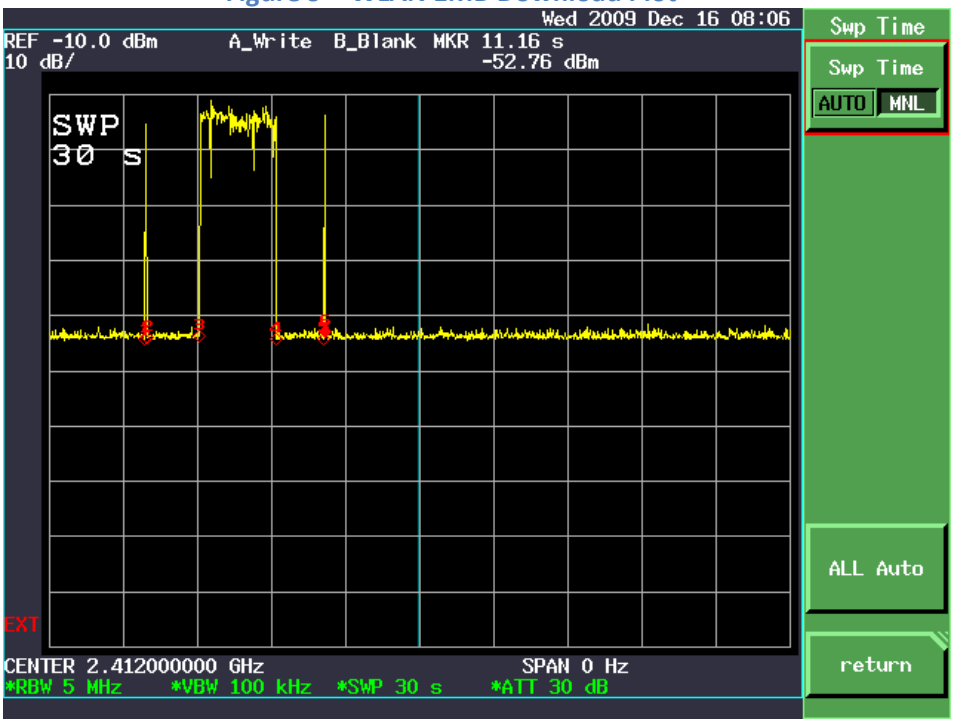
The following plots show typical wireless power-up and network registration sequences for EDGE: (WLAN network registration always occurs at the same data rate and exchanges the same information, so the network registration always takes the same amount of time)

Figure 8 - WLAN Power-up and Registration



The WLAN power-up and registration sequence shows a measurement time of 60 seconds with 4.56 seconds of active transmissions.

Figure 9 – WLAN 1MB Download Plot



This WLAN download plot shows a total measurement time of 30 seconds with 3.27 seconds of transmission time. These transmissions are the short acknowledgements (ACKs) that the WLAN client sends back to the Access Point during a download. In a time plot on this scale individual ACKs cannot be resolved individually.

The Plastic Logic QUE proReader only downloads content over the WLAN interface, there is no upload of data through this interface.

Using the data below, the UBTDF for WLAN is 4.94%, or – 13.06 dB.

Table 20: WLAN Event Duration & Transmit Times

Step	Event	Event Duration (in Sec)	Transmission on-time (in Sec)
1	Power up & Register on Network	34.56	4.56
2	*Launch Store Application**	20	0
3	Search for content	20	3
4	*Review search results**	150	0
5	*New search and review results**	90	4
6	*select an item for purchase**	20	3
7	purchase transaction	20	0
8	Download content (1MB)	3.27	3.27
9	Purchase Completed (Modem off)	3	0
	Totals:	360.83	17.83

** Requires user interaction*
(refer 'Aspects of User Interaction' on page 12)

% On-Time -> **4.94%**

WLAN Conducted Power

Table 21: 802.11b Conducted Output & Average Power

Channel	Frequency (MHz)	Peak Power Meter Reading (dBm)	Average Power (dBm)
Low	2412	18.00	16.50
Middle	2437	18.20	16.60
High	2462	17.50	16.20

RF Exposure Average Power

The maximum power for the WLAN Band is 16.60 dBm @2437MHz

Table 22: RF Exposure Average Power for WLAN

Category	Frequency	WLAN Power	Adjusted Ave Power
WLAN Average Power	2437 MHz	16.60dBm – 13.06 dB = 3.54 dBm	2.26 mW
WLAN RF Low Power Threshold	2437 MHz	60/2.437	24.62 mW

Summary: Since the WLAN average power of 2.26 mW is less than the 24.62 mW low-power threshold, we believe this device qualifies for SAR test exclusion.

Bluetooth

Table 23: Bluetooth Power Output

Frequency	Peak Power	Average Power
MHz	dBm	dBm
2402	3.62	1.43
2441	3.737	1.48
2480	3.71	1.48

The center of the band in which Bluetooth operates is 2441MHz. At this frequency the SAR test exclusion threshold is 60 / 2.441, or 24.6mW (13.9dBm). The highest average power of the Bluetooth radio interface is 1.48dBm, which is below the threshold. Based on this measurement and calculation, we believe this device qualifies for SAR test exclusion.