Appendix 14.7: Duty Cycle Calculation

1. Duty Cycle Calculation

This section describes the approach to demonstrate RF Exposure compliance for the Ironman ONE GPS+ (FCC ID EP9-TMXM061) Model M061fitness watch with reference to FCC evaluation procedures for Low Transmission duty factor devices as defined in KDB 447498 D01 V05r02.

The limited use cases of the M061 sports watch make it an ideal candidate for applying the duty factor procedures to adjust measured SAR levels to reflect the actual limited transmission characteristics of the device. The M061 enables software controls that limit the uplink transmissions to defined lengths of time as documented below.

Additional information is contained within the confidential document "Ironman ONE GPS+ 3G Duty Factor Derivation" filed with this application.

1.1.   Compliance Approach

The Ironman ONE GPS+ Model M061 product functions such that the WCDMA radio transmits for a period of time in support of the limited data upload model as defined in section 1.2.

Section 1.3.2 calculates duty factors for the M061 use cases based on conservatively slow 3G uplink data transmission rates supported by a WCDMA/HSDPA network. The conservative duty factors are derived from the parameters (e.g. use cases, data rates, uplink payload sizes) defined in Section 3.

The duty factor is used to correct the measured SAR values that reflect the transmission characteristics of the device. A standalone SAR report will reference this document and include measured SAR data adjusted by the duty factor defined in this document to demonstrate compliance for the M061 based on the device transmission characteristics.

1.1.1. HSDPA uplink and downlink transmission rates

The M061 supports WCDMA Release 99 and Release 5 Category 6 HSDPA with the uplink/downlink transmission rates show in **Error! Reference source not found.**. shows the 3GPP technology roadmap and associated data rates for reference.

The M061 does not support HSUPA or HSPA+ supported after 3GPP Release 5.

Table 1-1 3GPP uplink throughput data transmission rates

Technology	Uplink transmission rate	Downlink transmission rate	Standards reference
WCDMA Release 99	9.6 to 384 kbps	9.6 to 384 kbps	3GPP 25.306
HSDPA Category 6	9.6 to 384 kbps	1.8 to 3.6 Mbps	3GPP 25.306

1.1 M061Use Case Definitions

This section defines the M061 modes of operation that utilize the WCDMA modem.

Future features made available with software updates will need to operate within the constraints defined in this document.

The M061 does not have an open app store to add third-party applications features. All features must be provided by the device grantee.

1.1.1 Local tracking mode

The user activates the device to record (internally to device) location and physical activity data. The data is stored locally on the device until the stored data size reaches approximately 132k upon which the device uploads the stored data to M061 server in background while continuing the user workout session.

Upon completion of user workout session, the device initiates a data call to upload the workout data to the M061 server. The device will complete the request only after checking when the last upload event occurred and thus ensuring SAR compliance by enforcing transmission time duty factor. When this event occurs, the device will first check to see if the previous transmission start time is greater than 6mins. If not then the device will wait until that condition is met, but if yes, then the device will start a 150sec max allowed upload time timer and will start its upload attempts of the user data including retries if required. This total allowed upload timer of 150sec includes set up time/upload time/retry time. If the device is unable to upload all the user data within 150sec, then the device will store it until next upload attempt event is triggered (user data size reaches 132kB). The key points to ensure SAR compliance during Local Tracking use case are the following:

- Maximum upload time bound by timer of 150sec (satisfies SAR compliance limits) followed by enforced upload not allowed time for 210sec (41.7% duty factor based on period of 6mins)
- Default time between start of two transmissions is much greater than 6mins as device waits for 132kB of data to accumulate before attempting to upload.

The maximum time the device is configured to upload continuously is set to be 150 sec followed by a minimum of a 210 sec no upload time duration (41.7% Duty Factor).

1.1.2 Live tracking mode

The user may choose to initiate a live tracking fitness session which establishes a data call to upload location and physical activity data every 60 seconds. The device location and physical activity data can then be viewed by spectators via a website or mobile client application. The user cannot increase the frequency to provide updates faster than once per 60 seconds. The device will complete the live tracking upload only after checking when the last upload event occurred and thus ensuring SAR compliance by enforcing transmission time duty factor.

Live tracking is similar to local tracking but the user data is a much smaller data payload and the M061 limits the periodicity of uploads to once per minute. The key points to ensure SAR compliance during Live Tracking use case are the following:

- Maximum upload time bound by timer of 25sec (satisfies SAR compliance limits) followed by enforced upload not allowed time for 35sec (41.7% duty factor based on period of 6mins)
- Default time between start of two transmissions is 1min during which approximately 6kB of data is accumulated.

The maximum time the device is configured to upload continuously is set to be 25 sec followed by a minimum of a 35 sec no upload time duration (41.7% Duty Factor).

1.1.3 Messaging

The user may send an end-user message that is an IP data text message sent via the M061 server, addressed to an email contact or another M061 user. Alternatively, the user can also receive an IP data text message from an email contact or another M061 user via M061 server after a WWAN SMS 'wake up'.

The M061 Safety SOS feature is part of the messaging use case where the user can send location information to a message recipient.

The M061 Find Me Feature is similar to the messaging except that a network initiated messaging is first delivered to the device.

The maximum file size is approximately 42 kb that corresponds to 1 message exchange between M061 and server.

1.1.4 Contact synchronization

A user may choose to download contacts or make updates to contacts on the M061 via a web or mobile client application. Contact information is stored on the M061 server and then is synchronized on the device. The contact information includes both text information and graphics if available for the contact.

The maximum file size is 8880 kb and can only be downloaded to the device during the initial synchronization or if an entirely new contact list is being downloaded. After the initial synchronization only delta changes made to the contacts (add/delete/edit) are synchronized to the device.

1.1.5 GPS assistance file download

The M061 periodically downloads a GPS assistance data file to reduce the time required to acquire GPS lock. This download occurs automatically every four days or a maximum of once per day when local tracking mode starts.

The maximum file size is approximately 360 kb for downloading GPS assistance once.

1.2 Duty Cycle Determination

1.2.1 Conservative use case averaging time

The payload sizes for various M061 features shown in Table 1-1 are fixed values determined by the M061 system and also include the 3G overhead traffic. Networks typically take a worst case of 8-10 seconds for call setup and teardown where the uplink is active less than 50% of the time. 5 seconds is used as used in the uplink transmission time requirements for messaging, contact synchronization, GPS engine download. Local tracking and live tracking do not account for call setup due to the fixed duty cycle.

Table 1-1 defines conservative averaging times that are used in section 1.1.2to calculate the duty factor value used to adjust the measured SAR data based on the usage and transmission characteristics of the M061 watch.

Table 1-1 Use case SAR averaging time

Use case	Maximum file size (kb)	Minimum throughput data rate	Averaging time period	Basis for averaging time
Local tracking mode	529 kb / hour	9.6 kbps (uplink)	6 minutes	Fixed duty cycle
Live tracking mode	48.17	9.6 kbps (uplink)	60 seconds	Live tracking updates limited to 60 seconds by M061 device
Messaging	42	9.6 kbps (uplink)	60 seconds	Address rapidly sending messages
Initial contact synchronization with image	8880	100 kbps (downlink)	6 minutes	Infrequent occurrence
GPS engine download	360	100 kbps (downlink)	6 minutes	Infrequent occurrence

The minimum uplink throughput data rate of 9.6 kbps is used to represent a low throughput. It is expected that higher average uplink throughputs will be realized on a 3G network.

The minimum downlink throughput data rates for the address book download, GPS download are based on a conservative HSDPA download data rate of 100 kbps. The downlink data rate is referenced instead of uplink to determine the transmission time because the HSDPA download time defines the duration that the uplink is active in support of the download.

When downloading, the UL is used for system overhead and acknowledgements and so the uplink data rate is not factor in determining the overall transmission time. The device is expected to typically operate in HSDPA networks where the download rate can exceed 1.8 Mbps and the total download times for the M061 file sizes drop below 1 minute.

Table 1-2 Defines the software constrained inherent duty cycle of the M061 watch. Figure 1-1 graphically shows the duty cycles.

Table 1-2 Fixed Duty cycle values for Local and Live Tracking

	TX On		TX Off		Total Evaluation Time (min)	Duty Cycle (TX/Total time) %
Use Case	**sec**	**min**	**sec**	**min**		
Local tracking upload (max repetition once every 132kB data accumulated)	150	2.5	210	3.5	6.0	41.7%
Live tracking upload (max repetition once every 60 seconds)	25	0.4	35	0.6	1.0	41.7%
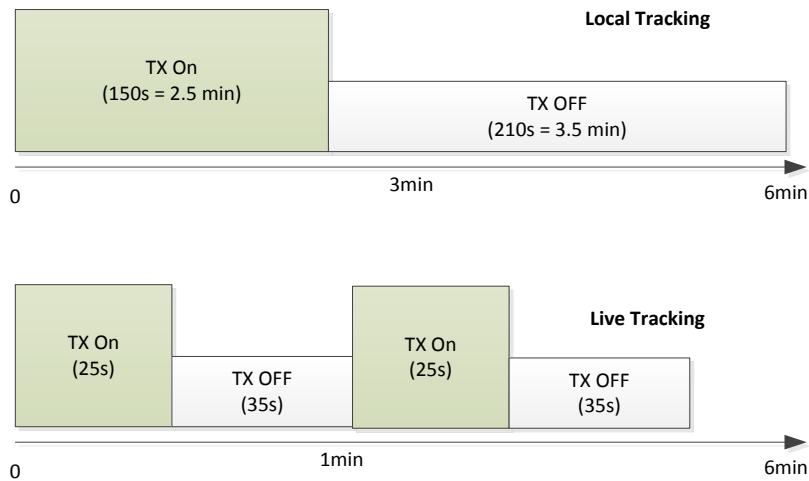
Figure 1-1 M061 Duty Cycle for Local and Live Tracking

1.1.2. Duty cycle calculations

Table 1-3 shows the duty factor calculations for the M061 use cases based on the data rates and system defined max allowed transmission time characteristics defined in this document.

Table 1-3 M061 duty factor calculations

Equation parameter	C	D	E	F	G	H
Equation	Input	Input	F-D	Input	F/60	D/F
Use Case	Data rate (kbps)	Uplink transmission ON time (sec)*	Uplink transmission OFF time (sec)	Total evaluation time (sec)	Total evaluation time (min)	Duty factor
Local tracking upload (max repetition once every 132kB data accumulated)	9.6	150	210	360	6	41.7%
Live tracking upload (max repetition once every 60 seconds)	9.6	25	35	60	1	41.7%
Messaging (bidirectional)	9.6	10**	50	60	1	16.7%
GPS file download (max is once per day)	100	3.6	356.4	360	6	1.0%
Initial address book download with images	100	88.8	271.2	360	6	24.7%

*Note: In the case of local and live tracking the max uplink transmission time is based on Table 1-2.

**Note: Messaging includes an extra five seconds of transmission time to account for data session setup and teardown.