Power Saving Techniques in GSM-GPRS-EDGE Handsets

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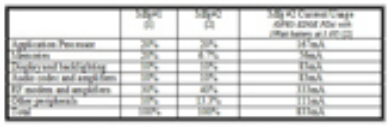
With over 600 million new mobile phone handsets shipped each year, mobile phones have become an integral part of our daily lives. As more and more new features are being demanded in smaller and thinner handset form factors, excessive current consumption and poor battery life become real issues for the mobile phone user. One way to address these power drain issues is to take advantage of advancements in battery technology that yield higher capacities in smaller form factors. Another approach is to reduce the power drain by employing semiconductor advancements - including smaller geometries resulting in significantly less power. Unfortunately, this approach can only be applied to digital circuits, and does not address power hungry analog and RF circuits. This article presents a brief overview of various GSM-GPRS-EDGE handset blocks, their influence on battery current drain and how to minimize it.

Mobile Phone Battery Budget and Power Management



	[illegible] (1)	[illegible] (2)	[illegible]
Application Processor	[illegible]	[illegible]	[illegible]
Memories	[illegible]	[illegible]	[illegible]
Display and backlighting	[illegible]	[illegible]	[illegible]
Audio codec and amplifiers	[illegible]	[illegible]	[illegible]
RF modem and amplifiers	[illegible]	[illegible]	[illegible]
Other peripherals	[illegible]	[illegible]	[illegible]
Total	[illegible]	[illegible]	[illegible]

Table 1. Battery consumption budget for high-end mobile phones.

[1]

Mobile phone manufacturers use a variety of chipsets and system configurations in their respective platforms, which are composed of typical functional blocks as listed in Table 1. This table compares the battery consumption budget allocation for two high-end GSM-EDGE handset manufacturers [1, 2], who have significantly different current allocations for both the Memory and RF functional blocks, which is a result of the platform’s intended purpose.

Effective power management in phone handsets requires an optimal mix of hardware and software power control and leakage mitigation techniques. The Power Management Unit (PMU) is a key hardware component for the control of power drain.

Memory, Display, and Audio Contribution to Current Consumption

High-end mobile handsets require significantly more memory than voice-centric mobile phones, primarily due to the sophisticated multimedia applications they run -

which may consume as much as 20% of the total handset current. Cellular-RAM (pseudo-static RAM with NOR-flash interface), Mobile RAM (based on NAND-type of flash memory) and Double-Data-Rate (DDR) memory are some of the advanced memory technologies found in smart phones.

Feature-rich handsets with an embedded camera and multimedia functions demand a high resolution color display. Super Twisted Nematic (STN) LCD has low current consumption, but is not suitable for color displays. Thin Film Transistor (TFT) LCD offers high data–reaction rates optimal for video applications, but needs relatively high current. Typical high-end phones use screen resolutions of 800 by 480 pixels or more.

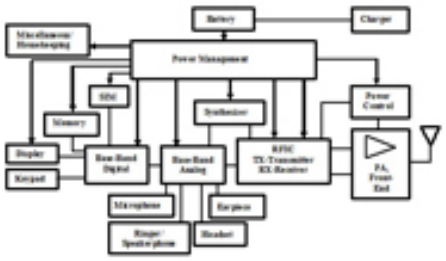


Fig. 1. Typical functional block-diagram of a GSM-GPRS handset.

[2]

When using a color LCD, it is necessary to provide white light backlighting for proper brightness, sharpness, and contrast. The Light Emitting Diode (LED) is the technology of choice for this application, and can consume up to 200mA of current, in addition to the display current. Organic LED (OLED) emits colored light naturally and does not require an additional backlight, thereby consuming significantly less power in the range of 110mA, which is almost half of that for a TFT LCD and backlight combination.

The handset audio functions generally include a dedicated Codec (coder-decoder), as well as various amplifiers, and many of these functions are included in the PMU. High quality sound from an MP3/MP4 player requires a stereo codec implementation, which can consume 15mA to 20mA of additional current.

Another popular peripheral in handsets is the camera module, which is typically CMOS technology due to its low power and price. Mobile TV and other video content are now available on mobile platforms. The feeds are delivered either through direct broadcast such as Digital Video Broadcast – Handheld (DVB-H), or content streamed from the internet. A DVB-H solution typically draws 7mA to 12mA of current [5]. On-line TV is a fairly power hungry application using up to 460mA of total average current. For comparison, watching a video over WLAN network on the same phone draws 355mA.

Wireless Connectivity and Current Consumption

Bluetooth is a short range communications technology and is widely adopted.

Bluetooth operates in a Time Domain Duplex mode (TDD) between two nodes named master and slave communicating with each other [6].

Bluetooth typically utilizes a maximum output power of +4dBm (class-2), but systems with output power up to +20dBm are being used in some mobile phones to extend the connection distance. The class-1 implementation results in an increased current by 100mA during a transmit burst.

Table 2. Average current consumption for various blocks in a GSM-GPRS handset (battery voltage 3.6V).

[3]

Wireless Local Area Network (WLAN) implementation in handsets has grown rapidly over the past few years. Internet services and Voice over Internet Protocol (VoIP) have become a driving force, and the high data load carried by the cellular networks has put more pressure on including handset WLAN capability in order to provide some relief through local WLAN “hot spots”.

WLAN systems use a time domain duplex architecture conveying information through data packet transmission. The packet burst length can lie between several tens of microseconds to several milliseconds. A high data rate can be used with a low duty cycle to save current drain for low data applications. At full power, the WLAN function including the PA can draw 200mA of current, but with a low data rate application, the average current would go down to 15mA.

Adding EDGE Mode to GSM-GPRS Mobiles

Figure 1 shows the main function blocks of a GSM-GPRS handset. From the users’ point of view, when a mobile phone is primarily used for voice call applications, the GSM mode is the main operation and efficiency for this mode should be made a high priority. Utilizing DC-DC converters, it is possible to improve the average efficiency of the PA by two or three times, resulting in as much as 50% more talk time [8].

The Enhanced Data rate for GSM Evolution (EDGE) increases data rates up to 3X to a peak of 236kbps. This higher data rate requires a highly linear RF PA with a power back-off margin, unlike the GSM PA that operates in a saturated highly efficient mode.

The output power transmitted by the handset in EDGE networks is typically +10 to +15 dBm, and the PA efficiency will be under 10% if using the same PA as for GSM-GPRS operation. To achieve a good linearity in EDGE mode, vendors are boosting the operating current for high power levels while implementing a “high-low” power mode switch, or providing a continuous power tracking mechanism [7]. Through the use of an adjustable DC-DC bias control, significant power savings and extended talk time can be realized [8].

Conclusion

The information on current drain from the system battery for various parts of a handset presented in this paper provides insight into the power budget for a mobile platform. This overview will also help with understanding current consumption constraints of these complex systems (see Table 2).

Today’s handsets are going worldwide for roaming and co-existence while implemented in GSM-GPRS-EDGE and CDMA-WCDMA systems, and the suggested improvement in reference [8] of the adjustable DC-DC converter for GSM-GPRS-EDGE mode can offer immediate talk time extension advantages, with the ability to be easily implemented for almost all types of PAs used in handsets.

Note

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