

GSM and PCS1900 Digital Cellular Phones

by Takayuki Nonami*

Since the GSM digital cellular phone standard was established in 1991, it has been adopted in about 100 nations and currently serves some 60 million subscribers. Mitsubishi Electric has recently developed a lightweight GSM cellular phone using 3V technology throughout to achieve a standby time in excess of 100 hours. This report introduces Model MT-30 for GSM applications and Model G100 for use under PCS1900, a GSM-based 1.9GHz-band system adopted by the United States.

The GSM Standard

The GSM system was developed by the Special Mobile Group of the European Telecommunication Standardization Institute (ETSI) based on ISDN network technology and time division multiplex access (TDMA) mobile communication technology. The basic functionality for the system was established in 1991 and Phase 1 trials were conducted in Germany in 1992. Mobile ISDN functions were implemented in Phase 2 trials beginning in 1996. ETSI is planning further additions and improvements to the GSM standard that will be tested in a Phase 2+ trial. Table 1 compares the functionality of each

of these versions of the GSM standard.

Although GSM was originally developed as a common standard for 900MHz-band communications in Europe, it also serves as the basis for the 1,800MHz Digital Cellular System (DCS) and the 1,900MHz Personal Communication System (PCS) in the United States. Table 2 lists the specifications of these systems.

GSM features international roaming support, a short-message service that transmits text messages of up to 160 characters, call transfer and hold functions, conference calling services, 9.6kbps fax and data transmission, and a subscriber identity module—a card containing user information.

GSM Cellular Phones

Table 3 lists the specifications of Models MT-30 and G100. Model MT-30 features extremely compact dimensions of 35 × 48 × 26mm and weight of 170g while delivering state-of-the-art performance: two hours of active operation or 120 hours on standby with the standard battery pack. Model G100 was developed concurrently and has similar specifications. Table 4 lists accessories available for these two products.

Table 1 GSM Development History

	Phase 1	Phase 2	Phase 2+
Specifications development	1987~1991	1992~1995	1995~1999
Trial period	1992~1996	1996~1999	1998~2000
Voice transmission modes	Full rate	Full rate, half rate	Full rate, half rate, enhanced full rate
Data transmission	Full rate (9.6kbps max.), half rate (4.8kbps max.)	Full rate (9.6kbps max.), half rate (4.8kbps max.)	Full rate (11.4kbps max.), half rate (4.8kbps max.), packet transmission (76.8kbps max.), high-speed circuit exchange (78.8kbps max.)
Supplementary services	Call transfer, call limiting	Call transfer, call limiting, hold, caller ID, advice of charge, conference calls (6 parties max.), etc.	Enhanced versions of Phase 2 services
Short message service	Bidirectional text transmission, cell-specific announcements	Category-specific text transmission (basic, voice mail notification), cell-specific announcements	Phase 2 capabilities plus data packet transfer and two-byte code transfer
Other	Global roaming, 5V SIM card	Global roaming, 3~5V SIM card, DCS1800 specifications	Global and domestic roaming, SIM toolkit, multiband GSM/DCS support, interoperability with DECT

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Table 2 Specifications of GSM and Derivative Systems

System	GSM	DCS1800	PCS1900
Transmit frequency	890~915MHz	1,710~1,785MHz	1,850~1,910MHz
Receive frequency	935~960MHz	1,805~1,880MHz	1,930~1,990MHz
Separation between transmit and receive channels	45MHz	95MHz	80MHz
Access method	TDMA-FDD		
Multiplex number	8		
TDMA frame length	4.615ms		
Channel spacing	200kHz		
Number of RF carrier channels	124	374	299
Modulation rate	270.833kbps		
Modulation type	GMSK, BT = 0.3		
Voice coding algorithm	22.8kbps RPE-LTP, 22.8kbps ACELP, 11.4kbps VSELP	22.8kbps RPE-LTP, 22.8kbps ACELP	22.8kbps RPE-LTP, 22.8kbps ACELP
User data transfer rate	2.4, 4.8 or 9.6kbps		
Waveform equalization	Up to 16 μ s		
Mobile unit transmission power	250mW avg., 2W peak	125mW avg., 1W peak	125mW avg., 1W peak

Key

TDMA-FDD Time division multiplex access, frequency division duplex
ACELP Algebraic code excited linear prediction

RPE-LTP Regular pulse excited, long-term prediction
VSELP Vector sum excited linear prediction

Table 3 Mobile Unit Specifications

Model	MT-30	G100
System	GSM	PCS1900
Dimensions	135 x 48 x 26mm with S battery	
Weight	170g (S battery)	
Supply voltage	3.6V	
Battery capacity	600mAh (S battery)	
Talk time	2 hours (S type, 50% DTX)	3 hours (S type, 50% DTX)
Standby time	120 hours (S type)	
Voice transmission	22.8kbps RPE-LTP	22.8kbps RPE-LTP, 22.8kbps ACELP
Data transfer rate	2.4, 4.8 or 9.6kbps	
Peak transmit power	2W	1W
Transmit frequency	890~915MHz	1,850~1,910MHz
Receive frequency	935~960MHz	1,930~1,960MHz

Externally, the cellular phones consist of a flip-open case with a large LCD panel and keypad. Table 5 lists the supported functions, which include a variety of call-transfer and supplementary services in addition to basic voice communication and speed-dialing functions.

Fig. 1 shows a block diagram of the MT-30/G100, which is divided into RF and baseband sections. Both sections operate on a single 3V

Table 4 Accessories

AC adapter	Available for US, UK, continental Europe and Australia
Battery pack	600mAh S type, 650mAh M type, 1,150mAh L type
High-speed desktop charger	Fits main unit and spare battery
Cigarette lighter charger	For rapid in-car charging
"Hands free" adapter	For hands-free operation while driving
Headset	Quasi hands-free conversation
Data adapter	PCMCIA card for fax and data transmission
Data cable	RS-232C for SMS, etc.

power supply. The RF section consists of a power amplifier for the transmitter, a receiver amplifier and an RF processor for transmit and receive functions. The baseband section consists of a microprocessor, DSP and ASICs for baseband and audio processing. Fig. 2 shows the configuration of the system software, which is based on a realtime multitasking operating system.

Fig. 3 shows the configuration of the baseband processing ASIC developed for this application. The device has an analog section with a GMSK modulator and demodulator ADC, and a digital

Table 5 Mobile Unit Functions

Display	4 lines of 12 characters each, double height character support, 11 icons
Control panel	4 cursor keys, 4 function keys, 2 volume control keys, 12-key touch-tone keypad
Antenna	Fixed 25mm
Connectors	RF, DC input, headset, SIM, external I/O
Communication services	Voice communication, emergency calls, bidirectional text message transmission, voice-mail and other notifications, fax and data transmission
Supplementary services	Call transfer, call restrictions, hold, conference calls, caller ID, advice of charge, extension calls and transfers
Speed dialing	Fixed and programmable speed dialing memory, redial, storage of called party's phone number, storage of non-answering party's phone number, scratch pad memory
Other	Network selection, display language selection, keypad lock, call elapsed time display

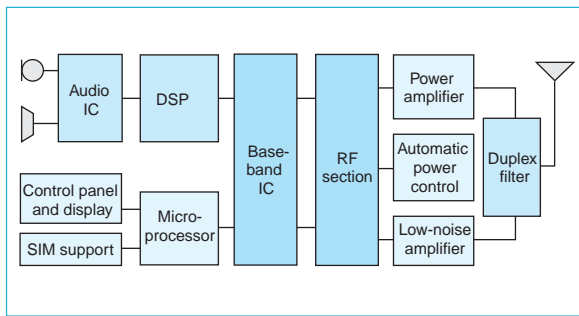


Fig. 1 Hardware configuration.

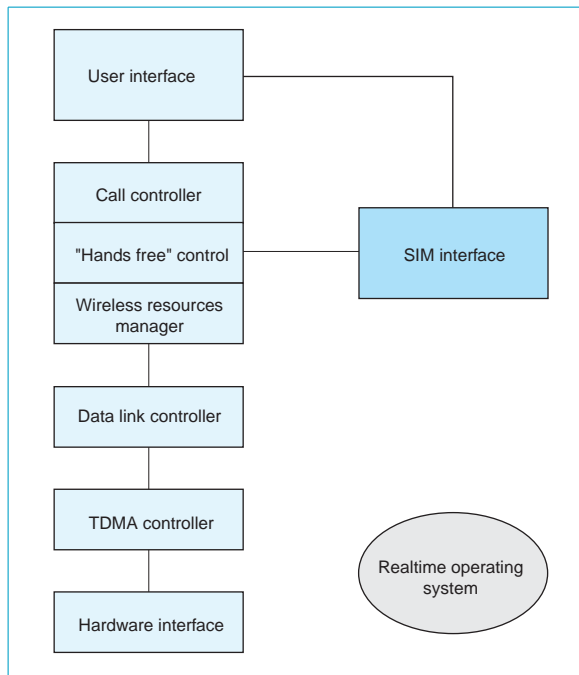


Fig. 2 Software configuration.

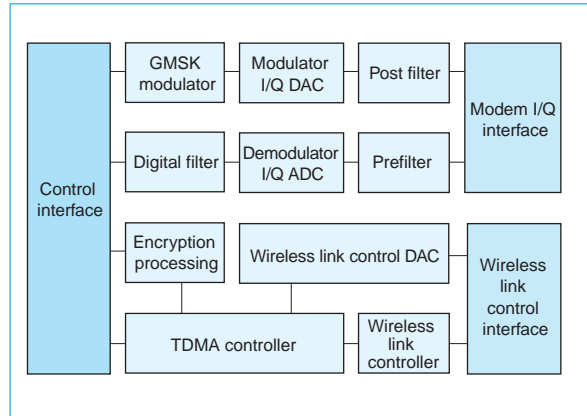


Fig. 3 Baseband IC configuration.

section with a TDMA controller and a micro-processor interface. The TDMA controller supports two clock frequencies, 13MHz and 32kHz, and switches to the slower frequency to save power whenever possible.

The DSP is a single-chip solution that implements a full-rate regular pulse excited long-term prediction (RPE-LTP) audio codec, an algebraic code excited linear prediction (ACELP) audio codec, error-correction coding functions for voice and data transmission and received signal sync detection.

The cellular phone's 3V 2W RF power amplifier IC was developed specifically for GSM applications. This hybrid GaAsFET device has a volume of just 0.4cc while achieving better than 50% efficiency.

Mitsubishi Electric plans to develop smaller and lighter GSM cellular phones based on the technologies presented here while tracking other industry trends and continuing to extend battery operating time. □