DESIGNING THE ISD33000 SERIES INTO DIGITAL CELLULAR PHONES

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Introduction

Cellular phone manufacturers are constantly under pressure to release new models of phones with compact designs and more user features. This puts tremendous pressure on their development teams to re-engineer the phone architecture, software development, hardware development and layout. Time to market with a new product is also crucial for manufacturers to remain competitive.

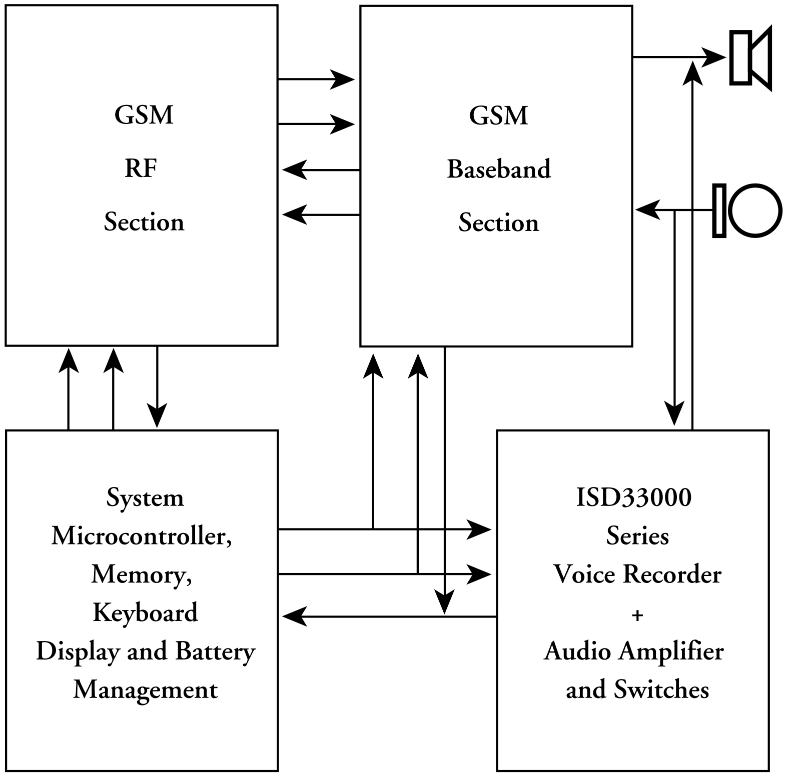
An emerging trend in cellular phone handsets is the addition of “voice” features. These voice features include: 1) the “on-the-fly” recording of telephone conversations, which eliminates the need for writing down notes and improves driving safety by enabling hands free usage, 2) recording voice memos, where reminders are left for oneself, and 3) integrating a telephone answering machine, which can screen or capture otherwise missed calls. The basic function which enables these new features is the ability to reliably record and playback voice messages. To meet the requirements of cellular handset performance, the solution must be low-power, to conserve battery life, have a small form factor, to enable a compact design, low-cost to keep the retail pricing down, and reproduce high quality sound, to meet the expectations of consumers. Additional factors to consider are development time and costs, since a quick time-to-market and effective design investment are critical for new products.

The following design illustrates how a single ISD33000 device can be integrated into a GSM cellular handset to enable these new “voice” features. With minimal hardware and software development, this solution provides one to four minutes of high quality, voice record and playback capability with low-power consumption and minimal board space. In addition, this implementation of the ISD33000 is easily portable to other analog or digital cellular, PCS or PHS handsets because it is integrated in a manner which is independent of the transmission and processing protocol being utilized.

Integration of an ISD33000 into a GSM Phone

The block diagram of the ISD33000 series voice recorder chip integrated into a typical GSM digital cellular phone is shown in Figure 1. The GSM architecture is based on a typical GSM chip-set available from one of the several semiconductor manufacturers in the U.S.A.

Figure 1



The ISD33000 series chip interfaces directly to the earpiece and microphone signals without involving the DSP software for speech encoding and decoding or adding code to the protocol stack, layer 1, layer 2 and layer 3 of the GSM protocol. The ISD33000 series is also connected directly to the system micro-controller's standard 8-bit general purpose I/O port. This connection provides the user interface control and message management.

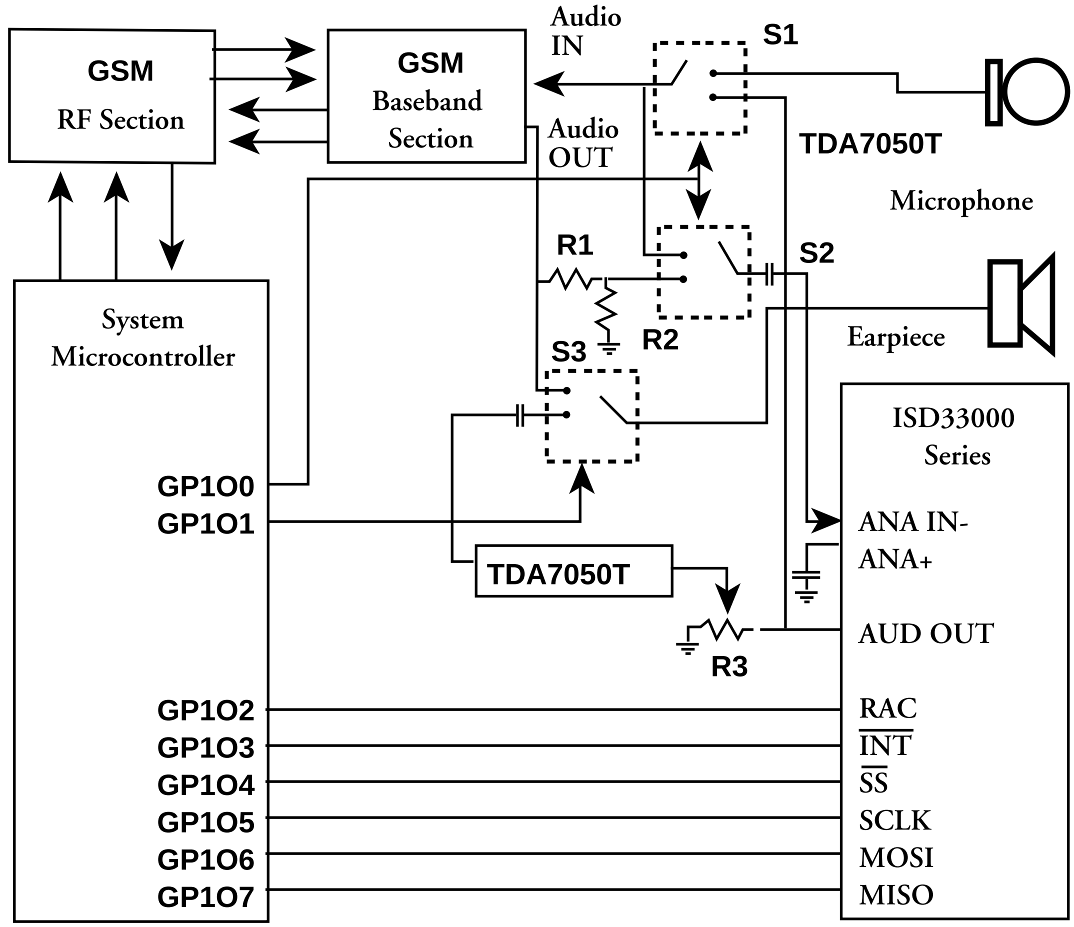


Figure 2

The detailed schematic of the ISD33000 series application is as shown in Figure 2. Besides the voice recorder chip, only two other ICs are needed. Switches S1, S2 and S3 are implemented by using a 74HC4053 as an analog multiplexer switch to select various audio input and output paths. This comes in a single 16-pin SOIC package. TDA7050T, which is packaged in a small 8-pin SOIC, is an integrated audio amplifier with fixed gain to drive the earpiece. A couple of capacitors are used for blocking the DC voltages in several sections of the design as shown.

The general purpose I/O lines on the system microcontroller are used to control and interface with the ISD33000 and the 74HC4053 switches. GPIO0 controls the switches S1 and S2 and does the source selection between the audio input / output of the ISD33000 and the GSM baseband section. Switch S3 is controlled by GPIO1 and multiplexes the audio output of the GSM baseband and the ISD33000 to the earpiece. Resistors R1 and R2 provide attenuation to the signal from the GSM baseband to the analog input of the ISD33000. R3 is used to attenuate signals going to the fixed gain audio amplifier TDA7050T. GPIO2:7 are used to interface with the ISD33000's control signals RAC, /INT, /SS, SCLK, MOSI and MISO. (Note: more information about these signals and their functions can be obtained from the data sheet for the ISD33000.)

Design Considerations for Optimum Performance

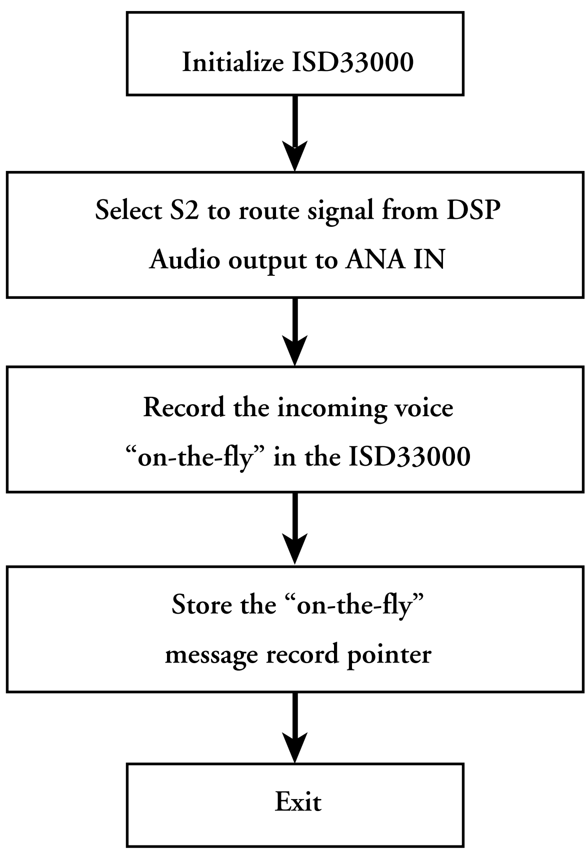
To optimize device performance, care should be exercised with the printed circuit board layout. Power supply decoupling capacitors should be placed as close to the ISD33000 as possible. A good ground plane around the device enhances the noise performance and audio reproduction. All the peripheral components should be placed as close to the ISD33000 as possible and lead lengths and trace lengths should be minimized. If possible, the RF and IF sections of the GSM radio section should be isolated from the baseband section of the phone to avoid noise, spurious injection or pickup from the proximity of resonating components.

Software Considerations

The software development for message management and control of the ISD33000 chip is straight forward. Figures 3, 4, 5 and 6 show basic flowcharts for in system recording "on-the-fly" conversations, announcement or memo recording, automatic answer and message recording, and message playback.

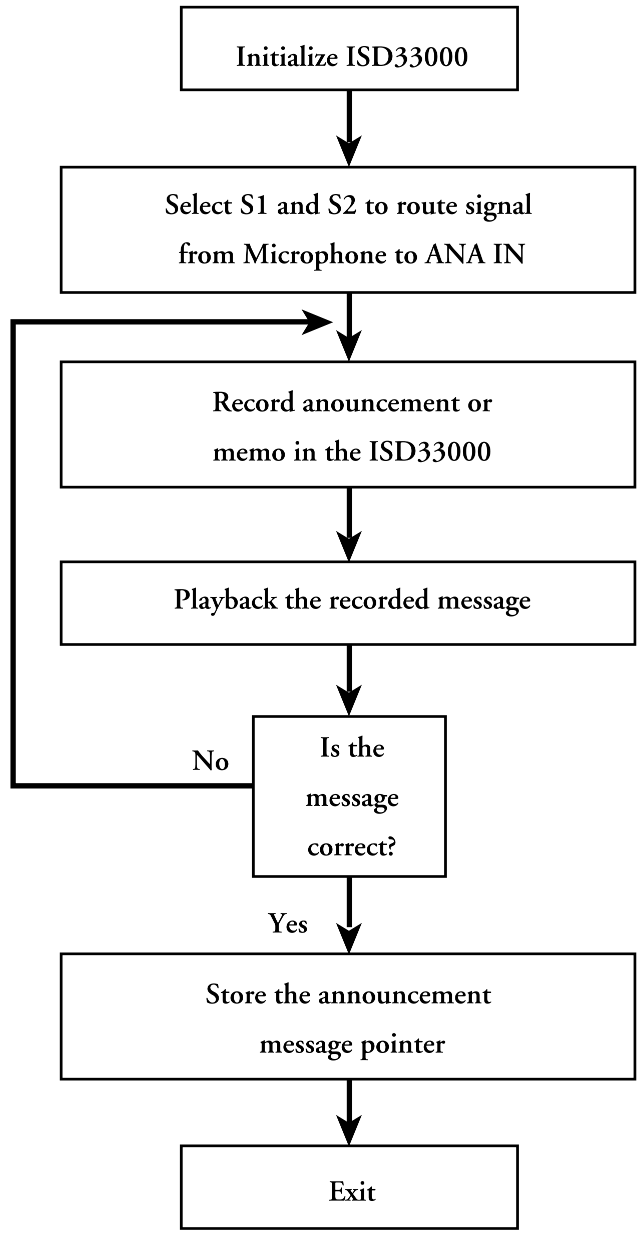
FLOWCHART TO RECORD "ON-THE-FLY"

Figure 3



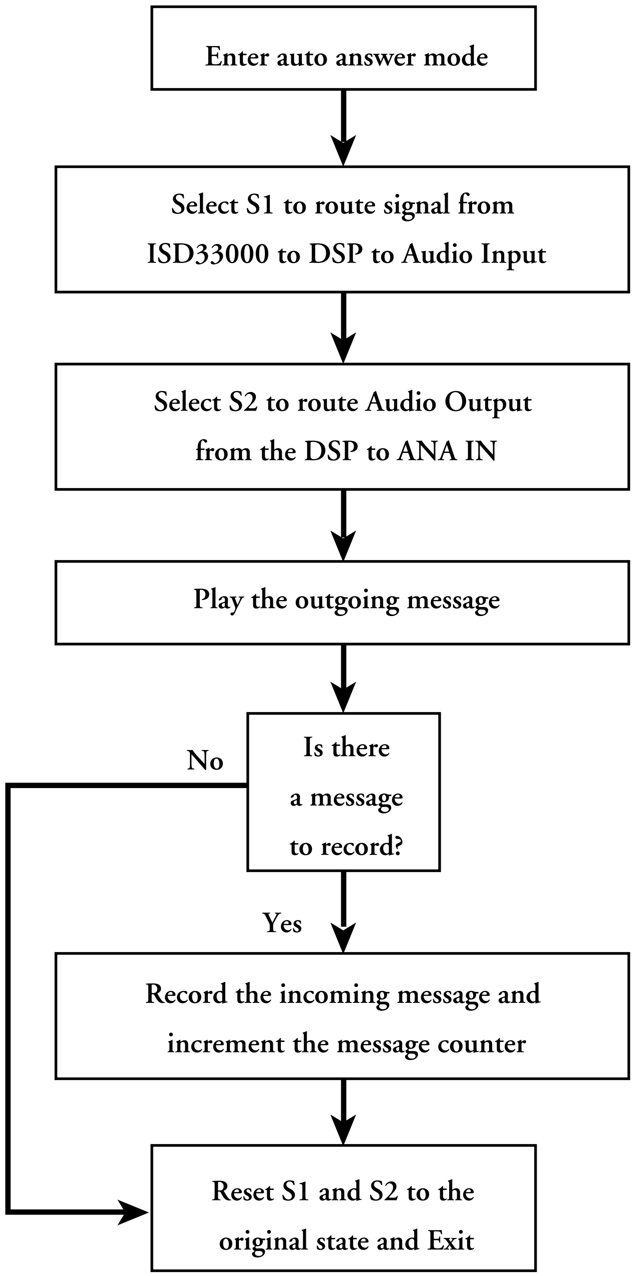
FLOWCHART TO RECORD ANNOUNCEMENT OR A REMINDER MEMO

Figure 4



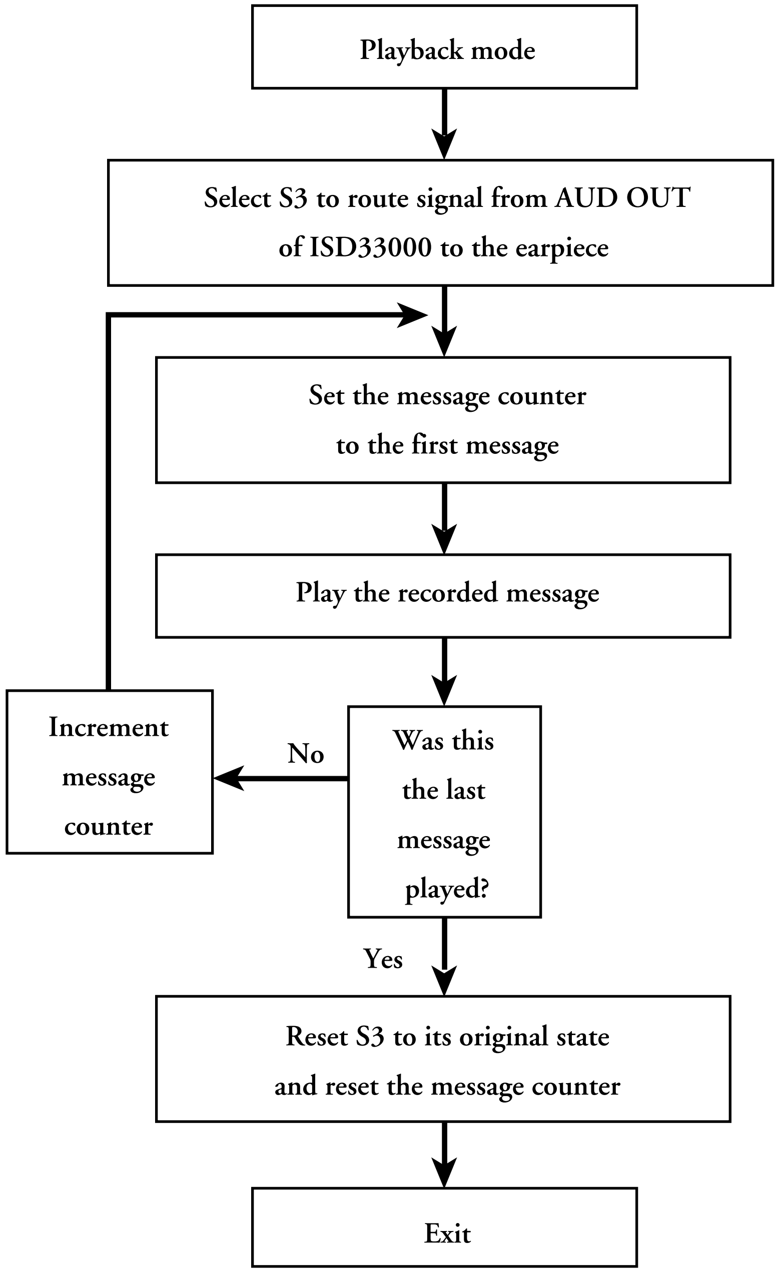
FLOWCHART FOR THE AUTO ANSWER AND RECORD MODE

Figure 5



FLOWCHART TO PLAYBACK RECORDED MESSAGES

Figure 6



Power Consumption

Because of the ISD33000's 3V supply and low current consumption characteristics, adding these new "voice" features does not heavily impact battery life. Table 1 displays the total power consumption for recording, playback and standby. For instance, the ISD33000 in standby mode contributes less than 10 uA. When in active mode it adds less than 45 mA to the system's power consumption.

Table 1

DEVICE	RECORD (mA)	PLAYBACK (mA)	STANDBY
DSP Engine / Core	65 mA	6 mA	6 mA
ISD33000 Series	40 mA	30 mA	10 uA
Micro-controller	30-45 mA	30-45 mA	2 mA
Switches / Amp	8 mA	20 mA	8 mA
Total	~150 mA	~90 mA	~ 16 mA

Advantages of Using the ISD33000 for Voice Storage

There are several advantages inherent in this implementation of the ISD33000 solution. First and foremost is the development time required. The ease-of-use of the ISD33000 series product enables not only a straight forward design, but also a relatively simple software development. In Table 2 overall development time has been estimated to take only a matter of weeks to integrate the ISD33000 into this GSM phone.

Table 2

DEVELOPMENT TASK	ISD33000 SERIES
Hardware Design	3 days
Printed Circuit Board Layout	1 day
Software Development	10 days
Storage Memory Management	2 Days
Message Management	4 days
Total Est. Development time	3 ~ 4 Weeks

This short development time accelerates to market these new “voice” features. Also the single-chip form factor and low-power performance insures the final cellular design will remain compact and provide long battery life. Because the ISD33000 is integrated in the analog audio path and not in the digital baseband section, this solution provides flexible cross-platform solution for digital or analog cellular phones. Since most digital cellular telephone architectures are similar regardless of the protocol standards they implement (IS-54, IS-136, CDMA, etc.), one can easily use this same type of design and expect similar results.

Conclusion

New cost effective features will continue to be required in cellular phones to increase the utility and value to the end-user and to help differentiate cellular phones between manufacturers. The ISD33000 was designed to enable new “voice” features to be added and brought to market quickly, independent of the cellular protocol. Its low-power, ease-of-use, and single-chip form factor all contribute to its value of any cellular phone.