# Line Powered ISDN Telephones Using National's Low Current EPROMs

National Semiconductor
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Designing line powered telephones for ISDN is now possible with the introduction of Low Current EPROMs by National Semiconductor. The stringent power budget of 380 mW imposed by the CCITT is now within the reach of the telecom designer by use of the Low Current EPROMs from the Power Miser family introduced by National Semiconductor. A large portion of the residential telecom lines do not require to carry data. Telephony is, and will continue to be the predominant residential telecommunication service. An ISDN terminal equipment with voice-only capability is sufficient to meet the telecom needs of such customers. Until now, design of line powered ISDN telephones presented a formidable task to the designer. This was due to the amount of power the phones were permitted to draw from the ISDN line. **The advent of Low Current EPROMs makes it possible now to design ISDN telephones which are wholly powered by the ISDN line**.

### THE STANDARDS

The standards for ISDN are specified by the CCITT and adapted for American use by the American National Standards Institute (ANSI). The standard (T1.605-1991) specifies the power consumption of such equipment. Power consumed is defined in terms of Power Consumption Units (PCUs). Under normal operating conditions a PCU is equivalent to 100 mW (NPCU). Under power failure i.e., restricted conditions it equals 95 mW (RPCU). Fractional units are not permitted and are rounded off to the next integer value. Under restricted conditions only 4 RPCUs are permitted. Hence, the figure of 380 mW. A line powered ISDN telephone must, therefore, be able to provide the entire set of features while consuming only 380 mW of power.

### THE DESIGN

*Figure 1* gives the block diagram of a line powered ISDN telephone. The following paragraphs describe the key features and elements of the design. The basic functions that need to be incorporated in the design are

- Protocol Control for signaling on the ''D'' Channel
- Circuit Switched channel for Voice Calls
- Monitoring Functions to power down equipment when not in use
- Keypad and display for user interaction

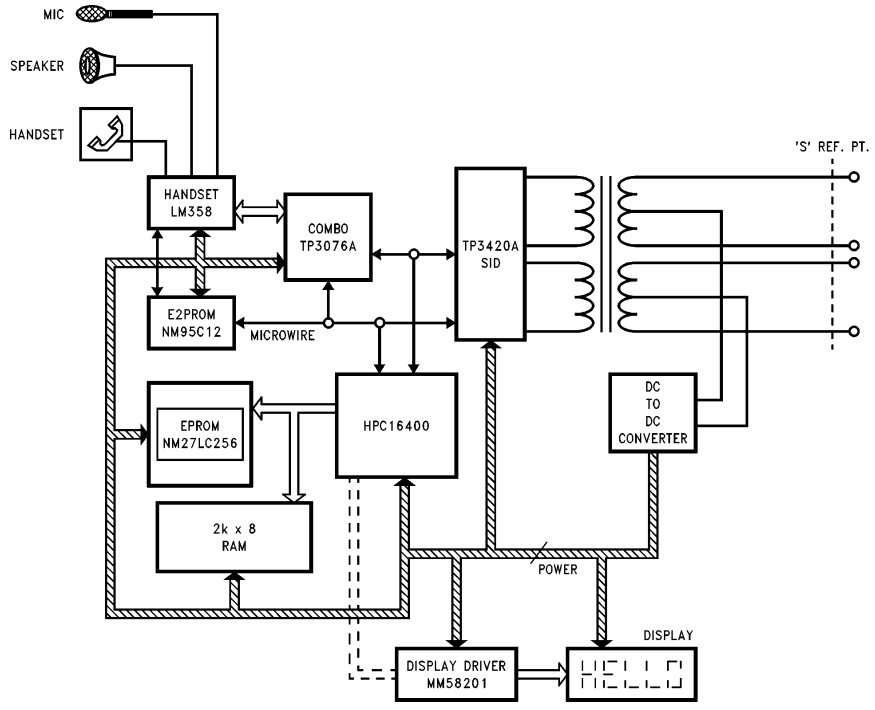


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**FIGURE 1. Block Diagram of ISDN Phone**

## MEMORY

As always, the EPROM is one of the critical components in a microcontroller/microprocessor based design. Important parameters of this building block include density, access time and power consumption. For a design based on 2 MHz processor speed, an access time of 250 ns or better is adequate. A Memory Density of 256 Kbits is typically adequate for ISDN telephony phone applications. The use of the Low Current NM27LC256 from National reduces the EPROM power consumption by over 60%, making line powered ISDN phones possible. As against a power consumption of up to 100 mW in case of standard part the NM27LC256 consumes only 40 mW. This massive reduction of power makes it possible to design an ISDN phone using only the power delivered by the line while implementing a full set of features.

**TABLE I**

| Functional Block | Component | Power |
|---|---|---|
| Microcontroller | HPC16400 | 10 mA |
| Line Interface (SID) | TP3420A | 26 mA |
| Display Driver | MM58201 | 0.3 mA |
| Display | Any 7-Seg 24 Digit | 0.5 mA |
| Codec/Combo | TP3076A | 22 mA |
| Handset Interface | LM358 | 2 mA |
| **Total Power ——** | | **60.8 mA** |

**TABLE II**

| Functional Block | Component | Power | Stdby Power |
|---|---|---|---|
| EPROM | 27LC256 | 4.5 mA | 100 $\mu$A |
| EEPROM | NM95C12 | 4 mA | 800 $\mu$A |
| RAM | 2k x 8 | 5 mA | 50 $\mu$A |
| **Total Power (Worst Case)** | | **5 mA** | **900 $\mu$A** |

Table I lists the components which are constantly on when the phone is in use. These components include the Microcontroller, Line Interface, Display, Display Driver and the Codec. These components form the basic building blocks of the telephone. Table II lists the components in the Memory Section of the telephone. The RAM is required for storing the incoming and outgoing signaling information, which is actually in the form of data packets. For this application a RAM density of 2 Kbytes is adequate. The RAM is also used for the stack operations of the microcontroller. It is important to note that the operation of EPROM and RAM is mutually exclusive. When either of them is accessed, the other is in the standby mode. It is possible, via the microcontroller serial port, to put the codec in the standby mode. This feature is used when activating the E$^2$PROM to reduce the instantaneous power consumption. This causes no operational problems as typically E$^2$PROM accesses are made for abbreviated dialing facility, single key dialing, etc. All this occurs in mutual exclusion to voice communication (conversation).

The E$^2$PROM used in this application is the versatile NM95C12 from National. This device features a 1024-bit E$^2$PROM array, a set of 8 switches which can be programmed to operate in a variety of modes. In this application, the switches are used to direct analog voice signals at the codec either to the handset or to the speaker phone. This feature obviates the use of analog switches, leading to savings in space and power.

**BOX 1**

| | |
|---|---|
| Total Power Available: | 380 mW |
| Available Power with a DC-DC Converter of 88% Efficiency (used in this design): | 380 $\times$ 0.88 = 334.4 mW |
| This gives a current of 66.88 mA @ 5V | |

Box 1 gives the power budget for the telephone system. A high efficiency DC-DC Converter (88% efficiency) was used in this application. It can be easily seen that the use of National's Low Current NM27LC256 makes it possible to meet the requirements imposed by the budget. This would not be the case had standard EPROMs been used. It is possible to design the entire software with the use of the 256 bytes of on-chip RAM on the microcontroller, eliminating the external RAM. Read/Write memory is required for storing incoming packets of information, formation of outgoing packets and stack for microcontroller operation. The packets are typically less than 16 bytes in size as only supervisory and un-numbered frames of LAPD are involved in signaling (no user information). Memory of 128 bytes or greater can be made available for the stack. This would permit the designer to use a standard DC-DC Converter with efficiencies in the range of 80%–85%.

## MICROCONTROLLER AND LINE INTERFACES

An ideal choice for the microcontroller is the HPC16400 from National. This device incorporates a 16-bit core, a selectable 8/16-bit external bus interface, 256 bytes of RAM and most importantly a Protocol Controller for the "D" channel. A key design issue in this case is the power consumption. The HPC16400 consumes a maximum of 10 mA at 5V when operating at 2 MHz—a speed adequate for telephone applications. The National TP3420A SID provides the entire physical interface and the physical layer protocol management for the "S" Reference Point—the interface definition for attachment of subscriber equipment to the ISDN line. The TP3076A from National is an integrated PCM codec and filter designed specifically for ISDN applications. This gives A/$\mu$ law selectability and programmable gain. The

LM358 Operational Amplifier from National operates from a single 5V supply and consumes only a worst case maximum current of 2 mA. The LM358 features dual Operational Amplifiers. One channel may be used for the Handset microphone interface and the other for the Speakerphone microphone.

National also produces a variety of display drivers for LCD applications. Of particular interest in this application is the MM58201 LCD display driver which drives up to 192 segments. It draws minimal power (0.3 mA) and is well suited for the ISDN application where different messages (alphanumeric) are displayed for user interaction (Calling Party Number Indication, Reverse Charging request Indication, etc.). It interfaces via a serial port to the Microcontroller.

**SUMMARY**

The introduction of Low Current EPROMs by National makes it possible now to design ISDN telephones which are wholly powered by the line. The entire set of components required to build an ISDN phone are available from National thus giving a single-point solution to the ISDN designer.

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