

## Connecting a PICmicro<sup>®</sup> Microcontroller to a Standard Analog Telephone Line

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### INTRODUCTION

This application note describes how to connect a PICmicro microcontroller device to a standard analog telephone line in order to send and receive single and multiple frequency signals through modulation and demodulation (i.e., MODEM). Although there are many different elements within a modem system, we are only concerned here with the line connection.

### THEORY

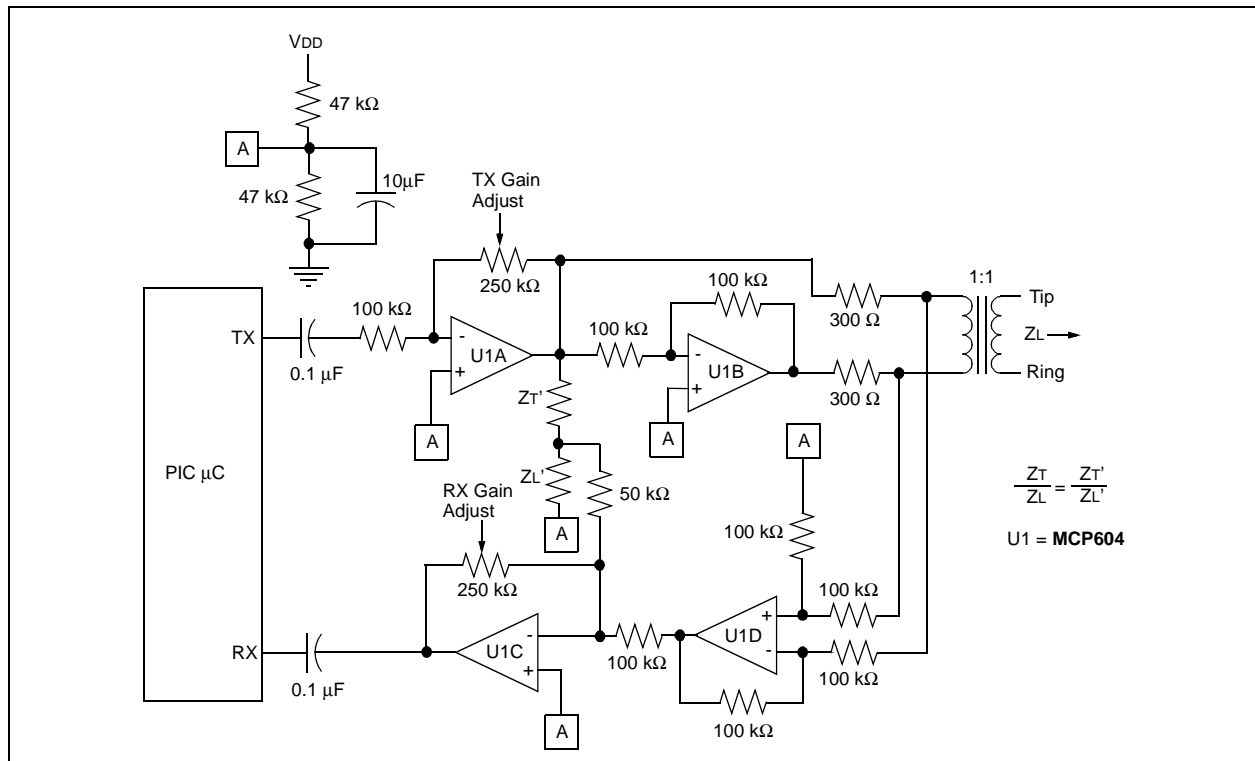
To interface an analog telephone line to a digital microcontroller such as a PICmicro MCU, it is necessary to provide circuitry that will not only condition the signaling, but also protect the microcontroller from over-voltage conditions and noise.

Figure 1 shows how the ring and tip lines run into the primary of a transformer. The hookswitch on the line side of the transformer is not shown but can be implemented with opto-couplers, relays or switches. When a ring is detected, the switch can be closed and the loop is made. This is how a telephone works; the ring is detected audibly and the handset is removed from the cradle creating a loop circuit and presenting an impedance of 600 ohms to the line. ZL represents the Line Impedance which is around 600 ohms. This should be matched on the Termination side (ZT), hence the two 300 ohm resistors. The equation for working out ZT' and ZL' shows that the values for the divider between the Receive and Transmit circuits are a ratio of this Impedance match. This provides the echo cancellation.

### IMPLEMENTATION

Here it is the transformer itself that presents a 600 ohm impedance (Radio Shack part number 273-1374). The primary and secondary windings of the transformer are equal, creating a 1:1 ratio. Analog signals on the line are able to pass in either direction across the transformer field.

**FIGURE 1: EXAMPLE LINE CONNECTION CIRCUIT**



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Some other signal conditioning is necessary to provide useful signals to the microcontroller, standard electronic techniques such as filtering, buffering and amplification are employed to present the signals.

A quad Op Amp (MCP604) is used to provide the two buffers and the two non-inverting amplifiers in the example circuit. A pair of potentiometers are employed to adjust the gain of the amplifiers. This is adequate in this application, but telephone specifications can be very broad, and factors such as distance from the local exchange can have a significant effect on ring and signal amplitude. Classic modem designs use an Automatic Gain Control (AGC) circuit to make sure the presented signals are of a specified size. This could be implemented using the PICmicro microcontroller and a Microchip Technology Inc. Digital Potentiometer via their onboard SPI™ Modules. The MCP42100 has max. resistance of 100K Ohms and has 2 pots in a single package.

## SUMMARY

Once the data is presented to the PICmicro MCU, it can be encoded and transmitted, or decoded and acted upon. Decoding applications include simple FSK/PSK fax/modem protocols (e.g., V.23/Bell202), DTMF decoding for routing, or simple data applications and Caller ID which is based largely on the 1200 baud FSK data specifications. Encoding applications include FSK/PSK fax/modem, DTMF telephone dialer and remote diagnostics, where, for example, a drinks machine in a hotel can dial-up to it's company and request service because it just ran out of diet beverages.

## REFERENCES

*PIC18CXX2 Data Sheet*, DS39026C -  
Microchip Technology Inc.

*Understanding Telephone Electronics* (4th Edition) -  
Bigelow, Carr and Winder

*Hughes Electrical Technology* - McKenzie Smith

*MCP60X Data Sheet*, DS21314D - Microchip  
Technology Inc.

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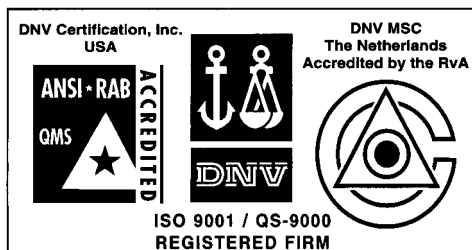
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08/01/02