TERIDIAN SEMICONDUCTOR CORP.
A Maxim Integrated Products Brand

73M1x22/73M1x66B
MicroDAA

WHITE PAPER

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MicroDAA Hybrid Operation

This white paper provides supplemental information as to how Teridian's MicroDAA™ devices (73M1x22 and 73M1x66B) manages the DAA two-to-four-wire conversion.

Introduction

The MicroDAA line-side operation has several different functions that support the interfacing to the telephone network.

Coming from the line, the first component, other than passives for EMI and surge protection, is the diode bridge. The reason for this is to assure that the DC voltage from the telephone network has the proper polarity in relation to the active circuitry in the active analog interface that follows it. The telephone network could have either of the pair of wires positive or negative in relation to the other. If any of the transistors or the line-side IC were to have the wrong polarity DC voltage applied, they would be destroyed.

There are also separate switches for the AC and DC Current paths. The DAA must present the proper DC load to the line so that the CO (Central Office) knows that the CPE is there and actively connected. This must sink the network supplied DC current that indicates to the CO that the line is off hook, and also present a high impedance to the AC signals. This current across the DC resistance sets the DC operating voltage across the line. The final functions are the AC circuits that do the actual analog communications to allow voice and data to be sent and received. Both the transmit and received signals are passed over this two-wire pair, and this must be done in such a way that they do not interfere with each other. The AC impedance must match the characteristic impedance of the line in order for the signals to be separated from each other effectively at each end. A circuit called a "hybrid" performs this separation. The Micro DAA performs the impedance matching internally by allowing the selection of the impedance through a programmable register. This minimizes the effect of the AC impedance of the network by presenting a similar impedance to the network, so the level is relatively constant at all frequencies.

Hybrid Operation

The purpose of the hybrid is to remove the transmitted signal from the mixed transmit and receive signals that are present on the line. This is done by summing an inverted transmit signal with the combined transmit and receive signals, which nulls out the transmit signal present on the line leaving (ideally) only the received signal. This is illustrated below using DC voltages, but the operation is also true of an AC signal as long as the phase relationship is maintained.

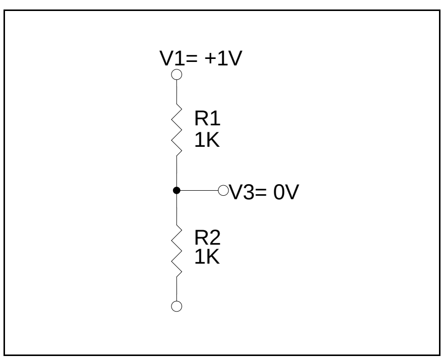

Figure 1: Illustration of the Nulling of a Voltage

A simplified diagram of the transmit and receive circuits is shown in Figure 2. The transmit signal drives the line as a transconductance amplifier. Its input signal is converted to current by impressing it across the 174 Ω ACS resistor. Both the transmit signal and the received line signal are shaped as needed by the impedance matching filter (not shown) and applied to the input of the AC transconductance circuit. The output used for the hybrid, TXM, is separate from the one used to drive the line. The receiver has two inputs. One comes from the combined transmit and receive signals that are connected to the line, and the other is for the signal that is used in to remove the transmit signal from the receive path.

The following illustrates the operation of the hybrid. If two equal but opposite voltages are applied to a pair of equal series resistors, the voltage at the point at which they connect will be equal to the sum of the voltages (+1 V + -1 V=0 V). If V1 is increased to 3 V and resistor R1 is increased to 3 kΩ, the current through R1 and R2 is still 1 mA, so the voltage drop across the resistors will still be equal to 0 V at V 3. As long as the scaling of the resistors and the voltages are maintained, the summing point V 3 will remain at 0 V.

Rather than summing directly, the inputs from the inverted transmit signal TXM is fed from a resistor into a current source which maintains the common mode voltage level of the RXM input. The transmit signal from TXM is scaled down to 1/3 the level sent onto the line because the 73M1916 and 73M1912 operate from a 3 V power supply and cannot work directly with the potentially higher levels seen at the line. The signal coming from the line, that has both the transmit and receive signals on it, comes into the RXP input and sees an identical current source to the one used on RXM, so the inputs for RXM and RXP appear electrically identical. The resistor from the line to RXP is three times the resistance (53.2 kΩ) as the resistor from TXM to RXM (17.4 kΩ), so the scaling of TXM output and the output from the transmitter are now the same as in the example. The outputs of the two amplifiers are summed and the signals from the transmit and inverted transmit from TXM cancel each other out leaving the receive signal. The receive signal is also scaled by one-half to prevent it from overdriving the receive circuits of line-side device.

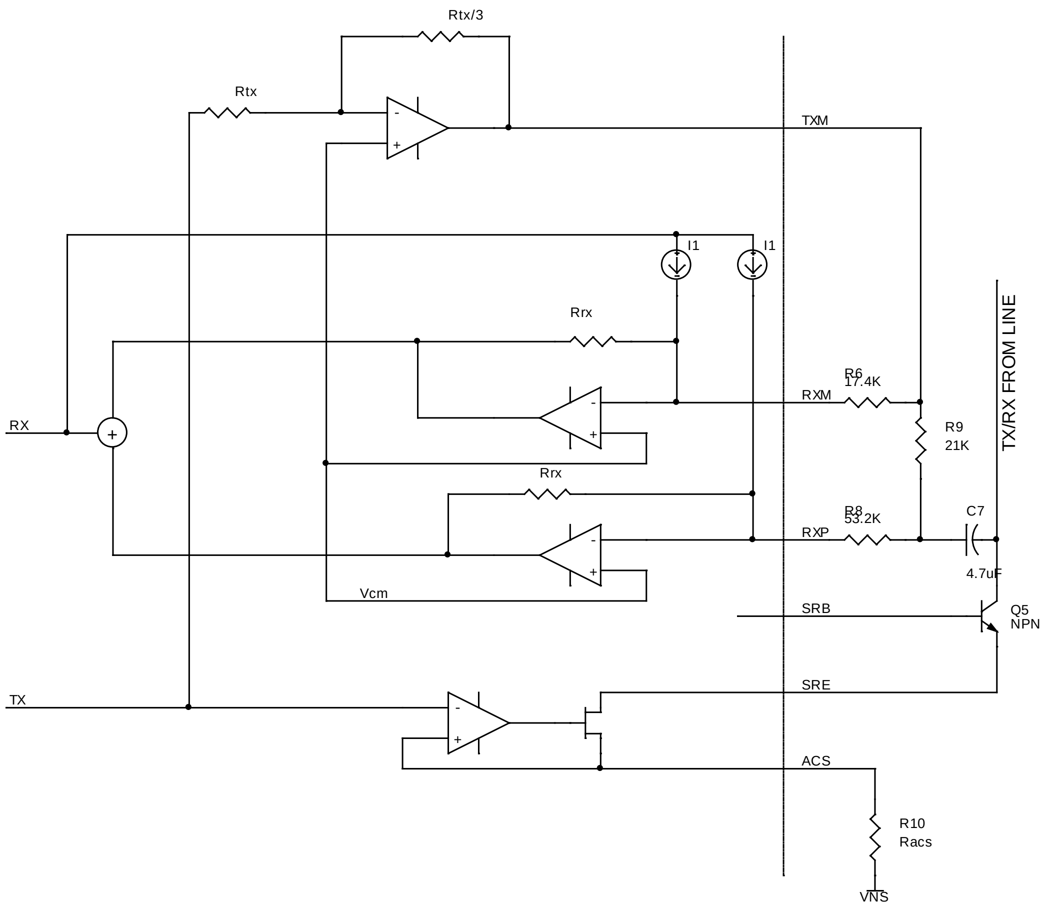

Figure 2: Simplified Line-Side Transmit and Receive Circuits

Although the topology of the 73M1x66B and 73M1x22 is unique in many ways, the theory of operation of the hybrid is not much different from many traditional designs. The high degree of integration makes it a little more difficult to understand what happens internally, it is not hard to understand once some of the details of the internal operation are revealed.