AN_2901_017 **JULY 2005**

73M2901CE Ring Detection Using Optocouplers

INTRODUCTION

Optocouplers have been commonly used for telecom ring detection for many years due to their simplicity and ease of use. Figure 1 shows a typical half wave optocoupler circuit. All the components except U1 and D1 are in series, therefore the order in which they are connected is not important. The ring detect circuit must be AC coupled and present a relatively high (60kΩ minimum) impedance to the line with low amplitude AC voltages. This is to prevent the circuit from interfering with the audio signals when the line is in use. In Figure 1, C1 provides AC coupling for the circuit. R1 limits the peak currents and D2 and D3 provide a method of preventing

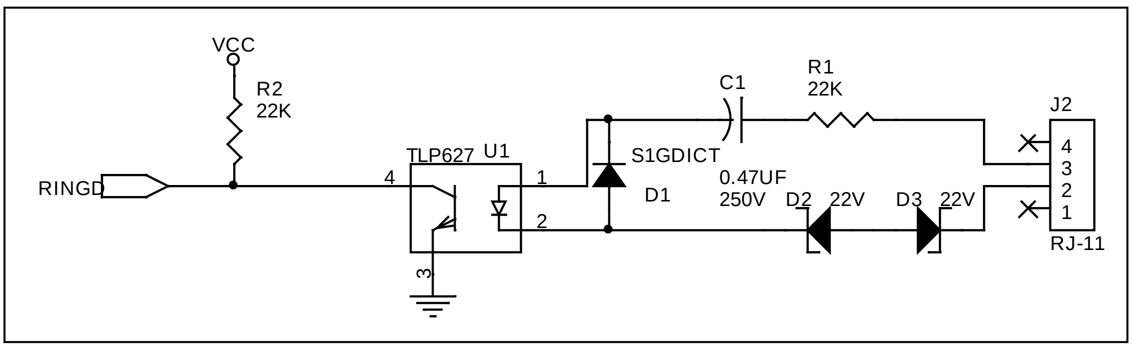

Figure 1: Typical Optocoupler Ring Detector Circuit

low-level ac signals and noise from triggering the circuit. Back-to-back zener diodes are used so the load is symmetrical on both AC half cycles. U1 requires D1 in parallel with the input diode opto-emitter to prevent the input of the optocoupler from acting as a rectifier and pumping up a DC voltage on C1 during ringing. If this were to happen, the circuit would stop detecting the incoming ring as the DC voltage builds up on each ring half cycle.

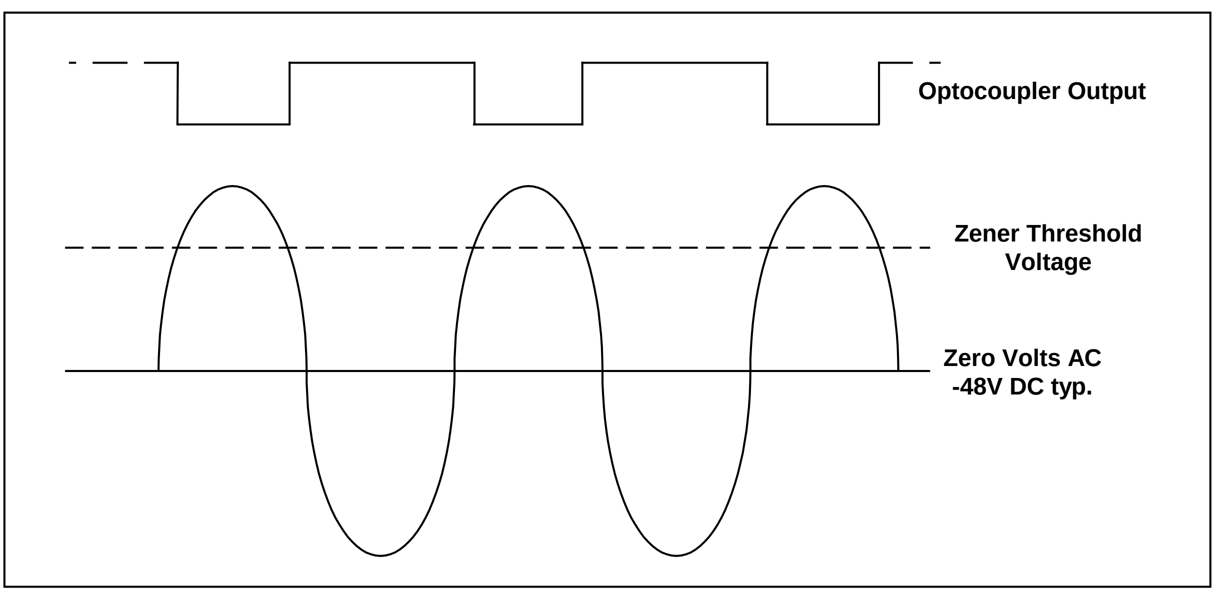

Figure 2: Ring Detector Waveforms for the Circuit in Figure 1

Figure 2 shows what the output will look like using the circuit in Figure 1. With each positive half cycle, when the ring signal exceeds the level of the Zener diode, the optocoupler input is turned on which causes the output to go low. If a full wave optocoupler is used, both the positive and negative peaks will trigger the output to go low.

When an optocoupler with a Darlington output is used, the current transfer ratio (CTR), or gain from input to output will be higher, so a larger resistor can be used for R1. The values of R1 and R2 are related by this CTR. The value of R2 determines the rise time of the output, so it should not be too large or higher frequency ring detection will be compromised. The ring voltage varies considerably worldwide, so the values for the zener diodes may need to be adjusted for countries that have lower ringing voltages. The components used in the ring detection input circuit affect the REN (Ringer Equivalency Number) rating of the modem. The REN is determined by the ratio of the AC impedance using different frequencies and voltages compared to the minimum allowable impedances for those conditions. The REN will be the highest value calculated from these values and will be a fraction of 1. Using the above circuit the worst case REN would be .7 at 68Hz and 62 VAC.

73M2901CE RING DETECTION

The 73M2901CE provides software support to discriminate virtually any ring signal that is likely to exist. Ring detection waveforms and cadence are illustrated in Figure 3. S17 and S18 determine the ring frequency range (not to be confused with the cadence) that will be accepted as a valid ring by analyzing the frequency of the ring detect circuit pulses. If the frequency falls between the upper (S18) and lower (S17) limits, the ring frequency is considered valid. Registers S51 through S58 determine the cadence of an acceptable ring signal. There are two cadences that can be defined. Registers S51 – S54 determine the on and off time limits for cadence A and registers S55 – S58 the on and off times limits for cadence B. If only cadence A is defined, only one cadence will be qualified. S29 register bit D6 is used to define whether two alternate cadences (either/or) or a dual cadence (both cadences must be present) will be qualified. The alternate cadence mode (S29 bit 6=0) is the default. The default settings only define cadence A, with time settings of 1.6 seconds ON minimum, 2.4 seconds ON maximum, 3.2 seconds OFF minimum, and 4.8 seconds OFF maximum. These values loosely bracket the 2 second ON and 4 second OFF times used in the U.S. See the 73M2901CE User Guide for details on setting S17, S18, and S51 through S58.

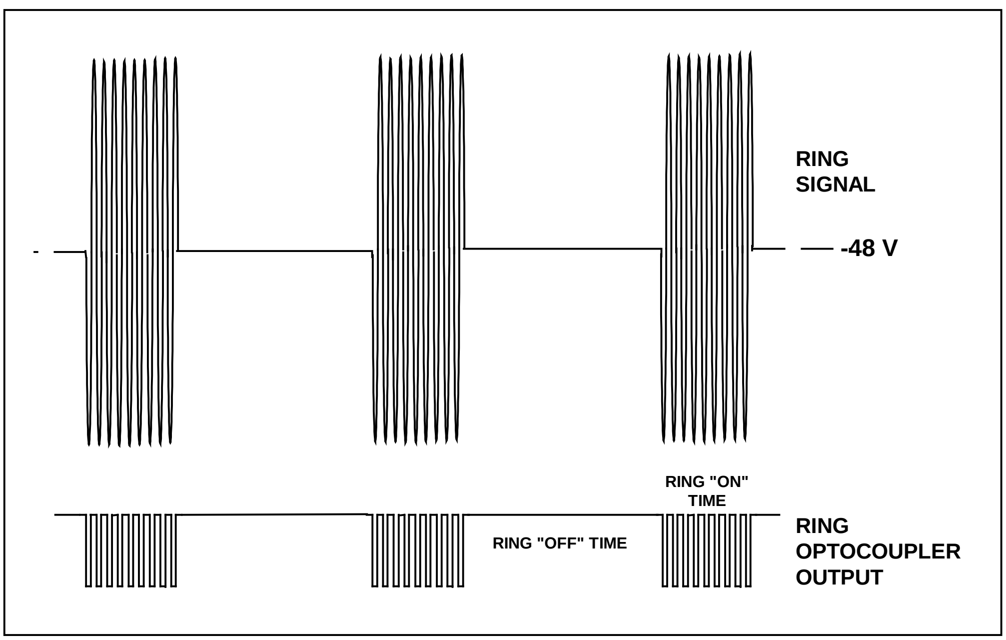

Figure 3: Ring Signal Input, Output, and Cadence

73M2901CE OPTOCOUPLER RING DETECTION TROUBLE SHOOTING

First, check for hardware problems. Look at the waveform of the ring signal at the ring input pin. This should be as symmetrical as possible; it does not need to be perfect (it really cannot be perfectly symmetrical since the optocoupler is only on for a fraction of a half cycle), but you do not want small slivers of a signal or signal levels limited by the rise and fall times of the optocoupler. This indicates that the signal is near the limits of operation for the detector circuit. If the ring peak voltage is not significantly higher than the zener voltage, the component values can be adjusted. The peak voltage should be about twice the voltage rating for the Zener diodes in the detector circuit. The series resistor and capacitor can also be scaled to the voltage and ring frequency. The pull-up on the optocoupler output can also be adjusted to improve the rise times, but be careful that the Vol level does not become too high as well (this is primarily a function of the CTR). Once you are sure the hardware is working properly, you can look at the settings of the S registers.

It is important to know the parameters governing the ring signals that need to be detected. Without knowing the range of ring frequencies and cadences that will be expected, it is difficult to set the limits through the S registers. Broad limits can be set, but in some cases, this could mean detection of things other that valid ringing. In some cases PTT testing will include signals that should not be detected, and these need to be accounted for in the register settings. It is much better to know the range of parameters that can be expected and setting limits loosely around them. Also, it should be noted that when using a full wave optocoupler, the output frequency of the detector will be twice what it is for a half wave detector, so S17 and S18 should be set accordingly with full wave detectors. In many cases the ring detect circuit is also used to detect line reversals for Caller ID, in which case a full wave detector is needed (the 73M2901CE software supports this feature).

73M2901CE ENERGY RING DETECTION

The 73M2901CE has a new feature that was added with the intention of lowering the total modem cost by eliminating some of the more expensive external components. The threshold for the ring detector depends on the setting of the S123 register and the components in the Caller ID path, especially the transformer. The number that S123 is set to represents the amplitude threshold of the ring signal (see Table 1). In a conventional ring detect circuit the threshold is set by the hardware, usually the values of the zener diodes in the ring detect circuit.

Table 1: Approximate Thresholds for 73M2901CE Energy Ring Detection

US Wet Transformer					
S123 Register Setting with Frequency Checking	20	15	10	5	3
Vrms min off to on	45	34	24	12	7
Vrms min on to off	42	32	22	10	5
Australian and CTR-21 Dry Transformer					
S123 Register Setting with Frequency Checking	20	15	10	5	3
Vrms min off to on	5	5	5	5	5
Vrms min on to off	5	5	5	5	5

Having the ability to set the threshold over a wide range through the S123 register eliminates the need to change components to adjust the ring detection sensitivity. Energy ring detection uses the Caller ID path and coupling transformer path to pass the incoming ring signal to the modem so it can detect the ring signal using the internal DSP. In an average design this can save at least $0.35 in the total parts cost or even more in lower volume products. The 73M2901CE supports the optocoupled ring detection method.

Wet transformers generally have poorer frequency response in the ring frequency range than dry transformers. This means that the threshold must be sent to a lower number for wet transformers than with some V.90-rated dry transformers. This also means that lower frequency ring signal detection will also require a lower setting.

The range of values for S123 can be from 1 to 127 when checking frequency (S17 and S18) or 129 to 255 when not checking frequency. The practical range is from 3 to 30 when checking frequency, depending on the transformer, Caller ID series resistor, capacitor, and the ring frequency.

The other ring parameters such as ring frequency (S17 and S18) and cadence (S51-S58) still need to be programmed when using energy ring detection.

The typical 73M2901CE initialization string for ring detection and auto answer for the U.S. would be:

ATS123=7S0=1<CR><LF>

For other countries, the other ring parameters should also be individually programmed, or the S99 register can be used to program all the country parameters.