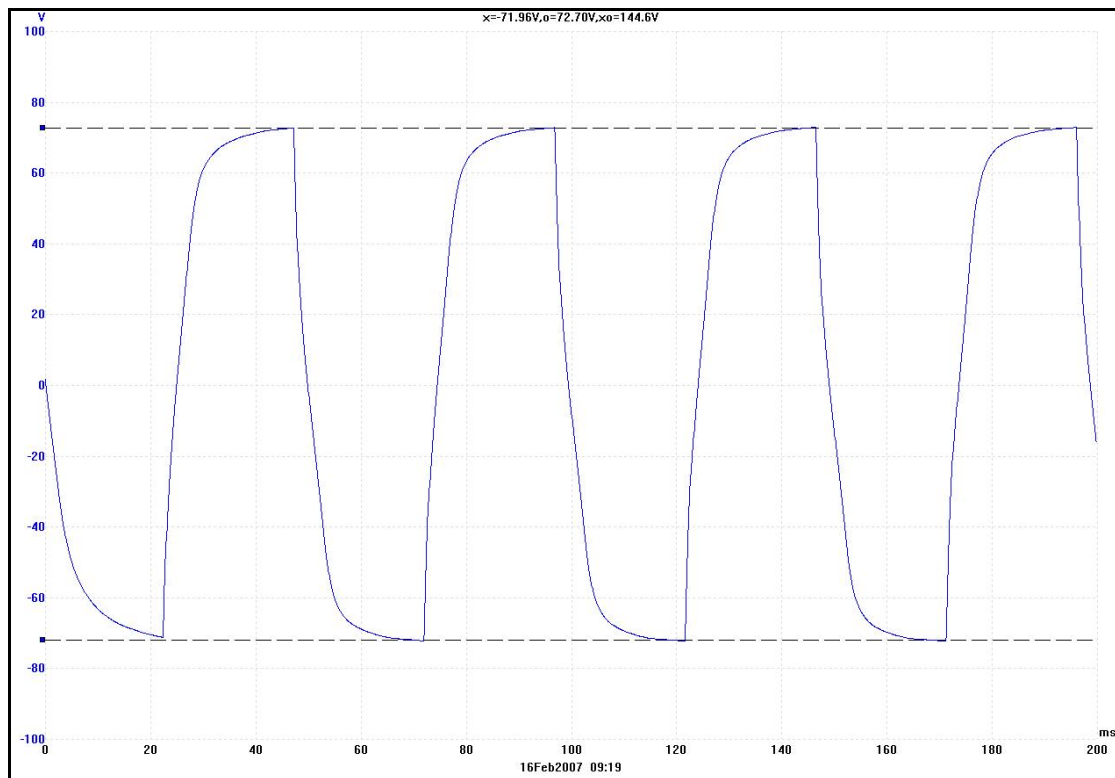


The Ag1170 can generate a ringing signal by simply toggling the F/R input at the required ringing frequency, with the appropriate ringing cadence applied to the RM input. This method is shown and explained in the “Ringing” section of the Ag1170 datasheet. Figure 1 shows the ringing signal at Tip – Ring when using this method - RM is set to Logic 1 and a 20Hz square wave is applied to F/R.



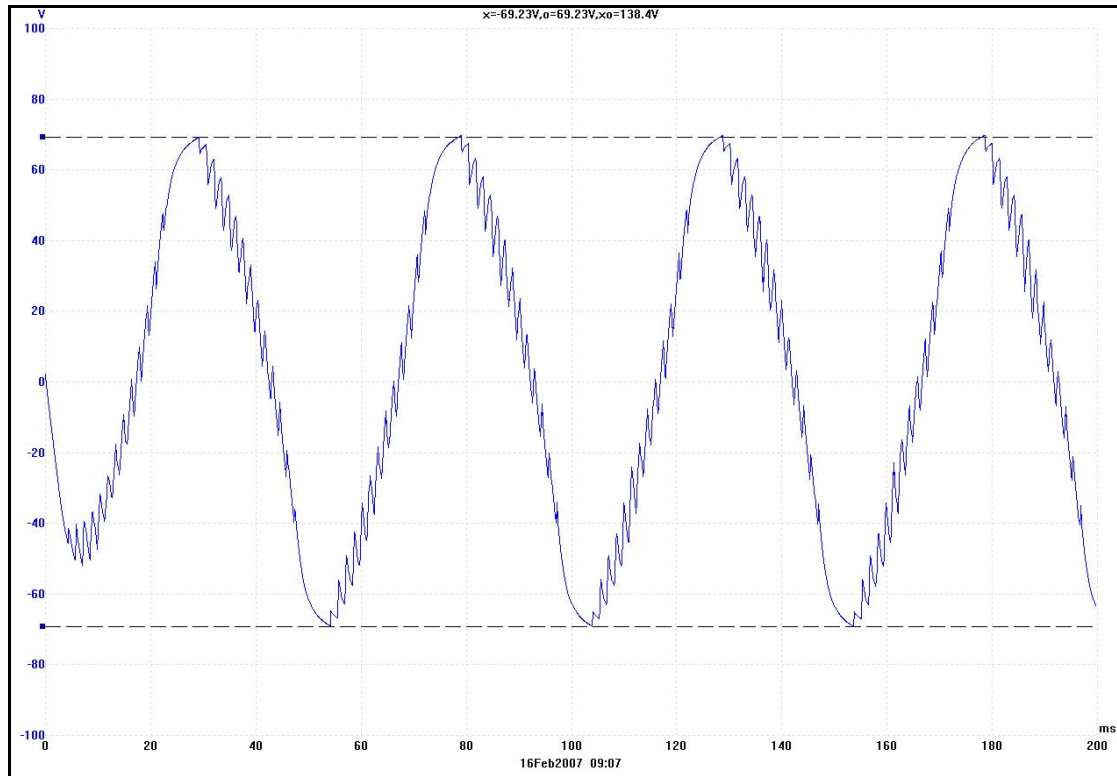
**Figure 1: Typical Ringing signal at Tip - Ring**

In practice this ringing output is perfectly acceptable and will ring almost all telephones with an electronic or mechanical ringer. Because of the trapezoidal shape of the ringing waveform the Total Harmonic Distortion (THD) is approximately 25%.

Some applications require a sine wave ringing waveform. An alternative method for generating the ringing signal is to apply a PWM signal to the F/R input (instead of a standard square wave). Applying a PWM signal will result in the Ag1170 producing an approximate sine wave at Tip – Ring, instead of a trapezoidal waveform which is produced when using a square wave.

Figure 3 shows a portion of the PWM signal applied to the F/R input and Figure 2 shows the ringing signal that is generated at Tip – Ring. By using this method a THD can be reduced to less than 5%.

# Ag1170 Sine Wave Ringing



**Figure 2: Sine Wave Ringing signal at Tip - Ring**

The example shown in this application note uses a carrier frequency of 700Hz. Residual carrier presents itself as noise in the THD + Noise result of 17%. However THD specifications measure only up to the 7<sup>th</sup> or 9<sup>th</sup> harmonic (180Hz) so the carrier frequency will not affect the THD measurement.

Sine wave ringing has a lower RMS voltage than square wave ringing (for the same peak voltage), this is shown in Table 1 below. For Square wave ringing the Ag1170 datasheet specification is 3 REN. As the Ag1170 output transistors spend a longer time in linear mode with sine wave ringing their power dissipation is higher. Because of this the maximum ringing load allowable is reduced to 2REN at 40Vrms.

REN load is FCC68 = 10uF + 7Kohm.

Load	Square wave	Sine wave	Comments
O/C	65Vrms	51Vrms	
1REN	58Vrms	46Vrms	
2REN	53Vrms	42Vrms	
3REN	46Vrms	38Vrms	Short time only to prevent overheating.

**Table 1: Ringing Load v Output**

# Ag1170 Sine Wave Ringing

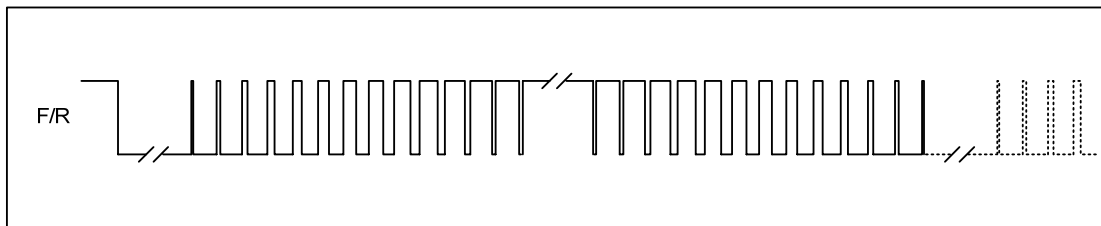
The measured Ag1170 "Ring Trip" capability (max. loop resistance to guarantee Off Hook detection while ringing) is reduced when using sine wave ringing. It is only 400 ohms (compared to 500 ohms for standard square wave ringing). With a 300R telephone set this leaves 100R for the loop resistance which is 600 metres of 24AWG (0.5mm) cable.

The PWM signal can be generated quite easily by using the following method. In the example given below 1 count = 100us, this will generate a 20Hz ringing frequency. The sum of the Logic 1 and Logic 0 counts shown in Table 2 = 500, this multiplied by 100us = 50ms (20Hz = 1 / 50ms). To generate 25Hz just change the count time, so 1 count = 80us, 500 counts x 80us = 40ms (25Hz = 1 / 40ms).

Start the ringing sequence with F/R set to logic 1 (Forward), then using Table 2 the first logic sequence starting at Step 1 "Logic 1 count" = 0. This is then followed by Step 1 "Logic 0 count" = 68, so this first step will set F/R to logic 0 for 68 counts (6800us). Now we move on to Step 2 "Logic 1 count" = 1 (100us), this is followed by Step 2 "Logic 0 count" = 13 (1300us). Continue through the rest of the 28 steps to complete one cycle, then go back to Step 1 "Logic 1 count" and repeat. Using this method Figure 3 shows the pulses that will be seen at the F/R input.

F/R Ramp Steps	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Logic 1 count	0	1	2	3	4	5	6	7	8	9	10	11	12	13	68	13	12	11	10	9	8	7	6	5	4	3	2	1
Logic 0 count	68	13	12	11	10	9	8	7	6	5	4	3	2	1	0	1	2	3	4	5	6	7	8	9	10	11	12	13

**Table 2: F/R Ramp Steps Sequence**



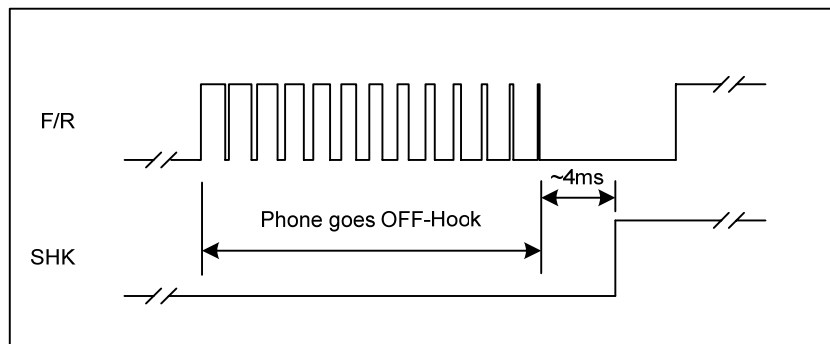
**Figure 3: PWM signal applied to the F/R input**

The F/R signal should be cadenced with the RM input as it would with square wave ringing. So if the required ringing cadence is 1 second ON and 3 seconds OFF, the following sequence must be followed: -

- 1 – Set RM to Logic 1
- 2 – Apply the logic sequence shown in Table 2 to F/R and repeat 20 times.
- 3 – Set F/R to Logic 1, set RM to Logic 0 and hold for 3 seconds.
- 4 – Repeat the above steps.

## Ag1170 Sine Wave Ringing

During the above sequence SHK must be monitored to determine when the phone goes OFF-Hook. When a valid OFF-Hook is encountered the ringing sequence must be exited with RM set to Logic 0 and F/R set to Logic 1. However the SHK output does not respond to an OFF-Hook condition during the PWM cycles (ramp steps 2 to 14 and 16 to 28) and takes approximately 4ms after these steps for SHK to respond. Figure 4 shows how SHK responds when the phone has gone OFF-Hook at some point during the PWM ramp steps 16 to 28. The best option is connect SHK to an interrupt, but if this is not possible then the best places to test SHK is after step 1 (before step 2) and after step 15 (before step 16).



**Figure 4: SHK Response Time**

The 68 count delays in steps 1 and 15 are sufficient to allow the SHK output (~4ms) to respond. If SHK is Logic 1 remember to recheck it after a few milliseconds to ensure that this is not a false SHK response. If it is a false SHK then return to the ringing routine and continue with the next step. If it is a valid SHK then exit the ringing routine setting F/R to Logic 1 and RM to Logic 0.

This application note has been tested on the Ag1170 evaluation board (EVALAG1170); which uses a Microchip PIC16F88. The schematic of this board and the assembler code (.asm file) for sine wave ringing are both available upon request.