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Generating Fixed Frequency Sine Waves with ML2035

The ML2035 Programmable Sine Wave Generator is a convenient solution for generating accurate sine waves. Often an accurate fixed sine wave reference is required in applications such as Uninterruptable Power Supplies. Normally a microcontroller or microprocessor is used to program the ML2035's output frequency.

Most power supplies do not incorporate a microprocessor. This application note will show several alternate methods for programming the ML2035 for 50 or 60Hz sine wave output using off-the-shelf components.

The circuit in Figure 1 programs the ML2035 for 60Hz. The circuit shifts in the decimal number 141 to get to 60Hz with a NTSC color burst crystal (3.579545 MHz).

The 'HC4060 counter is used as an oscillator and timer. Q5 stays high for 16 clock cycles. During the first 8, the 'HC165 shifts out the codes on A thru H which are the complements of 141 (Binary 1000 1101) LSB to MSB respectively. During that time, SI on the 'HC165 shift register is also high. That means that for the next 8 clock cycles the Q BAR output will be low, loading in 0's for the most significant 8 bits. SCK on the ML2035 and CLK on the shift register are run from complementary phases of the oscillator, since the 'HC165 changes data on the rising edge of its CLK and the ML2035 latches the same data on the rising edge.

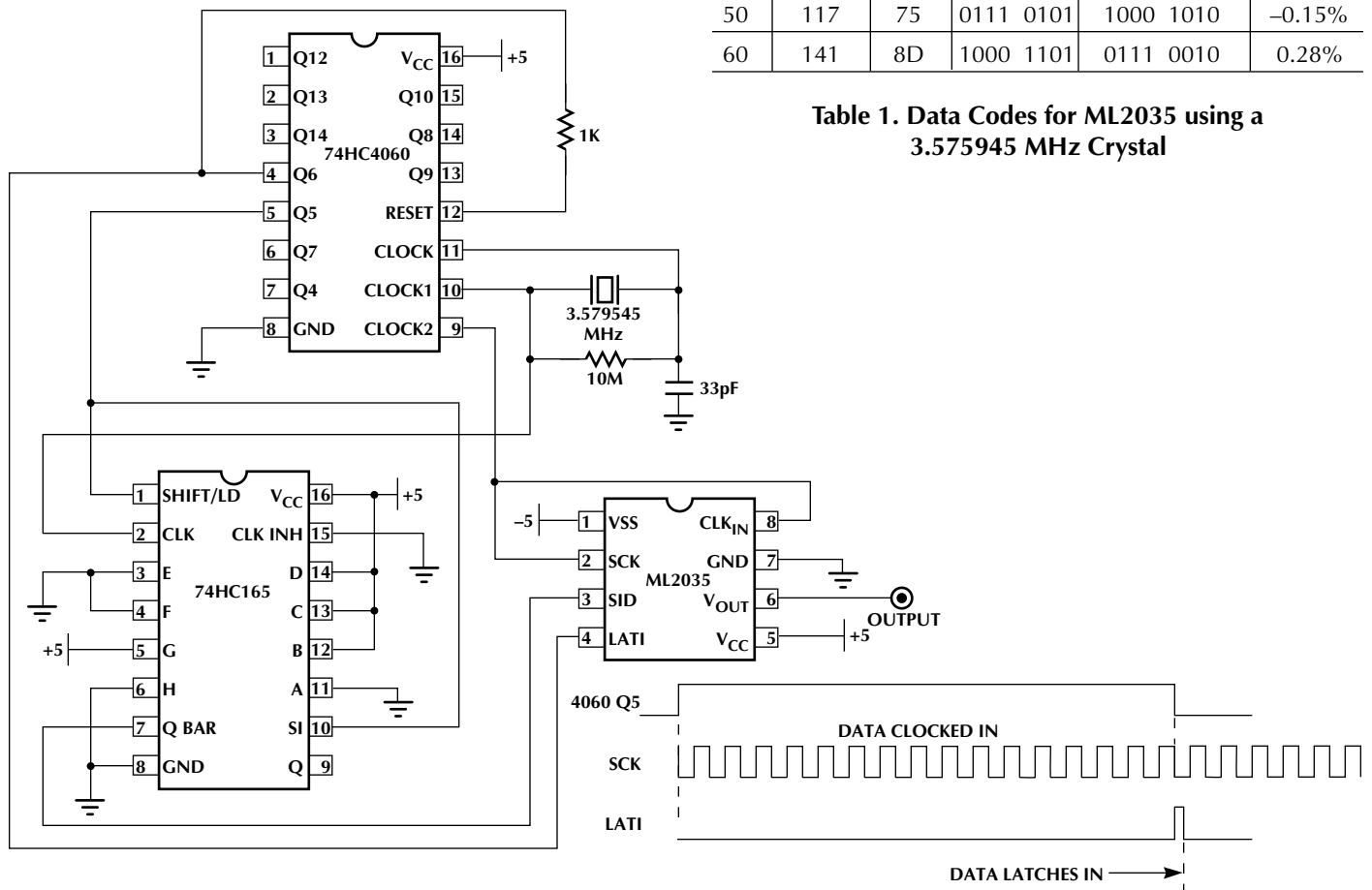


Figure 1. Programming the ML2035 for 60Hz. output using NTSC color burst crystal.

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When Q5 goes low again, Q6 goes high providing a reset for the counter and also a short pulse for the LATI input. The 1K resistor between Q6 and the 4060 Reset line delays the reset slightly, effectively stretching the LATI pulse to 50nS.

This circuit could also be run from +10V and GND by creating an "artificial ground" at 50% of the 10V line (two 1K resistors and a 10µF capacitor).

For 50 Hz output use the code shown in the table 1.

The circuit in Figure 1 allows the use of an inexpensive and readily available crystal, but has the disadvantage of not being "single pin" programmable for 50/60 Hz. The circuit in Figure 2 requires a non-standard, more expensive crystal frequency but has the advantages of being pin programmable for 50/60 Hz and eliminating the shift register. A 2.4576 MHz crystal is a standard value. A frequency of 2.467238 MHz is required to generate exactly 50 and 60Hz with no error.

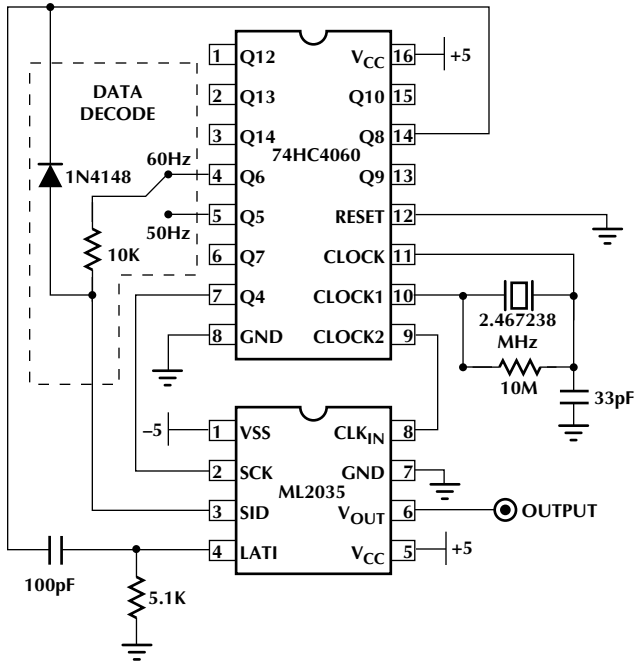


Figure 2. Single Jumper 50 or 60 Hz selection

These lower frequency (below 3.5Mhz) crystals, however tend to be larger in size and significantly more expensive.

F _{OUT}	D(dec)	Hex Value	Binary Value	Frequency Error
50	170	AA	1010 1010	-0.39%
60	204	CC	1100 1100	-0.39%

Table 2. Data Codes and error terms for ML2035 using a 2.4576 MHz standard crystal

Table 3 shows the codes necessary to generate 50 and 60 Hz sine waves with the circuit in Figure 1 from various standard crystal frequencies. Note that for the highest accuracy, the 4.194304 MHz crystal yields both 50 and 60Hz sine waves with no frequency error.

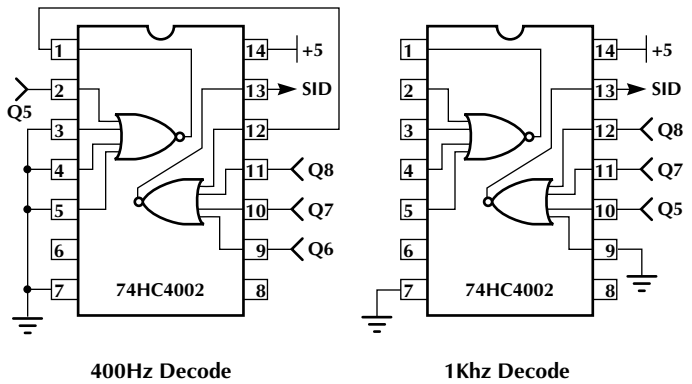
F _{CRYSTAL} (MHz)	F _{OUT}	D(dec)	D(hex)	74HC165 Code ABCD EFGH	Error
4.00	50	105	69	1001 0110	0.14%
4.00	60	126	7E	1000 0001	0.14%
4.194304	50	100	64	1001 1011	0.00%
4.194304	60	120	78	1000 0111	0.00%
6.00	50	70	46	1011 1001	0.14%
6.00	60	84	54	1010 1011	0.14%
8.00	50	52	34	1100 1011	-0.82%
8.00	60	63	3F	1100 0000	0.14%

Table 3. Shift register values and frequency errors for various standard crystal values (fig 1).

To generate 400Hz and 1KHz tones, the circuit of Figure 2 must be modified to shift in 0 for the first 8 clock pulses and the data in table 4 for the last 8 clocks. This can be accomplished by replacing the "Data Decode" blocks of Figure 2 with the decoding shown below.

F _{CRYSTAL} (MHz)	F _{OUT}	D(dec)	D(hex)	74HC165 Code ABCD EFGH	Error
6.5536	400	512	200	1111 1101	0.00%
6.5536	1000	1280	500	1111 1010	0.00%


Table 4. Generating 400Hz and 1Khz sine waves



Suggested Crystal Manufacturers:

Nymph/Saronix: (415) 855-6829
 Pletronics: (206) 776-1800

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