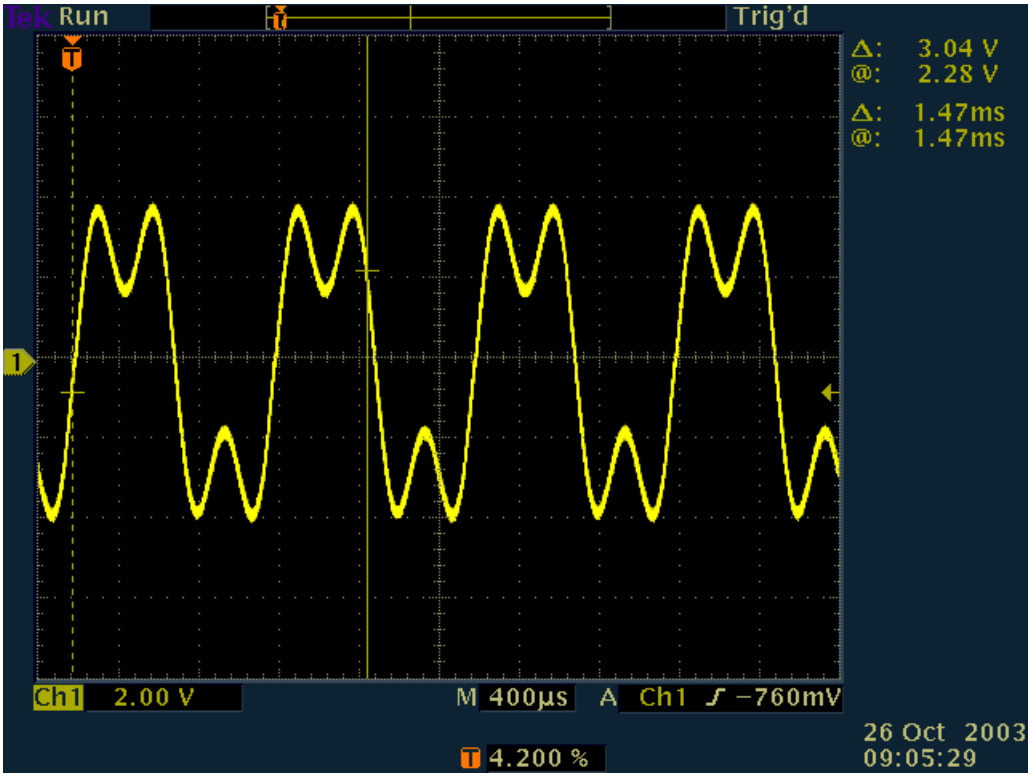
MultiLab

A Multi-purpose lab test instrument using the *Z8 Encore*™ MCU and a Palm Pilot™ user interface



Introduction

The project consists of a multi-purpose lab instrument comprising an arbitrary function generator, a digital pulse generator, a high resolution DC voltmeter and a DC reference source. To keep the unit compact and inexpensive, I wanted to eliminate the conventional “front panel” and use instead a Palm Pilot PDA to handle that function. The Z8 Encore’s DMA channels were ideal for the ‘arb function, and the irDA encoder/decoder block made implementing the IR link to the Palm Pilot easier

Designing the ‘Arb

A block diagram for a basic Arbitrary Function Generator is shown in Figure 1. The waveform memory is accessed sequentially by the address counter, and the data in the waveform memory array is fed to an 8-bit DAC. The DAC0801LCN is a current-mode DAC and an op amp converts this into the required output voltage waveform.

To generate a waveform of a desired frequency, the address counter must be incremented at this frequency multiplied by the depth of the waveform memory array. The depth of the array represents the number of data points that are used to make up one complete cycle of the output waveform, so the greater the depth, the more accurately one can simulate a particular waveform. For simple waveforms such as square waves and triangle waves, this is not too critical, but its obvious that to generate complex waveforms, the depth of the memory array must be commensurate with the complexity of the waveform.

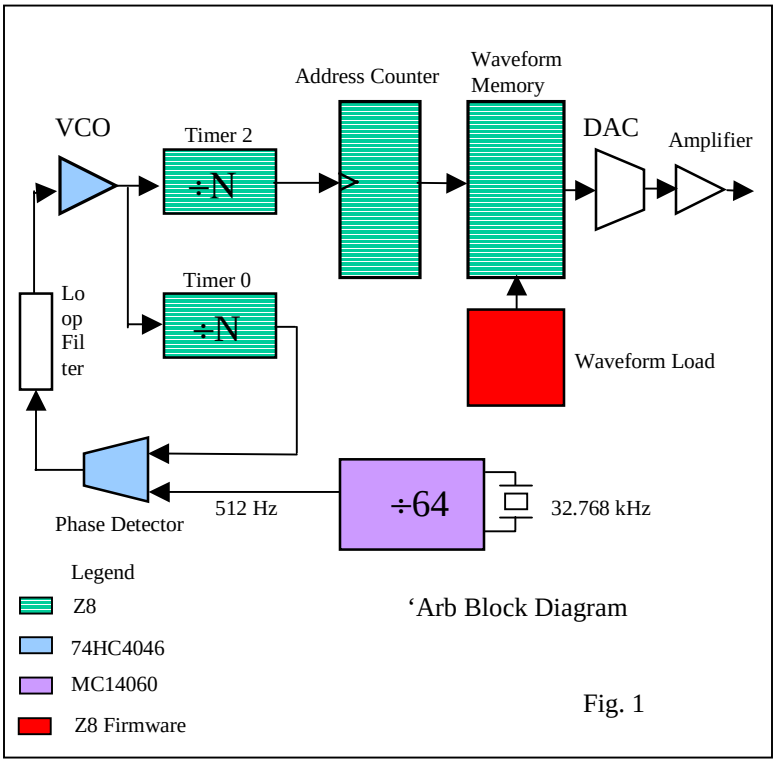


Figure 1

'Arb Specifications

Frequency Range	Waveform Depth	Resolution (Hz)
0.06 Hz-5000 Hz	256	2
5 kHz-10 kHz	128	4
10 kHz-20 kHz	64	8
20 kHz-40 kHz	32	16

Table 1

The 'arb generator works in two modes. For common waveforms such as sine, triangle, sawtooth and square, the Z8 firmware calculates these waveforms, using the C floating point routines, and loads them into RAM as needed. For any other waveform (i.e. arbitrary), the RAM memory is loaded up with values that have been previously saved in a 24LC256 I^2C Flash memory chip. For simplicity, I broke the 32K Flash memory space into 1K segments, allowing one to store up to thirty two arbitrary waveforms with a depth of 1024 (or less). Generating and downloading of these waveforms is the only function not done using the Palm Pilot. Rather, its accomplished

using a PC application (which can also act as the device's "front-panel" in lieu of the Palm Pilot)

The Pulse Generator

Since the Z8 Encore's timers are very versatile, including a PWM function, I decided to include pulse generation capability into the design. The only thing additional thing required was a bit more firmware- all hardware was already there.

Pulse Generator Specifications

Prescaler Ratio	Min, Max period	Resolution in us
128	16us – 0.52428 sec	8
64	8 us - 262 mS	4
32	4us - 131 mS	2
16	2 us - 65535 us	1
8	1 us – 32767 us	½
4	0.5us – 16383 us	¼
2	0.25 us – 8192 us	$^1/_8$
1	0.125us- 4095 us	$^1/_{16}$

Table 2

High Resolution DC Voltmeter

Another feature I thought would be useful in MultiLab, was a high resolution DC voltmeter. Since the timers and display were already there, all I had to add was a suitable A/D converter- the Microchip TC500

Basically the TC500 is a precision bipolar dual-slope integration A/D converter with a built-in auto-zero function. All you must add are three capacitors and a stable voltage reference, to complete the design. The MCU must provide two digital I/O signals (Control A,B) to control the four-phase conversion sequence that the device uses. Also, the MCU must accurately time both the integration and de-integration phases, and monitor the state of the TC500's comparator during the de-integrate phase. In this design, I use the Z8 Encore Timer1 to handle the timing, and two other I/O lines for the control and comparator monitoring function. To provide the good power line noise rejection, the integration phase is set to 16 power line cycles or 266.66 ms.

DC Voltage Reference

I often need an accurate DC voltage reference source. Generally this is in the 0-10 volt range, but occasionally I need to simulate a thermocouple which produces signals in the low millivolt range.

I chose a Burr-Brown 12-bit SPI DAC to provide this voltage reference source. The DAC7611 comes in 8-pin DIP and contains its own voltage reference. I added an op-amp output buffer and a 1000:1 voltage divider to provide for 0-10 volt and 0-10 millivolt output ranges.

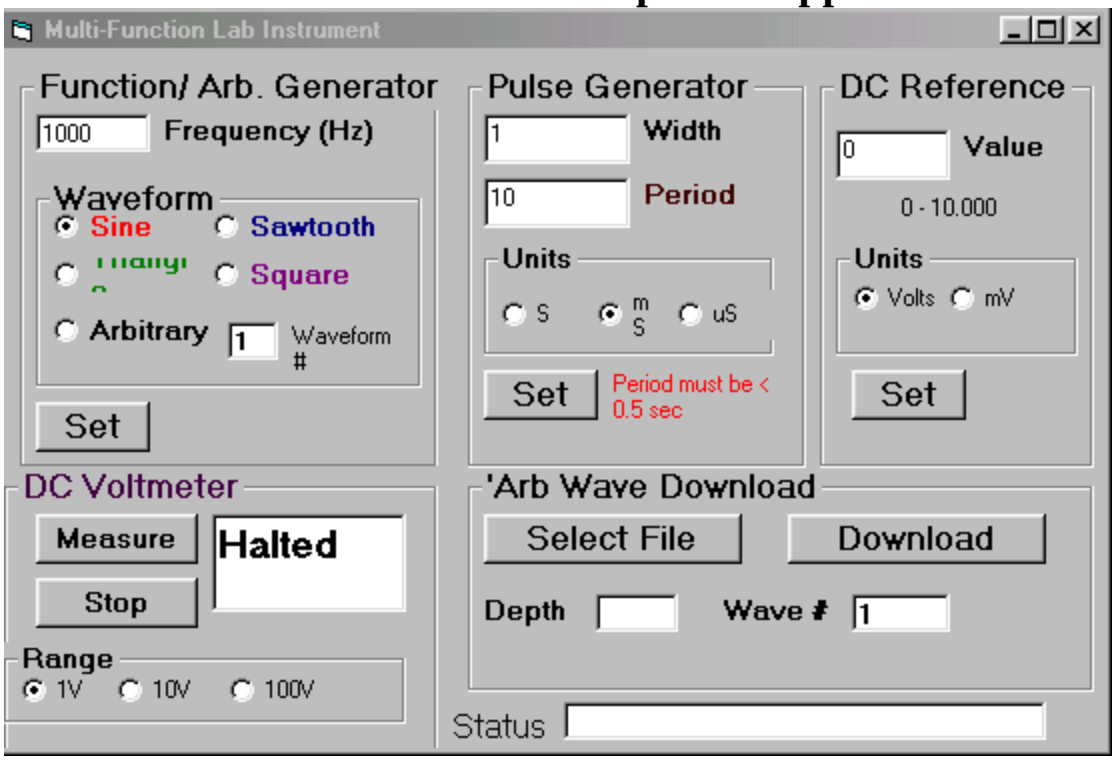
The irDA and RS-232 Links

The irDA link to the Palm Pilot was easier to design, thanks to Zilog. The Z8 Encore contains two UARTs, each of which includes a complete irDA encoder-decoder or ENDEC.

For the RS-232 link to a PC, I used UART0, with a MAX232 added for level-shifting.

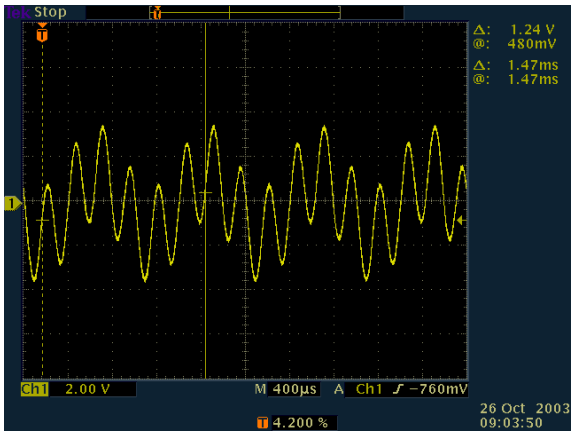
It was fortunate that the MobileVB software that I used to write the Palm Pilot application, supports both RS-232 and irDA communications links, and that it also provides for both “raw” (which I used) and irCOMM protocols for the irDA link.

Screen shot of PC “front panel” Application

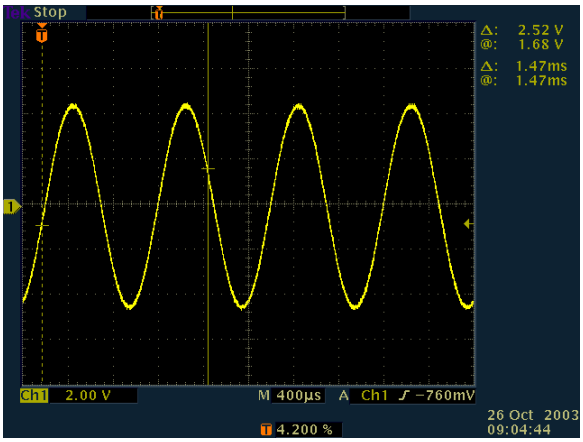


Following are a few ‘scope screen shots I took of the ‘arb generator’s output.

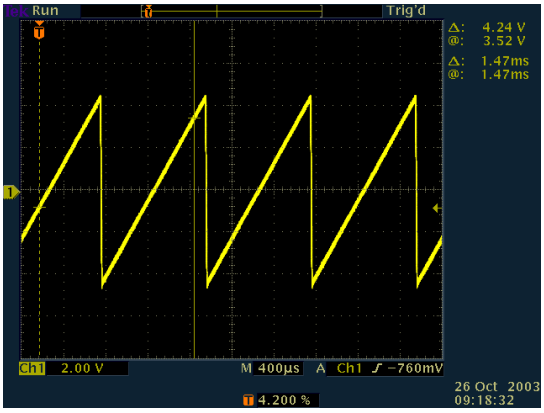
Sine with harmonics



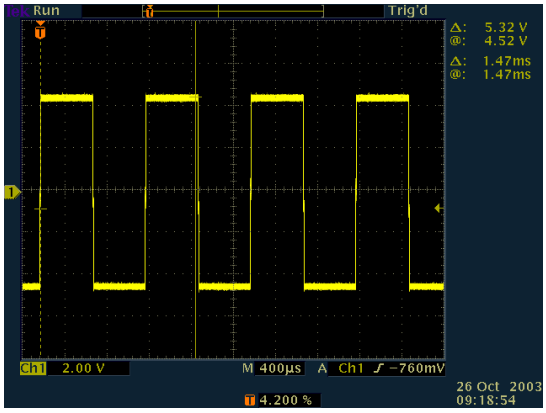
Pure Sine wave

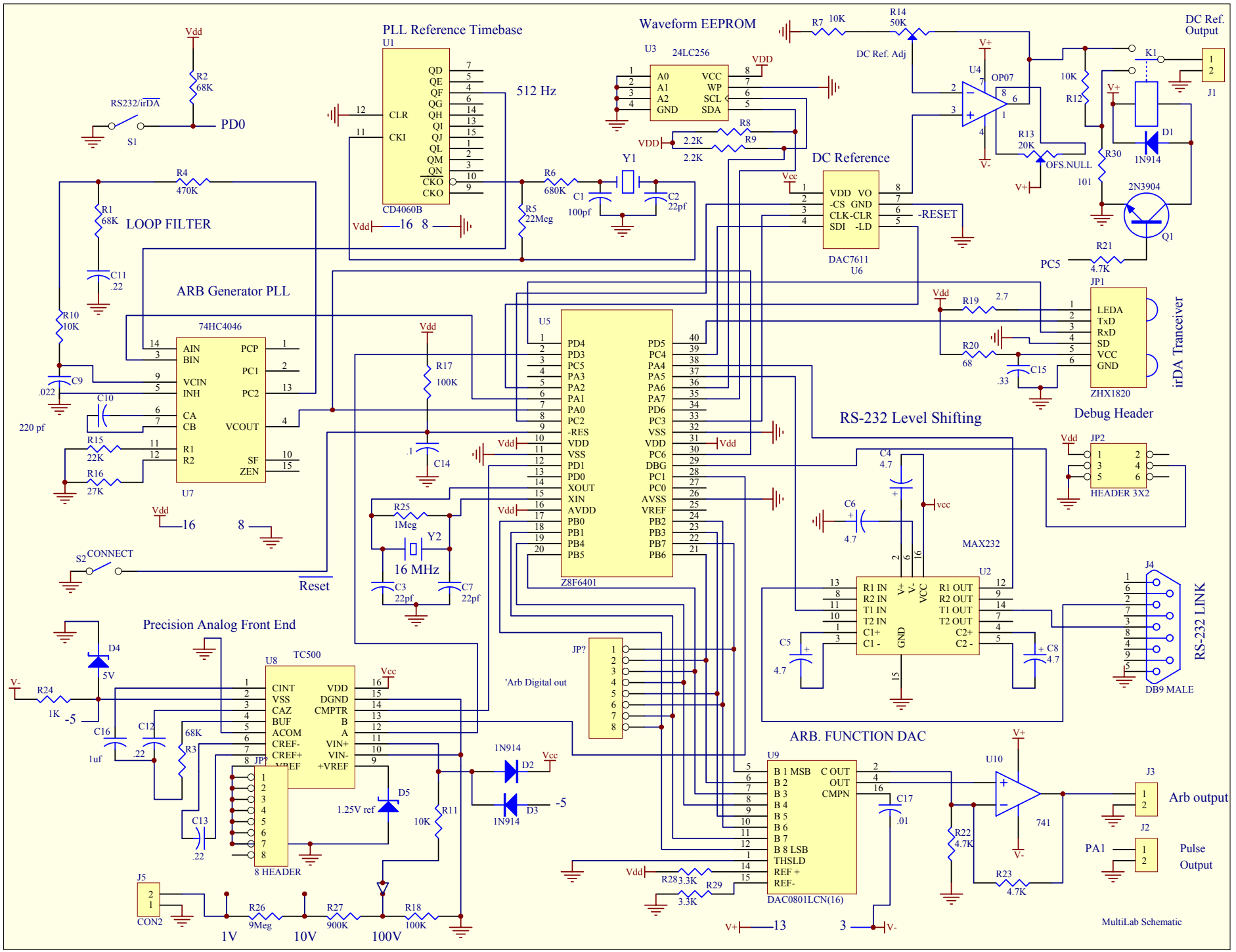


Sawtooth



Square




PLL Reference Timebase
U1
CD4060B
512 Hz
Waveform EEPROM
U3
24LC256
DC Ref. Output
DC Ref. Adj
DC Reference
DAC7611
U6
-RESET
LOOP FILTER
ARB Generator PLL
74HC4046
U7
Y1
16 MHz
Z8F6401
U5
Reset
CONNECT
RS-232/irDA
PD0
PC5
irDA Tranceiver
ZHX1820
JP1
Debug Header
HEADER 3X2
JP2
RS-232 Level Shifting
MAX232
U2
RS-232 LINK
DB9 MALE
Precision Analog Front End
TC500
U8
8 HEADER
'Arb Digital out
ARB. FUNCTION DAC
DAC0801LCN(16)
U9
741
U10
Arb output
Pulse Output
PA1
MultiLab Schematic