Machine Coder Explanation

The Z80 Machine Coder is an education system, the bridge between hardware and software. At the most basic level a microcomputer chip has an instruction set, a series of commands that it recognizes in the form of binary code or 1's and 0's. It inputs these commands and data in the form of 8 bits or 8 1's and 0's or a byte from a memory chip the microcomputer is connected to. When the microcomputer is reset it clears it's memory, begins counting up from zero, pulling in instructions, data, from the memory chip and executing programs. As decimal mathematics is based on the base-10 number system 1,10,100,1000,10,000,100,000, etc., the binary number system or base-2 represents1,2,4,8,16,32,64,128,256,512, etc. for each number position.

As you look at the photograph and video of the Z80 prototype you'll notice two sets of 8 LEDs, Light-Emitting-Diodes, one red on the left and one green on the right. The red LEDs on the left represent data that's input/output from the memory chip and the Z80, 8-bits equal 1 byte of data. The green LEDs on the right represent the address or location of data/instructions stored in the memory and accessed by the Z80. When you see me push a button on the lower left you'll notice that both LEDs flash very quickly then stop, this is the reset of the microcomputer which clears all it's registers and executes the program stored in memory starting at address zero, counting up. The Z80 uses an external clock or oscillator that can vary in speed up to millions of cycles per second, or even down to several cycles per second or one cycle at a time.

You'll also notice a 7-segment LED display showing decimal numbers. This display is used to program the memory starting at location zero, counting up together with the binary address, making it easy to see the memory location without having to translate the binary representation in your head. The 7-segment display counts in BCD or Binary-Coded-Decimal, counting up from 0-9 and then past that on the second display to the left to reach 99. This gives the programmer 99 memory locations to program which could easily be extended with more digits although the simple programs being taught at this stage usually only require 20 or less memory locations, some samples of programs are listed and explained at the end of this document.

You'll also notice a series of 8 push-button switches on the middle left, these are to input data and instructions into the memory for the Z80 to execute. The push-button towards the right and slightly above the other switches resets the display to zero and allows for entry of the next byte of data to be entered.

Most children start some form of reading and counting at the age of 5, some

before. The Z80 Machine Coder can be adapted as a learning system for children who do not need to know the details of how it works but can enter simple program and see the result, like moving a digit from one position shifted left or right and incrementing or decrementing a number. The level of training can be very sophisticated to introduce even a graduate engineer in computer science or electronics to the Z80 hardware/software. Beyond basic programming the system can be developed to input sensors like temperature sensors, measure the temperature and even control a switch to turn a device on or off, and can increase in complexity from there. Programs that control more sophisticated displays like a 5x7 dot-matrix display indicating alpha-numeric data or a combination of letters, numbers, could also be programmed, even simple games created. The endless levels of potential sophistication run the gamut from children to engineers, even interfacing other electronic circuits to control external systems.

The first major microcomputer chip was the 8080 from Intel in 1974, the Z80 was introduced in 1976, compatible with the 8080's instructions but with many other features including an extra 120 instructions, more internal memory registers, more complex interrupts and simplified connection to other hardware. An interrupt is an external input to the Z80 that allows it to immediately run a program and then get back to the main program. As the 8080 developed into the PC market, the Z80 moved into the industrial market and was a precursor to the embedded microcomputers in almost every device from washing machines to airplanes for system control.

Here is a simple example of a program that inputs a data byte from memory into the microcomputer, increments the number and outputs it back to the memory. You can follow the instructions listed using the Z80 Manual PDF download link.

Load Register Pair DE with integer from memory, increment, output to memory

0- 0000 0000 NOP, No Operation
1- 1110 1101 LD dd, (nn) /Input from memory/ **BC**=00/**DE**=01/**HL**=10/**SP**=11
2- 01**01** 1011 LD **DE**
3- 0000 1100 Address 12
4- 0000 0000
5- 00**01** 0011 INC **DE** /Increment
6- 1110 1101 LD (nn), dd /**DE** Output to memory
7- 01**01** 0011
8- 0001 0000 Memory Address 16
9- 0000 0000
10-
11-

12- 0000 0011 Integer 3 at Memory Location 12
13-
14-
15-
16- 0000 0100 Integer 4 at Memory Location 16