Microcomputer related problems often require the use of specialized equipment to debug the system hardware and software. Two very useful tools are the **logic analyzer** and the oscilloscope. A logic analyzer is essentially a multiple channel digital storage scope with many ways to trigger, see Figure 6.8. As a troubleshooting aid, it allows the experimenter to observe numerous digital signals at various points in time and thus make decisions based upon such observations. As with any debugging process, it is necessary to select which information to observe out of a vast set of possibilities. Any digital signal in the system can be connected to the logic analyzer. Figure 6.8 shows an 8-channel logic analyzer, but real devices can support 128 or more channels. One problem with logic analyzers is the massive amount of information that it generates. With logic analyzers (similar to other debugging techniques) we must strategically select which signals in the digital interfaces to observe and when to observe them. In particular, the triggering mechanism can be used to capture data at appropriate times eliminating the need to sift through volumes of output. Sometimes there are extra I/O pins on the microcontroller, not needed for the normal operation of the system (shown as the bottom two wires in Figure 6.8). In this case, we can connect the pins to a logic analyzer, and add software debugging instruments that set and clear these pins at strategic times within the software. In this way we can visualize the hardware/software timing.

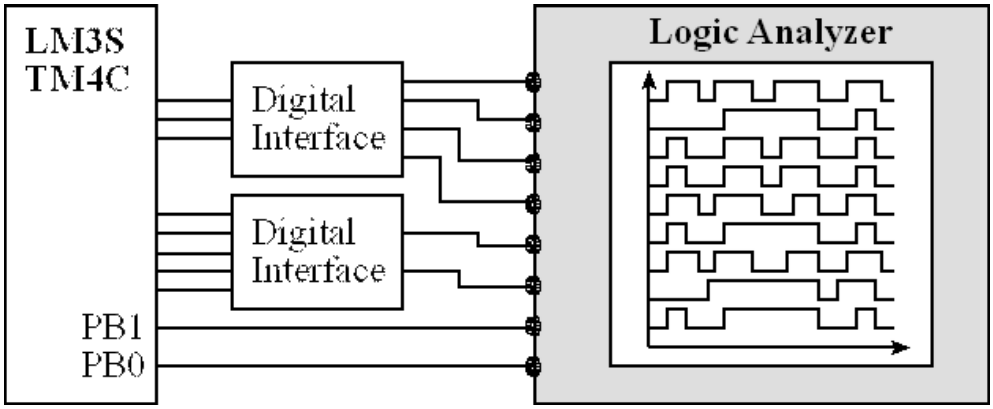

Figure 6.8. A logic analyzer and example output.

An **oscilloscope** can be used to capture voltage versus time data. You can adjust the voltage range and time scale. The oscilloscope trigger is how and when the data will be capture. In normal mode, we measure patterns that repeat over and over, and we use the trigger (e.g., rising edge of channel 1) to freeze the image. In single shot mode, the display is initially blank, and once the trigger occurs, one trace is captured and display.

Students in this edX class may purchase their own Analog Discovery logic analyzer/scope at **http://www.digilentinc.com** (http://www.digilentinc.com/Products/Detail.cfm?Prod=ANALOG-DISCOVERY) for $99 plus shipping. This hardware debugging tool is not required for this class, but we love ours a lot. When purchasing the Analog Discovery identify your school as edX and your class as UT.6.01x.