DIO-64 Simplifies Arbitrary Digital Waveform Generation

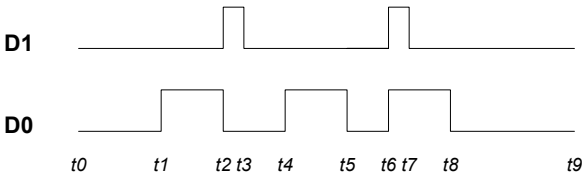
More than just a Digital Input Card!

Viewpoint System's DIO-64 Dynamic Digital I/O cards offer unique output capabilities that greatly simplify challenging digital waveform generation problems. The PCI-DIO-64 and PXI-DIO-64 can easily generate complex digital waveforms that can be synchronized to the rest of your system.

DIO-64 Output Basics

The DIO-64 allows you to specify any digital waveform in a very concise manner. Simply define the time when you want the outputs to change and what they should change to. This makes the DIO-64 the ideal instrument for your test bench: a 64-channel digital arbitrary function generator. Counter/Timer boards are good for generating simple repetitive waveforms, but quickly run out of channels or become impossibly complicated–the DIO-64 can generate almost any digital pattern on 64 channels.

An example goes a long way in explaining what's going on. For instance, consider the following waveform:

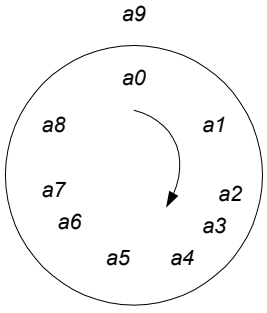


Time	D1 D0
t0	0 0
t1	0 1
t2	1 1
t3	0 0
t4	0 1
t5	0 0
t6	1 1
t7	0 1
t8	0 0
t9	0 0

Notice that a row in the table (*scan*) is supplied whenever one or more of the bits in the waveform change (the scan at *t9* is included in this example to set the overall duration of this particular waveform, something we will take advantage of later in our discussion). Only 2 bits are shown in this illustration, but the DIO-64 has 64 digital outputs at your disposal–wide enough for a 32-bit data channel with plenty left over for auxiliary control signals.

When the data in the table is run through the DIO-64's output routines, the result will be the waveform shown. An important consideration when programming the DIO-64 is the scan clock source and frequency that is to be used. The scan clock determines the time resolution that the DIO-64 will use to determine its time to send out the next scan. The times in the table for each do not need to be evenly spaced; the DIO-64 simply waits for the time specified before applying the new data to the outputs.

Don't overlook the fact that the DIO-64 can use clocks generated internally OR generated elsewhere in your system. The DIO-64's scan clock can come from an external source, such as an encoder, or via RTSI or PXI Trigger lines from other data acquisition cards. If the clock signal is tied to an encoder, the waveform generation will now be tied to the rotational angle of your system instead of time. The a0-a9 entries in the system now specify the angle at which the digital patterns will be generated. This is especially useful in systems that are rotational in nature, and it's more important where in the cycle something happens rather than when it happens.



Angle	D1 D0
a0	0 0
a1	0 1
a2	1 1
a3	0 0
a4	0 1
a5	0 0
a6	1 1
a7	0 1
a8	0 0
a9	0 0

Triggering

The DIO-64 output operation can be set to start in response to a trigger. This trigger can come from external connections or via the RTSI or PXI Trigger lines. This allows you to precisely define the beginning of the digital waveform. Once a start trigger is encountered, the DIO-64 ignores extra start trigger signals until the output operation is stopped and re-armed.

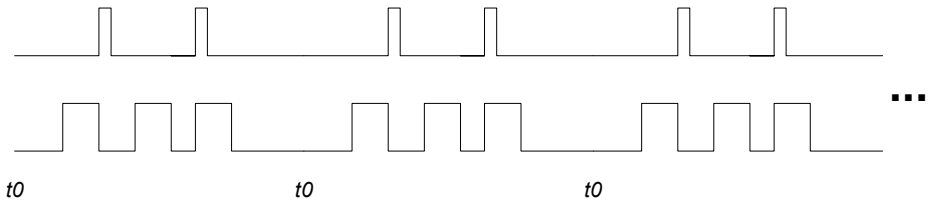
The DIO-64 output operation can be stopped in response to a stop trigger. This trigger can also come from external connections or via the RTSI or PXI Trigger lines. Typically a stop trigger indicates the end of the digital waveform output operation.

Continuous vs. Repetitive

The DIO-64 has a 512 scan on-board buffer or FIFO. This buffer allows the DIO-64 to generate bursts of scans that can be relatively close together in time. Typically an application keeps this FIFO full with the scan data that defines the waveform to be generated. This approach allows the DIO-64 to generate a continuous waveform of practically any duration, as long as the application keeps the FIFO full.

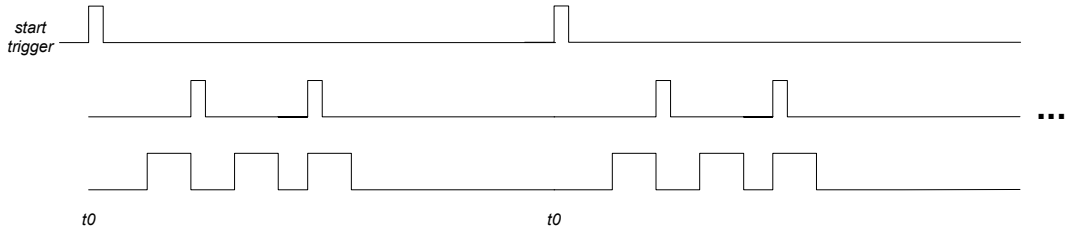
The DIO-64 can also use this buffer to define a waveform that is to be repeated, continuously or for a specific number of times. The waveform must consist of less than 512 scans (or bit changes) in order to use this mode. When the last scan has been applied, the DIO-64 automatically restarts the waveform generation from the beginning of the table.

One significant advantage of the repetitive approach is that the waveform generation is a load and go-type operation for the application. Once the data has been loaded and the generation started, the application can forget about it.



Retriggerable Repetitive Waveforms

Many applications require that an output waveform be synchronized to another signal in the system. The DIO-64 can take the repetitive waveform described above and synchronize the start of each waveform to the start trigger. This is a very useful technique that allows the DIO-64 to respond to other timing events. In this case, the digital waveforms will be the same each time, but applied exactly when the rest of the system needs to see them.



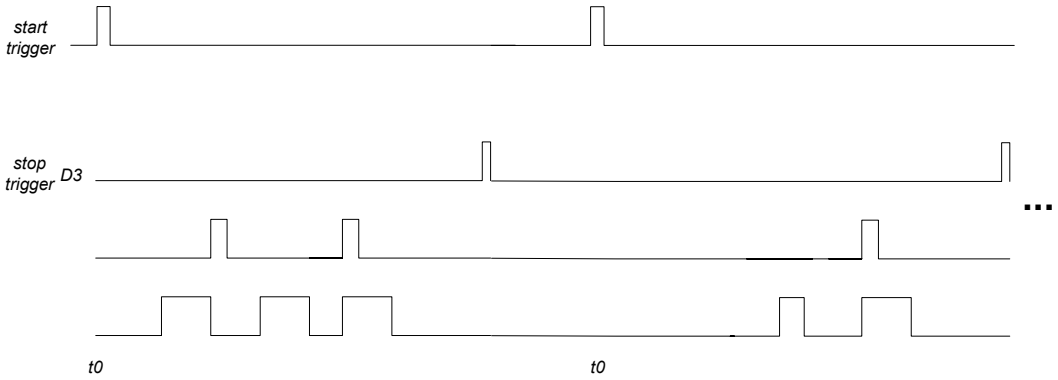
This approach takes advantage of the fact that the DIO-64 can automatically generate a stop trigger based on when the last scan of the buffer is output and that the operation can be specified to automatically re-arm itself when a stop trigger is detected. The stop trigger is specified in the DIO64 OutConfig VI and the re-arm mode is set through DIO64 SetAttribute VI.

The application can still treat this type of application as a load and go-type operation. Once the operation has been initiated, the DIO-64 takes care of the rest.

Retriggerable Continuous Waveforms

Occasionally, an application needs to go one step further and the DIO-64 is right there with you. The previous discussion covered cases where the **same output waveform** is generated based on a trigger event. What happens when you need to **output different waveforms** and still synchronize the outputs to a trigger?

This type of application is more like the continuous discussion earlier, when the application needs to keep supplying the DIO-64 output FIFO with data. The difference is that in order to pull off the synchronization of the individual segments of the waveform, the DIO-64 needs to see a stop trigger. Remember, the stop trigger–combined with the automatic re-arming attribute–allows the DIO-64 to wait for another start trigger. The trick here is to embed the stop trigger signal in one of the digital bits and wire it back into the stop trigger external connection.



The application needs to keep ahead of the system. It needs to make sure that the FIFO never starves for data. This is a very useful technique that allows you to precisely control when the waveforms are presented to the rest of your system.

Wrap-up

The DIO-64 Dynamic Digital I/O board gives you the ability to solve complex digital waveform generation problems. The DIO-64 allows you to specify the digital waveform in a very concise and practical form. This allows you to design complex digital waveforms in a manner you can easily understand. The triggering options and timing signal connectivity lets the DIO-64 work together with other aspects of your system.

The DIO-64 can be used to solve timing and waveform generation problems in a wide variety of applications from automotive engine timing to simulation of signals in copier chassis. The flexibility, speed, and ease of waveform definition makes the DIO-64 ideally suited for almost any digital waveform generation task.

The DIO-64 also can perform time stamping of digital input waveforms. The input mode records scans (timestamp and data) whenever designated bits have changed. This capability reduces the amount of data your application needs to sift through. The DIO-64 can perform input and output operations simultaneously, making it a great digital stimulus/response component for your system. Multiple boards can be combined to give your application the digital I/O channel counts needed by your application.

The DIO-64 is available in PCI and PXI form factors. Driver interfaces and example programs are supplied for LabVIEW, Visual C, and Visual Basic.

Check it out!

For more information be sure to check out the DIO-64 web pages at http://viewpointusa.com/dio64. Look for more application notes, software updates, and useful example programs.