Digitizing Oscilloscope Workshop
Triggering & Observing & Measuring A Complex Waveform

By: Walter Banzhaf, P.E.
Professor of Engineering Technology
University of Hartford
Ward College of Technology

Purpose:

Oscilloscopes can be rather obtuse creatures: they trigger **just as you tell them to** (source, slope, and level specified), and they don't "look" at the display to see if it's correct. For example, in Figure 1 the display is obviously not giving a correct picture of the waveform, since it shows two pulses as having both low and high levels present simultaneously. This procedure will acquaint you with **sweep holdoff**, which can be used to correct this problem. Sweep holdoff delays the next sweep until the user-controlled holdoff time has expired and a subsequent trigger has occurred; this avoids triggering on different pulses in an irregular pulse train. Unlike most analog 'scopes, the holdoff time on the digitizing oscilloscope doesn't change as the time/division is changed. This means that once you've adjusted the holdoff time correctly, you can change the time/div.

Equipment Required:

- Agilent 54600 - Series Oscilloscope
  [This experiment is written for the 4-channel Agilent 54601B - but could be easily adapted to a 2-Channel scope].

Introduction

Circuit Explanation:

The digital waveform generator (DWG) used in the digital fundamentals laboratory course will be used to produce an irregular pulse train. It needs only to be connected to a +5 V power supply.

Procedure A - Observing An Improperly Triggered Waveform:

1) Connect the DWG to a 5 V power supply, and turn on power. Observe DWG output **G** on channel 1, using a 10X probe. Press **SETUP**, then press **Default Setup**. Set the probe type for channel 1 to 10X by pressing **1** and **Probe**. Finally, press **AUTO-SCALE.** The display should look ***something*** like Figure 1. There's a triggering problem, since the 2nd and 3rd pulses have both low and high levels present simultaneously.

Procedure B - Using Holdoff To Properly Trigger On The Waveform:

1) While still looking at the **G** waveform, rotate the **Holdoff** control, located in the **TRIGGER** section, until the displayed waveform is "correct". Adjust the time/div as needed in order to see the waveform. The true pattern of pulses can now be seen clearly, with each pulse having a high level only.

Procedure C - Observing Four Channels Simultaneously:

1) Connect Channels 1, 2, 3 and 4 to DWG outputs A, B, C and D, respectively using 10X probes (set the probe type for each channel to 10X).

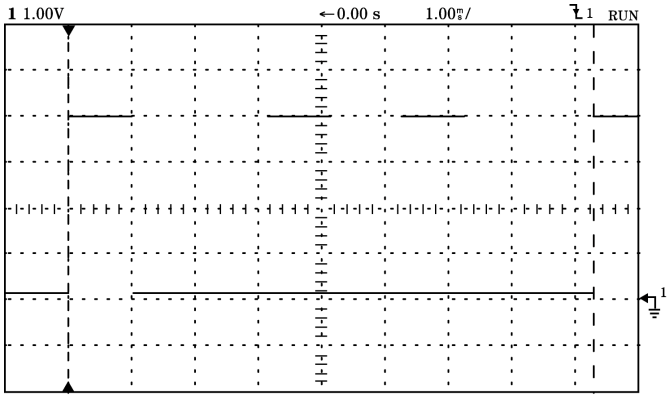
2) Press **AUTO-SCALE** ; the display should look like Figure 3.

3) Measure the frequency of Channels 1, 2, 3 and 4 using the Measure **Time** hardkey and the **Frequency** softkey.

4) Try measuring the time delay between the rising edge of Channels 3 & 4 using the Measure **Cursors** hardkey and the **t1 & t2** softkeys.

5) Press the **Source** hardkey in the Trigger section; notice that the **Autoscale** function had selected Channel 4 as the trigger source. It is just dumb luck that Channel 4 had the lowest frequency of the four channels, and as a result a stable display occurred.

6) Rotate inputs as follows: Channels 1 and 4 to DWG outputs D and A, respectively. Press **AUTO-SCALE** ; the display is no longer stable, as Channel 4 was selected again as trigger source, but Channel 4 is connected to the highest frequency in the system.



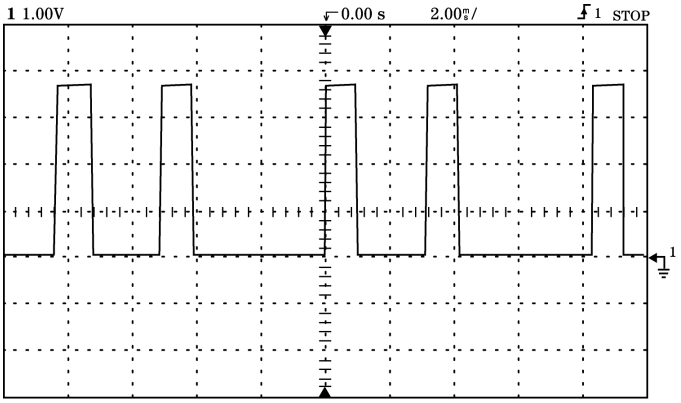
	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	1.000 V	-2.000 V	DC	Off	Off	10:1
Chan 2	Off	1.000 V	0.000 V	DC	Off	Off	10:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	1.000ms/	0.000 s	Left	----------	----------

	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Trigger	AutoLv1	Ch 1	1.281mV	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Figure 1 - Irregular Pulse Waveform (G of DWG), Improperly Triggered



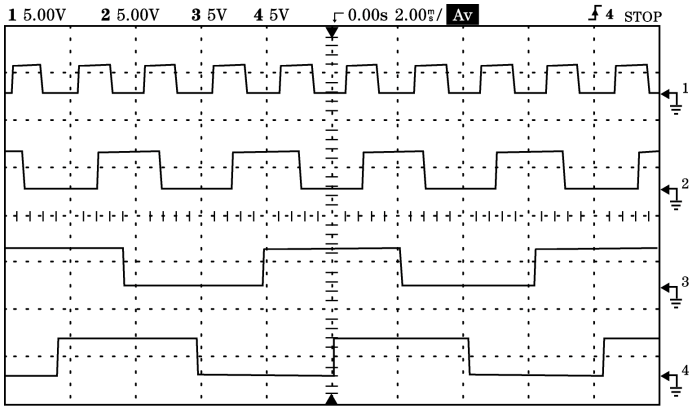
	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	1.000 V	-1.094 V	DC	Off	Off	10:1
Chan 2	Off	1.000 V	0.000 V	DC	Off	Off	1:1
Chan 3	Off	100.0mV	0.000 V	DC	---	---	1:1
Chan 4	Off	100.0mV	0.000 V	DC	---	---	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	2.000ms/	0.000 s	Cntr	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	AutoLv1	Ch 1	1.031mV	6.680ms	Pos	DC	Off	Off

Display Mode: Normal

Figure 2 - Irregular Pulse Waveform (G of DWG), Properly Triggered Using Holdoff



	State	Volts/Div	Position	Couplg	BW Lim	Invert	Prove
Chan 1	On	5.000 V	12.50 V	DC	Off	Off	10:1
Chan 2	On	5.000 V	3.000 V	DC	Off	Off	10:1
Chan 3	On	5.000 V	-7.219 V	DC	---	---	10:1
Chan 4	On	5.000 V	-16.72 V	DC	---	---	10:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	2.000ms/	0.000 s	Cntr	----------	----------

Trigger	Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
	AutoLv1	Ch 4	1.719 V	200.0ns	Pos	DC	Off	Off

Display Mode: Average # Average: 8

Figure 3 - Waveforms A, B, C and D of DWG, Properly Triggered on Channel 4