LW400-09A Digital Output Option

Introduction

The LW400-09A Digital Output option provides 8-bit TTL and ECL, digital outputs corresponding to the current value of the channel 1 analog output. The latched digital data, which is held for the duration of the sample clock, is available via two rear panel mounted connectors. Digital data is available whenever the channel 1 output is enabled.

LW400's, with the digital output option, include a special digital editing mode for the creation of user specified data patterns. Byte wide data patterns or selected bits within the 8-bit wide digital word may be programmed. Digital data patterns created using this editor are identified as "Digital" waveforms. Digital waveforms can be edited using the same "cut and paste" tools available for analog waveforms. The major difference between the two waveform types is that digital waveforms are not processed to remove discontinuities at transitions. This also means that Time editing functions, such as sub-sample Move, are not useable with digital waveforms and are limited to analog waveforms only.

Specifications

Digital outputs:	8 bits corresponding to the channel 1 analog output plus CLOCK and CLOCK* (TTL only).
Digital output modes:	ECL, TTL all available on output connectors simultaneously.
Mating output connector:	SMB for ECL output 20 pin P/N 3M-3421-7020 for TTL output.
Maximum data output clock rate:	ECL, 400 MBytes/sec; TTL 100 MBytes/sec.

ECL outputs:

Levels:

Parameter	Min	Typ	Max
V_{OH}	-0.98 V	-0.8 V	-0.71V
V_{OL}	-1.95 V	-1.8 V	-1.58 V

Note: output load is 50 Ω to -2 Volts.

Timing:

Parameter	Min	Typ	Max
Clock to Analog Output	7 ns	8 ns	9.8 ns
Setup Time *	T-660 ps	T-485 ps	T-310 ps
Hold Time	310 ps	485 ps	660 ps
Data skew	-	80 ps	250 ps

* T is clock period (i.e. 2.5 ns for 400 MHz clock)

TTL :

Levels:

Parameter	Min	Typ	Max
V_{OH}	2.00 V	2.60 V	-
V_{OL}	-	0.35 V	0.80 V

Timing:

Parameter	Min	Typ	Max
Clock to Analog Output		10 ns	-
Setup Time *	T -5.7 ns	T -0.5 ns	T+3.9 ns
Hold Time	-3.9 ns	0.5 ns	5.7 ns
Data skew	-	-	1 ns

* T is clock period (i.e. 10 ns for 100 MHz clock)

CONNECTOR PINOUTS

Note1: D7 signifies the bit which corresponds to analog signal most significant bit (MSB), and D0 signifies the bit which corresponds to the least significant bit (LSB).

Note2: TTL outputs back terminated in 75 ohms

TTL Port

1	- TCLK	2	Ground
3	- TCLK*	4	Ground
5	- D0 (LSB)	6	Ground
7	- D1	8	Ground
9	- D2	10	Ground
11	- D3	12	Ground
13	- D4	14	Ground
15	- D5	16	Ground
17	- D6	18	Ground
19	- D7 (MSB)	20	Ground

ECL Port

J800 - D0 (LSB)
J700 - D1
J600 - D2
J500 D3

J400 - D4
J300 - D5
J200 - D6
J100 - D7 (MSB)

J900 - ECLOCK

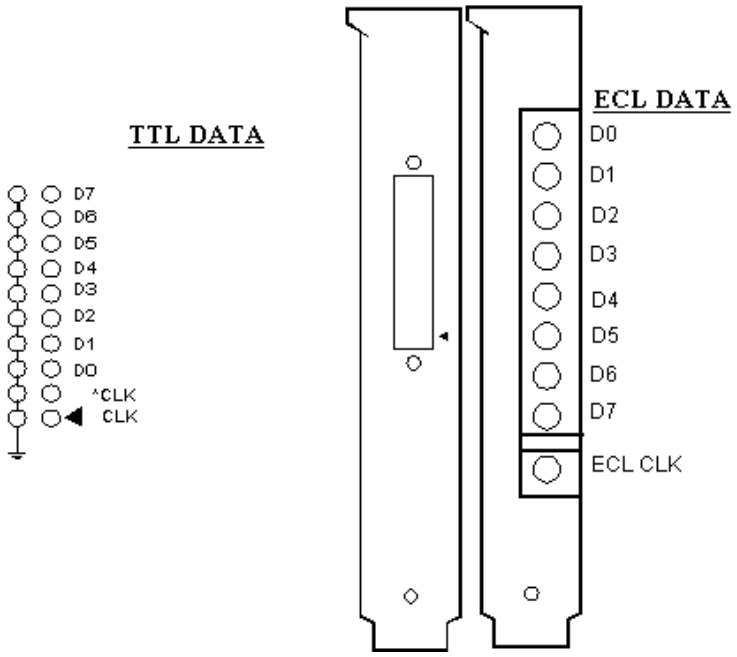
Interconnection Information:

TTL: The LW400-09A includes 75 Ω back terminations on all the TTL output lines. These resistors are used to match the transmission line impedance taking into account the additional source impedance of the TTL driver. The 75 Ω resistors match the 80Ω impedance of the flat cable fairly well. In this fashion, no termination resistor is required or desired. The most important consideration in this scheme is that the load should be as close to an open circuit as possible. One, or at most, two TTL loads should be placed at the termination of the line. Capacitance at the termination will have a detrimental effect on the rise time of the received signal. Every effort should be made to limit parasitic capacitance at the termination of the cable to under 10 pF. All grounds should be tied together at the load side of the cable.

ECL: The LW400-09A provides 464 Ω internal pulldown resistors at the ECL output drivers. The ECL outputs need to be terminated at the load side of the cable. The most optimum interconnection would utilize ECL line receivers at the receiver end of the cable, with termination resistors of 50 Ω tied to -2 Volts.

Cable Selection: For TTL output: Spectra Strip 843-132 - 280-020.

LW400-09A OUTPUT



Creating A Digital Waveform

A new digital waveform, as in the case of a new analog waveform, is created by pressing the **Select Wave** button on the front panel and choosing the **New** menu item. Select **New CH1 Wave** from the **New** menu and then enter the waveform name in the **Waveform** menu field. Press the **Accept** softkey to create the new waveform.

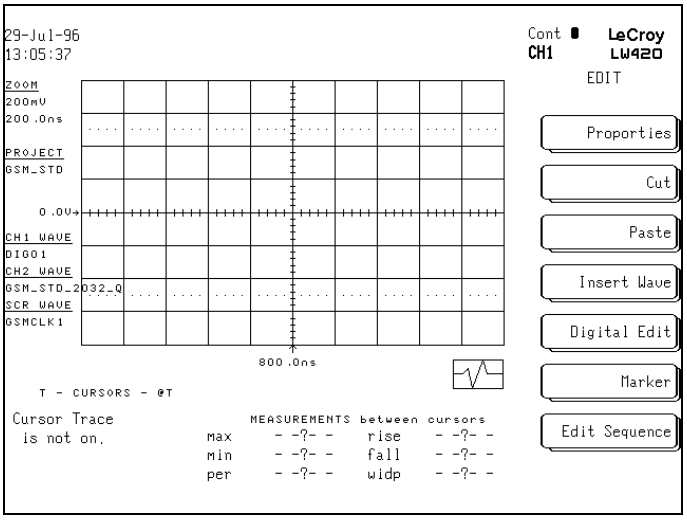


Figure C3.1

Press the **EDIT** button on the front panel of the WaveStation to display the **Edit** menu. The presence of the LW400-09A Digital Output option is indicated by the **Digital Edit** softkey shown in Figure C3.1 above. Select **Digital Edit** to display the **Digital Edit** menu, shown in figure C3.2 below. *Note that waveforms created in this editor are tagged as "digital". Digital waveforms are not subject to signal processing functions to remove discontinuities. They are also allowed to use a wider range of sample clock rates.*

Digital waveforms are created and edited by specifying the digital value of the waveform, in hexadecimal, in the **Value** field. This value is entered, starting at the location specified in the **Left Cursor** field, with a length set in the **Duration** field whenever the **Set Value** softkey is pressed. The **Duration** and **Left Cursor** fields will read out in units of time or sample points as selected by the user using the **Format** softkey switch. A user message, "Use the m-M keys for entering A-F" appears on the display while the **Digital Edit** or **Bit Edit** menus are displayed.

Note that the units multiplier buttons, m, µ, n, p, k, and M in the numeric keypad, are redefined during digital editing as hexadecimal characters A-F, respectively.

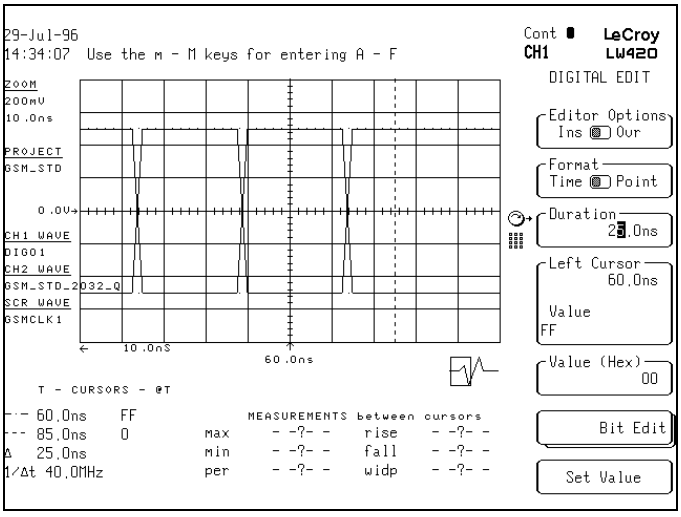
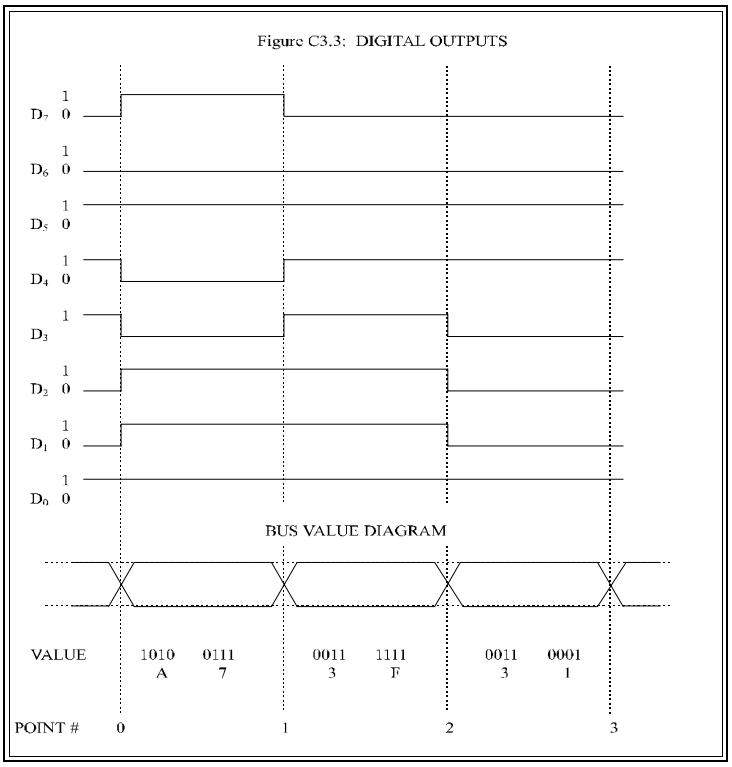


Figure C3.2

The **Editor Options** menu is used to select one of two editing modes—Insert (**Ins**) or Overwrite (**Ovr**). In insert mode the new digital waveform is inserted, starting at the left cursor location while any existing waveform elements are displaced to the right (later in time) by the duration of the new waveform. In overwrite mode the enabled bits of the new digital waveform replace the corresponding bits in any existing waveform, starting at the left cursor location for the preset duration. The **Bit Edit** menu is used to edit selected bits specified using a bit mask in conjunction with the **Value** field—see figure C3.4 on page C-9.

Digital waveforms are displayed on the LW400 as "Bus Level" diagrams which show the time interval of each part of the waveform having a given digital value. Individual bit waveforms are not displayed. Digital waveform amplitude values can be read, as hexadecimal numbers, from the time cursor amplitude annotation fields, in the lower left corner of the LW400 display. *Note that the Volt Cursors must be turned off by pressing the VOLT CURSOR button on the front panel and then selecting Volt Cursors off as indicated by the displayed menu.* See figure C3.2 above and the following figure C3.3 which shows an example of the relationship between the cursor readout fields and the actual bit patterns.



Editing A Digital Waveform

The **Bit Edit** menu is used to edit selected bits within a digital word. The 8 bit wide **Field Mask** is used to enable the desired bits. Setting a **Field Mask** bit to one (1), enables the corresponding bit in the digital waveform. The actual value of the enabled bit is determined by the user entered **Masked Value**. A zero (0) in the field mask means that the corresponding bit will be unchanged. Logically, the complement of the field mask is AND'd with the existing data value and the result is OR'd with the expanded version of the masked value. Symbolically, this is expressed as:

$$\text{Edited Value} = (\text{Value}_{\text{existing}} \bullet \overline{\text{Field Mask}}) + (\text{Masked Value})$$

The most significant bit (MSB) of the field mask, corresponding to the MSB in the digital waveform(D7) is shown on the left. Similarly, the least significant bit (LSB), corresponding the LSB (D0) of the digital waveform is shown at the right.

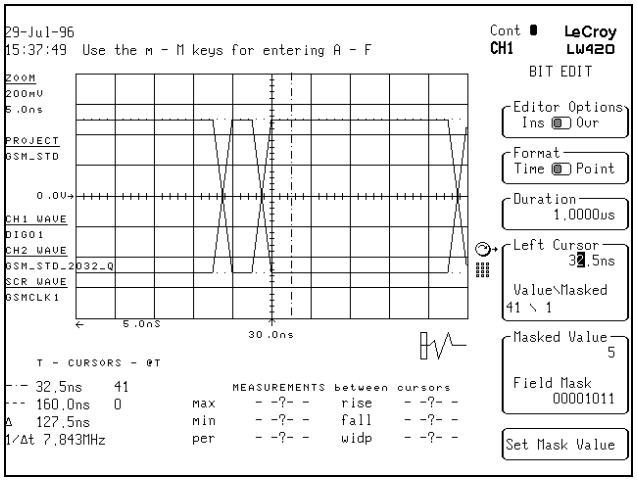


Figure C3.4

Consider the **Bit Edit** menu values shown in figure C3.4 . The field mask is set to 00001011 enabling 3 bits(D3, D1, and D0). The **Masked Value**, entered as a hexadecimal number, is set to 5(101 in binary). The 3 enabled bits are set to this value, D3=1, D1=0 and D0=1. The digital waveform **Value** is hexadecimal 41. And the expanded mask value is 1. *Note that the **Value** is read out at the left cursor position and displayed in the Left Cursor menu field.*

In the overwrite mode, only the enabled bits are replaced in an existing waveform. This is a simple way to edit selected bits in an existing digital waveform. For example, by setting the **Field Mask** to 10000000, in overwrite mode, the MSB (D7) can be edited starting at the left cursor location for the length set by the duration field.

In Insert mode, since the existing data is displaced, the expanded mask value is inserted into the waveform.

The following figure (figure C3.5) illustrates the relationship between the **Field Mask**, **Masked Value**, **Value**, and the resulting digital waveform bit pattern.

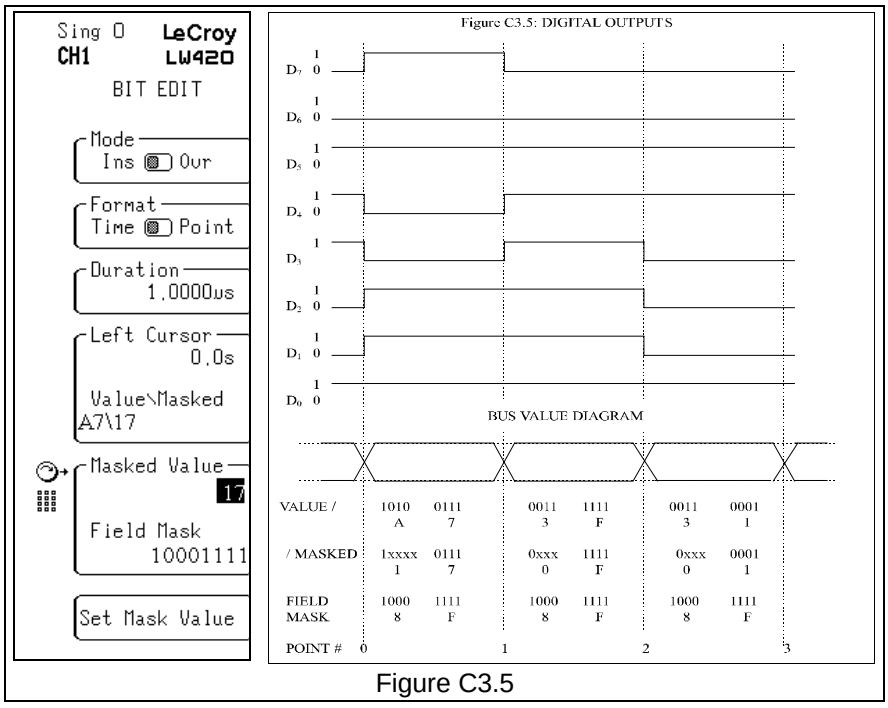


Figure C3.5

Setting Clock Rates For Digital Waveforms

The clock rate associated with a digital waveform has a much greater range of values than is available with analog waveforms. The clock on the LW400 and the LW400A can be set, by entering the frequency in the **Clock Rate** field on the **CLOCK CONTROL** menu. The clock ranges are described below:

Lower Limit MHz	Upper Limit MHz
355.000000	400.000000
177.500000	200.000000
118.333333	133.333333
88.750000	100.000000
71.000000	80.000000
59.166667	66.666667
50.714286	57.142857
0.006000	50.000000

In addition the LW400A has a continuous clock that can be set over a range of 6 kHz to 400 MHz, with 1 Hz resolution.

Refer to section 13 for addtional information related to setting the clock on the LW400 and LW400A.

Importing Digital Waveforms

Digital waveforms can be imported directly into AWG's with the LW400-09A Digital Output option. Any Easywave .WAV file as well as ASCII Hex and ASCII Binary files can be imported as digital waveforms.

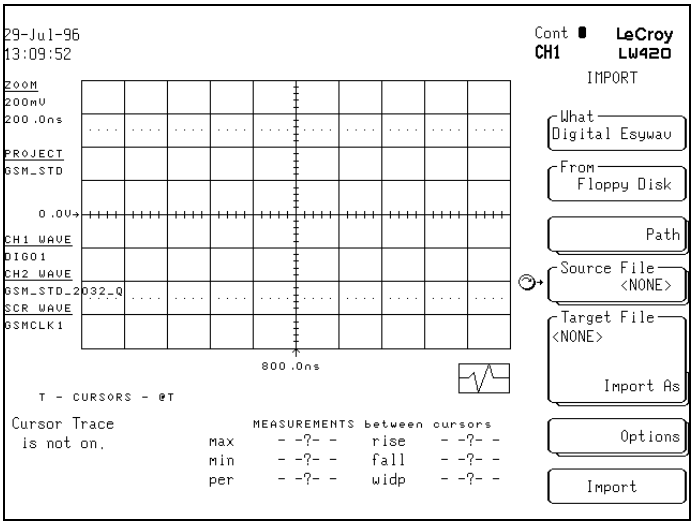


Figure C3.6

The Easywave .WAV file contains a single channel waveform created using LeCroy's Easywave waveform creation software.

ASCII Hex files contain groups of 2 digit hexadecimal numbers (0-F) separated by spaces. For example:

13 F0 03 8D C6 ...

ASCII BINARY files consist of groups of eight binary numbers (0's or 1's) separated by spaces. For Example:

10101010 00001011 01101111 ...

Waveforms are imported by pressing the **PROJECT** button then selecting the **Import** menu—see figure C3.6 above. Choose Digital Esywv, ASCII HEX, or ASCII BINARY in the **What** field. Select the desired **Source File** and press the **Import** soft key. The selected file will be imported into the current project as a digital waveform. Use the **Select Wave** button to select the waveform for editing.

Analog Output for Digital Waveforms

When a digital waveform is created the amplitude for the analog output is limited to the range of (500 mV, with -500 mV corresponding to the digital hex code 00 and +500 mV corresponding to the digital hex code FF .

After a digital waveform is created, changing the amplitude or offset affects the output amplifiers only and not the DAC. As a result there will be no change to the digital codes when the amplitude or offset is changed, however the analog output amplitude and offset will change based on the modified settings.

If it is desirable to produce an analog output with other than the (500 mV output the amplitude and offset need to be changed to the desired settings each time the waveform is loaded.

If an analog waveform is inserted into a digital waveform care must be taken to restrict its maximum voltage to ≤500 mV and the minimum voltage ≥-500 mV, otherwise the output will be incorrect.

Waveform Sequences Using Digital Waveforms

Digital waveforms can be combined in waveform sequences using the sequence editor in the normal manner. There is one key thing to keep in mind when creating sequences with digital waveforms. The signal processing functions used in generating sequences of analog waveforms are not used. Waveforms cannot be resampled to correct errors in timing caused by using segments created using different sampling rates. Therefore, if digital waveform segments are created at different clock rates, the highest clock rate is used when the sequence is compiled. Essentially, digital sequences always preserve points and timing errors can occur if you are not careful. **To avoid timing errors it is a good practice to create sequences from digital waveform segments which use the same clock rate.**

If you create a sequence using both analog and digital waveforms, then the sequence will be compiled as an analog waveform and the digital segments may be resampled, causing errors**. It is advisable not to mix analog and digital segments within the same sequence.**