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NovAtel

WAAS SIGGEN Unified DataSource Module (UDSM) User Guide

D25598

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	DOCUMENT NO.: D25598	PAGE: 1 of 36	REV: 2

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1 Scope

This document is a user guide to the L1/L5 WAAS Signal Generator (SIGGEN) Unified Data Source Module (UDSM). Throughout this document the previous version of this module and the previous WAAS GUS Type 1 SIGGEN is referred to as “Legacy”.

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2 Overview

The Unified Data Source Module:



Figure 2-1: UDSM Appearance

2.1 Package Contents



Figure 2-2: Package Contents

2.2 Features

The connectors, ports and switches of the UDSM are shown in the figure below.



Figure 2-3: Features

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3 Installation

The following sections are in the order of installation.

3.1 Software Installation

Download latest DataSource GUI software from NovAtel Inc. Open or execute the MSI file.

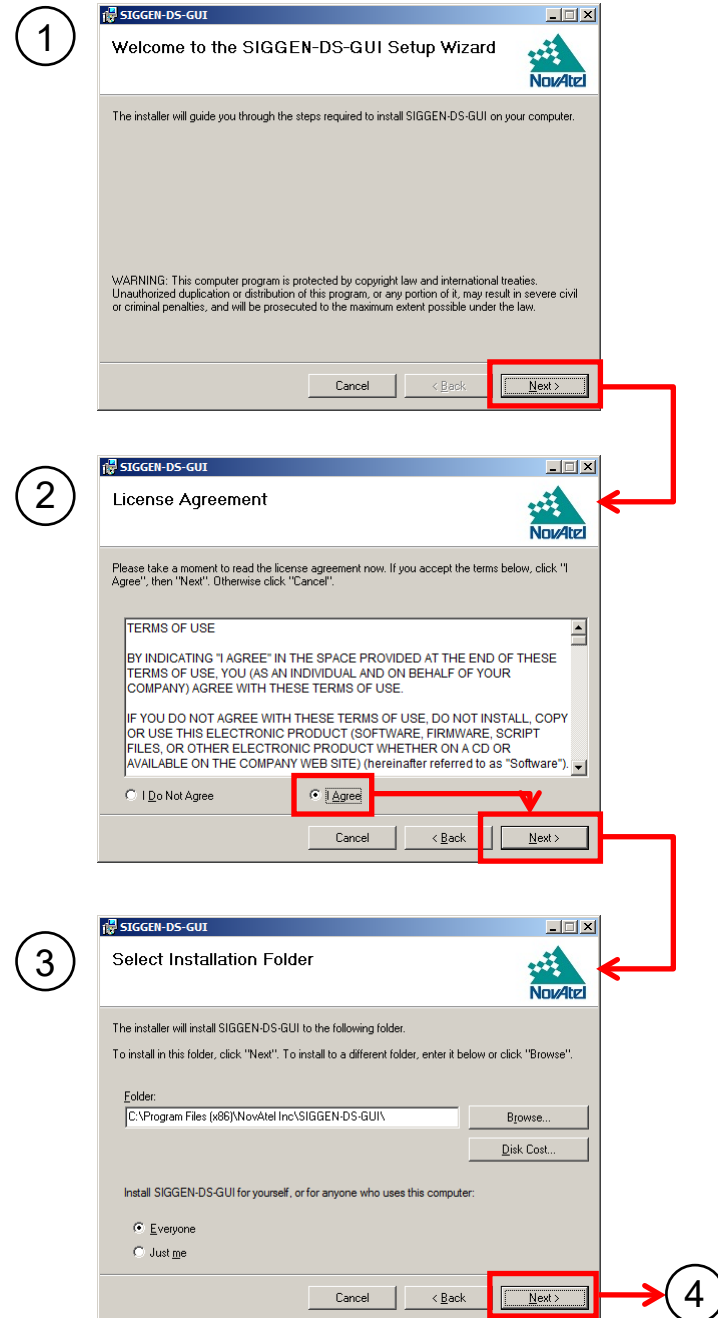


Figure 3-1: Software Installation 1 of 2

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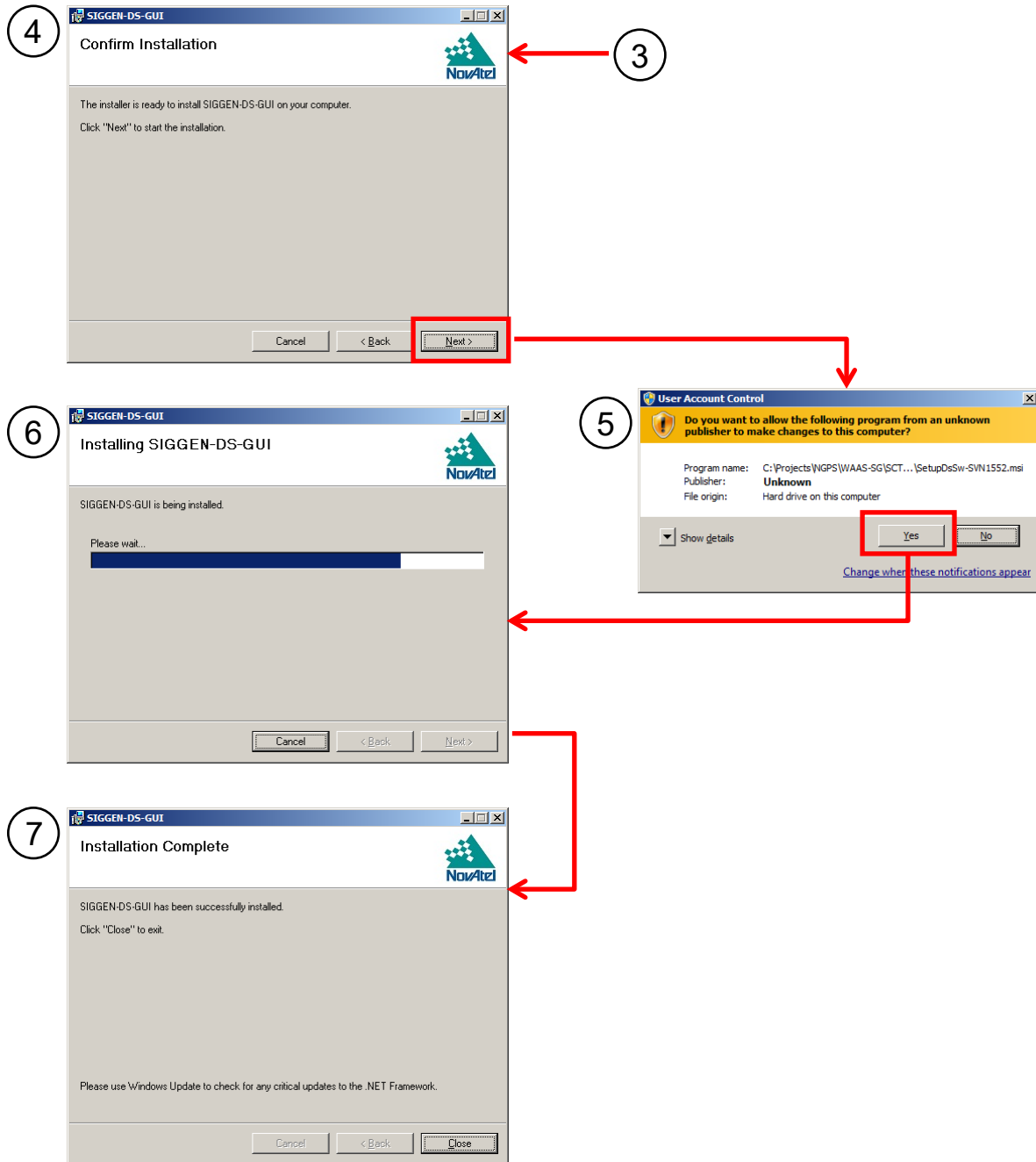


Figure 3-2: Software Installation 2 of 2

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3.2 Module Installation

This section assumes that two UDSMs will be installed on a single WAAS Signal Generator. One UDSM of the L1 channel and the other UDSM for the L5 channel.

If only one UDSM is to be installed, then the appropriate section may be ignored.

Needed equipment:

- One WAAS Signal Generator.
- Two UDSMs.
- Two coaxial cables (SMA Male to TNC Male).
- Two USB cables (USB A to micro-B).
- A small flat screwdriver.

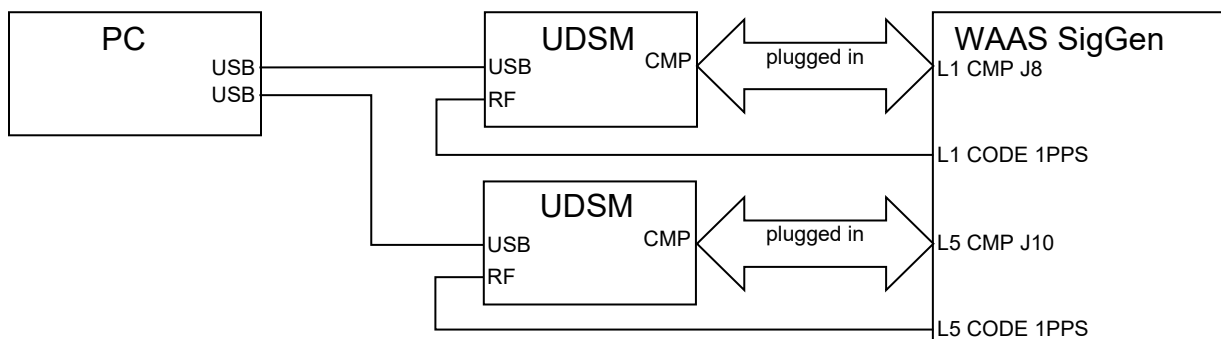


Figure 3-3: DataSource Connection Diagram - PC

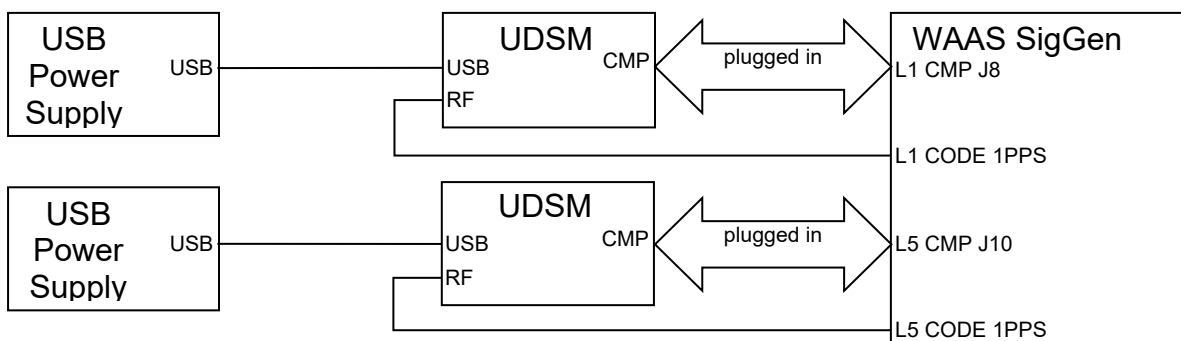


Figure 3-4: DataSource Connection Diagram - Standalone

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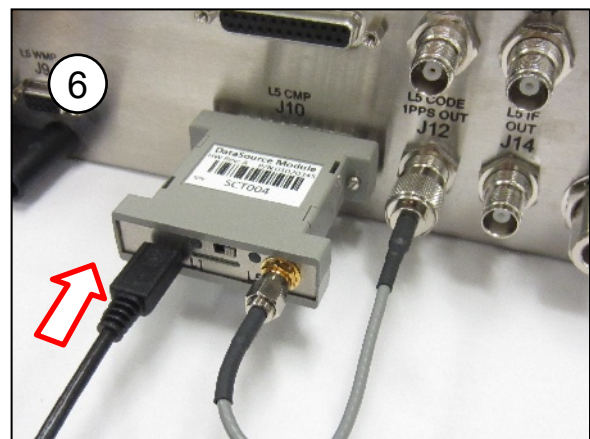
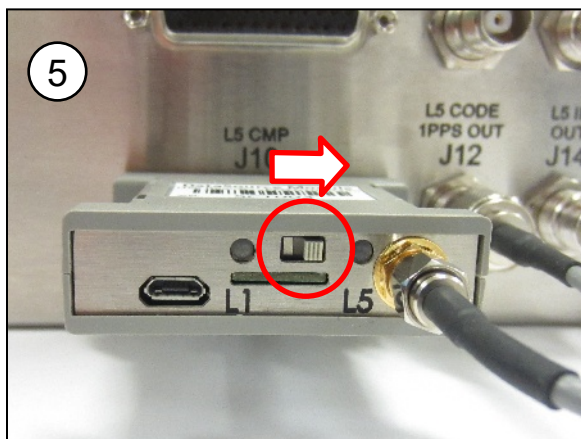
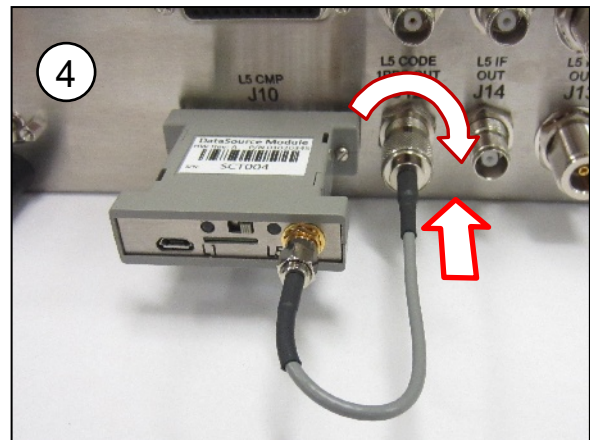
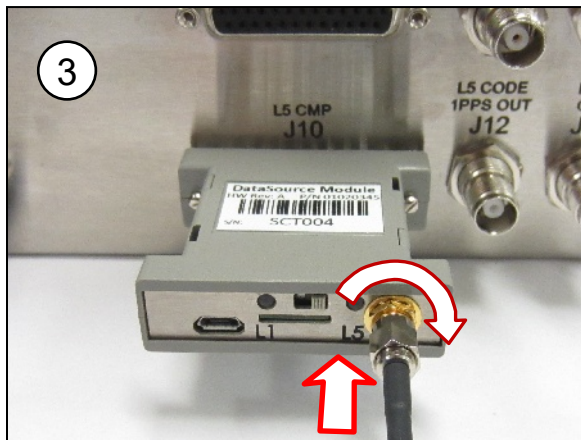
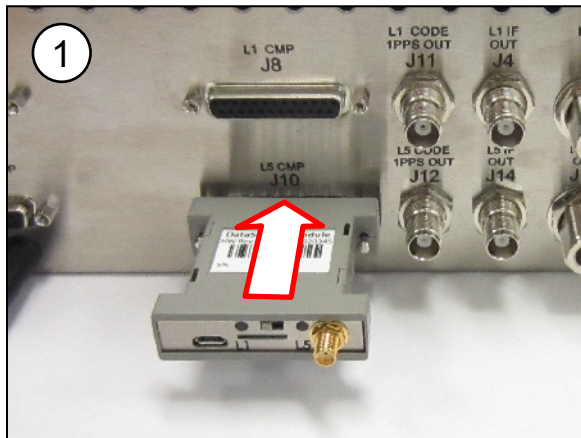


Figure 3-5: UDSM Installation 1 of 3

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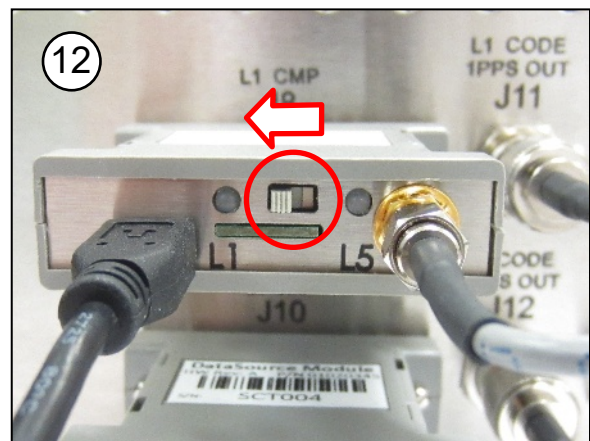
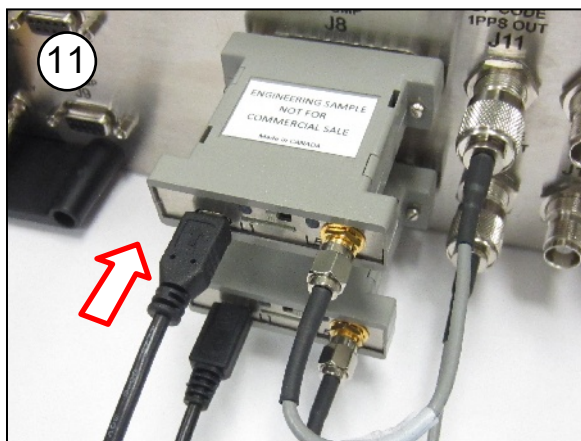
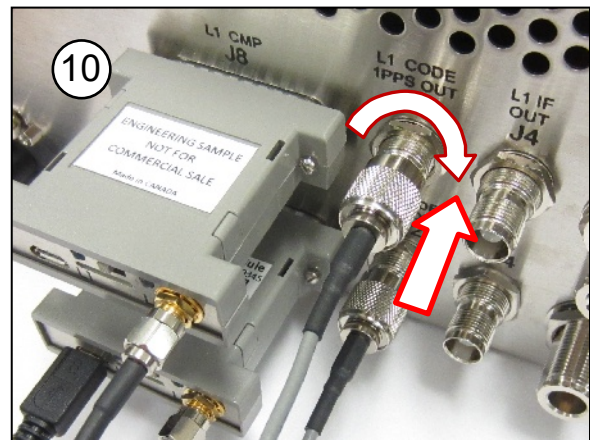
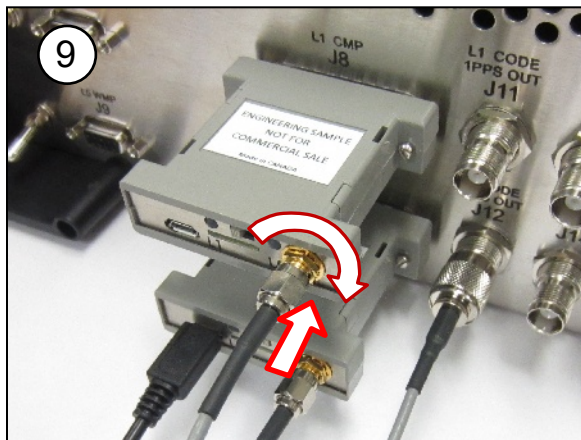
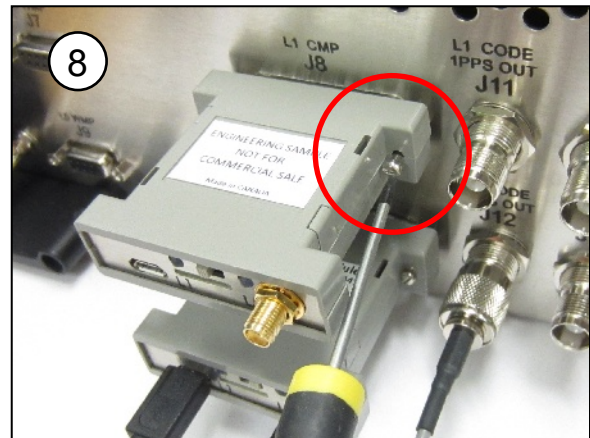
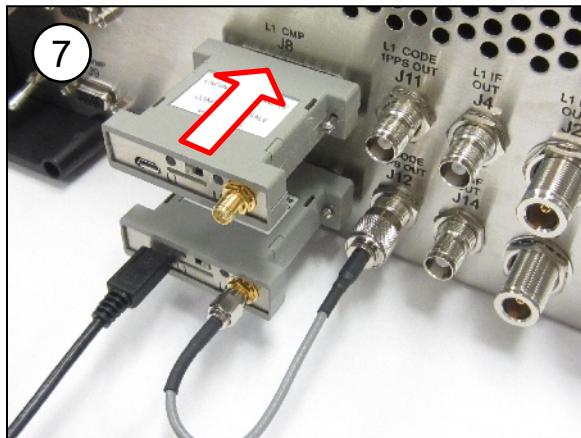


Figure 3-6: UDSM Installation 2 of 3

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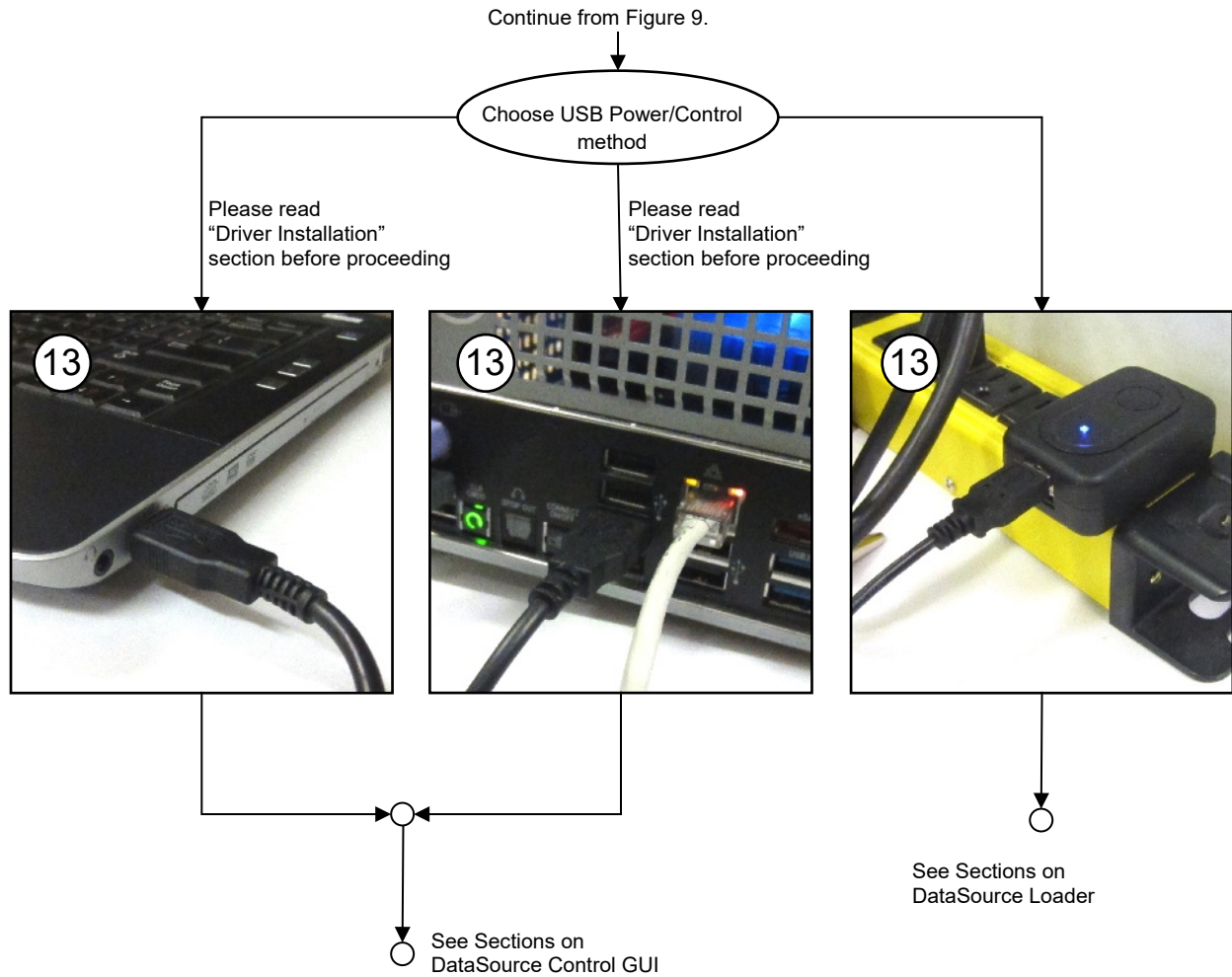


Figure 3-7: UDSM Installation 3of 3 – USB Power/Control Options

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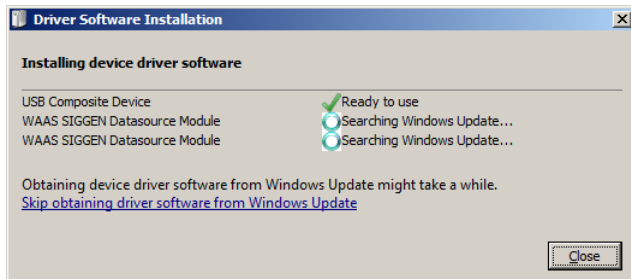
3.3 Driver Installation

The UDSM may be powered from a stand-alone USB power supply and this section may be ignored. The USB Power Supply is the same as any commercially available USB Wall Charger for tablets, cellphones, etc. Power supply is not included with the UDSM package.

No driver is shipped with the UDSM. The UDSM uses a FTDI driver that is installed automatically from Windows Update.

Alternatively, the drivers may be downloaded from FTDI (www.ftdichip.com).

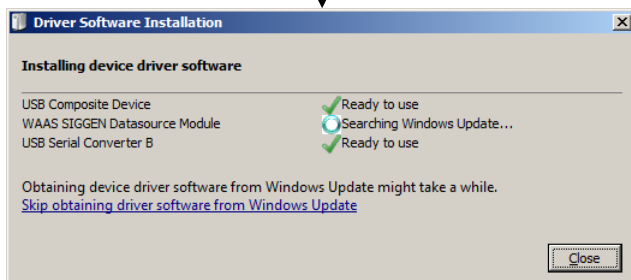
Upon the plugging one UDSM into a PC, the following information will be shown.



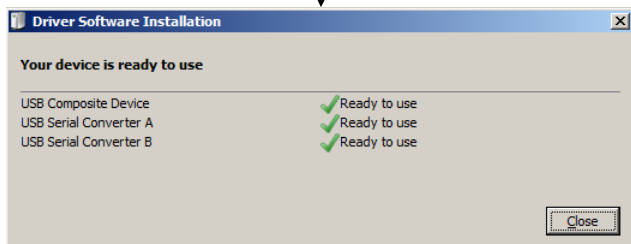
The "USB Composite Device" usually appears "Ready to use" almost immediately after the UDSM is plugged into the PC.

Each UDSM consists of two USB devices. This is characteristic of the underlying USB chip set.

Each UDSM will initially appear as a "WAAS SIGGEN Datasource Module". The search from "Windows Update" can take several minutes.



As the driver for each device is installed, the name for each device will change from "WAAS SIGGEN Datasource Module" to "USB Serial Converter" with a suffix "A" or "B".



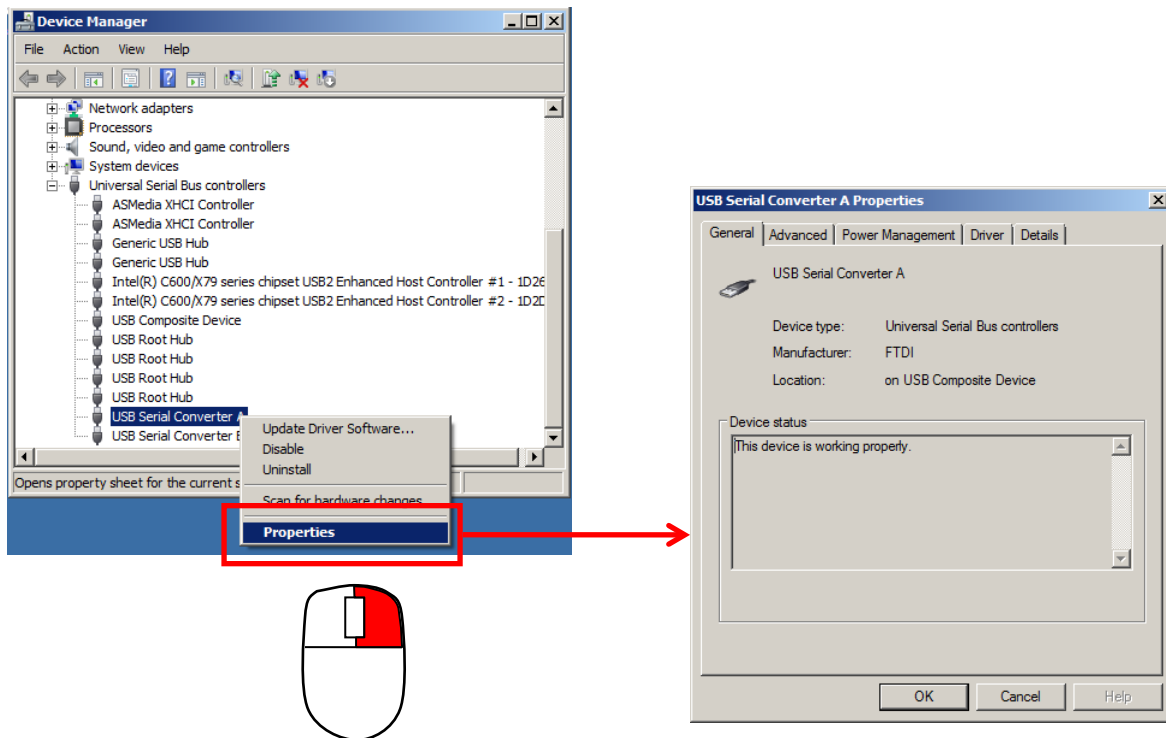


Figure 3-9: Optional Step - Confirm Driver through Device Manager (Windows 7)

3.4 Software Problem

The software is written using Visual Studio 2017 which requires a set of libraries to functional correctly. Most Windows machines are constantly updated with these libraries or acquire them as a side effect of installing other software.

The problem becomes apparent upon launching the DSLoad utility. The error message windows is shown below.

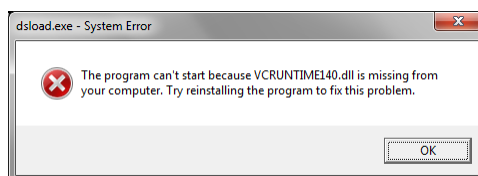


Figure 3-10: DSLoad Error

The problem will also appear with the DataSource GUI but with a different error message window. This error window will not appear immediately. It appears a few seconds or if a “Find” is executed. See below.

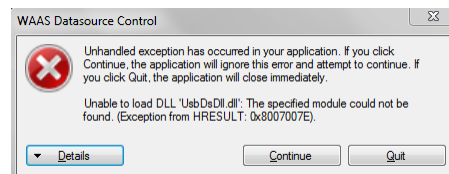


Figure 3-11: DataSource Control GUI Error

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The solutions is to manually install the Visual Studio libraries. These are available at the Microsoft website here:

<https://support.microsoft.com/en-ca/help/2977003/the-latest-supported-visual-c-downloads>

Each file is about 15MB in size and can take several minutes to download. The packages come as an executable file. Run the executable file and follow the dialog instructions.

At this time, the SIGGEN software supports the 32-bit platform only. Hence only the 32-bit redistributable package (vc_redist.x86.exe) need be installed.

The 64-bit package could and should be installed for possible future 64-bit versions of SigGen software or other 64 bit software.

3.5 Confirm Installation

Once the UDSMs are connected and powered up, confirm that the LEDs indicate L1 and L5 identities. The LED of the top or L1 UDSM will have a red color. The LED of the bottom or L5 UDSM will have a green color. If this is not case, correct the switch settings. See the figure below.

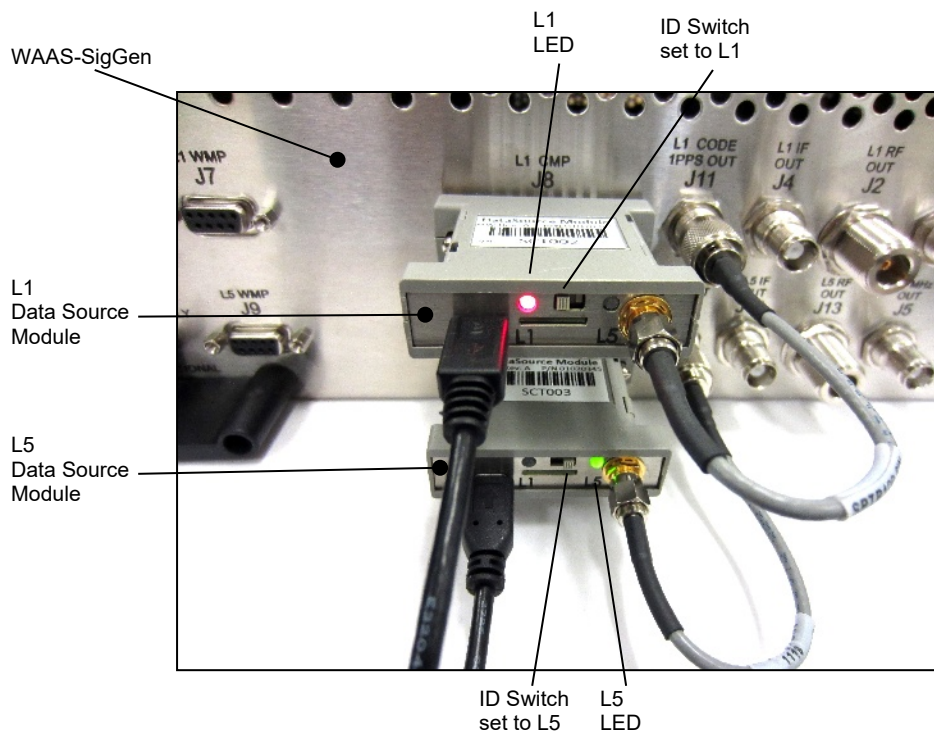


Figure 3-12: Confirm Installation

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4 DataSource Control GUI

The DataSource Control GUI is a Windows application running on a PC that replaces the original CMPSIM's hardware controls.

The Unified DataSource operates autonomously (without the GUI) if powered to send traffic through the CMP port. The GUI provides access to advanced CMPSim-derived features.

4.1 Prerequisites

Connect the DataSource modules and their PPS inputs to their respective ports on the SigGen. Set the identification switch on each Unified DataSource to match the port label on the SigGen (L1/L5).



To provide GUI control over the correct Unified DataSource, the operator must set the DataSource's identification switch to match the CMP interface (L1 or L5) to which it is connected.

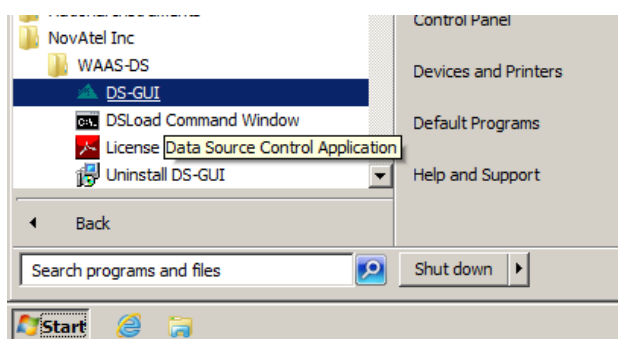


One or two Unified DataSource Modules must be connected to the PC for the DataSource Control GUI to function.

If the GUI finds no Unified DataSource Modules (or too many) connected when the GUI initializes, it must be restarted to take control of the UDSMs after the user corrects the connectivity problem.

4.2 Starting the Data Source Control GUI

The DataSource Control GUI can be started from either the "Start" menu or from the installed "Desktop" shortcut. The locations as seen on a Windows 7 PC are shown in the figure below. Windows 10 will be different.



OR



Figure 4-1: DataSource Control GUI Locations

4.3 Connecting to UDSMs

After the DataSource Control GUI control is launched, the window appears as shown below. It is initially in an unconnected state. All user interface controls are disabled or greyed out except the “Find” button and the “Exit” button.

Clicking on the “Find” button will result in one of the shown connected states or an error.

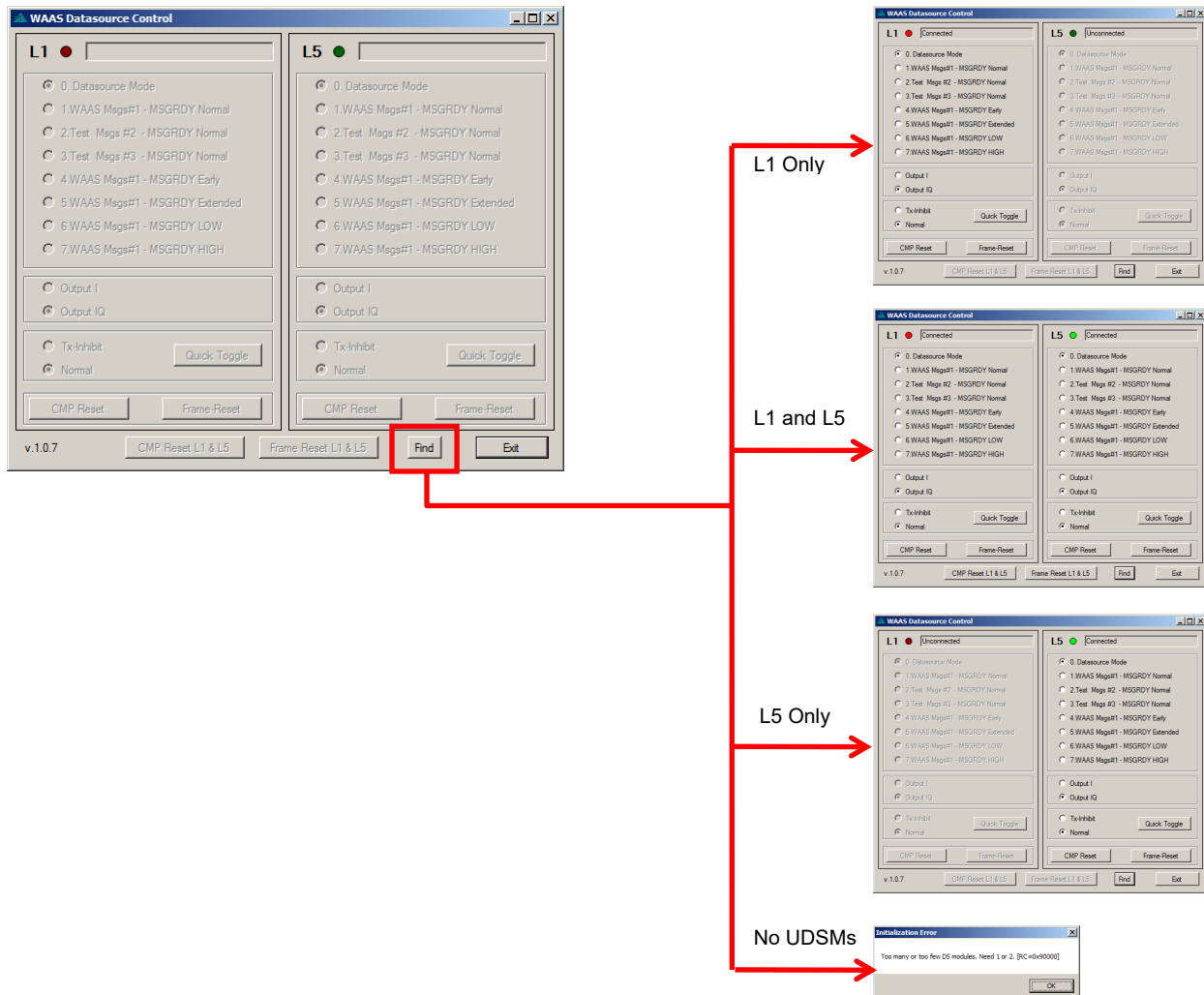


Figure 4-2: DataSource Control GUI Connecting

For the purpose of this discussion, it is will be assumed that the DataSource Control GUI finds and successfully connects to two UDSMs.

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4.4 Overview

The DataSource Control GUI is a very simple user interface consisting of exactly one dialog window. There are no menu bars, popup windows or any other dialog.

An overview of the user interface controls are shown in the figure below. More detail in subsequent sections.

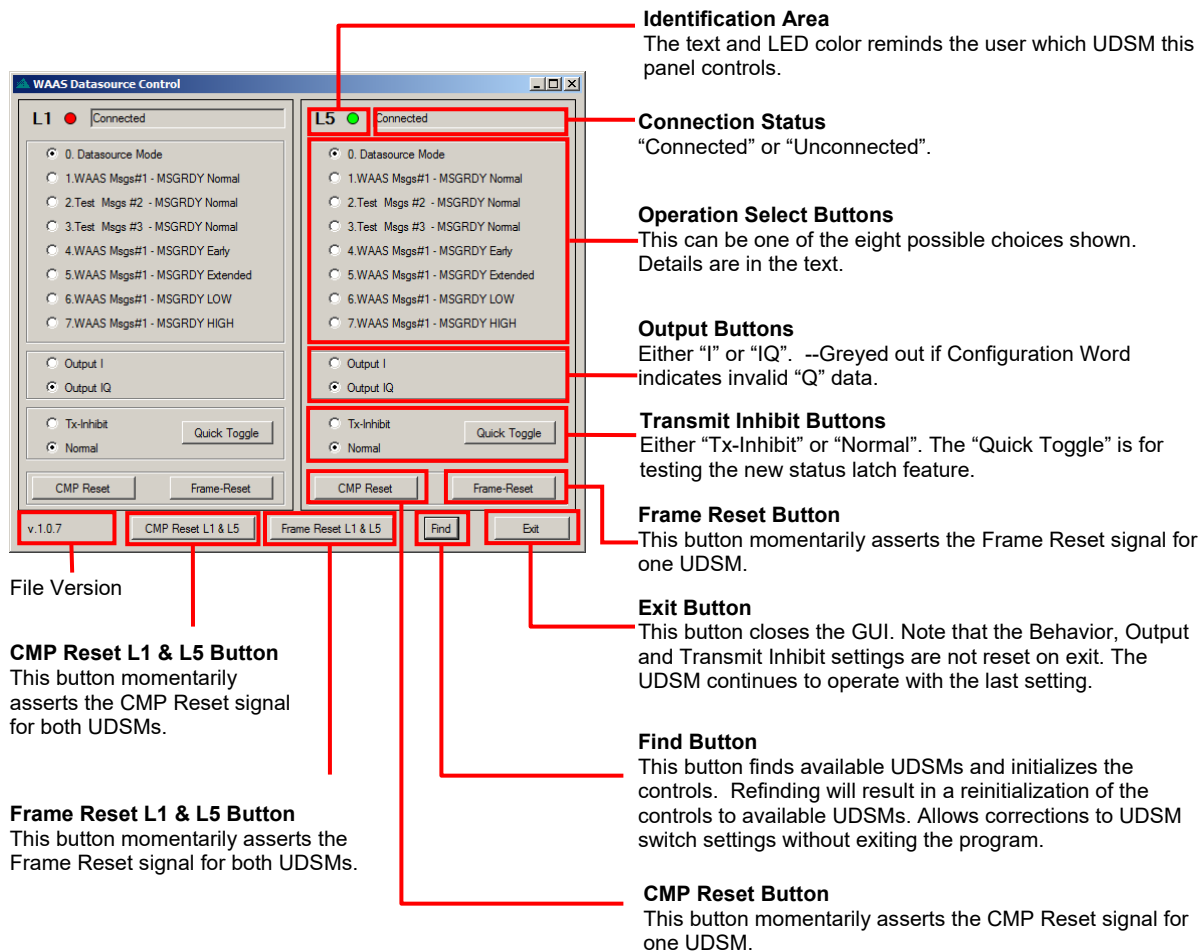


Figure 4-3: DataSource Control GUI Controls

4.5 Identification Area

The identification area consists of label text and a LED indicator. The color of the LED indicator will match the actual physical LED on the UDSM. See figure below.

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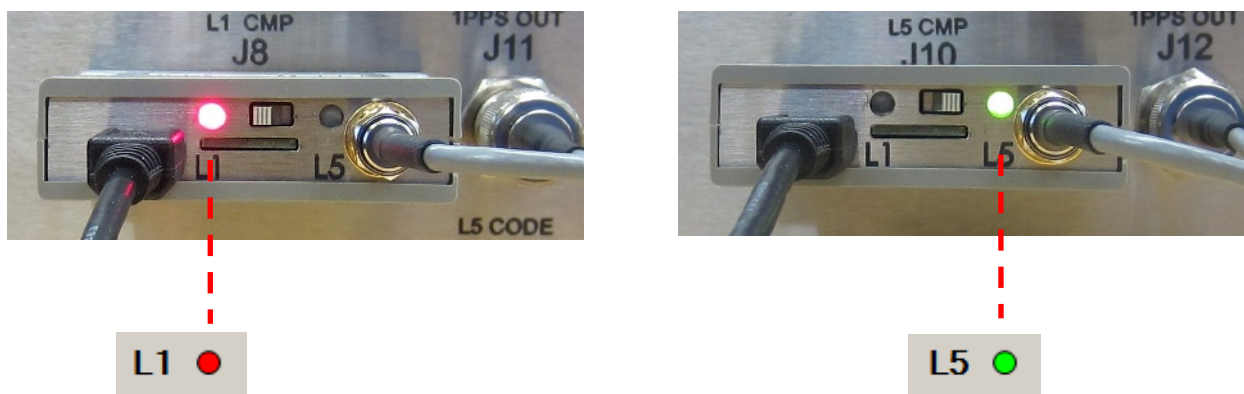


Figure 4-4: Identification Physical and Virtual

The label text is “L1” or “L5” and it does not change, i.e., the left panel is always “L1” and the right panel is always “L5”.

The LED indicator is color coded to the type, red for “L1” and green for “L5”. The LED indicator on the GUI panel will dim when not connected and brighten when connected.

4.6 Operation Select Buttons

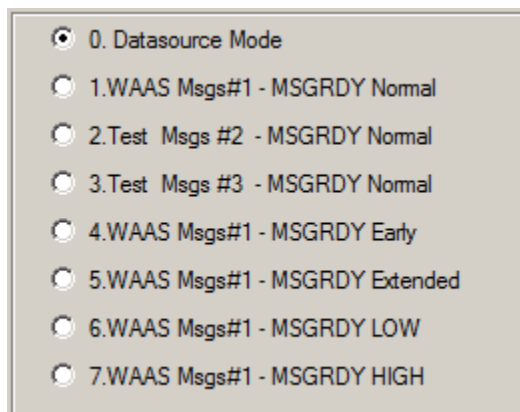


Figure 4-5: Operation Select Buttons

This control consists of a group of eight radio buttons. The GUI allows selecting only one at a time. The eight buttons provide equivalence to the seven choices of the switch on the Legacy CMPSim box plus a new choice corresponding to the Legacy DataSource Module. The meaning of each Operation Select control choice is broken out in the table below.

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Table 4-1: Operation Select Matrix

#	Mode	Messages	MSGRDY	Usage	Comments
0	DataSource	DataSource [†]	Normal	Normal	Optional page depth, Optional In-phase or both In-phase and Quadrature messages (set by Configuration Word).
1	CMPSim	Set #1 [‡]			
2		Set #2 [‡]			
3		Set #3 [‡]			
4		Set #1 [‡]	Early	Testing Only	MSGRDY de-asserted before 500th MSGCLK.
5			Extended		MSGRDY extended after 500th MSGCLK by 50 MSGCLK cycles.
6			LOW		MSGRDY stuck LOW (de-asserted).
7			HIGH		MSGRDY stuck HIGH (asserted)

[†] See Section 9.2 for more information regarding DataSource message contents.

[‡] See Section 10 for more information regarding CMPSim message contents.

The selected mode change takes effect at the arrival of the PPS pulse following the setting change. The page counter resets to the new mode's first message.

4.6.1 Data Source Mode Behavior

The original DataSource operated autonomously, so requires no controls in the GUI. At power-up, the Unified DataSource defaults to DataSource behavior as set in its Configuration Word (see Section 6.3)

Since the Unified DataSource combines the DataSource and CMPSim behaviors, some original CMPSim controls now exist when SELECT = "0. DataSource Mode" – the original DataSource lacked any external controls.

4.6.2 CMPSim Mode Behavior

Table 4-2: Q Message Enable

Operation Select	MSGRDY	Config.Q†	Button	Q Output	Comments
0 - DataSource 1-3 CMPSim	Normal	0	X	No	Buttons disabled
		1	I	No	
		1	IQ	Yes	
4-7 - CMPSim	Not Normal	X	X	No	Buttons disabled

† See Section 7 for more information regarding Configuration Word in flash memory.

The unshaded rows are ones where the Output Buttons control the Q Output. The Q Output will reflect the state of the Output Buttons.

In the shaded rows, the Q Output ignores the state of the Output Buttons. Clicking the Output Buttons will have no effect on the actual Q Output. The Output Buttons are disabled or greyed out to indicate that clicking on them has no effect. For example:

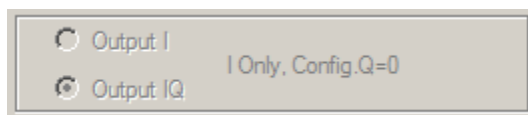


Figure 4-7: Output Buttons Disabled 1

or

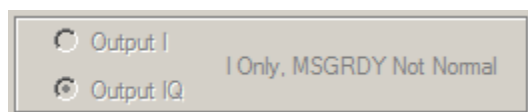


Figure 4-8: Output Buttons Disabled 2

A brief status message is shown with the reason why the control is disabled. Note that the selected output remains unchanged when the control is disabled. The signal is still at that setting but it is ignored by the UDSM.

The Q bit in the Configuration Word is programmed in the UDSM flash memory. To change the Configuration Word, the UDSM flash memory must be reprogrammed. See Section 6.3 for Configuration Word programming details

button “Tx-Inhibit” is selected (TX-INH is asserted); pressing the button will momentarily de-assert TX-INH.

The “Quick Toggle” is for testing the status latch feature in the SigGen firmware.

This control operates the same for both DataSource mode and CMPSim mode.

4.9 CMP Reset Buttons

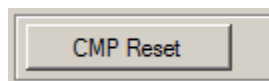


Figure 4-10: CMP Reset Button

This button controls the CMP RESET signal in the CMP interface. Clicking on the button asserts the RESET signal at its CMP connector for at least 100 milliseconds. The assertion actually begins upon the release of the mouse button.

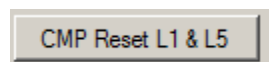


Figure 4-11: CMP Reset L1 & L5 Button

On the original CMPSim box, the CMP Reset switch was a toggle switch. It was possible to provide continuous assertion while depressed. The DataSource GUI will provide a fixed momentary assertion, i.e., holding the button down will not result in continuous assertion.

To reset both generators simultaneously press the “CMP Reset L1 & L5” button. This strobes the CMP RESET to both SigGen CMP interfaces for at least 100 milliseconds. This action is procedurally done at the software level and the two strobes will not actually occur simultaneously but near simultaneously. Theoretically, 128 microseconds between L1 and L5 signals.

These buttons operate the same for both DataSource mode and CMPSim mode.

4.10 Frame Reset Button

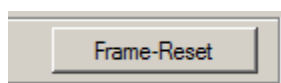


Figure 4-12: Frame Reset Button

This button forces the symbol page counter to the first message in the message set. This allows the operator to synchronize the symbol pages counters of two UDSMs at the next PPS.

Since USB is a serial interface, the possibility exists that the signals to the L1-connected and L5-connected Unified DataSource Modules straddle the arrival of the PPS (assuming synchronized PPS at each) causing the two DataSources' counters to be offset by 1. If the L1 and L5 PPS operate out of sync (see the SigGen's front panel LEDs to see if the both generators' 1 PPS LEDs flash out of sync) misalignment of the page counters becomes more likely.

This sometimes occurs in test modes if the two generators are brought out of reset at different times. See SIGGEN GUI User Guide document for details of simultaneous Channel Bring-up.

These buttons operate the same for both DataSource-mode and CMPSim mode.

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5 DataSource Control CLI

The DataSource Control Command Line Interface (CLI) is a Windows console application (cmpsim.exe) running on a PC that replaces the original CMPSIM hardware. The intended use of the CLI is for test scripts where a GUI is not required and would get in the way.

5.1 Synopsis

The cmpsim command has the following forms:

```
cmpsim {L1|L5} reset [on|off|toggle]
cmpsim {L1|L5} frame [on|off|toggle]
cmpsim {L1|L5} txinh [on|off|toggle]
cmpsim {L1|L5} output [i|i|q]
cmpsim {L1|L5} msg [ds|1|2|3]
cmpsim {L1|L5} msgrdy [normal|early|late|low|high]
```

5.2 Conventions

The command requires the parameters enclosed in square brackets ('[' and ']') unless using the command to display the current value.

The parameters enclosed in curly braces ('{' and '}') are optional.

The parameters are case-insensitive.

All parameters shown are literal text values. No substitution.

Contrary to the usual convention, the upper case parameters “L1” and “L5” are not substitution parameters but literal text values. The uppercase is shown to avoid confusing lower case ‘l’ (ell) with the number ‘1’. A lower case “l1” or “l5” is accepted as well.

5.3 Examples

5.3.1 Display Current Reset Signal

The example below will display the current state of the reset line on the UDSM with switch set to L1.

```
cmpsim L1 reset
```

The command will result in current state being displayed, either

on

or

```
cmpsim L1 reset toggle
```

The reset is momentarily inverted from its existing state before return back to that state. Set the state prior to calling toggle to establish a known existing state.

5.3.3 Set Messages

The example below sets the message data set to 2 on the UDSM with its switch selecting L5.

```
cmpsim L5 msg 2
```

Setting the msg value might change the msgrdy mode to “normal” if the msg value requires it. Some msg values are only available with a msgrdy of normal (per Table 4-1). In such cases, the CLI prints a warning when it changes the msgrdy value.

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6 DataSource Loader

The DataSource loader provides capability to load new messages for both DataSource and CMPSim modes of operation, and to write a Configuration Word onto the DataSource from a PC.

The loader also provides the Legacy capability to load and program the DataSource's CPLD. The Unified DataSource now uses the Configuration Word rather than a different CPLD load to offer different behaviors so typical users no longer require this function. It remains as a factory utility or for potential future upgrades.

The original DataSource Loader was used to load DataSource data into the DSM flash memory. The new DataSource still loads DataSource data into the UDSM but also accommodates other data associated with the new UDSM: It loads CMPSim data sets and the Configuration Word into the UDSM.

In the original DSM, the CMPSim data sets were permanent and unchangeable. The new UDSM is factory-programmed to the same CMPSim values as the original. Under typical use, the data sets are not reprogrammed.

The DataSource Loader is a command-line application called DSLoad.exe.

The first step is to open a command-line window and navigate to the directory containing the DSload.exe file. This can be done by clicking on the start button, choosing "Run..." and then entering "cmd" and clicking "OK". At the command prompt, enter "cd C:\NovAtel\Datasource" (substitute the installation directory for "C:\NovAtel\Datasource" as this directory was specified during the installation process detailed in Section 3.1).

6.1 Hardware Setup

Connect the UDSM to a PC using the included USB cable. The LED matching the Identification Switch setting illuminates when UDSM is powered.



Disconnect the DataSource from the SigGen's L1 or L5 CMP port before loading.

6.2 DataSource Messages

The section deals with writing, reading and verifying DataSource Messages to/from/in flash memory. In this regard, the new DSLoad utility behaves much the same as the old DSLoad. The command is the same as before.

6.2.1 Loading Messages

The data source loads (

The number of pages may also be optionally specified, but will default to 6 if not specified. Each page contains 16 messages, and if the message file does not contain enough messages to fill the specified number of pages, the loader repeats the message file in memory up to that number of pages.

After verifying the message programming (next section), set the Configuration Word (Section 6.3) to match the type and number of message pages if different from default.

6.2.2 Verifying Messages

Once the messages are loaded into flash memory, it is possible to verify that they loaded correctly. To do this, execute the following command:

```
DSload V <filename> {<pages>}
```

Where the “V” indicates that the loader should operate in “Verify Flash” mode and the “<filename>” is substituted with the location and name of the message file that is expected to be loaded in flash memory.

The number of pages can be optionally specified, but defaults to 6 if not specified. The program compares the messages currently stored in flash memory with the messages in the specified file and reports any inconsistencies.



It is strongly recommended that verification be done following every load.



For 4096-pages of messages use Logging Messages (Section 6.2.3) to log the memory contents to a new file and run File Compare (Windows built-in command line function) to compare files for faster results

6.2.3 Logging Messages

The DSLoad provides logging of the current contents of flash memory out to a file to allow inspection of the layout in memory or confirmation that it matches the expected input file. To do this, send a command of the following format:

```
DSload L <filename> {<pages>}
```

Where the “L” indicates that the loader should operate in “Log Flash” mode and the “<filename>” is substituted with the location and name of the filename to write the contents of flash memory to.

The number of pages can be optionally specified, but will default to 6 if not specified. Once complete, the specified file will contain a dump of what is currently in flash memory, including any message

To test GPIO inputs on the CPLD, the “DSLoad z” command injects test patterns (walking 0, walking 1) from the FTDI to the CPLD and checks the validity by reading the CPLD’s IO ring via JTAG. To test the CPLD’s output GPIO, the JTAG injects test patterns onto the CPLD outputs and checks the validity at the FTDI inputs.

```
DSload z
```

The test reports “PASSED” if successful. If it finds unexpected results it reports pin location(s) and “FAILED”.

6.3 Configuration Word

6.3.1 Loading Configuration Word

To load the Configuration Word to flash,

```
DSload G <filename>
```

Where the “G” indicates that the loader should operate in “Load Configuration Word” mode and the “<filename>” provides the location and name of the filename containing the desired Configuration Word value.



The UDSM reads its Configuration Word on initialization only, so requires a power cycle (disconnect USB) to load the new settings.

6.3.2 Logging Configuration Word

To confirm the value of the Configuration Word, log it out of flash into a file using:

```
DSload H <filename>
```

Where the “H” indicates that the loader should operate in “Log Configuration Word” mode and the “<filename>” provides the location and name of the filename into which DSLOAD writes the Configuration Word value from flash.

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7 Configuration Word

The original DataSource operated autonomously, so required neither controls nor GUI. To emulate this, at power-up, the Unified DataSource defaults to DataSource behavior as set in its Configuration Word.

The Configuration Word is stored in internal flash memory. It is factory-programmed to a value that results in operation equivalent to the original DataSource module. The Configuration Word can be reprogrammed with the DSLoad utility program.

The format of Configuration Word is shown in the figure below and described in the table below.

	15	8	7	6	5	4	3	2	1	0
Field	Unused							VALID		
Factory	0b11111111							0b011110		
								Q		
								0		
								P		
								0		

Figure 7-1: Identification Physical and Virtual

Table 7-1: Configuration Word Descriptions

8 Message Format

The DataSource and CMPSim messages share the same format. This section covers the format of the messages and its creation. The message is intended for one channel, e.g., I or Q.

To create the message, first choose one of the 3 valid 8 bit preambles as described in “WAAS Preamble” section below, then enter the message details (this may consist of random data).

Calculate a 24-bit CRC on the preamble and message details using the described CRC in “WAAS Cyclic Redundancy Check” section below.

FEC encode the entire message using the logic as detailed in the FEC section below.

Finally, zero pad the message until the entire message contains 1024 bits (256 hex characters).

8.1 GUS DataSource Message Contents

The GUS message file must include at least one WAAS message block. A WAAS message block consists of 250 bits, with the first 8 bits being the preamble, and the last 24 bits being the parity/CRC bits.

The preamble and the CRC bits must be correct in the WAAS message block in order for the receiver to track the signal. All other bits in the 250 bit message may consist of random data (or may contain actual data) as long as the preamble and the CRC are valid.

After the 250 bit message block is created, the message block must then be FEC encoded, and then zero padded to contain 1024 bits.

For full details on the WAAS message structure and contents, refer to FAA-E-2892B Change 1, U.S. Department of Transportation Federal Aviation Administration Specification Wide Area Augmentation System (WAAS), September 1, 1999.

8.2 WAAS Preamble

Each message block consists of 8 bits of preamble that can be 01010011 10011010 11000110, which means that the first 2 hexadecimal characters in any message block must be either “53”, “9A” or “C6” (before FEC encoding).

8.3 WAAS Cyclic Redundancy Check (CRC)

The last 24 bits in the message block contains the 24-bit CRC. The CRC word is calculated in the forward direction on the entire bit-oriented message, including the

The baseline data rate shall be 250 bits per second. The data shall always be rate 1/2 convolutional encoded with a Forward Error Correction (FEC) code. Therefore, the symbol rate that the GPS receiver must process is 500 symbols per second. The convolutional coding shall be constraint length 7 as standard for Viterbi decoding, with a convolutional encoder logic arrangement as illustrated in figure below. The G1 symbol is selected on the output as the first half of a 4 millisecond data bit period.

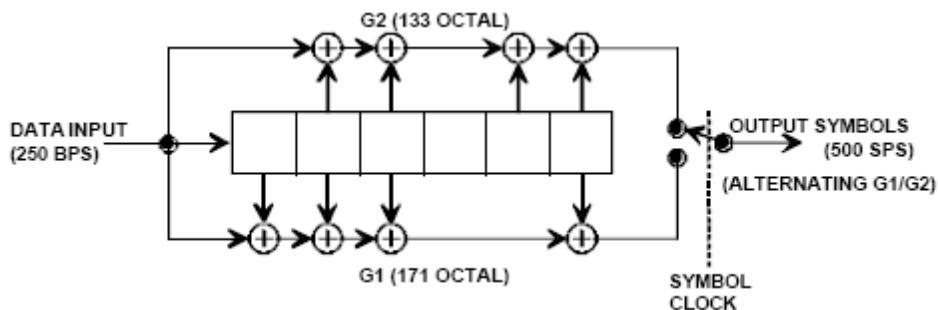


Figure 8-1: FEC Encoder Logic Diagram

Example:

Original 250 message block	c60d3ff800fff8001ffdfdfdfdfc001ffdfdfdf9ffd5113bbbd7b9bb3bb8f40
FEC encoded message	6f9e36176ae4ffc9ac00d94fffc9ac0003653ff10e3ff10e3ff10e3ff26b0003653ff10e3ffffffffffcac93ff1ef08cfc1df030336e1180df2c3ec1f030e75a0

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9 DataSource Message File

The data source needs to be loaded with a file that contains the WAAS message for the SigGen to transmit to the receiver. This section explains how to create the WAAS message. This message file is loaded onto the data source by the method described in Section 6.2.

9.1 File Format

The message file must be a “.txt” file.

Each file contains the navigation messages to be sent. Each message must be separated by a carriage return and line feed and each message must be zero-padded to be exactly 1024 bits long. The message must be entered in hexadecimal format, so each message consists of exactly 256 hex characters.

Example (word wrapped, does not actually contain carriage returns):

```
6f9e36176ae4ffc9ac00d94fffc9ac0003653ff10e3ff10e3ff10e3ff26b0003653ff10e3ffffffffffcac93f
f1ef08cfc1df030336e1180df2c3ec1f030e75a000000000000000000000000000000000000000000000000
00000000000000000000000000000000000000000000000000000000000000000000000000000000000
```

The .txt file will have the format:

<message 1>

<message 2>

....

<message n>

The .txt file may contain up to 4096*16 or 6*16 unique messages. The user must specify which page depth to use (either 6 pages or 4096 pages) by setting Bit 0 of the Configuration Word (Section 7). If the number of messages in the .txt file is less than the maximum amount, the DataSource Loader (see Section 6.2) command line application fills the memory by repeating the messages in the same order until all the pages are filled.

9.1.1 In-Phase and Quadrature Messages

Unlike the original DataSource, the new Unified DataSource

