Delsys Trigno and Vicon Nexus Integration

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Introduction

This guide provides specific instructions for interfacing the Delsys Trigno system with the Vicon Lock+/Lab systems. For earlier Vicon systems, please contact a representative from Delsys. The integration targets two goals:

a)   create a pathway for the Vicon Nexus software to directly manage data from the Trigno System

b)   ensure that data acquired from the Trigno System and the Vicon System are time synchronized.

Two approaches exist for achieving this integration. The Digital Integration approach gives the Vicon system direct control over the Trigno system, as depicted in the top pane of Figure 1. In this case the Trigno Trigger Module is used to ensure that both systems begin data collection at exactly the same point in time, with the resulting Trigno data being natively stored in the Vicon System. The Analog Integration approach depicted in the bottom pane of Figure 1 uses the analog data acquisition capabilities of the Vicon System to sample real-time analog outputs from the Trigno System. In this case, the data acquisition of Trigno signals is performed by the Vicon System, so the analog data are natively time synchronized with other Vicon Data sets. The analog signals from the Trigno System are systemically delayed by a fixed duration[1] which can be easily reconciled with features within the software.

[1] Please refer to the Trigno User's Guide for additional information on analog output delays.
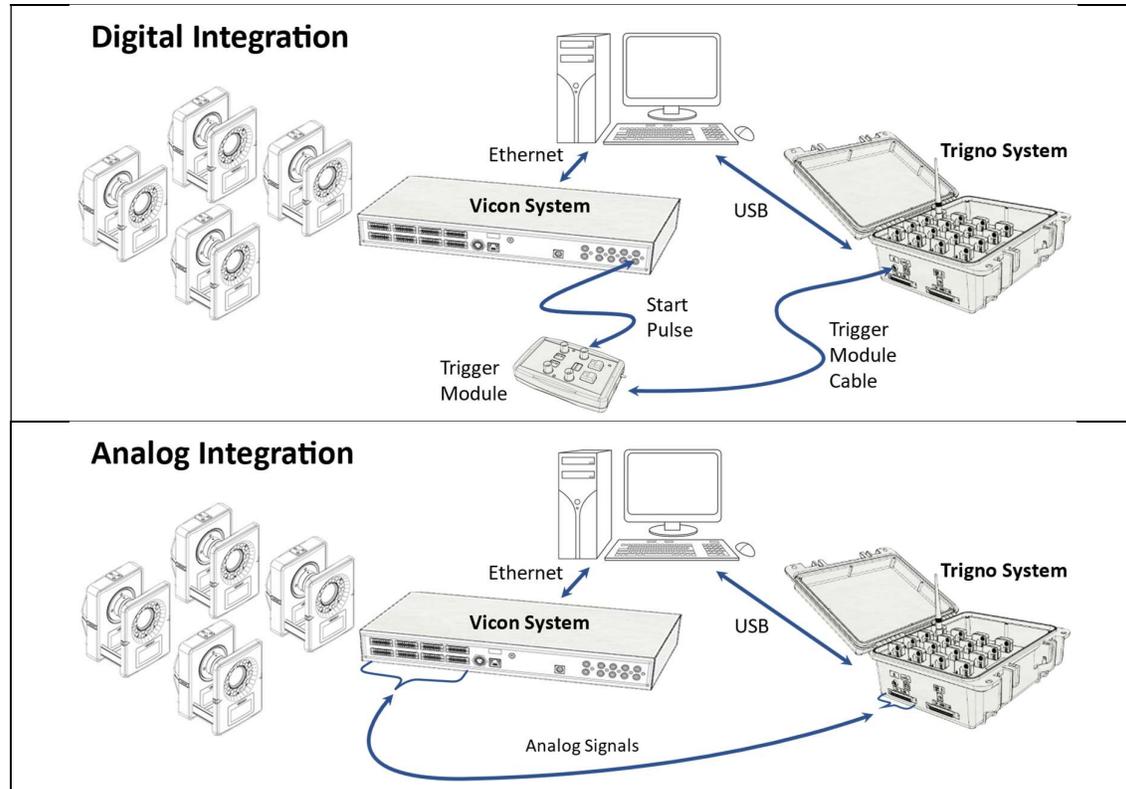
Figure 1: (Top pane) Digital Trigno and Vicon integration with a Trigger Module. (Bottom pane) Trigno analog signal sampled by the Vicon System.

Delsys Trigno Digital Integration with Vicon Nexus 2.x

The Digital Integration pathway gives the Vicon Nexus software direct control over the digital data stream of the Trigno System by way of a software plug-in (also known as a Vicon Digital Device, or VDD). In order to ensure proper time synchronization, the Nexus software issues a digital start pulse the moment it begins data collection, which connects to the Start In of the Trigno Trigger Module and initiates data acquisition. This setup ensures that the first Vicon frame and the first Trigno sample occur at exactly the same point in time (i.e., t=0s). If the Trigno Trigger Module is not connected and the Vicon Nexus plugin is operating in "non-triggered" mode the synchronization cannot be guaranteed and there will be a variable time delay between the measurement systems

Software Requirements for Digital Integration

Item	Version	Resource
Trigno Control Utility (TCU)	v3.6.0 and above	https://delsys.com/support/software/ Trigno Software Development Kit (SDK) Server[2]
Vicon Nexus (with license)	v2.14.0 (64-bit) v2.12.1 (32-bit)	https://www.vicon.com/software/nexus/?section=downloads
Delsys-Vicon Plugin (*.vdd)	v2.2.0 and above	https://delsys.com/support/software/ Vicon Plugin

[2] the TCU is included with EMGworks software or as a standalone SDK server package.

Hardware Requirements

1. Delsys Trigno Base Station
2. Delsys Trigno Sensors (See Appendix I for compatibility)
3. Delsys Trigno Trigger Module
4. Vicon Hardware (Lock+, Lock Lab, Giganet Lab)
5. BNC (male) to RCA (male) cable

Software Installation Instructions

1. Ensure that the Trigno Control Utility (TCU) is version 3.6.0 or later. If it needs to be updated or installed, uninstall any previous versions of EMGworks or the Trigno SDK prior to installing the most recent version from the link indicated in the "Software Requirements" section. Check to ensure that the Trigno Sensor firmware is compatible with your TCU version by using the Trigno Compatibility Guide (https://delsys.com/trigno-compatibility-guide/).

2. Check to ensure that the Vicon Nexus software is v2.14.0 or later. If it needs to be updated or installed, install the latest version using the link provided in the "Software Requirements" section.

3. Check to ensure that the Vicon Plugin is v2.2.0. If it needs to be updated or installed, download the latest Plugin (*.vdd) from the link provided in the "Software Requirements" section. The *.vdd will allow you to stream Trigno data directly into Vicon Nexus via Trigno Control Utility for SDK users.

4. Browse to *C:\Users\Public\Documents\Vicon\Nexus2.x* (Figure 2). If this is a new Vicon Nexus 2 installation, the folder path will not exist. In this case, you will first need to launch Nexus for the location to be created and then close Nexus.

For Vicon Nexus 2.14.0 or later:

   a) Navigate to the *DigitalDevices64* subfolder within the *Nexus2.x* location. If this folder does not exist, create it as shown in Figure 2a below.
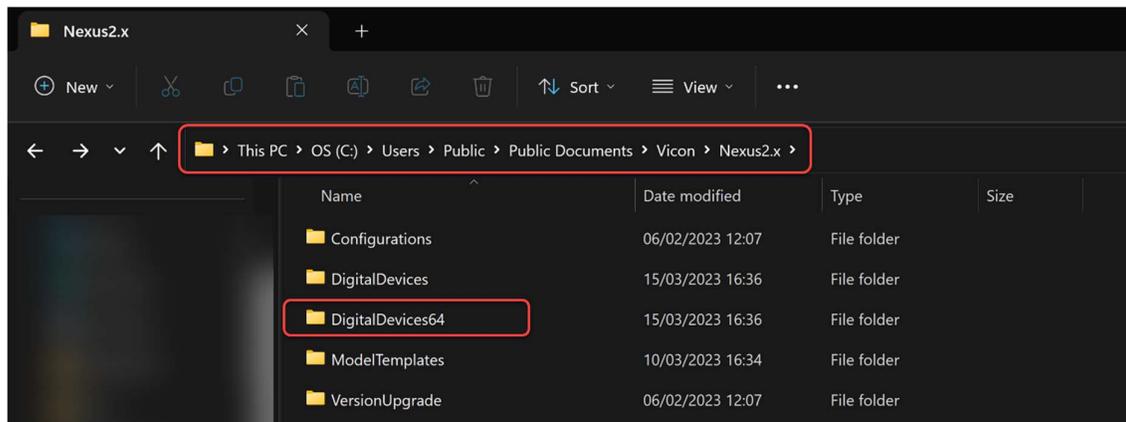

Figure 2a: Screenshot of the DigitalDevices64 folder.

   b) Place the **DelsysDigitalDevice_2.2.0.vdd** in the *DigitalDevices64* folder (Figure 2b).
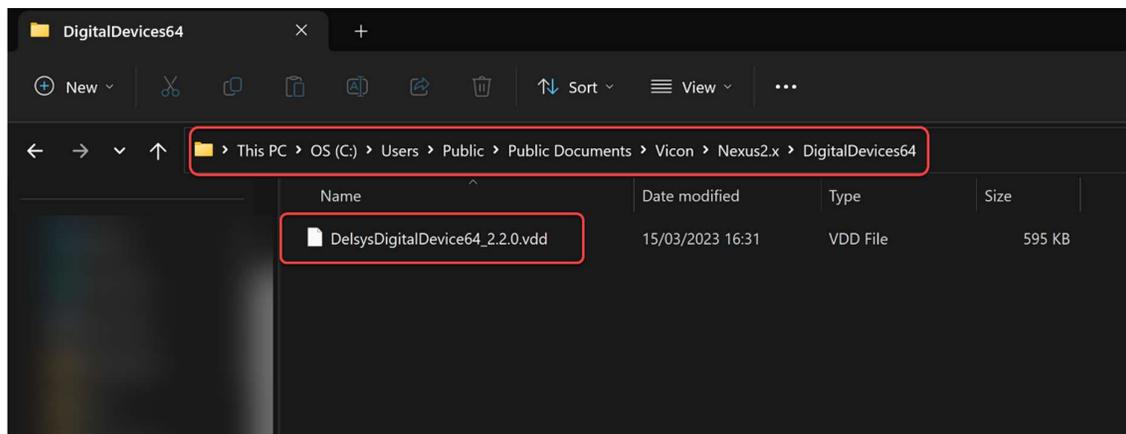

Figure 2b: Screenshot of the necessary file path for the .vdd file.

For Vicon Nexus 2.12.1 or earlier:

   a) Navigate to the *DigitalDevices* subfolder within the *Nexus2.x* location. If this folder does not exist, create it as shown in Figure 3a below.
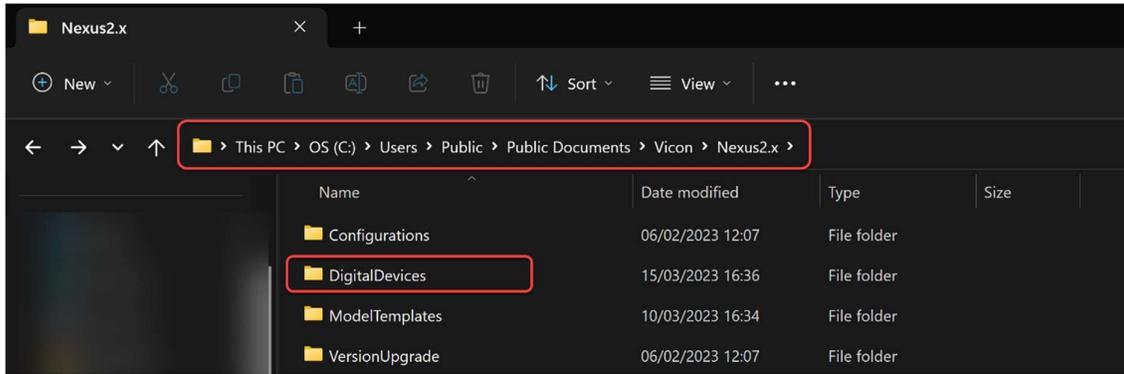
Figure 3a: Screenshot of the DigitalDevices folder.

b) Place the **DelsysDigitalDevice32_2.2.0.vdd** in the *DigitalDevices* folder (Figure 3b).
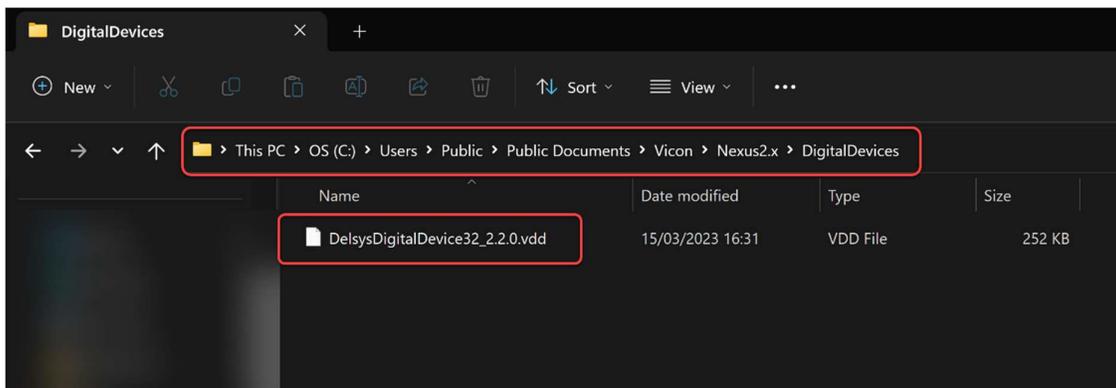
Figure 3b: Screenshot of the necessary file path for the .vdd file.

Integrating into Nexus Software

1. Launch the Trigno Control Utility (Figure 4) and ensure that Delsys Sensors have been paired and are connected.

    See the [Delsys Trigno User Guide](…) for reference.

   [https://delsys.com/support/documentation/#usersguide](…))
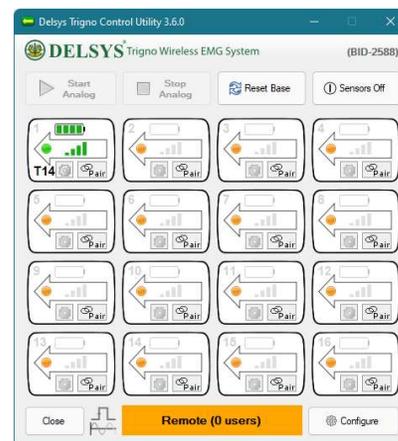
Figure 4: The Delsys Trigno Control Utility.

2. Connect the Delsys Trigger Module's LEMO connector to the trigger port on the Base Station, ensuring the red dots are aligned.

   Connect the BNC side of a BNC-RCA cable to the Start Trigger Input connector on the Delsys Trigger Module, ensuring that the Edge Selector is on the "Rising Edge" as shown in Figure 5A. The RCA end of the cable should then be connected to an available Sync Output port on the Lock+/Lab Box (Figure 5B). If using a BNC-BNC cable, please connect an RCA adapter to one end of the cable.
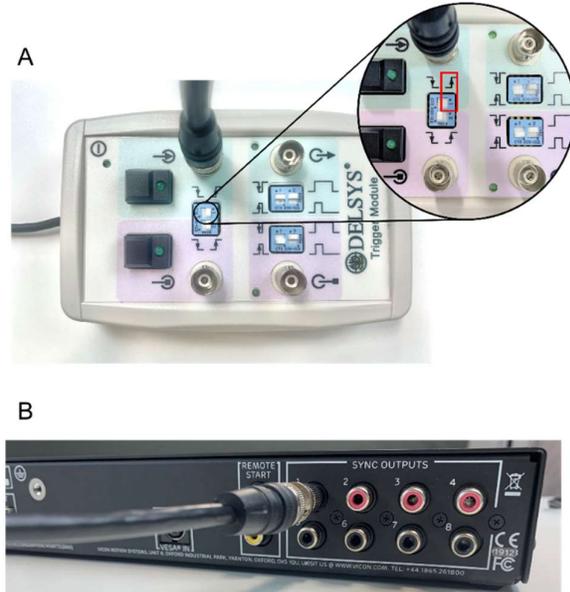

Figure 5: (A) Connecting the Start Trigger Input of the Delsys Trigger Module to the (B) Vicon Lock Lab GPO Sync Output.

3. Launch Vicon Nexus 2.X, right click on Devices in the System Tab, open *Add Digital Device* and then left click on *Add Delsys Trigno System* (Figure 6).
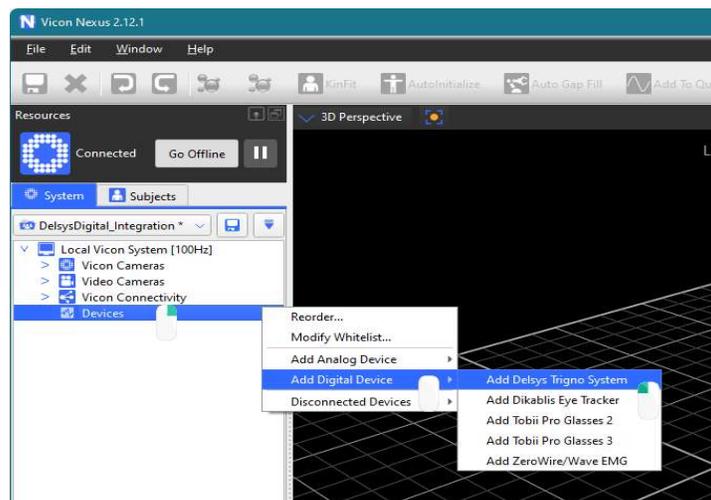
Figure 6: Adding a digital device to Vicon Nexus 2.x.

4. With Delsys Trigno System now available in the Devices Section of your Local Vicon System you will have four virtual devices representing the different components of the Delsys Trigno System (Figure 7):

- #1 [2000Hz] (Delsys EMG 2.2.0)
- #2 [~148.148Hz] (Delsys Accelerometers 2.2.0)
- #3 [2000Hz] (Delsys IM EMG 2.2.0)
- #4 [~148.148Hz] (Delsys IM AUX 2.2.0)

Please see Appendix II for further information on the data associated with each device.
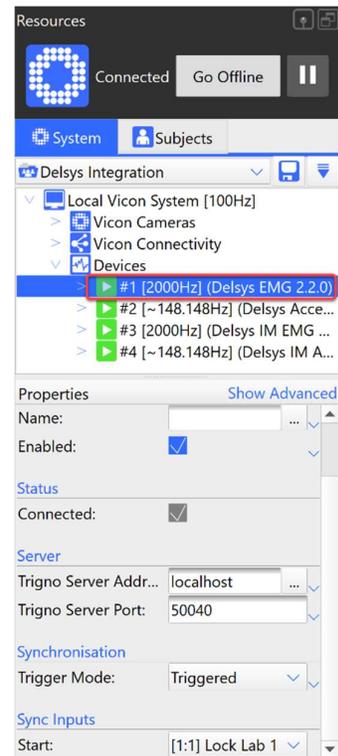

Figure 7: Delsys EMG devices containing data streaming from the Trigno System.

5. Select *#1 [2000Hz] (Delsys EMG 2.2.0)*.

In the Properties section, navigate to the Synchronisation section and in the Trigger Mode drop down menu, select *Triggered* (Figure 8). For more information on triggering, please see Technical Note 301 "Synchronization and Triggering" available here.

(https://delsys.com/support/documentation/#technote)
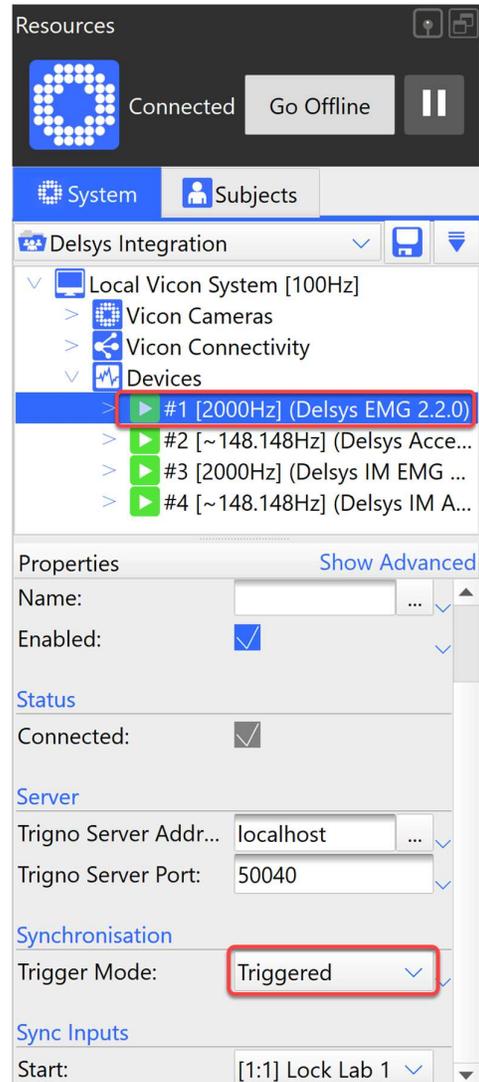
Figure 8: Selecting the synchronisation mode within the Properties window.

6. Navigate to the Sync Inputs section and in the Start drop down menu select the GPO port connected to the Delsys Trigger Module (Figure 9).
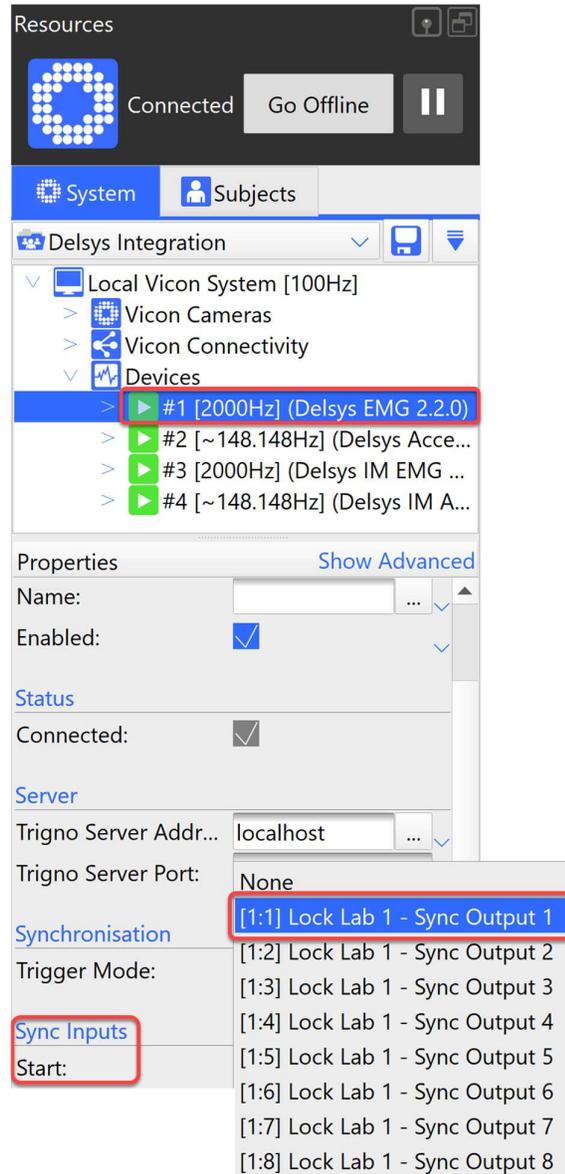
Figure 9: Available GPO Sync Ports on the Lock+/Lab unit.

7. To ensure that data from the Trigno System are streaming and that the Trigger Module is configured correctly check the status of the icons representing the system highlighted in Figure 10. Make sure both are now represented in blue.
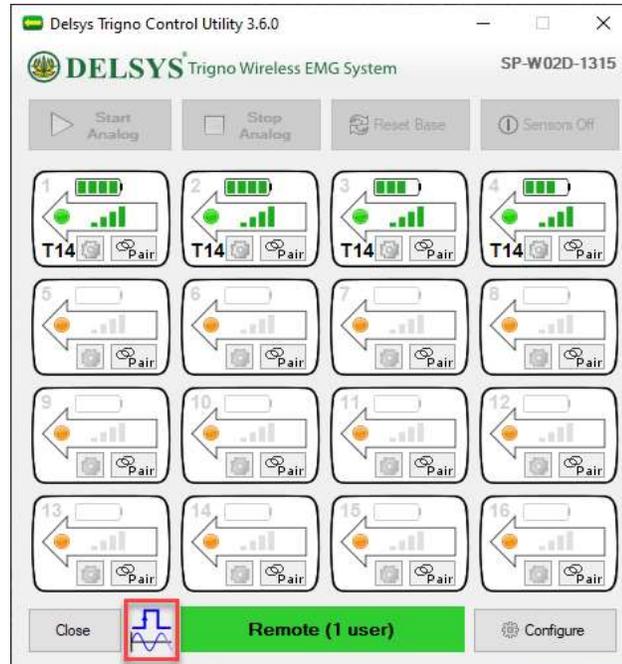
Figure 10: Icons highlighting the Trigger Module and data streaming status with the Delsys Trigno Control Utility.

8. When data capture is initiated in Vicon Nexus, a 5V pulse will be sent to the Delsys system via the Trigger Module to initiate recording and ensure that data streaming from the Delsys system is synchronised with the motion capture data (Figure 11).
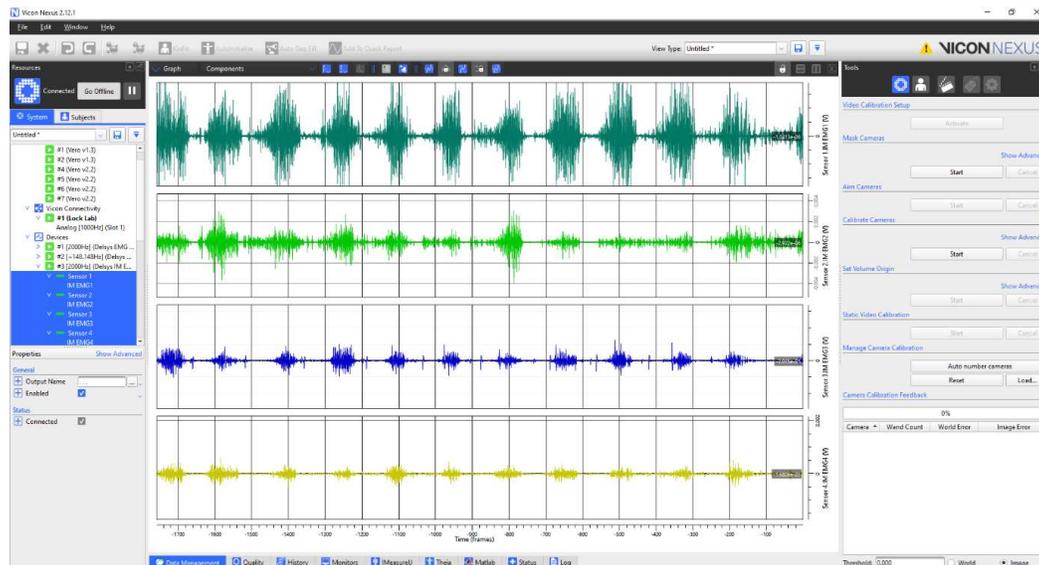

Figure 11: Delsys EMG data streaming directly into Vicon Nexus.

Delsys Trigno Analog Integration with Vicon Nexus 2.x

This guide provides instructions for interfacing the analog outputs of the Delsys Trigno system with the data acquisition inputs of the Vicon Lock+/Lab system. For earlier Vicon systems, please contact a representative from Delsys.

Hardware Setup – Trigno System Analog Outputs

The Trigno system provides simultaneous analog signal reconstruction of data being transmitted by Trigno sensors. These signals are made available on the 68-pin connectors located on the Trigno Base Station (Figure 12A). EMG signals at these outputs are amplified by a factor of 909, with full dynamic range of ±5V. Similarly, accelerometer and gyroscope signals are presented with a nominal full range of ±5V and must be calibrated according to their selected operational range. Note that EMG signals exhibit a fixed delay from the time the sensor detects the event to the time the analog signal is reproduced. Please refer to the Trigno User's Guide for details on the delay table. Refer to Technical Note TN301 "Synchronization and Triggering" available here for a detailed explanation of why this is so. (https://delsys.com/support/documentation/#technote)

Vicon offers Weidmüller wire terminal connectors (Figure 13) to enable users to connect third-party devices to their Lock+/Lab Sync box and capture analog signals. Delsys can supply a cable assembly that mates with the Trigno Analog Output connectors and breaks the individual channels out to single conductors (DC-A22 Unterminated Output Cable; Figure 12B).
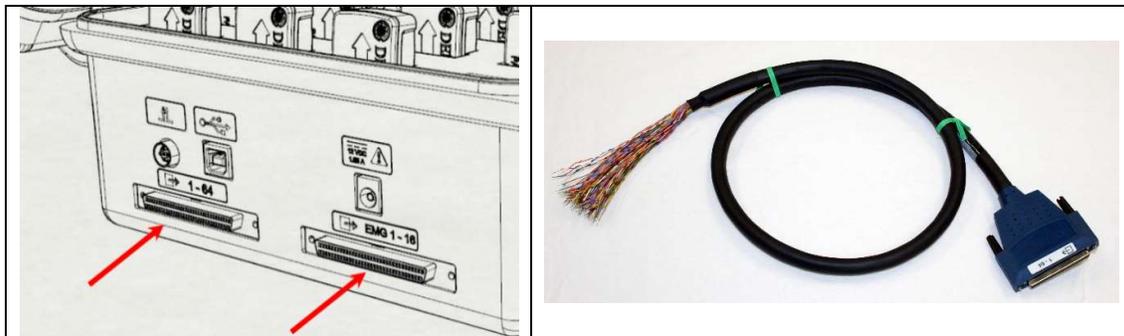

Figure 12: A) Trigno Base Station with analog output connectors. B) DC-A22 Unterminated analog output cable.

⚠️ Prior to making any connections, ensure that power is disconnected from both the Trigno and the Vicon Systems.

⚠️ Take care when inserting the output cable to the Trigno Base Station by ensuring correct orientation and securing the connector thumbscrews.

EMG 1 - 16

This connector makes 16 EMG channels available via analog outputs. It is compatible with many 16-channel National Instruments data acquisition modules and should not be used with the DC-A22 cable.

1 - 64

This connector makes available all 64 analog output channels in the 68-pin connector and should be used with the DC-A22 cable. This connector is compatible with some 80-channel data acquisition modules from National Instruments.

Hardware Setup – Vicon Lock+/Lab Box Analog Inputs

The individual conductors of the unterminated analog output cable from the Trigno Base Station should be connected to the Vicon Lock+/Lab box as shown in Figure 13. The individual wires should be inserted into the corresponding Weidmüller connectors (see Vicon Guide for further advice), following the designated colour coding reference (see section on Open-End Cable Wiring Assignments in the Delsys Trigno User Guide).

Link References:

https://docs.vicon.com/pages/viewpage.action?pageId=107484067

https://delsys.com/downloads/USERSGUIDE/trigno/wireless-biofeedback-system.pdf

Figure 13: DC-A22 integration with Weidmüller connectors and Vicon Lock+/Lab Box.

Software Requirements for Analog Integration

Item	Version	Resource
Trigno Control Utility (TCU)	v3.6.0 and above	https://delsys.com/support/software/ Trigno Software Development Kit (SDK) Server[2]
Vicon Nexus (with license)	v2.14.0 (64-bit) V2.12.1 (32-bit)	https://www.vicon.com/software/nexus/?section=downloads

Software Installation Instructions

1. Ensure that the Trigno Control Utility (TCU) is version 3.6.0 or later. If this needs to be updated or installed, uninstall any previous versions of EMGworks or the Trigno SDK prior to installing the most recent version from the link indicated in the "Software Requirements for Analog Integration" section. Check to ensure that the Trigno Sensor firmware is compatible with your version of the TCU by using the Trigno Compatibility Guide (https://delsys.com/trigno-compatibility-guide/).

2. Check to ensure that the Vicon Nexus software is v2.12.1 or later. If it needs to be updated, install the latest version using the link provided in the "Software Requirements for Analog Integration" section.

Software Setup for Analog Signals

The following instructions will detail how to setup the Vicon Nexus Software to sample the Trigno analog signal outputs.

1. Launch the Trigno Control Utility and ensure that Delsys Sensors have been paired and are connected.

2. Click the gear button for each sensor (Figure 14) to change the configuration type to an analog output compatible setting. The compatible settings are EMG + ACC and EMG + GYRO as they sample EMG data at 1926Hz.

    See Delsys Trigno User Guide for reference.

    https://delsys.com/support/documentation/#usersguide)
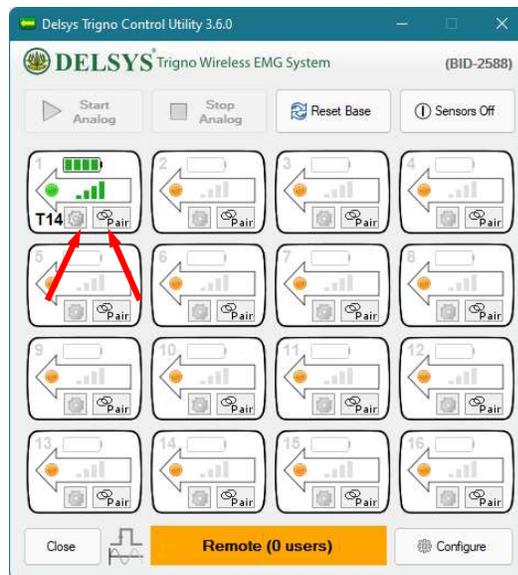
Figure 14: Configuring Trigno Sensors with the Delsys Trigno Control Utility.

3. Press the *Start Analog* button located in the top left corner of the control panel to initiate signal outputs (Figure 15). Minimize the window.
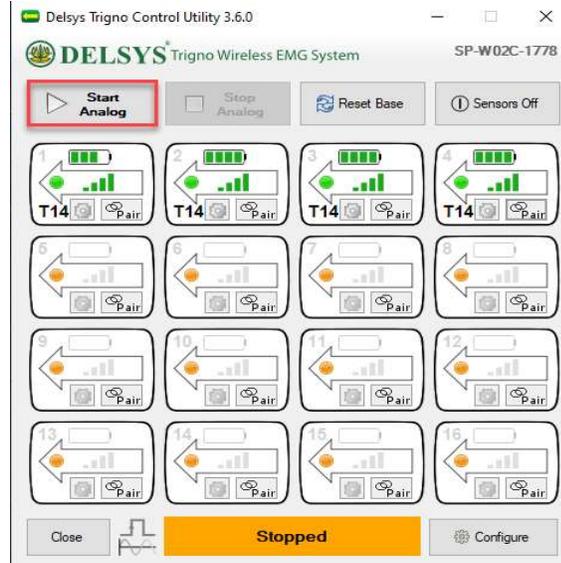

Figure 15: Initiating analog signal from the Trigno Control Utility.

4. Open Vicon Nexus and place into *Live Mode*, if not already selected (Figure 16).
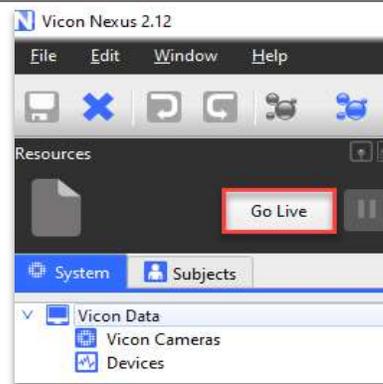
Figure 16: Entering Live mode in Vicon Nexus.

5. Once the Lock+/Lab is connected in the Local Vicon System panel, right click on Devices, and then navigate to *Add Analog EMG* (Figure 17).
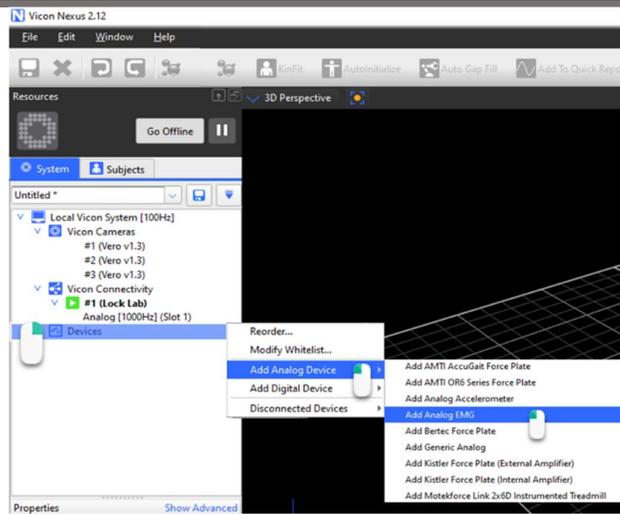

Figure 17: Adding an analog device into Vicon Nexus.

6. Select Analog EMG and determine an appropriate name for your system within the Properties. Then navigate to *Source* within the *Devices* tab to find and select the correct Lock+/Lab slot (Figure 18).
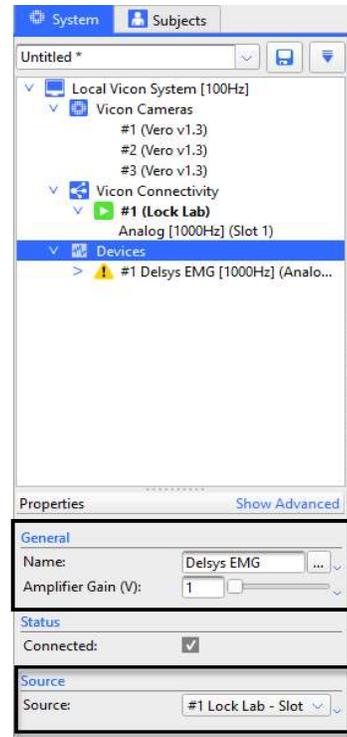
Figure 18: Adding in the Lock+/Lab Source in Vicon Nexus.

7. Time shifts can be implemented to compensate for delays associated with analog integration. Select the Delsys EMG device and expand the *Show Advanced* window from the Properties section. Adjust the Delay Compensation as necessary (Figure 19).

    See the Delsys Trigno User Guide for specific details on analog signal time delays.

    Reference:
   https://delsys.com/support/documentation/#usersguide
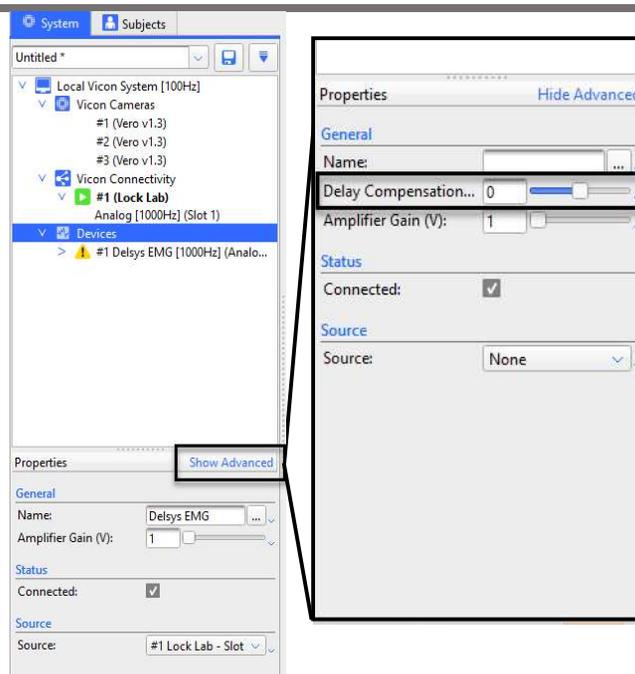
Figure 19: Compensating for analog signal time delays.

8. Select the carrot icon to open the Delsys EMG panel and right click on the *Voltage* tab to begin adding components (data channels; Figure 20).
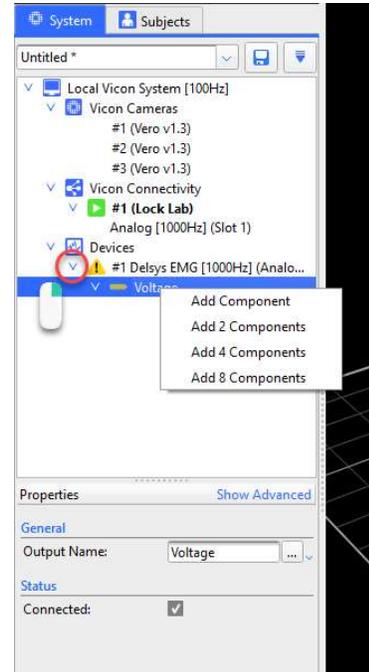

Figure 20: Adding in analog data channels in Vicon Nexus.

9. Within the properties window, determine a name for each channel, select the appropriate pin number (the pin number is the input signal to the Lock+/Lab), and set the gain (this information will be exported within the ASCII data). Repeat for all the remaining components (Figure 21).

The hardware and software should now be configured so that the Vicon Motion Capture systems will be sampled with the desired analog channels outputted from the Trigno EMG System.

Please refer to the relevant Vicon Nexus User Manuals for further information on any specific aspects.
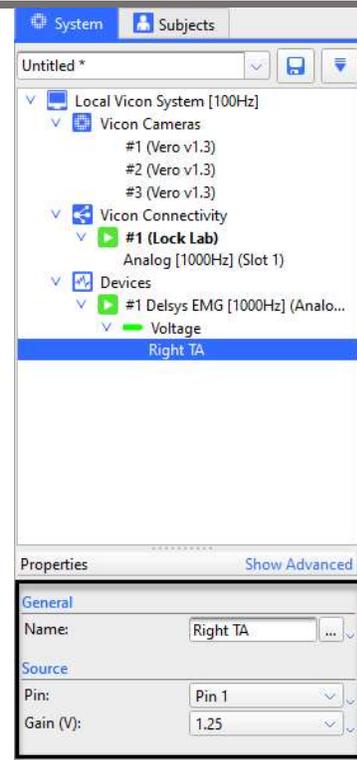
Figure 21: Configuring Delsys EMG channel settings in Vicon Nexus.

Appendix I – Supported Sensor Types for Vicon Nexus

- Trigno Standard Legacy (T3): FW 30:18
- Trigno Legacy IM (T11): FW 25:66
- Trigno Legacy Mini-Head (T9): FW 30:18
- Trigno Avanti EMG types (T14, T16, T17, T23, T24, T27): FW 40.44 and above
    - *Note:* Raw EMG signals from Trigno Galileo (T17) can be collected, but signal decomposition (NeuroMap) cannot be performed on the file.

Appendix II – Device Management

Device 1 = "Delsys EMG 2.2.0"

Device 2 = "Delsys AUX 2.2.0"

Device 3 = "Delsys EMG IM 2.2.0"

Device 4 = "Delsys AUX IM 2.2.0"

Sensor Type	Sensor Name	Vicon Nexus Device
Type 3	Standard EMG sensor	Device 1 and Device 2
Type 9	Mini-Head sensor	Device 1 and Device 2
Type 11	IM Sensor	Device 3 and Device 4
T14, T16, T17, T24, T27	Avanti type sensors (EMG only mode)	Device 3
T14, T16, T17, T24, T27	Avanti type sensors (EMG + ACC/ EMG + GYRO)	Device 1 and Device 2
T14, T16, T17, T24, T27	Avanti type sensors (EMG + IMU)	Device 3 and Device 4