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14. ABSTRACT The objective of this Test Operations Procedure (TOP) is to establish a formal procedure for the operation and setup of the Anthropomorphic Test Device (ATD) using the Data Acquisition for Anthropomorphic Test Devices (D4D) in vehicle vulnerability testing. The D4D is an onboard data acquisition system (DAS) that is intended for use with the Hybrid II/III ATD's.						
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U.S. ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURE

*Test Operations Procedure 02-1-100
DTIC AD No.

9 February 2016

ANTHROPOMORPHIC TEST DEVICE OPERATION AND SETUP

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1. SCOPE.

The objective of this Test Operations Procedure (TOP) is to establish a formal procedure for the operation and setup of the Anthropomorphic Test Device (ATD) using the Data Acquisition for Anthropomorphic Test Devices (D4D)** in vehicle vulnerability testing. The D4D is an onboard data acquisition system (DAS) that is intended for use with the Hybrid II/III ATD's. The D4D was developed to augment the existing DAS system, the legacy Versatile Information Systems Integrated On-Line (VISION) High-Speed Digitizer (VHSD) DAS. The D4D provides increased channel counts and more versatility for on the move vulnerability testing.

2. REQUIREMENTS.

- a. An ATD with the D4D wiring harness. The D4D interfaces to the ATD using a connector that is different from the connector used with the VHSD.
- b. A computer with the follow minimum system requirements:
 - (1) i7-950, 2.93 Gigahertz processor.
 - (2) 8 Gigabyte random access memory (RAM).
 - (3) 1 Terabyte, 7200 revolutions per minute (RPM) hard drive.
 - (4) 1 Gigabyte Ethernet adapter.
- c. An appropriately configured network switch.
- d. Opto-isolators for triggering.

3. SETUP.

3.1 Cable Harness.

The D4D cable harness uses a high density connector for the interface to the D4D resulting in four ATD channels per D4D connector. Each connector in the D4D cable harness is labeled with the range of channels that it represents. It is important to take note of those numbers and plug the connectors into the matching connectors on the D4D front panel.

**The use of brand names does not constitute endorsement by the Army or any other agency of the Federal Government, nor does it imply that it is best suited for its intended application.

3.2 Parameters.

a. To begin using the D4D, an ATD needs to be selected and its parameters need to be downloaded. To download the parameters, the Parameter Builder application that was developed by the Ballistics Engineering, Support, and Technology (BEST) Division, of the U.S. Army Aberdeen Test Center (ATC), needs to be downloaded and installed if not already on the personal computer (PC). The Parameter Builder application is typically located on the desktop, but if it is not, it can be downloaded via the BEST Apps application page (<http://best.atc.army.mil>). This is an ATC only website, and permission to access the site can be obtained from the ATC Ballistics Instrumentation Division (TEDT-AT-SLB). Open the Parameter Builder application and from the drop down menu select the ATD serial number and click Add Dummy (Figure 1). In the menu that comes up, select the crew member position and make sure D4D Generation 1 is selected for the acquisition system (Figure 2). Repeat this step for all ATDs that are being used in the test.

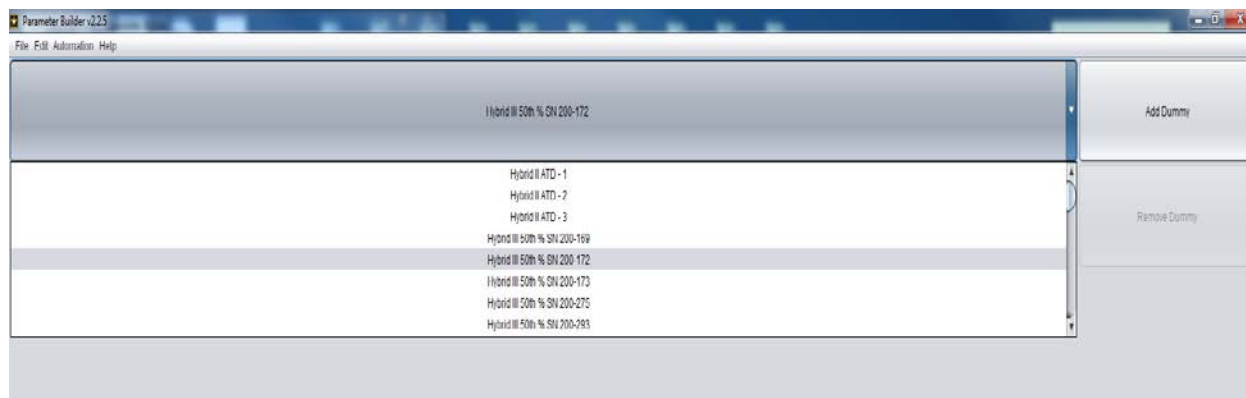


Figure 1. Select ATD from drop-down menu.

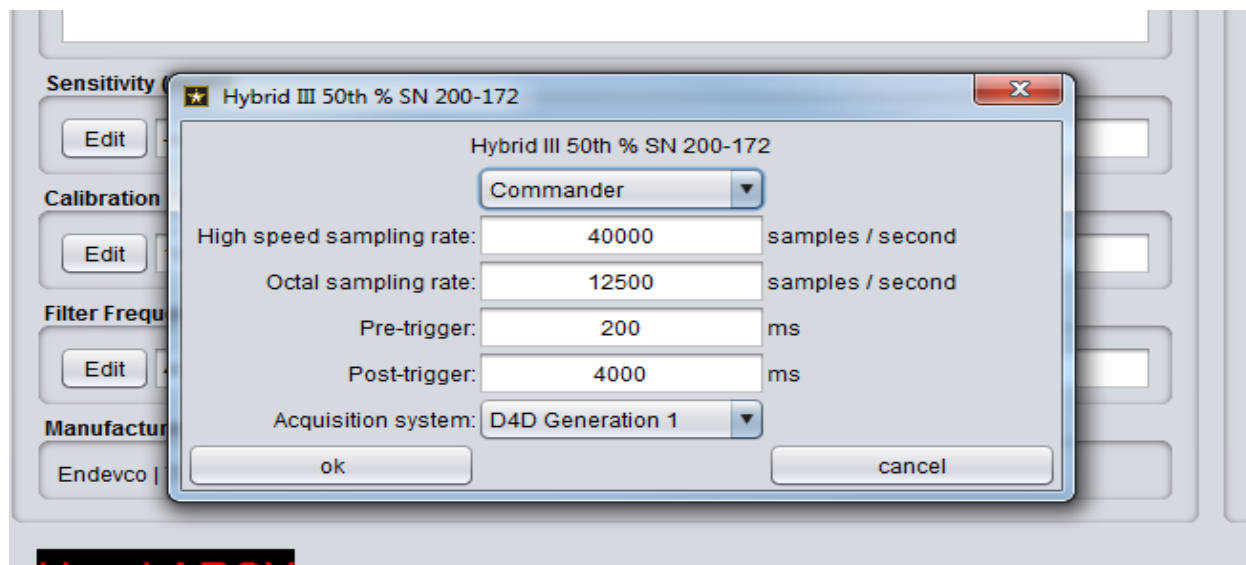


Figure 2. Crew member selection and acquisition system selection.

b. After all of the ATDs have been selected, the sensor channels within the ATD need to be assigned their corresponding DAS channel. To do this select the automation menu (Figure 3) in the upper left hand corner and select Populate D4D Gen 1 Channels. In the text box that comes up select the channels that you want to be associated with the specific ATD serial number (Figure 4).

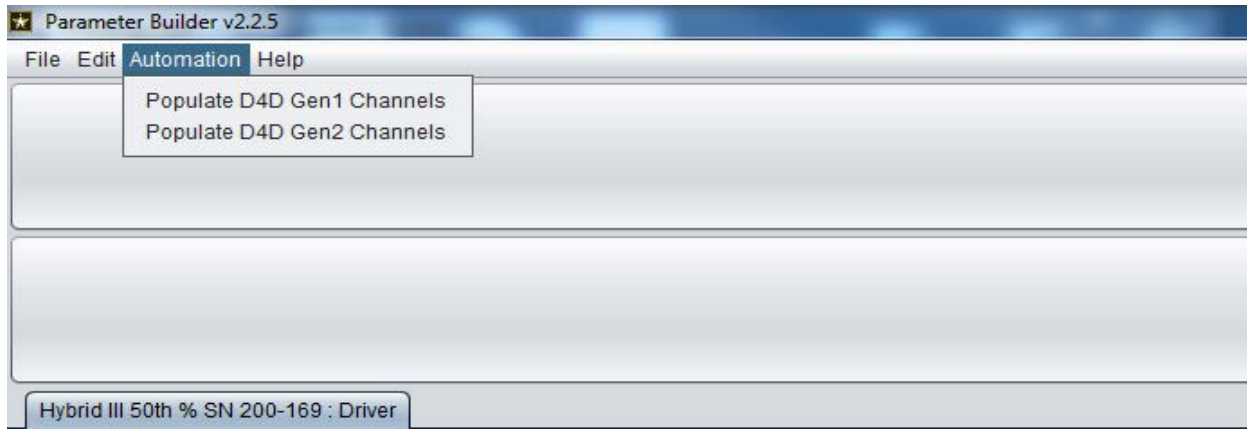


Figure 3. Automation selection.

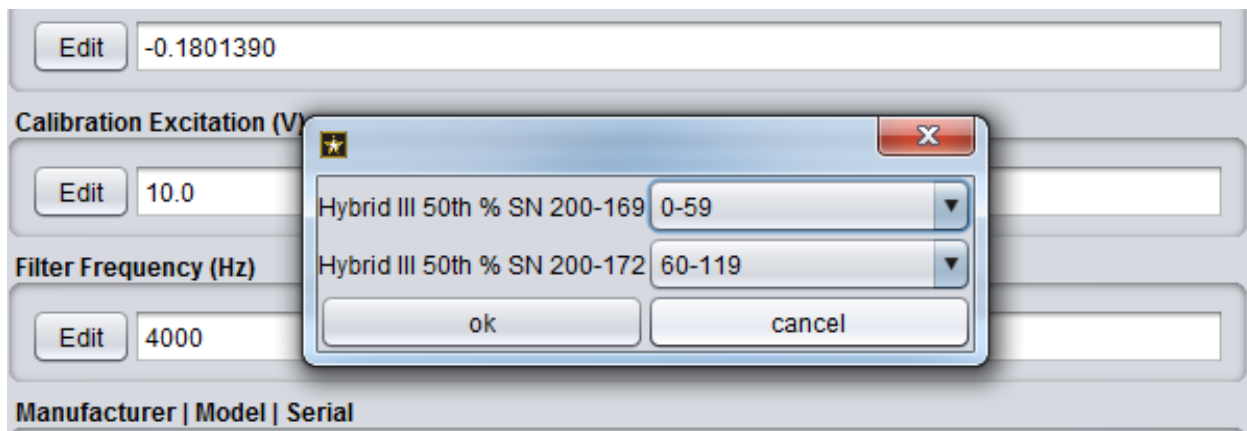


Figure 4. Channel assignment.

c. After channel numbers have been assigned to all of the ATD channels, it is now time to export the ATD channel configuration. Click on “Export Parameters” at the bottom of the window. In the dialogue box that pops up, confirm that all the channels are assigned to the appropriate ATD (Figure 5). In the drop down menu, if applicable, select the test event that the ATDs are going on. Next, select export. A warning may appear about some channels having a sensitivity of “0”, this is due to those channels not being installed in the ATD (Figure 6). Selecting OK will assign a sensitivity of 1 to those channels, or hit cancel and redo the channel assignment to not include those channels. If proceeding with assigning a sensitivity of 1 to those

channels, they will have to be deselected when the parameters are imported into the DAQ console. A prompt will be displayed asking where to save the ATD parameters. Select the desired location and click OK. Next click close on the dialogue box and finally close the Parameter Builder application.

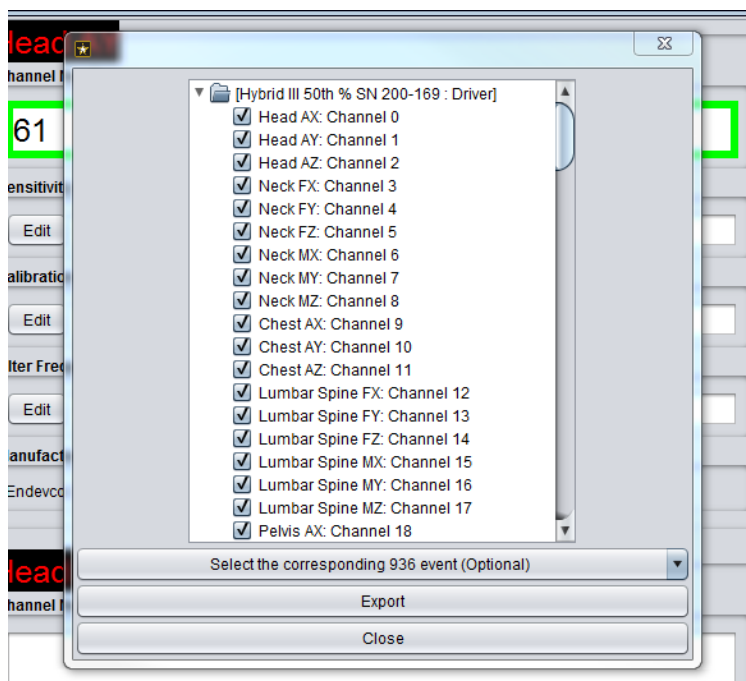


Figure 5.

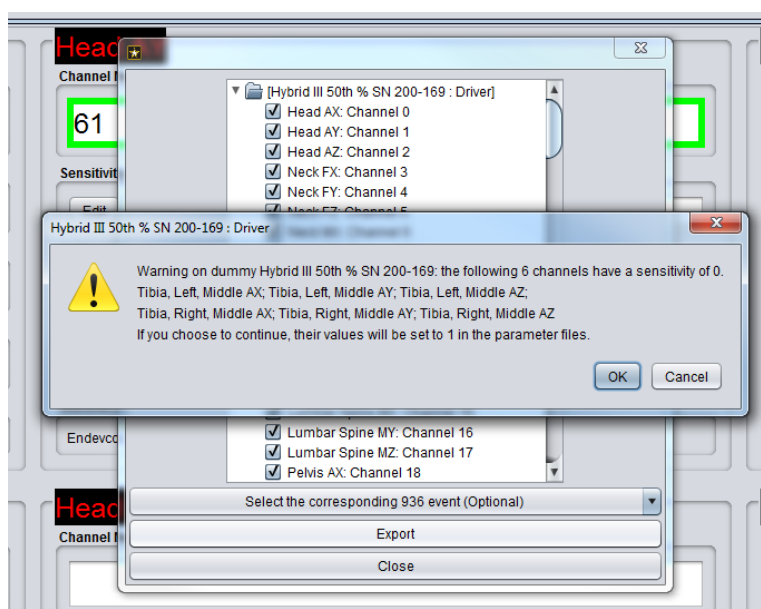


Figure 6. Sensitivity error.

3.3 Range Setup.

To be able to effectively collect D4D data on a live fire range, a private network needs to be installed. Most of the typical live fire ranges at ATC are setup to accommodate the D4D private network. The private network consists of two network switches on either end. They are connected via single mode fiber optic cable. The switch that is down near the test asset, is typically in a bombproof shelter to keep it from getting damaged. An Ethernet cable is run from the D4D located in the test asset, to the network switch in the bombproof. The PC's that are setup to operate the D4D's can only handle a maximum of four D4D's. Multiple computers will need to be used if there are more than 4 D4D's being used in a single test. The Cisco switches, up-range and down-range, will need to be programmed for logical separation so that multiple D4Ds and computers can be ran from the same switch over a single pair fiber. The D4D will also need to have a global positioning system (GPS) antenna attached to them and the antenna positioned where it will lock onto GPS. The GPS is necessary to ensure accurate timing. Once the GPS and Ethernet cables are connected the D4D can be powered on.

3.4 Triggering.

The D4D needs to record a trigger to be able to accurately line the data up with time zero. The trigger is a pulse that is sent out from the firing system and is recorded as a voltage on the D4D. The D4D has an input range of only 2.5 volts. To prevent any voltages higher than 2.5 from being put in the D4D an optoisolator needs to be used on the trigger channel. The optoisolator will take any level input voltage and drop it down to 2.2 volts. The optoisolators are provided with the D4D kit.

4. ACQUISITION.

a. The VHSD and the D4D use the same software for control and acquisition. Located on the desktop will be the Ballistics Test Site (BTSX) Icon. If this is not located on the desktop, follow the steps in Section 3.2 to download and install the BTSX application. Click on this icon to open the acquisition console. There will be a screen that appears, select the test range where the test is being conducted; make sure the box next to "Use BITE" is unchecked and make sure D4D is selected in the drop down box, then click go (Figure 7). When multiple D4D's are being used, the user will be prompted to assign the channel number range to the appropriate D4D (Figure 8).

b. Once the console loads, the user will have to set the total number channels. This is accomplished by taking the total number of D4D boxes and multiplying that by 60. This will give you the total number of channels being used. The absolute maximum number of channels that is allowed per PC is 240 channels, which equates to 4 D4D boxes. To set the console for the correct total number of channels, select tools and then options (Figure 9). Next, scroll down to the miscellaneous section and change the max number of channels to the number that was previously calculated (Figure 10). Click save changes and restart the console following the above steps.

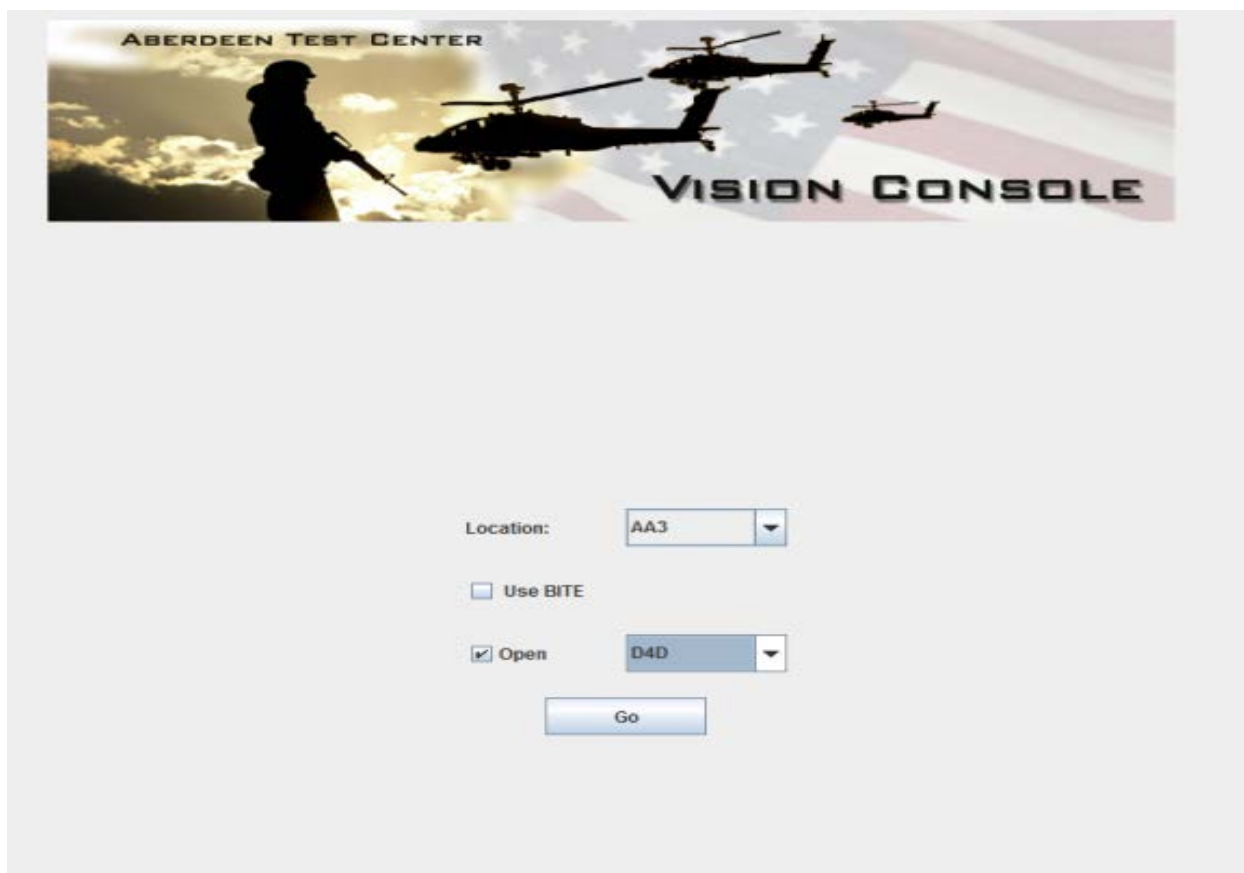


Figure 7. Console home screen.

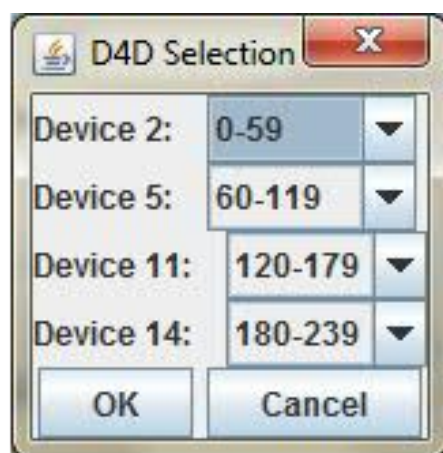


Figure 8. D4D channel assignment.

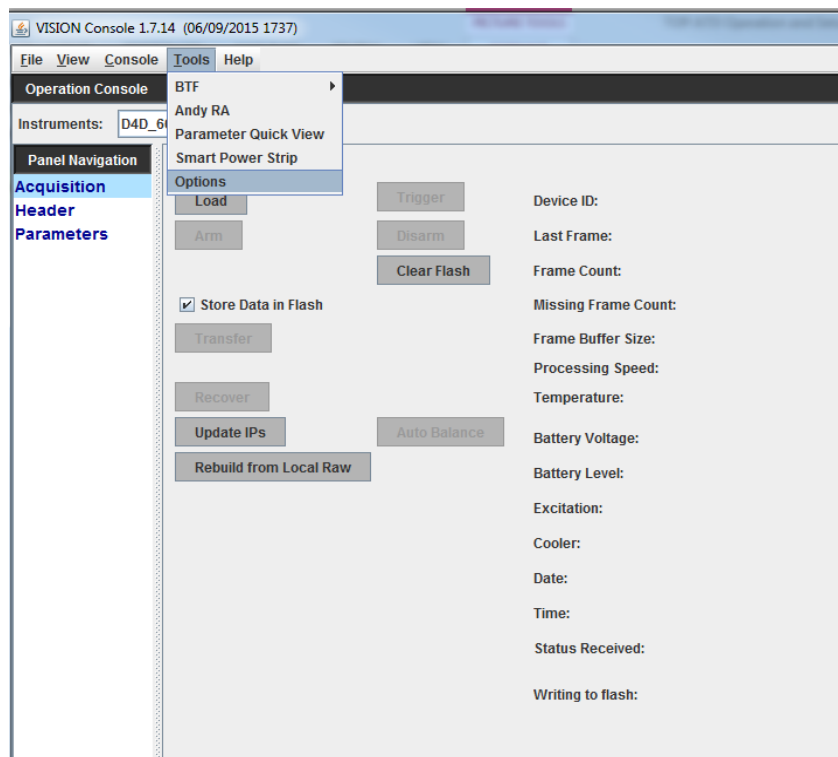


Figure 9. Console operations.

The screenshot shows the configuration window for the VISION Console 1.7.14. The window is titled "VISION Console 1.7.14 (06/09/2015 1737)". It contains several sections for configuration:

- RMS Address:** 0
- SCU Address:** 5
- SRC Address:** 4
- SWT PSG Address:** 8
- Misc:**
 - Capacitor Value pF:** 10,000
 - Data Directory:** C:\BTSX\data (with a "Browse" button)
 - Max Channels:** 120
- Signal Conditioner:**
 - IPs:** 10.10.10.100
 - Ports:** 28000
- UPS:**
 - IP 1:** 0.0.0.0
 - IP 2:** 0.0.0.0
- Fluke 1620A:**
 - IP:** 134.194.65.30
 - Port:** 10001

At the bottom of the window are three buttons: "Save Changes", "Revert", and "Cancel".

Figure 10. Console maximum channels.

4.1 Parameters.

a. Once the console has loaded it is now time to load the parameters that were previously saved using the Parameter Builder application. To import the parameters, select the Parameters Panel located on the left side of the console. Select import located at the top right of the screen and browse to the location where the parameters were saved (Figure 11). The default location for the saved parameters is located at C:\BTSX\saved\parameters. Click on the file, open and click continue. The parameters should have successfully imported. To verify that the parameters and channels are all active, click select and on the window that appears click select all, then OK.

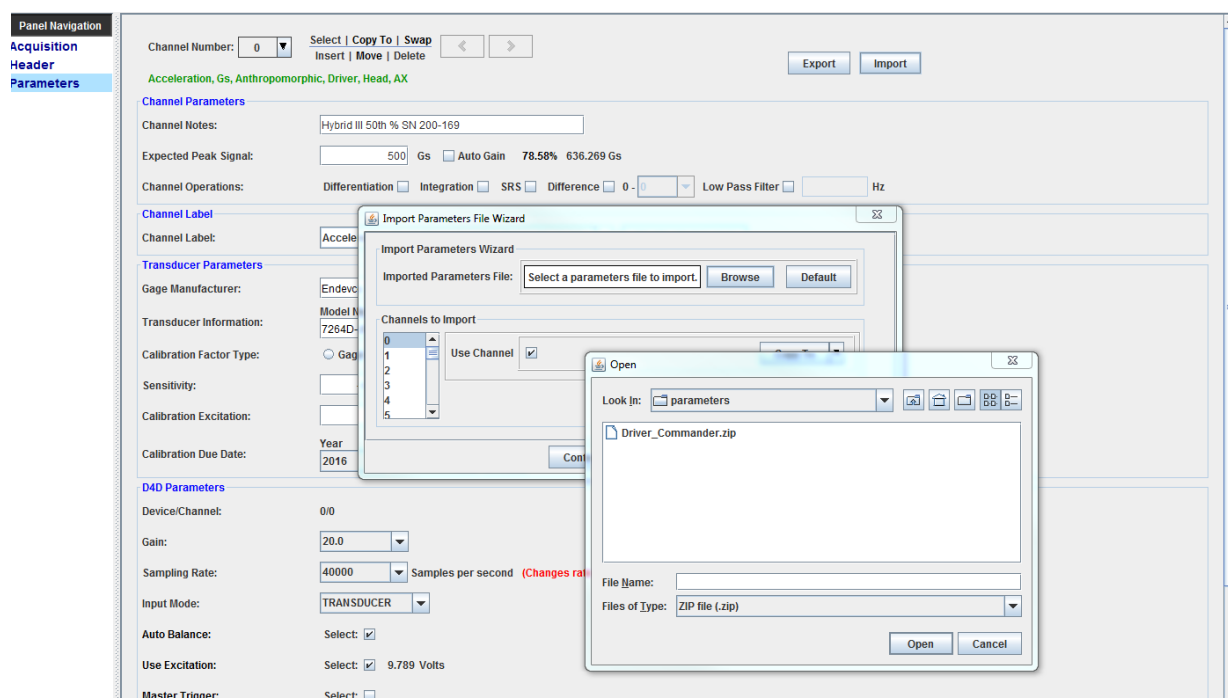


Figure 11. Parameter import.

b. Some ATDs do not have mid tibia accelerometers installed in them. If a warning came up when building the parameters it was likely because the mid tibia accelerometers are not installed in the ATD. This is not an issue, however the user needs to turn these channels off. This is done by first identifying which channels are the mid tibia channels then clicking on select and clicking on each channel to deselect them from the list. The number should turn from red in color to black in color. Red signifies that the channel is selected and will be used to collect data, black signifies that the channel is deselected and will not be used to collect data (Figure 12).

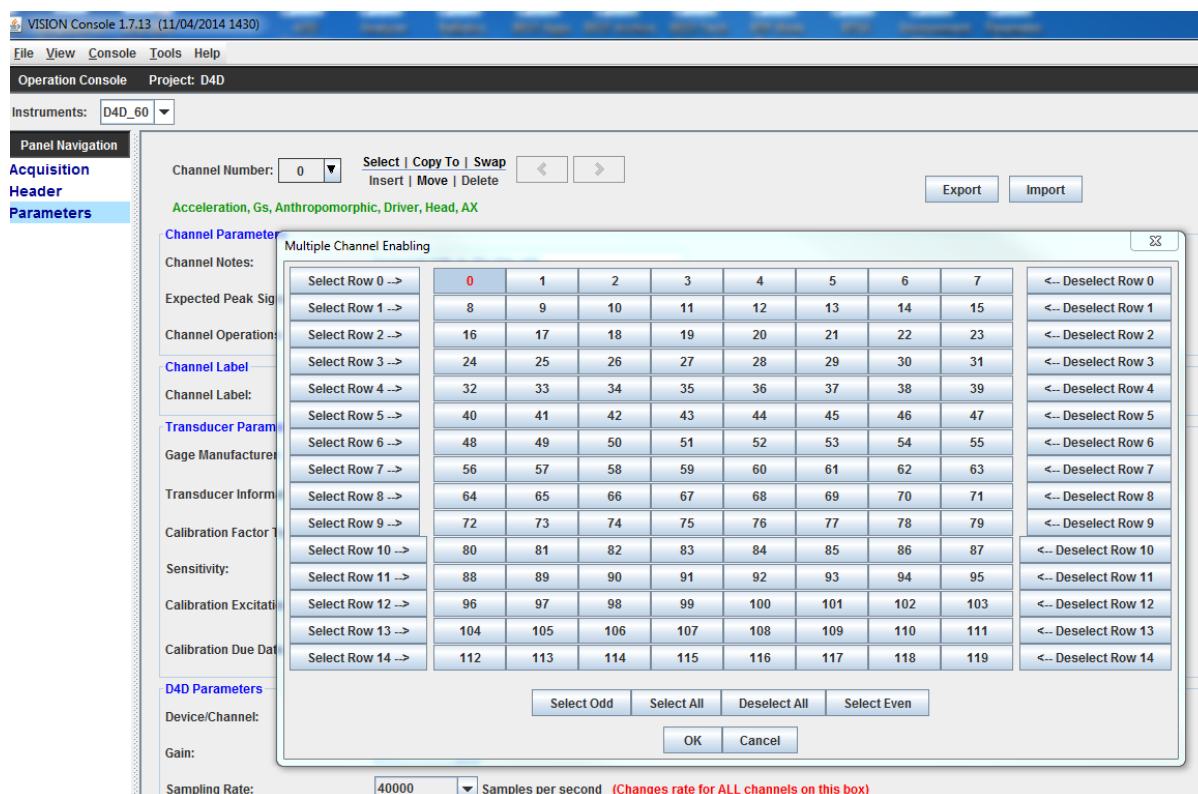


Figure 12. Channel selection.

c. Once all of the channels have been selected correctly, it is time to go through each individual channel to ensure the gain, excitation and triggering options are set correctly. Starting with channel zero click on the auto gain button to make sure the full scale of each channel is set correctly. This step has to be done manually for every channel being used. Next ensure that the Use Excitation box is checked and has the number 9.789 volts next to it. If any other number besides that number is listed, do not use the D4D to take data until consulting with the BEST Division for a fix. Under triggering options make sure Slave and Software triggers are selected and finally set the memory to 8,000 samples pre trigger and 800,000 samples post trigger. This should equate to 0.2 seconds of data before the trigger and 20.0 seconds of data post trigger (Figure 13).

The screenshot displays the 'Parameters' configuration window for the D4D system. The interface is organized into several sections:

- Channel Parameters:**
 - Channel Notes: Hybrid III 50th % SN 200-169
 - Expected Peak Signal: 300 Gs, Auto Gain: 59.52%, 503.9984 Gs
 - Channel Operations: Differentiation, Integration, SRS, Difference, 0 - 0 Hz
- Channel Label:**
 - Channel Label: Acceleration, Gs, Anthropomorphic, Driver, Pelvis, AZ
 - Modify / Build Label button
- Transducer Parameters:**
 - Gage Manufacturer: Endevco
 - Transducer Information: Model Number 7264D-2KTZ, Serial Number 10264
 - Calibration Factor Type: Gage Factor, Sensitivity (selected)
 - Sensitivity: -0.223215 mV / g
 - Calibration Excitation: 10.0 Volts
 - Calibration Due Date: Year 2016, Month March, Day 18
- D4D Parameters:**
 - Device/Channel: 0/20
 - Gain: 20.0
 - Sampling Rate: 40000 Samples per second (Changes rate for ALL channels on this box)
 - Input Mode: TRANSDUCER
 - Auto Balance: Select: ☒
 - Use Excitation: Select: ☒ 9.789 Volts
 - Master Trigger: Select: ☐
 - Trigger Options: Internal: ☐ Slave: ☒ Software: ☒
 - Memory: Pre-Trigger: 8,000 Samples, Post-Trigger: 800,000 Samples
 - Trigger Times: Pre-Trigger: 0.2, Post-Trigger: 20.0
 - Trigger Count: 1
 - Memory Being Used: Per Trigger: 808,000 Samples, Total Memory: 808,000 Samples

Figure 13. Sample of correct parameters.

d. After configuring all of the channels, a useful tool to ensure that all parameters are set correctly is the Parameter Quick View. This is located under the tools tab at the top of the screen (Figure 14). In the Parameter Quick View panel the user can configure the table to show different values. Once parameters have been verified the user can now start operations of the D4D (Figure 15).

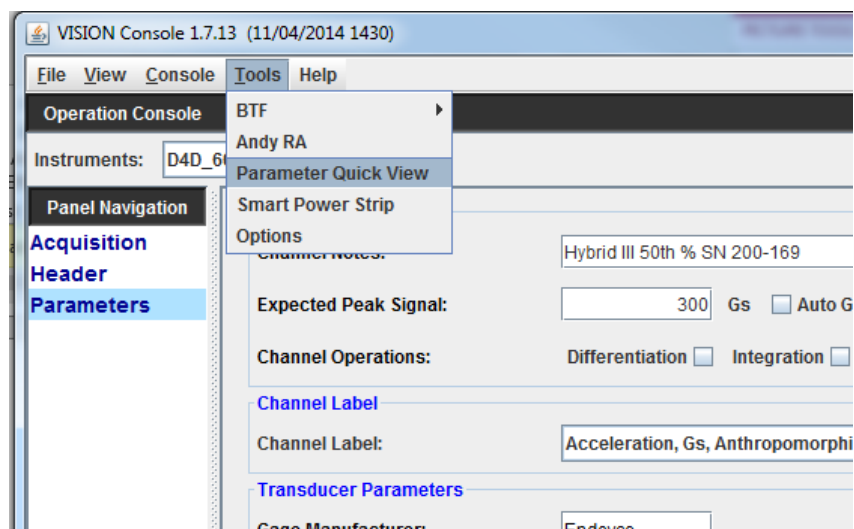


Figure 14. Parameter quick view.

Channel	Calibration Excitation	Modifier	Optional	Cutoff Frequency	Expected Peak Signal	Full Scale Value	Gain	Post-Trigger	Pre-Trigger	Sampling Rate
0	10.0	Anthropom.	DriverHeadAX	4000	500/536.269 Gs	20.0	160	8	40000	726
1	10.0	Anthropom.	DriverHeadAY	4000	500/553.0756 Gs	20.0	160	8	40000	726
2	10.0	Anthropom.	DriverHeadAZ	4000	500/525.643 Gs	20.0	160	8	40000	726
3	1.0	Anthropom.	DriverNeckFX	4000	2000/2650.4889 Pounds	100.0	160	8	40000	171
4	1.0	Anthropom.	DriverNeckFY	4000	2000/2744.9067 Pounds	100.0	160	8	40000	171
5	1.0	Anthropom.	DriverNeckFZ	4000	2000/5056.1798 Pounds	100.0	160	8	40000	171
6	1.0	Anthropom.	DriverNeckMX	4000	4000/5805.8076 Inch Pounds	50.0	160	8	40000	171
7	1.0	Anthropom.	DriverNeckMY	4000	4000/5825.4209 Inch Pounds	50.0	160	8	40000	171
8	1.0	Anthropom.	DriverNeckMZ	4000	4000/4850.1832 Inch Pounds	50.0	160	8	40000	171
9	10.0	Anthropom.	DriverChestAX	4000	300/504.1793 Gs	20.0	160	8	40000	726
10	10.0	Anthropom.	DriverChestAY	4000	300/555.2841 Gs	20.0	160	8	40000	726
11	10.0	Anthropom.	DriverChestAZ	4000	300/520.9226 Gs	20.0	160	8	40000	726
12	1.0	Anthropom.	DriverLumbar SpineFX	4000	6000/8190.7535 Pounds	50.0	160	8	40000	750
13	1.0	Anthropom.	DriverLumbar SpineFY	4000	6000/8199.7085 Pounds	50.0	160	8	40000	750
14	1.0	Anthropom.	DriverLumbar SpineFZ	4000	6000/9202.454 Pounds	100.0	160	8	40000	750
15	1.0	Anthropom.	DriverLumbar SpineMX	4000	15000/25743.7071 Inch Pounds	50.0	160	8	40000	750
16	1.0	Anthropom.	DriverLumbar SpineMY	4000	15000/26162.7907 Inch Pounds	50.0	160	8	40000	750
17	1.0	Anthropom.	DriverLumbar SpineMZ	4000	7000/8175.8721 Inch Pounds	100.0	160	8	40000	750
18	10.0	Anthropom.	DriverPelvisAX	4000	300/488.767 Gs	20.0	160	8	40000	726
19	10.0	Anthropom.	DriverPelvisAY	4000	300/490.7628 Gs	20.0	160	8	40000	726
20	10.0	Anthropom.	DriverPelvisAZ	4000	300/503.9984 Gs	20.0	800	8	40000	726
21	1.0	Anthropom.	DriverFemurLeftFX	4000	6000/5970.2602 Pounds	50.0	160	8	40000	191
22	1.0	Anthropom.	DriverFemurLeftFY	4000	6000/5942.3018 Pounds	50.0	160	8	40000	191
23	1.0	Anthropom.	DriverFemurLeftFZ	4000	10000/16617.4298 Pounds	50.0	160	8	40000	191
24	1.0	Anthropom.	DriverFemurLeftMX	4000	6000/8761.6822 Inch Pounds	50.0	160	8	40000	191
25	1.0	Anthropom.	DriverFemurLeftMY	4000	6000/8895.0385 Inch Pounds	50.0	160	8	40000	191
26	1.0	Anthropom.	DriverFemurLeftMZ	4000	6000/8295.4573 Inch Pounds	40.0	160	8	40000	191
27	1.0	Anthropom.	DriverTibiaLeftUpperFX	4000	5000/5835.0922 Pounds	50.0	160	8	40000	364
28	1.0	Anthropom.	DriverTibiaLeftUpperFY	4000	5000/5920.2736 Pounds	50.0	160	8	40000	364
29	1.0	Anthropom.	DriverTibiaLeftUpperFZ	4000	5000/5445.3049 Pounds	100.0	160	8	40000	364
30	1.0	Anthropom.	DriverTibiaLeftUpperMX	4000	7000/13293.1585 Inch Pounds	20.0	160	8	40000	364
31	1.0	Anthropom.	DriverTibiaLeftUpperMY	4000	7000/13365.8073 Inch Pounds	20.0	160	8	40000	364
32	10.0	Anthropom.	DriverTibiaLeftMiddleAX	4000	2000/2250 Gs	5.0	160	8	40000	N/A
33		Anthropom.	DriverTibia Left Middle AY	4000	2000	5	160	8	40000	N/A
34		Anthropom.	DriverTibia Left Middle AZ	4000	2000	5	160	8	40000	N/A
35	1.0	Anthropom.	DriverTibia Left Lower FX	4000	5000	50	160	8	40000	364
36	1.0	Anthropom.	DriverTibia Left Lower FY	4000	5000	50	160	8	40000	364
37	1.0	Anthropom.	DriverTibia Left Lower FZ	4000	5000	100	160	8	40000	364
38	1.0	Anthropom.	DriverTibia Left Lower MX	4000	7000	20	160	8	40000	364
39	1.0	Anthropom.	DriverTibia Left Lower MY	4000	7000	20	160	8	40000	364
40	1.0	Anthropom.	DriverFemur Right FX	4000	6000	50	160	8	40000	191
41	1.0	Anthropom.	DriverFemur Right FY	4000	6000	50	160	8	40000	191
42	1.0	Anthropom.	DriverFemur Right FZ	4000	10000	50	160	8	40000	191
43	1.0	Anthropom.	DriverFemur Right MX	4000	6000	50	160	8	40000	191
44	1.0	Anthropom.	DriverFemur Right MY	4000	6000	50	160	8	40000	191
45	1.0	Anthropom.	DriverFemur Right MZ	4000	6000	40	160	8	40000	191
46	1.0	Anthropom.	DriverTibia Right Upper FX	4000	5000	50	160	8	40000	364
47	1.0	Anthropom.	DriverTibia Right Upper FY	4000	5000	50	160	8	40000	364
48	1.0	Anthropom.	DriverTibia Right Upper FZ	4000	5000	50	160	8	40000	364
49	1.0	Anthropom.	DriverTibia Right Upper MX	4000	7000	20	160	8	40000	364
50	1.0	Anthropom.	DriverTibia Right Upper MY	4000	7000	20	160	8	40000	364
51		Anthropom.	DriverTibia Right Middle AX	4000	2000	5	160	8	40000	N/A
52		Anthropom.	DriverTibia Right Middle AY	4000	2000	5	160	8	40000	N/A
53		Anthropom.	DriverTibia Right Middle AZ	4000	2000	5	160	8	40000	N/A
54	1.0	Anthropom.	DriverTibia Right Lower FX	4000	5000	50	160	8	40000	364
55	1.0	Anthropom.	DriverTibia Right Lower FY	4000	5000	50	160	8	40000	364

Calibration Excitation is 10.0 for channel 32

Figure 15. Parameter quick view listing.

4.2 Operations.

a. The operation of the D4D is done through the Acquisition tab located on the left side of the console. Once in the Acquisition tab, click load. This will load all of the parameters that were just imported. After the parameters have been loaded and the D4D is communicating, note the battery level. If the battery voltage level is at or below 60 percent do not collect data for the actual test event. To conduct the actual test event the D4D must be charged to a minimum of 70 percent. Prior to each test event, the frame count for each D4D should be verified to be less than 4 million frames. If the D4D is approaching or at 4 million frames, the D4D needs to have the power cycled. Please reference the power cycling procedure in Section 5 of this document.

b. Now that all of the parameters have been loaded, the Header information should be updated. The Header tab is located on the left side of the console under the Acquisition tab (Figure 16). The Header contains the round or test event name as well as metadata that can be used at a later date to track all of the data that are taken within the Ballistics Instrumentation Division. Once all of the header information has been entered, return to the Acquisition tab.

The screenshot shows the VISION Console 1.7.13 interface. The top menu bar includes File, View, Console, Tools, and Help. Below the menu bar, the 'Operation Console' tab is active, and the 'Project: D4D' is selected. The 'Instruments' dropdown is set to 'D4D_60'. On the left, the 'Panel Navigation' sidebar shows 'Acquisition', 'Header', and 'Parameters' tabs, with 'Header' currently selected. The main area displays the 'HEADER META-DATA' form. This form is divided into two columns. The left column contains fields for Round (1), Test Director (Francis), Operator (Houseman), Acquisition System (MV-9), Test Type (Development), Test Location (ATD Lab), and a Comments text area. The right column contains fields for Asset_ID, TestCenter_ID, Inventory_ID, and Project_ID, all of which are currently set to 'n/a'. A format note 'Format: Uppercase Alpha-Numeric (No symbols)' is visible above the Test Director field.

Figure 16. Header information example.

c. At this point if all parameters have been verified, and the D4D is connected and powered on, it is time to auto balance the transducers. Click auto balance and wait for the D4D to complete the process. The auto balance button should change from gray to red. When auto balance is complete the button will return to gray. Auto balance can be confirmed in the text status located towards the bottom of the console.

d. After auto balance is complete, ensure the Store Data in Flash box is checked. Once that box is checked the D4D can now be armed. Before the D4D is armed the user must ensure that there is no data located in the analyzer portion of the console. If data files are in the analyzer they must be removed prior to arming the D4D. When conducting the actual test event, there will be a thirty second countdown to T-0; this is the time when the event goes off. When the countdown reaches thirty seconds the D4D will be armed. The arming process can take upwards of ten seconds. During the arming process the excitation and cooler buttons will switch to on. The D4D will start streaming data; this should be reflected by an incrementing frame count. Also in the text status there should be a command that says “Channels have started writing to flash”. The writing to flash dialogue should also switch to “Yes” to further confirm the D4D is armed and streaming. If this dialogue does not switch to “Yes” and remains at “No”, abort the countdown and disarm the D4D. Verify that the flash button is checked and retry the arming sequence. Take note that there is a slight delay from when a command is sent to the D4D to when the command is displayed in text status (Figures 17 and 18).

Device ID:	2	5	11
Last Frame:	1034309	1043159	1050589
Frame Count:	406110	406090	405950
Missing Frame Count:	0	10	0
Frame Buffer Size:	1	0	0
Processing Speed:	5.036 MB/s	5.035 MB/s	5.036 MB/s
Temperature:	127.0	118.6	126.6
Battery Voltage:	14.876	14.374	14.799
Battery Level:	97%	87%	95%
Excitation:	ON	ON	ON
Cooler:	ON	ON	ON
Date:	3-27-2013	3-27-2013	3-27-2013
Time:	00:31:03	00:09:06	00:09:21
Status Received:	●	●	●
Writing to flash:	NO	NO	NO

ave started real-time data.

Save Clear

Figure 17. Arming process.

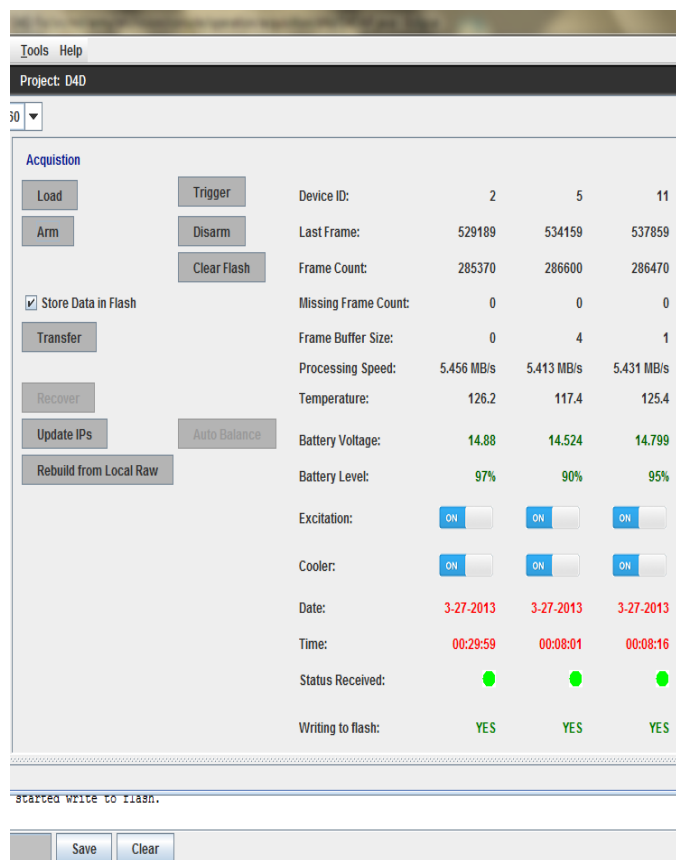


Figure 18. Arming process, writing to flash.

e. Once the D4D has successfully armed, the D4D will need to be triggered. The triggering and transfer process for the D4D is different compared to the VHSD. The D4D is triggered manually by clicking the trigger button on the console with about five seconds left on the countdown to T-0. Once the D4D is triggered it will record data for twenty seconds. The console will display a text status message in the text status box alerting the user that acquisition has completed. Once acquisition has completed, the transfer data process can occur. Unlike the VHSD, the data that are collected by the D4D is streamed to the PC and stored on the hard drive in a raw file. The transfer process for the D4D is simply building a file that will be viewable in the analyzer portion of the console.

4.3 Recover.

a. If using the method outlined in Section 4.2 there will be approximately 20 seconds of acquired data, causing the data file to be large. This makes viewing the data in the analyzer cumbersome. Using the recover function in the software allows the user to go back and make changes to the amount of data that are recorded. To view or “build” a smaller file, the data needs to be recovered from the flash memory on the D4D. This process starts by going into the parameters and adjusting the post trigger memory to 160,000 samples, which equates to four seconds of data. If more data post trigger are desired, adjust the number of samples to match the

amount of data required. This step has to be done for all channels. The next step is to make channel 59 the master channel. This is done by selecting the master trigger box, and selecting the internal trigger box. When the internal trigger box is selected, the user will be prompted to enter a trigger level. A typical trigger level is 0.5 volts. Remember, if the D4D channels are used to supplement VHSD channels, then the trigger sampling rate and threshold should be set the same. This will ensure a more accurate T0 recording by both systems so that data between the two can be compared back to the same reference time. The user also has the ability to change the slope type. The default slope should be set as positive. There is also an option to check absolute value. This box should remain unchecked (Figure 19).

Figure 19. Recover parameters.

b. After completing these steps, the header of the file needs to be adjusted to help distinguish between the two files. In the header section, add the words “RECOVER” to the end of the round name. After this is complete, go back into the acquisition section of the console and select load, then recover. A text status message should appear in the text status box showing that data playback has begun. It is important to not click arm before clicking recover. If arm is

selected, the data that are currently stored in the flash will be erased and the smaller file cannot be easily created.

4.4 Reference Time.

D4D units twelve and thirteen, GPS reference time is off by one second. This is not a major issue and can be corrected in the BTSX console. The one second difference will be noticeable when plotting data from multiple D4D's. In the analyzer select only the channels from the D4D(s) that have the one second difference. Click on Diagnostic, Fix Reference Time. When the window appears the default value is 1,000 milliseconds (one second). This number shouldn't have to be changed other than possibly making a negative value. Click continue and the reference time values will be shifted by one second. Reference Figures 20, 21, 22.

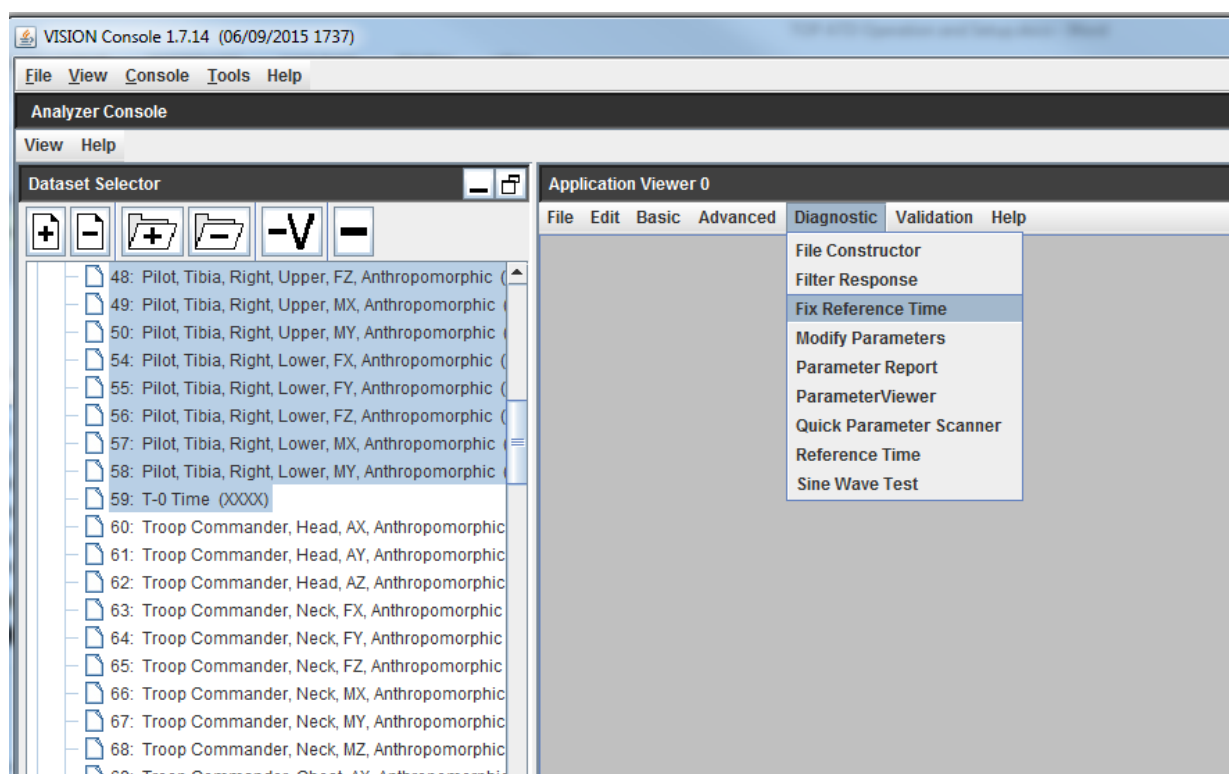


Figure 20. Fix reference time.

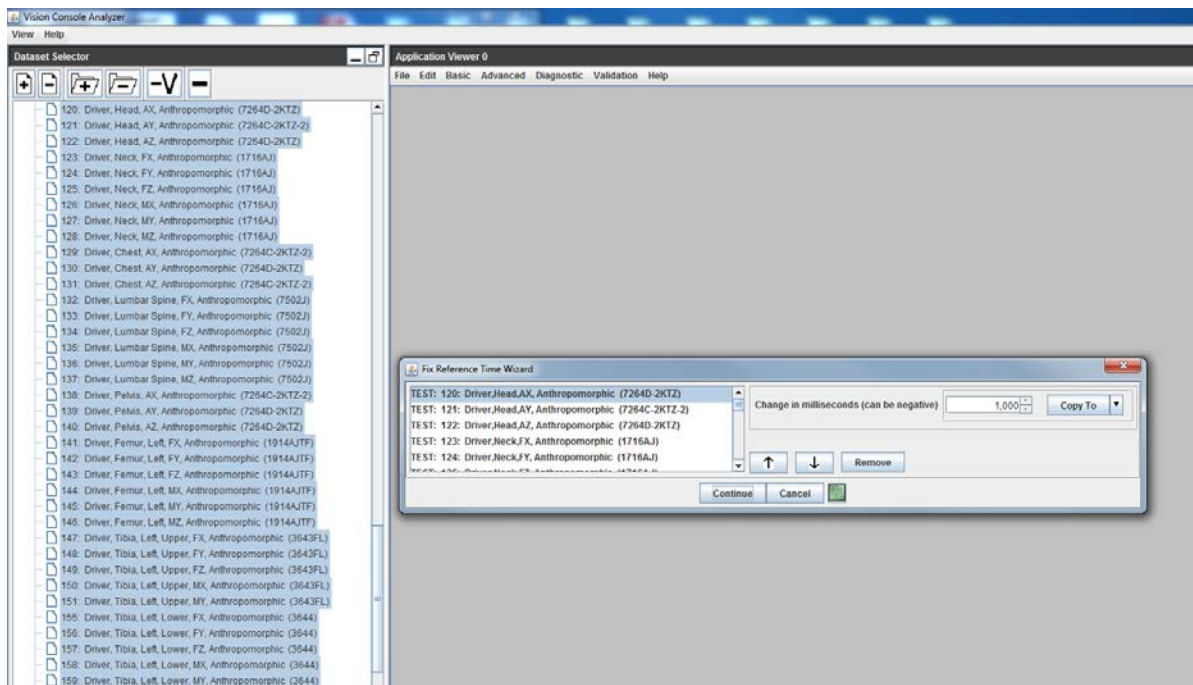


Figure 21. Reference time adjustment.

120: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)

121: Driver_Head_AY, Anthropomorphic (F72AD-2K1T-2)

122: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)

123: Driver_Neck_FX, Anthropomorphic (I716AJ)

124: Driver_Neck_FY, Anthropomorphic (I716AJ)

125: Driver_Neck_FZ, Anthropomorphic (I716AJ)

126: Driver_Neck_MX, Anthropomorphic (I716AJ)

127: Driver_Neck_MY, Anthropomorphic (I716AJ)

128: Driver_Neck_MZ, Anthropomorphic (I716AJ)

129: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)

130: Driver_Chest_AY, Anthropomorphic (F72AC-2K1T-2)

131: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)

132: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)

133: Driver_Lumbar_Spine_FY, Anthropomorphic (F72GJ-2K1T-2)

134: Driver_Lumbar_Spine_FZ, Anthropomorphic (F72GJ-2K1T-2)

135: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)

136: Driver_Lumbar_Spine_MY, Anthropomorphic (F72GJ-2K1T-2)

137: Driver_Lumbar_Spine_MZ, Anthropomorphic (F72GJ-2K1T-2)

138: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)

139: Driver_Pelvis_AY, Anthropomorphic (F72AC-2K1T-2)

140: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)

141: Driver_Femur_Left_FX, Anthropomorphic (I914AJTF)

142: Driver_Femur_Left_FY, Anthropomorphic (I914AJTF)

143: Driver_Femur_Left_FZ, Anthropomorphic (I914AJTF)

144: Driver_Femur_Left_MX, Anthropomorphic (I914AJTF)

145: Driver_Femur_Left_MY, Anthropomorphic (I914AJTF)

146: Driver_Femur_Left_MZ, Anthropomorphic (I914AJTF)

147: Driver_Tibia_Left_Upper_FX, Anthropomorphic (I643FL)

148: Driver_Tibia_Left_Upper_FY, Anthropomorphic (I643FL)

149: Driver_Tibia_Left_Upper_FZ, Anthropomorphic (I643FL)

150: Driver_Tibia_Left_Upper_MX, Anthropomorphic (I643FL)

151: Driver_Tibia_Left_Upper_MY, Anthropomorphic (I643FL)

152: Driver_Tibia_Left_Upper_MZ, Anthropomorphic (I643FL)

153: Driver_Tibia_Left_Lower_FX, Anthropomorphic (I644)

154: Driver_Tibia_Left_Lower_FY, Anthropomorphic (I644)

155: Driver_Tibia_Left_Lower_FZ, Anthropomorphic (I644)

156: Driver_Tibia_Left_Lower_MX, Anthropomorphic (I644)

157: Driver_Tibia_Left_Lower_MY, Anthropomorphic (I644)

158: Driver_Tibia_Left_Lower_MZ, Anthropomorphic (I644)

159: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I914AJTF)

160: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I914AJTF)

161: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I914AJTF)

162: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I914AJTF)

163: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I914AJTF)

164: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I914AJTF)

165: Driver_Femur_Right_FX, Anthropomorphic (I914AJTF)

166: Driver_Femur_Right_FY, Anthropomorphic (I914AJTF)

167: Driver_Femur_Right_FZ, Anthropomorphic (I914AJTF)

168: Driver_Femur_Right_MX, Anthropomorphic (I914AJTF)

169: Driver_Femur_Right_MY, Anthropomorphic (I914AJTF)

170: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I643FL)

171: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I643FL)

172: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I643FL)

173: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I643FL)

174: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I643FL)

175: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I643FL)

176: Driver_Tibia_Right_Lower_FX, Anthropomorphic (I644)

177: Driver_Tibia_Right_Lower_FY, Anthropomorphic (I644)

178: Driver_Tibia_Right_Lower_FZ, Anthropomorphic (I644)

179: Driver_Tibia_Right_Lower_MX, Anthropomorphic (I644)

180: Driver_Tibia_Right_Lower_MY, Anthropomorphic (I644)

181: Driver_Tibia_Right_Lower_MZ, Anthropomorphic (I644)

TEST: 120: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)

TEST: 121: Driver_Head_AY, Anthropomorphic (F72AD-2K1T-2)

TEST: 122: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)

TEST: 123: Driver_Neck_FX, Anthropomorphic (I716AJ)

TEST: 124: Driver_Neck_FY, Anthropomorphic (I716AJ)

TEST: 125: Driver_Neck_FZ, Anthropomorphic (I716AJ)

TEST: 126: Driver_Neck_MX, Anthropomorphic (I716AJ)

TEST: 127: Driver_Neck_MY, Anthropomorphic (I716AJ)

TEST: 128: Driver_Neck_MZ, Anthropomorphic (I716AJ)

TEST: 129: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)

TEST: 130: Driver_Chest_AY, Anthropomorphic (F72AC-2K1T-2)

TEST: 131: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)

TEST: 132: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)

TEST: 133: Driver_Lumbar_Spine_FY, Anthropomorphic (F72GJ-2K1T-2)

TEST: 134: Driver_Lumbar_Spine_FZ, Anthropomorphic (F72GJ-2K1T-2)

TEST: 135: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)

TEST: 136: Driver_Lumbar_Spine_MY, Anthropomorphic (F72GJ-2K1T-2)

TEST: 137: Driver_Lumbar_Spine_MZ, Anthropomorphic (F72GJ-2K1T-2)

TEST: 138: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)

TEST: 139: Driver_Pelvis_AY, Anthropomorphic (F72AC-2K1T-2)

TEST: 140: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)

TEST: 141: Driver_Femur_Left_FX, Anthropomorphic (I914AJTF)

TEST: 142: Driver_Femur_Left_FY, Anthropomorphic (I914AJTF)

TEST: 143: Driver_Femur_Left_FZ, Anthropomorphic (I914AJTF)

TEST: 144: Driver_Femur_Left_MX, Anthropomorphic (I914AJTF)

TEST: 145: Driver_Femur_Left_MY, Anthropomorphic (I914AJTF)

TEST: 146: Driver_Femur_Left_MZ, Anthropomorphic (I914AJTF)

TEST: 147: Driver_Tibia_Left_Upper_FX, Anthropomorphic (I643FL)

TEST: 148: Driver_Tibia_Left_Upper_FY, Anthropomorphic (I643FL)

TEST: 149: Driver_Tibia_Left_Upper_FZ, Anthropomorphic (I643FL)

TEST: 150: Driver_Tibia_Left_Upper_MX, Anthropomorphic (I643FL)

TEST: 151: Driver_Tibia_Left_Upper_MY, Anthropomorphic (I643FL)

TEST: 152: Driver_Tibia_Left_Upper_MZ, Anthropomorphic (I643FL)

TEST: 153: Driver_Tibia_Left_Lower_FX, Anthropomorphic (I644)

TEST: 154: Driver_Tibia_Left_Lower_FY, Anthropomorphic (I644)

TEST: 155: Driver_Tibia_Left_Lower_FZ, Anthropomorphic (I644)

TEST: 156: Driver_Tibia_Left_Lower_MX, Anthropomorphic (I644)

TEST: 157: Driver_Tibia_Left_Lower_MY, Anthropomorphic (I644)

TEST: 158: Driver_Tibia_Left_Lower_MZ, Anthropomorphic (I644)

TEST: 159: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I914AJTF)

TEST: 160: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I914AJTF)

TEST: 161: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I914AJTF)

TEST: 162: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I914AJTF)

TEST: 163: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I914AJTF)

TEST: 164: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I914AJTF)

TEST: 165: Driver_Femur_Right_FX, Anthropomorphic (I914AJTF)

TEST: 166: Driver_Femur_Right_FY, Anthropomorphic (I914AJTF)

TEST: 167: Driver_Femur_Right_FZ, Anthropomorphic (I914AJTF)

TEST: 168: Driver_Femur_Right_MX, Anthropomorphic (I914AJTF)

TEST: 169: Driver_Femur_Right_MY, Anthropomorphic (I914AJTF)

TEST: 170: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I643FL)

TEST: 171: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I643FL)

TEST: 172: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I643FL)

TEST: 173: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I643FL)

TEST: 174: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I643FL)

TEST: 175: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I643FL)

TEST: 176: Driver_Tibia_Right_Lower_FX, Anthropomorphic (I644)

TEST: 177: Driver_Tibia_Right_Lower_FY, Anthropomorphic (I644)

TEST: 178: Driver_Tibia_Right_Lower_FZ, Anthropomorphic (I644)

TEST: 179: Driver_Tibia_Right_Lower_MX, Anthropomorphic (I644)

TEST: 180: Driver_Tibia_Right_Lower_MY, Anthropomorphic (I644)

TEST: 181: Driver_Tibia_Right_Lower_MZ, Anthropomorphic (I644)

Application Viewer 0

File Edit Basic Advanced Diagnostic Validation Help

Fix Reference Time Report

Dataset	Parameter	Old Value	New Value
TEST: 120: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 121: Driver_Head_AY, Anthropomorphic (F72AD-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 122: Driver_Head_AZ, Anthropomorphic (F72AD-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 123: Driver_Neck_FX, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 124: Driver_Neck_FY, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 125: Driver_Neck_FZ, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 126: Driver_Neck_MX, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 127: Driver_Neck_MY, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 128: Driver_Neck_MZ, Anthropomorphic (I716AJ)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 129: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 130: Driver_Chest_AY, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 131: Driver_Chest_AZ, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 132: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 133: Driver_Lumbar_Spine_FY, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 134: Driver_Lumbar_Spine_FZ, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 135: Driver_Lumbar_Spine_FX, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 136: Driver_Lumbar_Spine_MY, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 137: Driver_Lumbar_Spine_MZ, Anthropomorphic (F72GJ-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 138: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 139: Driver_Pelvis_AY, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 140: Driver_Pelvis_AZ, Anthropomorphic (F72AC-2K1T-2)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 141: Driver_Femur_Left_FX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 142: Driver_Femur_Left_FY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 143: Driver_Femur_Left_FZ, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 144: Driver_Femur_Left_MX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 145: Driver_Femur_Left_MY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 146: Driver_Femur_Left_MZ, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 147: Driver_Tibia_Left_Upper_FX, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 148: Driver_Tibia_Left_Upper_FY, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 149: Driver_Tibia_Left_Upper_FZ, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 150: Driver_Tibia_Left_Upper_MX, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 151: Driver_Tibia_Left_Upper_MY, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 152: Driver_Tibia_Left_Upper_MZ, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 153: Driver_Tibia_Left_Lower_FX, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 154: Driver_Tibia_Left_Lower_FY, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 155: Driver_Tibia_Left_Lower_FZ, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 156: Driver_Tibia_Left_Lower_MX, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 157: Driver_Tibia_Left_Lower_MY, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 158: Driver_Tibia_Left_Lower_MZ, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 159: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 160: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 161: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 162: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 163: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 164: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 165: Driver_Femur_Right_FX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 166: Driver_Femur_Right_FY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 167: Driver_Femur_Right_FZ, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 168: Driver_Femur_Right_MX, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 169: Driver_Femur_Right_MY, Anthropomorphic (I914AJTF)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 170: Driver_Tibia_Right_Upper_FX, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 171: Driver_Tibia_Right_Upper_FY, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 172: Driver_Tibia_Right_Upper_FZ, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 173: Driver_Tibia_Right_Upper_MX, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 174: Driver_Tibia_Right_Upper_MY, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 175: Driver_Tibia_Right_Upper_MZ, Anthropomorphic (I643FL)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 176: Driver_Tibia_Right_Lower_FX, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 177: Driver_Tibia_Right_Lower_FY, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 178: Driver_Tibia_Right_Lower_FZ, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 179: Driver_Tibia_Right_Lower_MX, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 180: Driver_Tibia_Right_Lower_MY, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954
TEST: 181: Driver_Tibia_Right_Lower_MZ, Anthropomorphic (I644)	Reference Time	2015-06-16 17:09:12.618047999954	2015-06-16 17:09:13.618047999954

Figure 22. Reference time new values.

5. POWER CYCLING PROCEDURE.

There may be instances where the D4D needs to be reset. The most usual occurrence would be because the D4D has a large frame count. This usually happens when the D4D has been used several times to acquire data. To reset the D4D, the D4D needs to be physically turned off and the Ethernet cable needs to be removed for five seconds. Turn the D4D back on prior to reconnecting the Ethernet cable.

6. PRESENTATION OF DATA.

Data are usually presented in a table format. An example of how data can be presented is shown in Appendix A, Figure A-18.

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APPENDIX A. D4D OPERATOR GUIDE.

A.1 BACKGROUND.

a. The Syntronics D4DV2.5 is a small 60-channel data acquisition system designed especially to support vulnerability testing using anthropomorphic dummies. The design philosophy for the D4D was to pack as much performance into as small a box as possible in a cost effective manner. A number of tradeoffs were made in an attempt to provide a system which would effectively support anthropomorphic dummy testing. The D4D has been designed to support strain and voltage measurements only. The D4D was built under contract for ATC and is not a commercial product. The D4D was purchased without a documentation support package. A laboratory evaluation^{**1} was performed on the system. Technical specifications for the D4D are in Appendix B.

b. The purpose of this guide is to provide an operator who is familiar with the VHSD with an introduction to the D4D. While the D4D and VHSD have some similarities, there are many intrinsic differences that the operator must be aware of.

A.2 INTRODUCTION TO THE D4D.

a. Figure A-1 shows one end of the D4D enclosure. This end has the external direct current (DC) power input connector and the GPS antenna connector. The external DC power input connector can be connected to a 24 volt direct current (VDC) external source of power. The external power source can power the unit without charging the battery or power the unit and charge the battery. The pin outs for the external power connector are in Appendix C. The GPS connector is a SubMiniature version A (SMA) that provides power for an external antenna and receives the GPS signal. For accurate times to be recorded the GPS antenna must be connected and operational.



Figure A-1. External DC power connector and GPS connector.

** Superscript numbers correspond to Appendix F, References.

APPENDIX A. D4D OPERATOR GUIDE.

b. Figure A-2 shows the opposite end of the D4D enclosure. This end has the vent for the cooling system and the unit serial number. The vent must not be covered so that adequate air flow is provided to the unit.



Figure A-2. Vent and serial number.

c. Figure A-3 shows one side of the D4D enclosure. This side contains the battery switch, the Ethernet connector and a power indicator light emitting diode (LED). The battery switch connects the battery to the system power bus. When the battery switch is ON, the battery can be charged and supply power to the system. When the battery switch is OFF, the battery cannot be charged or supply power to the system. Note that there is no overall power switch. When supplied with external power, the system is always on. The LED indicator shows when system power is applied. The LED indicator is on whenever there is external power applied or the battery is on. The LED indicator is off whenever there is no external power applied and the battery is off. The Ethernet connector port provides the ability to connect to an external computer for control and streaming data purposes. The connector port will accept a standard RJ-45 connector or a ruggedized captive connector. The Ethernet connection must be present to load and arm the D4D. However, once armed, the connection can be removed. Later the D4D can be reconnected to allow the stored data to be removed.

APPENDIX A. D4D OPERATOR GUIDE.



Figure A-3. Battery switch, Ethernet connector and power indicator LED.

d. Figure A-4 shows the opposite side of the D4D enclosure. This side contains 15 data channel connectors and one test bus connector. The pin outs for these connectors are in Appendix C. Each data channel connector contains four channels. The test bus connector is used for calibration and laboratory tests and will not normally be used in the field.



Figure A-4. Data connectors and test bus connector.

APPENDIX A. D4D OPERATOR GUIDE.

e. Figure A-5 shows the top of the D4D enclosure. The fan baffle is visible on the top. The fan baffle must not be covered so that adequate air flow is provided to the unit.



Figure A-5. Fan baffle.

f. Figure A-6 shows the bottom of the D4D enclosure. The bottom of the D4D enclosure has four mounting holes tapped for 6-32 threads.

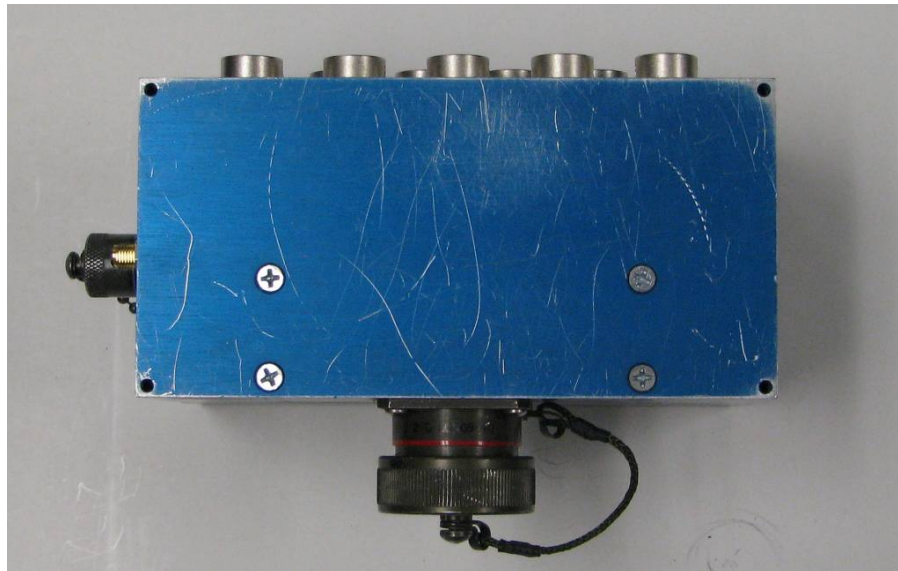


Figure A-6. Bottom mounting holes.

APPENDIX A. D4D OPERATOR GUIDE.

g. The bottom portion of the enclosure is an aluminum block that has been machined. All of the data acquisition system is located in the bottom portion. The white piece is nylon that provides thermal isolation between the electronics in the bottom portion of the enclosure and the cooler located in the top. The top portion of the enclosure contains the fan, cooler and ventilation ports.

A.3 CHANNEL DESIGN.

a. All 60 channels in the D4D are identical. The design of the D4D is inherently simple to allow fitting this many channels into a small space, to reduce the power consumption so that battery operation is practical, and to keep the cost down. Figure A-7 is a block diagram of a channel.

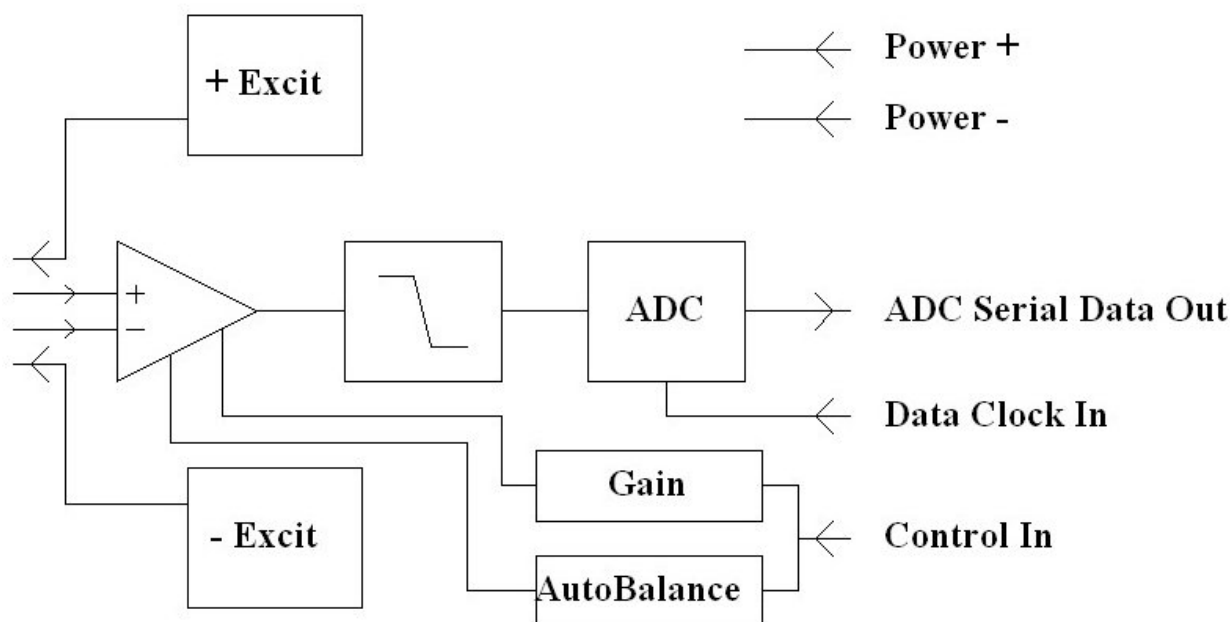


Figure A-7. Channel block diagram.

b. Although not shown in the block diagram, gain is actually broken into two stages. Gain is achieved through the use of digital potentiometers. Due to the limited number of steps in the digital potentiometers, most gains are low by 1 to 3 percent. The low pass filter is composed to two one-pole stages which are set close to 4 kilohertz (kHz). The analog-to-digital (ADC) converter is a successive approximation type and all converters in the box are synchronous. There is no mechanism to synchronize boxes. The ADC is running at 200 kilo-samples per second (kSps). The 200kSps data stream is digitally filtered and decimated to 40kSps. The 40kSps data stream is filtered again to produce an overall 4 kHz filter cutoff. There is no trigger processing done in the D4D itself.

APPENDIX A. D4D OPERATOR GUIDE.

c. Autobalance is accomplished with voltage insertion. Autobalance requires approximately one minute. During autobalance, the system will ARM itself. Each card has a total of four excitation regulators - two positive and two negative. The first 12 channels on a card share one pair of regulators while the remaining 8 channels on a card share the second pair of regulators. The positive and negative regulators are independent fixed voltage regulators.

d. Table A-1 highlights differences between a D4D channel and a typical VHSD channel

TABLE A-1. DIFFERENCES BETWEEN D4D AND VHSD CHANNELS

PARAMETER	D4D	VHSD	COMMENTS
Input range	+/-2.5V	+/-10V	D4D has an apparent gain of four times the same gain of VHSD
Input types	Voltage, strain	Voltage, strain, thermocouple, charge, IEPE, oscilloscope	
Input Impedance	2MOhm(+ to -) ARMED ~100kOhm disarmed	10MOhm	D4D must be armed for high impedance with no distortion
Excitation voltage value	+/-5V (10V nominal)	0 to +/-10V	
Excitation voltage present	Only when ARMED	When properly loaded	
Excitation sense	No	Yes	D4D must use short cables and minimize connector resistance
Excitation current limit	Fuse shared by four channels	Electronic shutdown per channel	A short on the D4D may require several minutes to clear
Excitation test	No	Each selected channel's excitation can be measured	
Gains	1, 2, 4, 5, 10, 20, 40, 50 and 100	41 gains ranging from 1 to 8,000/10,000	
Low pass filter	4kHz	Numerous options depending on card	
Digitizing rate	40,000Sps	Numerous options depending on card	

APPENDIX A. D4D OPERATOR GUIDE.

TABLE A-1. CONTINUED

PARAMETER	D4D	VHSD	COMMENTS
Hardware triggering	None	Internal, external, master/slave, software	All D4D triggering is accomplished in software running on the controlling computer
Channel memory	None	4MB to 32MB per channel depending on mode	
FLASH	4GB shared by all 60 streaming channels	4MB to 32MB per channel depending on mode	
Channel independence	Gain and autobalance are the only parameters that are adjustable on a per channel basis	Gain, autobalance, filter cutoff, rate, excitation voltage, guard, memory size and triggering options are adjustable on a per channel basis	
Channel selection	No - all 60 channels acquire/stream data	Yes	
Real time view	Not available at this time	Yes	
Channel Monitor	No	Yes	

A.4 CHANNEL QUADS.

a. To keep the size of the D4D enclosure small, it was necessary to group four channels into a connector. In addition to sharing the connector, the channel quad also shares two fuses for its excitation supply. There is one fuse for the positive excitation and a second fuse for the negative excitation. Thus, if one channel shorts and takes down the excitation supply, then the other three channels on the quad will also be impacted. Note that each fuse has an internal resistance of around 1 ohm. This means that the strain gage loads will produce a voltage drop in the fuses that is not corrected since there is no excitation sense.

APPENDIX A. D4D OPERATOR GUIDE.

b. Currently, the issue of excitation voltage is handled by using an average value for the entire box that reflects the standard loading of an anthropomorphic dummy. The average value being used is displayed on the parameter panel. This value is picked to minimize the errors.

NOTE: The operator is responsible for ensuring that the appropriate box average excitation value is being used.

A.5 SYSTEM DESIGN.

The overall design of the D4D can be broken down into five different assemblies:

- a. A connector board holds the 15 signal connectors plus the test bus connector.
- b. A backplane provides interconnections for the other boards.
- c. There are three data acquisition (DAQ) boards each containing 20 channels as discussed in Paragraph A.3. Each data acquisition board also contains a field programmable gate array (FPGA) that consolidates the 20 serial data streams from the analog to digital converters into a single data stream. There are two sets of excitation supply regulators on the DAQ boards. One set supplies the first three quads on the board while the second set supplies the last two quads on the board.
- d. A digital board consolidates the data from the three data acquisition boards, communicates with the control computer, sends commands to the data acquisition boards, handles GPS timing, contains mass storage and provides battery, power supply, and cooling control.
- e. A thermoelectric cooling unit provides the capacity to remove heat from the densely populated circuit boards.

NOTE: There are no operator serviceable parts inside the D4D. At no time should an attempt be made to disassemble the D4D.

Since D4D channels are part of larger assemblies, the failure of one or more channels cannot be easily swapped out; replacement of the entire unit is the only maintenance recourse.

A.6 MODES OF OPERATION.

The D4D essentially has two modes of operation: not armed and armed. Table A-2 identifies the properties of each mode of operation.

APPENDIX A. D4D OPERATOR GUIDE.

TABLE A-2. D4D MODES OF OPERATION

NOT ARMED	ARMED
1. Parameters can be loaded to channels. 2. AUTOBALANCE can be executed.	1. Excitation voltage is turned ON. 2. All 60 channels acquire data. 3. Data is streamed to Ethernet port. 4. Data is stored in flash (if selected).

A.7 SYSTEM POWER.

The D4D can be powered in a number of different ways. Table A-3 shows the salient features of each mode of operation.

TABLE A-3. SYSTEM POWER FEATURES

MODE	REASON FOR MODE	NOT ARMED	ARMED
External power with battery OFF	Setup Calibration Laboratory testing	$I = 0.25A$	$I = 1.0A + \text{gage loads}$
External power with battery ON	Charge battery	$I = 0.25A + \text{battery}$	$I = 1.0A + \text{gage loads} + \text{battery}$
Power over Ethernet (POE) with battery ON	Keep battery topped off prior to test		POE does not provide sufficient current for this mode - battery will supply current
Battery only	Test	See Reference 1 for battery time in this mode	See Reference 1 for battery time in this mode

A.8 SYSTEM TIMING.

a. The D4D has the capability to utilize GPS timing signals to derive accurate time coordination for the acquired data points. When a GPS signal is provided to the D4D and the BTSX software is operational, the current Coordinated Universal Time will be displayed on the operational console. Under these conditions, the data will be annotated with the correct time also. If the D4D locks on to the GPS signal and then loses the signal, the D4D will then use its internal clock to update the time. If a large amount of time elapses from the loss of signal to the capture of data, the time may not remain as high accuracy as when the GPS signal was present.

APPENDIX A. D4D OPERATOR GUIDE.

- b. If an adequate GPS signal is not provided to the D4D, then the BTSX software will display the correct date and a time derived from the turn on of the D4D. Under these conditions, the data will not be annotated with the correct absolute time.
- c. The D4D utilizes a crystal clock to control the digitizing rate. This clock is not locked to the GPS signal as is the clock in the VHSD. Therefore, during long acquisitions it is possible that the time associated with data points may drift.
- d. Each D4D on a test must be provided with a separate antenna or a GPS splitter must be used to provide independent signals. A single antenna should NOT be split to multiple D4Ds.
- e. All channels on the D4D have individual ADCs and all are clocked simultaneously.

A.9 SYSTEM MEMORY.

- a. When the D4D is armed, it starts to stream 60 channels of data out the Ethernet port. Currently streaming data cannot be turned off. With the appropriate software, the data stream can be captured and stored on a computer hard drive. In general, this should be the primary means of capturing D4D data.
- b. There is no channel memory in the D4D. However, there is a single 4GB flash memory that can store the data stream if it is enabled. If enabled, the flash memory is filled independently of data being streamed. Thus, the flash memory provides redundancy in case the Ethernet link is lost during a test. The 4GB flash will store approximately 12 minutes of data from ARM time until it fills. Once the flash fills, it shuts down and saves no more data. Using the BTSX operational software for the D4D, the contents of the flash can be retrieved at a later time (even if power to the D4D has been shut off).

NOTE: The operator needs to keep in mind that when armed, the D4D is writing to hard drive at the rate of 1GB every three minutes. During setup and testing, very large files may be written to hard drive. The operational software does not clean up these files.

A.10 SYSTEM COOLING.

- a. With the high density packaging employed, removing heat from the D4D is a major issue. The system incorporates an integral solid state cooling unit and two fans. One fan blows cool air onto the electronics, while the other fan exhausts heat created by the cooler.

APPENDIX A. D4D OPERATOR GUIDE.

b. The system has 16 temperature sensors: one on the digital electronics board and five on each channel board. The sensors on the channel boards are apportioned one to each channel quad. The sensor on the digital electronics board is active at all times. However, the sensors on the channel boards are active only when the system is in the ARM mode. The temperatures on the channel boards are monitored by the system controller. If the controller detects a temperature over 150 degrees Fahrenheit for an extended period, then the controller shuts down the electronics on the channel boards. In the case of a shutdown, the cooler is left on to assist in reducing the temperature of the package.

c. The channel board closest to the digital board normally runs the hottest with the other two boards running a few degrees lower. The hottest analog sensor normally runs about 40 degrees lower in temperature than the digital board. Thus, a temperature of ~190 degrees on the digital board is approaching shutdown.

NOTE: There is no special notification to the operator that temperature shutdown has occurred. The symptoms are that the system stops transferring data, the status indicator disappears, and there are no updates to temperature, voltage, etc. These same symptoms will occur if the communication link is severed. Looking at the status display for the last temperature is the only clue that thermal shutdown may have occurred.

It is essential that the cooling vents on the outside of the D4D package are not blocked.

A.11 AMPLITUDE CALIBRATION.

a. Since there is no access to the output of the signal conditioner, the calibration process cannot be broken up into signal conditioner and digitizer calibrations. Therefore, amplitude calibration is accomplished in a slightly different manner than the VHSD. For gain of 1, the gain is defined as 1.00000 and the calibration process defines a digitizer scale factor. For all other gains, the calibration digitizer scale factor is then used to derive a gain scale factor. This process allows the D4D calibration to closely resemble the VHSD calibration process. Once calculated, the digitizer scale factor and individual gain values are written into the D4D for storage.

b. Amplitude calibration requires a digital voltmeter, a programmable signal generator, a switch/control units and an E-Net adapter. If the calibration is performed through the channel connectors, then a 60-channel adapter is required. If the calibration is performed through the test bus input, then a test bus adapter cable is required. Amplitude calibration is normally performed in the laboratory, but it can be done using any VHSD system. In this case, the cable that normally goes to the 28000 test bus input should be brought to the D4D.

APPENDIX A. D4D OPERATOR GUIDE.

c. Due to the configuration of the calibration storage structure, there is not a good way to identify individual gains that have failed calibration. Gain values that have not passed calibration are set to 2/3 of their nominal value. Normally gains should be within a few percentage points of their nominal value. So any gain that is more than three percent low is an uncalibrated gain.

NOTE: Prior to arriving at the range, the operator should check that all channels possess valid calibration values and dates.

A.12 TIME CALIBRATION.

a. The internal crystal clock that controls the digitizing rate is not brought to the outside of the D4D. Thus, it is not possible to check the D4D time calibration directly. The time calibration of the D4D is accomplished by injecting a pulse into the channel inputs and simultaneously to a calibrated timer/counter. A comparison of the digitized pulse width to the timer/counter value serves to verify the time calibration of the D4D.

b. Time calibration requires a programmable signal generator, a calibrated counter/timer, an E-Net, adapter and several Bayonet Neill-Concelman (BNC) cables. The preferable method is to calibrate through the direct inputs. But the test bus input can be used if necessary.

c. At this time it is not possible tell if the system has been time calibrated.

A.13 CONTROL COMPUTER.

a. A control computer is required as a minimum to setup, load, and arm the D4D. As long as an Ethernet connection exists to an armed D4D, then there will be streaming data to be captured. The computer must have adequate performance to write the streaming data to the hard drive as well as process the data for triggers. Recall that there is no triggering of any kind inside the D4D. Left on its own, the D4D will not shut itself down. It will continue to stream data forever. The control computer monitors the streaming data for triggers and determines when acquisition is complete. When all channels have completed acquisition, the control computer sends the disarm signal to the D4D.

b. When the operator initiates a transfer, the control computer reads the raw file which contains all 60 channels of streamed data. At this time the control computer uses the operator selected parameters to determine what data from the raw file are saved into the hdf5 file. Thus, all of the trigger modes, trigger counts, and memory sizes set up in the parameter panel are actually carried out by the control computer during transfer.

APPENDIX A. D4D OPERATOR GUIDE.

c. When multiple D4Ds are connected to the same computer, the operator must ensure very high performance hard drives, lots of memory, a good Ethernet card, and fast processors are provided to avoid losing data. Each D4D is providing roughly 5 megabytes of data per second (50 megabits/sec). The program has to buffer these data in memory and write to the hard drive. The presence of a separate data hard drive may be necessary. It is important to remove non-essential processes. Currently, anti-virus programs are a major challenge. Table A-4 provides some guidance for computer selection.

TABLE A-4. NUMBER OF D4DS VERSUS COMPUTER TYPE

NUMBER OF D4DS	COMPUTER TYPE
1	Most desktops & laptops
2	Some desktops & laptops
3 to 4	High performance desktops & laptops
5 or 6	Specially tuned, high performance systems - expect problems

d. The D4D requires gigabit Ethernet capability. Thus, the computer used must have gigabit Ethernet or a gigabit switch must be used. A gigabit network switch is also required in the setup if multiple D4Ds are connected to the same computer.

e. Note that as the number of D4Ds connected to a single computer increases, parameter manipulation becomes more challenging.

NOTE: It is advisable to test the complete system that will be used on a range, in the exact configuration that will be used on the range, prior to shot day to ensure that streaming data are not lost.

A.14 OPERATION.

Operation of a system on the range requires the following:

- a. A GPS antenna for each D4D.
- b. An Ethernet cable from each D4D to the computer or network switch (if multiple D4Ds). Protection of this cable is important if data integrity is essential.
- c. A power source with adequate energy for the time required to setup and execute the test. This may consist of:

APPENDIX A. D4D OPERATOR GUIDE.

- (1) A charged D4D battery.
- (2) A DC voltage source.
- (3) A power over Ethernet (POE) switch.
- d. Signal cables that interface the D4D to the gages.
- e. A mount for the D4D that provides the necessary security to ensure that the D4D is not damaged during the test.
- f. Adequate ventilation or temperature conditioning to ensure that the D4D will not overheat.
- g. A computer that has the BTSX console software loaded and has adequate performance for the number of D4Ds being utilized.
- h. A D4D that has been properly calibrated and checked for operation.
- i. Entry of each channels operational parameters into the BTSX parameter panel.

A.15 SOFTWARE.

The software used to control the D4D is the BTSX console used to control the VHSD. Therefore, much of the software operation will be very familiar to operators. This section will provide enough information to get started and highlight a few of the differences between the two software sets.

- a. When opening the BTSX console for the D4D, the operator should select the D4D option and deselect the USE BITE box (unless BITE is available). See Figure A-8.

APPENDIX A. D4D OPERATOR GUIDE.

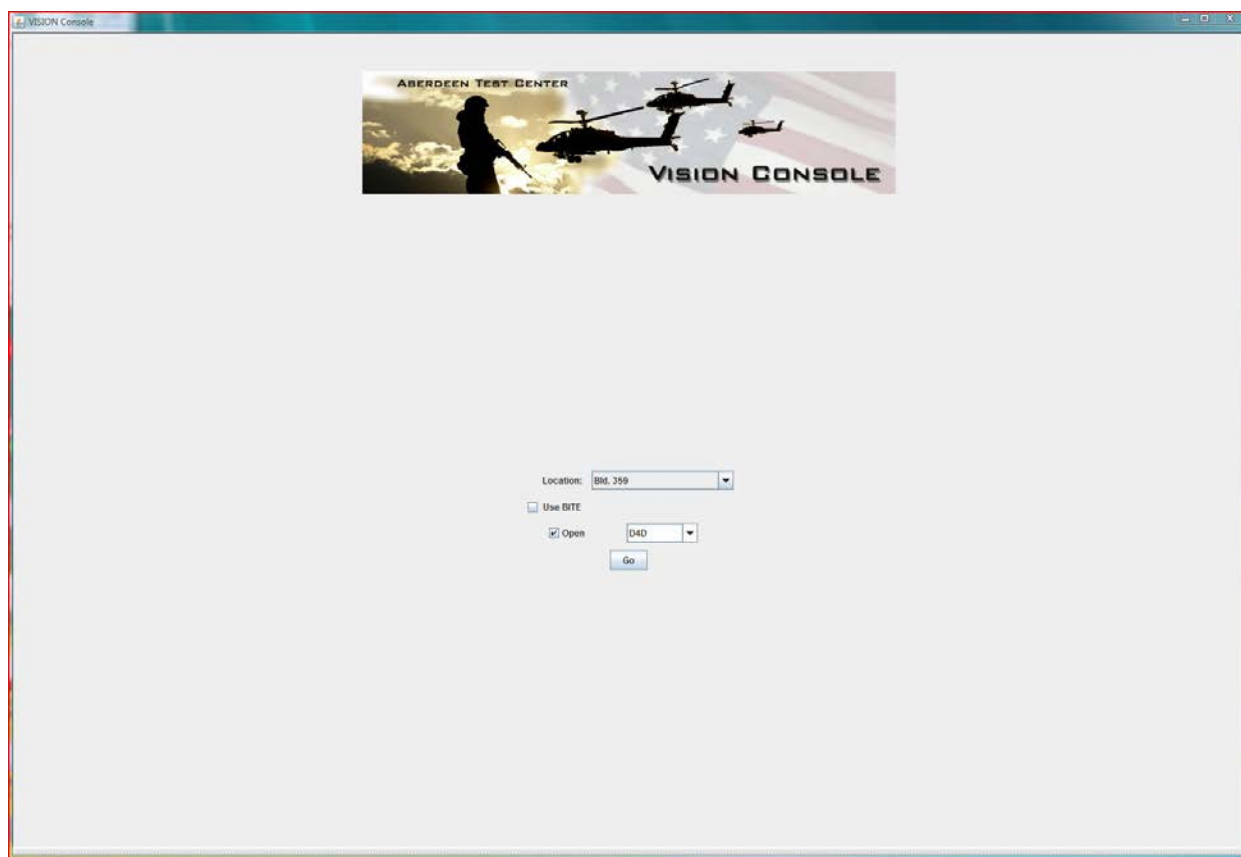


Figure A-8. Opening the BTSX console for D4D.

b. The program will then open the main console panel in the ACQUISITION tab. If a D4D is powered on and connected to the computer, then this panel should open with the operational controls and status panel for the D4D displayed. At the bottom is the test status panel. Note that there is no monitor panel or hardware monitor panel. On the left are the Acquisition, Header and Parameters tabs. On the right is the status panel for the D4D. Included in the display are the serial number of the box, its temperature, battery condition, data and time, and a status indicator. The status indicator will blink and the temperature and battery displays will update if the status message from the D4D is being received. If there is more than one D4D connected, then additional status displays will appear for each box. If GPS is working, the time will be the current coordinated universal time. If GPS is not working, then the time will count up from box power on. If the console does not find the D4D, then this status panel column will not appear. In that case, the operator should click on the UPDATE IPS button. If this works, the status display should appear. If it does not work, then the operator should check the setup, close the console and open it again. See Figure A-9.

APPENDIX A. D4D OPERATOR GUIDE.

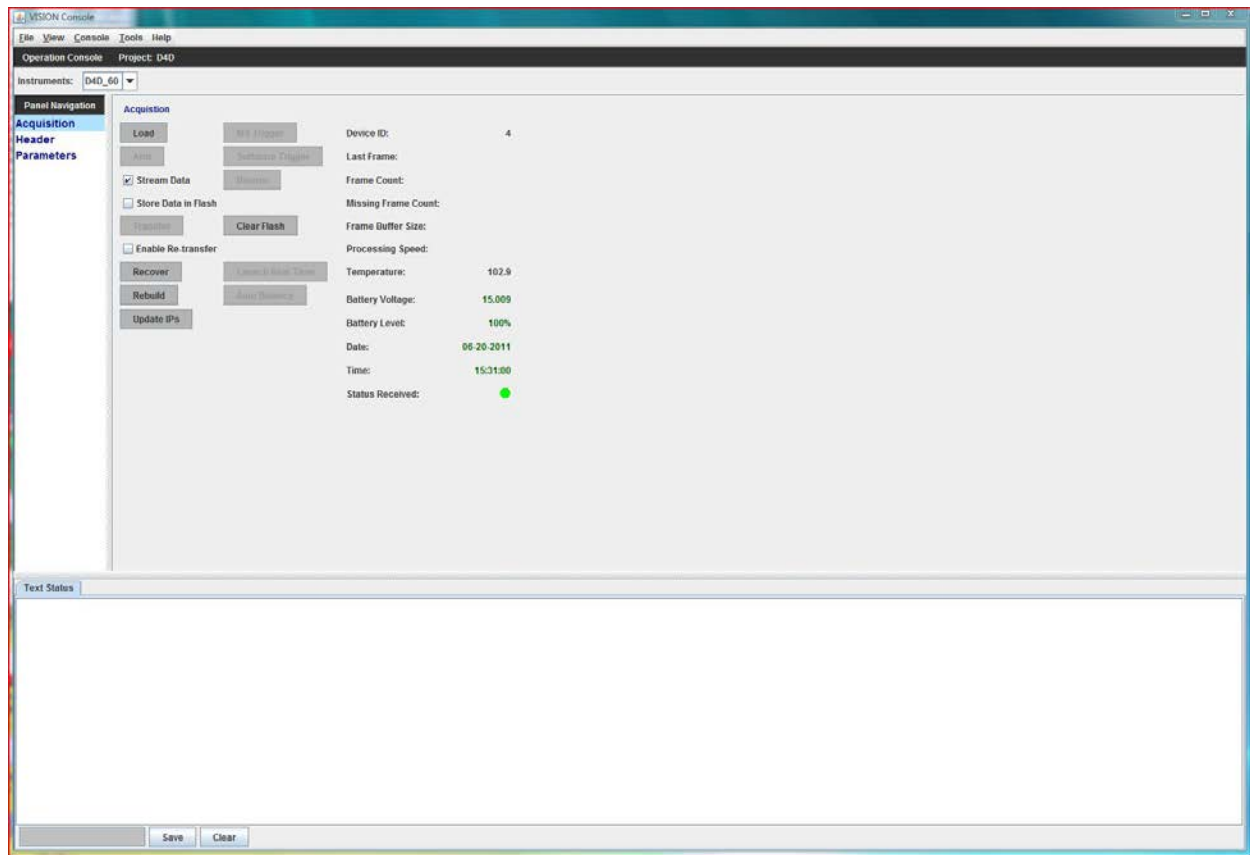


Figure A-9. BTSX console ACQUISITION tab when talking to the D4D.

c. Under Tools/Options is the system configuration panel. If the number of D4Ds attached to the system is changed, then the first order of business is to adjust the Max Channels entry to reflect the correct number of units. On occasion it may be necessary to adjust other parameters on this panel. See Figure A-10.

APPENDIX A. D4D OPERATOR GUIDE.

The screenshot shows a 'Console Properties' window with various configuration sections. The 'UserTable' is set to 'USERS'. The 'Log Level' section has checkboxes for 'Communication', 'Error', 'Full', 'Popup Error', and 'User', all of which are checked. The 'Viewable' section has a checked 'Rebuild' checkbox. The 'Digitizer' section has a checked 'Enable Back Panel MS Input' checkbox. The 'IP' field is set to '10.10.10.255'. The 'GPIB' section contains several address fields: 'Board Address' (0), 'CNT Address' (10), 'DH Address' (15), 'DVM Address' (7), 'Interface' (ENet), 'PSG Address' (6), 'RMS Address' (0), 'SCU Address' (5), and 'SRC Address' (4). The 'Misc' section includes 'Capacitor Value pF' (10,000), 'Data Directory' (C:\BTSX\data) with a 'Browse' button, and 'Max Channels' (60). The 'Signal Conditioner' section has 'IPs' (10.10.10.100) and 'Ports' (28000). The 'UPS' section has 'IP 1' and 'IP 2' both set to 0.0.0.0. At the bottom are 'Save Changes', 'Revert', and 'Cancel' buttons.

UserTable:	USERS
Log Level	
Communication:	☒
Error:	☒
Full:	☒
Popup Error:	☒
User:	☒
Viewable	
Rebuild:	☒
Digitizer	
Enable Back Panel MS Input:	☒
IP:	10.10.10.255
GPIB	
Board Address:	0
CNT Address:	10
DH Address:	15
DVM Address:	7
Interface:	ENet
PSG Address:	6
RMS Address:	0
SCU Address:	5
SRC Address:	4
Misc	
Capacitor Value pF:	10,000
Data Directory:	C:\BTSX\data Browse
Max Channels:	60
Signal Conditioner	
IPs:	10.10.10.100
Ports:	28000
UPS	
IP 1:	0.0.0.0
IP 2:	0.0.0.0

Save Changes Revert Cancel

Figure A-10. System configuration panel.

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- d. The HEADER tab is identical to the VHSD.
- e. The PARAMETER tab operates in the same general manner as the VHSD. However, there are a few differences in the parameter choices. There is no need to select a signal conditioner card as the D4D is integrated. The sample rate is currently fixed at 40,000 Sps. The Use Excitation box has the value of excitation voltage that will be used. The nominal value is 10 V, but due to fuse resistance and regulator errors, this value reflects the fleet average for use with an anthropomorphic dummy. The remaining entries (Master Trigger, Trigger Options, Memory, Trigger Times and Trigger Count) are not D4D parameters, but rather software parameters that determine how the streaming data are processed. See Figure A-11.

The screenshot displays the VISION Console software interface for configuring the D4D (Data Display Device). The main window is titled "VISION Console" and includes a menu bar (File, View, Console, Tools, Help) and a toolbar. The "Operation Console" section shows the "Project: D4D" and "Instruments: D4D_60". The "Panel Navigation" sidebar on the left has tabs for "Acquisition", "Header", and "Parameters", with "Parameters" currently selected.

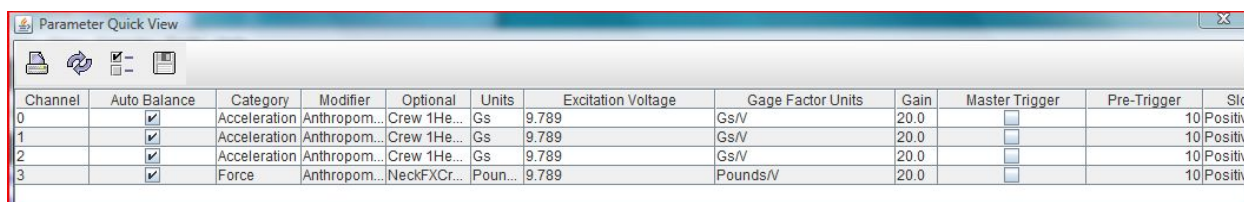
The "Parameters" panel is divided into several sections:

- Channel Parameters:** Includes "Channel Notes" (Hybrid III 50th % SN 200-006), "Expected Peak Signal" (0.002 Gs), "Channel Operations" (Differentiation, Integration, SRS, Difference), and "Low Pass Filter" (100 Hz).
- Channel Label:** Shows the "Channel Label" (Acceleration, Gs, Anthropomorphic, Crew 1, Head, AX) and a "Modify / Build Label" button.
- Transducer Parameters:** Includes "Gage Manufacturer" (Endevco), "Transducer Information" (Model Number: 7264C-2KTZ, Serial Number: P51458), "Calibration Factor Type" (Gage Factor selected), "Gage Factor" (-46882.3254 Gs/V), "Calibration Excitation" (1 Volts), and "Calibration Due Date" (Year: 2011, Month: May, Day: 26).
- D4D Parameters:** Includes "Device/Channel" (4/0), "Gain" (20.0), "Sampling Rate" (40000 Samples per second), "Input Mode" (TRANSDUCER), "Auto Balance" (Select: checked), "Use Excitation" (Select: checked, 9.789 Volts), "Master Trigger" (Select: unchecked), "Trigger Options" (Internal: unchecked, Slave: checked, Software: checked), "Memory" (Pre-Trigger: 10,000 Samples, Post-Trigger: 320,000 Samples), "Trigger Times" (Pre-Trigger: 0.25, Post-Trigger: 8.0), "Trigger Count" (1), and "Memory Being Used" (Per Trigger: 330,000 Samples, Total Memory: 330,000 Samples).

Figure A-11. D4D parameter panel.

APPENDIX A. D4D OPERATOR GUIDE.

f. The operator can see a consolidated display of all of the parameters using the Options/Parameter Quick View which brings up a separate window with the selected channels parameters. This panel is configured similarly to the VHSD. See Figure A-12.



Channel	Auto Balance	Category	Modifier	Optional	Units	Excitation Voltage	Gage Factor Units	Gain	Master Trigger	Pre-Trigger	Slid
0	☒	Acceleration	Anthropom...	Crew 1He...	Gs	9.789	Gs/V	20.0	☐		10 Positiv
1	☒	Acceleration	Anthropom...	Crew 1He...	Gs	9.789	Gs/V	20.0	☐		10 Positiv
2	☒	Acceleration	Anthropom...	Crew 1He...	Gs	9.789	Gs/V	20.0	☐		10 Positiv
3	☒	Force	Anthropom...	NeckFXCr...	Poun...	9.789	Pounds/V	20.0	☐		10 Positiv

Figure A-12. D4D parameter quick view display.

g. Once the parameters are set up, the operator can return to the ACQUISITION panel. As with the VHSD, the D4D must be have the parameters loaded by clicking the LOAD button. A message should appear in the test status window when the load is complete. Also, once the load completes, the ARM and AUTO BALANCE button should become active. See Figure A-13.

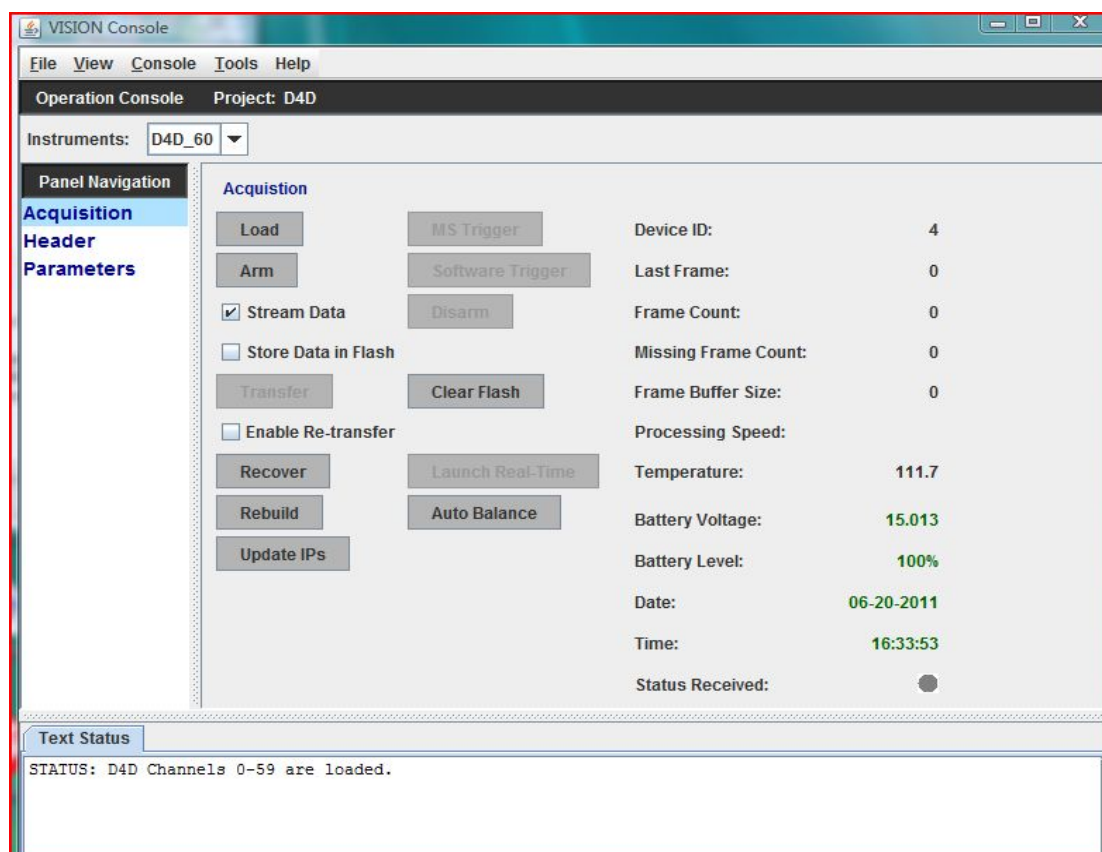


Figure A-13. D4D acquisition panel after load.

APPENDIX A. D4D OPERATOR GUIDE.

h. If the operator desires to auto balance the channels that have auto balance selected, then this can be done at any time after the load is complete by simply clicking on the AUTO BALANCE button. The auto balance requires approximately 1 minute. When the auto balance completes, a message will appear in the Text Status panel. The operator needs to read this message to determine that all of the desired channels did achieve auto balance. See Figure A-14.

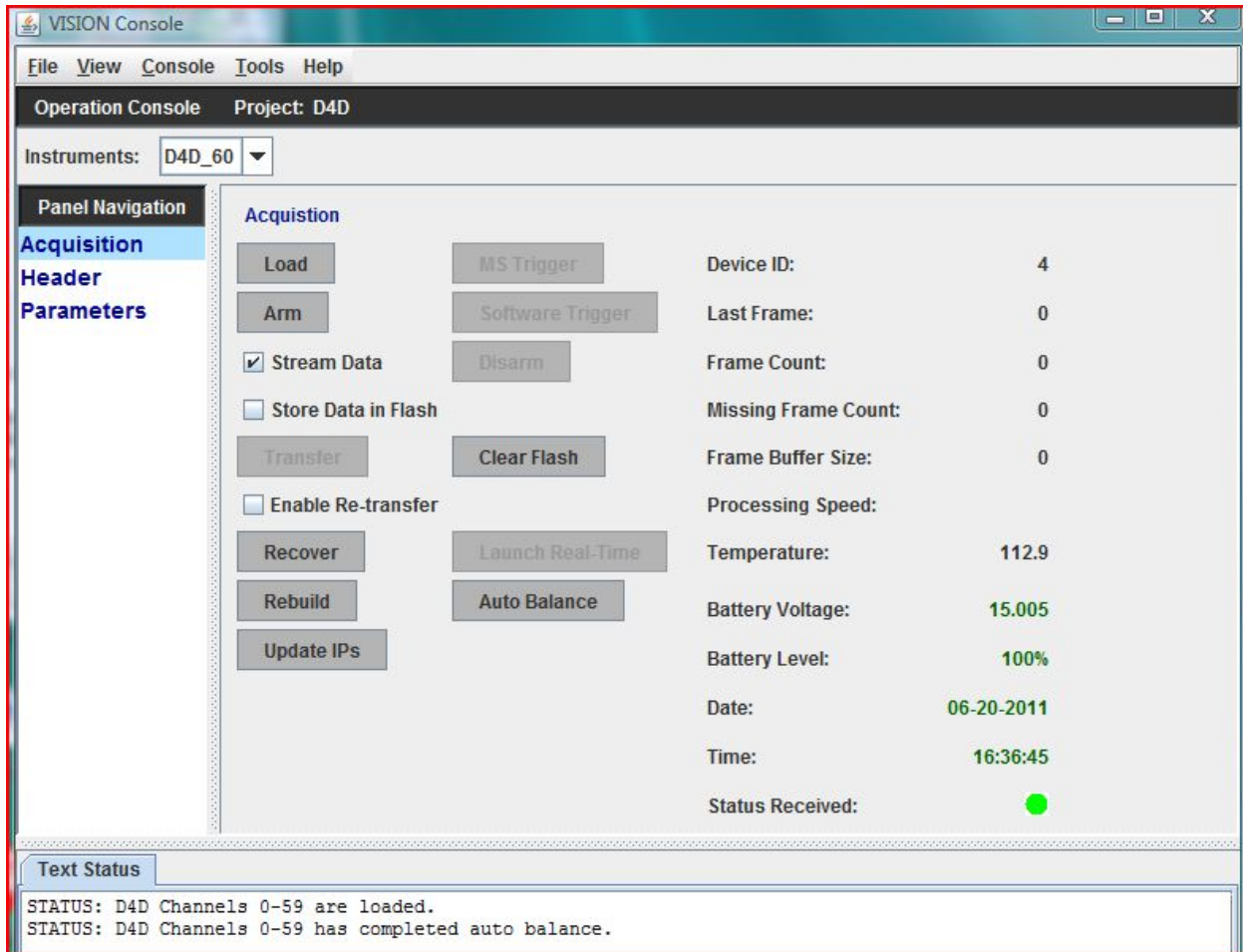


Figure A-14. D4D acquisition panel after auto balance.

i. When the operator is ready to take data, then the ARM command must be issued. Note that because of the internal sequence of events that occurs within the D4D, it may take 20 seconds for the system to actually start taking data. Note that after the ARM occurs, the Transfer, Software Trigger, and Disarm buttons will become active and the Auto Balance button will become inactive. More importantly, the Last Frame, Frame Count, Missing Frame Count, Frame Buffer Size, and Processing Speed will start to display values. These values reflect that the D4D is streaming data into the computer. See Figure A-15.

APPENDIX A. D4D OPERATOR GUIDE.

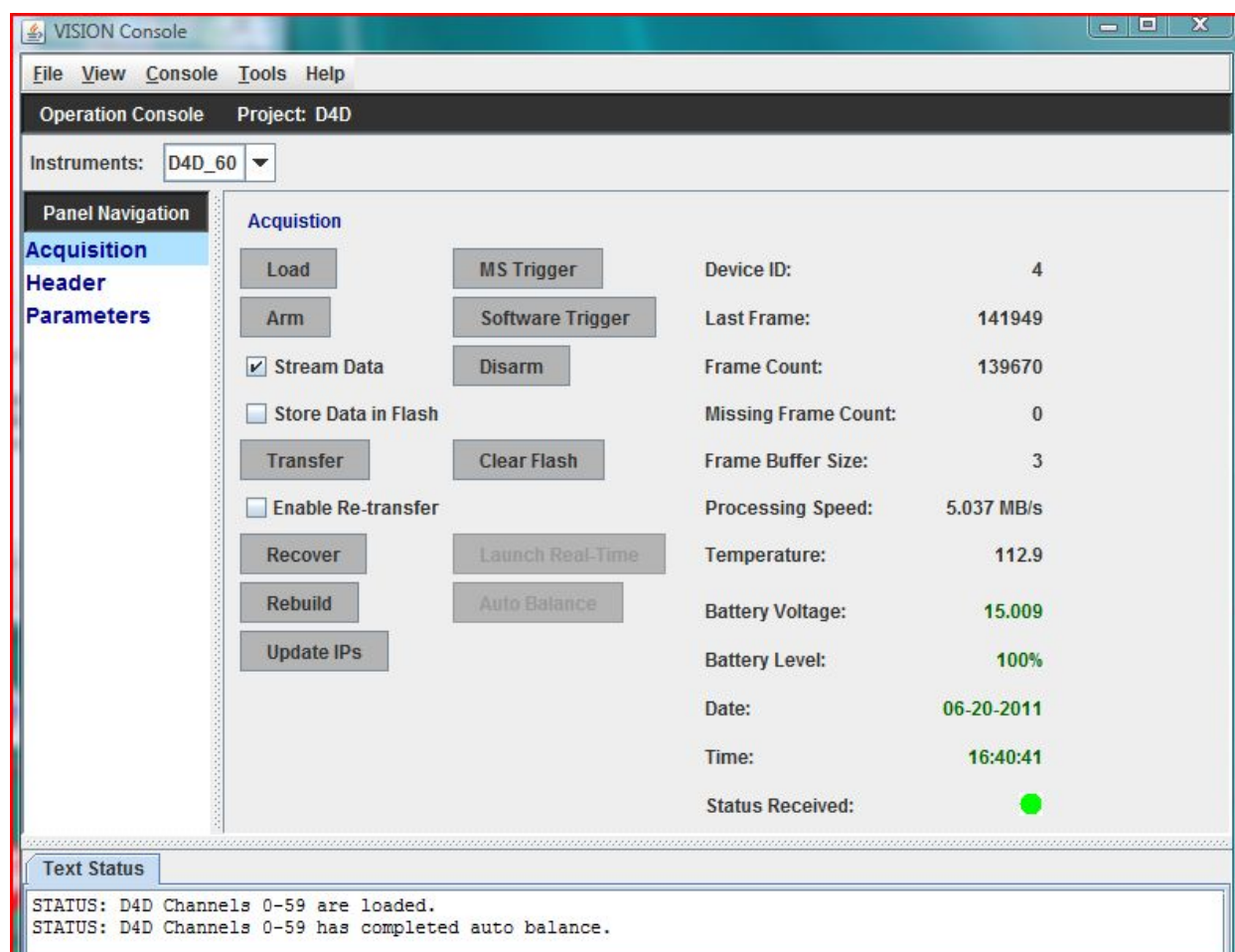
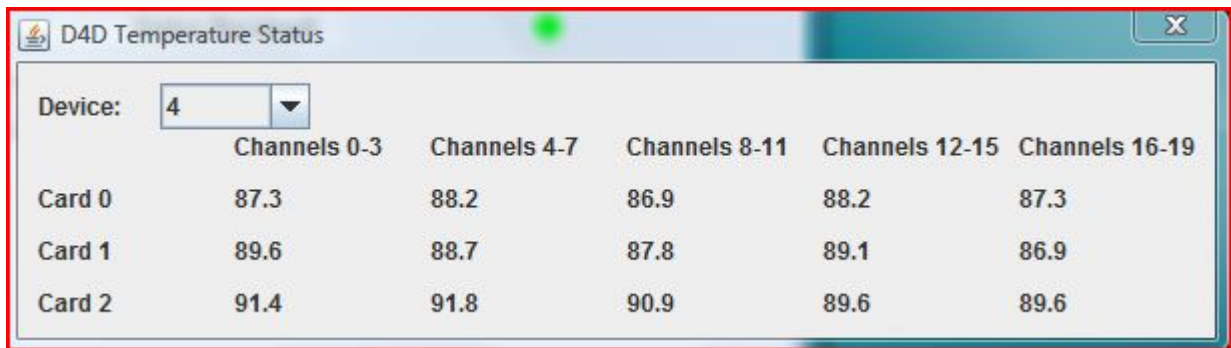


Figure A-15. D4D acquisition panel after ARM.

j. At this point it is important for the operator to keep an eye on the temperature and battery values displayed in the status panel. The temperature displayed on the panel is the digital card reading. If this temperature reaches a value of 190, then the D4D is in danger of shutdown. The battery level is trickier to monitor as the level can change rapidly. Values in the low 60s or high 50s are indicative of approaching battery failure.

k. If the operator wants to view the temperatures of the sensors on the analog cards, then the word "Temperature" in the status display should be selected. This will bring up a display of the 15 analog card sensors. The analog sensors will shut the D4D down if they reach a temperature of 150. See Figure A-16.

APPENDIX A. D4D OPERATOR GUIDE.



The screenshot shows a window titled "D4D Temperature Status". At the top left, there is a "Device:" label followed by a dropdown menu showing the value "4". Below this, the window contains a table with temperature readings for three cards (Card 0, Card 1, Card 2) across five channel groups: Channels 0-3, Channels 4-7, Channels 8-11, Channels 12-15, and Channels 16-19.

	Channels 0-3	Channels 4-7	Channels 8-11	Channels 12-15	Channels 16-19
Card 0	87.3	88.2	86.9	88.2	87.3
Card 1	89.6	88.7	87.8	89.1	86.9
Card 2	91.4	91.8	90.9	89.6	89.6

Figure A-16. D4D temperature status.

l. If the operator wants to stop the data acquisition process for any reason, then the DISARM button should be clicked.

m. If software trigger was selected for some or all channels, the SOFTWARE TRIGGER button can be clicked to initiate the software trigger. If channels are set for master/slave and/or internal trigger, then the console will scan the streaming data looking for triggers. When all channels complete acquisition, the console will send a disarm message to the D4D to end the streaming of data.

NOTE: When multiple boxes are used, a software trigger will not trigger the boxes at the same time. A simultaneous hardware trigger to each box is required to trigger the boxes at the same time.

n. When all channels have triggered, the operator can initiate TRANSFER. Since the data were already streamed to the hard drive, this is really a misnomer. However, for consistency with the VHSD, the term was retained. During this process, the data for selected channels will be transferred to an HDF5 file with all meta-data. The streamed data file with all 60 channels per unit is stored in BTSX*<date>*\Raw and the HDF5 file is stored in BTSX*<date>*. See Figure A-17.

APPENDIX A. D4D OPERATOR GUIDE.

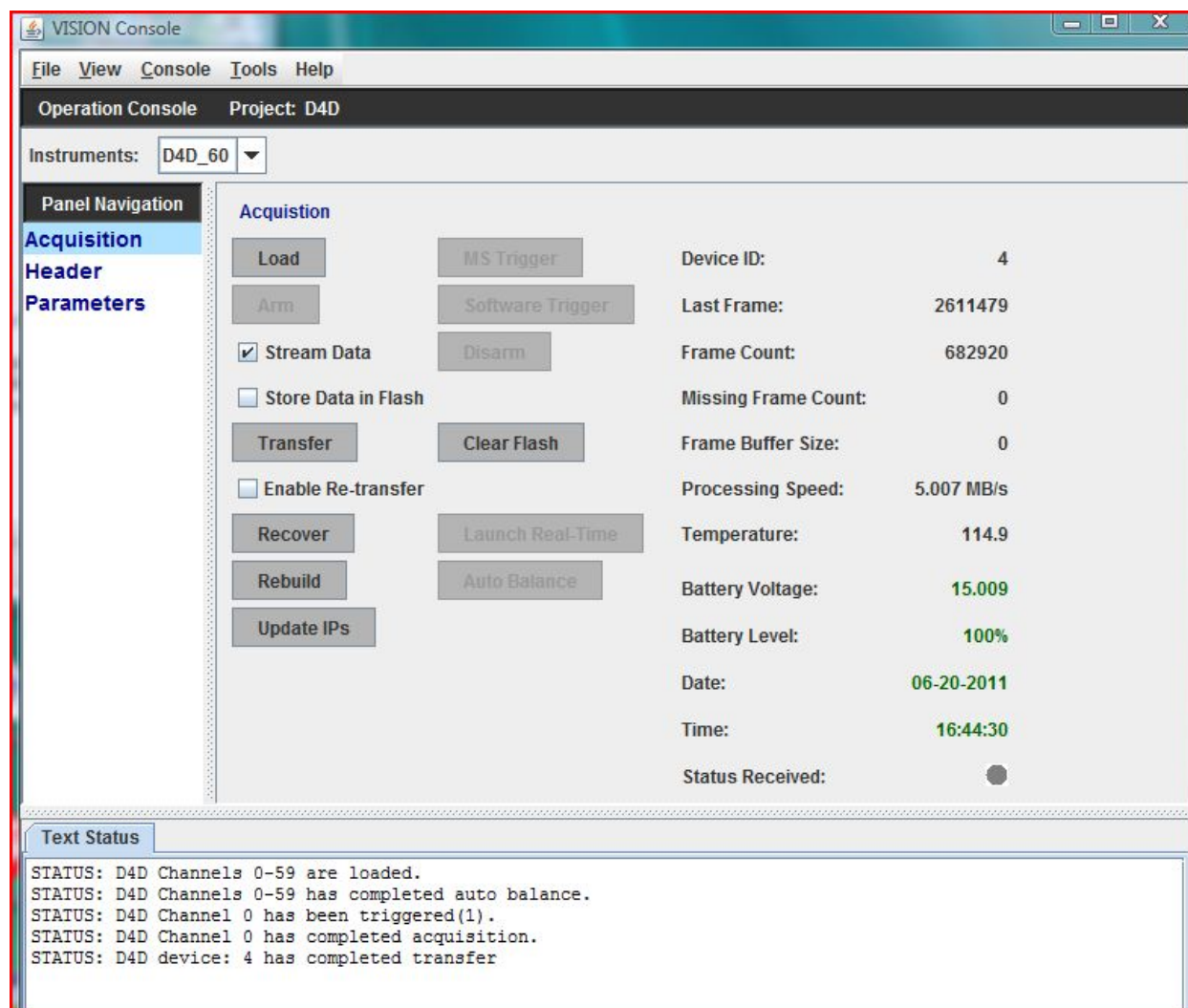


Figure A-17. D4D acquisition panel after transfer.

- o. Once transfer is complete, the operator can select Console/Analyzer and process the data in the same manner as a VHSD data file would be processed.
- p. Under Console/Calibration the operator will find three commands that apply to the D4D:
 - (1) D4D Gain Calibration provides the mechanism to amplitude calibrate the D4D.
 - (2) D4D Time Calibration provides the mechanism to time calibrate the D4D.

APPENDIX A. D4D OPERATOR GUIDE.

(3) Digitizer Calibration Report provides the mechanism to read the current calibrated gain values and the calibration date. The operator should use this command to check that current gain calibration values are present. If a valid date is not found or a valid gain error is not found, then a gain calibration should be performed. See Figure A-18.

Device	Channel	Name	% Error	Calibrated Value	Calibration Date
4 - 0	0	Digitizer Count	0.774	7.6884E-5	6/1/2011
4 - 0	0	Gain of 2	-1.117	1.97766	6/1/2011
4 - 0	0	Gain of 4	-3.789	3.84844	6/1/2011
4 - 0	0	Gain of 5	-1.075	4.94625	6/1/2011
4 - 0	0	Gain of 10	-1.442	9.8558	6/1/2011
4 - 0	0	Gain of 20	-2.545	19.491	6/1/2011
4 - 0	0	Gain of 40	-0.596	39.7616	6/1/2011
4 - 0	0	Gain of 50	-2.507	48.7465	6/1/2011
4 - 0	0	Gain of 100	-2.793	97.207	6/1/2011
4 - 1	1	Digitizer Count	0.86	7.695E-5	6/1/2011
4 - 1	1	Gain of 2	-1.066	1.97868	6/1/2011
4 - 1	1	Gain of 4	-3.717	3.85132	6/1/2011
4 - 1	1	Gain of 5	-0.997	4.95015	6/1/2011
4 - 1	1	Gain of 10	-1.361	9.8639	6/1/2011
4 - 1	1	Gain of 20	-2.39	19.522	6/1/2011
4 - 1	1	Gain of 40	-0.42	39.832	6/1/2011
4 - 1	1	Gain of 50	-2.332	48.834	6/1/2011
4 - 1	1	Gain of 100	-2.622	97.378	6/1/2011
4 - 2	2	Digitizer Count	1.016	7.7069E-5	6/1/2011
4 - 2	2	Gain of 2	-1.11	1.9778	6/1/2011
4 - 2	2	Gain of 4	-3.78	3.8488	6/1/2011
4 - 2	2	Gain of 5	-1.071	4.94645	6/1/2011
4 - 2	2	Gain of 10	-1.448	9.8552	6/1/2011
4 - 2	2	Gain of 20	-2.513	19.4974	6/1/2011
4 - 2	2	Gain of 40	-0.546	39.7816	6/1/2011
4 - 2	2	Gain of 50	-2.433	48.7835	6/1/2011
4 - 2	2	Gain of 100	-2.716	97.284	6/1/2011
4 - 3	3	Digitizer Count	0.777	7.6887E-5	6/1/2011
4 - 3	3	Gain of 2	-1.125	1.9775	6/1/2011
4 - 3	3	Gain of 4	-3.804	3.84784	6/1/2011
4 - 3	3	Gain of 5	-1.094	4.9453	6/1/2011
4 - 3	3	Gain of 10	-1.464	9.8536	6/1/2011
4 - 3	3	Gain of 20	-2.556	19.4888	6/1/2011
4 - 3	3	Gain of 40	-0.615	39.754	6/1/2011
4 - 3	3	Gain of 50	-2.523	48.7385	6/1/2011
4 - 3	3	Gain of 100	-2.799	97.201	6/1/2011
4 - 4	4	Digitizer Count	0.822	7.6921E-5	6/1/2011

Figure A-18. D4D gain calibration report.

APPENDIX A. D4D OPERATOR GUIDE.

q. Under Console/Diagnostics the operator will find four commands that apply to the D4D:

(1) Automated Sine Wave Test provides a mechanism for performing the sine wave test on the box. This test should be performed if the operator is suspicious of any channel not working properly. Normally this test should be executed with the Stanford Research DS-360 programmable signal generator. This command does not support using the test bus.

(2) Bandwidth Test provides a mechanism for measuring the frequency response of a channel. This test should be performed if the operator is suspicious of any channel's filtering not working properly.

(3) DC Linearity Test provides a mechanism for measuring the DC linearity of a channel.

(4) Noise Test provides a mechanism for measuring the noise of a channel. This test should be performed if the operator is suspicious of any channel's noise performance.

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APPENDIX B. TECHNICAL SPECIFICATIONS.

Number of channels	60
Input range	$\pm 2.5V$
Input Resistance	2MOhm (Sig+ to Sig-); 1MOhm (Sig+/- to GND)
Noise-RTO	$< 12\mu V * GAIN + 12\mu V$ (RMS)
CMRR	$> 80dB$ at 100Hz
DC Linearity	$< 0.003\%$ at gain of 1; $< 0.1\%$ at gain of 100
Crosstalk	$> -120dB$ relative to input signal
Excitation voltage	$\pm 5V$ for 10V total
Autobalance	Available
Gains	1, 2, 4, 5, 10, 20, 40, 50, 100
Filter	4 kHz, 4-pole, Bessel-like, combination of analog and digital
Digitizer rate	40,000 samples per second
Digitizer resolution	16 bits
Effective number of bits	12.9 P-P; 13.9 RMS (400Hz at 4Vp-p in at gain of 1)
	8.9 P-P; 10.4 RMS (400Hz at 0.4V p-p in at gain of 100)
GPS	Powered antenna input, provides time tagging with 1usec resolution
Power	External 24VDC input, internal battery or power over Ethernet (POE)
Current Consumption	Not ARMED - 0.25A
	ARMED - 1.0A + Strain Gage Load
Communication	Ethernet
FLASH	4GB (~12 minutes of recording)
Size	6.5 x 4.13 x 4.13 inches (WDH)
Weight	4.0 pounds
Manufacturer	Syntronics

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APPENDIX C. CONNECTOR PIN ASSIGNMENTS.

QUAD CHANNEL CONNECTOR	
PIN	Assignment
1	Ch0 SIG+
2	Ch0 SIG-
3	EXCIT +
4	EXCIT -
5	AGND
6	Ch1 SIG+
7	Ch1 SIG-
8	EXCIT +
9	EXCIT -
10	AGND
11	Ch2 SIG+
12	Ch2 SIG-
13	EXCIT +
14	EXCIT -
15	AGND
16	Ch3 SIG+
17	Ch3 SIG-
18	EXCIT +
19	EXCIT -
20	AGND

Hirose Electric Co HR10A-13P-20S Female solder pins

POWER CONNECTOR	
PIN	Assignment
A	NEG
B	NEG
C	POS
D	POS

MS3116F8-4P

TEST BUS CONNECTOR	
PIN	Assignment
1	SIG + OUT
2	GND
3	SIG - OUT
4	GND
5	IN +
6	
7	IN -

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APPENDIX D. D4D OPERATIONAL NOTES.

D.1 SIMILARITIES BETWEEN D4D AND VHSD.

- a. Software look and feel.
- b. Parameters setup.
- c. Load Command.
- d. Auto-balance command (several minutes for 60 channels).
- e. Analyzer.

D.2 D4D AND VHSD DIFFERENCES.

- a. Excitation is off until the D4D is ARMed.
- b. ARM command:
 - (1) Turns on power to the analog boards.
 - (2) Turns on excitation to the sensors.
 - (3) Clears flash memory if flash is selected.
 - (4) Starts the D4D streaming and recording to flash if flash is selected.
 - (5) Data streams live to the PC over the network when ARMed.
- c. D4D Trigger is software based; meaning the PC scans the live streaming data as it comes in looking for a signal to cross the trigger threshold. When a signal exceeded the trigger level the PC sends a command back to the D4D saying it has been triggered.
- d. TRANSFER command builds an HDF5 from the streamed data that is already on the PC.
- e. D4D does not have a real time viewer (yet).
- f. D4D filter is fixed to 4 kHz.
- g. D4D sample rate is fixed to 40 kHz.
- h. D4D has 4 channels/connector, 0-59 channels. On the D4D / Dummy wiring harness channel 59 is reserved for a trigger channel.

APPENDIX D. D4D OPERATIONAL NOTES.

- i. D4D Input signal is $\pm 2.5\text{V}$ not $\pm 10\text{V}$ like the VHSD.

D.3 D4D CHARGING.

- a. Fast charge - Charge through the external connector (24V @ 1.3A) or use the D4D external supply. D4D will run during charging. Make sure the D4D is powered on.
- b. Slow Charge - D4D will trickle charge over Ethernet if the switch provides POE. Make sure the D4D is powered on before connecting to a switch with POE. D4D will run during charging.
- c. Manual switch on the D4D must be on to charge the batteries.
- d. DO NOT provide external power and POE simultaneously.

D4. POWERING THE D4D.

- a. The D4D can be powered 3 ways:
 - (1) Battery via manually turning on the switch.
 - (2) External via external power supply.
 - (3) POE via the Ethernet switch. The D4D must be powered up before connecting a switch with POE.
- b. Always cover the D4D power switch with a cap before the shot.
- c. Never operate a D4D on external power during the shot. Always switch on the internal D4D batteries.

D.5 D4D EXTREME OPERATING CONDITIONS.

- a. DO NOT OPERATE THE D4D - When the temperature inside the D4D has maintained 155°F or greater for longer than one hour as indicated on the main temperature sensor on the power supply board.
 - (1) D4D charging increases temperature 4° - 7°F.
 - (2) D4D Cooler turns on when the system is ARMed. Temperature will increase approximately 3° - 4°F but will level off and stabilize.

APPENDIX D. D4D OPERATIONAL NOTES.

(3) D4D will automatically shut off when any of the 3 analog board temperatures exceed 145°F for 5 seconds. Analog board temperatures can only be displayed when the D4D is ARMed.

b. Battery Operating time:

(1) With the D4D idling in low power mode (just turned on) and with POE or external power the system will run indefinitely.

(2) D4D running on battery only:

(a) When starting with a fully charged D4D the system will idle for approximately 4.5 – 5.5 hours.

(b) When the D4D reaches 60% of full charge there is still enough battery life remaining to operate on full power for several minutes (basically one auto-balance, and approximately 2-3 minutes of data acquisition). This should be more than enough time to acquire the needed data and deal with a sequence abort but not a misfire abort that requires a 30 minute wait time.

(c) If the D4D is at 60% charged shooting should be imminent. Do not shoot if the D4D is less than 60% charged. Hold the test for 30 minutes to re-charge the D4Ds using an external power supply. 30 minutes is sufficient time to produce a full charge.

c. DO NOT re-ARM the D4D until all data have been validated after the shot. ARming erases flash memory from all previously stored data. Validate the D4D data by looking for missing frames or blank spaces in the data. If missed frames are detected LOAD and RESTORE from flash. Don't forget to change the round name in the header.

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APPENDIX E. ABBREVIATIONS.

ADC	analog-to-digital
ATC	U.S. Army Aberdeen Test Center
ATD	anthropomorphic test device
BEST	Ballistics Engineering, Support, and Technology
BNC	Bayonet Neill-Concelman
BTSX	Ballistics Test Site
D4D	data acquisition for anthropomorphic test devices
DAQ	data acquisition
DAS	data acquisition system
dB	decibel
DC	direct current
FPGA	field programmable gate array
GB	gigabyte
GPS	global positioning system
Hz	hertz
kHz	kilohertz
kSps	kilo-samples per second
LED	light emitting diode
MB	megabyte
PC	personal computer
POE	power over Ethernet
RAM	random access memory
RPM	revolutions per minute
SMA	SubMiniature version A
TOP	Test Operations Procedure
V	volt
VDC	volt direct current
VHSD	VISION high-speed digitizer
VISION	Versatile Information Systems Integrated On-Line

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APPENDIX F. REFERENCES.

1. C. Lee Francis, Laboratory Evaluation of Syntronics Model D4DV2.5, September 2010.

For information only (related publications).

- a. GPS Source, S18 Technical Product Data, Rev 004, December, 2006.

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APPENDIX G. APPROVAL AUTHORITY.

CSTE-TM

9 February 2016

MEMORANDUM FOR

Commanders, All Test Centers
Technical Directors, All Test Centers
Directors, U.S. Army Evaluation Center
Commander, U.S. Army Operational Test Command

SUBJECT: Test Operations Procedure (TOP) 02-1-100 Anthropomorphic Test Device
Operation and Setup, Approved for Publication

1. TOP 02-1-100 Anthropomorphic Test Device Operation and Setup, has been reviewed by the U.S. Army Test and Evaluation Command (ATEC) Test Centers, the U.S. Army Operational Test Command, and the U.S. Army Evaluation Center. All comments received during the formal coordination period have been adjudicated by the preparing agency. The scope of the document is as follows:

The objective of this TOP is to establish a formal procedure for the operation and setup of the Anthropomorphic Test Device (ATD) using the Data Acquisition for Anthropomorphic Test Devices (D4D) in vehicle vulnerability testing. The D4D is an onboard data acquisition system (DAS) that is intended for use with the Hybrid II/III ATD's. The D4D was developed to augment the existing DAS system, the legacy Versatile Information Systems Integrated On-Line (VISION) High-Speed Digitizer (VHSD) DAS. The D4D provides increased channel counts and more versatility for on the move vulnerability testing.

2. This document is approved for publication and will be posted to the Reference Library of the ATEC Vision Digital Library System (VDLS). The VDLS website can be accessed at <https://vdls.atc.army.mil/>.

3. Comments, suggestions, or questions on this document should be addressed to U.S. Army Test and Evaluation Command (CSTE-TM), 2202 Aberdeen Boulevard-Third Floor, Aberdeen Proving Ground, MD 21005-5001; or e-mailed to usarmy.apg.atec.mbx.atec-standards@mail.mil.

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Forward comments, recommended changes, or any pertinent data which may be of use in improving this publication to the following address: Range Infrastructure Division (CSTE-TM), U.S. Army Test and Evaluation Command, 2202 Aberdeen Boulevard, Aberdeen Proving Ground, Maryland 21005-5001. Technical information may be obtained from the preparing activity: Ballistics Instrumentation Division (TEDT-AT-SLB), U.S. Army Aberdeen Test Center, 400 Collieran Road, Aberdeen Proving Ground, Maryland. Additional copies can be requested through the following website: <http://www.atec.army.mil/publications/topsindex.aspx>, or through the Defense Technical Information Center, 8725 John J. Kingman Rd., STE 0944, Fort Belvoir, VA 22060-6218. This document is identified by the accession number (AD No.) printed on the first page.