PRODUCT DEVELOPMENT

Extratech M3514 Motion Controller

Engineering Test Procedure and Report

Author:

Tony Whyte

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ABSTRACT

This document describes how the Extratech M3514 Motion Controller will be engineering tested. This testing is a precursor to the Verification and Validation test phases. It emphasizes verifying the interaction and communication with the controller as it supports motion commands on both primary and secondary robot arms. The command to response timing performance is closely characterized and evaluated against that which is noted with its predecessor, the M2514 controller.

AUTHORIZATION

|  |  |
| --- | --- |
| Functional Role | OTIS Role |
| Author | Business Owner |
| System Development | Product Development |
| Management Sponsor | Management – Supervision |

REVISION HISTORY

|  |  |
| --- | --- |
| **DATE** | **DESCRIPTION OF CHANGE** |
| 20 April, 2013 | Original Release |
| 28 July, 2013 | Updated to test Extratech 2.1.21 Firmware |

LIST OF ITEMS “TO BE DECIDED / TO BE RESOLVED” (TBD/TBR)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **TBD/TBR #** | **PAGE #** | PARAGRAPH OR FIGURE # | **DESCRIPTION** | **ASSIGNED TO** |
| None |  |  |  |  |

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# Test Plan

## INTRODUCTION

### Purpose

Test the functions of the M3514 motion controller by comparing its operation and behavior against those of the M2514 controller.

### Definitions

**IP:** Internet Protocol

**STD:** Standard Deviation

**TCP:** Transmission Control Protocol

**UUT**:Unit Under Test

**msec/msecs:** Unit of measure time to 10^-3 seconds

**usec/usecs:** Unit of measure time to 10^-6 Volts

### References

J27552, VITROS SSRD: Sample and Reagent Metering (SRME)

J28192, VITROS 4,3FS Design Specification: Sample and Reagent Metering (SRME)

J26254, VITROS 4, 3 Product Requirements Document

J26255, VITROS 4, 3 Architecture & Interface

J27078, 4,3 FS System Timing Diagram

D26175, Extratech Motion Controller Obsolescence Test Plan

Change Order #15383

## TEST ITEMS

This procedure will test the Extratech M3514 hardware executing its v2.1.21 software**.**

## APPROACH

M3514 Motion Controller testing will consist of installing the unit into a 5600 Analyzer thus replacing its M2514 controller. The analyzers non-metering subsystems will be emulated. Interlocks will be bypassed to allow physical and visual access to the robot arms. A series of operational command scripts will be created and executed to drive the analyzer in ways that demonstrate its operation in basic and advanced operational scenarios. Messaging data will then be collected at the Ethernet IP interface level and analyzed. Central to the testing is the comparison of results obtained when the equivalent testing is performed with the M2514 installed.

## RESOURCE REQUIREMENTS

### Equipment and Materials Required

1. VITROS 5600 Analyzer executing V2.0 software
2. 2 Extratech M3514 controllers with v2.1.21 software installed.
3. PC running Microsoft XP Professional Service Pack 3
4. Wireshark Protocol analyzer V1.6.4 installed on PC.
5. OCD Qnx port of tcpdump software protocol analyzer available on OCD analyzer.
6. Extratech OCD Packet Capture Tool executable installed on PC.
7. OCD Packet Capture Tool analysis script.
8. 4 port Network Hub

### Skills Required

Electrical/Software Engineer and Technicians having:

1. Familiarity with IP network analysis electrical test equipment
2. Familiarity with analyzer script creation and editing.
3. Familiarity with scripted parsing of OCD log files and network IP capture files.

### Environments

Testing will be performed in a standard lab environment at ambient temperature and humidity. This test does not require any bio-hazardous fluids.

# Test Procedure

## Basic Communications Test

### Description

This test sends standard “go to home” move commands simultaneously to the primary and secondary metering robot arms. The objective of the test is to isolate and characterize high rate IP command message handling behavior of the controller. We repeat the command for (3) 20000repetition test cycles and evaluate the command to response timing characteristics in comparison to the same testing performed with the M2514 installed.

### Test Steps

| **Step** | **Action** | **Expected Result** | **Actual Result** | **P / F /**  **I / NE** |
| --- | --- | --- | --- | --- |
|  | | | | |
|  | Boot up the analyzer and allow initialization. | Visual:  System Status Legend changes from ‘Initializing’ to ‘Ready’. | * As Expected |  |
|  | On the Emulation Page of the analyzer enable simulation of all subsystems except the Primary, Secondary, and Reference Metering subsystems. | Visual:  Check box Icon shows as simulated except for Primary, Secondary and Reference metering. | * As Expected |  |
|  | Cycle the Emulator log file with the following command  senddebug –w –f emulator | The current Emulator log in /oasis/workfiles/datalog/sw\_dev increments to the next highest numeric suffix | * As Expected |  |
|  | Prepare tcpdump for capture   * Enter ‘export SOCK=/srme’ at a QNX command shell prompt. * cd to the /tmp directory with ‘cd /tmp’ command. | NA | * As Expected |  |
|  | Launch the ‘tcpdump’ application with the following command line.  nice –n -41 /usr/local/service/tcpdump -i en0 –n –s 1000 –w *‘yourFileName.pcap’*  Parameter Details:   * nice –n 41 , raises the execution process priority of tcpdump as it runs to 51. * -n, suppresses IP name resolution which is expensive cpu wise. * -s, sets the packet byte length to be captured per message * -w, commits the captured data to ‘pcap’ file for later analysis. | Visual:  The following appears at the command prompt.  SOCK=/srme  Number of instructions: 1  Size of struct bpf\_insn: 8  tcpdump: listening on en0 | * As Expected |  |
|  | Enable the Stop On Failure checkbox on the Scripting Page interface. | Visual:  Check box shows as enabled. | * As Expected |  |
|  | Specify a repeat command count of 20000 on the Scripting Page interface. | NA | NA |  |
|  | Note the script to be run as: HEADER,extratech\_basic\_comms\_test.dep,DEP\_TYPE,NO\_DESCRIPTION  SET,1,0,NO\_INSERT\_SCRIPT  OP,1,LclDelay100Ms,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,2,PrimMetTrkMvToHome,1,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,3,SecMetTrkMvToHome,1,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,4,LclDelay100Ms,2,3,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE | | |  |
|  | Start execution of the **extratech\_basic\_comms\_test.dep** script **and** quickly press the **‘?’** help button.  (This action bypasses the processing that is required to update the scripting interface page at a high rate, which was found to effect test results) | Visual:  Scripting page begins to show commands being sent and executed.  The Help Page of the analyzer is displayed on the monitor. | * As Expected |  |
|  | When the script has completely executed all repetitions stop the tcpdump capture by entering CTRL-C at the Qnx window where tcpdump was launched.   * Note number of packets dropped. | Visual**:**  \_\_ packets received by filter  \_\_ packets dropped by kernel  is displayed in command shell. | * As Expected |  |
|  | When the script has completely executed all repetitions, collocate all the accumulated ‘pcap” files to an appropriate media such as a USB flash drive. | NA | NA |  |
|  | Copy the files on the USB flash drive to a PC that has the OCD Packet Capture Tool installed on it. | Files are now located in a directory ready for processing with Packet capture tool. | NA |  |
|  | Open the OCD Packet Capture Tool and Start “Capture” on each of the pcap files collected during the test. | As appropriate the ‘Port 29’ and Port31’ panes populate with command text details. | * As Expected |  |
|  | Select and copy all of the text data in each pane using the Ctrl-A, Ctrl-C actions. | Text data is highlighted. | * As Expected |  |
|  | Open a new text document and name it similarly to the originating pcap source file, while differentiating for “primary” or “secondary” axis appropriate. | NA | NA |  |
|  | Use Ctrl-V to paste all of the text from the OCD Capture Tool panes into the respective files created in previous step. | Text is populated into the newly created text file. | * As Expected |  |
|  | Repeat above analysis steps for the other metering arm. | NA | NA |  |
|  | Select and **print** any conditions posted during execution of this test case (since the last reset). | | |  |
|  | Run the PCAP file analysis script on each of the OCD Packet Capture renderings for primary and secondary metering arms **xtra\_tech\_capture\_pcap.pl ‘Your OCD Packet Capture file name’** | | |  |
|  | Retain the output of the scripted analysis and incorporate results into a spreadsheet in next section of this document. | | |  |
|  | Repeat (2) additional iterations of this test where 20000 “go to home” commands are sent to the metering arms. | | |  |
|  | Install a M3514 controller with v2.1.21 software into the analyzer and repeat all steps of this test. | | |  |

## Basic Communications - Test Results

### 2514 Basic Communications Command-Response Message Statistics – Primary Arm

These results reflect 3 sets of data. Each set applies to 20000 cycles of a “go to home” Move Arm command.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| PrimMetTrkMvToHome | 20121217PrimStatus20000\_2514\_tcp51.txt | 20000 | 0.000 | 183.97 | 6.37 | 10.87 |
| PrimMetTrkMvToHome | 20121218PrimStatus20000\_2514\_tcp51\_2.txt | 20000 | 0.000 | 183.97 | 6.90 | 10.94 |
| PrimMetTrkMvToHome | 20121218PrimStatus20000\_2514\_tcp51\_3.txt | 20000 | 0.000 | 150.98 | 6.16 | 10.67 |

### 3514 Basic Communications Command-Response Message Statistics – Primary Arm (v2.1.21)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| PrimMetTrkMvToHome | 20130715PrimStatus20000\_3514\_2121\_tcp51\_1.txt | 20000 | 0.000 | 195.97 | 8.99 | 16.03 |
| PrimMetTrkMvToHome | 20130715PrimStatus20000\_3514\_2121\_tcp51\_2.txt | 20000 | 0.000 | 205.97 | 9.04 | 16.54 |
| PrimMetTrkMvToHome | 20130715PrimStatus20000\_3514\_2121\_tcp51\_3.txt | 20000 | 0.000 | 205.97 | 9.25 | 16.63 |

### Basic Communications – 2514 vs. 3514 Command-Response Probability Density Plot Comparison – Primary Arm

| **Primary Arm 2514** | **Primary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121217PrimStatus20000_2514_tcp51.txt_PrimaryHome--PrimaryHome_dens.png | C:\WireSharkCaptures\20130715StatusPrimary20000_3514_2121_tcp51.txt_PrimaryHome--PrimaryHome_dens.png |
| C:\WireSharkCaptures\20121218PrimStatus20000_2514_tcp51.txt_PrimaryHome--PrimaryHome_dens.png | C:\WireSharkCaptures\20130715PrimStatus_3514_2121_tcp51_2.txt_PrimaryHome--PrimaryHome_dens.png |
| C:\WireSharkCaptures\20121218PrimStatus20000_2514_tcp51_2.txt_PrimaryHome--PrimaryHome_dens.png | C:\WireSharkCaptures\20130715PrimStatus_3514_2121_tcp51_3.txt_PrimaryHome--PrimaryHome_dens.png |

### Basic Communications – 2514 vs. 3514 Command-Response Plot Comparison – Primary Arm

| **Primary Arm 2514** | **Primary Arm 3514** |
| --- | --- |
| 20121217PrimStatus20000_2514_tcp51.txt_PrimaryHome--PrimaryHome.png | C:\WireSharkCaptures\20130715StatusPrimary20000_3514_2121_tcp51.txt_PrimaryHome--PrimaryHome.png |
| C:\WireSharkCaptures\20121218PrimStatus20000_2514_tcp51.txt_PrimaryHome--PrimaryHome.png | C:\WireSharkCaptures\20130715SecStatus_3514_2121_tcp51_2.txt_SecondaryHome--SecondaryHome.png |
| 20121218SecStatus20000_2514_tcp51_2.txt_SecondaryHome--SecondaryHome.png | C:\WireSharkCaptures\20130715PrimStatus_3514_2121_tcp51_3.txt_PrimaryHome--PrimaryHome.png |

### 2514 Basis Communications Command-Response Message Statistics – Secondary Arm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| SecMetTrkMvToHome | 20121217SecStatus20000\_2514\_tcp51.txt | 20000 | 0.000 | 183.97 | 6.83 | 12.41 |
| SecMetTrkMvToHome | 20121218SecStatus20000\_2514\_tcp51.txt | 20000 | 0.000 | 183.97 | 7.42 | 12.50 |
| SecMetTrkMvToHome | 20121218SecStatus20000\_2514\_tcp51\_2.txt | 20000 | 0.000 | 150.98 | 6.76 | 12.60 |

### 3514 Basis Communications Command-Response Message Statistics – Secondary Arm (v2.1.21)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| SecMetTrkMvToHome | 20130715SecStatus20000\_3514\_2121\_tcp51\_1.txt | 20000 | 0.000 | 195.97 | 7.86 | 18.07 |
| SecMetTrkMvToHome | 20130715SecStatus\_3514\_2121\_tcp51\_2.txt | 20000 | 0.000 | 205.97 | 8.04 | 18.04 |
| SecMetTrkMvToHome | 20130715SecStatus\_3514\_2121\_tcp51\_3.txt | 20000 | 0.000 | 205.97 | 8.10 | 18.02 |

### Basic Communications – 2514 vs. 3514 Command-Response Probability Density Plot Comparisons – Secondary Arm

| **Secondary Arm 2514** | **Secondary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121217SecStatus20000_2514_tcp51.txt_SecondaryHome--SecondaryHome_dens.png | C:\WireSharkCaptures\20130715StatusSecondary20000_3514_2121_tcp51.txt_SecondaryHome--SecondaryHome_dens.png |
| C:\WireSharkCaptures\20121218SecStatus20000_2514_tcp51.txt_SecondaryHome--SecondaryHome_dens.png | C:\WireSharkCaptures\20130715SecStatus_3514_2121_tcp51_2.txt_SecondaryHome--SecondaryHome_dens.png |
| C:\WireSharkCaptures\20121218SecStatus20000_2514_tcp51_2.txt_SecondaryHome--SecondaryHome_dens.png | C:\WireSharkCaptures\20130715SecStatus_3514_2121_tcp51_3.txt_SecondaryHome--SecondaryHome_dens.png |

### Basic Communications – 2514 vs. 3514 Command-Response Plot Comparisons – Secondary Arm

| **Secondary Arm 2514** | **Secondary Arm 3514** |
| --- | --- |
| 20121217SecStatus20000_2514_tcp51.txt_SecondaryHome--SecondaryHome.png | C:\WireSharkCaptures\20130715StatusSecondary20000_3514_2121_tcp51.txt_SecondaryHome--SecondaryHome.png |
| 20121217SecStatus20000_3514_tcp51_2.txt_SecondaryHome--SecondaryHome.png | C:\WireSharkCaptures\20130715SecStatus_3514_2121_tcp51_2.txt_SecondaryHome--SecondaryHome.png |
| 20121217SecStatus20000_3514_tcp51_3.txt_SecondaryHome--SecondaryHome.png | C:\WireSharkCaptures\20130715SecStatus_3514_2121_tcp51_3.txt_SecondaryHome--SecondaryHome.png |

### Basic Communications – Outliers

This test consisted of sending many “go to home” move commands to both metering arms. This was done at a very high frequency as the test attempted to reveal any weaknesses in the message handling of the controller. It was not intended to reflect an expected operational scenario that the controller would operate under.

One phenomenon found during the testing was the very occasional duration outlier. The duration was defined by the difference in timestamps associated with the sending of a command and the receipt of a response with a status of DONE. When an outlier was detected we noted in the associated capture data indicators such as "***TCP ACKed unseen segment***". This indicated that an acknowledgement of a message was received but the message itself was not in the capture. This can sometimes be the case because acknowledgements are smaller data payloads and have a better chance of being captured versus larger message payloads.

Also noted with outliers were indicators such as “***Previous segment not captured***”. This either meant that the packet was lost on the way (unlikely) or it got through to the receiver but the capture device (Wireshark or tcpdump) didn't record it. This is most likely the case. Here tcpdump was able to detect and flag the message inconsistencies but there was some small loss of data capture.

It should be noted that during baseline testing of the 2514, on at least one occasion, such a timeout was also noted. (Secondary Arm 12/05/2012)

It is therefore concluded that the duration outliers are a side effect of the very high rate messaging and capture requirements of this test case and do not represent an issue that can be attributed to the new controller itself.

### Command-Response Sequence Anomalies

The predominant successful message exchange with the controller was found to appear as follows in Figure 7

Command = Move Arm

Extratech M3514

Status = IN CMD Cmd

Status = DONE

OCD Analyzer

Figure 7

The Expected Message Exchange Sequence

On some occasions, within a typical pcap file, exceptions to this “contract” were noted. For instance, the occurrence of two DONE status messages was noted. Similarly, a DONE status after an IN CMD status could be found. These exceptions did not manifest as errors on the analyzer and it should be noted that this was seen occasionally, in the data, while running with the 2514 board also.

## Concurrent Truck Movement Test

### Description

This test sends a set of moves simultaneously to both the secondary and primary trucks. The moves are constructed to maximize the concurrent moving and slowing of both metering arms. This is done in order to “stress” the controller as it coordinates command messages to the arms. Among the move command sets are the most timeout sensitive moves that the analyzer supports.

### Test Steps

| **Step** | **Action** | **Expected Result** | **Actual Result** | **P / F /**  **I / NE** |
| --- | --- | --- | --- | --- |
|  | | | | |
|  | Boot up the analyzer and allow initialization. | Visual:  System Status Legend changes from ‘Initializing’ to ‘Ready’. | * As Expected |  |
|  | On the Emulation Page of the analyzer enable simulation of all subsystems except the Primary, Secondary, and Reference Metering subsystems. | Visual:  Check box Icon shows as simulated except for Primary, Secondary and Reference metering. | * As Expected |  |
|  | Cycle the Emulator log file with the following command  senddebug –w –f emulator | The current Emulator log in /oasis/workfiles/datalog/sw\_dev increments to the next highest numeric suffix | * As Expected |  |
|  | Prepare tcpdump for capture   * Enter ‘export SOCK=/srme’ at a QNX command shell prompt. * cd to the /tmp directory with ‘cd /tmp’ command. | NA | * As Expected |  |
|  | Launch the ‘tcpdump’ application with the following command line.  nice –n -10 /usr/local/service/tcpdump –n –s 1000 –w *‘yourFileName.pcap’*  Parameter Details:   * nice –n 10 , raises the execution process priority of tcpdump as it runs to 20. * -n, suppresses IP name resolution which is expensive cpu wise. * -s, sets the packet byte length to be captured per message * -w, commits the captured data to ‘pcap’ file for later analysis. | Visual:  The following appears at the command prompt.  SOCK=/srme  Number of instructions: 1  Size of struct bpf\_insn: 8  tcpdump: listening on en0 | * As Expected |  |
|  | Note content of Extratech\_concurrent\_moves.dep to be:  HEADER,extratech\_concurrent\_moves.dep,DEP\_TYPE,  SET,1,0,NO\_INSERT\_SCRIPT  OP,10,PrimMetTrkMvToSeal,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,20,SecMetTrkMvToDump,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,30,SecMetTrkMvDumpToVtip,20,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,40,PrimMetTrkMvSealToQtip,10,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE  OP,50,PrimMetTrkMvQtipToVtip,40,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE | NA | NA |  |
|  | Enable the Stop On Failure checkbox on the Scripting Page Interface. | Visual:  Check box shows as enabled. | * As Expected |  |
|  | Specify a repeat command count of 20000 on the Scripting Page interface. | NA | NA |  |
|  | Start execution of the **extratech\_concurrent\_moves.dep** script **and** quickly press the **‘?’** help button.  (This action bypasses the processing that is required to update the scripting interface page which was found to effect test results) | Visual:  Scripting page begins to show commands being sent and executed.  The Help Page of the analyzer is displayed on the monitor. | * As Expected |  |
| **Exit Steps** | | | | |
|  | When the script has completely executed all repetitions stop the tcpdump capture process by entering CTRL-C at the Qnx window where tcpdump was launched.   * Note number of packets dropped. | Visual**:**  \_\_packets received by filter  \_\_packets dropped by kernel  is displayed in command shell. | * As Expected |  |
|  | Open the OCD Capture Tool and Start “Capture” on each of the pcap files collected during the test. | As appropriate the ‘Port 29’ and Port31’ panes populate with command text details. | * As Expected |  |
|  | Select and copy all of the text data in each pane using the Ctrl-A, Ctrl-C actions. | Test is highlighted. | * As Expected |  |
|  | Open a new text document and name it similarly to the originating pcap source file, while differentiating for “primary” or “secondary” as is appropriate. | NA | NA |  |
|  | Use Ctrl-V to paste all of the text from the OCD Capture Tool panes into the respective files created in previous step. | Text is populated into the newly created text file. | * As Expected |  |
|  | Repeat above analysis steps for the other metering arm. | NA | NA |  |
|  | Select and **print** any conditions posted during execution of this test case (since the last reset). | | |  |
|  | Run the PCAP file analysis script on each of the OCD Packet Capture renderings for primary and secondary metering arms **xtra\_tech\_capture\_pcap.pl *‘yourFileName.txt’*** | | |  |
|  | Retain the output of the scripted analysis | | |  |
|  | Install the M3514 unit into the analyzer and repeat all steps of this test. | | |  |

## Concurrent Truck Movement - Test Results

### 2514 Concurrent Moves Command-Response Message Statistics – Primary Arm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| PrimaryQtip--PrimaryVtip | 20130123PrimParallel20000\_2514\_tcp20.txt | 20000 | 439.932 | 509.92 | 1.12 | 456.05 |
| PrimaryTipSeal--PrimaryQtip | 20130123PrimParallel20000\_2514\_tcp20.txt | 20000 | 132.98 | 215.97 | 1.14 | 199.26 |
| PrimaryVtip--PrimaryTipSeal | 20130123PrimParallel20000\_2514\_tcp20.txt | 20000 | 880.865 | 964.85 | 1.06 | 897.06 |

### 3514 Concurrent Moves Command-Response Message Statistics – Primary Arm (v2.1.21)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| PrimaryQtip--PrimaryVtip | 20130718PrimParallel20000\_3514\_2121\_tcp20.txt | 20000 | 323.951 | 582.91 | 5.54 | 460.77 |
| PrimaryTipSeal--PrimaryQtip | 20130718PrimParallel20000\_3514\_2121\_tcp20.txt | 20000 | 167.975 | 334.95 | 2.16 | 199.08 |
| PrimaryVtip--PrimaryTipSeal | 20130718PrimParallel20000\_3514\_2121\_tcp20.txt | 20000 | 804.877 | 929.86 | 1.21 | 896.83 |

### Concurrent Moves – 2514 vs. 3514 Command-Response Probability Density Plot Comparison – Primary Arm

| **Primary Arm 2514** | **Primary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimaryQtip--PrimaryVtip_dens.png |  |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimaryVtip--PrimaryTipSeal_dens.png |  |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimaryTipSeal--PrimaryQtip_dens.png |  |

### Concurrent Moves – 2514 vs. 3514 Command-Response Plot Comparison – Primary Arm

| **Primary 2514** | **Primary 3514** |
| --- | --- |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimaryQtip--PrimaryVtip.png |  |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimarySeal--PrimaryQtip.png |  |
| C:\WireSharkCaptures\20130123PrimParallel20000_2514_tcp20.txt_PrimaryVtip--PrimarySeal.png |  |

### 2514 Concurrent Moves Command-Response Message Statistics – Secondary Arm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| SecondaryDump--SecondaryVtip | 20130123SecParallel20000\_2514\_tcp20.txt | 20000 | 487.926 | 596.91 | 1.30 | 580.12 |
| SecondaryVtip--SecondaryDump | 20130123SecParallel20000\_2514\_tcp20.txt | 20000 | 1008.846 | 1156.82 | 1.41 | 1025.08 |

### 3514 Concurrent Moves Command-Response Message Statistics – Secondary Arm (v2.1.21)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| SecondaryDump--SecondaryVtip | 20130806SecParallel20000\_3514\_2121\_tcp20.txt | 20000 | 545.92 | 608.91 | 1.32 | 580.18 |
| SecondaryVtip--SecondaryDump | 20130806SecParallel20000\_3514\_2121\_tcp20.txt | 20000 | 1004.85 | 1060.84 | 1.25 | 1026.02 |

### Concurrent Moves – 2514 vs. 3514 Command-Response Probability Density Comparison – Secondary Arm

|  |  |
| --- | --- |
| **Secondary Arm 2514** | **Secondary Arm 3514** |
| C:\WireSharkCaptures\20130123SecParallel20000_2514_tcp20.txt_SecondaryVtip--SecondaryDump_dens.png | C:\WireSharkCaptures\20130806SecParallel20000_3514_2121_tcp20.txt_SecondaryVtip--SecondaryDump_dens.png |
| C:\WireSharkCaptures\20130123SecParallel20000_2514_tcp20.txt_SecondaryDump--SecondaryVtip_dens.png | C:\WireSharkCaptures\20130806SecParallel20000_3514_2121_tcp20.txt_SecondaryDump--SecondaryVtip_dens.png |

### Concurrent Moves – 2514 vs. 3514 Command-Response Plot Comparison – Secondary Arm

|  |  |
| --- | --- |
| **Secondary Arm 2514** | **Secondary Arm 3514** |
| C:\WireSharkCaptures\20130123SecParallel20000_2514_tcp20.txt_SecondaryDump--SecondaryVtip.png | C:\WireSharkCaptures\20130806SecParallel20000_3514_2121_tcp20.txt_SecondaryDump--SecondaryVtip.png |
| C:\WireSharkCaptures\20130123SecParallel20000_2514_tcp20.txt_SecondaryVtip--SecondaryDump.png | C:\WireSharkCaptures\20130806SecParallel20000_3514_2121_tcp20.txt_SecondaryVtip--SecondaryDump.png |

### Concurrent Moves - Move Timeouts

During this test, the move known as PrimarySealToQtip was operated on each test repetition. This move is specified to timeout at 225msec which is very close to the 200 msec that is required to perform the move under ideal circumstances. It was found during testing that this timeout was breached in approximately 1 of every 5000 PrimarySealToQtip moves. At the time the WireShark measurement strategy was being used. The issue was communicated to Extratech but they could not reproduce the issue on their test systems. It was decided to see if the timeout phenomena could be created when the network routing to the measurement PC was removed and the analyzer was connected to the controller directly as it is under normal operation. When this was done the timeouts could no longer be created. At that time it became beneficial to create the means to measure the messaging traffic via **“tcpdump”** instead of Wireshark.

When ‘tcpdump’ was used as the measurement technique the SealToQtip timeouts were **not reproducible**. Tcpdump measurement however now reflected a ‘trade off ‘interaction between the analyzers processes and the tcpdump measurement process itself. This is explainable because all processes were sharing the analyzers processor bandwidth.

This led to the eventual creation of a best practice ‘tcpdump with nicing’ command line which involved assessing the impact to the measurement statistics as various ‘nice –n –#’ combinations were explored. The most appropriate nice level was determined to be -10. This gave the tcpdump process an effective priority level of 20. The first 10 points of the 20 are what the analyzer allocates as a default to all command line process in the QNX environment.

## SalesShow\_All\_SaHa Movement Test

### Description

This test leverages an existing standard production script, **3600\_SalesShow\_All\_SaHa.dep**. This script was originally created in order to demonstrate the functioning of the metering robot arms in a manner that is very representative of a customer job. It includes moves to many uIA and uS stations and all internal SaHa tray positions. As such it is an ideal way to test and measure the performance and characteristics of the M3514 controller.

### Test Steps

| **Step** | **Action** | **Expected Result** | **Actual Result** | **P / F /**  **I / NE** |
| --- | --- | --- | --- | --- |
|  | | | | |
|  | Boot up the analyzer and allow initialization. | Visual:  System Status Legend changes from ‘Initializing’ to ‘Ready’. | * As Expected |  |
|  | On the Emulation Page of the analyzer enable simulation of all subsystems except the Primary, Secondary, and Reference Metering subsystems. | Visual:  Check box Icon shows as simulated except for Primary, Secondary and Reference metering. | * As Expected |  |
|  | Cycle the Emulator log file with the following command  senddebug –w –f emulator | The current Emulator log in /oasis/workfiles/datalog/sw\_dev increments to the next highest numeric suffix | * As Expected |  |
|  | Prepare tcpdump for capture   * Enter ‘export SOCK=/srme’ at a QNX command shell prompt. * cd to the /tmp directory with ‘cd /tmp’ command. | NA | * As Expected |  |
|  | Launch the ‘tcpdump’ application with the following command line.  nice –n -10 /usr/local/service/tcpdump –n –s 1000 –w *‘yourFileName.pcap’*  Parameter Details:   * nice –n 10 , raises the execution process priority of tcpdump as it runs to 20. * -n, suppresses IP name resolution which is expensive cpu wise. * -s, sets the packet byte length to be captured per message * -w, commits the captured data to ‘pcap’ file for later analysis. | Visual:  The following appears at the command prompt.  SOCK=/srme  Number of instructions: 1  Size of struct bpf\_insn: 8  tcpdump: listening on en0 | * As Expected |  |
|  | Boot up the analyzer and allow initialization. | Visual:  System Status Legend changes from ‘Initializing’ to ‘Ready’. | * As Expected |  |
|  | On the Emulation Page of the analyzer enable simulation of all subsystems except the Primary and Secondary Metering. | Visual  Check boxes shows as simulated except for primary and secondary metering. | * As Expected |  |
|  | Enable the Stop On Failure checkbox on the Scripting Page Interface. | Visual:  Check box shows as enabled. | * As Expected |  |
|  | Specify a repeat command count of **1000** on the Scripting Page interface. | NA | NA |  |
|  | Note content of 3600\_SalesShow\_All\_SaHa.dep to be as specified in Appendix B | | |  |
|  | Start execution of the **3600\_SalesShow\_All\_SaHa.dep** script **and** quickly press the **‘?’** help button. | Visual:  Both secondary and primary metering trucks begin initializing and moving.  The Help Page of the analyzer is displayed on the monitor. | * As Expected |  |
| **Exit Steps** | | | | |
|  | When the script has completely executed all repetitions, collocate all the accumulated ‘pcap” files to an appropriate media such as a USB flash drive. | NA | NA |  |
|  | Open the OCD Capture Tool and Start “Capture” on each of the pcap files collected during the test. | As appropriate the ‘Port 29’ and Port31’ panes populate with command text details. | * As Expected |  |
|  | Select and copy all of the text data in each pane using the Ctrl-A, Ctrl-C actions. | Test is highlighted. | * As Expected |  |
|  | Open a new text document and name it similarly to the originating pcap source file, while differentiating for “primary” or “secondary” as is appropriate. | NA | NA |  |
|  | Use Ctrl-V to paste all of the text from the OCD Capture Tool panes into the respective files created in previous step. | Text is populated into the newly created text file. | * As Expected |  |
|  | Repeat above analysis steps for the other metering arm. | NA | NA |  |
|  | Select and **print** any conditions posted during execution of this test case (since the last reset). | | |  |
|  | Run the PCAP file analysis script on each of the OCD Packet Capture renderings for primary and secondary metering arms **xtra\_tech\_capture\_pcap.pl ‘ OCD Packet Capture file name’** | | |  |
|  | Retain the output of the scripted analysis | | |  |
|  | Install the M3514 unit into the analyzer and repeat all steps of this test. | | |  |

## SalesShow\_All\_SaHa Movement - Test Results

### SalesShow\_All\_SaHa – 2514 Message Statistics - Primary Arm

| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| --- | --- | --- | --- | --- | --- | --- |
| PrimaryCmTl—PrimarySeal | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 933.857 | 965.85 | 1.1 | 949.33 |
| PrimaryDump—PrimaryHome | 2012123PrimShow1000\_2514\_tcp20.txt | 1000 | 1227.813 | 1265.81 | 1.58 | 1242.42 |
| PrimaryHome—PrimaryDump | 2012123PrimShow1000\_2514\_tcp20.txt | 1000 | 1222.813 | 1247.81 | 1.28 | 1239.35 |
| PrimaryHome—PrimaryHome | 2012123PrimShow1000\_2514\_tcp20.txt | 1000 | 0 | 32.99 | 1.16 | 12.16 |
| PrimaryHome—PrimaryVtip | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 441.932 | 472.93 | 0.89 | 458.22 |
| PrimaryQtip—PrimaryHome | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 1084.834 | 1140.83 | 2.59 | 1101.26 |
| PrimarySaha—PrimaryHome | 2012123PrimShow1000\_2514\_tcp20.txt | 1000 | 0 | 33.99 | 1.27 | 11.98 |
| PrimarySaha—PrimarySaha | 2012123PrimShow1000\_2514\_tcp20.txt | 1000 | 0 | 25 | 1 | 11.08 |
| PrimarySeal—PrimaryQtip | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 184.972 | 216.97 | 1.15 | 200.57 |
| PrimaryStat—PrimaryCmTl | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 988.848 | 1019.84 | 1.07 | 1005.63 |
| PrimaryVtip—PrimaryStat | 2012123PrimShow1000\_2514\_tcp20.txt | 3000 | 274.958 | 306.95 | 1.15 | 291.36 |

### SalesShow\_ All\_Saha – 3514 Message Statistics - Primary Arm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| PrimaryCmTl—PrimarySeal | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 918.859 | 970.85 | 2.05 | 945.42 |
| PrimaryDump—PrimaryHome | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 1000 | 1221.813 | 1272.81 | 2.09 | 1241.95 |
| PrimaryHome—PrimaryDump | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 1000 | 1222.813 | 1261.81 | 1.51 | 1240.68 |
| PrimaryHome—PrimaryHome | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 999 | 0 | 41.99 | 2.18 | 14.17 |
| PrimaryHome—PrimaryVtip | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 435.933 | 482.93 | 1.81 | 458.54 |
| PrimaryQtip—PrimaryHome | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 1068.837 | 1161.82 | 4.02 | 1101.01 |
| PrimarySaha—PrimaryHome | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 999 | 0 | 32.99 | 1.27 | 12.61 |
| PrimarySaha—PrimarySaha | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 999 | 0 | 39.99 | 1.86 | 12.39 |
| PrimaryStat—PrimaryCmTl | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 985.849 | 1114.83 | 2.52 | 1006.43 |
| PrimaryTipSeal—PrimaryQtip | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 171.974 | 224.97 | 2.11 | 201.18 |
| PrimaryVtip—PrimaryStat | 20130719PrimShow1000\_3514\_2121\_tcp20.txt | 3000 | 267.959 | 320.95 | 2.25 | 292.07 |

### SalesShow\_All\_SaHa – 2514 vs. 3514 Command-Response Probability Density Plot Comparison – Primary Arm

| **Primary Arm 2514** | **Primary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryVtip_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryVtip_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryHome_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryHome_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryDump_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryDump_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryDump--PrimaryHome_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryDump--PrimaryHome_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryCmTl--PrimarySeal_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryCmTl--PrimaryTipSeal_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryVtip--PrimaryStat_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryVtip--PrimaryStat_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryStat--PrimaryCmTl_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryStat--PrimaryCmTl_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySeal--PrimaryQtip_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryTipSeal--PrimaryQtip_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySaha--PrimarySaha_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimarySaha--PrimarySaha_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySaha--PrimaryHome_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimarySaha--PrimaryHome_dens.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryQtip--PrimaryHome_dens.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryQtip--PrimaryHome_dens.png |

### SalesShow\_All\_SaHa – 2514 vs. 3514 Command-Response Plot Comparisons – Primary Arm

| **Primary Arm 2514** | **Primary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryCmTl--PrimarySeal.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryCmTl--PrimaryTipSeal.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryDump--PrimaryHome.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryDump--PrimaryHome.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryDump.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryDump.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryHome.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryHome.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryHome--PrimaryVtip.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryHome--PrimaryVtip.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryQtip--PrimaryHome.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryQtip--PrimaryHome.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySaha--PrimaryHome.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimarySaha--PrimaryHome.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySaha--PrimarySaha.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimarySaha--PrimarySaha.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimarySeal--PrimaryQtip.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryTipSeal--PrimaryQtip.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryStat--PrimaryCmTl.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryStat--PrimaryCmTl.png |
| C:\WireSharkCaptures\20121223PrimShow1000_2514_tcp20.txt_PrimaryVtip--PrimaryStat.png | C:\WireSharkCaptures\20130719PrimShow1000_3514_2121_tcp20.txt_PrimaryVtip--PrimaryStat.png |

### SalesShow\_ All\_SaHa - 2514 Command-Response Message Statistics - Secondary Arm

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| SecondaryDump—SecondaryDump | 20121223SecShow1000\_2514\_tcp20.txt | 2000 | 0 | 28 | 1.19 | 13.11 |
| SecondaryDump—SecondaryHome | 20121223SecShow1000\_2514\_tcp20.txt | 2000 | 980.85 | 1065.84 | 26.77 | 1016 |
| SecondaryDump—SecondaryVtip | 20121223SecShow1000\_2514\_tcp20.txt | 2000 | 544.917 | 575.91 | 3.25 | 564.02 |
| SecondaryHome—SecondaryDump | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 1042.84 | 1066.84 | 1.09 | 1050.46 |
| SecondaryHome—SecondaryVtip | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 460.93 | 485.93 | 1.36 | 478.28 |
| SecondaryIncMid—SecondarySeal | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 759.884 | 791.88 | 1.33 | 776.26 |
| SecondaryIncOtr—SecondaryIncOtr | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 0 | 28 | 1.34 | 9.01 |
| SecondaryIncOtr--SecondarySaHa3 | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 920.859 | 951.85 | 1.44 | 937.71 |
| SecondaryIncOtr--SecondarySaha1 | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 908.861 | 936.86 | 0.9 | 924.82 |
| SecondaryIncOtr—SecondarySeal | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 766.882 | 798.88 | 1.28 | 781.86 |
| SecondarySaHa2—SecondaryIncOtr | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 767.882 | 799.88 | 1.42 | 785.84 |
| SecondarySaHa3—SecondarySeal | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 830.873 | 857.87 | 1.12 | 841.58 |
| SecondarySaha0—SecondaryIncOtr | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 994.848 | 1023.84 | 1.41 | 1010.12 |
| SecondarySaha1—SecondaryIncOtr | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 969.852 | 994.85 | 1.01 | 986.37 |
| SecondarySeal—SecondarySealQtip | 20121223SecShow1000\_2514\_tcp20.txt | 3000 | 180.972 | 212.97 | 1.25 | 196.59 |
| SecondarySealQtip—SecondaryDump | 20121223SecShow1000\_2514\_tcp20.txt | 3000 | 735.887 | 768.88 | 1.21 | 752.54 |
| SecondaryStat—SecondaryIncMid | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 955.853 | 981.85 | 2.19 | 967.24 |
| SecondaryVtip--SecondarySaHa2 | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 1037.841 | 1065.84 | 0.89 | 1052.63 |
| SecondaryVtip--SecondarySaha0 | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 1135.826 | 1155.82 | 1.01 | 1152.18 |
| SecondaryVtip—SecondaryStat | 20121223SecShow1000\_2514\_tcp20.txt | 1000 | 1169.821 | 1183.82 | 0.64 | 1177.44 |

### SalesShow\_All\_SaHa - 3514 Command-Response Message Statistics - Secondary Arm

| **Move Name** | **File Name** | **Iterations** | **Min (msec)** | **Max (msec)** | **STD** | **Mean (msec)** |
| --- | --- | --- | --- | --- | --- | --- |
| SecondaryDump--SecondaryDump | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1999 | 0 | 133.98 | 3.38 | 14.6 |
| SecondaryDump--SecondaryHome | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1999 | 899.863 | 1075.84 | 27.26 | 1017.38 |
| SecondaryDump--SecondaryVtip | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 2000 | 524.92 | 594.91 | 4.53 | 564.9 |
| SecondaryHome--SecondaryDump | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 1027.842 | 1077.84 | 2.24 | 1051.85 |
| SecondaryHome--SecondaryVtip | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 451.931 | 506.92 | 2.3 | 479.07 |
| SecondaryIncMid--SecondarySeal | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 766.883 | 797.88 | 3.64 | 778.06 |
| SecondaryIncOtr--SecondaryIncOtr | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 0 | 40.99 | 1.95 | 10.8 |
| SecondaryIncOtr--SecondarySaHa1 | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 903.861 | 945.86 | 1.87 | 925.57 |
| SecondaryIncOtr--SecondarySaHa3 | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 917.859 | 958.85 | 2.03 | 937.88 |
| SecondaryIncOtr--SecondarySeal | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 755.884 | 818.88 | 3.6 | 784.48 |
| SecondarySaHa0--SecondaryIncOtr | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 979.85 | 1029.84 | 2.4 | 1008.45 |
| SecondarySaHa1--SecondaryIncOtr | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 960.852 | 1021.84 | 2.26 | 984.91 |
| SecondarySaHa2--SecondaryIncOtr | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 757.884 | 807.88 | 2 | 786.54 |
| SecondarySeal--SecondarySealQtip | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 3000 | 167.974 | 235.96 | 2.6 | 197.5 |
| SecondarySealQtip--SecondaryDump | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 3000 | 726.889 | 774.88 | 1.92 | 752.86 |
| SecondaryStat--SecondaryIncMid | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 953.854 | 980.85 | 1.29 | 966.02 |
| SecondaryVtip--SecondarySaHa0 | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 1120.829 | 1189.82 | 2.55 | 1152.3 |
| SecondaryVtip--SecondarySaHa2 | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 1029.842 | 1068.84 | 1.63 | 1053.39 |
| SecondaryVtip--SecondaryStat | 20130719SecShow1000\_3514\_2121\_tcp20.txt | 1000 | 1152.824 | 1207.82 | 2.08 | 1177.72 |

### SalesShow\_All\_SaHa – 2514 To 3514 Command-Response Probability Density Plot Comparisons – Secondary Arm

| **Secondary Arm 2514** | **Secondary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryVtip--SecondaryStat_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryVtip--SecondaryStat_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryVtip--SecondarySaHa2_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryVtip--SecondarySaHa2_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryVtip--SecondarySaHa0_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryVtip--SecondarySaHa0_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryStat--SecondaryIncMid_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryStat--SecondaryIncMid_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySeal--SecondarySealQtip_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySeal--SecondarySealQtip_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySealQtip--SecondaryDump_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySealQtip--SecondaryDump_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa3--SecondarySeal_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa3--SecondarySeal_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa2--SecondaryIncOtr_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa2--SecondaryIncOtr_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa1--SecondaryIncOtr_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa1--SecondaryIncOtr_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa0--SecondaryIncOtr_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa0--SecondaryIncOtr_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySeal_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySeal_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySaHa3_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySaHa3_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySaHa1_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySaHa1_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondaryIncOtr_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondaryIncOtr_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncMid--SecondarySeal_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncMid--SecondarySeal_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryHome--SecondaryVtip_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryHome--SecondaryVtip_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryHome--SecondaryDump_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryHome--SecondaryDump_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryVtip_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryVtip_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryHome_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryHome_dens.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryDump_dens.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryDump_dens.png |

### SalesShow\_All\_SaHa – 2514 To 3514 Command-Response Plot Comparisons – Secondary Arm

| **Secondary Arm 2514** | **Secondary Arm 3514** |
| --- | --- |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryDump.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryDump.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryHome.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryHome.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryDump--SecondaryVtip.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryDump--SecondaryVtip.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryHome--SecondaryDump.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryHome--SecondaryDump.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryHome--SecondaryVtip.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryHome--SecondaryVtip.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncMid--SecondarySeal.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncMid--SecondarySeal.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondaryIncOtr.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondaryIncOtr.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySaha1.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySaHa1.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySaHa3.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySaHa3.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryIncOtr--SecondarySeal.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryIncOtr--SecondarySeal.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaha0--SecondaryIncOtr.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa0--SecondaryIncOtr.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaha1--SecondaryIncOtr.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa1--SecondaryIncOtr.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa2--SecondaryIncOtr.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa2--SecondaryIncOtr.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySaHa3--SecondarySeal.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySaHa3--SecondarySeal.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySeal--SecondarySealQtip.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondarySeal--SecondarySealQtip.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondarySealQtip--SecondaryDump.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryVtip--SecondaryStat.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryStat--SecondaryIncMid.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryStat--SecondaryIncMid.png |
| C:\WireSharkCaptures\20121223SecShow1000_2514_tcp20.txt_SecondaryVtip--SecondarySaha0.png | C:\WireSharkCaptures\20130719SecShow1000_3514_2121_tcp20.txt_SecondaryVtip--SecondarySaHa0.png |

# MEASUREMENT ENVIRONMENTS

The message communications measurement strategy for this test matured during the course of the testing. Initially the **Emulator Log files** were considered as a starting point to extract messaging. As results were gathered it was found that using the emulator log files didn’t sufficiently isolate the messaging at the IP interface level. It permitted possible tainting of data by processing that was not related to the controller itself. To make a purer interface level measurement the use of the Windows based **Wireshark Protocol Analyzer** software was pursued. A small network hub was placed between the analyzer and the controller such that Wireshark could capture messages going to and from the controller. This technique was useful but it was detected that occasionally some small move movements would timeout given the small amount of time longer it was requiring to route the messages through the switch and then to the controller and then back. Some of the smaller movements have very low timeout overhead and would occasionally breach the analyzers scheduler time threshold logic. A third measurement optimization was to create a **QNX based tcpdump** executable that would allow on board analyzer measurement without the need for any external networking such as that required for Wireshark measurement for instance.

Finally, it was found that the tcpdump measurement process had to be elevated in priority to allow the best results for data capture. Tcpdump was not a perfect measurement environment but offered the best alternative in addition to the flexibility of being able to measure without the need for additional networked measurement hardware.

# CONCLUSIONS

The ability to observe the behavior of the new controller in the context of this engineering testing consisted of executing movement commands and extracting the message data moving to and from the controller board. As testing progressed the measurement strategy evolved to the point where it could reliably capture and statistically quantify subtle effects in the board’s performance as we received changes in the manufacturer’s board hardware and firmware.

Included in the report are comprehensive results portraying raw capture of command-response duration for each movement command executed. Additionally, to highlight differences in behavior, probability density plot comparisons are included. These plots provide the ability to quickly grasp and contrast the nature and magnitude of performance differences between the new and legacy controllers.

These data have shown that the new controller communicates very much like its predecessor. While there are differences in the command messaging statistics they are not significant enough to affect the controllers operation in the analyzer. The differences are essentially invisible at the analyzer system level.

# APPENDIX A – DATa analysis workflow

## Background

The Extratech M3514 Motion Controller board is the successor to the M2514. The communications with the M3514 is still Ethernet based. System logging pertaining to this interface is well supported in the Emulator log capability. It was found however, that as the analyzer executes, performing and logging its many concurrently executing tasks, that using the Emulator logging for measuring the Extratech messaging wasn’t ideal. Subsequently, it was decided to capture the messaging at the interface level. This provided a truer representation of the messaging performance to and from the board.

To perform this capture a software package known as the ***Wireshark Network Protocol Analyzer***was used. It has the ability to capture all the TCP/IP traffic traveling between the OCD analyzer and the Extratech board.

## Wireshark Measurement Workflow

To do this a PC running the Wireshark software is networked to the analyzer via a small Ethernet switch or hub. See Figure 1.

4 Port Switch



OCD Analyzer

Extratech M3514

\*.pcap files

OCD Packet Capture Tool

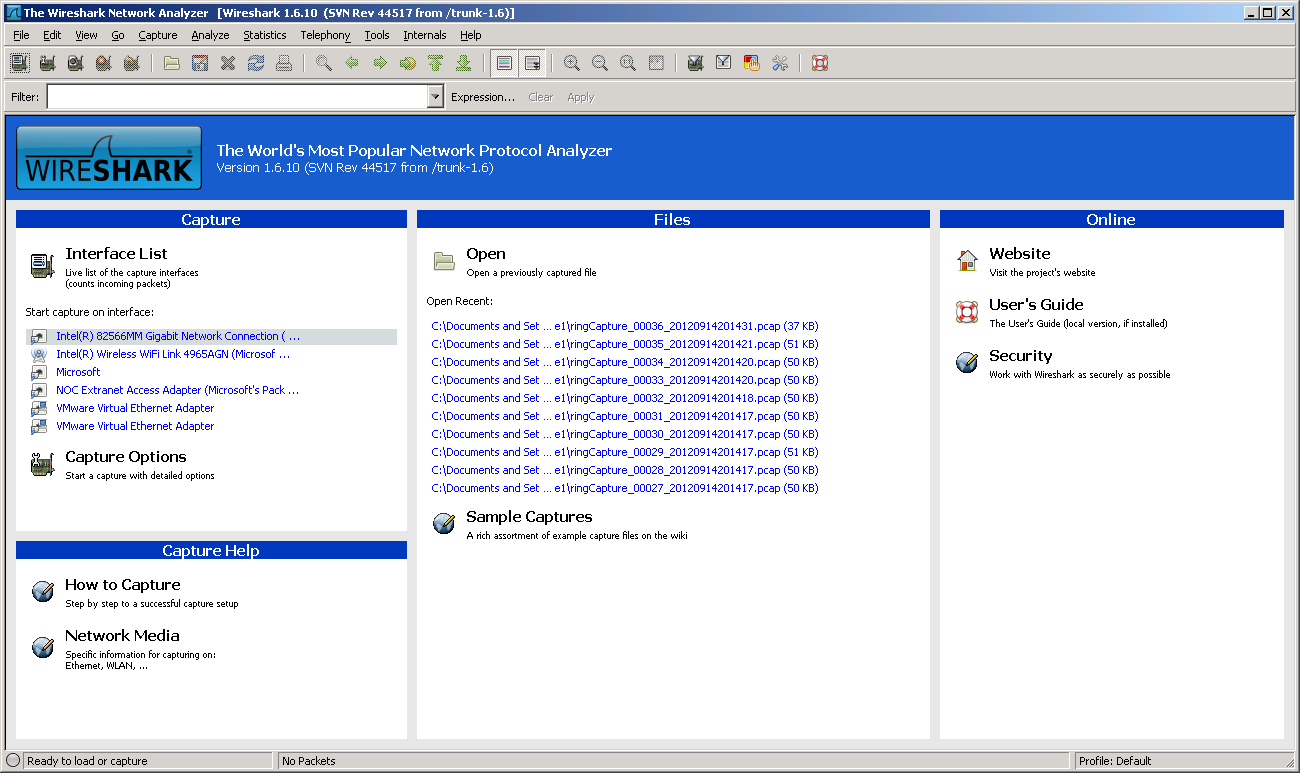
\*.txt files

PC running Wireshark

**Figure 1A**

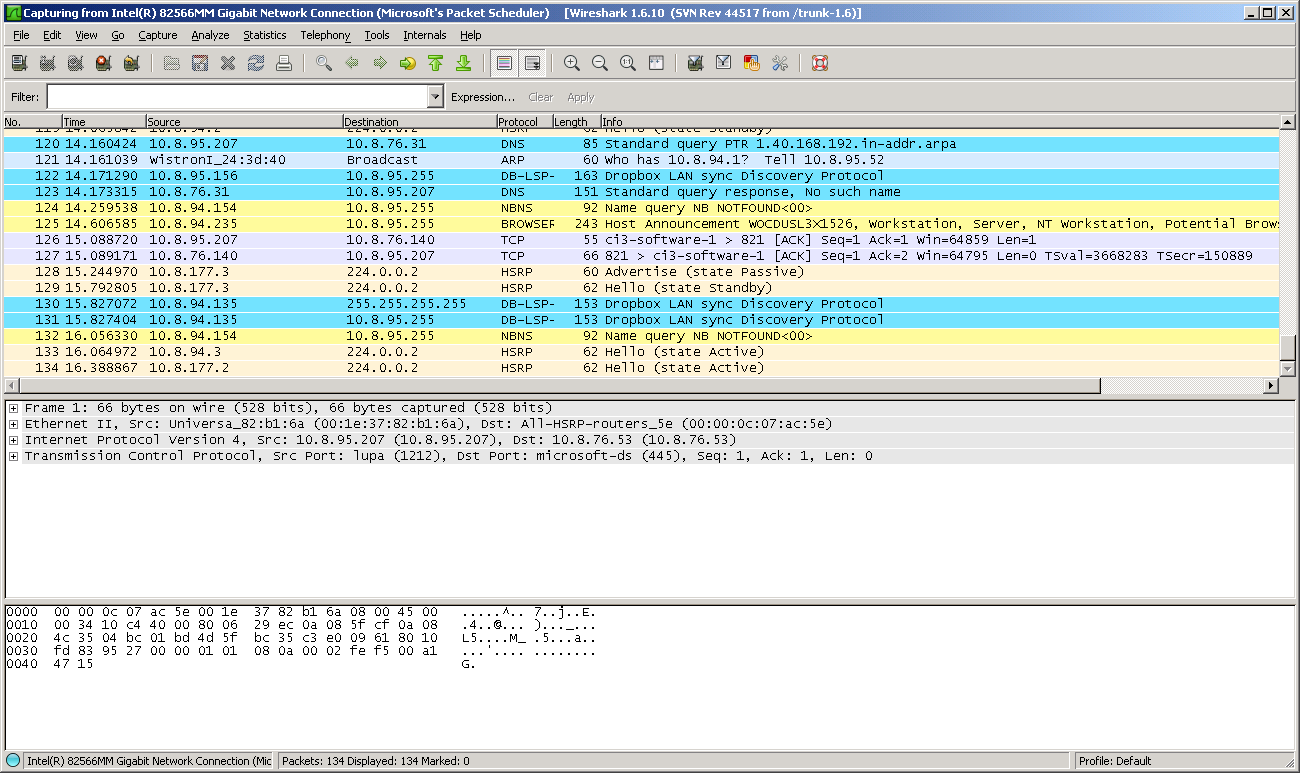
The Wireshark software is then configured to capture on the PCs network card which can now see all the traffic coming into and out of the switch.

1. Connect PC with the switch per Figure 1A. This PC has Wireshark Network Protocol Analyzer application installed.
2. Launch Wireshark application and specify collection on its Ethernet interface card. See bolded item in **Interface List** section of interface in Figure 2A.



**Figure 2A**

1. This will launch an interface that displays what is being captured on the Ethernet interface. See Figure 3.

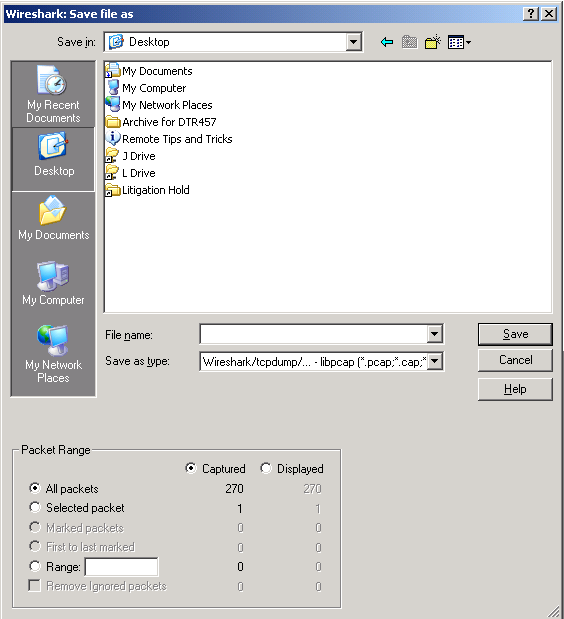


**Figure 3A**

1. Once traffic is noted as being captured as expressed by messages accumulating in a time wise manner in the middle portion of the above interface, you can initiate your test script or assay job on the analyzer.
2. When the analyzer script or job has finished running you can stop the capture via the

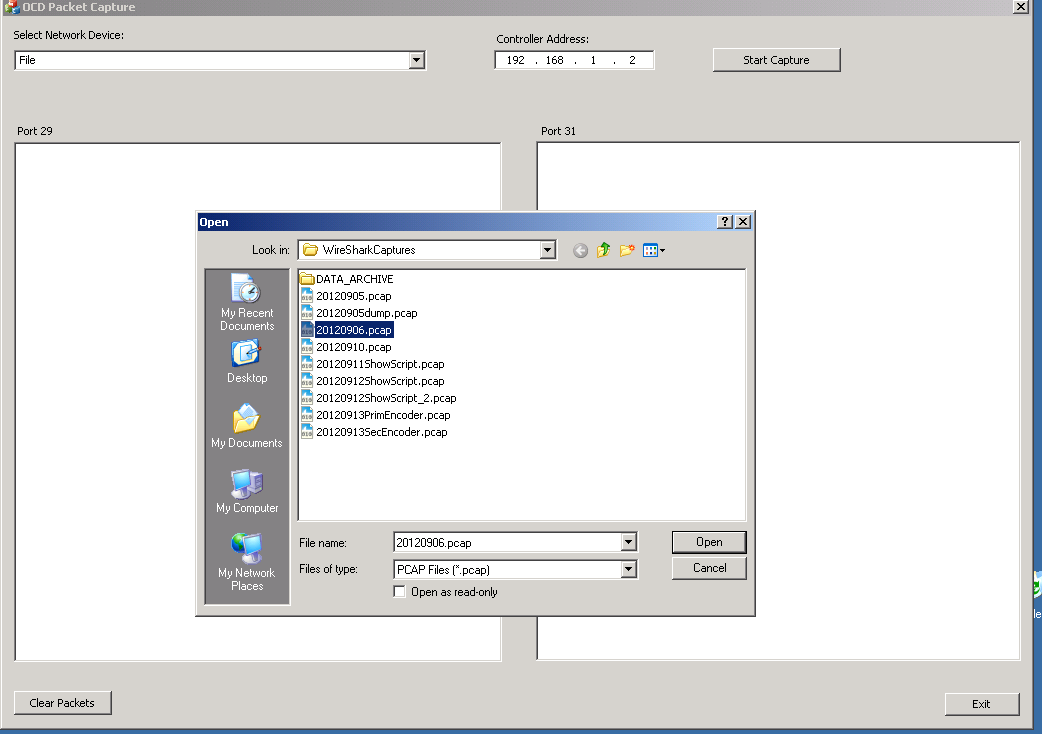
**‘Capture->Stop’** menu bar item**.**

1. Now save the capture to the hard drive of the PC using the File-> SaveAs menu bar item as show in Figure 4. Be sure to specify the file type as ‘libpcap’ \*.pcap.



**Figure 4A**

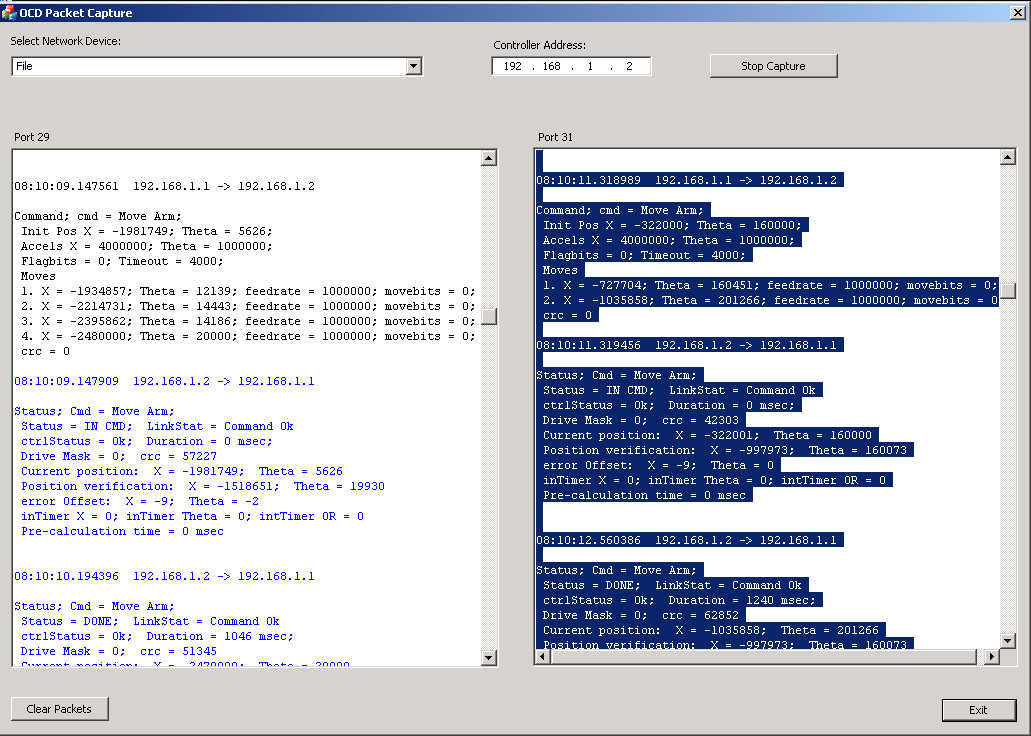
1. With the ‘pcap’ file now saved to a file we can proceed to opening the ‘pcap’ file into the OCD Packet Capture utility. See Figure 5A. This utility, which has been provided to us by Extratech, can interpret the recently saved ‘pcap’ file and present the messages in a formatted textual form.



**Figure 5A**

1. To open the file Select Network Device as ‘File’ and press the ‘Start Capture’ button on the interface.
2. Navigate to where the file is located.
3. Select the file as type ‘\*.pcap’ and press the ‘Open’ button.

1. The details of the messaging that was captured are displayed in the two text areas in the interface. See Figure 6. Port 31 on the right is for the Primary truck. Port 29 on the left is for the Secondary Truck.



**Figure 6A**

1. To get access to this data in its textual form you can perform a ‘Ctrl A’ -Select All and a Ctrl C - Copy as depicted also in Figure 6A.
2. Next you can Ctrl V – Paste the now selected data into a text document.
3. Perform this for both the Primary (Port 31 side) and Secondary (Port 29 side) Truck data.
4. The data can now be imported or parsed using Microsoft Excel or scripting (See *4.3 Data Extraction*) to generate statistical assessments of the command and response behaviors of the various interface messages.

## TCPDump Measurement Workflow

Extratech M3514

\*.pcap files

PC Running OCD Packet Capture Tool

\*.txt files

OCD Analyzer With ‘*tcpdump’* Installed

Statistics via text file parsing.

Tcpdump would be launched with a command such as

## Scripted Data Extraction

Using the output file(s) of the OCD Packet Capture Tool gives visibility to the details of the messaging but requires a specialized approach to extracting data. A script was created to parse the files and identify the messages as known OCD movement commands versus their ‘X, and Theta’ command equivalents. This script:

1. Parses OCD Packet capture files to identify commands being sent to and responses being received from the Extratech.
2. Converts the X, Theta Commands to their OCD command equivalents.
3. Accumulates command-response times for each message type.
4. Performs statistical calculations of MAX, MIN, STDDEV, and MEAN on these accumulated results.
5. Outputs statistics data in a simple textual format.

## Testing the Data Extraction

In order to confirm the mathematical results of the scripted parsing, a portion of an actual capture file was imported into an Excel spreadsheet. Statistical results from that spreadsheet were then compared to the results obtained when the script was used to parse the same capture file.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **MIN** | **MAX** | **STDDEV** | **MEAN** |
| **Excel** | 196.784 | 197.604 | 0.282 | 197.0502 |
| **Script** | 196.784 | 197.60 | 0.28 | 197.05 |

# APPENDIX B – SalesShow\_ALL\_SAHA

HEADER, 3600\_SalesShow\_All\_SaHa.dep, DEP\_TYPE, NO\_DESCRIPTION

SET, 1, 0, NO\_INSERT\_SCRIPT

OP,10,SaHaSTATShtlToLoad,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,20,SaHaSTATShtlToMet,10,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,50,SaHaConvInit,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,55,SaHaConvIndex,50,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,60,SaHaTrays03Init,55,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,90,VtipRingInit,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,100,VtipSupBlowerInit,90,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,110,VtipSupHopperCarouselInit,100,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,120,VtipSupRailVibratorInit,110,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,130,VtipSupEscapementInit,120,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,140,VtipSupEnableStaging,130,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,141,SecMetZInitNoLearnNoRaise,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,151,SecMetTrkInit,141,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,161,SecMetTrkMvToDump,151,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,162,SecMetZInit,161,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,171,SecMetDumpTipUninit,162,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,181,SecMetPumpInit,171,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,183,SecMetTrkMvStepsY,181,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,184,PrimMetTrkMvStepsY,183,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,191,SecMetTrkMvToHome,181,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,201,PrimMetZInitNoLearnNoRaise,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,211,PrimMetTrkInit,191,201,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,212,PrimMetZInit,211,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,221,PrimMetTrkMvToDump,212,0,0,0,0,0,0,0,0,0,ENABLED,POS=PRIM\_FAR\_DUMP&

OP,231,PrimMetDumpTipUninit,221,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,241,PrimMetPumpInit,231,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,251,PrimMetTrkMvToHome,241,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,259,MwrmZInitNoLearnNoRaise,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,260,MwrmThetaInitToHome,259,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

SET, 2, 0, NO\_INSERT\_SCRIPT

OP,44,SecMetTrkMvToVtip,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,45,SaHaConvIndex,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,46,SecMetTrkMvToSaHa,45,0,0,0,0,0,0,0,0,0,ENABLED,POS=SAHA\_0&

OP,47,LclDelay500Ms,46,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,48,SecMetTrkMvToMwpcIncOtr,47,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,49,SecMetTrkMvToSaHa,48,0,0,0,0,0,0,0,0,0,ENABLED,POS=SAHA\_1&

OP,50,LclDelay500Ms,49,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,51,SecMetTrkMvToMwpcIncOtr,50,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,52,LclDelay500Ms,51,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,53,SecMetTrkMvMwpcIncToSeal,52,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,54,SecMetTrkMvSealToQtip,53,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,55,SecMetTrkMvToDump,54,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,56,MwrmThetaMvToTipPickup,55,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,57,LclDelay500Ms,56,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,58,MwrmThetaMvToInrReag,57,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,59,LclDelay500Ms,58,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,60,MwrmThetaMvToOtrInc,59,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,61,LclDelay500Ms,60,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,62,PrimMetTrkMvToVtip,61,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,63,MwrmThetaMvToTipDump,62,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,64,PrimMetTrkMvVtipToStat,63,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,65,MwrmThetaMvToHome,64,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,66,LclDelay500Ms,65,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,68,PrimMetTrkMvToCmTl,66,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,69,MwrmThetaMvToTipPickup,68,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,70,LclDelay250Ms,69,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,71,PrimMetTrkMvToSeal,70,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,72,MwrmThetaMvToOtrReag,71,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,73,LclDelay500Ms,72,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,74,PrimMetTrkMvToQtip,73,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,75,MwrmThetaMvToOtrInc,74,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,76,LclDelay500Ms,75,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,77,PrimMetTrkMvToHome,76,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,78,MwrmThetaMvToTipDump,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,79,MwrmThetaMvToHome,78,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,80,MwpcPrimWashMetZMvToWellTop,79,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,81,MwpcPrimWashMetZMvToHome,80,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,82,MwpcAuxWashMetZMvToWellTop,81,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,83,MwpcAuxWashMetZMvToHome,82,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,84,MwpcSrMetArmZMvToWellTop,81,83,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,85,MwpcSrMetArmZMvToHome,84,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

SET, 3, 0, NO\_INSERT\_SCRIPT

OP,44,SecMetTrkMvToVtip,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,46,SecMetTrkMvToStat,44,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,47,LclDelay500Ms,46,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,48,SecMetTrkMvToMwpcIncMid,47,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,49,LclDelay500Ms,48,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,50,SecMetTrkMvMwpcIncToSeal,49,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,51,SecMetTrkMvSealToQtip,50,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,52,SecMetTrkMvToDump,51,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,53,MwrmThetaMvToTipPickup,52,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,54,LclDelay500Ms,53,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,55,MwrmThetaMvToInrReag,54,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,56,LclDelay500Ms,55,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,57,MwrmThetaMvToMidInc,56,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,58,LclDelay500Ms,57,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,59,PrimMetTrkMvToVtip,58,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,60,MwrmThetaMvToTipDump,59,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,61,PrimMetTrkMvVtipToStat,60,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,62,MwrmThetaMvToHome,61,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,63,LclDelay500Ms,62,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,64,PrimMetTrkMvToCmTl,63,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,66,MwrmThetaMvToTipPickup,64,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,67,LclDelay250Ms,66,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,68,PrimMetTrkMvToSeal,67,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,69,MwrmThetaMvToOtrReag,68,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,70,LclDelay500Ms,69,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,71,PrimMetTrkMvToQtip,70,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,72,MwrmThetaMvToMidInc,71,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,73,LclDelay500Ms,72,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,74,PrimMetTrkMvToHome,73,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,75,MwrmThetaMvToTipDump,74,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,77,MwrmThetaMvToHome,75,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,80,MwpcPrimWashMetZMvToWellTop,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,81,MwpcPrimWashMetZMvToHome,80,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,82,MwpcAuxWashMetZMvToWellTop,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,83,MwpcAuxWashMetZMvToHome,82,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,84,MwpcSrMetArmZMvToWellTop,81,83,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,85,MwpcSrMetArmZMvToHome,84,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

SET,4,0,NO\_INSERT\_SCRIPT

OP,44,SecMetTrkMvToVtip,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,45,SaHaConvIndex,0,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,46,SecMetTrkMvToSaHa,45,0,0,0,0,0,0,0,0,0,ENABLED,POS=SAHA\_2&

OP,47,LclDelay500Ms,46,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,48,SecMetTrkMvToMwpcIncOtr,47,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,49,SecMetTrkMvToSaHa,48,0,0,0,0,0,0,0,0,0,ENABLED,POS=SAHA\_3&

OP,50,LclDelay500Ms,46,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,51,SecMetTrkMvToMwpcIncOtr,50,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,52,LclDelay500Ms,51,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,53,SecMetTrkMvMwpcIncToSeal,52,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,54,SecMetTrkMvSealToQtip,53,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,55,SecMetTrkMvToDump,54,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,56,MwrmThetaMvToTipPickup,55,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,57,LclDelay500Ms,56,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,58,MwrmThetaMvToInrReag,57,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,59,LclDelay500Ms,58,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,60,MwrmThetaMvToOtrInc,59,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,61,LclDelay500Ms,60,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,62,PrimMetTrkMvToVtip,61,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,63,MwrmThetaMvToTipDump,62,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,64,PrimMetTrkMvVtipToStat,63,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,65,MwrmThetaMvToHome,64,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,66,LclDelay500Ms,65,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,67,PrimMetTrkMvToCmTl,66,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,68,MwrmThetaMvToTipPickup,67,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,69,LclDelay250Ms,68,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,70,PrimMetTrkMvToSeal,69,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,71,MwrmThetaMvToOtrReag,70,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,72,LclDelay500Ms,71,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,73,PrimMetTrkMvToQtip,72,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,74,MwrmThetaMvToOtrInc,73,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,75,LclDelay500Ms,74,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,76,PrimMetTrkMvToHome,75,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,77,MwrmThetaMvToTipDump,76,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,78,MwrmThetaMvToHome,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,80,MwpcPrimWashMetZMvToWellTop,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,81,MwpcPrimWashMetZMvToHome,80,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,82,MwpcAuxWashMetZMvToWellTop,77,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,83,MwpcAuxWashMetZMvToHome,82,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,84,MwpcSrMetArmZMvToWellTop,81,83,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE

OP,85,MwpcSrMetArmZMvToHome,84,0,0,0,0,0,0,0,0,0,ENABLED,NO\_OVERRIDE