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Tevatron Beam Position Monitor Front End Software User's Guide

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Abstract

This document is geared to help past developers remember what they did, future developers to know how to build and distribute the software, commissioners to understand how to configure a system, and maintainers to help diagnose software problems. Contact tev-bpm-daqsw@fnal.gov for comments/updates.

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1 Overview

This document is intended to be a guide for the front end users of the Tevatron BPM system. It is meant to help

- developers build system and verify the builds
- commissioners now how install and commission boards and crates
- maintainers diagnose problems

2 Commissioning

2.1 Crate Controller Configuration

The crate controller in a TBPM house is a Motorola 2400 running vxWorks. Node names are selected with the convention of tbpm<id> where <id> is a two character identifier of location in the ring, e.g., tbpma3.

2.1.1 Registration

General instructions can be found at:

http://www-bd.fnal.gov/controls/micro_p/rom_install.html.

IP addresses must be obtained through the Acceleration Division networking group. Before requesting an IP address, you must know the Fermilab ID and Ethernet MAC address of the board. Once that has been identified, register the board at:

http://www-bdnew.fnal.gov/Netwebrequests/net-connection.asp

Once the IP address is obtained, each host will also need an ACNET address, which consists of the above node name plus an assigned trunk and node id. Contact Brian Hendricks to procure a trunk and node id.

2.1.2 Boot Parameters

Boards are currently running VxWorks v5.5. Each crate controller should have the following boot parameters:

```
boot device          : dc0
processor number     : 0
host name            : fecode-bd
file name            : vxworks_boot/kernel/mv2400-512MB/vxWorks-a32-512
```

```
inet on ethernet (e) : 131.225.<xxx>.<yyy>:ffffff00
inet on backplane (b):
host inet (h)        : 131.225.121.145
gateway inet (g)     : 131.225.<xxx>.200
user (u)             : vxworks_boot
ftp password (pw) (blank = use rsh):
flags (f)            : 0x0
target name (tn)     : <nodename>_0x<trunkid><nodeid>
startup script (s)   : vxworks_boot/fe/tpm/tpmstartup
other (o)            :
```

Where <xxx>, <yyy>, <trunkid>, and <nodeid> are obtained in the registration step above.

Note that this is a custom kernel – it specifically adds the gateway node to the route table with the following command:

```
routeAdd "0.0.0.0", "131.225.<xxx>.200"
```

This is done so that all houses can use the same startup script.

2.1.3 Startup Script

The Tevatron BPM software is designed to detect EchoTek board addresses at run time, so all BPMs can share the same startup script. The startup script pointed to in the boot parameters currently contains:

```
#-----------------------------------------------------------------------
#--- General initialization
#-----------------------------------------------------------------------
shellPromptSet( "Booting incomplete->" )
taskPrioritySet( taskIdFigure( "tExcTask" ), 1 )
taskPrioritySet( taskIdFigure( "tLogTask" ), 250 )
# get target name in 6 characters
targetName=malloc(20)
gethostname(targetName,20)
targetName[6]=0
#routeAdd ("239.128.1.1","131.225.126.200")
#-----------------------------------------------------------------------
# mount NFS file systems - 1217, 5143 is user vxworks_boot group bdmicrop
#-----------------------------------------------------------------------
topLevel="vxworks_write/fe/tbpm"
outputDir=malloc (strlen(topLevel) + strlen(targetName))
strcpy(outputDir,topLevel)
strcat(outputDir,targetName)
nfsMount( "fecode-bd", "vxworks_boot/module/PPC604", "/controls"  )
nfsMount( "fecode-bd", "vxworks_boot/fe", "/fe"  )
nfsMount( "fecode-bd", outputDir, "/write" )
nfsAuthUnixSet( "fecode-bd", 1217, 5143, 0, 0 )

# TEMPORARY
nfsMount( "fecode-bd", "vxworks_write/fe/fccts1", "/write1")

#-----------------------------------------------------------------------
#--- Load MOOC and ACNET services
# THESE LOCATIONS NEEED TO CHANGE!!!!!
#-----------------------------------------------------------------------
# class library to initialize the techno box
ld (1, 1, "vxworks_boot/fe/rbpm/controls/pmcclassLib_mv2400-lastest.o");
# mooc

# 5.4 libraries
#ld < /controls/libpmctrig-latest.o
#ld < /controls/libssm-2.3.o
#ld < /controls/acnet-1.021.o
```

```
#ld < /controls/libmooc-3.6.o

# 5.5 libraries
ld < /controls/libpmctrig-2.13.o
ld < /controls/libssm-2.4.o
ld < /controls/acnet-1.026.o
ld < /controls/libmooc-3.7.o
#ld < /controls/libmooc-3.6.o
#ld < /controls/libmooc-latest.o

ACNET_SSM_avail=0

# what is this?
ld < /fe/rfiinst/devlib/VW_54/MVME2434/libmiscutil.out
# bpm stuff
ld < /fe/echotek_tbpm/libechotek_tbpm.out
# Warren's ECSG-1R3ADC-PMC I/O drivers
ld < /fe/rfiinst/lib/VW_54/MVME2434/libecsg1r3adcfermi.out
ld < /fe/tbpm/libculite.out
ld < /fe/gbpm/libgbpm.out
ld < /fe/tbpm/libtbpm.out


#------------------------------------------------------------------------
#--- Start things
# THESE LOCATIONS NEEED TO CHANGE!!!!!
#------------------------------------------------------------------------
# set the downloadable file
set_rbf_file ("vxworks_boot/fe/rbpm/controls/pmcucd.rbf");
# download the techno box; 0 is the instance or slot
pmcucd_start(0)
# set the addresses for ucd
pmcucd_set_adr (get_alteramem(0))
pmcucd_set_madr (get_alteramem(0)+0x1000)

initssc (0,calloc(0x10000,1))
MoocNew()

# void ecsg( int fref, int n, int p, int r, int b, int a, int c, int d );
# request 73.5 MHz and get 73.444444 MHz
#ecsg( 53104696, 504, 8, 40, 63, 0, 3, 3)

cd( "/fe/tbpm/ini" )
ecdr814gcReadSetup("53MHzNarrowBand.ini",    0);
ecdr814gcReadSetup("53MHzEnsemble.ini",      1);
ecdr814gcReadSetup("53MHzEnsemble-debug.ini",2);
#ecdr814gcReadSetup("rawDmaD64.ini",          3);
#ecdr814gcReadSetup("rawDmaD64.ini",          4);
#ecdr814gcReadSetup("rawDmaD64.ini",          5);
#ecdr814gcReadSetup("rawDmaD64.ini",          6);
ecdr814gcReadSetup("rawDmaD64.ini",          7);
ecdr814gcReadSetup("rawDmaD64Long.ini",      8);
ecdr814gcReadSetup("count.ini",             19);
ecdr814gcShowSetupAll();

# FilterSetIndex( 0, 23 )
# FilterSetIndex( 2, 23 )

#$$$MoocAlarmScan( 1 )
MoocDeviceDownLoad( 0 )

#------------------------------------------------------------------------
#--- Start trace buffer
#------------------------------------------------------------------------
# Clock prescale value
*0xfef80020=0x63ce0001
traceInit 100000,10,0xfef80100
traceMode 1
traceGlobalOn 0,25,0
traceOff 1,0,31,0

#traceMode 2
#traceGlobalOn 0,31,2
#traceOff 1,0,31,2
traceGlobalOff 17,17,0
traceGlobalOff 19,19,0
traceGlobalOff 20,20,0
```

```
#------------------------------------------------------------------------
#--- Finish up
#------------------------------------------------------------------------
prompt = malloc(30)
strcpy (prompt,targetName)
strcat (prompt,":tbpm> ")
shellPromptSet ( prompt )
free(prompt)
free(targetName)
free(outputDir)

traceOthersOff

#ecdr814gcInstall("ECDR-GC814-
FV2",0x9000,0x19000000,0,"/config/rcvr_stratix_dual_14b.rbf",4)
#ecdr814gcDemo_count( "/write/Count_Test_0x9000", 1, 0, 0, 0, 100 )

TBPMSetPriority ("ucd60hz", 40);
TBPMSetPriority ("tExcTask", 40);
TBPMSetPriority ("tWdbTask", 40);

# Change the priority of the tShell task
TBPMChangeShellPriority (50);

#traceGlobalOff 12,12,0
#traceGlobalOff 16,16,0
traceGlobalOff 15,16,0

bpmStart 500

a_alarms_enable ()
a_reload_data ()
```

2.1.4 Changing the vxWorks startup script for all houses

The Tevatron BPM houses share a common startup script that resides in nova.fnal.gov:/fecodde-bd/vxworks_boot/fe/tbpm; however, it is maintained in the tbpm CVS module. If the startup scripts for all houses need to change, please follow the build instructions in subsequent section.

Note that we are loading fixed versions of the ACNET/MOOC libraries. These versions need to match the versions of ACNET/MOOC header files that are compiled into both gbpm and tbpm. When reloading a different version of mooc, you will also need to edit the _acnetheaders.h file in both packages and recompile (see build instructions below).

2.1.5 Changing the vxWorks startup script for a particular house

While debugging problems at a specific house, there will sometimes be a need to have a startup script that is specific to that particular house. Since this is only a temporary state, there is no need to track the changes. Simply:

```
nova> cd /fecode-bd/vxworks_boot/fe/tbpm
nova> cp tbpmstartup temp_startup
```

Edit the temp_startup script as necessary, being sure to change the vxworks boot parameters to use this script. Please remember to reset the boot parameters to use the canonical script when done.

2.2 Echotek Board Configuration

The current Echotek driver supports up to 20 different setup files that are specified in the startup script. Different configurations are used based on the mode of operation of the software. See document #860 for a description of the operational modes. In a particular mode, all Echotek modules in a house will use the same setup file, i.e. there is no provision for allowing the boards to be configured differently. By convention, these setup files have an extension of `.ini`.

Additionally, each board setup file contains another pointer to a file that contains information regarding a channel setup. Unless you really know what you're doing, all channels should be configured with the same file. By convention, the channel setup files have an extension of `.ch`. By convention, the `<abc>.ini` file will read in a channel file named `<abc>.ch`.

The driver reads the associated files from the current working directory, so it's important to cd to this directory in the VxWorks startup script.

Operational Mode	Setup file index
Closed orbit	0
Turn X Turn	1
First injection	1
Raw ADC	7
Closed orbit debug	2

Table 1 – Echotek configuration files used for the different modes of operation

2.3 Timing Module Configuration

The timing board is described in detail in the document #1065. The base address defined for the timing board is 0x2000. If the board is set to any other address the software will not be able to contact it.

3 Developing

There are 3 packages that constitute the Tevatron BPM software, they are:

- gbpm – generic bpm classes
- tbpm – bpm implementation specific to the tevatron
- echotek_tbpm – underlying echotek driver

3.1 Build Environment

The Tevatron BPM software uses the RFI build methodology. Please refer to Beams Document #1271 for a description of the tools and, for first time users, how to configure your account on nova.fnal.gov. Following these instructions please set your work group to rfiinst. All code is compiled on nova.fnal.gov.

3.2 Build Instructions

All packages are built in a similar fashion

```
      nova-> cd ~/esd/src            # only do once; create if needed
      nova-> cvs checkout gbpm       # only do this once
      nova-> setup gbpm
      nova-> cvs update -d           # cvs checkout gbpm if first time
      nova-> make clean
      nova-> make
      nova-> make development        # put in development location
      nova-> make test               # put in test location
      nova-> make production         # put in production location (will
                                     # be installed at next reboot)
Library locations are:

nova.fnal.gov:/fecode-bd/vxworks_boot/fe/gpm/devgpm.out  # development
nova.fnal.gov:/fecode-bd/vxworks_boot/fe/gpm/testgpm.out # test
nova.fnal.gov:/fecode-bd/vxworks_boot/fe/gpm/libgpm.out  # production
```

There is a similar set of commands to build tbpm and echotek_tbpm.

The Targets

3.3 Unit Tests

The three tbpm packages have unit or module tests associated with them. The unit tests are designed to verify the core functionality of the packages. The tests should be used only when adding new functionality to the software in order to check whether new code has affected existing functions. The gbpm and tbpm packages use an underlying software package called culite.

The culite product is based on CppUnitLite, developed by Michael Feathers (http://c2.com/cgi/wiki?CppUnitLite). The source code is available from the Computing Division repository: cvsuser@cdcvs.fnal.gov:/cvs/cd. Version v1_0 is installed on nova on `/fecode-bd/vxworks_boot/fe/culite`.

3.3.1 GBPM Unit Tests

The GBPM unit tests can be executed by running the command `GBPMUnitTest`, which should generate the following output:

```
fccts0:tbpm-dev> GBPMUnitTest
traceLevel array at 0x1da1ba50, traceTid array at 0x1da1bcd8
sizeof(ENTRY_T)=32
callocing 32000 bytes
traceCircQueBegin=0x1d2561f0, traceCircQueEnd=0x1d25deef (last byte of
allocation)
cfreeing
*** Starting Unit Tests ***
1) DataEntry
There were no test failures
2) TestDataEntry
There were no test failures
3) Packer
There were no test failures
4) TestPacker
There were no test failures
5) Event
There were no test failures
6) EventListener
There were no test failures
7) EventGenerator
There were no test failures
8) InterruptEventGenerator
There were no test failures
9) HardwareInterruptEventGenerator
There were no test failures
10) TimeEventGenerator
There were no test failures
11) AuxTimeEventGenerator
There were no test failures
12) TCLKEventGenerator
There were no test failures
13) AlarmGenerator
There were no test failures
14) DataAcquisitionTask
There were no test failures
15) DataBuffer
There were no test failures
16) CircularDataBuffer
There were no test failures
17) TestControl
There were no test failures
18) TestControlTask
There were no test failures
19) AlarmTask
There were no test failures
20) StateChangeEventGenerator
Please set V:PING to 5 or 10
Failure: "Listener didn't receive ping event in time" line 77 in
StateChangeEventGeneratorUnitTest.cpp
Failure: "For succeeding in this unit test you must set V:PING to 5 or
10" line 78 in StateChangeEventGeneratorUnitTest.cpp
Failure: "Listener didn't receive ping event in time" line 82 in
StateChangeEventGeneratorUnitTest.cpp
Failure: "For succeeding in this unit test you must set V:PING to 5 or
10" line 83 in StateChangeEventGeneratorUnitTest.cpp
There were 4 failures
21) ConfigStateChangeListener
There were no test failures
22) ConfigStateChangeTask
There were no test failures
23) FTPClass
There were no test failures
*** Unit Tests End ***
```

```
value = 2543116 = 0x26ce0c = cout
```

Each test (from 1 to 23) can be executed individually. The entry point is the name of the test followed by `UnitTest` (e.g. `AlarmTaskUnitTest`).

The `StateChangeEventGenerator` unit test expects the state device `V:PING` to be changed to 10 after the test is started. It waits for 5 seconds. If the state device does not change within this period the test fails. In order to change the value of `V:PING` one should use the ACL script window available through the ACNET pages. The command '`set V:PING=10`' should be issued.

3.3.2 TBPM Unit Tests

```
fccts0:tbpm-dev> TBPMUnitTest
traceLevel array at 0x1da1ba50, traceTid array at 0x1da1bcd8
sizeof(ENTRY_T)=32
traceCircQueBegin=0x1d254420, traceCircQueEnd=0x1d25c11f (last byte of
allocation)
*** Starting TBPMUnit Tests ***
1) TBPMClosedOrbitPacker
There were no test failures
2) TBPMTurnByTurnPacker
There were no test failures
3) TBPMDiagnosticSystem
There were no test failures
4) EchoTekPool
*** TBPMUnit Tests End ***
value = 2543116 = 0x26ce0c = cout
```

3.3.3 Echotek Driver Unit Test

The Echotek driver uses a different testing structure. The command `ecdr814gcUnitTest` can be used to test the driver. The command has two arguments. The first is the address of the Echotek card to be tested, followed by the setup file index.

The addresses used for the Tevatron BPM project always start at `0x8000`, increasing by `0x1000`. The Echotek board closer to the processor board always has the lowest address. Neighbor boards to the right have higher base addresses.

The setup file index available can be showed by using the command `ecdr814gcShowSetupAll`:

```
fccts0:tbpm-dev> ecdr814gcShowSetupAll

0: 53MHzNarrowBand.ini
1: 53MHzEnsemble.ini
2: 53MHzEnsemble-debug.ini
3: 53MHzEnsembleSafe.ini
7: rawDmaD64.ini
8: rawDmaD64Long.ini
18: diagnostic_test.ini
19: count.inivalue = 0 = 0x0
```

The setup index 19 contains the most basic setup for testing an Echotek board. It sets the board to a simple counting mode and the unit test checks if the data generated is correct. The following is a sample output from the unit test:

```
fccts0:tbpm-dev> ecdr814gcUnitTest 0x8000,19
0x1da441e0 (tShell): Test board(s)  at:  0x8000 (0 means all), using
setup #19 ( count.ini )
0x1da441e0 (tShell): Candiate board at:  0x8000,  local address:  0xfbff8000
0x1da441e0 (tShell): Program the gray chips ...
0x1da441e0 (tShell): Set up the daq conditions
0x1da441e0 (tShell): Reset the board(s)
0x1da441e0 (tShell): Do a software trigger
0x1da441e0 (tShell): Read out the board(s) ...
value = 32 = 0x20 = ' '
fccts0:tbpm-dev> 0x1da441e0 (tShell): Check the counting sequences ...
0x1da441e0 (tShell): Done with the checking
```

4 Diagnostics

Once the system is up and running, how do you start analyzing problems? There are many diagnostic tools available. Choosing the right one to most expediently analyze the problem is a combination of experience and instinct. The following sections describe various diagnostic information that are available in the tbpm software.

4.1 Software Statistics

The bpm software internally keeps structures that one can peek at through the vxworks shell. The bpmHelp command will list the most current set of commands that are available:

```
tbpma0:tbpm> bpmHelp
BPMHelp> help
list - display list of available BPM commands.
help - print this help.
quit - exit BPM help.
BPMHelp> list
Commands available:
        bpmAlarm                bpmChangeBool
        bpmChangeChannel        bpmChangeConfig
        bpmChangeFloat          bpmClearAlarm
        bpmClearBuffers         bpmDumpAll
        bpmDumpBuffer           bpmMode
        bpmPeek                 bpmPeekPos
        bpmStart                bpmStartTest
        bpmShow                 bpmShowAlarms
        bpmShowBuffers          bpmShowChannels
        bpmShowConfig           bpmShowGenerators
        bpmShowModes            bpmShowQueues
        bpmShowStates           bpmShowTasks
        bpmShowTCLK             bpmPeekDiag
        bpmTBTEvent             bpmTCLK
BPMHelp> quit
value = 0 = 0x0
tbpma0:tbpm>
```

The following are the description for each of the commands available through the bpmHelp command and a sample output where applicable.

4.1.1 bpmAlarm

```
BPMHelp> bpmAlarm
-------------------------------------------------
bpmAlarm (alarmNumber, alarmMessage)
Description:
        Generate an alarm that is processed by the system
Parameters:
        alarmNumber: integer number for alarm
        alarmMessage: character string with message
-------------------------------------------------
```

The `bpmAlarm` command should be used for development only.

4.1.2 bpmChangeBool

```
BPMHelp> bpmChangeBool
-------------------------------------------------
bpmChangeBool (index, value)
Description:
        Assign a new value to the boolean variable at the given index
Parameters:
        index: entry number in the config manager to be changed
        value: boolean value to be assigned (0 or 1)
-------------------------------------------------
```

This command can be used to change any booleans shown by the `bpmShowConfig` command. There are only a few boolean variables defined in the system, all of them used for development and debugging purposes.

```
+-------- Booleans ----------------------------------+
| 20    - USE_TEST_SOURCE              false
| 21    - DIAGNOSTIC_MODE              false
| 22    - CHECK_PHASE                  false
| 23    - USE_CALIBRATION              false
+-------------   End of configuration   -------------+
```

4.1.3 bpmChangeChannel

```
BPMHelp> bpmChangeChannel
-------------------------------------------------
bpmChangeChannel (bpm, type, on/off)
Description:
        Enable or disable the readout of a particular proton or pbar channel
Parameters:
        bpm: bpm index (0 - 11), -1 to change all bpms
        type: 0 for proton, 1 for pbar and -1 for both
        on/off: 0 to turn channel off, 1 to turn it on
-------------------------------------------------
```

For more information check the `bpmShowChannel` command section.

Be careful when using this command. You may disable a bpm channel by mistake.

4.1.4 bpmChangeConfig

```
BPMHelp> bpmChangeConfig
-------------------------------------------------
bpmChangeConfig (index, value)
Description:
        Assign a new value to the integer variable at the given index
Parameters:
        index: entry number in the config manager to be changed
        value: integer value to be assigned
-------------------------------------------------
```

This command can be used to change any integers shown by the `bpmShowConfig` command.

Be careful when using this command. You may change by mistake important system parameters.

4.1.5 bpmChangeFloat

```
BPMHelp> bpmChangeFloat
-------------------------------------------------
bpmChangeFloat (index, value)
Description:
        Assign a new value to the float variable at the given index
Parameters:
        index: entry number in the config manager to be changed
        value: float value to be assigned
-------------------------------------------------
```

This command can be used to change any floats shown by the `bpmShowConfig` command. There are only a few float variables defined in the system. They are used for defining thresholds, default values and parameters.

```
+--------  Floats -------------------------------------+
| 20    - PROTON_INTENSITY_THRESHOLD    10
| 21    - PBAR_INTENSITY_THRESHOLD      20
| 22    - LOW_INTENSITY_POSITION        999
| 23    - BPM_SCALE_FACTOR              26
| 24    - SAFE_MODE_VARIATION           0.1
```

4.1.6 bpmClearAlarm

```
BPMHelp> bpmClearAlarm
-------------------------------------------------
bpmClearAlarm (alarmNumber)
Description:
        Clear the specified alarm
Parameters:
        alarmNumber: alarm to be cleared
-------------------------------------------------
```

4.1.7 bpmClearBuffers

```
BPMHelp> bpmClearBuffers
-------------------------------------------------
bpmClearBuffers ()
Description:
        Clear all buffers in the system
-------------------------------------------------
```

All buffers in the system are cleared with this command. Pointers are reset and data is zeroed.

4.1.8 bpmDumpAll

```
BPMHelp> bpmDumpAll
-------------------------------------------------
bpmDumpAll (buffer)
Description:
        Display all contents of the buffer for all bpms. The position/intensities and I/Q
pairs are shown
Parameters:
        buffer:
                fast abort (11)
                slow abort (12)
                profile (13)
                display (14)
                user TCLK (15)
                turn-by-turn (16)
                injection (17)
                injection closed orbit (18)
                diagnostic (19)
                closed orbit (20)
                safe injection (21)
-------------------------------------------------
```

The buffer index starts at 11 instead of 0. Lower buffer indexes are reserved for internal use and tests.

Data from all BPMs for the specified buffer is written to the standard output. The output can be redirected to a file. This command is an alternative for ACNET when reading data from the front-ends. The following example shows how to read all fast abort data for all front-end BPMs:

```
tbpma0:tbpm> bpmDumpAll 11 > /write1/fastAbort-A0.data
value = 0 = 0x0
tbpma0:tbpm>
```

The output generated has the following pattern:

```
### BPM 0
1010>[-0.845604, 115.784][-9.48365, 58.5636] - [-57,-18] [-56,1] [-34,-21] [-15,-11]
1011>[-0.864243, 115.444][-9.58456, 59.1785] - [-49,34] [-33,45] [-38,14] [-18,5]
1012>[-0.744931, 114.862][-9.68906, 59.8979] - [-3,59] [14,54] [-13,39] [-8,17]
1013>[-0.883092, 116.123][-10.0692, 58.1158] - [30,-52] [11,-55] [29,-28] [14,-11]
1014>[-0.803378, 116.031][-9.91739, 58.1995] - [-21,-56] [-35,-44] [-4,-40] [0,-18]
…
### BPM 3
778>[7.72163, 172.731][9.01028, 34.9162] - [-17,71] [-27,96] [7,-12] [1,-21]
779>[7.70948, 174.039][9.41197, 34.8618] - [44,59] [58,82] [-4,-13] [-16,-14]
780>[7.7781, 173.306][9.35311, 33.2237] - [73,3] [100,7] [-12,-5] [-20,3]
```

```
781>[7.82088, 173.499][10.0281, 33.1212] - [48,-55] [68,-74] [-11,6] [-10,18]
782>[7.67408, 174.288][9.73124, 34.7426] - [-67,31] [-93,38] [13,-3] [17,-13]
```

The first number (e.g. `1011>`) can be ignored. It is the entry number within the buffer. The following numbers are the [proton position, proton intensity][anti-proton position, anti-proton intensity]. The raw I and Q values are printed after the dash. The first two [I,Q] pairs are from the proton channels and the last two are from the anti-proton channels.

Even though the front-end may have only a few BPMs (e.g. A0 has 4), the system allocates buffers for the maximum of 12 BPMs. Values for the non-existing BPMs are still printed out with the `bpmDumpAll` command, they will be all zeros.

Please check section 4.1.17 for potential problems regarding this command.

4.1.9 bpmDumpBuffer

```
BPMHelp> bpmDumpBuffer
-----------------------------------------------------
bpmDumpBuffer (bpm, buffer)
Description:
        Display all contents of the buffer for a given bpm. The position/intensities and
I/Q pairs are shown
Parameters:
        bpm: 0 through 11
        buffer:
                fast abort (11)
                slow abort (12)
                profile (13)
                display (14)
                user TCLK (15)
                turn-by-turn (16)
                injection (17)
                injection closed orbit (18)
                diagnostic (19)
                closed orbit (20)
                safe injection (21)
-----------------------------------------------------
```

This command alows the user to dump the contents of a given buffer for a given BPM. The BPM index always starts at 0.

Please check section 4.1.17 for potential problems regarding this command.

4.1.10 bpmMode

```
BPMHelp> bpmMode
-----------------------------------------------------
bpmMode (mode, turns)
Description:
        Change system the mode of operation
Parameters:
        mode: 0 for displaying list of modes
        turns: number of turns if in turn-by-turn mode
```

```
--------------------------------------------------
```

The bpmMode command can be used to force the system to enter a specific mode of operation. The system changes mode automatically according to TCLKs received.

☞ If the system is not in the expected mode of operation, e.g. in turn-by-turn or abort mode when it should be in the closed orbit mode, one can use the command 'bpmMode 10' to force the front-end to get back to the closed orbit mode.

4.1.11 bpmPeek

```
BPMHelp> bpmPeek
--------------------------------------------------
bpmPeek (bpm, buffer)
Description:
        Show the latest entry for a selected buffer
Parameters:
        bpm: 0 through 11
        buffer:
                fast abort (11)
                slow abort (12)
                profile (13)
                display (14)
                user TCLK (15)
                turn-by-turn (16)
                injection (17)
                injection closed orbit (18)
                diagnostic (19)
                closed orbit (20)
                safe injection (21)
```

The bpmPeek command can be used to check the most recent data from any of the system buffers. If no parameters are passed to the command, the most recent value from the first bpm on the closed orbit buffer (index 20) is displayed. The following is an example of a bpmPeek command.

```
tbpma0:tbpm> bpmPeek
========= BPM 0 [1023] ====
Status: 0x0
Proton position=5.164508 intensity=3918.397461
Pbar position=3.024627 intensity=2622.326904
I/Q Pairs: [-1362 781] [-1557 1758] [310 807] [299 505]
Turn Timestamp: MON SEP 19 11:20:54 2005
BPM Timestamp: 0x0000 0x0499 0x7ab9 0x0f8f
==========================
```

The status shows the intensity for the BPM is above the predefined threshold. The first bit represents the status of the proton channels and the second bit is the status of the anti-proton channels. The intensity threshold defined for protons and anti-protons are available through the bpmShowConfig command.

The next two lines show the calculated positions and intensities for proton and anti-proton channels, followed by the raw I and Q values for the two proton channels and the two anti-proton channels.

There are two timestamps displayed. The first (`Turn Timestamp`) is a course time of the day timestamp. The `BPM Timestamp` is a counter from the timing board, which is reset on every injection (BSYNC event 0x7C) and incremented at 106 MHz.

Please check section 4.1.17 for potential problems regarding this command.

4.1.12 bpmPeekPos

```
BPMHelp> bpmPeekPos
-------------------------------------------------
bpmPeekPos (bpm, buffer, position, format)
Description:
        Show element at specified location
Parameters:
        bpm: 0 through 11
        buffer:
                fast abort (11)
                slow abort (12)
                profile (13)
                display (14)
                user TCLK (15)
                turn-by-turn (16)
                injection (17)
                injection closed orbit (18)
                diagnostic (19)
                closed orbit (20)
                safe injection (21)
        position: element index in buffer (starting at 0)
        format: 0 (proton/pbar) - 1 (proton) - 2 (pbar)
-------------------------------------------------
```

The `bpmPeekPos` command is very similar to `bpmPeek`. However it allows the user to specify a position within the buffer. The first position is always zero and the last one is the buffer size minus one. The following example shows the entry number 500 of the fast abort buffer. An explanation of each field displayed is available in the previous command description.

```
tbpma0:tbpm> bpmPeekPos 0,11,500
========= BPM 0 [500] ====
Status: 0x0
Proton position=4.962633 intensity=3758.565430
Pbar position=3.048932 intensity=2361.975586
I/Q Pairs: [-237 1502] [377 2206] [717 299] [497 115]
Turn Timestamp: MON SEP 19 14:12:14 2005
BPM Timestamp: 0x0000 0x0597 0xaf92 0x2e0f
=========================
```

4.1.13 bpmStart

```
BPMHelp> bpmStart
-------------------------------------------------
bpmStart (rate, source, useTCLK, bsyncBase)
Description:
        Start up the TBPM system
Parameters:
        rate: closed orbit rate (in Hz)
        source: 0 (EchoTek) - 1 (TestEchoTek)
        useTCLK: 0 (enable) - 1 (disable)
        bsyncBase: BSYNC decoder base address
```

```
-------------------------------------------------
```

The `bpmStart` command is invoked by the production startup script. When using the development startup script the user should use this command to start the system. Usually the ACNET/MOOC processes are already started by the script.

If no parameters are specified to the command the system is started with the closed orbit rate set to 50 Hz. For starting it at 500 Hz the first parameter should be specified. The next three parameters should be used for development and debugging only. Source defines whether the Echotek boards are used or data are generated by software (TestEchoTek); useTCLK enables or disables the decoding of TCLK signals; and bsyncBase defines the base address of the timing board.

4.1.14 bpmStartTest

```
BPMHelp> bpmStartTest
-------------------------------------------------
bpmStartTest (rate)
Description:
        Start the TBPM system using no hardware
Parameters:
        rate: closed orbit rate (in Hz)
-------------------------------------------------
```

This command used for development and debugging only. It is used instead of the regular `bpmStart` command. The system is started up without configuring the Echotek boards and the timing hardware.

4.1.15 bpmShow

```
BPMHelp> bpmShow
-------------------------------------------------
bpmShow ()
Description:
        Display general system information
-------------------------------------------------
```

The `bpmShow` command displays general information about the system. A typical output of this command consists of three parts. The first shows the current mode of operation (for all available modes use the command `bpmMode` without arguments), the state (usually the same as the mode), the closed orbit frequency, status of the diagnostics (on or off) and the versions of the GBPM and TBPM libraries.

If the mode of operation shown by `bpmShow` is not in the expected mode of operation, e.g. in turn-by-turn or abort mode when it should be in the closed orbit mode, one can use the command '`bpmMode 10`' to force the front-end to get back to the closed orbit mode.

The second part of the report contains information regarding the Echotek boards and their configuration. The number of boards is shows, followed by the current burst count (1 for

closed orbit mode and 8192 for turn-by-turn mode), number of triggers, samples to be skipped and channel pair delays. The versions of the driver as well as the FPGA code are displayed. The following fields show information about calibration. Currently the upper portion (Survey offsets used (house)) is being used, but the system is expected to start using the data shown on the "Calibration Data" section. That calibration data is read from a database and pushed down to the front-ends.

The last part contains information about the timing system (please refer to document 1065 for more details about the timing system).

☞ If the system is not taking data, e.g. the values on Fast Time Plots are stuck on the same value, please use the `bpmShow` command and check if the mode of operation is correct of if there is some missing signal reported by the timing system report, e.g. `53MHz: not present`.

```
tbpma0:tbpm> bpmShow
TBPM system started on THU SEP 08 10:37:14 2005
        Mode:   10 (CLOSED ORBIT)
        State:  10
        Freq:   500 Hz
        Diag:   off
        GBPM version: v1_37
        TBPM version: v1_61
# Hit enter to continue or 'q'>
EchoTekPool information:
        Boards: 2
        Burst:  1
        Trig:   1
        Skip:   0
        Delays: 4 4 4 4
                6 6 6 6
        Driver version: v1_6
        FPGA version:   2000007
        Survey offsets used (a0):
        0, -0.4, 0.8, 3.7
Calibration Data:
BPM     Scale   Surv.   Fud(p)  Fud(a)  T(p)    T(a)    K(p)    K(a)
0       26      0       0       0       0.89060 1.00046 0       0
1       26      -0.4    0       0       1.02001 0.95634 0       0
2       26      0.8     0       0       1.03338 0.94923 0       0
3       26      3.7     0       0       1.01676 0.95797 0       0
# Hit enter to continue or 'q'>
Timing Signal Generator information:
        Acquisition enabled
        BSYNC: enabled  TCLK: enabled   53MHz: present
        Turn event:   0xaa      present
        Start event:  0x10      NOT PRESENT
        Trig. delay:  6
        Global delay: 0
        House delay:  2140
        Board delays: 0 2 0 0 0 0
        Turns counter: -132142356
        Missing turn: 66542
        FPGA version: 2.1.1
        BSYNC received: 0x7c 0xaa 0xda
        TCLK received: 0x0 0x2 0x5 0x7 0x8 0x9 0xa 0xb 0xc 0xd
                0xe 0xf 0x10 0x11 0x12 0x13 0x14 0x15 0x16 0x17
                0x18 0x19 0x1a 0x1b 0x1c 0x1d 0x1e 0x1f 0x21 0x22
                0x23 0x24 0x25 0x26 0x27 0x28 0x29 0x2a 0x2b 0x2c
                0x2d 0x2e 0x2f 0x30 0x31 0x34 0x35 0x36 0x38 0x39
                0x3a 0x3b 0x3c 0x3d 0x40 0x41 0x42 0x43 0x44 0x45
                0x46 0x47 0x48 0x4a 0x4b 0x4c 0x4d 0x4e 0x4f 0x50
                0x51 0x52 0x53 0x55 0x5b 0x5c 0x5d 0x5e 0x60 0x61
                0x62 0x63 0x64 0x65 0x68 0x69 0x6c 0x6d 0x6f 0x71
                0x72 0x73 0x74 0x75 0x76 0x77 0x78 0x79 0x7a 0x7b
                0x7c 0x7d 0x7e 0x80 0x81 0x82 0x83 0x84 0x87 0x88
                0x8c 0x8d 0x8e 0x8f 0x90 0x91 0x92 0x93 0x94 0x95
```

```
                0x99 0x9a 0x9c 0xa4 0xa5 0xa6 0xa8 0xa9 0xb8 0xc0
                0xc1 0xc3 0xc4 0xc5 0xc6 0xc7 0xc9 0xcb 0xce 0xcf
                0xd4 0xdb 0xdd 0xe0 0xe2 0xe3 0xe4 0xe7 0xe8 0xeb
                0xec 0xed 0xee 0xef 0xf0 0xf2 0xf3 0xf5 0xf7 0xfa
```

4.1.16 bpmShowAlarms

```
BPMHelp> bpmShowAlarms
-----------------------------------------------------
bpmShowAlarms (enabled)
Description:
        Show current alarms in the system
Parameters:
        enabled: 0 (only enabled alarms) - 1 (all alarms)
-----------------------------------------------------
```

This command displays a summary of the alarms detected by the front-end system. The current version (GBPM v1_37 and TBPM v1_61) defines the following alarms:

0 – Missing TCLK signal
1 – Missing BSYNC signal
2 – Missing 53 MHz signal
3 – Failure to start timing board
4 – Failure to start EchoTek boards
5 – Low proton intensity detected on closed orbit
6 – Low pbar intensity detected on closed orbit
7 – Safe injection mode is enabled

The following is the output of the `bpmShowAlarms` command:

```
tbpma0:tbpm> bpmShowAlarms
Alarm   Counter Low     High    Clear   Disp    Enable  Msg
0       0       -       -       0       0       1
1       0       -       -       0       0       1
2       0       -       -       0       0       1
3       0       -       -       0       0       1
4       0       -       -       0       0       1
5       10      -       -       0       0       1 Low proton intensity on closed orbit.
6       147     -       -       0       0       1 Low pbar intensity on closed orbit.
7       0       -       -       0       0       1
```

These alarms should be mapped to ACNET alarms. The current implementation does not generate ACNET alarms. Alarms 5 and 6, for low signal intensity, should be disregarded. Many of those alarms, possibly all of them, are being mistakenly generated. The software does not check if the machine has protons or anti-protons circulating and assumes that the low intensity is an error instead of the simple lack of particles in the machine.

4.1.17 bpmShowBuffers

```
BPMHelp> bpmShowBuffers
-----------------------------------------------------
```

```
bpmShowBuffers ()
Description:
        Display current status/info of system buffers
-------------------------------------------------
```

The `bpmShowBuffers` command can be used to monitor the current number of elements in all the buffers available in the system. An example of output is shown below. For each buffer the current number of elements and the maximum number of elements is shown. The output also informs if there are any blocked tasks trying to access the buffer. Buffers are shared resources between the system tasks and can be accessed only after the task has acquired a lock associated with the buffer. If the task is waiting for the buffer lock then its name will be printed out as a blocked task.

```
tbpma0:tbpm> bpmShowBuffers
System Buffers:
                Elemts  Size    Blocked Tasks
ClosedOrbit:    1024    1024    None
FastAbort:      1024    1024    None
SlowAbort:      1024    1024    None
Profile:        36      128     None
Display:        0       1       None
TurnByTurn:     8192    8192    None
I.TurnByTurn:   8192    8192    None
SafeInjection:  0       8192    None
I.ClosedOrbit:  1       1       None
User TCLK:      0       128     None
```

The `bpmPeek` and `bpmDump` commands all need to access to get the buffer lock before accessing the data. If those commands are killed in the middle of the processing (after acquiring the lock) then the buffer will not be accessible by other tasks. For example, if there was a `bpmPeek` command invoked to check the latest closed orbit value and the user killed it using ^C before it finished, then the system will not be able to add new values to the buffer and `bpmShowBuffer` will show that the ClosedOrbit task is blocked.

4.1.18 bpmShowChannels

```
BPMHelp> bpmShowChannels
-------------------------------------------------
bpmShowChannels ()
Description:
        Display EchoTek channel mask
-------------------------------------------------
```

The front-end creates buffers for the maximum amount of BPMs for a house, which is 12. However not all houses have 12 BPMs installed. In fact only 1 of the 27 houses around the ring has the 12 BPMs. In order to avoid processing unnecessary data, the front-end system defines a channel mask for every house. The values are hardcoded, but the configuration of what channel is on or off can be controlled by the `bpmChangeChannel` command. The front-end knows which house it is running based on the hostname. Next is an example of the command output.

```
tbpma0:tbpm> bpmShowChannels
BPM 0: proton [enabled] pbar [enabled]
```

```
BPM 1: proton [enabled] pbar [enabled]
BPM 2: proton [enabled] pbar [enabled]
BPM 3: proton [enabled] pbar [enabled]
BPM 4: proton [disabled] pbar [disabled]
BPM 5: proton [disabled] pbar [disabled]
BPM 6: proton [disabled] pbar [disabled]
BPM 7: proton [disabled] pbar [disabled]
BPM 8: proton [disabled] pbar [disabled]
BPM 9: proton [disabled] pbar [disabled]
BPM 10: proton [disabled] pbar [disabled]
BPM 11: proton [disabled] pbar [disabled]
```

4.1.19 bpmShowConfig

```
BPMHelp> bpmShowConfig
-----------------------------------------------------
bpmShowConfig ()
Description:
        Display detailed system configuration
-----------------------------------------------------
```

The front-end software has several configuration parameters that can be changed by the user while the system is running (`bpmChangeConfig`, `bpmChangeFloat`, `bpmChangeBool`). Some of those parameters are used at initialization time and event if the user changes them later the system will not be affected by its change. For example the `CLOSED_ORBIT_RATE` (index 21) value is used only when the system is started.

The command shows all variables defined in the system at once. One can always redirect the command output to a file if it is not possible to see all values. The following is a sample output:

```
tbpma0:tbpm> bpmShowConfig
+--------------- BPM Configuration      ---------------+
| Index Variable                        Value
+-------------------------------------------------------+
|          Integers
| 0     - DEFAULT_EVENT_QUEUE_SIZE      100
| 1     - TCLK_REG_BASE                 0x6000
| 2     - TCKL_MEM_BASE                 0x8000000
| 3     - BSYNC_REG_BASE                0x2000
| 4     - CONTROL_TASK_PRIORITY         15
| 5     - ALARM_TASK_PRIORITY           42
| 5     - ALARM_TASK_PRIORITY           42
| 7     - BSYNC_START_EVENT             0x10
| 8     - BSYNC_TURN_EVENT              0xaa
| 9     - CONTROL_TASK                  0x1da35110
| 10    - MODE                          10
| 11    - MODE_CHANGE_TIME              1127943228
| 12    - START_TIME                    1126175834
|         Booleans
| 0     - DEFAULT_READOUT               false
| 1     - USE_TEST_TCLK                 false
| 2     - USE_TEST_TIMING               false
+-------------   End of configuration   -------------+
+-------------   TeV BPM Configuration  -------------+
| Index Variable                        Value
+-------------------------------------------------------+
+-------- Integers ---------------------------------+
| 20    - SAMPLES                       64
| 21    - CLOSED_ORBIT_RATE             500
| 22    - DATA_SOURCE                   0
| 23    - TRIGGER_TYPE                  0
| 24    - TRIGGER_VALUE                 500
| 25    - BUNCH_TYPE_PROTON             2
| 26    - BUNCH_TYPE_PBAR               2
| 27    - MACHINE_STATE                 14
```

```
| 28    - HELIX_STATE                   2
| 29    - PROTON_BUNCHES                0
| 30    - PBAR_BUNCHES                  0
| 31    - ECHOTEK_CONFIG                0
| 32    - ECHOTEK_READ_TIMEOUT          10
| 33    - DIAG_CHANNELA                 0
| 34    - DIAG_CHANNELB                 1
| 35    - DIAG_TRIGGER_TYPE             0
| 36    - DIAG_TRIGGER_VALUE            500
| 37    - DIAG_DATA_MODE                0
| 38    - DIAG_RAW_DATA_TYPE            2
| 39    - DATA_MODE                     0
| 40    - CLOSED_ORBIT_PRIORITY         19
| 41    - FAST_ABORT_PRIORITY           25
| 42    - SLOW_ABORT_PRIORITY           35
| 43    - PROFILE_PRIORITY              35
| 44    - DISPLAY_PRIORITY              35
| 45    - TBT_PRIORITY                  18
| 46    - TBT_PRIORITY_LOW              27
| 47    - INJEC_TBT_PRIORITY            18
| 48    - INJ_TBT_PRIORITY_LOW          27
| 49    - INJEC_CO_PRIORITY             30
| 50    - USER_TCLK_PRIORITY            35
| 51    - TBT_START_EVENT               0xda
| 52    - ECHOTEK_TRIGGER_COUNT         8192
| 53    - ECHOTEK_BURST_COUNT           32
| 54    - DEFAULT_USER_TCLK             0xff
| 55    - PROFILE_CLEAR_TCLK            0xc2
| 56    - DISPLAY_CLEAR_TCLK            0xc1
| 57    - SLOW_ABORT_SAMPLES            100
| 58    - ACQSPEC_ARM_EVENT             0xda
| 59    - ACQSPEC_TRIGGER_EVENT         0xaa
| 60    - ACQSPEC_MODE                  0
| 61    - INJ_TBT_START_EVENT           0x7c
| 62    - INJ_TBT_TRIGGER_COUNT         8192
| 63    - TBT_ARM_EVENT                 0x4c
| 64    - TEVBPM_STATE                  2
| 65    - INJ_CO_SKIP                   0
| 66    - INJ_CO_TURNS                  8192
| 67    - CHECK_STATUS_TIME             3
| 68    - FLASH_FRAME_INDEX             9
| 69    - CLOSED_ORBIT_CONFIG           0
| 70    - TURN_BY_TURN_CONFIG           1
| 71    - SAFE_MODE_CONFIG              3
| 72    - COUNT_CONFIG                  19
| 73    - DEBUG_CO_CONFIG               2
| 74    - RAW_CO_CONFIG                 7
| 75    - ZERO_FIFO                     0
| 76    - SAFE_MODE_STATE               1
| 77    - SAFE_MODE_START_EVENT         0x7c
| 78    - SAFE_MODE_WINDOW              10
| 79    - TBPMSF_STATE                  1
+--------  Floats -------------------------------------+
| 20    - PROTON_INTENSITY_THRESHOLD    10
| 21    - PBAR_INTENSITY_THRESHOLD      20
| 22    - LOW_INTENSITY_POSITION        999
| 23    - BPM_SCALE_FACTOR              26
| 24    - SAFE_MODE_VARIATION           0.1
+-------- Booleans -----------------------------------+
| 20    - USE_TEST_SOURCE               false
| 21    - DIAGNOSTIC_MODE               false
| 22    - CHECK_PHASE                   false
| 23    - USE_CALIBRATION               false
+-------------   End of configuration   -------------+
```

The following tables contain the meaning of all variables. The names shown by `bpmShowConfig` command are used internally with prefixes such as `CFG_INT`, `CFG_BOOL`, `TBPM_CFG_INT`, `TBPM_CFG_BOOL`.

Variable	Meaning
CFG_INT_TCLK_REG_BASE	VME base address for TCLK registers
CFG_INT_TCLK_MEM_BASE	VME base address for TCLK memory
CFG_INT_BSYNC_REG_BASE	VME base address for BSYNC decoder register

CFG INT CONTROL TASK PRIORITY	Priority for the control task
CFG INT ALARM TASK PRIORITY	Priority for the alarm task
CFG INT STATE CHANGE TASK PRIORITY	Priority for state change task
CFG INT BSYNC START EVENT	BSYNC start event
CFG INT BSYNC TURN EVENT	BSYNC turn event
CFG INT CONTROL TASK	ptr to the control task (used for sending evts)
CFG INT MODE	system mode of operation
CFG INT MODE CHANGE TIME	time of the last mode change
CFG INT START TIME	system startup time

Table 2 – Integer configuration variables defined for GBPM

Variable	true	false
TBPM CFG BOOL USE TEST TCLK	don't use TCLK board	use TCLK board
TBPM CFG BOOL USE TEST TIMING	use 2ms timer	use Timing board

Table 3 – Boolean configuration variables defined for GBPM

Variable	Meaning
TBPM CFG INT SAMPLES	number of samples taken after the turn marker
TBPM CFG INT CLOSED ORBIT RATE	rate (in Hz) for closed orbit sampling
TBPM CFG INT DATA SOURCE	source of the data (see TBPMDefs.hpp for values)
TBPM CFG INT TRIGGER TYPE	type of the trigger in use (idem)
TBPM_CFG_INT_TRIGGER_VALUE	value for the trigger in use. The meaning of this field depends on the value of the trigger type.
TBPM CFG INT BUNCH TYPE PROTON	proton bunch type (V:COALAP)
TBPM CFG INT BUNCH TYPE PBAR	pbar bunch type (V:COALA)
TBPM CFG INT MACHINE STATE	current tevatron state (V:CLDRST)
TBPM CFG INT HELIX STATE	current helix state (V:HELIX)
TBPM CFG INT PROTON BUNCHES	proton bunches (V:PBKTC)
TBPM CFG INT PBAR BUNCHES	pbar bunches (V:ABKTC)
TBPM CFG INT ECHOTEK CONFIG	current echotek configuration
TBPM CFG INT ECHOTEK READ TIMEOUT	timeout for an echotek read
TBPM CFG INT DIAG CHANNELA	diagnostic channel number A
TBPM CFG INT DIAG CHANNELB	diagnostic channel number B
TBPM CFG INT DIAG TRIGGER TYPE	type of the trigger in use (idem)
TBPM CFG INT DIAG TRIGGER VALUE	value for the trigger in use
TBPM CFG INT DIAG DATA MODE	current operating mode (diagnostics)
TBPM CFG INT DIAG RAW DATA TYPE	type of data being generated
TBPM CFG INT DATA MODE	current operating mode
TBPM CFG INT FAST ABORT PRIORITY	fast abort task priority
TBPM CFG INT SLOW ABORT PRIORITY	slow abort task priority
TBPM CFG INT PROFILE PRIORITY	profile task priority
TBPM CFG INT DISPLAY PRIORITY	display task priority
TBPM CFG INT TBT PRIORITY	turn-by-turn task priority
TBPM_CFG_INT_TBT_PRIORITY_LOW	Low priority for turn-by-turn task, used when system is not in turn-by-turn mode
TBPM CFG INT INJEC TBT PRIORITY	injection turn-by-turn task priority
TBPM_CFG_INT_INJ_TBT_PRIORITY_LOW	Low priority for injection turn-by-turn task. Used when system is not in injection mode
TBPM CFG INT INJEC CO PRIORITY	injection closed orbit task priority
TBPM CFG INT USER TCLK PRIORITY	user TCLK task priority
TBPM CFG INT TBT START EVENT	turn-by-turn BSYNC start event
TBPM CFG INT ECHOTEK TRIGGER COUNT	number of triggers for the echoteks
TBPM CFG INT ECHOTEK BURST COUNT	number of points taken on each turn
TBPM CFG INT DEFAULT USER TCLK	TCLK used to trigger the user buffer
TBPM CFG INT PROFILE CLEAR TCLK	TCLK used to clear the profile buffer
TBPM CFG INT DISPLAY CLEAR TCLK	TCLK used to clear the display buffer
TBPM CFG INT SLOW ABORT SAMPLES	number of elements in the slow abort avrg
TBPM CFG INT ACQSPEC ARM EVENT	acquisition specification arm event
TBPM CFG INT ACQSPEC TRIGGER EVENT	acquisition specification trig. event
TBPM CFG INT ACQSPEC MODE	acquisition spec. mode (define time delays)
TBPM CFG INT INJ TBT START EVENT	BSYNC start event for the injection mode
TBPM CFG INT INJ TBT TRIGGER COUNT	number of events to be taken in inj.mod
TBPM CFG INT TBT ARM EVENT	TCLK event used to arm a turn-by-turn
TBPM CFG INT TEVBPM STATE	Allow injection turn-by-turn (V:TEVBPM)
TBPM CFG INT INJ CO SKIP	Number of injection tbt to be skip'd

TBPM CFG INT INJ CO TURNS	Number of turns to average
TBPM CFG INT CHECK STATUS TIME	Time int. to check BSYNC and TCLK signals
TBPM CFG INT FLASH FRAME INDEX	Flash index in the injection tbt buffer
TBPM CFG INT CLOSED ORBIT CONFIG	EchoTek setup file index for close orbit
TBPM CFG INT TURN BY TURN CONFIG	EchoTek setup file index for TBT
TBPM CFG INT SAFE MODE CONFIG	EchoTek setup file index for SAFE mode
TBPM CFG INT COUNT CONFIG	EchoTek setup file index for couting test
TBPM CFG INT DEBUG CO CONFIG	EchoTek setup file index for debug C.O.
TBPM CFG INT RAW CO CONFIG	EchoTek setup file index for the raw mode
TBPM_CFG_INT_ZERO_FIFO	if 1 then zeros EchoTek FIFOs before TBT, if 0 then don't zero the FIFOs
TBPM CFG INT SAFE MODE START EVENT	safe mode BSYNC start event
TBPM CFG INT SAFE MODE WINDOW	safe mode average window size
TBPM CFG INT TBPMSF STATE	Defines if system is in safe or regular inj.
TBPM CFG INT POS BCAST1	1st. BPM index whose position will be broadcast
TBPM CFG INT POS BCAST2	2nd. BPM index whose position will be broadcast
TBPM CFG INT BCAST RATE	Frequency for the position broadcast

Table 4 – Integer configuration variables defined for TBPM

Variable	Meaning
TBPM CFG FLT PROTON INTENSITY THRESHOLD	Min acceptable p intensity
TBPM CFG FLT PBAR INTENSITY THRESHOLD	Min acceptable pbar intensity
TBPM CFG FLT LOW INTENSITY POSITION	Position to be reported if
Intensity is bellow min threshold	
TBPM CFG FLT BPM SCALE FACTOR	BPM scale factor (26mm or 72.6mm on F0)
TBPM CFG FLT BPM SAFE MODE VARIATION	variation on the averages

Table 5 – Floating point configuration variables defined for TBPM

Variable	true	false
TBPM CFG BOOL USE TEST SOURCE	use TestEchoTekPoo	use EchoTekPool
TBPM CFG BOOL DIAGNOSTIC MODE	In diagnostic mode	not in diag mode
TBPM CFG BOOL CHECK PHASE	check BPM0 phases	don't check phase
TBPM CFG BOOL USE CALIBRATION	use calib. from DB	no calib from DB
TBPM CFG BOOL POS BROADCAST	broadcasts BPM pos	no broadcast using UDP

Table 2 – Boolean configuration variables defined for TBPM

4.1.20 bpmShowGenerators

```
BPMHelp> bpmShowGenerators
-------------------------------------------------
bpmShowGenerators ()
Description:
        Display status of the event generators
-------------------------------------------------
```

The front-end system has several of the so-called event generators. They are software components that generate *events*, where an event can be a TCLK received, a BSYNC received or a timing event. These events are broadcast to a certain number of listener tasks, triggering some specific computation.

The `bpmShowGenerators` displays the total number of events generated, which is a sum of the number of events broadcast when the generator was enabled, number of times events failed to be the broadcast and the number of events not broadcast because the generator was disabled.

The output below shows the status of the generators. The print out also shows whether the generator is enabled or not at that time.

```
tbpma0:tbpm> bpmShowGenerators
Generator       Enabled         Fail            Disabled        Total
C. Orbit  (Off) 901820524       0               8               901820532
FastAbort (On)  796688863       0               105131604       901820467
SlowAbort (On)  1593377         0               0               1593377
TurnXTurn (Off) 621             0               0               621
Inj. C.O. (On)  451             0               0               451
TCLK 0x47 (On)  24              0               0               24
TCLK 0x4B (On)  949             0               0               949
TCLK 0x4D (On)  1698            0               0               1698
TCLK 0x71 (On)  1425            0               0               1425
TCLK 0x75 (On)  2507            0               0               2507
TCLK 0x78 (On)  1242            0               611             1853
Arm TxT   (On)  170             0               0               170
User TCLK (On)  0               0               0               0
Check     (On)  607242          0               0               607242
```

4.1.21 bpmShowModes

```
BPMHelp> bpmShowModes
-----------------------------------------------------
bpmShowModes ()
Description:
        Show the last N modes of operation of the system
-----------------------------------------------------
```

This command shows the last 500 modes of operation of the system. Whenever the system enters a new mode of operation (e.g. when a turn-by-turn is requested) a new entry is added. Each entry contains shows the operating mode and the time when the mode switch completed.

```
tbpma0:tbpm> bpmShowModes
Mode History (elements = 500)
0) Mode CLOSED ORBIT - FRI JUL 01 08:49:49 2005
1) Mode ABORT - FRI JUL 01 08:50:08 2005
2) Mode INJECTION - FRI JUL 01 08:50:46 2005
3) Mode CLOSED ORBIT - FRI JUL 01 08:50:49 2005
4) Mode ABORT - FRI JUL 01 08:51:08 2005
5) Mode INJECTION - FRI JUL 01 08:51:46 2005
6) Mode CLOSED ORBIT - FRI JUL 01 08:51:49 2005
7) Mode ABORT - FRI JUL 01 08:52:08 2005
8) Mode INJECTION - FRI JUL 01 08:52:46 2005
9) Mode CLOSED ORBIT - FRI JUL 01 08:52:49 2005
10) Mode ABORT - FRI JUL 01 08:53:08 2005
…
491) Mode INJECTION - TUE JUL 05 04:29:59 2005
492) Mode CLOSED ORBIT - TUE JUL 05 04:30:02 2005
493) Mode ABORT - TUE JUL 05 04:30:45 2005
494) Mode INJECTION - TUE JUL 05 04:31:13 2005
495) Mode CLOSED ORBIT - TUE JUL 05 04:31:16 2005
496) Mode ABORT - TUE JUL 05 04:39:49 2005
497) Mode INJECTION - TUE JUL 05 04:40:28 2005
498) Mode CLOSED ORBIT - TUE JUL 05 04:40:31 2005
499) Mode ABORT - TUE JUL 05 04:56:54 2005
```

The output of the commands `bpmShowModes`, `bpmShowStates`, `bpmShowTCLK` and `bpmShowConfig` can be used to generate valuable information when the system is not responding correctly (e.g. a system is stuck in injection mode). The output of those commands should be saved for further analysis. The command output can be saved to a file by redirecting the output to a file, e.g. "`bpmShowMode > /write1/A0_MODES`".

4.1.22 bpmShowQueues

```
BPMHelp> bpmShowQueues
-------------------------------------------------
bpmShowQueues ()
Description:
        Display status of event queues
-------------------------------------------------
```

All events generated in the system are sent to event queues. The `bpmShowQueues` allows the user to check if there is some event queue with pending events. Every line shows the queue name, the current number of messages followed by some VxWorks queue properties. The last column shows the tasks that are currently waiting for events to appear in the queue. The number of messages in the queue should be at most 1. A greater number indicates problem. The number of tasks blocked should also be 1 or 0 (as in the case of the ClosedOrbit queue below).

```
tbpma0:tbpm> bpmShowQueues
System Queues:
               Msgs   T.Wait  S.Tout  R.Tout  Opts    MaxLen  MaxTask Blocked Tasks
ClosedOrbit    0      0       0       0       0       100     256     None
FastAbort      0      1       0       0       0       100     256     FastAbort
SlowAbort      0      1       0       0       0       100     256     SlowAbort
Profile        0      1       0       0       0       100     256     Profile
Display        0      1       0       0       0       100     256     Display
TurnByTurn     0      1       0       0       0       100     256     TurnByTurn
I.TurnByTurn   0      1       0       0       0       100     256     InjectionTurnByTurn
User TCLK      0      1       0       0       0       100     256     TBPMUserTCLK
Control        0      1       0       0       0       100     256     ControlTask
```

4.1.23 bpmShowStates

```
BPMHelp> bpmShowStates
-------------------------------------------------
bpmShowStates ()
Description:
        Display the state device change history
-------------------------------------------------
```

The `bpmShowStates` displays a history of the state changes recorded by the front-end. The number of state change history is set to 1000. Every line shows the device identifier and the new state value along with the time stamp when the change was received. The state id can be translated to a device name using the application page D80.

```
tbpma0:tbpm> bpmShowStates
State History (elements = 1000)
Last state change received on MON AUG 22 06:14:00 2005
0) Device: 146764 State: 1 - SUN AUG 14 08:18:30 2005
1) Device: 171151 State: 2 - SUN AUG 14 08:18:33 2005
2) Device: 146764 State: 8 - SUN AUG 14 12:09:21 2005
3) Device: 146764 State: 9 - SUN AUG 14 12:10:48 2005
4) Device: 146764 State: 10 - SUN AUG 14 12:12:23 2005
5) Device: 146764 State: 11 - SUN AUG 14 12:12:59 2005
6) Device: 171151 State: 4 - SUN AUG 14 12:13:25 2005
7) Device: 171151 State: 2 - SUN AUG 14 12:13:29 2005
8) Device: 171151 State: 4 - SUN AUG 14 12:14:18 2005
9) Device: 171151 State: 2 - SUN AUG 14 12:14:18 2005
10) Device: 146764 State: 17 - SUN AUG 14 12:35:19 2005
```

```
…
991) Device: 146764 State: 10 - MON AUG 22 05:57:30 2005
992) Device: 146764 State: 11 - MON AUG 22 05:58:09 2005
993) Device: 171151 State: 4 - MON AUG 22 05:58:48 2005
994) Device: 171151 State: 2 - MON AUG 22 05:58:51 2005
995) Device: 171151 State: 4 - MON AUG 22 05:59:40 2005
996) Device: 171151 State: 2 - MON AUG 22 05:59:41 2005
997) Device: 146764 State: 12 - MON AUG 22 06:00:51 2005
998) Device: 146764 State: 13 - MON AUG 22 06:01:34 2005
999) Device: 146764 State: 14 - MON AUG 22 06:14:05 2005
```

4.1.24 bpmShowTasks

```
BPMHelp> bpmShowTasks
-------------------------------------------------
bpmShowTasks ()
Description:
        Display status of the data acquisition tasks
-------------------------------------------------
```

Command used to get current readout information from the data acquisition tasks. For every task there is information regarding the number of events read out, number of failed read out events and number of times the read out was disabled.

```
tbpma0:tbpm> bpmShowTasks
                              Readout
Task                  Counter Failed  Disabled
ClosedOrbit           116062  0       0
FastAbort             98766   0       0
SlowAbort             0       0       0
Profile               2726    1225    0
Display               1636    0       0
TurnByTurn            0       0       0
InjectionTurnByTurn   0       0       0
TBPMUserTCLK          0       0       0
```

A failed read out event can result from a destination buffer being full or the source buffer had no data available. It is also possible to have failed read out events in case the system is not in the correct mode of operation, for example if a profile frame is requested while the system is in turn-by-turn or abort mode.

4.1.25 bpmShowTCLK

```
BPMHelp> bpmShowTCLK
-------------------------------------------------
bpmShowTCLK ()
Description:
        Display the TCLK history
-------------------------------------------------
```

The `bpmShowTCLK` command shows a history of the last 500 TCLKs received by the front-end. Along with the TCLK received there are three timestamps. The first one, preceded by `(T)` is the timing board TCLK timestamp, which records the timestamp at the last TCLK 0x4B. The second timestamp `(B)` is also from the timing boards, however it is the timestamp of the last BYNC 0x7C (last injection). Finally a time of the day timestamp at the time the TCLK was received is displayed.

```
tbpma0:tbpm> bpmShowTCLK
TCLK History (elements = 500)
Last TCLK received on TUE JUL 05 05:53:21 2005
0) TCLK 0x75 - (T) 0xa967c48c553 - (B) 0xaf6197f7 - SUN JUL 03 23:51:21 2005
1) TCLK 0x75 - (T) 0xa967c48c553 - (B) 0xaf6197f7 - SUN JUL 03 23:51:27 2005
2) TCLK 0x75 - (T) 0xa967c48c553 - (B) 0xaf6197f7 - SUN JUL 03 23:51:33 2005
3) TCLK 0x75 - (T) 0xa967c48c553 - (B) 0xaf6197f7 - SUN JUL 03 23:51:41 2005
4) TCLK 0x4b - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:53:15 2005
5) TCLK 0xc1 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:53:45 2005
6) TCLK 0x75 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:53:56 2005
7) TCLK 0x75 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:54:18 2005
8) TCLK 0x75 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:54:32 2005
9) TCLK 0x75 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:54:41 2005
10) TCLK 0x75 - (T) 0xa9becbfed61 - (B) 0xaf6197f7 - SUN JUL 03 23:54:48 2005
…
491) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:51:52 2005
492) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:51:57 2005
493) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:02 2005
494) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:07 2005
495) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:12 2005
496) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:17 2005
497) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:22 2005
498) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:52:27 2005
499) TCLK 0x75 - (T) 0x29a10d691c - (B) 0x75d0f0e7 - TUE JUL 05 05:53:21 2005
```

4.1.26 bpmPeekDiag

```
BPMHelp> bpmPeekDiag
-----------------------------------------------------
bpmPeekDiag ()
Description:
        Display current contents of the diagnostic buffer
-----------------------------------------------------
```

The command bpmPeekDiag displays the first elements of the diagnostics buffer. That buffer is used only when the front-end is in diagnostics mode (using the `bpmMode 30` command or using the page W25).

4.1.27 bpmTBTEvent

```
BPMHelp> bpmTBTEvent
-----------------------------------------------------
bpmTBTEvent (tclk)
Description:
        Change the TCLK event that arms a turn-by-turn measurement
Parameters:
        tclk: TCLK that will arm the turn-by-turn
-----------------------------------------------------
```

This command is for development and debugging only. It changes the TCLK that arms turn-by-turn measurements.

There is an equivalent ACNET variable for changing the TCLK event, the device is T:xxTTEV, where xx is the house name (e.g. A0).

The current TCLK for arming turn-by-turn can be viewed with the `bpmShowConfig` command. The configuration variable is called TBT_ARM_EVENT and has index 63.

4.1.28 bpmTCLK

```
BPMHelp> bpmTCLK
-----------------------------------------------------
bpmTCLK (tclk)
Description:
        Generate a TCLK event that is processed by the system
Parameters:
        tclk:
                0x47: ABORT
                0x4D: Tevatron reset - proton injection
                0x71: Prepare for beam
                0x75: BPM profile
                0x77: Arm turn-by-turn measurement
                0x78: BPM display
                0x100: User TCLK generation
-----------------------------------------------------
```

This is a development and debugging command. Should not be using during normal operations. This command creates a fake TCLK. For example, the command `bpmTCLK 0x47` will make the system enter the ABORT mode.

4.2 Trace Diagnostics

The Tevatron BPM software packages are using a trace facility to monitor software behavior. This document is not meant to be a tutorial for that facility - Refer to the output of the traceHelp command (sample below) for an overview of the trace commands that are available.

```
fccts1:tbpm-dev> traceHelp
Trace Facility Help

traceMode(mode)          Sets the target(s) of the trace messages.
                         'mode' can be:
                             0 = tracing is disabled
                             1 = trace into circular buffer
                             2 = trace to VxWorks log facility
                             3 = trace to both

traceModeGet()           Returns the current trace mode.

traceInfo()              Shows information associated with the
                         trace facility. Each trace source is
                         also shown along with its level mask.

traceShow(opts, lines, skip, fd)
                         Dumps the contents of the trace buffer.
                         The arguments have the following effects:
                         'opts' is a bit mask:
                           bits 0,1:
                             0 = Relative timestamps are shown
                             1 = Absolute, but zeroed, timestamps
                             2 = Absolute timestamps
                           bit 2:
                             0 = do not show trace level
                             1 = show trace level
                         'lines' can be:
                             0 = Display all entries (default)
                                 Otherwise only display the first
                                 'lines' entries
                         'skip' can be:
```

```
                              0 = Don't skip entries
                                  Otherwise display every 'skip'
                                  entry
                          'fd' can be an open file descriptor. If
                          it is zero, then standard output is used.

traceReset()              Clears the circular trace buffer.

traceOn(id, lo, hi, f)       Turns on the specified levels of trace
                          source 'id'. This value can be found
                          using traceInfo(). 'lo' and 'hi' define
                          the range of levels to enable (0 - 31).
                          f is the "function" (currently -
                          0=circular, 1=logMsg.

traceOff(id, lo, hi, f)      Turns off the specified levels of trace
                          source 'id'. 'lo' and 'hi' define
                          the range of levels to disable (0 - 31).
                          f is same as above.

traceGlobalOn(lo, hi, f)     Like traceOn(), but it affects every
                          trace source.
                          f is same as above.

traceGlobalOff(lo, hi, f)    Like traceOff(), but it affects every
                          trace source.
                          f is same as above.

traceFreezeOn(lo, hi)     Enables a range of "freeze" levels. If
                          your code calls traceFreeze(lvl) and the
                          lvl'th freeze bit was set, the circular
                          trace queue is frozen (similar to calling
                          traceMode(0).) traceInfo() shows the
                          current freeze mask.

traceFreezeOff(lo, hi)    Disables a range of "freeze" levels.
```

As a quick overview, we typically use the tracing facility in a circular buffer mode where all traced processes write into that buffer. The software is exploiting many levels of trace that can be turned on/off to fine tune which information is stored in the buffer.

As an example, the following use of the traceShow command would display (on standard output) the most recent 100 entries in the trace buffer without skipping any entries, and each entry would be shown with an absolute timestamp and its trace level.

```
traceShow 6, 100, 0, 0
```

4.2.1 Trace Levels

The GBPM library defines in the file `Defs.h` the trace levels used for the different parts of the system. The following table defines the levels used throughout the code.

Level	Start	End
ERROR_LEVEL	0	0
DRIVER_LEVEL	1	8
EVENT_LEVEL	9	11
READOUT_LEVEL	12	15
BUFFER_LEVEL	16	17
CONTROL_LEVEL	18	18
ACNET_LEVEL	19	20
ALARM_LEVEL	21	21
TIMING_LEVEL	22	23

4.3 VME Backplane Diagnostics

Bus analyzers are a powerful tool in understanding what is actually happening on the backplane. Using a Vanguard VME bus analyzer and the companion Bus Analyzer software version 4 the following traces where obtained to show VME timing of typical transfers:

AbsTime	Transfer	AM/XAM	Address	Data	Size	Cycle	Status	Iack	IRQ[7:1]*
Timing board interrupt (500 Hz rate)									
0.0ns	Single	A16nD	IACK=6	......A0	LBYTE	Rd	Data	IACK6	1011111
Echotek interrupt - First channel of first board is done									
1.358ms	Single	A16nD	IACK=7	......E1	LBYTE	Rd	Data	IACK7	111111
Interrupt handler checks the status of all channels									
1.362ms	Single	A16nD	8314	FF000000	D32	Rd	Data	-----	111111
1.363ms	Single	A16nD	8314	1000000	D32	Wr	Data	-----	1111111
1.367ms	Single	A16nD	8314	FE000000	D32	Rd	Data	-----	1111111
1.368ms	Single	A16nD	8314	FE000000	D32	Wr	Data	-----	1111111
1.369ms	Single	A16nD	9314	FF000000	D32	Rd	Data	-----	1111111
1.370ms	Single	A16nD	9314	FF000000	D32	Wr	Data	-----	1111111
1.370ms	Single	A16nD	A314	FF000000	D32	Rd	Data	-----	1111111
1.371ms	Single	A16nD	A314	FF000000	D32	Wr	Data	-----	1111111
1.372ms	Single	A16nD	B314	FF000000	D32	Rd	Data	-----	1111111
1.373ms	Single	A16nD	B314	FF000000	D32	Wr	Data	-----	1111111
1.373ms	Single	A16nD	C314	FF000000	D32	Rd	Data	-----	1111111
1.374ms	Single	A16nD	C314	FF000000	D32	Wr	Data	-----	1111111
1.375ms	Single	A16nD	D314	FF000000	D32	Rd	Data	-----	1111111
1.376ms	Single	A16nD	D314	FF000000	D32	Wr	Data	-----	1111111
1.377ms	Single	A32nD	18000000	010FF001	D32	Rd	Data	-----	1111111
1.378ms	Single	A32nD	18000000	010FF000	D32	Wr	Data	-----	1111111
1.379ms	Single	A32nD	19000000	010FF001	D32	Rd	Data	-----	1111111
1.380ms	Single	A32nD	19000000	010FF000	D32	Wr	Data	-----	1111111
1.381ms	Single	A32nD	1A000000	010FF001	D32	Rd	Data	-----	1111111
1.382ms	Single	A32nD	1A000000	010FF000	D32	Wr	Data	-----	1111111
1.383ms	Single	A32nD	1B000000	010FF001	D32	Rd	Data	-----	1111111
1.384ms	Single	A32nD	1B000000	010FF000	D32	Wr	Data	-----	1111111
1.385ms	Single	A32nD	1C000000	010FF001	D32	Rd	Data	-----	1111111
1.386ms	Single	A32nD	1C000000	010FF000	D32	Wr	Data	-----	1111111
1.387ms	Single	A32nD	1D000000	010FF001	D32	Rd	Data	-----	1111111
1.388ms	Single	A32nD	1D000000	010FF000	D32	Wr	Data	-----	1111111
Board 0 - data read out (8 single transfers)									
1.389ms	Single	A32nD	18100000	0000FFFF	D32	Rd	Data	-----	1111111
1.391ms	Single	A32nD	18180000	0	D32	Rd	Data	-----	1111111
1.392ms	Single	A32nD	18200000	1	D32	Rd	Data	-----	1111111
1.394ms	Single	A32nD	18280000	0000FFFF	D32	Rd	Data	-----	1111111
1.396ms	Single	A32nD	18300000	0	D32	Rd	Data	-----	1111111

```
1.397ms   Single   A32nD   18380000   0          D32   Rd   Data   -----   1111111
1.399ms   Single   A32nD   18400000   0          D32   Rd   Data   -----   1111111
1.400ms   Single   A32nD   18480000   0          D32   Rd   Data   -----   1111111
                        Board 1 - data read out (8 single transfers)
1.402ms   Single   A32nD   19100000   0          D32   Rd   Data   -----   1111111
1.404ms   Single   A32nD   19180000   0000FFFF   D32   Rd   Data   -----   1111111
1.406ms   Single   A32nD   19200000   1          D32   Rd   Data   -----   1111111
1.407ms   Single   A32nD   19280000   0          D32   Rd   Data   -----   1111111
1.409ms   Single   A32nD   19300000   0          D32   Rd   Data   -----   1111111
1.410ms   Single   A32nD   19380000   0000FFFF   D32   Rd   Data   -----   1111111
1.412ms   Single   A32nD   19400000   0          D32   Rd   Data   -----   1111111
1.414ms   Single   A32nD   19480000   0000FFFF   D32   Rd   Data   -----   1111111
                        Board 2 - data read out (8 single transfers)
1.415ms   Single   A32nD   1A100000   0          D32   Rd   Data   -----   1111111
1.417ms   Single   A32nD   1A180000   0000FFFF   D32   Rd   Data   -----   1111111
1.419ms   Single   A32nD   1A200000   1          D32   Rd   Data   -----   1111111
1.420ms   Single   A32nD   1A280000   0          D32   Rd   Data   -----   1111111
1.422ms   Single   A32nD   1A300000   1          D32   Rd   Data   -----   1111111
1.423ms   Single   A32nD   1A380000   0          D32   Rd   Data   -----   1111111
1.425ms   Single   A32nD   1A400000   0          D32   Rd   Data   -----   1111111
1.426ms   Single   A32nD   1A480000   0          D32   Rd   Data   -----   1111111
                        Board 3 - data read out (8 single transfers)
1.428ms   Single   A32nD   1B100000   1          D32   Rd   Data   -----   1111111
1.430ms   Single   A32nD   1B180000   0          D32   Rd   Data   -----   1111111
1.432ms   Single   A32nD   1B200000   0000FFFF   D32   Rd   Data   -----   1111111
1.433ms   Single   A32nD   1B280000   0          D32   Rd   Data   -----   1111111
1.435ms   Single   A32nD   1B300000   0          D32   Rd   Data   -----   1111111
1.436ms   Single   A32nD   1B380000   0          D32   Rd   Data   -----   1111111
1.438ms   Single   A32nD   1B400000   0          D32   Rd   Data   -----   1111111
1.440ms   Single   A32nD   1B480000   0000FFFF   D32   Rd   Data   -----   1111111
                        Board 4 - data read out (8 single transfers)
1.441ms   Single   A32nD   1C100000   0          D32   Rd   Data   -----   1111111
1.443ms   Single   A32nD   1C180000   1          D32   Rd   Data   -----   1111111
1.445ms   Single   A32nD   1C200000   0          D32   Rd   Data   -----   1111111
1.446ms   Single   A32nD   1C280000   0          D32   Rd   Data   -----   1111111
1.448ms   Single   A32nD   1C300000   0          D32   Rd   Data   -----   1111111
1.449ms   Single   A32nD   1C380000   0          D32   Rd   Data   -----   1111111
1.451ms   Single   A32nD   1C400000   0          D32   Rd   Data   -----   1111111
1.452ms   Single   A32nD   1C480000   0          D32   Rd   Data   -----   1111111
                        Board 5 - data read out (8 single transfers)
1.454ms   Single   A32nD   1D100000   1          D32   Rd   Data   -----   1111111
1.456ms   Single   A32nD   1D180000   0          D32   Rd   Data   -----   1111111
1.458ms   Single   A32nD   1D200000   0          D32   Rd   Data   -----   1111111
1.459ms   Single   A32nD   1D280000   1          D32   Rd   Data   -----   1111111
1.461ms   Single   A32nD   1D300000   0000FFFF   D32   Rd   Data   -----   1111111
1.462ms   Single   A32nD   1D380000   1          D32   Rd   Data   -----   1111111
1.464ms   Single   A32nD   1D400000   0000FFFF   D32   Rd   Data   -----   1111111
1.466ms   Single   A32nD   1D480000   0          D32   Rd   Data   -----   1111111
                        Reading timing boad registers (timestamp and turns count)
```

1.469ms	Single	A16nD	203A	0000	WORD	Rd	Data	-----	1111111
1.471ms	Single	A16nD	203C	0000	WORD	Rd	Data	-----	1111111
1.472ms	Single	A16nD	203E	0000	WORD	Rd	Data	-----	1111111
1.473ms	Single	A16nD	2040	0000	WORD	Rd	Data	-----	1111111
1.475ms	Single	A16nD	2054	0000	WORD	Rd	Data	-----	1111111
1.476ms	Single	A16nD	2052	0000	WORD	Rd	Data	-----	1111111
Board 0 arming (38 ms - Total of 35 VME read and write operations, first and last shown only)									
1.525ms	Single	A32nD	18010000	016B9006	D32	Wr	Data	-----	1111111
1.563ms	Single	A32nD	18000000	010FF001	D32	Wr	Data	-----	1111111
Board 1 arming (38 us)									
1.564ms	Single	A32nD	19010000	016B9006	D32	Wr	Data	-----	1111111
1.602ms	Single	A32nD	19000000	010FF001	D32	Wr	Data	-----	1111111
Board 2 arming (37 us)									
1.603ms	Single	A32nD	1A010000	016B9006	D32	Wr	Data	-----	1111111
1.640ms	Single	A32nD	1A000000	010FF001	D32	Wr	Data	-----	1111111
Board 3 arming (38 us)									
1.641ms	Single	A32nD	1B010000	016B9006	D32	Wr	Data	-----	1111111
1.679ms	Single	A32nD	1B000000	010FF001	D32	Wr	Data	-----	1111111
Board 4 arming (37 us)									
1.680ms	Single	A32nD	1C010000	016B9006	D32	Wr	Data	-----	1111111
1.717ms	Single	A32nD	1C000000	010FF001	D32	Wr	Data	-----	1111111
Board 5 arming (38 us)									
1.718ms	Single	A32nD	1D010000	016B9006	D32	Wr	Data	-----	1111111
1.756ms	Single	A32nD	1D000000	010FF001	D32	Wr	Data	-----	1111111
Waiting for next timing board interrupt…									
2.012ms	Single	A16nD	IACK=6	......A0	LBYTE	Rd	Data	IACK6	1011111
3.370ms	Single	A16nD	IACK=7	......E1	LBYTE	Rd	Data	IACK7	111111

AbsTime	Transfer	AM/XAM	Address	Data	Size	Cycle	Status	Iack	IRQ[7:1]*
Timing board interrupt - BSYNC 0x7C or 0xDA received									
0.0ns	Single	A16nD	IACK=6	......A1	LBYTE	Rd	Data	IACK6	1111111
Echotek interrupt - First channel of first board is done. 8192 turns sampled									
171.817ms	Single	A16nD	IACK=7	......E1	LBYTE	Rd	Data	IACK7	111111
Interrupt handler checks the status of all channels									
171.822ms	Single	A16nD	8314	FF000000	D32	Rd	Data	-----	111111
171.824ms	Single	A16nD	8314	1000000	D32	Wr	Data	-----	1111111
171.833ms	Single	A16nD	8314	FE000000	D32	Rd	Data	-----	1111111
171.834ms	Single	A16nD	8314	FE000000	D32	Wr	Data	-----	1111111
171.835ms	Single	A16nD	9314	FF000000	D32	Rd	Data	-----	1111111
171.835ms	Single	A16nD	9314	FF000000	D32	Wr	Data	-----	1111111
171.836ms	Single	A16nD	A314	FF000000	D32	Rd	Data	-----	1111111
171.837ms	Single	A16nD	A314	FF000000	D32	Wr	Data	-----	1111111
171.838ms	Single	A16nD	B314	FF000000	D32	Rd	Data	-----	1111111
171.838ms	Single	A16nD	B314	FF000000	D32	Wr	Data	-----	1111111
171.839ms	Single	A16nD	C314	FF000000	D32	Rd	Data	-----	1111111
171.840ms	Single	A16nD	C314	FF000000	D32	Wr	Data	-----	1111111
171.841ms	Single	A16nD	D314	FF000000	D32	Rd	Data	-----	1111111

```
171.842ms  Single    A16nD     D314           FF000000        D32    Wr    Data    -----  1111111
171.844ms  Single    A32nD     18000000       010FF001        D32    Rd    Data    -----  1111111
171.845ms  Single    A32nD     18000000       010FF000        D32    Wr    Data    -----  1111111
171.846ms  Single    A32nD     19000000       010FF001        D32    Rd    Data    -----  1111111
171.847ms  Single    A32nD     19000000       010FF000        D32    Wr    Data    -----  1111111
171.848ms  Single    A32nD     1A000000       010FF001        D32    Rd    Data    -----  1111111
171.850ms  Single    A32nD     1A000000       010FF000        D32    Wr    Data    -----  1111111
171.851ms  Single    A32nD     1B000000       010FF001        D32    Rd    Data    -----  1111111
171.852ms  Single    A32nD     1B000000       010FF000        D32    Wr    Data    -----  1111111
171.853ms  Single    A32nD     1C000000       010FF001        D32    Rd    Data    -----  1111111
171.854ms  Single    A32nD     1C000000       010FF000        D32    Wr    Data    -----  1111111
171.856ms  Single    A32nD     1D000000       010FF001        D32    Rd    Data    -----  1111111
171.857ms  Single    A32nD     1D000000       010FF000        D32    Wr    Data    -----  1111111
171.859ms  Single    A32nD     18000020            400        D32    Wr    Data    -----  1111111
171.859ms  Single    A32nD     18000024       8800000C        D32    Wr    Data    -----  1111111
171.860ms  Single    A16nD     8220           007F0000        D32    Wr    Data    -----  1111111
171.860ms  Single    A16nD     8218              40000        D32    Wr    Data    -----  1111111
171.861ms  Single    A16nD     8204                  0        D32    Wr    Data    -----  1111111
171.861ms  Single    A16nD     8220           0C000088        D32    Wr    Data    -----  1111111
171.864ms  Start     A32sMBLT  25079800 FFF   E000100000001   D64    Wr    Data    -----  1111111
                                      32702 VME operations omitted
176.859ms  Start     A32sMBLT  24980800 FFF   F0001FFFD0005   D64    Wr    Data    -----  1111111
                                    DMA ready interrupt for board 0
176.870ms  Single    A16nD     IACK=7         ......E1        LBYTE  Rd    Data    IACK7  111111
176.874ms  Single    A16nD     8314              10000        D32    Rd    Data    -----  111111
176.875ms  Single    A16nD     8314              10000        D32    Wr    Data    -----  1111111
176.970ms  Single    A32nD     19000020            400        D32    Wr    Data    -----  1111111
176.971ms  Single    A32nD     19000024       8800000C        D32    Wr    Data    -----  1111111
176.971ms  Single    A16nD     9220           007F0000        D32    Wr    Data    -----  1111111
176.972ms  Single    A16nD     9218              40000        D32    Wr    Data    -----  1111111
176.972ms  Single    A16nD     9204                  0        D32    Wr    Data    -----  1111111
176.972ms  Single    A16nD     9220           0C000088        D32    Wr    Data    -----  1111111
176.976ms  Start     A32sMBLT  24878800 000   0FFFF00010000   D64    Wr    Data    -----  1111111
181.963ms  Start     A32sMBLT  2417F800 FFF   F000000010002   D64    Wr    Data    -----  1111111
                                    DMA ready interrupt for board 1
181.974ms  Single    A16nD     IACK=7         ......E3        LBYTE  Rd    Data    IACK7  111111
181.978ms  Single    A16nD     9314           10000           D32    Rd    Data    -----  111111
181.979ms  Single    A16nD     9314           10000           D32    Wr    Data    -----  1111111
182.068ms  Single    A32nD     1A000020       400             D32    Wr    Data    -----  1111111
182.069ms  Single    A32nD     1A000024       8800000C        D32    Wr    Data    -----  1111111
182.069ms  Single    A16nD     A220           007F0000        D32    Wr    Data    -----  1111111
182.069ms  Single    A16nD     A218           40000           D32    Wr    Data    -----  1111111
182.070ms  Single    A16nD     A204           0               D32    Wr    Data    -----  1111111
182.070ms  Single    A16nD     A220           0C000088        D32    Wr    Data    -----  1111111
182.074ms  Start     A32sMBLT  24077800 FFF   F000100000004   D64    Wr    Data    -----  1111111
                                      32704 VME operations omitted
187.064ms  Start     A32sMBLT  2397E800 FFF   E0003FFFF0003   D64    Wr    Data    -----  1111111
                                    DMA ready interrupt for board 2
187.075ms  Single    A16nD     IACK=7         ......E5        LBYTE  Rd    Data    IACK7  111111
```

187.079ms	Single	A16nD	A314	10000	D32	Rd	Data	-----	111111
187.080ms	Single	A16nD	A314	10000	D32	Wr	Data	-----	1111111
187.168ms	Single	A32nD	1B000020	400	D32	Wr	Data	-----	1111111
187.169ms	Single	A32nD	1B000024	8800000C	D32	Wr	Data	-----	1111111
187.169ms	Single	A16nD	B220	007F0000	D32	Wr	Data	-----	1111111
187.170ms	Single	A16nD	B218	40000	D32	Wr	Data	-----	1111111
187.170ms	Single	A16nD	B204	0	D32	Wr	Data	-----	1111111
187.171ms	Single	A16nD	B220	0C000088	D32	Wr	Data	-----	1111111
187.174ms	Start	A32sMBLT	23876800 000	10001	D64	Wr	Data	-----	1111111
32704 VME operations omitted									
192.162ms	Start	A32sMBLT	2317D800 000	00001FFFF0001	D64	Wr	Data	-----	1111111
DMA ready interrupt for board 3									
192.173ms	Single	A16nD	IACK=7	.....E7	LBYTE	Rd	Data	IACK7	111111
192.177ms	Single	A16nD	B314	10000	D32	Rd	Data	-----	111111
192.178ms	Single	A16nD	B314	10000	D32	Wr	Data	-----	1111111
192.267ms	Single	A32nD	1C000020	400	D32	Wr	Data	-----	1111111
192.268ms	Single	A32nD	1C000024	8800000C	D32	Wr	Data	-----	1111111
192.268ms	Single	A16nD	C220	007F0000	D32	Wr	Data	-----	1111111
192.269ms	Single	A16nD	C218	40000	D32	Wr	Data	-----	1111111
192.269ms	Single	A16nD	C204	0	D32	Wr	Data	-----	1111111
192.270ms	Single	A16nD	C220	0C000088	D32	Wr	Data	-----	1111111
192.273ms	Start	A32sMBLT	23075800 000	1FFFFFFFE0001	D64	Wr	Data	-----	1111111
32704 VME operations omitted									
197.349ms	Start	A32sMBLT	2297C800 FFF	D0002FFFF0003	D64	Wr	Data	-----	1111111
DMA ready interrupt for board 4									
197.362ms	Single	A16nD	IACK=7	.....E9	LBYTE	Rd	Data	IACK7	111111
197.365ms	Single	A16nD	C314	10000	D32	Rd	Data	-----	111111
197.366ms	Single	A16nD	C314	10000	D32	Wr	Data	-----	1111111
197.470ms	Single	A32nD	1D000020	400	D32	Wr	Data	-----	1111111
197.470ms	Single	A32nD	1D000024	8800000C	D32	Wr	Data	-----	1111111
197.471ms	Single	A16nD	D220	007F0000	D32	Wr	Data	-----	1111111
197.471ms	Single	A16nD	D218	40000	D32	Wr	Data	-----	1111111
197.472ms	Single	A16nD	D204	0	D32	Wr	Data	-----	1111111
197.472ms	Single	A16nD	D220	0C000088	D32	Wr	Data	-----	1111111
197.476ms	Start	A32sMBLT	22874800 000	0FFFD00000000	D64	Wr	Data	-----	1111111
32704 VME operations omitted									
202.650ms	Start	A32sMBLT	2217B800 000	0FFFE0002FFFE	D64	Wr	Data	-----	1111111
DMA ready interrupt for board 5									
202.663ms	Single	A16nD	IACK=7	.....EB	LBYTE	Rd	Data	IACK7	111111
202.667ms	Single	A16nD	D314	10000	D32	Rd	Data	-----	111111
202.668ms	Single	A16nD	D314	10000	D32	Wr	Data	-----	1111111
Timing information from timing board									
202.762ms	Single	A16nD	203A	0000	WORD	Rd	Data	-----	1111111
202.763ms	Single	A16nD	203C	0000	WORD	Rd	Data	-----	1111111
202.765ms	Single	A16nD	203E	0000	WORD	Rd	Data	-----	1111111
202.766ms	Single	A16nD	2040	0000	WORD	Rd	Data	-----	1111111
202.769ms	Single	A16nD	2044	0000	WORD	Rd	Data	-----	1111111
202.771ms	Single	A16nD	2042	0000	WORD	Rd	Data	-----	1111111
202.773ms	Single	A16nD	2048	0000	WORD	Rd	Data	-----	1111111

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202.774ms  Single    A16nD     2046          ....0000       WORD   Rd     Data    -----  1111111
                        Configure timing board to start taking closed orbits
202.818ms  Single    A16nD     2030          ....1603       WORD   Rd     Data    -----  1111111
202.819ms  Single    A16nD     2030          ....1000       WORD   Wr     Data    -----  1111111
202.820ms  Single    A16nD     2030          ....1000       WORD   Rd     Data    -----  1111111
202.821ms  Single    A16nD     2030          ....1040       WORD   Wr     Data    -----  1111111
202.822ms  Single    A16nD     2060          ....09A1       WORD   Rd     Data    -----  1111111
202.823ms  Single    A16nD     2060          ....09A1       WORD   Wr     Data    -----  1111111
202.826ms  Single    A16nD     2066          ....0000       WORD   Rd     Data    -----  1111111
202.829ms  Single    A16nD     2034          ....00AA       WORD   Wr     Data    -----  1111111
202.830ms  Single    A16nD     2036          ....0010       WORD   Wr     Data    -----  1111111
202.830ms  Single    A16nD     2010          ....0001       WORD   Wr     Data    -----  1111111
202.831ms  Single    A16nD     2012          ....0001       WORD   Wr     Data    -----  1111111
202.832ms  Single    A16nD     2014          ....0001       WORD   Wr     Data    -----  1111111
202.833ms  Single    A16nD     2016          ....0001       WORD   Wr     Data    -----  1111111
202.834ms  Single    A16nD     2018          ....0001       WORD   Wr     Data    -----  1111111
202.835ms  Single    A16nD     201A          ....0001       WORD   Wr     Data    -----  1111111
202.835ms  Single    A16nD     201C          ....0001       WORD   Wr     Data    -----  1111111
202.836ms  Single    A16nD     201E          ....0001       WORD   Wr     Data    -----  1111111
202.837ms  Single    A16nD     2030          ....0040       WORD   Wr     Data    -----  1111111
202.838ms  Single    A16nD     2026          ....005F       WORD   Wr     Data    -----  1111111
202.839ms  Single    A16nD     2030          ....0040       WORD   Rd     Data    -----  1111111
202.840ms  Single    A16nD     2030          ....00C0       WORD   Wr     Data    -----  1111111
202.843ms  Single    A16nD     2060          ....01A0       WORD   Wr     Data    -----  1111111
202.844ms  Single    A16nD     2070          ....0009       WORD   Wr     Data    -----  1111111
              Load closed orbit configuration - board 0 (7216 VME transfers - 10 ms)
205.776ms  Single    A32nD     18000000      0              D32    Wr     Data    -----  1111111
              Load closed orbit configuration - board 1 (7216 VME transfers - 10 ms)
215.294ms  Single    A32nD     19000000      0              D32    Wr     Data    -----  1111111
              Load closed orbit configuration - board 2 (7216 VME transfers - 10 ms)
224.810ms  Single    A32nD     1A000000      0              D32    Wr     Data    -----  1111111
              Load closed orbit configuration - board 3 (7216 VME transfers - 10 ms)
234.311ms  Single    A32nD     1B000000      0              D32    Wr     Data    -----  1111111
              Load closed orbit configuration - board 4 (7216 VME transfers - 10 ms)
243.808ms  Single    A32nD     1C000000      0              D32    Wr     Data    -----  1111111
              Load closed orbit configuration - board 5 (7216 VME transfers - 10 ms)
253.653ms  Single    A32nD     1D000000      0              D32    Wr     Data    -----  1111111
                                    Board 0 arming (36 us)
263.317ms  Single    A16nD     8310          1010000        D32    Rd     Data    -----  1111111
                                    Board 1 arming (29 us)
263.353ms  Single    A16nD     9310          10000          D32    Rd     Data    -----  1111111
                                    Board 2 arming (28 us)
263.382ms  Single    A16nD     A310          10000          D32    Rd     Data    -----  1111111
                                    Board 3 arming (29 us)
263.410ms  Single    A16nD     B310          10000          D32    Rd     Data    -----  1111111
                                    Board 4 arming (28 us)
263.439ms  Single    A16nD     C310          10000          D32    Rd     Data    -----  1111111
                                    Board 5 arming (30 us)
263.467ms  Single    A16nD     D310          10000          D32    Rd     Data    -----  1111111
```

```
263.497ms  Single   A32nD   18000018   0          D32   Wr   Data   -----  1111111
263.497ms  Single   A32nD   19000018   0          D32   Wr   Data   -----  1111111
263.498ms  Single   A32nD   1A000018   0          D32   Wr   Data   -----  1111111
263.499ms  Single   A32nD   1B000018   0          D32   Wr   Data   -----  1111111
263.499ms  Single   A32nD   1C000018   0          D32   Wr   Data   -----  1111111
263.500ms  Single   A32nD   1D000018   0          D32   Wr   Data   -----  1111111
263.501ms  Single   A32nD   18000004   FFFF8100   D32   Rd   Data   -----  1111111
263.528ms  Single   A32nD   19000004   FFFF8100   D32   Rd   Data   -----  1111111
263.553ms  Single   A32nD   1A000004   FFFF8100   D32   Rd   Data   -----  1111111
263.577ms  Single   A32nD   1B000004   FFFF8100   D32   Rd   Data   -----  1111111
263.601ms  Single   A32nD   1C000004   FFFF8100   D32   Rd   Data   -----  1111111
263.626ms  Single   A32nD   1D000004   FFFF8100   D32   Rd   Data   -----  1111111
263.658ms  Single   A32nD   18010000   016B9006   D32   Wr   Data   -----  1111111
263.699ms  Single   A32nD   19010000   016B9006   D32   Wr   Data   -----  1111111
263.737ms  Single   A32nD   1A010000   016B9006   D32   Wr   Data   -----  1111111
263.776ms  Single   A32nD   1B010000   016B9006   D32   Wr   Data   -----  1111111
263.814ms  Single   A32nD   1C010000   016B9006   D32   Wr   Data   -----  1111111
263.853ms  Single   A32nD   1D010000   016B9006   D32   Wr   Data   -----  1111111
263.905ms  Single   A16nD   2060       ....01A0   WORD  Rd   Data   -----  1111111
263.906ms  Single   A16nD   2060       ....11A0   WORD  Wr   Data   -----  1111111
263.916ms  Single   A16nD   2030       ....00C0   WORD  Rd   Data   -----  1111111
263.917ms  Single   A16nD   2030       ....02C0   WORD  Wr   Data   -----  1111111
263.918ms  Single   A16nD   2062       ....10C6   WORD  Rd   Data   -----  1111111
263.919ms  Single   A16nD   2062       ....10C6   WORD  Wr   Data   -----  1111111
263.921ms  Single   A16nD   2030       ....02C0   WORD  Rd   Data   -----  1111111
263.922ms  Single   A16nD   2030       ....02C0   WORD  Wr   Data   -----  1111111
263.923ms  Single   A16nD   2062       ....10C6   WORD  Rd   Data   -----  1111111
263.924ms  Single   A16nD   2062       ....10C6   WORD  Wr   Data   -----  1111111
263.926ms  Single   A16nD   2030       ....02C0   WORD  Rd   Data   -----  1111111
263.928ms  Single   A16nD   2030       ....02C0   WORD  Wr   Data   -----  1111111
263.929ms  Single   A16nD   2062       ....10C6   WORD  Rd   Data   -----  1111111
263.930ms  Single   A16nD   2062       ....10C6   WORD  Wr   Data   -----  1111111
263.931ms  Single   A16nD   2030       ....02C0   WORD  Rd   Data   -----  1111111
263.932ms  Single   A16nD   2030       ....0280   WORD  Wr   Data   -----  1111111
263.933ms  Single   A16nD   2030       ....0280   WORD  Rd   Data   -----  1111111
263.934ms  Single   A16nD   2030       ....0683   WORD  Wr   Data   -----  1111111
                            Waiting for next closed orbit trigger
265.294ms  Single   A16nD   IACK=6     ......A0   LBYTE Rd   Data   IACK6  1011111
266.653ms  Single   A16nD   IACK=7     ......E1   LBYTE Rd   Data   IACK7  111111
```

4.4 Looking at ACNET variables

From an ACNET console page, select the "ACL Edit/Run" option from the Pgm_Tools menu which is located near the top right corner of the page. In the Action section of the ACL Edit Window, type 'read <variableName>' and type <ctrl>-r to run the command. When the command is run, the ACNET window will split into two parts, the command

source (which you typed) and the output. As an example, 'read V:PING' followed by <ctrl-r> should return a result like "V:PING = 5 ping" in the output pane.

Setting ACNET variables uses the same ACL Edit/Run application, but first you need to configure your ACNET console to allow variables to be set. This is done from the Utilities window. Click on the Setting option in the Utilities window and set the value to one hour. Back on the ACL Edit/Run page, you can now set variable values using commands of the form 'set <variableName>=<value>'. For example, to set the value of V:PING, you could use a command like 'set V:PING=5' (followed by <ctrl>-r).

5 Appendix: Node name/ACNET addresses

node name	ip address	ACNET address	Location
FCCTS0	131.225.126.243	0x0BD3	FCC3
TBPMA0	131.225.127.116	0x0C28	A0
TBPMA1	131.225.127.117	0x0C29	A1
TBPMA2	131.225.127.118	0x0C2A	A2
TBPMA3	131.225.127.233	0x0C2B	A3
TBPMA4	131.225.127.119	0x0C2C	A4
TBPMB0	131.225.127.115	0x0C2D	B0
TBPMB1	131.225.127.120	0x0C2E	B1
TBPMB2	131.225.127.121	0x0C2F	B2
TBPMB3	131.225.127.128	0x0C30	B3
TBPMB4	131.225.127.122	0x0C31	B4
TBPMC1	131.225.127.123	0x0C32	C1
TBPMC2	131.225.127.124	0x0C33	C2
TBPMC3	131.225.127.130	0x0C34	C3
TBPMC4	131.225.127.131	0x0C35	C4
TBPMD0	131.225.128.207	0x0C36	D0
TBPMD1	131.225.128.172	0x0C37	D1
TBPMD2	131.225.128.173	0x0C38	D2
TBPMD3	131.225.128.174	0x0C39	D3
TBPMD4	131.225.128.176	0x0C3A	D4
TBPME1	131.225.128.193	0x0C3B	E1
TBPME2	131.225.128.194	0x0C3C	E2
TBPME3	131.225.128.195	0x0C3D	E3
TBPME4	131.225.128.196	0x0C3E	E4
TBPMF1	131.225.128.197	0x0C3F	F1
TBPMF2	131.225.128.198	0x0C40	F2
TBPMF3	131.225.128.199	0x0C41	F3
TBPMF4	131.225.128.205	0x0C42	F4

6 Appendix: Full VME trace

AbsTime	Transfer	AM/XAM	Address	Data	Size	Cycle	Status	Iack	IRQ[7:1]*
0.0ns	Single	A16nD	IACK=6	......A0	LBYTE	Rd	Data	IACK6	1011111
1.358ms	Single	A16nD	IACK=7	......E1	LBYTE	Rd	Data	IACK7	111111
1.362ms	Single	A16nD	8314	FF000000	D32	Rd	Data	-----	111111
1.363ms	Single	A16nD	8314	1000000	D32	Wr	Data	-----	1111111
1.367ms	Single	A16nD	8314	FE000000	D32	Rd	Data	-----	1111111
1.368ms	Single	A16nD	8314	FE000000	D32	Wr	Data	-----	1111111
1.369ms	Single	A16nD	9314	FF000000	D32	Rd	Data	-----	1111111
1.370ms	Single	A16nD	9314	FF000000	D32	Wr	Data	-----	1111111
1.370ms	Single	A16nD	A314	FF000000	D32	Rd	Data	-----	1111111
1.371ms	Single	A16nD	A314	FF000000	D32	Wr	Data	-----	1111111
1.372ms	Single	A16nD	B314	FF000000	D32	Rd	Data	-----	1111111
1.373ms	Single	A16nD	B314	FF000000	D32	Wr	Data	-----	1111111
1.373ms	Single	A16nD	C314	FF000000	D32	Rd	Data	-----	1111111
1.374ms	Single	A16nD	C314	FF000000	D32	Wr	Data	-----	1111111
1.375ms	Single	A16nD	D314	FF000000	D32	Rd	Data	-----	1111111
1.376ms	Single	A16nD	D314	FF000000	D32	Wr	Data	-----	1111111
1.377ms	Single	A32nD	18000000	010FF001	D32	Rd	Data	-----	1111111
1.378ms	Single	A32nD	18000000	010FF000	D32	Wr	Data	-----	1111111
1.379ms	Single	A32nD	19000000	010FF001	D32	Rd	Data	-----	1111111
1.380ms	Single	A32nD	19000000	010FF000	D32	Wr	Data	-----	1111111
1.381ms	Single	A32nD	1A000000	010FF001	D32	Rd	Data	-----	1111111
1.382ms	Single	A32nD	1A000000	010FF000	D32	Wr	Data	-----	1111111
1.383ms	Single	A32nD	1B000000	010FF001	D32	Rd	Data	-----	1111111
1.384ms	Single	A32nD	1B000000	010FF000	D32	Wr	Data	-----	1111111
1.385ms	Single	A32nD	1C000000	010FF001	D32	Rd	Data	-----	1111111
1.386ms	Single	A32nD	1C000000	010FF000	D32	Wr	Data	-----	1111111
1.387ms	Single	A32nD	1D000000	010FF001	D32	Rd	Data	-----	1111111
1.388ms	Single	A32nD	1D000000	010FF000	D32	Wr	Data	-----	1111111
1.389ms	Single	A32nD	18100000	0000FFFF	D32	Rd	Data	-----	1111111
1.391ms	Single	A32nD	18180000	0	D32	Rd	Data	-----	1111111
1.392ms	Single	A32nD	18200000	1	D32	Rd	Data	-----	1111111
1.394ms	Single	A32nD	18280000	0000FFFF	D32	Rd	Data	-----	1111111
1.396ms	Single	A32nD	18300000	0	D32	Rd	Data	-----	1111111
1.397ms	Single	A32nD	18380000	0	D32	Rd	Data	-----	1111111
1.399ms	Single	A32nD	18400000	0	D32	Rd	Data	-----	1111111
1.400ms	Single	A32nD	18480000	0	D32	Rd	Data	-----	1111111
1.402ms	Single	A32nD	19100000	0	D32	Rd	Data	-----	1111111
1.404ms	Single	A32nD	19180000	0000FFFF	D32	Rd	Data	-----	1111111
1.406ms	Single	A32nD	19200000	1	D32	Rd	Data	-----	1111111
1.407ms	Single	A32nD	19280000	0	D32	Rd	Data	-----	1111111
1.409ms	Single	A32nD	19300000	0	D32	Rd	Data	-----	1111111
1.410ms	Single	A32nD	19380000	0000FFFF	D32	Rd	Data	-----	1111111
1.412ms	Single	A32nD	19400000	0	D32	Rd	Data	-----	1111111
1.414ms	Single	A32nD	19480000	0000FFFF	D32	Rd	Data	-----	1111111
1.415ms	Single	A32nD	1A100000	0	D32	Rd	Data	-----	1111111

1.417ms	Single	A32nD	1A180000	0000FFFF	D32	Rd	Data	-----	1111111
1.419ms	Single	A32nD	1A200000	1	D32	Rd	Data	-----	1111111
1.420ms	Single	A32nD	1A280000	0	D32	Rd	Data	-----	1111111
1.422ms	Single	A32nD	1A300000	1	D32	Rd	Data	-----	1111111
1.423ms	Single	A32nD	1A380000	0	D32	Rd	Data	-----	1111111
1.425ms	Single	A32nD	1A400000	0	D32	Rd	Data	-----	1111111
1.426ms	Single	A32nD	1A480000	0	D32	Rd	Data	-----	1111111
1.428ms	Single	A32nD	1B100000	1	D32	Rd	Data	-----	1111111
1.430ms	Single	A32nD	1B180000	0	D32	Rd	Data	-----	1111111
1.432ms	Single	A32nD	1B200000	0000FFFF	D32	Rd	Data	-----	1111111
1.433ms	Single	A32nD	1B280000	0	D32	Rd	Data	-----	1111111
1.435ms	Single	A32nD	1B300000	0	D32	Rd	Data	-----	1111111
1.436ms	Single	A32nD	1B380000	0	D32	Rd	Data	-----	1111111
1.438ms	Single	A32nD	1B400000	0	D32	Rd	Data	-----	1111111
1.440ms	Single	A32nD	1B480000	0000FFFF	D32	Rd	Data	-----	1111111
1.441ms	Single	A32nD	1C100000	0	D32	Rd	Data	-----	1111111
1.443ms	Single	A32nD	1C180000	1	D32	Rd	Data	-----	1111111
1.445ms	Single	A32nD	1C200000	0	D32	Rd	Data	-----	1111111
1.446ms	Single	A32nD	1C280000	0	D32	Rd	Data	-----	1111111
1.448ms	Single	A32nD	1C300000	0	D32	Rd	Data	-----	1111111
1.449ms	Single	A32nD	1C380000	0	D32	Rd	Data	-----	1111111
1.451ms	Single	A32nD	1C400000	0	D32	Rd	Data	-----	1111111
1.452ms	Single	A32nD	1C480000	0	D32	Rd	Data	-----	1111111
1.454ms	Single	A32nD	1D100000	1	D32	Rd	Data	-----	1111111
1.456ms	Single	A32nD	1D180000	0	D32	Rd	Data	-----	1111111
1.458ms	Single	A32nD	1D200000	0	D32	Rd	Data	-----	1111111
1.459ms	Single	A32nD	1D280000	1	D32	Rd	Data	-----	1111111
1.461ms	Single	A32nD	1D300000	0000FFFF	D32	Rd	Data	-----	1111111
1.462ms	Single	A32nD	1D380000	1	D32	Rd	Data	-----	1111111
1.464ms	Single	A32nD	1D400000	0000FFFF	D32	Rd	Data	-----	1111111
1.466ms	Single	A32nD	1D480000	0	D32	Rd	Data	-----	1111111
1.469ms	Single	A16nD	203A	0000	WORD	Rd	Data	-----	1111111
1.471ms	Single	A16nD	203C	0000	WORD	Rd	Data	-----	1111111
1.472ms	Single	A16nD	203E	0000	WORD	Rd	Data	-----	1111111
1.473ms	Single	A16nD	2040	0000	WORD	Rd	Data	-----	1111111
1.475ms	Single	A16nD	2054	0000	WORD	Rd	Data	-----	1111111
1.476ms	Single	A16nD	2052	0000	WORD	Rd	Data	-----	1111111
1.525ms	Single	A32nD	18010000	016B9006	D32	Wr	Data	-----	1111111
1.526ms	Single	A32nD	18010010	016B9006	D32	Wr	Data	-----	1111111
1.528ms	Single	A32nD	18011440	FF001E08	D32	Rd	Data	-----	1111111
1.529ms	Single	A32nD	18011440	FF001E08	D32	Wr	Data	-----	1111111
1.530ms	Single	A32nD	18011C40	FF001E08	D32	Rd	Data	-----	1111111
1.532ms	Single	A32nD	18011C40	FF001E08	D32	Wr	Data	-----	1111111
1.533ms	Single	A32nD	18010000	0E738F06	D32	Wr	Data	-----	1111111
1.534ms	Single	A32nD	18010010	0E738F06	D32	Wr	Data	-----	1111111
1.534ms	Single	A32nD	18020000	016B9006	D32	Wr	Data	-----	1111111
1.535ms	Single	A32nD	18020010	016B9006	D32	Wr	Data	-----	1111111
1.536ms	Single	A32nD	18021440	FF001E08	D32	Rd	Data	-----	1111111
1.538ms	Single	A32nD	18021440	FF001E08	D32	Wr	Data	-----	1111111

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1.539ms   Single   A32nD   18021C40   FF001E08   D32   Rd   Data   -----   1111111
1.541ms   Single   A32nD   18021C40   FF001E08   D32   Wr   Data   -----   1111111
1.542ms   Single   A32nD   18020000   0E738F06   D32   Wr   Data   -----   1111111
1.542ms   Single   A32nD   18020010   0E738F06   D32   Wr   Data   -----   1111111
1.543ms   Single   A32nD   18030000   016B9006   D32   Wr   Data   -----   1111111
1.544ms   Single   A32nD   18030010   016B9006   D32   Wr   Data   -----   1111111
1.545ms   Single   A32nD   18031440   FF001E08   D32   Rd   Data   -----   1111111
1.547ms   Single   A32nD   18031440   FF001E08   D32   Wr   Data   -----   1111111
1.548ms   Single   A32nD   18031C40   FF001E08   D32   Rd   Data   -----   1111111
1.550ms   Single   A32nD   18031C40   FF001E08   D32   Wr   Data   -----   1111111
1.550ms   Single   A32nD   18030000   0E738F06   D32   Wr   Data   -----   1111111
1.551ms   Single   A32nD   18030010   0E738F06   D32   Wr   Data   -----   1111111
1.552ms   Single   A32nD   18040000   016B9006   D32   Wr   Data   -----   1111111
1.553ms   Single   A32nD   18040010   016B9006   D32   Wr   Data   -----   1111111
1.554ms   Single   A32nD   18041440   FF001E08   D32   Rd   Data   -----   1111111
1.556ms   Single   A32nD   18041440   FF001E08   D32   Wr   Data   -----   1111111
1.557ms   Single   A32nD   18041C40   FF001E08   D32   Rd   Data   -----   1111111
1.559ms   Single   A32nD   18041C40   FF001E08   D32   Wr   Data   -----   1111111
1.559ms   Single   A32nD   18040000   0E738F06   D32   Wr   Data   -----   1111111
1.560ms   Single   A32nD   18040010   0E738F06   D32   Wr   Data   -----   1111111
1.561ms   Single   A32nD   18000000   010FF000   D32   Rd   Data   -----   1111111
1.562ms   Single   A32nD   18000000   010FF000   D32   Rd   Data   -----   1111111
1.563ms   Single   A32nD   18000000   010FF001   D32   Wr   Data   -----   1111111
1.564ms   Single   A32nD   19010000   016B9006   D32   Wr   Data   -----   1111111
1.565ms   Single   A32nD   19010010   016B9006   D32   Wr   Data   -----   1111111
1.566ms   Single   A32nD   19011440   FF001E08   D32   Rd   Data   -----   1111111
1.568ms   Single   A32nD   19011440   FF001E08   D32   Wr   Data   -----   1111111
1.569ms   Single   A32nD   19011C40   FF001E08   D32   Rd   Data   -----   1111111
1.571ms   Single   A32nD   19011C40   FF001E08   D32   Wr   Data   -----   1111111
1.571ms   Single   A32nD   19010000   0E738F06   D32   Wr   Data   -----   1111111
1.572ms   Single   A32nD   19010010   0E738F06   D32   Wr   Data   -----   1111111
1.573ms   Single   A32nD   19020000   016B9006   D32   Wr   Data   -----   1111111
1.574ms   Single   A32nD   19020010   016B9006   D32   Wr   Data   -----   1111111
1.575ms   Single   A32nD   19021440   FF001E08   D32   Rd   Data   -----   1111111
1.577ms   Single   A32nD   19021440   FF001E08   D32   Wr   Data   -----   1111111
1.578ms   Single   A32nD   19021C40   FF001E08   D32   Rd   Data   -----   1111111
1.579ms   Single   A32nD   19021C40   FF001E08   D32   Wr   Data   -----   1111111
1.580ms   Single   A32nD   19020000   0E738F06   D32   Wr   Data   -----   1111111
1.581ms   Single   A32nD   19020010   0E738F06   D32   Wr   Data   -----   1111111
1.582ms   Single   A32nD   19030000   016B9006   D32   Wr   Data   -----   1111111
1.583ms   Single   A32nD   19030010   016B9006   D32   Wr   Data   -----   1111111
1.584ms   Single   A32nD   19031440   FF001E08   D32   Rd   Data   -----   1111111
1.585ms   Single   A32nD   19031440   FF001E08   D32   Wr   Data   -----   1111111
1.587ms   Single   A32nD   19031C40   FF001E08   D32   Rd   Data   -----   1111111
1.588ms   Single   A32nD   19031C40   FF001E08   D32   Wr   Data   -----   1111111
1.589ms   Single   A32nD   19030000   0E738F06   D32   Wr   Data   -----   1111111
1.590ms   Single   A32nD   19030010   0E738F06   D32   Wr   Data   -----   1111111
1.591ms   Single   A32nD   19040000   016B9006   D32   Wr   Data   -----   1111111
1.591ms   Single   A32nD   19040010   016B9006   D32   Wr   Data   -----   1111111
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1.593ms   Single   A32nD   19041440   FF001E08   D32   Rd   Data   -----   1111111
1.594ms   Single   A32nD   19041440   FF001E08   D32   Wr   Data   -----   1111111
1.596ms   Single   A32nD   19041C40   FF001E08   D32   Rd   Data   -----   1111111
1.597ms   Single   A32nD   19041C40   FF001E08   D32   Wr   Data   -----   1111111
1.598ms   Single   A32nD   19040000   0E738F06   D32   Wr   Data   -----   1111111
1.599ms   Single   A32nD   19040010   0E738F06   D32   Wr   Data   -----   1111111
1.600ms   Single   A32nD   19000000   010FF000   D32   Rd   Data   -----   1111111
1.601ms   Single   A32nD   19000000   010FF000   D32   Rd   Data   -----   1111111
1.602ms   Single   A32nD   19000000   010FF001   D32   Wr   Data   -----   1111111
1.603ms   Single   A32nD   1A010000   016B9006   D32   Wr   Data   -----   1111111
1.603ms   Single   A32nD   1A010010   016B9006   D32   Wr   Data   -----   1111111
1.605ms   Single   A32nD   1A011440   FF001E08   D32   Rd   Data   -----   1111111
1.606ms   Single   A32nD   1A011440   FF001E08   D32   Wr   Data   -----   1111111
1.607ms   Single   A32nD   1A011C40   FF001E08   D32   Rd   Data   -----   1111111
1.609ms   Single   A32nD   1A011C40   FF001E08   D32   Wr   Data   -----   1111111
1.610ms   Single   A32nD   1A010000   0E738F06   D32   Wr   Data   -----   1111111
1.611ms   Single   A32nD   1A010010   0E738F06   D32   Wr   Data   -----   1111111
1.611ms   Single   A32nD   1A020000   016B9006   D32   Wr   Data   -----   1111111
1.612ms   Single   A32nD   1A020010   016B9006   D32   Wr   Data   -----   1111111
1.614ms   Single   A32nD   1A021440   FF001E08   D32   Rd   Data   -----   1111111
1.615ms   Single   A32nD   1A021440   FF001E08   D32   Wr   Data   -----   1111111
1.616ms   Single   A32nD   1A021C40   FF001E08   D32   Rd   Data   -----   1111111
1.618ms   Single   A32nD   1A021C40   FF001E08   D32   Wr   Data   -----   1111111
1.619ms   Single   A32nD   1A020000   0E738F06   D32   Wr   Data   -----   1111111
1.620ms   Single   A32nD   1A020010   0E738F06   D32   Wr   Data   -----   1111111
1.620ms   Single   A32nD   1A030000   016B9006   D32   Wr   Data   -----   1111111
1.621ms   Single   A32nD   1A030010   016B9006   D32   Wr   Data   -----   1111111
1.622ms   Single   A32nD   1A031440   FF001E08   D32   Rd   Data   -----   1111111
1.624ms   Single   A32nD   1A031440   FF001E08   D32   Wr   Data   -----   1111111
1.625ms   Single   A32nD   1A031C40   FF001E08   D32   Rd   Data   -----   1111111
1.627ms   Single   A32nD   1A031C40   FF001E08   D32   Wr   Data   -----   1111111
1.628ms   Single   A32nD   1A030000   0E738F06   D32   Wr   Data   -----   1111111
1.628ms   Single   A32nD   1A030010   0E738F06   D32   Wr   Data   -----   1111111
1.629ms   Single   A32nD   1A040000   016B9006   D32   Wr   Data   -----   1111111
1.630ms   Single   A32nD   1A040010   016B9006   D32   Wr   Data   -----   1111111
1.631ms   Single   A32nD   1A041440   FF001E08   D32   Rd   Data   -----   1111111
1.633ms   Single   A32nD   1A041440   FF001E08   D32   Wr   Data   -----   1111111
1.634ms   Single   A32nD   1A041C40   FF001E08   D32   Rd   Data   -----   1111111
1.636ms   Single   A32nD   1A041C40   FF001E08   D32   Wr   Data   -----   1111111
1.636ms   Single   A32nD   1A040000   0E738F06   D32   Wr   Data   -----   1111111
1.637ms   Single   A32nD   1A040010   0E738F06   D32   Wr   Data   -----   1111111
1.638ms   Single   A32nD   1A000000   010FF000   D32   Rd   Data   -----   1111111
1.639ms   Single   A32nD   1A000000   010FF000   D32   Rd   Data   -----   1111111
1.640ms   Single   A32nD   1A000000   010FF001   D32   Wr   Data   -----   1111111
1.641ms   Single   A32nD   1B010000   016B9006   D32   Wr   Data   -----   1111111
1.642ms   Single   A32nD   1B010010   016B9006   D32   Wr   Data   -----   1111111
1.643ms   Single   A32nD   1B011440   FF001E08   D32   Rd   Data   -----   1111111
1.645ms   Single   A32nD   1B011440   FF001E08   D32   Wr   Data   -----   1111111
1.646ms   Single   A32nD   1B011C40   FF001E08   D32   Rd   Data   -----   1111111
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1.648ms   Single   A32nD   1B011C40   FF001E08   D32   Wr   Data   -----   1111111
1.648ms   Single   A32nD   1B010000   0E738F06   D32   Wr   Data   -----   1111111
1.649ms   Single   A32nD   1B010010   0E738F06   D32   Wr   Data   -----   1111111
1.650ms   Single   A32nD   1B020000   016B9006   D32   Wr   Data   -----   1111111
1.651ms   Single   A32nD   1B020010   016B9006   D32   Wr   Data   -----   1111111
1.652ms   Single   A32nD   1B021440   FF001E08   D32   Rd   Data   -----   1111111
1.654ms   Single   A32nD   1B021440   FF001E08   D32   Wr   Data   -----   1111111
1.655ms   Single   A32nD   1B021C40   FF001E08   D32   Rd   Data   -----   1111111
1.656ms   Single   A32nD   1B021C40   FF001E08   D32   Wr   Data   -----   1111111
1.657ms   Single   A32nD   1B020000   0E738F06   D32   Wr   Data   -----   1111111
1.658ms   Single   A32nD   1B020010   0E738F06   D32   Wr   Data   -----   1111111
1.659ms   Single   A32nD   1B030000   016B9006   D32   Wr   Data   -----   1111111
1.660ms   Single   A32nD   1B030010   016B9006   D32   Wr   Data   -----   1111111
1.661ms   Single   A32nD   1B031440   FF001E08   D32   Rd   Data   -----   1111111
1.662ms   Single   A32nD   1B031440   FF001E08   D32   Wr   Data   -----   1111111
1.664ms   Single   A32nD   1B031C40   FF001E08   D32   Rd   Data   -----   1111111
1.665ms   Single   A32nD   1B031C40   FF001E08   D32   Wr   Data   -----   1111111
1.666ms   Single   A32nD   1B030000   0E738F06   D32   Wr   Data   -----   1111111
1.667ms   Single   A32nD   1B030010   0E738F06   D32   Wr   Data   -----   1111111
1.668ms   Single   A32nD   1B040000   016B9006   D32   Wr   Data   -----   1111111
1.668ms   Single   A32nD   1B040010   016B9006   D32   Wr   Data   -----   1111111
1.670ms   Single   A32nD   1B041440   FF001E08   D32   Rd   Data   -----   1111111
1.671ms   Single   A32nD   1B041440   FF001E08   D32   Wr   Data   -----   1111111
1.672ms   Single   A32nD   1B041C40   FF001E08   D32   Rd   Data   -----   1111111
1.674ms   Single   A32nD   1B041C40   FF001E08   D32   Wr   Data   -----   1111111
1.675ms   Single   A32nD   1B040000   0E738F06   D32   Wr   Data   -----   1111111
1.676ms   Single   A32nD   1B040010   0E738F06   D32   Wr   Data   -----   1111111
1.676ms   Single   A32nD   1B000000   010FF000   D32   Rd   Data   -----   1111111
1.678ms   Single   A32nD   1B000000   010FF000   D32   Rd   Data   -----   1111111
1.679ms   Single   A32nD   1B000000   010FF001   D32   Wr   Data   -----   1111111
1.680ms   Single   A32nD   1C010000   016B9006   D32   Wr   Data   -----   1111111
1.680ms   Single   A32nD   1C010010   016B9006   D32   Wr   Data   -----   1111111
1.682ms   Single   A32nD   1C011440   FF001E08   D32   Rd   Data   -----   1111111
1.683ms   Single   A32nD   1C011440   FF001E08   D32   Wr   Data   -----   1111111
1.684ms   Single   A32nD   1C011C40   FF001E08   D32   Rd   Data   -----   1111111
1.686ms   Single   A32nD   1C011C40   FF001E08   D32   Wr   Data   -----   1111111
1.687ms   Single   A32nD   1C010000   0E738F06   D32   Wr   Data   -----   1111111
1.688ms   Single   A32nD   1C010010   0E738F06   D32   Wr   Data   -----   1111111
1.688ms   Single   A32nD   1C020000   016B9006   D32   Wr   Data   -----   1111111
1.689ms   Single   A32nD   1C020010   016B9006   D32   Wr   Data   -----   1111111
1.690ms   Single   A32nD   1C021440   FF001E08   D32   Rd   Data   -----   1111111
1.692ms   Single   A32nD   1C021440   FF001E08   D32   Wr   Data   -----   1111111
1.693ms   Single   A32nD   1C021C40   FF001E08   D32   Rd   Data   -----   1111111
1.695ms   Single   A32nD   1C021C40   FF001E08   D32   Wr   Data   -----   1111111
1.696ms   Single   A32nD   1C020000   0E738F06   D32   Wr   Data   -----   1111111
1.696ms   Single   A32nD   1C020010   0E738F06   D32   Wr   Data   -----   1111111
1.697ms   Single   A32nD   1C030000   016B9006   D32   Wr   Data   -----   1111111
1.698ms   Single   A32nD   1C030010   016B9006   D32   Wr   Data   -----   1111111
1.699ms   Single   A32nD   1C031440   FF001E08   D32   Rd   Data   -----   1111111
```

```
1.701ms   Single   A32nD   1C031440   FF001E08   D32   Wr   Data   -----   1111111
1.702ms   Single   A32nD   1C031C40   FF001E08   D32   Rd   Data   -----   1111111
1.704ms   Single   A32nD   1C031C40   FF001E08   D32   Wr   Data   -----   1111111
1.704ms   Single   A32nD   1C030000   0E738F06   D32   Wr   Data   -----   1111111
1.705ms   Single   A32nD   1C030010   0E738F06   D32   Wr   Data   -----   1111111
1.706ms   Single   A32nD   1C040000   016B9006   D32   Wr   Data   -----   1111111
1.707ms   Single   A32nD   1C040010   016B9006   D32   Wr   Data   -----   1111111
1.708ms   Single   A32nD   1C041440   FF001E08   D32   Rd   Data   -----   1111111
1.710ms   Single   A32nD   1C041440   FF001E08   D32   Wr   Data   -----   1111111
1.711ms   Single   A32nD   1C041C40   FF001E08   D32   Rd   Data   -----   1111111
1.712ms   Single   A32nD   1C041C40   FF001E08   D32   Wr   Data   -----   1111111
1.713ms   Single   A32nD   1C040000   0E738F06   D32   Wr   Data   -----   1111111
1.714ms   Single   A32nD   1C040010   0E738F06   D32   Wr   Data   -----   1111111
1.715ms   Single   A32nD   1C000000   010FF000   D32   Rd   Data   -----   1111111
1.716ms   Single   A32nD   1C000000   010FF000   D32   Rd   Data   -----   1111111
1.717ms   Single   A32nD   1C000000   010FF001   D32   Wr   Data   -----   1111111
1.718ms   Single   A32nD   1D010000   016B9006   D32   Wr   Data   -----   1111111
1.719ms   Single   A32nD   1D010010   016B9006   D32   Wr   Data   -----   1111111
1.720ms   Single   A32nD   1D011440   FF001E08   D32   Rd   Data   -----   1111111
1.722ms   Single   A32nD   1D011440   FF001E08   D32   Wr   Data   -----   1111111
1.723ms   Single   A32nD   1D011C40   FF001E08   D32   Rd   Data   -----   1111111
1.725ms   Single   A32nD   1D011C40   FF001E08   D32   Wr   Data   -----   1111111
1.725ms   Single   A32nD   1D010000   0E738F06   D32   Wr   Data   -----   1111111
1.726ms   Single   A32nD   1D010010   0E738F06   D32   Wr   Data   -----   1111111
1.727ms   Single   A32nD   1D020000   016B9006   D32   Wr   Data   -----   1111111
1.728ms   Single   A32nD   1D020010   016B9006   D32   Wr   Data   -----   1111111
1.729ms   Single   A32nD   1D021440   FF001E08   D32   Rd   Data   -----   1111111
1.731ms   Single   A32nD   1D021440   FF001E08   D32   Wr   Data   -----   1111111
1.732ms   Single   A32nD   1D021C40   FF001E08   D32   Rd   Data   -----   1111111
1.733ms   Single   A32nD   1D021C40   FF001E08   D32   Wr   Data   -----   1111111
1.734ms   Single   A32nD   1D020000   0E738F06   D32   Wr   Data   -----   1111111
1.735ms   Single   A32nD   1D020010   0E738F06   D32   Wr   Data   -----   1111111
1.736ms   Single   A32nD   1D030000   016B9006   D32   Wr   Data   -----   1111111
1.737ms   Single   A32nD   1D030010   016B9006   D32   Wr   Data   -----   1111111
1.738ms   Single   A32nD   1D031440   FF001E08   D32   Rd   Data   -----   1111111
1.739ms   Single   A32nD   1D031440   FF001E08   D32   Wr   Data   -----   1111111
1.741ms   Single   A32nD   1D031C40   FF001E08   D32   Rd   Data   -----   1111111
1.742ms   Single   A32nD   1D031C40   FF001E08   D32   Wr   Data   -----   1111111
1.743ms   Single   A32nD   1D030000   0E738F06   D32   Wr   Data   -----   1111111
1.744ms   Single   A32nD   1D030010   0E738F06   D32   Wr   Data   -----   1111111
1.745ms   Single   A32nD   1D040000   016B9006   D32   Wr   Data   -----   1111111
1.745ms   Single   A32nD   1D040010   016B9006   D32   Wr   Data   -----   1111111
1.747ms   Single   A32nD   1D041440   FF001E08   D32   Rd   Data   -----   1111111
1.748ms   Single   A32nD   1D041440   FF001E08   D32   Wr   Data   -----   1111111
1.749ms   Single   A32nD   1D041C40   FF001E08   D32   Rd   Data   -----   1111111
1.751ms   Single   A32nD   1D041C40   FF001E08   D32   Wr   Data   -----   1111111
1.752ms   Single   A32nD   1D040000   0E738F06   D32   Wr   Data   -----   1111111
1.753ms   Single   A32nD   1D040010   0E738F06   D32   Wr   Data   -----   1111111
1.753ms   Single   A32nD   1D000000   010FF000   D32   Rd   Data   -----   1111111
```

```
1.755ms    Single    A32nD    1D000000    010FF000    D32      Rd     Data     -----    1111111
1.756ms    Single    A32nD    1D000000    010FF001    D32      Wr     Data     -----    1111111



          --
TRIG:     --   0.0ns             Single    A16nD       IACK=6        ......A1          LBYTE    Rd    Data
          --
1         --   171.817ms         Single    A16nD       IACK=7        ......E1          LBYTE    Rd    Data
          --
2         --   171.822ms         Single    A16nD       8314          FF000000          D32      Rd    Data
          --
3         --   171.824ms         Single    A16nD       8314          1000000           D32      Wr    Data
          --
4         --   171.833ms         Single    A16nD       8314          FE000000          D32      Rd    Data
          --
5         --   171.834ms         Single    A16nD       8314          FE000000          D32      Wr    Data
          --
6         --   171.835ms         Single    A16nD       9314          FF000000          D32      Rd    Data
          --
7         --   171.835ms         Single    A16nD       9314          FF000000          D32      Wr    Data
          --
8         --   171.836ms         Single    A16nD       A314          FF000000          D32      Rd    Data
          --
9         --   171.837ms         Single    A16nD       A314          FF000000          D32      Wr    Data
          --
10        --   171.838ms         Single    A16nD       B314          FF000000          D32      Rd    Data
          --
11        --   171.838ms         Single    A16nD       B314          FF000000          D32      Wr    Data
          --
12        --   171.839ms         Single    A16nD       C314          FF000000          D32      Rd    Data
          --
13        --   171.840ms         Single    A16nD       C314          FF000000          D32      Wr    Data
          --
14        --   171.841ms         Single    A16nD       D314          FF000000          D32      Rd    Data
          --
15        --   171.842ms         Single    A16nD       D314          FF000000          D32      Wr    Data
          --
16        --   171.844ms         Single    A32nD       18000000      010FF001          D32      Rd    Data
          --
17        --   171.845ms         Single    A32nD       18000000      010FF000          D32      Wr    Data
          --
18        --   171.846ms         Single    A32nD       19000000      010FF001          D32      Rd    Data
          --
19        --   171.847ms         Single    A32nD       19000000      010FF000          D32      Wr    Data
          --
20        --   171.848ms         Single    A32nD       1A000000      010FF001          D32      Rd    Data
          --
21        --   171.850ms         Single    A32nD       1A000000      010FF000          D32      Wr    Data
          --
22        --   171.851ms         Single    A32nD       1B000000      010FF001          D32      Rd    Data
          --
23        --   171.852ms         Single    A32nD       1B000000      010FF000          D32      Wr    Data
          --
24        --   171.853ms         Single    A32nD       1C000000      010FF001          D32      Rd    Data
          --
25        --   171.854ms         Single    A32nD       1C000000      010FF000          D32      Wr    Data
          --
26        --   171.856ms         Single    A32nD       1D000000      010FF001          D32      Rd    Data
          --
27        --   171.857ms         Single    A32nD       1D000000      010FF000          D32      Wr    Data
          --
28        --   171.859ms         Single    A32nD       18000020                400     D32      Wr    Data
          --
29        --   171.859ms         Single    A32nD       18000024      8800000C          D32      Wr    Data
          --
30        --   171.860ms         Single    A16nD       8220          007F0000          D32      Wr    Data
          --
31        --   171.860ms         Single    A16nD       8218                 40000      D32      Wr    Data
          --
32        --   171.861ms         Single    A16nD       8204                       0    D32      Wr    Data
          --
33        --   171.861ms         Single    A16nD       8220          0C000088          D32      Wr    Data
          3-                                                        25079800
34        --   171.864ms         Start     A32sMBLT    FFF           E000100000001     D64      Wr    Data
```

290	3---	171.903ms	Start	A32sMBLT	2507A000 FFF	F00010000FFFF	D64	Wr	Data
32738	3---	176.859ms	Start	A32sMBLT	24980800 FFF	F0001FFFD0005	D64	Wr	Data
32802	---	176.870ms	Single	A16nD	IACK=7	......E1	LBYTE	Rd	Data
32803	---	176.874ms	Single	A16nD	8314	10000	D32	Rd	Data
32804	---	176.875ms	Single	A16nD	8314	10000	D32	Wr	Data
32805	---	176.970ms	Single	A32nD	19000020	400	D32	Wr	Data
32806	---	176.971ms	Single	A32nD	19000024	8800000C	D32	Wr	Data
32807	---	176.971ms	Single	A16nD	9220	007F0000	D32	Wr	Data
32808	---	176.972ms	Single	A16nD	9218	40000	D32	Wr	Data
32809	---	176.972ms	Single	A16nD	9204	0	D32	Wr	Data
32810	---	176.972ms	Single	A16nD	9220	0C000088	D32	Wr	Data
32811	3---	176.976ms	Start	A32sMBLT	24878800 000	0FFFF00010000	D64	Wr	Data
65515	3---	181.963ms	Start	A32sMBLT	2417F800 FFF	F000000010002	D64	Wr	Data
65579	---	181.974ms	Single	A16nD	IACK=7	......E3	LBYTE	Rd	Data
65580	---	181.978ms	Single	A16nD	9314	10000	D32	Rd	Data
65581	---	181.979ms	Single	A16nD	9314	10000	D32	Wr	Data
65582	---	182.068ms	Single	A32nD	1A000020	400	D32	Wr	Data
65583	---	182.069ms	Single	A32nD	1A000024	8800000C	D32	Wr	Data
65584	---	182.069ms	Single	A16nD	A220	007F0000	D32	Wr	Data
65585	---	182.069ms	Single	A16nD	A218	40000	D32	Wr	Data
65586	---	182.070ms	Single	A16nD	A204	0	D32	Wr	Data
65587	---	182.070ms	Single	A16nD	A220	0C000088	D32	Wr	Data
65588	3---	182.074ms	Start	A32sMBLT	24077800 FFF	F000100000004	D64	Wr	Data
98292	3---	187.064ms	Start	A32sMBLT	2397E800 FFF	E0003FFFF0003	D64	Wr	Data
98356	---	187.075ms	Single	A16nD	IACK=7	......E5	LBYTE	Rd	Data
98357	---	187.079ms	Single	A16nD	A314	10000	D32	Rd	Data
98358	---	187.080ms	Single	A16nD	A314	10000	D32	Wr	Data
98359	---	187.168ms	Single	A32nD	1B000020	400	D32	Wr	Data
98360	---	187.169ms	Single	A32nD	1B000024	8800000C	D32	Wr	Data
98361	---	187.169ms	Single	A16nD	B220	007F0000	D32	Wr	Data
98362	---	187.170ms	Single	A16nD	B218	40000	D32	Wr	Data
98363	---	187.170ms	Single	A16nD	B204	0	D32	Wr	Data
98364	---	187.171ms	Single	A16nD	B220	0C000088	D32	Wr	Data
98365	3---	187.174ms	Start	A32sMBLT	23876800 000	10001	D64	Wr	Data
131069	3---	192.162ms	Start	A32sMBLT	2317D800 000	00001FFFF0001	D64	Wr	Data
131133	---	192.173ms	Single	A16nD	IACK=7	......E7	LBYTE	Rd	Data
131134	---	192.177ms	Single	A16nD	B314	10000	D32	Rd	Data
131135	---	192.178ms	Single	A16nD	B314	10000	D32	Wr	Data
131136	---	192.267ms	Single	A32nD	1C000020	400	D32	Wr	Data

131137	--	192.268ms	Single	A32nD	1C000024	8800000C	D32	Wr	Data
131138	--	192.268ms	Single	A16nD	C220	007F0000	D32	Wr	Data
131139	--	192.269ms	Single	A16nD	C218	40000	D32	Wr	Data
131140	--	192.269ms	Single	A16nD	C204	0	D32	Wr	Data
131141	--	192.270ms	Single	A16nD	C220	0C000088	D32	Wr	Data
131142	3--	192.273ms	Start	A32sMBLT	23075800 000	1FFFFFFFE0001	D64	Wr	Data
163846	3--	197.349ms	Start	A32sMBLT	2297C800 FFF	D0002FFFF0003	D64	Wr	Data
163910	--	197.362ms	Single	A16nD	IACK=7	......E9	LBYTE	Rd	Data
163911	--	197.365ms	Single	A16nD	C314	10000	D32	Rd	Data
163912	--	197.366ms	Single	A16nD	C314	10000	D32	Wr	Data
163913	--	197.470ms	Single	A32nD	1D000020	400	D32	Wr	Data
163914	--	197.470ms	Single	A32nD	1D000024	8800000C	D32	Wr	Data
163915	--	197.471ms	Single	A16nD	D220	007F0000	D32	Wr	Data
163916	--	197.471ms	Single	A16nD	D218	40000	D32	Wr	Data
163917	--	197.472ms	Single	A16nD	D204	0	D32	Wr	Data
163918	--	197.472ms	Single	A16nD	D220	0C000088	D32	Wr	Data
163919	3--	197.476ms	Start	A32sMBLT	22874800 000	0FFFD00000000	D64	Wr	Data
196623	3--	202.650ms	Start	A32sMBLT	2217B800 000	0FFFE0002FFFE	D64	Wr	Data
196687	--	202.663ms	Single	A16nD	IACK=7	......EB	LBYTE	Rd	Data
196688	--	202.667ms	Single	A16nD	D314	10000	D32	Rd	Data
196689	--	202.668ms	Single	A16nD	D314	10000	D32	Wr	Data
196690	--	202.762ms	Single	A16nD	203A	0000	WORD	Rd	Data
196691	--	202.763ms	Single	A16nD	203C	0000	WORD	Rd	Data
196692	--	202.765ms	Single	A16nD	203E	0000	WORD	Rd	Data
196693	--	202.766ms	Single	A16nD	2040	0000	WORD	Rd	Data
196694	--	202.769ms	Single	A16nD	2044	0000	WORD	Rd	Data
196695	--	202.771ms	Single	A16nD	2042	0000	WORD	Rd	Data
196696	--	202.773ms	Single	A16nD	2048	0000	WORD	Rd	Data
196697	--	202.774ms	Single	A16nD	2046	0000	WORD	Rd	Data
196698	--	202.818ms	Single	A16nD	2030	1603	WORD	Rd	Data
196699	--	202.819ms	Single	A16nD	2030	1000	WORD	Wr	Data
196700	--	202.820ms	Single	A16nD	2030	1000	WORD	Rd	Data
196701	--	202.821ms	Single	A16nD	2030	1040	WORD	Wr	Data
196702	--	202.822ms	Single	A16nD	2060	....09A1	WORD	Rd	Data
196703	--	202.823ms	Single	A16nD	2060	....09A1	WORD	Wr	Data
196704	--	202.826ms	Single	A16nD	2066	0000	WORD	Rd	Data
196705	--	202.829ms	Single	A16nD	2034	....00AA	WORD	Wr	Data
196706	--	202.830ms	Single	A16nD	2036	0010	WORD	Wr	Data
196707	--	202.830ms	Single	A16nD	2010	0001	WORD	Wr	Data

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          --
196708    --   202.831ms        Single    A16nD       2012          ....0001          WORD      Wr     Data
          --
196709    --   202.832ms        Single    A16nD       2014          ....0001          WORD      Wr     Data
          --
196710    --   202.833ms        Single    A16nD       2016          ....0001          WORD      Wr     Data
          --
196711    --   202.834ms        Single    A16nD       2018          ....0001          WORD      Wr     Data
          --
196712    --   202.835ms        Single    A16nD       201A          ....0001          WORD      Wr     Data
          --
196713    --   202.835ms        Single    A16nD       201C          ....0001          WORD      Wr     Data
          --
196714    --   202.836ms        Single    A16nD       201E          ....0001          WORD      Wr     Data
          --
196715    --   202.837ms        Single    A16nD       2030          ....0040          WORD      Wr     Data
          --
196716    --   202.838ms        Single    A16nD       2026          ....005F          WORD      Wr     Data
          --
196717    --   202.839ms        Single    A16nD       2030          ....0040          WORD      Rd     Data
          --
196718    --   202.840ms        Single    A16nD       2030          ....00C0          WORD      Wr     Data
          --
196719    --   202.843ms        Single    A16nD       2060          ....01A0          WORD      Wr     Data
          --
196720    --   202.844ms        Single    A16nD       2070          ....0009          WORD      Wr     Data
          --
196721    --   205.776ms        Single    A32nD       18000000      0                 D32       Wr     Data
          --
203937    --   215.294ms        Single    A32nD       19000000      0                 D32       Wr     Data
          --
211153    --   224.810ms        Single    A32nD       1A000000      0                 D32       Wr     Data
          --
218369    --   234.311ms        Single    A32nD       1B000000      0                 D32       Wr     Data
          --
225585    --   243.808ms        Single    A32nD       1C000000      0                 D32       Wr     Data
          --
232801    --   253.653ms        Single    A32nD       1D000000      0                 D32       Wr     Data
          --
240017    --   263.317ms        Single    A16nD       8310          1010000           D32       Rd     Data
          --
240018    --   263.318ms        Single    A16nD       8310          10000             D32       Wr     Data
          --
240019    --   263.319ms        Single    A16nD       8314          FFFFFFFF          D32       Wr     Data
          --
240020    --   263.319ms        Single    A16nD       8310          10000             D32       Rd     Data
          --
240021    --   263.320ms        Single    A16nD       8310          1010000           D32       Wr     Data
          --
240022    --   263.321ms        Single    A32nD       18000008      000000FF          D32       Wr     Data
          --
240064    --   263.353ms        Single    A16nD       9310          10000             D32       Rd     Data
          --
240065    --   263.354ms        Single    A16nD       9310          10000             D32       Wr     Data
          --
240066    --   263.354ms        Single    A16nD       9314          FFFFFFFF          D32       Wr     Data
          --
240067    --   263.355ms        Single    A16nD       9310          10000             D32       Rd     Data
          --
240068    --   263.356ms        Single    A16nD       9310          10000             D32       Wr     Data
          --
240069    --   263.356ms        Single    A32nD       19000008      000000FF          D32       Wr     Data
          --
240111    --   263.382ms        Single    A16nD       A310          10000             D32       Rd     Data
          --
240112    --   263.383ms        Single    A16nD       A310          10000             D32       Wr     Data
          --
240113    --   263.383ms        Single    A16nD       A314          FFFFFFFF          D32       Wr     Data
          --
240114    --   263.384ms        Single    A16nD       A310          10000             D32       Rd     Data
          --
240115    --   263.385ms        Single    A16nD       A310          10000             D32       Wr     Data
          --
240116    --   263.385ms        Single    A32nD       1A000008      000000FF          D32       Wr     Data
          --
240158    --   263.410ms        Single    A16nD       B310          10000             D32       Rd     Data
          --
240159    --   263.411ms        Single    A16nD       B310          10000             D32       Wr     Data
```

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          --
240160    --   263.412ms        Single    A16nD       B314          FFFFFFFF          D32       Wr     Data
          --
240161    --   263.412ms        Single    A16nD       B310          10000             D32       Rd     Data
          --
240162    --   263.413ms        Single    A16nD       B310          10000             D32       Wr     Data
          --
240163    --   263.414ms        Single    A32nD       1B000008      000000FF          D32       Wr     Data
          --
240205    --   263.439ms        Single    A16nD       C310          10000             D32       Rd     Data
          --
240206    --   263.440ms        Single    A16nD       C310          10000             D32       Wr     Data
          --
240207    --   263.440ms        Single    A16nD       C314          FFFFFFFF          D32       Wr     Data
          --
240208    --   263.441ms        Single    A16nD       C310          10000             D32       Rd     Data
          --
240209    --   263.442ms        Single    A16nD       C310          10000             D32       Wr     Data
          --
240210    --   263.442ms        Single    A32nD       1C000008      000000FF          D32       Wr     Data
          --
240252    --   263.467ms        Single    A16nD       D310          10000             D32       Rd     Data
          --
240253    --   263.468ms        Single    A16nD       D310          10000             D32       Wr     Data
          --
240254    --   263.469ms        Single    A16nD       D314          FFFFFFFF          D32       Wr     Data
          --
240255    --   263.469ms        Single    A16nD       D310          10000             D32       Rd     Data
          --
240256    --   263.470ms        Single    A16nD       D310          10000             D32       Wr     Data
          --
240257    --   263.471ms        Single    A32nD       1D000008      000000FF          D32       Wr     Data
          --
240299    --   263.497ms        Single    A32nD       18000018      0                 D32       Wr     Data
          --
240300    --   263.497ms        Single    A32nD       19000018      0                 D32       Wr     Data
          --
240301    --   263.498ms        Single    A32nD       1A000018      0                 D32       Wr     Data
          --
240302    --   263.499ms        Single    A32nD       1B000018      0                 D32       Wr     Data
          --
240303    --   263.499ms        Single    A32nD       1C000018      0                 D32       Wr     Data
          --
240304    --   263.500ms        Single    A32nD       1D000018      0                 D32       Wr     Data
          --
240305    --   263.501ms        Single    A32nD       18000004      FFFF8100          D32       Rd     Data
          --
240324    --   263.528ms        Single    A32nD       19000004      FFFF8100          D32       Rd     Data
          --
240343    --   263.553ms        Single    A32nD       1A000004      FFFF8100          D32       Rd     Data
          --
240362    --   263.577ms        Single    A32nD       1B000004      FFFF8100          D32       Rd     Data
          --
240381    --   263.601ms        Single    A32nD       1C000004      FFFF8100          D32       Rd     Data
          --
240400    --   263.626ms        Single    A32nD       1D000004      FFFF8100          D32       Rd     Data
          --
240419    --   263.658ms        Single    A32nD       18010000      016B9006          D32       Wr     Data
          --
240454    --   263.699ms        Single    A32nD       19010000      016B9006          D32       Wr     Data
          --
240489    --   263.737ms        Single    A32nD       1A010000      016B9006          D32       Wr     Data
          --
240524    --   263.776ms        Single    A32nD       1B010000      016B9006          D32       Wr     Data
          --
240559    --   263.814ms        Single    A32nD       1C010000      016B9006          D32       Wr     Data
          --
240594    --   263.853ms        Single    A32nD       1D010000      016B9006          D32       Wr     Data
          --
240629    --   263.905ms        Single    A16nD       2060          ....01A0          WORD      Rd     Data
          --
240630    --   263.906ms        Single    A16nD       2060          ....11A0          WORD      Wr     Data
          --
240631    --   263.916ms        Single    A16nD       2030          ....00C0          WORD      Rd     Data
          --
240632    --   263.917ms        Single    A16nD       2030          ....02C0          WORD      Wr     Data
          --
240633    --   263.918ms        Single    A16nD       2062          ....10C6          WORD      Rd     Data
```

```
          --
240634    --   263.919ms        Single    A16nD       2062          ....10C6          WORD      Wr    Data
          --
240635    --   263.921ms        Single    A16nD       2030          ....02C0          WORD      Rd    Data
          --
240636    --   263.922ms        Single    A16nD       2030          ....02C0          WORD      Wr    Data
          --
240637    --   263.923ms        Single    A16nD       2062          ....10C6          WORD      Rd    Data
          --
240638    --   263.924ms        Single    A16nD       2062          ....10C6          WORD      Wr    Data
          --
240639    --   263.926ms        Single    A16nD       2030          ....02C0          WORD      Rd    Data
          --
240640    --   263.928ms        Single    A16nD       2030          ....02C0          WORD      Wr    Data
          --
240641    --   263.929ms        Single    A16nD       2062          ....10C6          WORD      Rd    Data
          --
240642    --   263.930ms        Single    A16nD       2062          ....10C6          WORD      Wr    Data
          --
240643    --   263.931ms        Single    A16nD       2030          ....02C0          WORD      Rd    Data
          --
240644    --   263.932ms        Single    A16nD       2030          ....0280          WORD      Wr    Data
          --
240645    --   263.933ms        Single    A16nD       2030          ....0280          WORD      Rd    Data
          --
240646    --   263.934ms        Single    A16nD       2030          ....0683          WORD      Wr    Data
          --
240647    --   265.294ms        Single    A16nD       IACK=6        ......A0          LBYTE     Rd    Data
          --
240648    --   266.653ms        Single    A16nD       IACK=7        ......E1          LBYTE     Rd    Data
```