# Current Accelerator Operations Use of Matlab - System Overview 2004

**7.2.61.5- Rev 0**

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# REVISION HISTORY

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# 1.0 INTRODUCTION

## 1.1 PURPOSE

This manual describes the current state and use of Matlab and associated scripts in use at the Canadian Light Source. This document attempts to capture the current design used to model the Storage Ring (SR) lattice and the associated scripts used to take measurements and make modifications to the SR. It is assumed that the reader is familiar with using Matlab.

## 1.2 SCOPE

At the time of authorship of this document, Matlab is primarily used by the Accelerator Operations group and as such, this document will limit its scope to the Matlab software used by that group. Future plans for Matlab include a framework that will allow Matlab to be used on all of the beam lines as a scripting tool. As this is the first document of its kind at the CLS on Matlab it will integrate other previously written documents on Matlab where appropriate.

## 1.3 BACKGROUND

Matlab was introduced into the control system at the CLS in the fall of 2003. At that time, the Accelerator Operations group (AOD) was in the process of commissioning the SR and they needed a quick way to make measurements and to apply changes to elements of the SR lattice. Using a software library called Matlab Channel Access (MCA) to connect Matlab to the underlying EPICS control system allowed them to quickly realize their goal. Matlab software from SPEAR was also integrated into the tools being written by the commissioning team, in order to take advantage of the wealth of experience and knowledge of the SPEAR team using Matlab for the same purpose.

## 1.4 ORGANISATION

Section 2 of the manual consists of a description of the organizational structure of the SR model that is created in Matlab and Section 2.4 will attempt to outline the main functions and Matlab scripts called M (.m) files that are used routinely by the AOD. Appendix A will concentrate on listing all of the scripts that currently make up the installation of Matlab that is in use by the AOD. Many of the M files contain comments on their purpose and scope in the code so no attempt to explain each of those scripts will be made.

# 2.0 ORGANISATIONAL STRUCTURE

The MatLab software currently used by the AOD can be subdivided into four major parts: a MatLab Channel Access (MCA) Toolbox as the interface between the MatLab and EPICS runtime database, an Accelerator Object (AO) structure for data organization, management, and name convention mapping, an Accelerator Data (AD) structure for file organization and basic parameter storage, and a set of MatLab functions and scripts, which provides with a variety of routines for database access, conversions, response matrix computation and etc.

## 2.1 THE MATLAB CHANNEL ACCESS (MCA) PRIMITIVES

MatLab Channel Access (MCA) Toolbox is the interface between MatLab and EPICS Channel Access (CA) client library. By employing the MCA Toolbox, applications use MatLab workspace

variables to read from or write to EPICS Process Variables (PV). The computation and graphics capability of MatLab is fully utilized to process EPICS PV values in an on-line manner.

The MCA Toolbox implements most of CA client library in a few MatLab functions. Some core functions are: *mcaopen, mcaclose , mcaget, mcaput,* and *mcainfo.*

### 2.1.1 mcaopen

Function *mcaopen* opens a Channel Access connection to an EPICS PV and returns a nonzero integer handle to identify this PV if the connection is successful. In MCA, all other routines refer to this PV by its handle instead of the PV name.

### 2.1.2 mcaclose

Function *mcaclose* closes the channels identified by their integer handles, previously opened with *mcaopen*.

### 2.1.3 mcaget

Function *mcaget* retrieves values of PVs specified by their integer handles provided the connections are established. Type of return value depends on the native type and the number of elements in the EPICS record.

### 2.1.4 mcaput

Function *mcaput* writes values into PVs.

### 2.1.5 mcainfo

Function *mcainfo* returns connection status and other information about a PV.

### 2.1.6 getpv

Function *getpv* retrieves values of EPICS PVs. In *getpv*, the part that actually communicates with EPICS PVs are the *mcaopen* and *mcaget* routines. What *getpv* adds to the functionality is an input checking and dissecting mechanism, which makes multiple input parameter patterns possible.

Four input methods are supported:

#### *2.1.6.1 Family/Device List*

This uses family name and device indices to locate a PV.

Here is an example of retrieving horizontal Beam Position Monitor (BPM) data using family name 'BPMx', and device indices [4, 1]:

*getpv*('BPMx', 'Monitor', [4,1])

#### *2.1.6.2 Family/Element List*

This uses family name and an element list index to locate a PV.

Following is an example retrieving horizontal BPM data specifying family name ‘BPMx’ and a column vector ‘BPMx_Element_List’ containing element index:

*getpv*('BPMx', ‘Monitor’, BPMx_Element_List)

#### *2.1.6.3 Common Name*

This uses common name to locate a PV.

Here is an example retrieving horizontal BPM data using character matrix BPMx_Common_Name containing common names for a number of BPMs:

*getpv*([],’Monitor’, BPMx_Common_Name)

#### *2.1.6.4 PV name*

Directly uses PV names to access PVs.

Here is an example retrieving horizontal BPM data using character matrix BPMx_PV_Name containing PV names for a number of BPMs:

*getpv*(BPMx_PV_Name)

### 2.1.7 setpv

Function *setpv* set values of EPICS PVs. Similar to *getpv*, it is based on *mcaopen* and *mcaget* routines, and uses input checking and dissecting to support multiple input patterns. Function *setpv* supports all the same input methods as described in 2.2.1.

Four input methods are supported:

#### *2.1.7.1 Family/Device List*

This uses family name and device indices to locate a PV.

Here is an example of setting a Horizontal Corrector Magnets (HCM) to 1.23 using family name ‘HCM’ and device index [6 4]:

*setpv*('HCM','Setpoint', 1.23, [6 4])

#### *2.1.7.2 Family/Element List*

This uses family name and an element list index to locate a PV.

Here is an example of setting a Horizontal Corrector Magnets (HCM) to values contained in a column vector New_HCM_Setpoint using a column vector HCM_Element_List containing element indices:

*setpv*('HCM','Setpoint', New_HCM_Setpoint, HCM_Element_List)

#### *2.1.7.3 Common Name*

This uses common name to locate a PV.

Here is an example of setting a number of Horizontal Corrector Magnets (HCM) to values contained in a column vector New_Setpoint using a character matrix HCM_Common_Name containing common names:

*setpv*([],'Setpoint', New_Setpoint, HCM_Common_Name)

#### *2.1.7.4 PV Name*

Directly uses PV names to access PVs.

Here is an example of setting a number of Horizontal Corrector Magnets (HCM) to values contained in a column vector New_Setpoint using a character matrix HCM_PV_Name containing PV names:

*setpv*(HCM_PV_Name, New_Setpoint)

Section 2.2.1 gives detailed description of those methods

### 2.1.8 getam

Function *getam* calls *getpv* with the AO structure field being set as 'Monitor'. It returns the values of monitor channels. Section 2.2 gives descriptions of the AO structure and the Monitor field.

Here is an example of retrieving all the Vertical Corrector Magnets (VCM) data:

*getam*('VCM')

## 2.2 THE ACCELERATOR OBJECT (AO) STRUCTURE

The Accelerator Object (AO) is a MatLab structure defined in the file *clsinit*. It is loaded into the memory by executing command *aoinit*. When Matlab is started, the command *setpathcls* adds the necessary folders to the Matlab path and calls *clsinit.* The AO structure is designed for the following purposes:

- Lattice data storage
- Lattice data organization
- Store EPICS Channel Access information for lattice devices

A sample from the beginning of *clsinit* includes CLS parameters and location of specific directories:

```
AD.Machine      = 'CLS';
AD.Energy       = 2.9;
AD.ATModel      = 'clsat';
   ...
% Top Level Directories
[DirectoryName,FileName,ExtentionName]=fileparts(which('getsp'));
AD.Directory.AccCont  = [DirectoryName];
AD.Directory.DataRoot = [DirectoryName,filesep,'clsdata\User\'];
          ...
```

For each family in the storage ring and BTS a list of PV, common and family names, indices, units and conversions are given. For example, BPMx family:

```
AO{SR_BPMX_FAM}.FamilyName          = 'BPMx';
AO{SR_BPMX_FAM}.FamilyType          = 'BPM';
AO{SR_BPMX_FAM}.MemberOf            = {'BPM'; 'Diagnostics'};
AO{SR_BPMX_FAM}.Monitor.Mode        = 'SIMULATOR';
AO{SR_BPMX_FAM}.Monitor.DataType    = 'Scalar';
```

```
AO{SR_BPMX_FAM}.Monitor.Units        = 'Hardware';
```

A full array for each member of the family:

```
bpm={
'BPM1401-01:x' 'BPMx' 1 'BPM1401-01:y' 'BPMy' 1 [1, 1]  1; ...
'BPM1401-02:x' 'BPMx' 1 'BPM1401-02:y' 'BPMy' 1 [1, 2]  2; ...
...
```

Information from above list is assigned to members of the AO structure:

```
for ii = 1:size(bpm,1)
        AO{SR_BPMX_FAM}.CommonNames(ii,:)              = bpm{ii,2};
        AO{SR_BPMX_FAM}.Monitor.ChannelNames(ii,:)     = bpm{ii,1};
        AO{SR_BPMX_FAM}.Monitor.Handles(ii,1)          = NaN;
        AO{SR_BPMX_FAM}.Status(ii,1)                   = bpm{ii,3};
        AO{SR_BPMX_FAM}.DeviceList(ii,:)               = bpm{ii,7};
        AO{SR_BPMX_FAM}.ElementList(ii,1)              = bpm{ii,8};
        AO{SR_BPMX_FAM}.Monitor.HW2PhysicsParams(ii,1) = 1;
        AO{SR_BPMX_FAM}.Monitor.Physics2HWParams(ii,1) = 1;
end

% Gain, Golden, and Offset orbits
AO{SR_BPMX_FAM}.Gain  =ones(size(AO{SR_BPMX_FAM}.ElementList));
AO{SR_BPMX_FAM}.Offset=zeros(size(AO{SR_BPMX_FAM}.ElementList));
```

'Golden' files that AOD creates are loaded into the AO:

```
load([ad.Directory.OpsData ad.OpsData.BPMGoldenFile '.mat']);
AO{SR_BPMX_FAM}.Golden = BPMxData.Data;
```

The SRMaster screen is called at the end of *clsinit. SRMaster* contains button links to many of the commonly functions used by AOD as well as the Save and Restore Setpoint control.

## 2.2.1 AO Name Conventions

The AO structure supports multiple name conventions, which enables accelerator physicists to access the system in their own terminology, without having to take care of PV names and other control details.

The AO structure provides four approaches to access a desired PV:

- Family/Device List approach,
- Family/Element List approach,
- Common Name approach.
- Specifying a PV by directly referring to its name

### *2.2.1.1 Family/Device List*

The Family/Device List and Family/ Element List approach mimics the naming schemes used in most accelerator simulation codes. Accelerator physicists view the system in terms of families

(BPM, corrector, quadruple, etc). Similarly, in the Family/Device List approach, hardware is also organized into groups called families. Each family is specified by a unique family name.

In every family, each member is specified by the sector number and the device number in the sector.

Ex1: the fourth horizontal Beam Position Monitor (BPM) in Sector 3 is specified as BPMx [3 4].

Ex2: calling getpv using family name 'QFA' and device indices [5 1]:

*getpv*('QFA', 'Monitor', [5,1])

Ex3: calling *setpv* using family name 'BPMy' and device index matrix d_index, new setpoint values are passed to *setpv* by column vector new_value:

*setpv*('BPMy','Setpoint', new_value, d_index)

#### *2.2.1.2 Family/Element List*

In the Family/Element List approach, hardware is grouped into families the same way as in 2.2.1.1. Instead of device indices, each family member is specified by the sequential order in the accelerator.

Ex1: the fourth horizontal Beam Position Monitor (BPM) in Sector 3 is specified as BPMx 12

Ex2: calling *getpv* using family name 'VCM' and element index vector e_index:

*getpv*('QFA', 'Monitor', e_index)

Ex3: calling *setpv* using family name 'HCM' and element index 24, new setpoint is 1.23

*setpv*('HCM','Setpoint', 1.23, 24)

#### *2.2.1.3 Common Name*

The Common Name is typically a name for a lattice device which encapsulates the family, sector and sector element information into a single name.

Ex: the fourth Horizontal Corrector Magnet (HCM) in Sector 3 is specified as 3CX4

### 2.2.2 Accelerator Object Format

Corresponding to the Family/Device List and Family/Element List naming scheme, lattice data are organized and stored into family units. Accelerator Object is the data container used for this purpose.

The Accelerator Object is a MatLab structure. In the *clsinit* file, a complete set of Accelerator Objects are specified. Function *getao* returns the AO structure with the following format:

| | Family Name |
|---|---|
| **Accelerator Object (AO)** | BPMx |
| | BPMy |
| | HCM |
| | VCM |
| | BEND |
| | QFA |
| | QFB |
| | QFC |
| | SF |
| | SD |
| | RF |
| | TUNE |
| | DCCT |
| | CHICANES |
| | SQS |
| | BPMXall |
| | BPMYall |
| | RFC |
| | BTSQUADS |
| | BTSSTEER |
| | BTSBEND |
| | BTSSEPT |
| | BTSKICK |
| | BTSSCRAPE |

Figure 2.1 Accelerator Object structure diagram

The right column of Figure 2.1 shows 24 named fields for the Accelerator Object. The field names are exactly the family names. In turn, each field itself is a structure containing different subfields for the organization and storage of the family information. A typical family structure AO.HCM has the format as shown in Figure 2.2.2

Different families can have different subfields. Some important subfields are: CommonNames, DeviceList, ElementList, Monitor, Setpoint, on, and Amps.

#### *2.2.2.1 CommonNames field*

This is a character array containing common names of each member in a family.

#### *2.2.2.2 DeviceList field*

A $X \times 2$ double array containing device indices of a family.

#### *2.2.2.3 ElementList field*

A $X \times 1$ double array containing element index of each member in a family.

#### *2.2.2.4 Monitor field*

This field is itself a MatLab structure. It contains necessary information for PV monitoring operations. Every family has the Monitor field. However, it may have different formats in different families. The following is a typical format of a Monitor field.

| | |
|---|---|
| **Mode** | 'Online', 'Simulator', 'Manual', or 'Special' |
| **DataType** | 'Scalar' or 'Vector' |
| **Units** | 'Hardware' or 'Physics' |
| **HWUnits** | string name of the hardware unit |
| **PhysicsUnits** | string name of the physics unit |
| **ChannelNames** | character array containing PV names for monitoring operations |
| **Handles** | handle vector for MCA operations |
| **HW2PhysicsParams** | vector containing hardware to physics conversion factors |
| **Physics2HWParams** | vector containing physics to hardware conversion factors |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **AO.HCM** | **FamilyName** | 'HCM' | | | | | | | | | | | | |
| | **FamilyType** | 'COR' | | | | | | | | | | | | |
| | **MemberOf** {4x1 cell} | 'MachineConfig' | | | | | | | | | | | | |
| | | 'COR' | | | | | | | | | | | | |
| | | 'HCM' | | | | | | | | | | | | |
| | | 'Magnet' | | | | | | | | | | | | |
| | **Monitor** [structure] | **Mode** | 'Online' | | | | | | | | | | | |
| | | **DataType** | 'Scalar' | | | | | | | | | | | |
| | | **Units** | 'Hardware' | | | | | | | | | | | |
| | | **HWUnits** | 'Counts' | | | | | | | | | | | |
| | | **PhysicsUnits** | 'Radian' | | | | | | | | | | | |
| | | **ChannelNames** | ... | ... | ...48x16 char... | | | | | | | | | |
| | | **Handles** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **HW2PhysicsParams** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **Physics2HWParams** | ... | ... | ...48x1 double... | | | | | | | | | |
| | **Setpoint** [structure] | **Mode** | 'Online' | | | | | | | | | | | |
| | | **DataType** | 'Scalar' | | | | | | | | | | | |
| | | **Units** | 'Hardware' | | | | | | | | | | | |
| | | **HWUnits** | 'Counts' | | | | | | | | | | | |
| | | **PhysicsUnits** | 'Radian' | | | | | | | | | | | |
| | | **ChannelNames** | ... | ... | ...48x16 char... | | | | | | | | | |
| | | **Range** | ... | ... | ...48x2 double... | | | | | | | | | |
| | | **Tolerance** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **Handles** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **HW2PhysicsParams** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **Physics2HWParams** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **DeltaRespMat** | ... | ... | ...48x1 double... | | | | | | | | | |
| | **DeviceList** | ... | ... | ... | ... | ... | ...48x2 double... | | | | | | | |
| | **ElementList** | ... | ... | ... | ... | ... | ...48x1 double... | | | | | | | |
| | **On** [structure] | **Handles** | ... | ... | ...48x1 double... | | | | | | | | | |
| | | **Mode** | 'Online' | | | | | | | | | | | |
| | | **DataType** | 'Scalar' | | | | | | | | | | | |
| | | **Units** | 'Hardware' | | | | | | | | | | | |
| | | **HWUnits** | '' | | | | | | | | | | | |
| | | **PhysicsUnits** | '' | | | | | | | | | | | |
| | | **HW2PhysicsParams** | 1 | | | | | | | | | | | |
| | | **Physics2HWParams** | 1 | | | | | | | | | | | |
| | | **ChannelNames** | ... | ... | ...48x15 char... | | | | | | | | | |
| | | **PhysicsUnits** | '' | | | | | | | | | | | |
| | **Status** | ... | ... | ... | ... | ... | ...48x1 double... | | | | | | | |
| | **CommonNames** | ... | ... | ... | ... | ... | ...48x8 char... | | | | | | | |
| | **AT** [structure] | **ATType** | 'HCM' | | | | | | | | | | | |
| | | **ATIndex** | ... | ... | ...48x1 double... | | | | | | | | | |
| | **Position** | ... | ... | ... | ... | ... | ...48x1 double... | | | | | | | |
| | **Gain** | ... | ... | ... | ... | ... | ...48x1 double... | | | | | | | |
| | **Offset** | ... | ... | ... | ... | ... | ...48x1 double... | | | | | | | |

Figure 2.2.2 HCM family data in the AO.HCM structure

#### *2.2.2.5 Setpoint field*

This field is also a MatLab structure containing information for writing setpoints to PVs. A typical Setpoint structure is given as following :

| | |
|---|---|
| **Mode** | 'Online', 'Simulator', 'Manual', or 'Special' |
| **DataType** | 'Scalar' or 'Vector' |
| **Units** | 'Hardware' or 'Physics' |
| **HWUnits** | string name of the hardware unit |
| **PhysicsUnits** | string name of the physics unit |
| **ChannelNames** | character array containing PV names for writing operations |
| **Range** | 2wo column matrix containing [Min Max] range for the setpoint |
| **Tolerance** | Tolerance column vector for SP-AM comparison |
| **Handles** | handle vector for MCA operations |
| **HW2PhysicsParams** | vector containing hardware to physics conversion factors |
| **Physics2HWParams** | vector containing physics to hardware conversion factors |
| **DeltaRespMat** | Delta setpoint for measuring response matrices |

#### *2.2.2.6 On*

Families that specify magnets contain an **On** field, which is a MatLab structure containing information to turn on or turn off the magnet powersupply. The **On** field has the following format:

| | |
|---|---|
| **Mode** | 'Online', 'Simulator', 'Manual', or 'Special' |
| **DataType** | 'Scalar' or 'Vector' |
| **Units** | 'Hardware' or 'Physics' |
| **HWUnits** | '' |
| **PhysicsUnits** | '' |
| **ChannelNames** | character array containing PV names for on/off operations |
| **Handles** | handle vector for MCA operations |
| **HW2PhysicsParams** | hardware to physics conversion factors |
| **Physics2HWParams** | physics to hardware conversion factors |

#### *2.2.2.7 Amps*

The **Amps** field is only used in the QFA, QFB, and QFC family. It is a MatLab structure containing information for reading back Amps values. Structure format is given as following

| | |
|---|---|
| **Mode** | 'Online', 'Simulator', 'Manual', or 'Special' |
| **DataType** | 'Scalar' or 'Vector' |
| **Units** | 'Hardware' or 'Physics' |
| **HWUnits** | 'Amps' |
| **PhysicsUnits** | 'K' |
| **ChannelNames** | character array containing PV names for Amps value |
| **Handles** | handle vector for MCA operations |
| **HW2PhysicsParams** | hardware to physics conversion factors |
| **Physics2HWParams** | physics to hardware conversion factors |

#### *2.2.2.8 Name Mapping*

In a family, the fields DeviceList, ElementList, and CommonNames must have the same row number. When DataType='scalar', the row numbers of ChannelNames and Handles must also equal the row number of DeviceList.

Figure 2.2 gives an example for Family/Device List approach. It is assumed that the family name BPMx, and device indices [10 2] are given, and field Monitor is also given to specify read operations. From the family name BPMx, the AO.BPMx structure is located. By comparing the device indices [10 2] to the elements in the AO.BPMx.DeviceList array, the array index is determined to be 38. The Field name Monitor indicates the channel name is stored in the AO.BPMx.Monitor structure. By referring to the same index in the AO.BPMx.Monitor.ChannelNames array, the corresponding PV name is located as AO.BPMx.Monitor.ChannelName(38,:)= BPM1410-03:x. The Family/Element List approach and the common name approach use the same principles to specify PV names.

For a complete AO structure name mapping, please refer to Appendix B.

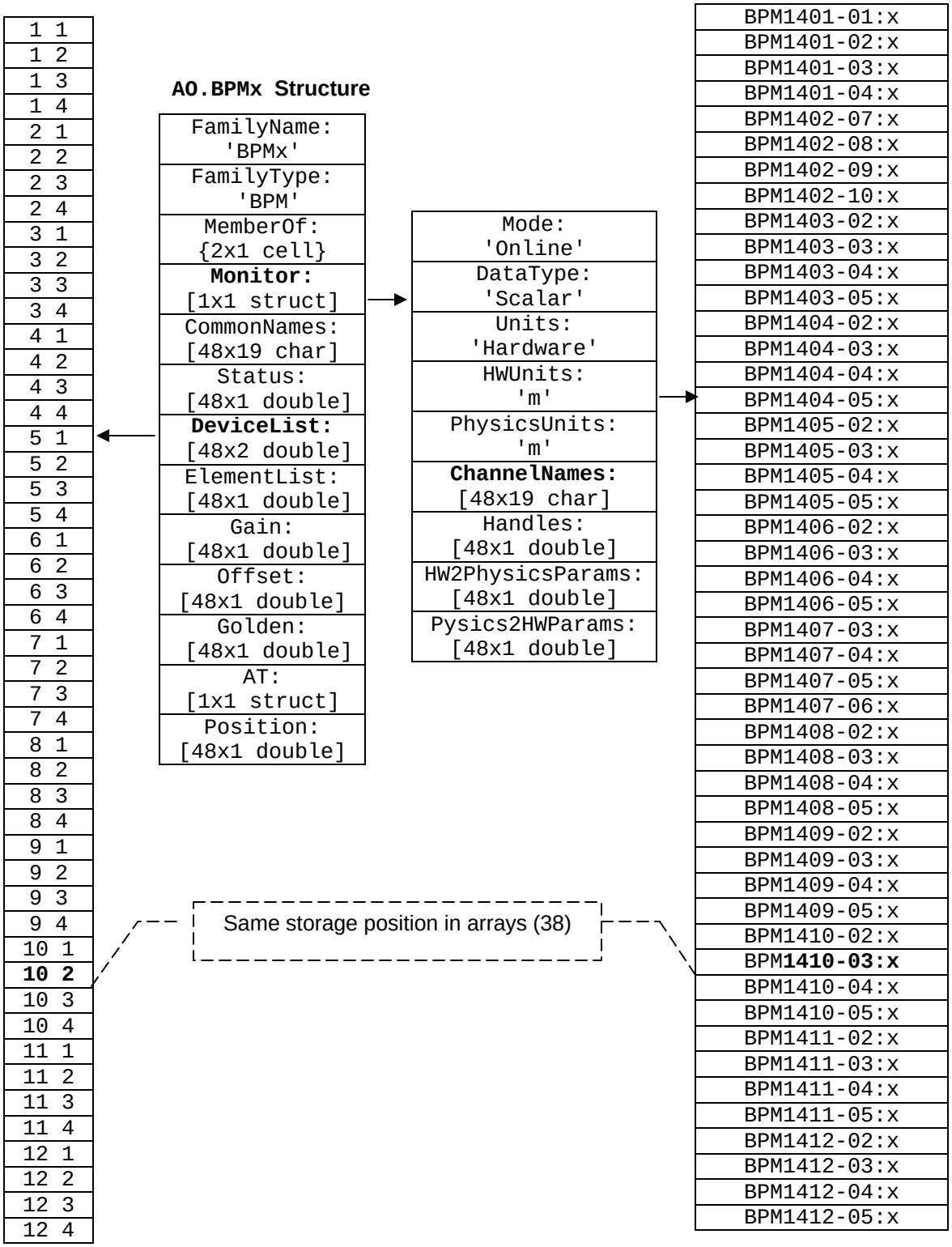


Figure 2.2.3 Family/Device List approach using the Accelerator Object structure

## 2.3 ACCELERATOR DATA (AD) STRUCTURE

The Accelerator Data (AD) is a MatLab structure containing information on directory locations, file names, and basic accelerator parameters. As the AO structure, the Accelerator Data is also defined in the *clsinit* file and loaded into memory by executing command *aoinit*. Once the AD has been defined and loaded into memory, all scripts and functions can quickly get the locations of configuration and measurement data that has been saved.

The AD structure has the following format

| | | |
|---|---|---|
| **Accelerator Data** (AD) Structure | Machine | 'CLS' |
| | Energy | 2.9000 |
| | ATModel | 'clsat' |
| | CLight | 299792458 |
| | Circumference | 170.8800 |
| | MCF | 0.0038 |
| | Directory | [1x1 structure] |
| | Default | [1x1 structure] |
| | OpsData | [1x1 structure] |
| | Deck | [1x1 structure] |
| | Restore | [1x1 structure] |
| | TuneDelay | 0.1000 |
| | Chromaticity | [1x1 structure] |

Figure 2.3.1 Accelerator Data structure

In the AD structure, the Directory field contains relative directory locations used by measurement scripts and other functions. The Default and OpsData fields contain the file names for storage of operations data.

## 2.4 ACCELERATOR CONTROL FUNCTIONS AND SCRIPTS

*SRMaster*

Most of the common tasks are available from the GUI *SRmaster*. The Matlab PC in the control room is configured to start SRmaster upon Matlab startup.

Programs and tasks available from *SRmaster* include:

- **Initialize CLS Lattice**: calls clsinit.
- **Load Quad Centers**: allows for selection of new folder containing quad centers (in acceleratorapplications/clsdata/user/QMS/). When the AT is initializing, the quad center folder with 'USE-' as a prefix is loaded automatically.
- **Run Topup Mode** calls a simple program for testing topup; a script sends the signal for a single injected pulse at fixed intervals if the current is below some maximum.
- **Cycle Ring Quads** opens a GUI interface for fast quad cycling, .m and .fig files are clscyclemags.
- Three files in the Data to Text Panel write selected .mat files to .txt for use outside Matlab.

- **ID Correction Coil Calib** brings up a program for creating lookup tables for all the permanent magnet IDs including the EPUs. The detailed procedure is in Document 5.7.25.1.Rev.A-Calibration Procedure for ID Correction Coils.
- **SQ Calibration**: program for measuring and correcting transverse coupling with the SR skew quadrupoles.
- **XSR/OSR Analysis** is used to convert the beam profile (in 4-sigmas) from the diagnostic beamline cameras to horizontal and vertical emittances.
- **Adjust Quad Families** is used for changing the tunes; options are to change x and/or y tune by fractions, percents, frequency (from spectrum analyzer) or by K-value as found from simulation software.
- **Adjust Dispersion** applies a fixed change to each quad family based on numbers calculated in DIMAD to move to different dispersions while keeping the tunes constant.
- **Adjust Chromaticity** changes the two families of sextupole magnets to values corresponding to x and y chromaticity as calculated in DIMAD.
- **Adjust Skew Quads** allows for individual SQ control or application of a saved file for all SQs.
- Save and Restore Panel: **Save Config** writes all the setpoints for the listed families into a .mat file in /acceleratorcontrol/clsdata/user/MachineConfig. **Restore Config** restores the setpoints from a selected file to all the families with the radio button selected. * Must be in Machine Studies for most of the setpoints to change.
- **CLS Orbit Control** opens clsorb. See Document 7.9.2.61.6-Rev A. CLSORB: Slow SR Orbit Control in Matlab.
- **Plotfamily** opens plotfamily. This is primarily used for viewing setpoint and feedback of the quads, correctors and BPMs for quick diagnostics.

*Plotfamily Lattice Menu*

In the Lattice menu are a number of diagnostic and plotting tools AOD uses on a regular basis.

- Measure:
    - Dispersion: automatically shifts the SR frequency offset and measures the change in orbit as a result, resulting x and y dispersion in physics units, results are plotted.
    - Chromaticity: automatically shifts RF frequency, requires operator to input shift in tune manually by reading the change in tune peak position on the Signal Analyzer.
    - BPM Response measures the response at all BPMs for all correctors in the ring for use by clsorb. The measurement takes ~ 1 hour.
    - Quad Centers: Beam based alignment, the position where cycling the quadrupoles has no effect is written as the golden BPM positions for clsorb to correct to. Only families QFA and QFC are taken because they have a BPM near. A complete set takes ~ 4 hours.
- Monitor: Magnet and BPM data is monitored for a number of minutes (default 3) and plotted. Noisy power supplies, BPMs, etc. are identified this way. * Timed corrections on clsorb must be off.
- Plot: Response from File – used to see the consistency and symmetry of a BPM response matrix.
- New Operational Files: especially BPM response and Dispersion response. These files are needed for clsorb to calculate corrections properly.

## 2.5 INSTALLATION TIPS

When the AT sandbox is created from the Matlab Project (MKS) on a new computer, a few additions to the environment variables are needed.

Add to system path:

C:/aodsandbox/matlabapplications/mca/win32/R3.14.4/mca;
C:/aodsandbox/matlabapplications/labca/bin/win32-x86/labca;

Create environment variable:

ATROOT: C:/aodsandbox/matlabapplications/at;

Add to Matlab path:

C:/aodsandbox/matlabapplications/acceleratorcontrol;

The Matlab *startup.m* file is modified to suppress the warning about case-sensitive mismatches of filenames, and calls the file *setpathcls*. This appends all necessary folders to the Matlab path and calls *clsinit.*

# APPENDIX A: DIRECTORY AND FILE LISTING

**<BaseDirectory>\acceleratorcontrol**

**[.] [..] [at] [cls] [clsdata] [clsopsdata] [compile] [docs] [labca] [mca]**

| | | | |
|---|---|---|---|
| addAOprefix.m | addlabel.m | addmenuad.m | addmenuao.m |
| addmenustruct.m | analbpmresp.m | aokeep.m | |
| appendtimestamp.m | bpm2quad.m | calceta.m | cap.m |
| cddataroot.m | cdopsdata.m | cell2field.m | |
| channel2common.m | channel2dev.m | channel2family.m | |
| channel2handle.m | checkforao.m | checklimits.m | chkmags.m |
| clearmcahandles.m | clsLoadQcenterData.m | common2channel.m | |
| common2dev.m | common2family.m | common2handle.m | |
| copybpmrespfile.m | copybpmsigmafile.m | copychrorespfile.m | |
| copydispersionfile.m | copydisprespfile.m | copymachineconfigfile.m | |
| copytunerespfile.m | correctors2golden.m | dev2common.m | dev2elem.m |
| DirList.doc | editlist.m | editlist2.m | elem2dev.m |
| family2channel.m | family2common.m | family2dev.m | |
| family2handle.m | family2status.m | family2tol.m | family2units.m |
| ffanal.m | ffanalepu.m | ffanalt.m | ffcompare.m |
| ffdeltasp.m | fffilter.m | ffgettbl.m | ffgettblepu.m |
| ffgettblepugap.m | ffgettblepushift.m | ffread.m | fftable.m |
| fftableepu.m | fftest.m | field2cell.m | findkeyword.m |
| findmemberof.m | findrf.m | findrowindex.m | getad.m |
| getam.m | getao.m | getbpm.m | getbpmresp.m |
| getbpmsigma.m | getbrho.m | getchro.m | getchroresp.m |
| getdata.m g | etdcct.m | getdisp.m | getenergy.m |
| getfamilydata.m | getfamilylist.m | getfamilytype.m | getgain.m |
| getgolden.m | getlifetime.m | getlist.m | |
| getmachineconfig.m | getmcf.m | getmemberof.m | getmode.m |
| getoffset.m | getphysdata.m | getpv.asv | getpv.m |
| getrespmat.m | getrf.m | getrunflag.m | getsigma.m |
| getsp.m | getspos.m | gettime.m | gettol.m |
| gettune.m | gettuneresp.m | getunits.m | getx.m |
| gety.m | golden2sim.m | gotodirectory.m | hcm2golden.m |
| hcm2zero.m | hw2physics.m | isfamily.m | ismemberof.m |
| loadat.m | loadmachineconfig.m | loadorbit.m | machine2sim.m |
| magstep.m | makebump.m | makelocoinputdata.m | maxsp.m |
| measbpmresp.m | measbpmsigma.m | measchro.m | |
| measchroresp.m | meascmhysteresis.m | measdisp.m | measdispresp.m |
| measlifetime.m | measlocodata.m | measquad2tuneresp.m | measrate.m |
| measrespmat.m | measrespmatdisp.m | measTuneresp.m | minsp.m |
| mkconfigramp.m | monAbpm.asv | monbpm.m | monitor.m |
| monitorchannels.m | monmags.m | monrates.m | physics2hw.m |
| plotbpmresp.m | plotbpmrespsym.m | plotchro.m | plotcm.m |
| plotdisp.m | plotfamily.fig | plotfamily.m | |
| plotgoldenorbit.m | plotlattice.m | plotoffsetorbit.m | plotorbit.m |
| plotorbitdata.m | popplot.m | prependtimestamp.m | quad2bpm.m |

| | | | |
|---|---|---|---|
| quadcenter.m | quaderrors.m | quadplot.m | raw2real.m |
| real2raw.m | rmdisp.m | savemachineconfig.m | |
| scanaperture.m | scandispquad.m | scanorbit.m | setad.m |
| setam.m | setao.m | setchro.m | setenergy.m |
| setfamilydata.m | setmachineconfig.m | setorbit.m | setorbitbump.m |
| setpathat.m | setpathcls.m | setpathclslabca.m | |
| setpathspear3.m | setphysdata.m | setpv.m | setrf.m |
| setsp.m | settune.m | showfamily.m | |
| showmachinedata.m | sim2machine.m | sleep.m | srsetup.m |
| stepchro.m | steppv.m | steprf.m | stepsp.m |
| steptune.m | subfig.m | sweepenergy.m | |
| SweepInjectionAngle.m | switch2hw.m | switch2interlock.m | switch2online.m |
| switch2physics.m | switch2sim.m | tune2manual.m | tune2online.m |
| tune2sim.m | vcm2golden.m | vcm2zero.m | xaxis.m |
| xaxiss.m | yaxis.m | yaxiss.m | zaxis.m |

217 File(s) 1,392,189 bytes
13 Dir(s) 32,137,719,808 bytes free

**<BaseDirectory>\acceleratorcontrol\cls**

| | | |
|---|---|---|
| **[.]** | **[..]** | |
| aoinit.m | BPM2TXT.m | buildlocoinput.m |
| CLS_DIMADSkeleton_Group.m | clsat.m | clsautosave.m |
| clsAvOrbit.m | clsBuildQcenterData.asv | clsBuildQcenterData.m |
| clschrom.fig | clschrom.m | clscolshift.m |
| clsConditionVac.m | clsCycleMags.fig | clsCycleMags.m |
| clsdemo1.m | clsdifforbitQ.m | clsdisplaySetpoints.m |
| clsGetFigData.m | clsinit.m | clsLoadQcenterData.m |
| clsmachine2sim.m | clsMonitorSrCurrent.m | clsphysdata.mat |
| clsshiftcol.m | clsshiftrow.m | clsTopUp.m |
| clsTrackOrbitDrift.m | correctorCheck.m | dispersion2.fig |
| dispersion2.m | getbpmx | getbpmy |
| getbpmaverages.m | getclsconfig.m | getkickerdelay.m |
| getquad.m | getquadresp.m | getrclsresp.m |
| getXclsresp.m | getXYclsresp.m | getYclsresp.m |
| initmode_model.m | initmode_user.m | loadChnlData.m |
| magnetScan.m | magsinit.m | makephysdata.m |
| monAbpm.m | mov2sim.m | orbcorh.m |
| orbcorv.m | plotBpm.m | plotBpmx.m |
| printConfig.m | printmachineconfig.m | quadamps2k.m |
| quadcalforcontrols.xls | quadcenterall.m | quadcenterinit.m |
| QuadFamilies.fig | QuadFamilies.m | quadgains.txt |
| quadplotall.m | quads2.fig | quads2.m |
| saveOrbitAsTxt.m | septumfb.m | setbpmaverages.m |
| setclsconfig.m | setcorrectors.m | sethcmslow.m |
| SetKickerAngle.m | setkickerdelay.m | setOCMfromFile.m |
| setoperationalmode.m | setorbitdefault.m | setQk.m |
| setquad.m | setvcmslow.m | showcfgfile.m |
| showfamilydata.m | srinit.m | SRmaster.fig |

SRmaster.m
SRUtil.fig
SRUtil.m
stepkickerdelay.m
stubphysdata.m
svdorbX.m
svdorbY.m
SweepKickerAngle.m
sweepkickerdelay.m
turnOnPs.m
viewconfigfile.m
zerocorrectors.m
zeromags.m

121 File(s) 3,800,635 bytes

2 Dir(s) 32,137,715,712 bytes free

# APPENDIX B: ACCELERATOR OBJECT NAME CONVENTION

| BPMx Family | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** |
| BPM1401-01:x | 1 1 | 1 | BPM1401-01:x |
| BPM1401-02:x | 1 2 | 2 | BPM1401-02:x |
| BPM1401-03:x | 1 3 | 3 | BPM1401-03:x |
| BPM1401-04:x | 1 4 | 4 | BPM1401-04:x |
| BPM1402-07:x | 2 1 | 5 | BPM1402-07:x |
| BPM1402-08:x | 2 2 | 6 | BPM1402-08:x |
| BPM1402-09:x | 2 3 | 7 | BPM1402-09:x |
| BPM1402-10:x | 2 4 | 8 | BPM1402-10:x |
| BPM1403-02:x | 3 1 | 9 | BPM1403-02:x |
| BPM1403-03:x | 3 2 | 10 | BPM1403-03:x |
| BPM1403-04:x | 3 3 | 11 | BPM1403-04:x |
| BPM1403-05:x | 3 4 | 12 | BPM1403-05:x |
| BPM1404-02:x | 4 1 | 13 | BPM1404-02:x |
| BPM1404-03:x | 4 2 | 14 | BPM1404-03:x |
| BPM1404-04:x | 4 3 | 15 | BPM1404-04:x |
| BPM1404-05:x | 4 4 | 16 | BPM1404-05:x |
| BPM1405-02:x | 5 1 | 17 | BPM1405-02:x |
| BPM1405-03:x | 5 2 | 18 | BPM1405-03:x |
| BPM1405-04:x | 5 3 | 19 | BPM1405-04:x |
| BPM1405-05:x | 5 4 | 20 | BPM1405-05:x |
| BPM1406-02:x | 6 1 | 21 | BPM1406-02:x |
| BPM1406-03:x | 6 2 | 22 | BPM1406-03:x |
| BPM1406-04:x | 6 3 | 23 | BPM1406-04:x |
| BPM1406-05:x | 6 4 | 24 | BPM1406-05:x |
| BPM1407-03:x | 7 1 | 25 | BPM1407-03:x |
| BPM1407-04:x | 7 2 | 26 | BPM1407-04:x |
| BPM1407-05:x | 7 3 | 27 | BPM1407-05:x |
| BPM1407-06:x | 7 4 | 28 | BPM1407-06:x |
| BPM1408-02:x | 8 1 | 29 | BPM1408-02:x |
| BPM1408-03:x | 8 2 | 30 | BPM1408-03:x |
| BPM1408-04:x | 8 3 | 31 | BPM1408-04:x |
| BPM1408-05:x | 8 4 | 32 | BPM1408-05:x |
| BPM1409-02:x | 9 1 | 33 | BPM1409-02:x |
| BPM1409-03:x | 9 2 | 34 | BPM1409-03:x |
| BPM1409-04:x | 9 3 | 35 | BPM1409-04:x |
| BPM1409-05:x | 9 4 | 36 | BPM1409-05:x |
| BPM1410-02:x | 10 1 | 37 | BPM1410-02:x |
| BPM1410-03:x | 10 2 | 38 | BPM1410-03:x |
| BPM1410-04:x | 10 3 | 39 | BPM1410-04:x |
| BPM1410-05:x | 10 4 | 40 | BPM1410-05:x |
| BPM1411-02:x | 11 1 | 41 | BPM1411-02:x |
| BPM1411-03:x | 11 2 | 42 | BPM1411-03:x |
| BPM1411-04:x | 11 3 | 43 | BPM1411-04:x |
| BPM1411-05:x | 11 4 | 44 | BPM1411-05:x |
| BPM1412-02:x | 12 1 | 45 | BPM1412-02:x |

| | | | |
|---|---|---|---|
| BPM1412-03:x | 12 2 | 46 | BPM1412-03:x |
| BPM1412-04:x | 12 3 | 47 | BPM1412-04:x |
| BPM1412-05:x | 12 4 | 48 | BPM1412-05:x |

| BPMy Family | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** |
| BPM1401-01:y | 1 1 | 1 | BPM1401-01:y |
| BPM1401-02:y | 1 2 | 2 | BPM1401-02:y |
| BPM1401-03:y | 1 3 | 3 | BPM1401-03:y |
| BPM1401-04:y | 1 4 | 4 | BPM1401-04:y |
| BPM1402-07:y | 2 1 | 5 | BPM1402-07:y |
| BPM1402-08:y | 2 2 | 6 | BPM1402-08:y |
| BPM1402-09:y | 2 3 | 7 | BPM1402-09:y |
| BPM1402-10:y | 2 4 | 8 | BPM1402-10:y |
| BPM1403-02:y | 3 1 | 9 | BPM1403-02:y |
| BPM1403-03:y | 3 2 | 10 | BPM1403-03:y |
| BPM1403-04:y | 3 3 | 11 | BPM1403-04:y |
| BPM1403-05:y | 3 4 | 12 | BPM1403-05:y |
| BPM1404-02:y | 4 1 | 13 | BPM1404-02:y |
| BPM1404-03:y | 4 2 | 14 | BPM1404-03:y |
| BPM1404-04:y | 4 3 | 15 | BPM1404-04:y |
| BPM1404-05:y | 4 4 | 16 | BPM1404-05:y |
| BPM1405-02:y | 5 1 | 17 | BPM1405-02:y |
| BPM1405-03:y | 5 2 | 18 | BPM1405-03:y |
| BPM1405-04:y | 5 3 | 19 | BPM1405-04:y |
| BPM1405-05:y | 5 4 | 20 | BPM1405-05:y |
| BPM1406-02:y | 6 1 | 21 | BPM1406-02:y |
| BPM1406-03:y | 6 2 | 22 | BPM1406-03:y |
| BPM1406-04:y | 6 3 | 23 | BPM1406-04:y |
| BPM1406-05:y | 6 4 | 24 | BPM1406-05:y |
| BPM1407-03:y | 7 1 | 25 | BPM1407-03:y |
| BPM1407-04:y | 7 2 | 26 | BPM1407-04:y |
| BPM1407-05:y | 7 3 | 27 | BPM1407-05:y |
| BPM1407-06:y | 7 4 | 28 | BPM1407-06:y |
| BPM1408-02:y | 8 1 | 29 | BPM1408-02:y |
| BPM1408-03:y | 8 2 | 30 | BPM1408-03:y |
| BPM1408-04:y | 8 3 | 31 | BPM1408-04:y |
| BPM1408-05:y | 8 4 | 32 | BPM1408-05:y |
| BPM1409-02:y | 9 1 | 33 | BPM1409-02:y |
| BPM1409-03:y | 9 2 | 34 | BPM1409-03:y |
| BPM1409-04:y | 9 3 | 35 | BPM1409-04:y |
| BPM1409-05:y | 9 4 | 36 | BPM1409-05:y |
| BPM1410-02:y | 10 1 | 37 | BPM1410-02:y |
| BPM1410-03:y | 10 2 | 38 | BPM1410-03:y |
| BPM1410-04:y | 10 3 | 39 | BPM1410-04:y |
| BPM1410-05:y | 10 4 | 40 | BPM1410-05:y |
| BPM1411-02:y | 11 1 | 41 | BPM1411-02:y |
| BPM1411-03:y | 11 2 | 42 | BPM1411-03:y |
| BPM1411-04:y | 11 3 | 43 | BPM1411-04:y |
| BPM1411-05:y | 11 4 | 44 | BPM1411-05:y |
| BPM1412-02:y | 12 1 | 45 | BPM1412-02:y |

| | | | |
|---|---|---|---|
| BPM1412-03:y | 12 2 | 46 | BPM1412-03:y |
| BPM1412-04:y | 12 3 | 47 | BPM1412-04:y |
| BPM1412-05:y | 12 4 | 48 | BPM1412-05:y |

Note: Families BPMxALL and BPMyALL are very similar to BPMx and BPMy only they include the BPMs in the center of the ID straights – useful for creating ID lookup tables. Instead of 'getx' and 'gety', use 'getbpmx' and 'getbpmy' for the full set.

| HCM Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| 1CX1 | 1 1 | 1 | OCH1401-01:adc | OCH1401-01:dac | OCH1401-01:on |
| 1CX2 | 1 2 | 2 | SOA1401-01:X:adc | SOA1401-01:X:dac | OCH1401-02:on |
| 1CX3 | 1 3 | 3 | SOA1401-02:X:adc | SOA1401-02:X:dac | SOA1401-01:X:on |
| 1CX4 | 1 4 | 4 | OCH1401-02:adc | OCH1401-02:dac | SOA1401-02:X:on |
| 2CX1 | 2 1 | 5 | OCH1402-01:adc | OCH1402-01:dac | OCH1402-01:on |
| 2CX2 | 2 2 | 6 | SOA1402-01:X:adc | SOA1402-01:X:dac | OCH1402-02:on |
| 2CX3 | 2 3 | 7 | SOA1402-02:X:adc | SOA1402-02:X:dac | SOA1402-01:X:on |
| 2CX4 | 2 4 | 8 | OCH1402-02:adc | OCH1402-02:dac | SOA1402-02:X:on |
| 3CX1 | 3 1 | 9 | OCH1403-01:adc | OCH1403-01:dac | OCH1403-01:on |
| 3CX2 | 3 2 | 10 | SOA1403-01:X:adc | SOA1403-01:X:dac | OCH1403-02:on |
| 3CX3 | 3 3 | 11 | SOA1403-02:X:adc | SOA1403-02:X:dac | SOA1403-01:X:on |
| 3CX4 | 3 4 | 12 | OCH1403-02:adc | OCH1403-02:dac | SOA1403-02:X:on |
| 4CX1 | 4 1 | 13 | OCH1404-01:adc | OCH1404-01:dac | OCH1404-01:on |
| 4CX2 | 4 2 | 14 | SOA1404-01:X:adc | SOA1404-01:X:dac | OCH1404-02:on |
| 4CX3 | 4 3 | 15 | SOA1404-02:X:adc | SOA1404-02:X:dac | SOA1404-01:X:on |
| 4CX4 | 4 4 | 16 | OCH1404-02:adc | OCH1404-02:dac | SOA1404-02:X:on |
| 5CX1 | 5 1 | 17 | OCH1405-01:adc | OCH1405-01:dac | OCH1405-01:on |
| 5CX2 | 5 2 | 18 | SOA1405-01:X:adc | SOA1405-01:X:dac | OCH1405-02:on |
| 5CX3 | 5 3 | 19 | SOA1405-02:X:adc | SOA1405-02:X:dac | SOA1405-01:X:on |
| 5CX4 | 5 4 | 20 | OCH1405-02:adc | OCH1405-02:dac | SOA1405-02:X:on |
| 6CX1 | 6 1 | 21 | OCH1406-01:adc | OCH1406-01:dac | OCH1406-01:on |
| 6CX2 | 6 2 | 22 | SOA1406-01:X:adc | SOA1406-01:X:dac | OCH1406-02:on |
| 6CX3 | 6 3 | 23 | SOA1406-02:X:adc | SOA1406-02:X:dac | SOA1406-01:X:on |
| 6CX4 | 6 4 | 24 | OCH1406-02:adc | OCH1406-02:dac | SOA1406-02:X:on |
| 7CX1 | 7 1 | 25 | OCH1407-01:adc | OCH1407-01:dac | OCH1407-01:on |
| 7CX2 | 7 2 | 26 | SOA1407-01:X:adc | SOA1407-01:X:dac | OCH1407-02:on |
| 7CX3 | 7 3 | 27 | SOA1407-02:X:adc | SOA1407-02:X:dac | SOA1407-01:X:on |
| 7CX4 | 7 4 | 28 | OCH1407-02:adc | OCH1407-02:dac | SOA1407-02:X:on |
| 8CX1 | 8 1 | 29 | OCH1408-01:adc | OCH1408-01:dac | OCH1408-01:on |
| 8CX2 | 8 2 | 30 | SOA1408-01:X:adc | SOA1408-01:X:dac | OCH1408-02:on |
| 8CX3 | 8 3 | 31 | SOA1408-02:X:adc | SOA1408-02:X:dac | SOA1408-01:X:on |
| 8CX4 | 8 4 | 32 | OCH1408-02:adc | OCH1408-02:dac | SOA1408-02:X:on |
| 9CX1 | 9 1 | 33 | OCH1409-01:adc | OCH1409-01:dac | OCH1409-01:on |
| 9CX2 | 9 2 | 34 | SOA1409-01:X:adc | SOA1409-01:X:dac | OCH1409-02:on |
| 9CX3 | 9 3 | 35 | SOA1409-02:X:adc | SOA1409-02:X:dac | SOA1409-01:X:on |
| 9CX4 | 9 4 | 36 | OCH1409-02:adc | OCH1409-02:dac | SOA1409-02:X:on |
| 10CX1 | 10 1 | 37 | OCH1410-01:adc | OCH1410-01:dac | OCH1410-01:on |
| 10CX2 | 10 2 | 38 | SOA1410-01:X:adc | SOA1410-01:X:dac | OCH1410-02:on |
| 10CX3 | 10 3 | 39 | SOA1410-02:X:adc | SOA1410-02:X:dac | SOA1410-01:X:on |
| 10CX4 | 10 4 | 40 | OCH1410-02:adc | OCH1410-02:dac | SOA1410-02:X:on |

| | | | | | | |
|---|---|---|---|---|---|---|
| 11CX1 | 11 | 1 | 41 | OCH1411-01:adc | OCH1411-01:dac | OCH1411-01:on |
| 11CX2 | 11 | 2 | 42 | SOA1411-01:X:adc | SOA1411-01:X:dac | OCH1411-02:on |
| 11CX3 | 11 | 3 | 43 | SOA1411-02:X:adc | SOA1411-02:X:dac | SOA1411-01:X:on |
| 11CX4 | 11 | 4 | 44 | OCH1411-02:adc | OCH1411-02:dac | SOA1411-02:X:on |
| 12CX1 | 12 | 1 | 45 | OCH1412-01:adc | OCH1412-01:dac | OCH1412-01:on |
| 12CX2 | 12 | 2 | 46 | SOA1412-01:X:adc | SOA1412-01:X:dac | OCH1412-02:on |
| 12CX3 | 12 | 3 | 47 | SOA1412-02:X:adc | SOA1412-02:X:dac | SOA1412-01:X:on |
| 12CX4 | 12 | 4 | 48 | OCH1412-02:adc | OCH1412-02:dac | SOA1412-02:X:on |

| VCM Family | | | | | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Device List** | | **Element List** | **Channel Name** | | |
| | | | | **Monitor** | **Setpoint** | **On** |
| 1CY1 | 1 | 1 | 1 | OCV1401-01:adc | OCV1401-01:dac | OCV1401-01:on |
| 1CY2 | 1 | 2 | 2 | SOA1401-01:Y:adc | SOA1401-01:Y:dac | OCV1401-02:on |
| 1CY3 | 1 | 3 | 3 | SOA1401-02:Y:adc | SOA1401-02:Y:dac | SOA1401-01:Y:on |
| 1CY4 | 1 | 4 | 4 | OCV1401-02:adc | OCV1401-02:dac | SOA1401-02:Y:on |
| 2CY1 | 2 | 1 | 5 | OCV1402-01:adc | OCV1402-01:dac | OCV1402-01:on |
| 2CY2 | 2 | 2 | 6 | SOA1402-01:Y:adc | SOA1402-01:Y:dac | OCV1402-02:on |
| 2CY3 | 2 | 3 | 7 | SOA1402-02:Y:adc | SOA1402-02:Y:dac | SOA1402-01:Y:on |
| 2CY4 | 2 | 4 | 8 | OCV1402-02:adc | OCV1402-02:dac | SOA1402-02:Y:on |
| 3CY1 | 3 | 1 | 9 | OCV1403-01:adc | OCV1403-01:dac | OCV1403-01:on |
| 3CY2 | 3 | 2 | 10 | SOA1403-01:Y:adc | SOA1403-01:Y:dac | OCV1403-02:on |
| 3CY3 | 3 | 3 | 11 | SOA1403-02:Y:adc | SOA1403-02:Y:dac | SOA1403-01:Y:on |
| 3CY4 | 3 | 4 | 12 | OCV1403-02:adc | OCV1403-02:dac | SOA1403-02:Y:on |
| 4CY1 | 4 | 1 | 13 | OCV1404-01:adc | OCV1404-01:dac | OCV1404-01:on |
| 4CY2 | 4 | 2 | 14 | SOA1404-01:Y:adc | SOA1404-01:Y:dac | OCV1404-02:on |
| 4CY3 | 4 | 3 | 15 | SOA1404-02:Y:adc | SOA1404-02:Y:dac | SOA1404-01:Y:on |
| 4CY4 | 4 | 4 | 16 | OCV1404-02:adc | OCV1404-02:dac | SOA1404-02:Y:on |
| 5CY1 | 5 | 1 | 17 | OCV1405-01:adc | OCV1405-01:dac | OCV1405-01:on |
| 5CY2 | 5 | 2 | 18 | SOA1405-01:Y:adc | SOA1405-01:Y:dac | OCV1405-02:on |
| 5CY3 | 5 | 3 | 19 | SOA1405-02:Y:adc | SOA1405-02:Y:dac | SOA1405-01:Y:on |
| 5CY4 | 5 | 4 | 20 | OCV1405-02:adc | OCV1405-02:dac | SOA1405-02:Y:on |
| 6CY1 | 6 | 1 | 21 | OCV1406-01:adc | OCV1406-01:dac | OCV1406-01:on |
| 6CY2 | 6 | 2 | 22 | SOA1406-01:Y:adc | SOA1406-01:Y:dac | OCV1406-02:on |
| 6CY3 | 6 | 3 | 23 | SOA1406-02:Y:adc | SOA1406-02:Y:dac | SOA1406-01:Y:on |
| 6CY4 | 6 | 4 | 24 | OCV1406-02:adc | OCV1406-02:dac | SOA1406-02:Y:on |
| 7CY1 | 7 | 1 | 25 | OCV1407-01:adc | OCV1407-01:dac | OCV1407-01:on |
| 7CY2 | 7 | 2 | 26 | SOA1407-01:Y:adc | SOA1407-01:Y:dac | OCV1407-02:on |
| 7CY3 | 7 | 3 | 27 | SOA1407-02:Y:adc | SOA1407-02:Y:dac | SOA1407-01:Y:on |
| 7CY4 | 7 | 4 | 28 | OCV1407-02:adc | OCV1407-02:dac | SOA1407-02:Y:on |
| 8CY1 | 8 | 1 | 29 | OCV1408-01:adc | OCV1408-01:dac | OCV1408-01:on |
| 8CY2 | 8 | 2 | 30 | SOA1408-01:Y:adc | SOA1408-01:Y:dac | OCV1408-02:on |
| 8CY3 | 8 | 3 | 31 | SOA1408-02:Y:adc | SOA1408-02:Y:dac | SOA1408-01:Y:on |
| 8CY4 | 8 | 4 | 32 | OCV1408-02:adc | OCV1408-02:dac | SOA1408-02:Y:on |
| 9CY1 | 9 | 1 | 33 | OCV1409-01:adc | OCV1409-01:dac | OCV1409-01:on |
| 9CY2 | 9 | 2 | 34 | SOA1409-01:Y:adc | SOA1409-01:Y:dac | OCV1409-02:on |
| 9CY3 | 9 | 3 | 35 | SOA1409-02:Y:adc | SOA1409-02:Y:dac | SOA1409-01:Y:on |
| 9CY4 | 9 | 4 | 36 | OCV1409-02:adc | OCV1409-02:dac | SOA1409-02:Y:on |
| 10CY1 | 10 | 1 | 37 | OCV1410-01:adc | OCV1410-01:dac | OCV1410-01:on |

| | | | | | | |
|---|---|---|---|---|---|---|
| 10CY2 | 10 | 2 | 38 | SOA1410-01:Y:adc | SOA1410-01:Y:dac | OCV1410-02:on |
| 10CY3 | 10 | 3 | 39 | SOA1410-02:Y:adc | SOA1410-02:Y:dac | SOA1410-01:Y:on |
| 10CY4 | 10 | 4 | 40 | OCV1410-02:adc | OCV1410-02:dac | SOA1410-02:Y:on |
| 11CY1 | 11 | 1 | 41 | OCV1411-01:adc | OCV1411-01:dac | OCV1411-01:on |
| 11CY2 | 11 | 2 | 42 | SOA1411-01:Y:adc | SOA1411-01:Y:dac | OCV1411-02:on |
| 11CY3 | 11 | 3 | 43 | SOA1411-02:Y:adc | SOA1411-02:Y:dac | SOA1411-01:Y:on |
| 11CY4 | 11 | 4 | 44 | OCV1411-02:adc | OCV1411-02:dac | SOA1411-02:Y:on |
| 12CY1 | 12 | 1 | 45 | OCV1412-01:adc | OCV1412-01:dac | OCV1412-01:on |
| 12CY2 | 12 | 2 | 46 | SOA1412-01:Y:adc | SOA1412-01:Y:dac | OCV1412-02:on |
| 12CY3 | 12 | 3 | 47 | SOA1412-02:Y:adc | SOA1412-02:Y:dac | SOA1412-01:Y:on |
| 12CY4 | 12 | 4 | 48 | OCV1412-02:adc | OCV1412-02:dac | SOA1412-02:Y:on |

| **BEND Family** | | | | | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Device List** | | **Element List** | **Channel Name** | | |
| | | | | **Monitor** | **Setpoint** | **On** |
| 1BND1 | 1 | 1 | 1 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 1BND2 | 1 | 2 | 2 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 2BND1 | 2 | 1 | 3 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 2BND2 | 2 | 2 | 4 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 3BND1 | 3 | 1 | 5 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 3BND2 | 3 | 2 | 6 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 4BND1 | 4 | 1 | 7 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 4BND2 | 4 | 2 | 8 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 5BND1 | 5 | 1 | 9 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 5BND2 | 5 | 2 | 10 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 6BND1 | 6 | 1 | 11 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 6BND2 | 6 | 2 | 12 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 7BND1 | 7 | 1 | 13 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 7BND2 | 7 | 2 | 14 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 8BND1 | 8 | 1 | 15 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 8BND2 | 8 | 2 | 16 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 9BND2 | 9 | 1 | 17 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 9BND2 | 9 | 2 | 18 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 10BND1 | 10 | 1 | 19 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 10BND2 | 10 | 2 | 20 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 11BND1 | 11 | 1 | 21 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 11BND2 | 11 | 2 | 22 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 12BND1 | 12 | 1 | 23 | B1400-00:adc | B1400-00:dac | B1400-00:on |
| 12BND2 | 12 | 2 | 24 | B1400-00:adc | B1400-00:dac | B1400-00:on |

| **QFA Family** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Common Name** | **Device List** | | **Element List** | **Channel Name** | | | |
| | | | | **Monitor** | **Setpoint** | **On** | **Amps** |
| 1QFA1 | 1 | 1 | 1 | QFA1401-01:adc | QFA1401-01:dac | QFA1401-01:on | QFA1401-01:Amp |
| 1QFA2 | 1 | 2 | 2 | QFA1401-02:adc | QFA1401-02:dac | QFA1401-02:on | QFA1401-02:Amp |
| 2QFA1 | 2 | 1 | 3 | QFA1402-01:adc | QFA1402-01:dac | QFA1402-01:on | QFA1402-01:Amp |
| 2QFA2 | 2 | 2 | 4 | QFA1402-02:adc | QFA1402-02:dac | QFA1402-02:on | QFA1402-02:Amp |
| 3QFA1 | 3 | 1 | 5 | QFA1403-01:adc | QFA1403-01:dac | QFA1403-01:on | QFA1403-01:Amp |
| 3QFA2 | 3 | 2 | 6 | QFA1403-02:adc | QFA1403-02:dac | QFA1403-02:on | QFA1403-02:Amp |
| 4QFA1 | 4 | 1 | 7 | QFA1404-01:adc | QFA1404-01:dac | QFA1404-01:on | QFA1404-01:Amp |
| 4QFA2 | 4 | 2 | 8 | QFA1404-02:adc | QFA1404-02:dac | QFA1404-02:on | QFA1404-02:Amp |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5QFA1 | 5 1 | 9 | QFA1405-01:adc | QFA1405-01:dac | QFA1405-01:on | QFA1405-01:Amp |
| 5QFA2 | 5 2 | 10 | QFA1405-02:adc | QFA1405-02:dac | QFA1405-02:on | QFA1405-02:Amp |
| 6QFA1 | 6 1 | 11 | QFA1406-01:adc | QFA1406-01:dac | QFA1406-01:on | QFA1406-01:Amp |
| 6QFA2 | 6 2 | 12 | QFA1406-02:adc | QFA1406-02:dac | QFA1406-02:on | QFA1406-02:Amp |
| 7QFA1 | 7 1 | 13 | QFA1407-01:adc | QFA1407-01:dac | QFA1407-01:on | QFA1407-01:Amp |
| 7QFA2 | 7 2 | 14 | QFA1407-02:adc | QFA1407-02:dac | QFA1407-02:on | QFA1407-02:Amp |
| 8QFA1 | 8 1 | 15 | QFA1408-01:adc | QFA1408-01:dac | QFA1408-01:on | QFA1408-01:Amp |
| 8QFA2 | 8 2 | 16 | QFA1408-02:adc | QFA1408-02:dac | QFA1408-02:on | QFA1408-02:Amp |
| 9QFA1 | 9 1 | 17 | QFA1409-01:adc | QFA1409-01:dac | QFA1409-01:on | QFA1409-01:Amp |
| 9QFA2 | 9 2 | 18 | QFA1409-02:adc | QFA1409-02:dac | QFA1409-02:on | QFA1409-02:Amp |
| 10QFA1 | 10 1 | 19 | QFA1410-01:adc | QFA1410-01:dac | QFA1410-01:on | QFA1410-01:Amp |
| 10QFA2 | 10 2 | 20 | QFA1410-02:adc | QFA1410-02:dac | QFA1410-02:on | QFA1410-02:Amp |
| 11QFA2 | 11 1 | 21 | QFA1411-01:adc | QFA1411-01:dac | QFA1411-01:on | QFA1411-01:Amp |
| 11QFA2 | 11 2 | 22 | QFA1411-02:adc | QFA1411-02:dac | QFA1411-02:on | QFA1411-02:Amp |
| 12QFA1 | 12 1 | 23 | QFA1412-01:adc | QFA1412-01:dac | QFA1412-01:on | QFA1412-01:Amp |
| 12QFA2 | 12 2 | 24 | QFA1412-02:adc | QFA1412-02:dac | QFA1412-02:on | QFA1412-02:Amp |

| QFB Family | | | | | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** | | | |
| | | | **Monitor** | **Setpoint** | **On** | **Amps** |
| 1QFB1 | 1 1 | 1 | QFB1401-01:adc | QFB1401-01:dac | QFB1401-01:on | QFB1401-01:Amp |
| 1QFB2 | 1 2 | 2 | QFB1401-02:adc | QFB1401-02:dac | QFB1401-02:on | QFB1401-02:Amp |
| 2QFB1 | 2 1 | 3 | QFB1402-01:adc | QFB1402-01:dac | QFB1402-01:on | QFB1402-01:Amp |
| 2QFB2 | 2 2 | 4 | QFB1402-02:adc | QFB1402-02:dac | QFB1402-02:on | QFB1402-02:Amp |
| 3QFB1 | 3 1 | 5 | QFB1403-01:adc | QFB1403-01:dac | QFB1403-01:on | QFB1403-01:Amp |
| 3QFB2 | 3 2 | 6 | QFB1403-02:adc | QFB1403-02:dac | QFB1403-02:on | QFB1403-02:Amp |
| 4QFB1 | 4 1 | 7 | QFB1404-01:adc | QFB1404-01:dac | QFB1404-01:on | QFB1404-01:Amp |
| 4QFB2 | 4 2 | 8 | QFB1404-02:adc | QFB1404-02:dac | QFB1404-02:on | QFB1404-02:Amp |
| 5QFB1 | 5 1 | 9 | QFB1405-01:adc | QFB1405-01:dac | QFB1405-01:on | QFB1405-01:Amp |
| 5QFB2 | 5 2 | 10 | QFB1405-02:adc | QFB1405-02:dac | QFB1405-02:on | QFB1405-02:Amp |
| 6QFB1 | 6 1 | 11 | QFB1406-01:adc | QFB1406-01:dac | QFB1406-01:on | QFB1406-01:Amp |
| 6QFB2 | 6 2 | 12 | QFB1406-02:adc | QFB1406-02:dac | QFB1406-02:on | QFB1406-02:Amp |
| 7QFB1 | 7 1 | 13 | QFB1407-01:adc | QFB1407-01:dac | QFB1407-01:on | QFB1407-01:Amp |
| 7QFB2 | 7 2 | 14 | QFB1407-02:adc | QFB1407-02:dac | QFB1407-02:on | QFB1407-02:Amp |
| 8QFB1 | 8 1 | 15 | QFB1408-01:adc | QFB1408-01:dac | QFB1408-01:on | QFB1408-01:Amp |
| 8QFB2 | 8 2 | 16 | QFB1408-02:adc | QFB1408-02:dac | QFB1408-02:on | QFB1408-02:Amp |
| 9QFB1 | 9 1 | 17 | QFB1409-01:adc | QFB1409-01:dac | QFB1409-01:on | QFB1409-01:Amp |
| 9QFB2 | 9 2 | 18 | QFB1409-02:adc | QFB1409-02:dac | QFB1409-02:on | QFB1409-02:Amp |
| 10QFB1 | 10 1 | 19 | QFB1410-01:adc | QFB1410-01:dac | QFB1410-01:on | QFB1410-01:Amp |
| 10QFB2 | 10 2 | 20 | QFB1410-02:adc | QFB1410-02:dac | QFB1410-02:on | QFB1410-02:Amp |
| 11QFB2 | 11 1 | 21 | QFB1411-01:adc | QFB1411-01:dac | QFB1411-01:on | QFB1411-01:Amp |
| 11QFB2 | 11 2 | 22 | QFB1411-02:adc | QFB1411-02:dac | QFB1411-02:on | QFB1411-02:Amp |
| 12QFB1 | 12 1 | 23 | QFB1412-01:adc | QFB1412-01:dac | QFB1412-01:on | QFB1412-01:Amp |
| 12QFB2 | 12 2 | 24 | QFB1412-02:adc | QFB1412-02:dac | QFB1412-02:on | QFB1412-02:Amp |

| QFC Family | | | | | | |
|---|---|---|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** | | | |
| | | | **Monitor** | **Setpoint** | **On** | **Amps** |
| 1QFC1 | 1 1 | 1 | QFC1401-01:adc | QFC1401-01:dac | QFC1401-01:on | QFC1401-01:Amp |
| 1QFC2 | 1 2 | 2 | QFC1401-02:adc | QFC1401-02:dac | QFC1401-02:on | QFC1401-02:Amp |
| 2QFC1 | 2 1 | 3 | QFC1402-01:adc | QFC1402-01:dac | QFC1402-01:on | QFC1402-01:Amp |
| 2QFC2 | 2 2 | 4 | QFC1402-02:adc | QFC1402-02:dac | QFC1402-02:on | QFC1402-02:Amp |
| 3QFC1 | 3 1 | 5 | QFC1403-01:adc | QFC1403-01:dac | QFC1403-01:on | QFC1403-01:Amp |
| 3QFC2 | 3 2 | 6 | QFC1403-02:adc | QFC1403-02:dac | QFC1403-02:on | QFC1403-02:Amp |
| 4QFC1 | 4 1 | 7 | QFC1404-01:adc | QFC1404-01:dac | QFC1404-01:on | QFC1404-01:Amp |
| 4QFC2 | 4 2 | 8 | QFC1404-02:adc | QFC1404-02:dac | QFC1404-02:on | QFC1404-02:Amp |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5QFC1 | 5 | 1 | 9 | QFC1405-01:adc | QFC1405-01:dac | QFC1405-01:on | QFC1405-01:Amp |
| 5QFC2 | 5 | 2 | 10 | QFC1405-02:adc | QFC1405-02:dac | QFC1405-02:on | QFC1405-02:Amp |
| 6QFC1 | 6 | 1 | 11 | QFC1406-01:adc | QFC1406-01:dac | QFC1406-01:on | QFC1406-01:Amp |
| 6QFC2 | 6 | 2 | 12 | QFC1406-02:adc | QFC1406-02:dac | QFC1406-02:on | QFC1406-02:Amp |
| 7QFC1 | 7 | 1 | 13 | QFC1407-01:adc | QFC1407-01:dac | QFC1407-01:on | QFC1407-01:Amp |
| 7QFC2 | 7 | 2 | 14 | QFC1407-02:adc | QFC1407-02:dac | QFC1407-02:on | QFC1407-02:Amp |
| 8QFC1 | 8 | 1 | 15 | QFC1408-01:adc | QFC1408-01:dac | QFC1408-01:on | QFC1408-01:Amp |
| 8QFC2 | 8 | 2 | 16 | QFC1408-02:adc | QFC1408-02:dac | QFC1408-02:on | QFC1408-02:Amp |
| 9QFC1 | 9 | 1 | 17 | QFC1409-01:adc | QFC1409-01:dac | QFC1409-01:on | QFC1409-01:Amp |
| 9QFC2 | 9 | 2 | 18 | QFC1409-02:adc | QFC1409-02:dac | QFC1409-02:on | QFC1409-02:Amp |
| 10QFC1 | 10 | 1 | 19 | QFC1410-01:adc | QFC1410-01:dac | QFC1410-01:on | QFC1410-01:Amp |
| 10QFC2 | 10 | 2 | 20 | QFC1410-02:adc | QFC1410-02:dac | QFC1410-02:on | QFC1410-02:Amp |
| 11QFC1 | 11 | 1 | 21 | QFC1411-01:adc | QFC1411-01:dac | QFC1411-01:on | QFC1411-01:Amp |
| 11QFC2 | 11 | 2 | 22 | QFC1411-02:adc | QFC1411-02:dac | QFC1411-02:on | QFC1411-02:Amp |
| 12QFC1 | 12 | 1 | 23 | QFC1412-01:adc | QFC1412-01:dac | QFC1412-01:on | QFC1412-01:Amp |
| 12QFC2 | 12 | 2 | 24 | QFC1412-02:adc | QFC1412-02:dac | QFC1412-02:on | QFC1412-02:Amp |

| SF Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| 1SF | 1 1 | 1 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 2SF | 2 1 | 2 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 3SF | 3 1 | 3 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 4SF | 4 1 | 4 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 5SF | 5 1 | 5 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 6SF | 6 1 | 6 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 7SF | 7 1 | 7 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 8SF | 8 1 | 8 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 9SF | 9 1 | 9 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 10SF | 10 1 | 10 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 11SF | 11 1 | 11 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |
| 12SF | 12 1 | 12 | SB1400-00:adc | SB1400-00:dac | SB1400-00:on |

| SD Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| 1SD1 | 1 1 | 1 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 1SD2 | 1 2 | 2 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 2SD1 | 2 1 | 3 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 2SD2 | 2 2 | 4 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 3SD1 | 3 1 | 5 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 3SD2 | 3 2 | 6 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 4SD1 | 4 1 | 7 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 4SD2 | 4 2 | 8 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 5SD1 | 5 1 | 9 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 5SD2 | 5 2 | 10 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 6SD1 | 6 1 | 11 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 6SD2 | 6 2 | 12 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 7SD1 | 7 1 | 13 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 7SD2 | 7 2 | 14 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 8SD1 | 8 1 | 15 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |

| | | | | | |
|---|---|---|---|---|---|
| 8SD2 | 8 2 | 16 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 9SD1 | 9 1 | 17 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 9SD2 | 9 2 | 18 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 10SD1 | 10 1 | 19 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 10SD2 | 10 2 | 20 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 11SD1 | 11 1 | 21 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 11SD2 | 11 2 | 22 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 12SD1 | 12 1 | 23 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |
| 12SD2 | 12 2 | 24 | SOA1400-00:adc | SOA1400-00:dac | SOA1400-00:on |

| RF Family (frequency offset) | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name (Monitor/Setpoint)** |
| RF1 | 1 1 | 1 | CRYOSTAT:frequency_offset |

| RFC Family (center frequency) | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name (Monitor)** |
| RFC | 1 1 | 1 | FQC1503-001:read |

| TUNE Family | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** |
| xtune | 1 1 | 1 | MeasTune |
| xtune | 1 2 | 2 | MeasTune |
| xtune | 1 3 | 3 | MeasTune |

| DCCT Family | | | |
|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** |
| DCCT | 1 1 | 1 | PCT1402-01:mA:fbk |

| CHICANES Family | | | | | |
|---|---|---|---|---|---|
| **Common Name** | **Device List** | **Element List** | **Channel Name** | | |
| | | | **Monitor** | **Setpoint** | **On** |
| BID0801 | 8 1 | 1 | BID1408-01:adc | BID1408-01:dac | BID1408-01:on |
| BID0802 | 8 2 | 2 | BID1408-02:adc | BID1408-02:dac | BID1408-02:on |
| BID0803 | 8 3 | 3 | BID1408-03:adc | BID1408-03:dac | BID1408-03:on |
| BID1001 | 10 1 | 4 | BID1410-01:adc | BID1410-01:dac | BID1410-01:on |
| BID1002 | 10 2 | 5 | BID1410-02:adc | BID1410-02:dac | BID1410-02:on |
| BID1003 | 10 3 | 6 | BID1410-03:adc | BID1410-03:dac | BID1410-03:on |
| BID1004 | 10 4 | 7 | BID1410-04:adc | BID1410-04:dac | BID1410-04:on |
| BID1005 | 10 5 | 8 | BID1410-05:adc | BID1410-05:dac | BID1401-05:on |
| BID1101 | 11 1 | 9 | BID1411-01:adc | BID1411-01:dac | BID1411-01:on |
| BID1102 | 11 2 | 10 | BID1411-02:adc | BID1411-02:dac | BID1411-02:on |
| BID1103 | 11 3 | 11 | BID1411-03:adc | BID1411-03:dac | BID1411-03:on |

| SQS Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| SQ0101 | 1 1 | 1 | SOA1401-01:adc | SOA1401-01:dac | SOA1401-01:on |
| SQ0102 | 1 2 | 2 | SOA1401-02:adc | SOA1401-02:dac | SOA1401-02:on |
| SQ0201 | 2 1 | 3 | SOA1402-01:adc | SOA1402-01:dac | SOA1402-01:on |
| SQ0202 | 2 2 | 4 | SOA1402-02:adc | SOA1402-02:dac | SOA1402-02:on |
| SQ0301 | 3 1 | 5 | SOA1403-01:adc | SOA1403-01:dac | SOA1403-01:on |
| SQ0302 | 3 2 | 6 | SOA1403-02:adc | SOA1403-02:dac | SOA1403-02:on |
| SQ0401 | 4 1 | 7 | SOA1404-01:adc | SOA1404-01:dac | SOA1404-01:on |
| SQ0402 | 4 2 | 8 | SOA1404-02:adc | SOA1404-02:dac | SOA1404-02:on |
| SQ0501 | 5 1 | 9 | SOA1405-01:adc | SOA1405-01:dac | SOA1405-01:on |
| SQ0601 | 6 1 | 10 | SOA1406-01:adc | SOA1406-01:dac | SOA1406-01:on |
| SQ0701 | 7 1 | 11 | SOA1407-01:adc | SOA1407-01:dac | SOA1407-01:on |
| SQ0801 | 8 1 | 12 | SOA1408-01:adc | SOA1408-01:dac | SOA1408-01:on |
| SQ0901 | 9 1 | 13 | SOA1409-01:adc | SOA1409-01:dac | SOA1409-01:on |
| SQ1001 | 10 1 | 14 | SOA1410-01:adc | SOA1410-01:dac | SOA1410-01:on |
| SQ1101 | 11 1 | 15 | SOA1411-01:adc | SOA1411-01:dac | SOA1411-01:on |
| SQ1201 | 12 1 | 16 | SOA1412-01:adc | SOA1412-01:dac | SOA1412-01:on |
| SQ1202 | 12 2 | 17 | SOA1412-02:adc | SOA1412-02:dac | SOA1412-02:on |

## Booster to Storage Ring Transfer Line

| BTSQUADS Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| QD1 | 1 1 | 1 | QD1305-01:adc | QD1305-01:dac | QD1305-01:on |
| QD2 | 2 1 | 2 | QD1305-02:adc | QD1305-02:dac | QD1305-02:on |
| QD3 | 3 1 | 3 | QD1400-01:adc | QD1400-01:dac | QD1400-01:on |
| QD4 | 4 1 | 4 | QD1400-02:adc | QD1400-02:dac | QD1400-02:on |
| QD5 | 5 1 | 5 | QD1400-03:adc | QD1400-03:dac | QD1400-03:on |
| QF1 | 1 2 | 6 | QF1305-01:adc | QF1305-01:dac | QF1305-01:on |
| QF2 | 2 2 | 7 | QF1305-02:adc | QF1305-02:dac | QF1305-02:on |
| QF3 | 3 2 | 8 | QF1400-01:adc | QF1400-01:dac | QF1400-01:on |
| QF4 | 4 2 | 9 | QF1400-02:adc | QF1400-02:dac | QF1400-02:on |
| QF5 | 5 2 | 10 | QF1400-03:adc | QF1400-03:dac | QF1400-03:on |

| BTSSTEER Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| STV1 | 1 1 | 1 | STV1305-01:adc | STV1305-01:dac | STV1305-01:on |
| STV2 | 2 1 | 2 | STV1305-02:adc | STV1305-02:dac | STV1305-02:on |
| STV3 | 3 1 | 3 | STV1400-01:adc | STV1400-01:dac | STV1400-01:on |
| STV4 | 4 1 | 4 | STV1400-02:adc | STV1400-02:dac | STV1400-02:on |
| STV5 | 5 1 | 5 | STV1400-03:adc | STV1400-03:dac | STV1400-03:on |
| STH1 | 1 2 | 6 | STH1305-01:adc | STH1305-01:dac | STH1305-01:on |
| STH2 | 2 2 | 7 | STH1305-02:adc | STH1305-02:dac | STH1305-02:on |
| STH3 | 3 2 | 8 | STH1400-01:adc | STH1400-01:dac | STH1400-01:on |
| STH4 | 4 2 | 9 | STH1400-02:adc | STH1400-02:dac | STH1400-02:on |
| STH5 | 5 2 | 10 | STH1400-03:adc | STH1400-03:dac | STH1400-03:on |

| BTSBEND Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| B1 | 1 1 | 1 | B1305-01:adc | B1305-01:dac | B1305-01:on |

| BTSSEPT Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| SEP1 | 1 1 | 1 | SEP1400-01:adc | SEP1400-01:dac | SEP1400-01:on |
| SEP1Time | 1 2 | 2 | SEP1400-01:delay:ns | SEP1400-01:delay:ns | |
| SEP2 | 2 1 | 3 | SEP1401-01:adc | SEP1401-01:dac | |

| BTSSCRAPE Family | | | | |
|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | |
| | | | Monitor | Setpoint |
| SCP1 | 1 1 | 1 | SCP1401-01:mm:fbk | SCP1401-01:mm |
| SCP2 | 2 1 | 2 | SCP1401-02:mm:fbk | SCP1401-02:mm |
| SCP3 | 3 1 | 3 | SCP1401-03:mm:fbk | SCP1401-03:mm |

| BTSKICK Family | | | | | |
|---|---|---|---|---|---|
| Common Name | Device List | Element List | Channel Name | | |
| | | | Monitor | Setpoint | On |
| KS1 | 1 1 | 1 | KS1412-01:HV | KS1412-01:HV | KS1412-01:onoff |
| KS1Time | 1 2 | 2 | K1412-01:delay:ns | K1412-01:delay:ns | |
| KS1OnOff | 1 3 | 3 | KS1412-01:onoff | KS1412-01:onoff | |
| KS1Thyra | 1 4 | 4 | KS1412-01:thyratron | KS1412-01:thyratron | |
| KS2 | 2 1 | 5 | KS1401-01:HV | KS1401-01:HV | KS1401-01:onoff |
| KS2Time | 2 2 | 6 | K1401-01:delay:ns | K1401-01:delay:ns | |
| KS2OnOff | 2 3 | 7 | KS1401-01:onoff | KS1401-01:onoff | |
| KS2Thyra | 2 4 | 8 | KS1401-01:thyratron | KS1401-01:thyratron | |
| KS3 | 3 1 | 9 | KS1401-02:HV | KS1401-02:HV | KS1401-02:onoff |
| KS3Time | 3 2 | 10 | K1401-02:delay:ns | K1401-02:delay:ns | |
| KS3OnOff | 3 3 | 11 | KS1401-02:onoff | KS1401-02:onoff | |
| KS3Thyra | 3 4 | 12 | KS1401-02:thyratron | KS1401-02:thyratron | |
| KS4 | 4 1 | 13 | KS1402-01:HV | KS1402-01:HV | KS1402-01:onoff |
| KS4Time | 4 2 | 14 | K1402-01:delay:ns | K1402-01:delay:ns | |
| KS4OnOff | 4 3 | 15 | KS1402-01:onoff | KS1402-01:onoff | |
| KS4Thyra | 4 4 | 16 | KS1402-01:thyratron | KS1402-01:thyratron | |

# REFERENCES

Main Accelerator Toolbox Website: http://www-ssrl.slac.stanford.edu/at/. Includes newest versions, installation and operating instructions.

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