



S1 TITAN/TRACER 5^I

- **Communication Protocol**



Bruker Titan OEM/Remote Control Protocol

Revision History

Revision	Editor	Description	BrukerS1 Version	Date
01	KDW	Initial release	2.3.42.193 (OEM Beta)	4/20/2015
02	KDW	Added entries for new commands and changes to result XML data.	2.3.42.194 (OEM Beta)	5/5/2015
03	KDW	Corrected error in description of connection sequence	2.3.42.195 (OEM Beta)	5/15/2015
04	KDW	Added query command to retrieve instrument definition data.	2.3.42.198 (OEM Beta)	6/5/2015
05	KDW	Expanded functionality of Transmit Results configure command to include parameters that specify elements on/off and library search\limit set processing results on/off	2.3.43.203 (OEM Beta)	7/10/2015
06	KDW	Added "index" parameter to the grade and element tags to facilitate string searching in systems that are not using an XML parser.	2.3.43.204 (OEM Beta)	7/14/2015
07	KDW	Added query and configure commands related to system time and transmission control of status messages. Reformatted this document and added forgotten entries.	2.3.43.212 (OEM Beta)	11/02/2015
08	KDW	Added response messages to the command messages that didn't issue them previously.	2.3.43.214(OEM Beta)	11/6/2015
09	KDW	Removed statement related to the Statusmsg configure command that indicated the setting was not persisted. Added documentation for new proximity sensor configuration command.	2.3.43.217(OEM Beta)	12/08/2015
10	KDW	Added definition for STATUS_CHANGE packets to structure that defines message type values Added definition of status change messages.	2.3.43.217(OEM Beta)	12/15/2015
11	KDW	Removed description of the S1Sync connection process.	2.3.43.217(OEM Beta)	1/6/2016
12	KDW	Added query configure commands that enable/disable proximity sensor and display of error/information dialogs on the instrument UI.	2.3.43.219 (OEM Beta)	1/6/2016
13	KDW	Documented additional status messages and query/configure commands for a receive/send delay setting.	2.3.43.220 (OEM Beta)	1/12/2016
14	KDW	Added description of the software version, store results and spectra status query and configure commands.	2.3.43.222 (OEM Beta)	1/14/2016
15	KDW	Added description of added assay status message	2.3.43.223 (OEM Beta)	1/25/2016
16	KDW	Fixed error in Phase time query and configure command descriptions	2.3.43.225 (OEM Beta)	2/1/2016
17	KDW	Added query command to retrieve a list of the alloys defined in the active grade libraries. Fixed some errors in specification of the XML encoding	2.3.43.226 (OEM Beta)	2/9/2016



		in this documentation, it was UTF-16 on some response messages when it should have been UTF-8.		
18	KDW	Added a query command that reports the active quantification post processing settings. Added a status message indicating the instrument changed phases during an assay.	2.3.43.227 (OEM Beta)	2/26/2016
19	KDW	Added query commands and status messages in support of Tracer operations.	2.3.45.232	4/05/2016
20	KDW	Added description of the Manual Beam Filters query command. Fixed erroneous layout of the MsgTxtID, MsgRcvID, UserAckable and UserAacked XML attributes in the info and error report messages.	2.3.45.234	4/22/2016
21	KDW	Fixed an error in the shown response to the "Transmit Spectra" query command	2.3.43.195 (OEM Beta)	5/12/2016
22	KDW	Description of status attribute added to response messages. Corrected errors in some example response messages.	2.3.45.240	6/29/2016
23	KDW	Fixed "Limit Set" configure command to operate as documented. Added "Reset" keyword to "Edit Field" configure command. Added commands that support a more flexible RxBx performance envelope of operation.	2.3.45.248	7/14/2016

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Theory of operation

The Titan software is designed to operate in 2 modes, Analyzer and Spectrometer. In Analyzer mode the user is given the ability to select from a number of preinstalled applications that define most of the operating parameters that control how an assay is collected and elemental results are calculated. In Spectrometer mode the user is given the ability to set the operating parameters in order to optimize them to collect data which may be analyzed offline, no elemental concentrations are calculated.

When running in analyzer mode the user activates an application and is given the ability to adjust some settings related to it. These Adjustments include setting assay length/phase times, enable/disable Grade Id/Limit Set processing, activating Grade Library(s) or Limit Sets, activating a specific method/calibration and applying type standardization. The user is not allowed to adjust x-ray tube output or beam filter settings. During an assay the calculated elemental concentrations, Grade Id/Limit Set and energy spectrum are displayed and updated at most once per second. When the assay is complete several data files may be stored or updated depending on how the settings which control this are configured. If configured to do so the software writes the elemental concentrations to .CSV (comma separated values) and .TSV (tab separated values) and the energy spectrum along with the concentrations to a proprietary binary format file (PDZ).

When running in spectrometer mode the user has the ability to adjust the x-ray tube output and beam filter to any setting within the operating range of the hardware. These adjustments include x-ray tube high voltage, anode current, beam filter and assay length. If the instrument is equipped with a filter wheel the user can select one of the 5 filters installed. If the instrument has the option of using a manual filter the user is given the ability to enter a description of the filter materials used. If the instrument has a fixed beam filter the user cannot change the beam filter specification. In the case where there is a filter wheel and the ability to use a manual filter the information from both will be combined. During an assay the energy spectrum is displayed and updated once per second. When the assay is complete the energy spectrum is stored to a PDZ file.

The most basic function of the instrument is to generate an x-ray beam that causes the sample material to fluoresce and generate a return signal that's characteristic of its constituent elements. In a Titan instrument this function follows a series of steps as outlined here:

1. The user selects an application or spectrometer mode
2. The x-ray tube/beam filter settings are configured to produced a desired output energy and flux.
3. A hardware trigger or remote software control initiates an assay
4. X-rays are produced and the return photons are measured by the detector producing a histogram of events within energy bins. This "spectrum" defaults to 2048 bins.
5. At 1 second intervals the histogram is transferred from the measurement hardware to the instruments central processor, the hardware resets to begin collecting another 1 second of events.
6. The central processor receives the histogram (spectrum packet) and initiates a series of processing steps, depending on the active mode (analyzer or spectrometer).

This cycle continues until one of 3 events signal the end of the assay then the generated is stored and the instrument is reset to begin another assay. The end of assay signal events are the hardware "trigger" has been released, a preset time limit is reached or a safety condition/hardware malfunction is encountered.

The process described above is the simplest form of assay, the instrument has the ability to process a multi-phase assay. These assays are different from the process described above in that they are defined to configure the x-ray output and associated calibration, collect spectrum packets for a preset time then change



the output settings, calibration and collect spectrum packets for another preset length of time, possibly unlimited, which continues until the hardware signals a stop condition.

The OEM/Remote Control protocol enables a program residing on any device capable of standard TCP/IP network operations and either a Wi-Fi or USB-RNDIS interface to control the above described aspects of a Titan instrument. The protocol and connectivity specifics are described in this document.

**** Use of this protocol will require some form of custom software that establishes a TCP/IP connection with the instrument, creates the query, configure and command messages, parses the responses / assay results and reacts accordingly. This is not Plug-and-Play functionality. ****

Connectivity

Bruker Titan instruments support communication with another computer via standard Wi-Fi networking and TCP/IP via USB hardware. Standard TCP/IP packet operations are used to establish connections and transfer data to/from the instrument. IPv4 is supported, IPv6 is not currently supported. Wi-Fi supports use of either a fixed or dynamically assigned IP address. USB supports use of a fixed IP address. Upon connection of a USB cable between the instrument and a PC the PC is assigned an address by the instrument forming a local point-to-point subnet. Connect to port 55204 when using this protocol.

Example: 192.168.137.139:55204

This is the default USB fixed IP address.

S1Sync Protocol

When the instrument boots or the BrukerS1 main application is restarted the active communication protocol is designed for use by S1Sync. This protocol does not provide the capability to control and configure the instrument, it's intended to transfer files to/from the instrument and install firmware updates. The operation of this protocol begins with the instrument sending UDP broadcast packets at one second intervals. These packets contain the instrument serial number and a "magic" number that indicates they were generated by the BrukerS1 application. These packets can be used to determine the IP address of the instrument as a method to simplify connection to an instrument that has been assigned an IP address via DHCP.

The OEM Protocol

The protocol has been designed to provide the ability to control most of the features of a Titan instrument. A fixed set of queries and commands have been implemented that retrieve/change current configuration settings and start/stop assays. The commands and responses are encoded in XML. Three XML packet types are implemented:

1. Query – These request information related to a specific setting or available options for a setting
2. Configure – These change active operating settings
3. Command – These initiate actions such as starting or stopping an assay.

The XML commands (from PC to instrument) are formatted as follows:

```
<?xml version="1.0" encoding="utf-8"?>  
<Query parameter="ActiveApplication">Include Methods</Query>
```

Or

```
<?xml version="1.0" encoding="utf-8"?>  
<Configure parameter="Application">Alloys</Configure>
```

Or

```
<?xml version="1.0" encoding="utf-8"?>  
<Command parameter="Assay">Start</Command>
```

The XML responses (from instrument to PC) are formatted as follows:

```
<?xml version="1.0" encoding="utf-8"?>  
<Response parameter="ActiveApplication" status="success">Alloys</Response>
```

Where the parameter attribute of the response will match the parameter attribute of the associated command.

The "status" attribute will have one of the following values:

1. success – indicates the associated command was successfully processed
2. error – indicates an error was encountered while processing the command

The response tag will contain the requested information, an indication of the state of the system following a command or a message indicating the error condition encountered.

List of the “Query” messages and a short description of each:

Queryable Parameters:

- ActiveApplication
- Applications
- Method
- Library
- PassFail Grades
- Limit Set
- User Preferences
- Edit Fields
- Phase Times
- x-ray Settings
- Beam Filters
- Armed State
- Login State
- Instrument Definition
- System Time
- Transmission of Status Messages
- Proximity Sensor Required
- UI Popup display
- Delay response messages
- Software version
- Store Results
- Store Spectra
- Transmit Spectra
- Transmit Results
- Quantification post processing settings
- Remote ID
- Instrument Nose Pressure
- Instrument Nose Temperature
- Collimator (Spot Size)
- Manual Beam Filters
- High Voltage Range
- Minimum High voltage
- Maximum High Voltage
- Anode Current Range
- Minimum Anode Current
- Maximum Anode Current

Descriptions:

- **ActiveApplication** – Query the name of the active application
 - Optionally the available calibrations can also be returned, as shown in the example

```
<?xml version="1.0" encoding="utf-8"?>
```

<Query parameter="ActiveApplication">Include Methods</Query>

- The response is the name of the currently active application on the instrument.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="activeapplication" status="success">
  <Application>Alloys SMARTGrade</Application>
  <ActiveMethod>Auto</ActiveMethod>
  <MethodList>
    <Method>Auto</Method>
    <Method>Aluminium Alloys</Method>
    <Method>Titanium Alloys</Method>
    .
  </MethodList>
</Response>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="ActiveApplication"></Query>
```

```
<Response parameter="activeapplication" status="success">
  <Application>Alloys SMARTGrade</Application>
</Response>
```

- **Applications** – Query list of installed applications

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Applications"/>
```

- The response is a list of all the installed applications

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="applications" status="success">
  <ApplicationList>
    <Application>Alloys</Application>
    <Application>Auxiliary Alloys</Application>
    <Application>TATA-Zn_g_per_m2</Application>
    .
  </ApplicationList>
</Response>
```

- **Method** – Returns a list of methods/calibrations for an application
 - Optionally the application name can be left blank to request the list for the active application

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Method"></Query>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="method" status="success">
  <Application>Alloys SMARTGrade</Application>
  <MethodList>
    <Method>Auto</Method>
```



```

<Method>Aluminium Alloys</Method>
<Method>Titanium Alloys</Method>
.
.
</MethodList>
<ActiveMethod>Other Alloys</ActiveMethod>
</Response>

```

- Request an method names with invalid application name

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Method">RANDOM</Query>

```

- Response to Query with invalid application name

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="method" status="error">Invalid Method Query:Unknown Application::
RANDOM</Response>

```

- **Library** – Returns a list of the installed grade libraries

- Optionally the name of the active library can be requested by adding “Active” to the request as shown below.

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Library">Active</Query>

```

- Response when there is no active library.

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Library" status="success">None</Response>

```

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Library"></Response>

```

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Library" status="success">
<LibraryList>
<Library>Standard</Library>
<Library>DIN</Library>
<Library>Gold Karat</Library>
.
.
</LibraryList>
</Response>

```

- **PassFail Grades** – Returns a list of grade library entries that should generate a PASS response

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="PassFail Grades/">

```

- Response when no PassFail grades are defined

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="passfail grades" status="success">None</Response>

```

- Response when PassFail grades are defined



```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="passfail grades" status="success">
  <PFGradeList>
    <PFGrade>2205SS</PFGrade>
    <PFGrade>2507SS</PFGrade>
    .
    .
  </PFGradeList >
</Response>
```

- **Grade List** – Returns a list of grade library entries from the active library(s)

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Grade List/">

  ○ Response when no grade library is active
  <?xml version="1.0" encoding="utf-8"?>
  <Response parameter="grade list" status="success">None</Response>
```

```
  ○ Response when one or more grade libraries are active
  <?xml version="1.0" encoding="utf-8"?>
  <Response parameter="grade list" status="success">
    <GradeList>
      <Grade>1100 Al</Grade>
      <Grade>1100 Al Family</Grade>
      <Grade>2011 Al</Grade>
      <Grade>2014 Al</Grade>
      <Grade>2014/2024 Al</Grade>
      .
      .
    </GradeList >
  </Response>
```

- **Limit Set** – Returns a list of the defined limit sets

```
  ○ Optionally the name of the Active set can be requested by adding “Active” to the request as
  shown below.
  <?xml version="1.0" encoding="utf-8"?>
  <Query parameter="Limit Set">Active</Query>
```

```
  ○ Response when there is no active limit set.
  <?xml version="1.0" encoding="utf-8"?>
  <Response parameter="limit set" status="success">None</Response>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="limit set" status="success"></Response>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="limit set" status="success">
  <LimitsetList>
    <LimitSet>IEC Limits</LimitSet >
```



```

<LimitSet>Pb 0.25</LimitSet >
<LimitSet>SDWA</LimitSet >
.
.
</ LimitsetList >
</Response>

```

- **User Application Preferences** – request the user preference variables and current values for an application.

- Can be requested with a blank application name to retrieve settings for the active application.

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Query parameter="User Preferences">Alloys</Query>
```

- Response

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="user preferences" status="success">
  <APUseDefaults enabled="No" />
  <APSelectedCalibration>Auto</APSelectedCalibration>
  <APIsAutoSelectedCalibration>Yes</APIsAutoSelectedCalibration>
  <APBeepActive>Yes</APBeepActive>
  <APAutoTriggerActive>Yes</APAutoTriggerActive>
  <APDisplayLimitColors>Yes</APDisplayLimitColors>
  <APFirstResultTimeLimit>0</APFirstResultTimeLimit>
  <APFirstPostProcTimeLimit>0</APFirstPostProcTimeLimit>
  <APDecimalsToDisplay>2</APDecimalsToDisplay>
  <APSTDDisplayLimit>3</APSTDDisplayLimit>
  <APNumberOfResultsToAverage>3</APNumberOfResultsToAverage>
  <APDisplayUnits>PercentWeight</APDisplayUnits>
  <APFontSize>Medium</APFontSize>
  <APResultSort order="Increasing">Element</APResultSort>
  <APResultElementSortBy>ElementNo</APResultElementSortBy>
  <APLibraryLimit>Grade</APLibraryLimit>
  <APDisplayMultipleGrades>Yes</APDisplayMultipleGrades>
  <APProcessTrampElements>No</APProcessTrampElements>
  <APProcessResidualElements>No</APProcessResidualElements>
  <APDisplayLOD>Yes</APDisplayLOD>
  <APEnableNominalChemistry>No</APEnableNominalChemistry>
  <APDisplayCalibrationName>Yes</APDisplayCalibrationName>
  <APDisplayYear>Yes</APDisplayYear>
  <APDisplayUserField>Yes</APDisplayUserField>
  <APDisplayDate>Yes</APDisplayDate>
  <APDisplayTime>Yes</APDisplayTime>
  <APDisplayMatchQuality>Yes</APDisplayMatchQuality>
  <APDisplaySequenceNumber>Yes</APDisplaySequenceNumber>
  <APDisplayAssayLength>Yes</APDisplayAssayLength>
  <APActiveLimitSet>Kens Test</APActiveLimitSet>
  <SampleIDFieldsFile>Alloys.xml</SampleIDFieldsFile>
  <APElementList />
  <APActiveLibraries>
    <APLibraryName>Standard</APLibraryName>
  </APActiveLibraries>

```



```
<APPassFailStandards>
  <APAlloyId>2014/2024 Al</APAlloyId>
</APPassFailStandards>
<APApplicationPhase ordinal="1">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">5</APPhaseLength>
</APApplicationPhase>
<APApplicationPhase ordinal="2">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">10</APPhaseLength>
</APApplicationPhase>
<APApplicationPhase ordinal="3">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">10</APPhaseLength>
</APApplicationPhase>
<CameraPointerType>0</CameraPointerType>
<IlluminationLevel>0</IlluminationLevel>
<EnableCamera>Yes</EnableCamera>
<CameraImageCount>5</CameraImageCount>
</Response>
```

- **Edit Fields** – request a list of the current user edit fields and their values

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Edit Fields"/>

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="edit fields" status="success">
  <EditFieldList>
    <EditField FieldName="Name">Bart Simpson</EditField>
    <EditField FieldName="ID">0987-654-321</EditField>
    <EditField FieldName="Num">26</EditField>
  </EditFieldList>
</Response>
```

- **Phase times** – returns a list of the assay phase times defined for an application
 - Optionally the phase times can be requested for the active application by leaving the data in the Query tag blank or assigning “ActiveApplication”. As shown below.

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Phase Times"/>

  ○ Response when the Tag is empty
  ○ The response will be identical if the Query tag is
    ■ <Query parameter="Phase Times">ActiveApplication</Query>

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="phase times" status="success">
  <Application>Alloys</Application>
  <PhaseList>
    <Phase number="0">
      <Name>High Voltage</Name>
      <Enabled>Yes</Enabled>
```



```

    <UnlimitedDuration>No</UnlimitedDuration>
    <Duration>5</Duration>
    <FactoryDefaultEnabled>Yes</FactoryDefaultEnabled>
    <FactoryDurationUnlimited>No</FactoryDurationUnlimited>
    <FactoryDefaultDuration>5</FactoryDefaultDuration>
  </Phase>
  <Phase number="1">
    <Name>Low Voltage/AlMg Alloy Low Voltage </Name>
    <Enabled>Yes</Enabled>
    <UnlimitedDuration>No</UnlimitedDuration>
    <Duration>10</Duration>
    <FactoryDefaultEnabled>Yes</FactoryDefaultEnabled>
    <FactoryDurationUnlimited>Yes</FactoryDurationUnlimited>
    <FactoryDefaultDuration>0</FactoryDefaultDuration>
  </Phase>
</PhaseList>
</Response>

```

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Phase Times">TATA-Zn_g_per_m2</Query>

```

- Response when Query contains a valid Application name

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="phase times" status="success">
  <Application>TATA-Zn_g_per_m2</Application>
  <PhaseList>
    <Phase number="0">
      <Name>High Voltage</Name>
      <Enabled>Yes</Enabled>
      <UnlimitedDuration>No</UnlimitedDuration>
      <Duration>5</Duration>
      <FactoryDefaultEnabled>Yes</FactoryDefaultEnabled>
      <FactoryDurationUnlimited>No</FactoryDurationUnlimited>
      <FactoryDefaultDuration>5</FactoryDefaultDuration>
    </Phase>
    <Phase number="1">
      <Name>Low Voltage</Name>
      <Enabled>Yes</Enabled>
      <UnlimitedDuration>Yes</UnlimitedDuration>
      <Duration>0</Duration>
      <FactoryDefaultEnabled>Yes</FactoryDefaultEnabled>
      <FactoryDurationUnlimited>Yes</FactoryDurationUnlimited>
      <FactoryDefaultDuration>0</FactoryDefaultDuration>
    </Phase>
  </PhaseList>
</Response>

```

- **XRay Settings** – Query current x-ray tube output settings

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="XRay Settings"/>

```



- Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="xray settings" status="success">
  <HighVoltage>40</HighVoltage>
  <AnodeCurrent>4.75</AnodeCurrent>
</Response>
```

- **Beam Filter** – Query current x-ray beam filter information

- Optionally include ListFilters to request a list of the beam filters installed in the wheel

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Beam Filter"/>
```

- Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="beam filter" status="success">
  <FilterType>Wheel</FilterType>
  <Position>1</Position>
  <FilterDescription>Ti 25um:Al 300um</FilterDescription>
</Response>
```

- Query including list of filters

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Beam Filter">ListFilters</Query>
```

- Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="beam filter" status="success">
  <FilterType>Wheel</FilterType>
  <FilterList>
    <Filter position="1">Ti 25um:Al 300um</Filter>
    <Filter position="2">
</Filter>
    <Filter position="3">Cu 75um:Ti 25um:Al 200um</Filter>
    <Filter position="4">
</Filter>
    <Filter position="5">Al 38um</Filter>
  </FilterList>
  <Position>1</Position>
  <FilterDescription>Ti 25um:Al 300um</FilterDescription>
</Response>
```

- **Armed State**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Armed State"/>
```

- Response (Yes – The system is Armed, No – the system is not Armed)

- The system must be armed in order to start an assay

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="armed state" status="success">Yes</Response>
```

- **Login State**

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Query parameter="Login State"/>
```

- Response (Yes – A user is logged into the system, No – No user is logged into the system)

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Response parameter="login state" status="success">Yes</Response>
```

- **Instrument Definition Information**

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Query parameter="Instrument Definition"/>
```

- Response

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Response parameter="instrument definition" status="success">
```

```
<InstrumentDefinition>
```

```
<FileVersion>0.08</FileVersion>
```

```
<SerialNumber>SMX-301</SerialNumber>
```

```
<Model>TitanLE</Model>
```

```
<AmbientTemperatureMinInC>-10</AmbientTemperatureMinInC>
```

```
<AmbientTemperatureMaxInC>85</AmbientTemperatureMaxInC>
```

```
<SafetyConfiguration>Standard</SafetyConfiguration>
```

```
<HasVacuum>No</HasVacuum>
```

```
<HasChangeableCollimator>No</HasChangeableCollimator>
```

```
<FilterType>Wheel</FilterType>
```

```
<!-- other option is "Manual" -->
```

```
<StorageCapacityInMB>256</StorageCapacityInMB>
```

```
<SampleIncidentAngle>45</SampleIncidentAngle>
```

```
<SampleTakeoffAngle>63</SampleTakeoffAngle>
```

```
<TouchScreen>
```

```
<ResolutionInPixelsPerInch>216.22</ResolutionInPixelsPerInch>
```

```
<BitsPerPixel>16</BitsPerPixel>
```

```
<WidthInPixels>480</WidthInPixels>
```

```
<HeightInPixels>640</HeightInPixels>
```

```
<WidthInMM>56.16</WidthInMM>
```

```
<HeightInMM>74.88</HeightInMM>
```

```
<Type>TFT</Type>
```

```
<!-- options are ??? -->
```

```
</TouchScreen>
```

```
<Filter>
```

```
<NumberOfFilters>5</NumberOfFilters>
```

```
<FilterPosition number="1">Ti 25um:Al 300um</FilterPosition>
```

```
<FilterPosition number="2">
```

```
</FilterPosition>
```

```
<FilterPosition number="3">Cu 75um:Ti 25um:Al 200um</FilterPosition>
```

```
<FilterPosition number="4">
```

```
</FilterPosition>
```

```
<FilterPosition number="5">Al 38um</FilterPosition>
```

```
</Filter>
```

```
<XrayTube>
```

```

<SampleIncidentAngle>45</SampleIncidentAngle>
<SampleTakeOffAngle>65</SampleTakeOffAngle>
<TubeTakeoffAngle>45</TubeTakeoffAngle>
<BerylliumWindowThicknessInuM>125</BerylliumWindowThicknessInuM>
<TargetElementNumber>45</TargetElementNumber>
<TargetThicknessInuM>0.6</TargetThicknessInuM>
<MaxHighVoltage>50</MaxHighVoltage>
<MaxAnodeCurrentInuA>100</MaxAnodeCurrentInuA>
<MinAnodeCurrentInuA>4.5</MinAnodeCurrentInuA>
<MaxOutputPowerInmW>2000.0</MaxOutputPowerInmW>
<TransmissionType>Through</TransmissionType>
<!-- other option is "Side" -->
<Manufacturer>Moxtek</Manufacturer>
<!-- other option is "Moxtek" -->
<FirmwareVersionRequired>9.1L</FirmwareVersionRequired>
<IlluminationDefinition>
  <ID>Std Alloy Low-Z</ID>
  <ID>Mining-Soil Low-Z</ID>
  <HighVoltage>15</HighVoltage>
  <AnodeCurrent default="No">12.3</AnodeCurrent>
  <FilterPosition>
  </FilterPosition>
  <TestSample>Cu 1100</TestSample>
  <CountRangeMin>139000</CountRangeMin>
  <CountRangeMax>141000</CountRangeMax>
  <ActualCounts>139063</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>Soil Hi-Z</ID>
  <HighVoltage>45</HighVoltage>
  <AnodeCurrent default="No">5.7</AnodeCurrent>
  <FilterPosition>Ti 25um:Al 300um</FilterPosition>
  <TestSample>Al 7075</TestSample>
  <CountRangeMin>33000</CountRangeMin>
  <CountRangeMax>35000</CountRangeMax>
  <ActualCounts>34069</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>Soil 50 Hi-Z A</ID>
  <HighVoltage>50</HighVoltage>
  <AnodeCurrent default="No">8.05</AnodeCurrent>
  <FilterPosition>Ti 25um:Al 300um</FilterPosition>
  <TestSample>Al 7075</TestSample>
  <CountRangeMin>49000</CountRangeMin>
  <CountRangeMax>51000</CountRangeMax>
  <ActualCounts>50194</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>RoHS 50 Hi-Z</ID>
  <HighVoltage>50</HighVoltage>
  <AnodeCurrent default="No">11.35</AnodeCurrent>

```

```

<FilterPosition>Cu 75um:Ti 25um:Al 200um</FilterPosition>
<TestSample>Cu 1100</TestSample>
<CountRangeMin>66000</CountRangeMin>
<CountRangeMax>68000</CountRangeMax>
<ActualCounts>67166</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>FAC Low Alloy</ID>
  <ID>RoHS Low-Z</ID>
  <HighVoltage>15</HighVoltage>
  <AnodeCurrent default="No">14.95</AnodeCurrent>
  <FilterPosition>Al 38um</FilterPosition>
  <TestSample>Cu 1100</TestSample>
  <CountRangeMin>124000</CountRangeMin>
  <CountRangeMax>126000</CountRangeMax>
  <ActualCounts>125331</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>AlMg Alloy Low-Z</ID>
  <HighVoltage>15</HighVoltage>
  <AnodeCurrent default="No">39.05</AnodeCurrent>
  <FilterPosition>
  </FilterPosition>
  <TestSample>Al 7075</TestSample>
  <CountRangeMin>134000</CountRangeMin>
  <CountRangeMax>136000</CountRangeMax>
  <ActualCounts>135011</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>Std Alloy Hi-Z</ID>
  <HighVoltage>40</HighVoltage>
  <AnodeCurrent default="No">4.75</AnodeCurrent>
  <FilterPosition>Ti 25um:Al 300um</FilterPosition>
  <TestSample>Cu 1100</TestSample>
  <CountRangeMin>124000</CountRangeMin>
  <CountRangeMax>126000</CountRangeMax>
  <ActualCounts>125767</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>Soil 50 Hi-Z F3</ID>
  <HighVoltage>50</HighVoltage>
  <AnodeCurrent default="No">14.7</AnodeCurrent>
  <FilterPosition>Cu 75um:Ti 25um:Al 200um</FilterPosition>
  <TestSample>Al 7075</TestSample>
  <CountRangeMin>18000</CountRangeMin>
  <CountRangeMax>20000</CountRangeMax>
  <ActualCounts>19112</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
  <ID>TubeStab50</ID>
  <HighVoltage>50</HighVoltage>

```

```

<AnodeCurrent default="No">6</AnodeCurrent>
<FilterPosition>Ti 25um:Al 300um</FilterPosition>
<TestSample>2205 SS</TestSample>
<CountRangeMin>53000</CountRangeMin>
<CountRangeMax>55000</CountRangeMax>
<ActualCounts>0</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
<ID>TubeStab15</ID>
<HighVoltage>15</HighVoltage>
<AnodeCurrent default="No">60</AnodeCurrent>
<FilterPosition>
</FilterPosition>
<TestSample>2205 SS</TestSample>
<CountRangeMin>134000</CountRangeMin>
<CountRangeMax>136000</CountRangeMax>
<ActualCounts>0</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
<ID>Limestone 15</ID>
<HighVoltage>15</HighVoltage>
<AnodeCurrent default="No">16.15</AnodeCurrent>
<FilterPosition>
</FilterPosition>
<TestSample>Al 7075</TestSample>
<CountRangeMin>56000</CountRangeMin>
<CountRangeMax>58000</CountRangeMax>
<ActualCounts>57400</ActualCounts>
</IlluminationDefinition>
<IlluminationDefinition>
<ID>RadProfile</ID>
<HighVoltage>40</HighVoltage>
<AnodeCurrent default="No">39</AnodeCurrent>
<FilterPosition>
</FilterPosition>
<TestSample>
</TestSample>
<CountRangeMin>100000</CountRangeMin>
<CountRangeMax>110000</CountRangeMax>
<ActualCounts>0</ActualCounts>
</IlluminationDefinition>
<FirmwareVersion>21.2A</FirmwareVersion>
</XrayTube>
<Detector>
<Manufacturer>Bruker</Manufacturer>
<DetectorType>SDD</DetectorType>
<!-- other option is "SiPin" -->
<TypicalResolutionIneV>145</TypicalResolutionIneV>
<OperatingTempMinInC>-7.5</OperatingTempMinInC>
<OperatingTempMaxInC>-6.5</OperatingTempMaxInC>
<SiliconThicknessInMM>.46</SiliconThicknessInMM>

```



```

<EffectiveAreaInMMSq>10</EffectiveAreaInMMSq>
<BerylliumWindowThicknessInuM>8</BerylliumWindowThicknessInuM>
<RequireTempCalibration>No</RequireTempCalibration>
<SpectralProcessing>GainDriftV1Calc</SpectralProcessing>
</Detector>
<DPP>
<HardwareVersion>00.1</HardwareVersion>
<FPGAVersionRequired>11.01A</FPGAVersionRequired>
<MicroControllerVersionRequired>1.02A</MicroControllerVersionRequired>
<MemoryDefinition>
<DetectorTempSetInC>249</DetectorTempSetInC>
<DetectorTempSetOffsetLow>100</DetectorTempSetOffsetLow>
<DetectorTempSetOffsetHigh>32</DetectorTempSetOffsetHigh>
<PeltierMinCodeLow>0</PeltierMinCodeLow>
<PeltierMinCodeHigh>0</PeltierMinCodeHigh>
<PeltierMaxCodeLow>255</PeltierMaxCodeLow>
<PeltierMaxCodeHigh>2</PeltierMaxCodeHigh>
<TempDriftCorrectionLow>0</TempDriftCorrectionLow>
<TempDriftCorrectionHigh>0</TempDriftCorrectionHigh>
<DetectorTempSensorPreScale>33</DetectorTempSensorPreScale>
<PeltierFeedbackSensitivityScale>16</PeltierFeedbackSensitivityScale>
<PeltierFeedbackRateScale>16</PeltierFeedbackRateScale>
<PeltierTempApproachThreshold>3</PeltierTempApproachThreshold>
<ModeA>253</ModeA>
<ActivateDelayInSec>60</ActivateDelayInSec>
<FlashSizeInMbit>16</FlashSizeInMbit>
<SpectrumSizeIn256BBlock>16</SpectrumSizeIn256BBlock>
<PermissionFlags>194</PermissionFlags>
<InstrumentNumberLowByte>0</InstrumentNumberLowByte>
<InstrumentNumberHighByte>4</InstrumentNumberHighByte>
<BoardNumberLowByte>33</BoardNumberLowByte>
<BoardNumberHighByte>81</BoardNumberHighByte>
<MainThresholdLow>100</MainThresholdLow>
<MainThresholdHigh>0</MainThresholdHigh>
<ShapingCode>3</ShapingCode>
<OperatingMode>0</OperatingMode>
<GainPower>7</GainPower>
<GainMantissa1>140</GainMantissa1>
<GainMantissa2>210</GainMantissa2>
<ControlFlags>28</ControlFlags>
<FrequencyAdjustmentCode>125</FrequencyAdjustmentCode>
<OscilloscopeOffset>250</OscilloscopeOffset>
<WindowStartChannelLow>0</WindowStartChannelLow>
<WindowStartChannelHigh>0</WindowStartChannelHigh>
<WindowSizeMinusOne>0</WindowSizeMinusOne>
<LowEnergyThresholdLow>190</LowEnergyThresholdLow>
<LowEnergyThresholdHigh>0</LowEnergyThresholdHigh>
<PeltierLow>24</PeltierLow>
<PeltierHigh>1</PeltierHigh>
<TempConfigurationCode>134</TempConfigurationCode>
<TempSelect1>164</TempSelect1>

```

```

<TempSelect2>140</TempSelect2>
<TempSelect3>135</TempSelect3>
<ProcessControlFlags>141</ProcessControlFlags>
<NFSCControlWord>0</NFSCControlWord>
<RS232ControlWord>0</RS232ControlWord>
<ADCCControlWord>16</ADCCControlWord>
<PowerSaveControlWord>31</PowerSaveControlWord>
<TempSelect4>137</TempSelect4>
<TempSelect5>131</TempSelect5>
<MainResetHoldLength>4</MainResetHoldLength>
<DCOffsetLow>0</DCOffsetLow>
<DCOffsetHigh>0</DCOffsetHigh>
<DCBalanceLow>0</DCBalanceLow>
<DCBalanceHigh>0</DCBalanceHigh>
<ShaperTop>7</ShaperTop>
<ShaperFINDelay>5</ShaperFINDelay>
<ShaperReadDelay>3</ShaperReadDelay>
<ShaperReadExtension>0</ShaperReadExtension>
<Unused1>255</Unused1>
<Unused2>255</Unused2>
<Unused3>255</Unused3>
<Unused4>255</Unused4>
<TimeZone>255</TimeZone>
<RTCSeconds>255</RTCSeconds>
<RTCMinutes>255</RTCMinutes>
<RTCHours>255</RTCHours>
<RTCDate>255</RTCDate>
<RTCMonth>255</RTCMonth>
<RTCYear>255</RTCYear>
<RTCDOW>255</RTCDOW>
<RTCUSER1>255</RTCUSER1>
<RTCUSER2>255</RTCUSER2>
<Unused8>255</Unused8>
<SWSimFlags>0</SWSimFlags>
<SWSimRampSlopeCode>0</SWSimRampSlopeCode>
<SWSimEventLow>40</SWSimEventLow>
<SWSimEventHigh>11</SWSimEventHigh>
<TEMPSEL>255</TEMPSEL>
<Unused5>0</Unused5>
<Unused6>0</Unused6>
<Unused7>0</Unused7>
<OffsetCodeLow>0</OffsetCodeLow>
<OffsetCodeHigh>0</OffsetCodeHigh>
<PacketAcquireTime>255</PacketAcquireTime>
</MemoryDefinition>
<DefaultEnergyMinInKeV>0</DefaultEnergyMinInKeV>
<DefaultEnergyMaxInKeV>40</DefaultEnergyMaxInKeV>
<DefaultEVPerChannel>20</DefaultEVPerChannel>
<NumberOfChannels>2048</NumberOfChannels>
<ADCFrequencyInKHz>65536</ADCFrequencyInKHz>
<FirmwareVersion>1.03</FirmwareVersion>

```



```

    <Reload8051Settings>No</Reload8051Settings>
    <XilinxFirmwareVersion>11.01</XilinxFirmwareVersion>
  </DPP>
  <OMAP>
    <HardwareVersion>RevD</HardwareVersion>
    <KernelVersion>6.3.15</KernelVersion>
  </OMAP>
  <SUP>
    <FirmwareVersionRequired>1.59</FirmwareVersionRequired>
    <HighVoltageOutOfRangeIsSafetyError>Yes</HighVoltageOutOfRangeIsSafetyError>
    <AnodeCurrentOutOfRangeIsSafetyError>Yes</AnodeCurrentOutOfRangeIsSafetyError>
    <FirmwareVersion>1.59</FirmwareVersion>
  </SUP>
  <UUP>
    <FirmwareVersionRequired>2.27</FirmwareVersionRequired>
    <VacuumRangeMin>15</VacuumRangeMin>
    <VacuumRangeMax>115</VacuumRangeMax>
    <TemperatureRangeMin>-40</TemperatureRangeMin>
    <TemperatureRangeMax>125</TemperatureRangeMax>
    <FirmwareVersion>2.28</FirmwareVersion>
  </UUP>
  <Safety>
    <SafetyConfiguration>
      <ID>Standard</ID>
      <AllowDisableProximity>Yes</AllowDisableProximity>
      <AllowTimedAssay>Yes</AllowTimedAssay>
      <RequireAuxTrigger>No</RequireAuxTrigger>
      <MaxAssayLength>300</MaxAssayLength>
      <!-- In Seconds -->
      <SoundBuzzer>No</SoundBuzzer>
      <AllowWirelessAssayCtrl>Yes</AllowWirelessAssayCtrl>
    </SafetyConfiguration>
    <SafetyConfiguration>
      <ID>Canadian</ID>
      <AllowDisableProximity>Yes</AllowDisableProximity>
      <AllowTimedAssay>No</AllowTimedAssay>
      <RequireAuxTrigger>No</RequireAuxTrigger>
      <MaxAssayLength>300</MaxAssayLength>
      <!-- In Seconds -->
      <SoundBuzzer>Yes</SoundBuzzer>
      <AllowWirelessAssayCtrl>No</AllowWirelessAssayCtrl>
    </SafetyConfiguration>
    <SafetyConfiguration>
      <ID>Swiss</ID>
      <AllowDisableProximity>No</AllowDisableProximity>
      <AllowTimedAssay>No</AllowTimedAssay>
      <RequireAuxTrigger>Yes</RequireAuxTrigger>
      <MaxAssayLength>300</MaxAssayLength>
      <!-- In Seconds -->
      <SoundBuzzer>No</SoundBuzzer>
      <AllowWirelessAssayCtrl>No</AllowWirelessAssayCtrl>

```



```

    </SafetyConfiguration>
  </Safety>
  <WindowMaterial>Ultralene</WindowMaterial>
  <SpotSize>8</SpotSize>
  <Camera>
    <HasCamera>Yes</HasCamera>
    <CropSize>
      <Xposition>124</Xposition>
      <Yposition>0</Yposition>
      <width>624</width>
      <height>480</height>
    </CropSize>
    <CrossHair>
      <Xposition>384</Xposition>
      <Yposition>276</Yposition>
    </CrossHair>
  </Camera>
  <BuildNumber>SMX-301</BuildNumber>
</InstrumentDefinition>
</Response>

```

- **System Time**

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="System Time"/>

```

- Response – The returned system date / time will always be formatted as follows:
YYYY-MM-DD HH:MM:SS

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="System Time" status="success">2015-11-02 09:02:35</Response>

```

- **Transmission of status messages**

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Statusmsg Transmission"/>

```

- Response – (Yes – status messages are transmitted, No – status messages are not transmitted)

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Statusmsg Transmission" status="success">Yes</Response>

```

- **Proximity Sensor Required**

```

<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Proximity Required"/>

```

- Response – (Yes – proximity sensor must be satisfied for instrument to ARM, No – no requirement to satisfy proximity sensor for instrument to ARM)

```

<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Proximity Required" status="success">Yes</Response>

```



- **UI Popups displayed**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="UI Popups"/>
```

- Response – (Yes – Error and information messages will be displayed on screen potentially pausing the program waiting for user interaction, No – Error and information messages will not be displayed on screen)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="UI Popups" status="success">Yes</Response>
```

- **Delay Response Messages**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="RcvSnd Delay"/>
```

- Response – (Minimum number of milliseconds to delay between receipt of a query or configure command and transmission of the response)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="RcvSnd Delay" status="success">50</Response>
```

- **Software Version**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Version"/>
```

- Response – (Version number of the instrument software)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Version" status="success">2.3.43.222</Response>
```

- **Store Results**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Store Results"/>
```

- Response – (Yes – Elemental, Grade and Pass/Fail Results are stored to an instrument local file, No – Results are not stored)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Store Results" status="success">Yes</Response>
```

- **Store Spectra**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Store Spectra"/>
```

- Response – (Yes – Spectra are stored in PDZ files on the instrument, No – Spectra are not stored into PDZ files.)



```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Store Spectra" status="success">Yes</Response>
```

- **Transmit Spectra**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Transmit Spectra"/>
```

- Response – (Yes – Spectra packets will be transmitted, No – Spectra packets will not be transmitted)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="Transmit Spectra" status="success">Yes</Response>
```

- **Transmit Results**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Transmit Results"/>
```

- Response – (Yes – Results will be transmitted if at completion of an assay if they're calculated, No – Results are not transmitted)
- Additionally the configuration settings that control transmission of element concentrations, and grades are included as sub-elements in the XML tag.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="transmit results" status="success">Yes
  <Grades>Yes</Grades><Elements>Yes</Elements></Response>
```

- **Quantification Post Processing setting**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Post Processing"/>
```

- Response – A string indicating the active post processing setting
 - Grade Search – Performs a grade library search using the calculated element concentrations.
 - Grade PASSFAIL – Compares the grade identified as the best match to a list of grades the user identifies as either a PASS or FAIL.
 - Limit Set – Compares the calculated element concentrations to a list of limits to determine whether they produce a PASS or FAIL status.
 - None – No processing of the calculated element concentrations is performed.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="post processing" status="success">Grade Search</Response>
```

- **Remote ID**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Remote ID"/>
```



- Response – A number from 0 to 7 where the least significant 3 bits encodes an accessory ID according to the following table.

Index	Accessory	Remote ID			Device Type	RS-232	Local Trigger
		2	1	0			
0	None	0	0	0	N/A	N/A	N/A
1	Remote Pistol Trigger	0	0	1	Trigger Interlock	Not active	Disabled
2	Benchtop Stand	0	1	0	Door Interlock	Active	Enabled
3	Footswitch	0	1	1	Trigger Interlock	Active	Disabled
4	RS-232 debug cable	1	0	0	Coms only	Active	Enabled
5	Extension Pole	1	0	1	Trigger Interlock	Not active	Disabled
6	OEM use	1	1	0	Non-interlocking	Unassigned	Unassigned
7	OEM use	1	1	1	Interlocking	Unassigned	Disabled

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="remote id" status="success">1</Response>
```

- **Instrument Nose Pressure**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Nose Pressure"/>
```

- Response – The absolute pressure in the nose of the instrument in milliBar (mBar)

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="nose pressure" status="success">998</Response>
```

- **Instrument Nose Temperature**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Nose Temperature"/>
```

- Response – The temperature in the nose of the instrument in degrees C.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="nose temperature" status="success">25.8</Response>
```

- **Collimator (Spot Size)**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Spot Size"/>
```

- Response – The spot size of the collimator/filter assembly currently installed in the instrument.
- Valid values for an F1 Tracer are “3mm” and “8mm”.
- If no collimator/filter assembly is installed the reported size will be “Empty”.
- If an undefined collimator/filter assembly is installed the reported size will be “Unknown”.



- A Titan has a fixed collimator which is reported as “Fixed” whose size can be found in the instrument definition data.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="spot size" status="success">8mm</Response>
```

- **Manual Beam Filters**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="Manual Filters"/>
```

- Response – The list of defined manual beam filters found in the ManualFilters.csv file in the \Bruker\System folder on the instrument
- Each filter will have the following data associated with it
 - Name – Name assigned to the filter definition, ex. Green
 - Locked – Indicates the filter is used in an illumination defined in the instrument definition file, these cannot be deleted or modified
 - Definition – filter layers following the format used by the filters in the filter wheel

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="manual filters" status="success">
  <DefinitionList>
    <Definition name="Blue" locked="No">Sn 75um</Definition>
    <Definition name="Red" locked="No">Fe 50um:Ti 25um:Al 250um</Definition>
    <Definition name="Green" locked="No">Cu 100um:Ti 25um:Al 200um</Definition>
  </DefinitionList>
</Response>
```

- **High Voltage Range**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="HighVoltageRange"/>
```

- Response – The minimum and maximum allowed high voltage values the x-ray source will accept.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="highvoltage range" status="success">
  <MinHighVoltage>6</MinHighVoltage><MaxHighVoltage>50</MaxHighVoltage>
</Response>
```

- **Minimum High Voltage**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="MinHighVoltage"/>
```

- Response – The minimum allowed high voltage value the x-ray source will accept.

```
<?xml version="1.0" encoding="utf-8"?>
```



```
<Response parameter="minhighvoltage" status="success">
  <MinHighVoltage>6</MinHighVoltage>
</Response>
```

- **Maximum High Voltage**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="MaxHighVoltage"/>
```

- Response – The maximum allowed high voltage value the x-ray source will accept.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="maxhighvoltage" status="success">
  <MaxHighVoltage>50</MaxHighVoltage>
</Response>
```

- **Anode Current Range**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="AnodeCurrentRange">45</Query>
```

- The high voltage setting to return the allowed range for is required. (See example above)
 - The voltage setting should be an integer value
 - It must be in the allowed range of voltage settings
- Response – The minimum and maximum allowed anode current values the x-ray source will accept for the voltage setting.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="anodecurrentrange" status="success">
  <MinAnodeCurrent>4.5</MinAnodeCurrent><MaxAnodeCurrent>43.5</MaxAnodeCurrent>
</Response>
```

- **Minimum Anode Current**

```
<?xml version="1.0" encoding="utf-8"?>
<Query parameter="MinAnodeCurrent">40</Query>
```

- The high voltage setting to return the allowed minimum for is required. (See example above)
 - The voltage setting should be an integer value
 - It must be in the allowed range of voltage settings
- Response – The minimum allowed anode current value the x-ray source will accept for the voltage setting.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="minanodecurrent" status="success">
  <MinAnodeCurrent>4.5</MinAnodeCurrent>
</Response>
```

- **Maximum Anode Current**

```
<?xml version="1.0" encoding="utf-8"?>
```

<Query parameter="MaxAnodeCurrent">40</Query>

- The high voltage setting to return the allowed maximum for is required. (See example above)
 - The voltage setting should be an integer value
 - It must be in the allowed range of voltage settings
- Response – The maximum allowed anode current value the x-ray source will accept for the voltage setting.

```
<?xml version="1.0" encoding="utf-8"?>
<Response parameter="maxanodecurrent" status="success">
  <MaxAnodeCurrent>50.0</MaxAnodeCurrent>
</Response>
```




List of the “Configure” messages and a short description of each:

Configurable Parameters:

- Application
- Method
- Library
- Limit Set
- PassFail Grades
- User Preferences
- Edit Fields
- Phase Times
- Transmit Results
- Transmit Spectra
- System Time
- Transmission of Status Messages
- Proximity Sensor Required
- UI Popup display
- Delay response messages
- Store Spectra
- Store Results

Descriptions:

- **Application** – Activate an application
 - If a specific method is desired a separate command must be used to activate it

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Application">Alloys</Configure>
```

- **Method** – Activate a method/calibration associated with the active application

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Method">Titanium Alloys</Configure>
```

- **Library** – Used to activate one or more grade libraries to be used when searching for the best grade id based on the elemental concentrations
 - This tag can accept a list of libraries, a single library or “None” as a keyword to disable grade id processing, several examples follow.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Library">
  <LibraryList>
    <Library>Gold Karat</Library>
    <Library>DIN</Library>
  </LibraryList>
</Configure>
```

```
<?xml version="1.0" encoding="utf-8"?>
```



```
<Configure parameter="Library">Standard</Configure>
```

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="Library">None</Configure>
```

- **Limit Set** – Activates a limit set
 - Use the keyword “None” to deactivate limit set processing
 - A single limit set can be activated
 - Examples follow

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="Limit Set">IEC Limits</Configure>
```

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="Limit Set">None</Configure>
```

- **PassFail Grades** – Sets a list of grades to generate a PASS response and activates “LIBRARY SEARCH PASSFAIL” mode.
 - Use the keyword “None” to delete the list of PassFail grades. Emptying the list will set the instrument to either “LIBRARY SEARCH” or “CONCENTRATIONS” mode.
 - Examples follow

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="PassFail Grades">
```

```
  <PFGradeList>
```

```
    <PFGrade>2205SS</PFGrade>
```

```
    <PFGrade>2207SS</PFGrade>
```

```
    .
```

```
    .
```

```
  </PFGradeList>
```

```
</Configure>
```

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="PassFail Grades">None</Configure>
```

- **User Preferences** – Change the application specific settings contained in the user preferences structure
 - All the tags should be present in this message, consequently the best method of updating this structure is to issue a request, update the DOM then submit the changes back to the instrument.
 - An Example is shown below
 - The APAppName tag is not part of the structure returned by the request, if the setting to be updated are not for the active application this tag must be added as shown in the example. If this tag is absent the active application settings will be updated

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Configure parameter="User Preferences">
```

```
  <APAppName>Alloys</APAppName>
```

```
  <APUseDefaults enabled="No" />
```

```
  <APSelectedCalibration>Auto</APSelectedCalibration>
```

```
  <APIsAutoSelectedCalibration>Yes</APIsAutoSelectedCalibration>
```

```
  <APBeepActive>Yes</APBeepActive>
```

```

<APAutoTriggerActive>Yes</APAutoTriggerActive>
<APDisplayLimitColors>Yes</APDisplayLimitColors>
<APFirstResultTimeLimit>0</APFirstResultTimeLimit>
<APFirstPostProcTimeLimit>0</APFirstPostProcTimeLimit>
<APDecimalsToDisplay>2</APDecimalsToDisplay>
<APSTDDisplayLimit>3</APSTDDisplayLimit>
<APNumberOfResultsToAverage>3</APNumberOfResultsToAverage>
<APDisplayUnits>PercentWeight</APDisplayUnits>
<APFontSize>Medium</APFontSize>
<APResultSort order="Increasing">Element</APResultSort>
<APResultElementSortBy>ElementNo</APResultElementSortBy>
<APLibraryLimit>Grade</APLibraryLimit>
<APDisplayMultipleGrades>Yes</APDisplayMultipleGrades>
<APProcessTrampElements>No</APProcessTrampElements>
<APProcessResidualElements>No</APProcessResidualElements>
<APDisplayLOD>Yes</APDisplayLOD>
<APEnableNominalChemistry>No</APEnableNominalChemistry>
<APDisplayCalibrationName>Yes</APDisplayCalibrationName>
<APDisplayYear>Yes</APDisplayYear>
<APDisplayUserField>Yes</APDisplayUserField>
<APDisplayDate>Yes</APDisplayDate>
<APDisplayTime>Yes</APDisplayTime>
<APDisplayMatchQuality>Yes</APDisplayMatchQuality>
<APDisplaySequenceNumber>Yes</APDisplaySequenceNumber>
<APDisplayAssayLength>Yes</APDisplayAssayLength>
<APActiveLimitSet>Kens Test</APActiveLimitSet>
<SampleIDFieldsFile>Alloys.xml</SampleIDFieldsFile>
<APElementList />
<APActiveLibraries>
  <APLibraryName>Standard</APLibraryName>
</APActiveLibraries>
<APPassFailStandards>
  <APAlloyId>2014/2024 Al</APAlloyId>
</APPassFailStandards>
<APApplicationPhase ordinal="1">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">5</APPhaseLength>
</APApplicationPhase>
<APApplicationPhase ordinal="2">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">10</APPhaseLength>
</APApplicationPhase>
<APApplicationPhase ordinal="3">
  <APPhaseEnabled enabled="Yes" />
  <APPhaseLength unlimited="No">10</APPhaseLength>
</APApplicationPhase>
<CameraPointerType>0</CameraPointerType>
<IlluminationLevel>0</IlluminationLevel>
<EnableCamera>Yes</EnableCamera>
<CameraImageCount>5</CameraImageCount>
</Configure>

```

- **Edit Fields** – Provides full edit field configuration

- An example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Edit Fields">
  <FieldList>
    <Field type="Fixed">
      <Name>Name</Name>
      <Value>Bart Simpson</Value>
    </Field>
    <Field type="Fixed">
      <Name>ID</Name>
      <Value>0987-654-321</Value>
    </Field>
    <Field type="Counter">
      <Name>Num</Name>
      <Value>1</Value>
    </Field>
  </FieldList>
</Configure>
```

- The following example shows how to reset the edit field list, this produces an empty list of edit fields.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Edit Fields">Reset</Configure>
```

- **Phase Times** – Set phase times for the active application

- Can set the times for a single phase or multiple, examples follow

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Phase Times">
  <PhaseList>
    <Phase number="0" enabled="Yes">
      <Duration unlimited="No">5</Duration>
    </Phase>
    <Phase number="1" enabled="Yes">
      <Duration unlimited="No">10</Duration>
    </Phase>
  </PhaseList>
</Configure>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Phase Times">
  <Phase number="1" enabled="Yes">
    <Duration unlimited="No">10</Duration>
  </Phase>
</Configure>
```

- **Transmit Results** – Controls transmission of elemental concentrations and either grade id or limit set processing results. This data is transmitted at completion of the assay.



- Optionally the Transmit Results command can include additional parameters that control which results are transmitted.
- Examples follow

This example enables results transmission, grade id/pass fail and elemental concentrations are enabled by default if those parameters are not specified.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Results">Yes</Configure>
```

This example disables results transmission.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Results">No</Configure>
```

This example enables results transmission, disables transmission of the elemental concentrations and enables transmission of the grade id/pass fail results.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Results" grades="Yes" elements="No">Yes</Configure>
```

This example enables results transmission, enables transmission of the elemental concentrations and disables transmission of the grade id/pass fail results.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Results" grades="No" elements="Yes">Yes</Configure>
```

- **Transmit Spectra** – Controls transmission of spectrum packets
 - If enabled a spectrum packet is transmitted by the instrument at roughly 1 second intervals while an assay is active.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Spectra">Yes</Configure> (Yes-enables transmission, No-disables transmission)
```

- **System Time** – Sets system date and time. Can be used to synchronize to an external time source.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="System Time">2015-11-02 09:02:35</Configure >
```

- **Transmission Status Messages** – Enable/disable transmission of trigger pull/release and assay start/stop status messages.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Transmit Statusmsg">No</Configure> (Yes-enables transmission, No-disables transmission)
```

- **Proximity Sensor Requirement** – Enable/disable requirement to satisfy the proximity sensor in the nose of the instrument to allow x-ray generation and assay collection.

```
<?xml version="1.0" encoding="utf-8"?>
<Configure parameter="Proximity Required">No</Configure> (Yes-proximity sensor must be satisfied, No-proximity sensor status ignored)
```

- **UI Message Popups Displayed** – Enable/disable display of Error/Information message dialog windows on the instrument.

```
<?xml version="1.0" encoding="utf-8"?>
```



<Configure parameter="UI Popups">No</Configure> (Yes - Message dialog windows are displayed on the instrument screen. No - Message dialog windows are not displayed on the instrument screen)

- **Delay Response Messages** – Set the minimum elapsed time in milliseconds between receipt of a query or configure command and transmission of the response. A time value of 0 disables the delay, the maximum allowed value is 1000 which produces a minimum 1 second delay.

<?xml version="1.0" encoding="utf-8"?>

<Configure parameter="RcvSnd Delay">50</Configure>

- **Store Spectra** – Controls storage of spectra (PDZ files) on the instrument
 - If enabled the spectrum is written to a PDZ file at completion of an assay.

<?xml version="1.0" encoding="utf-8"?>

<Configure parameter="Store Spectra">Yes</Configure> (Yes-enables storage, No-disables storage)

- **Store Results** – Controls store of calculated results on the instrument
 - If enabled the element concentrations, grades and pass/fail results are written to various files on the instrument, if disabled no results are stored on the instrument.

<?xml version="1.0" encoding="utf-8"?>

<Configure parameter="Store Results">Yes</Configure> (Yes-enables transmission, No-disables transmission)



List of the “Command” messages and a short description of each:

Command Messages:

- **Assay (Start/Stop)**
- **Arm**
- **Disarm**
- **Login**
- **X-Ray Source (Validate settings)**

Descriptions:

- **Assay** – Start/Stop an assay (assuming the system is “Armed”)
 - Optionally the Start command can include a set of x-ray tube/filter settings to set. This overrides the active application and starts a “Spectrum Only” assay.
 - For operations with a Titan its preferred that the following tags not be included:
 - Manual Filter
 - Atmosphere
 - Spot Size
 - Examples follow

```
<?xml version="1.0" encoding="utf-8"?>
<Command parameter="Assay">Start</Command>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Command parameter="Assay">Stop</Command>
```

- This message starts an assay of 15 seconds duration after setting the x-ray tube high voltage to 40kV, anode current to 6.2 uA and the filter wheel to the position with the matching filter material.
- Backscatter value of -1 indicates use of the intelligent backscatter algorithm
 - The backscatter, valid entries are:
 - -1 – Use an intelligent algorithm that examines peaks in the spectrum to determine if a sample is in front of the instrument.
 - 0 – disable the backscatter algorithm.
 - > 0 – Threshold of raw counts in each spectrum packet that must be exceeded to indicate a sample is in front of the instrument.
- Reject 1 spectrum packet at the beginning of the assay
 - Rejected packets are not transmitted by the instrument or include in the final accumulated spectrum.
 - This allows the x-ray source to stabilize.
 - Valid values are any positive integer. Generally a good value is 1 or 2.
- A manual filter named “Green” is requested
 - The definition of this filter will be read from a file stored on the instrument.
 - An error is displayed if the requested filter is not found in the file or if the combined number of layers in the manual filter and the wheel filter exceed 3.
 - If no manual filter is used the tag may be eliminated or left blank.
 - <ManualFilter /> or <ManualFilter></ManualFilter>
- Atmosphere is set to Air which indicates no vacuum or flush is being used.
 - Valid entries for this field are: Air, Vacuum, Flush



- A spot size of 3mm is requested, this is informational only.
 - The actual spot size of the installed collimator and the requested spot size are stored in the PDZ file.

```
<?xml version="1.0" encoding="utf-8"?>
<Command parameter="Assay">
  <StartParameters>
    <Filter>Ti 25um:Al 300um</Filter>
    <HighVoltage>40.0</HighVoltage>
    <AnodeCurrent>6.2</AnodeCurrent>
    <AssayDuration>15</AssayDuration>
    <BackScatterLimit>-1</BackScatterLimit>
    <RejectPackets>1</RejectPackets>
    <ManualFilter>Green</ManualFilter>
    <Atmosphere>Air</Atmosphere>
    <SpotSize>3</SpotSize>
  </StartParameters>
</Command>
```

Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">Assay Start</Response>
```

A Titan equivalent to the prior message follows:

```
<?xml version="1.0" encoding="utf-8"?>
<Command parameter="Assay">
  <StartParameters>
    <Filter>Ti 25um:Al 300um</Filter>
    <HighVoltage>40.0</HighVoltage>
    <AnodeCurrent>6.2</AnodeCurrent>
    <AssayDuration>15</AssayDuration>
    <BackScatterLimit>-1</BackScatterLimit>
    <RejectPackets>1</RejectPackets>
  </StartParameters>
</Command>
```

Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">Assay Start</Response>
```

- **Arm System** – Arms the system if the UI is in a appropriate state to accept the command
 - Will be successful if the UI is either at the “Ready to Assay” or “Results Display” screen.

```
<?xml version="1.0" encoding="utf-8"?>
<Command>Arm System</Command>
```

Response



```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">System Armed/Ready</Response>
```

OR, if the instrument is in a state where it cannot start an assay

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">System Armed/Not Ready</Response>
```

- **Disarm System** – Disarms the system, this prevents the system from starting an assay

```
<?xml version="1.0" encoding="utf-8"?>
<Command>Disarm System</Command>
```

Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">System Disarmed </Response>
```

- **Login** – Issue this message after the system has finished booting up, this causes the UI to display the “Ready to Assay” screen allowing the system to be armed in order a enable collection of assays.

```
<?xml version="1.0" encoding="utf-8"?>
<Command>Login</Command>
```

Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">Logged in as SUPERVISOR</Response>
```

OR, if a user has already logged in via the instrument UI.

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">Already logged in as USER</Response>
```

- **X-Ray Source (Validate Settings)** –

```
<?xml version="1.0" encoding="utf-8"?>
<Command parameter="x-ray source">
  <ValidateSettings>
    <HighVoltage>40</HighVoltage>
    <AnodeCurrent>50</AnodeCurrent>
  </ValidateSettings>
</Command>
```

Response

```
<?xml version="1.0" encoding="utf-8"?>
<Response status="success">The submitted x-ray settings are valid</Response>
```

OR, if the voltage, current combination is not valid.

```
<?xml version="1.0" encoding="utf-8"?>
```



<Response status="error">Invalid X-Ray Tube Output Settings:Invalid parameter value(s)</Response>

Status Change Messages:

- **Trigger Status**
- **Assay Status**
- **Phase time change**
- **Phase change**
- **Application selection**
- **Method selection**
- **Library selection**
- **Limit set selection**
- **Grade limit selection**
- **Nose Door**

Descriptions:

- **Trigger Status** – Sent when the system trigger is pulled or released
 - Examples follow

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Trigger">Pulled</Status>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Trigger">Released</Status>
```

- **Assay Status** – Sent when an assay is Started, Stopped and Completed (ready to start another) by a trigger event, a timeout, a command packet or an error.
 - Examples follow

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Assay">Start</Status>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Assay">Stop</Status>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Assay">Completed</Status>
```

- **Phase time change** – Sent when the OK button on the "SETTINGS" form is tapped by a user on the instrument.
 - Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Phase Time Change</Status>
```

- **Phase change** – Sent when the instrument moves from one phase of an assay to another. The value in the tag indicates the phase the instrument is changing to.
 - Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Phase Change"> 2</Status>
```



- **Application Selection**– Sent when the OK button on the “APPLICATION” form is tapped by a user on the instrument.

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Application Selection</Status>
```

- **Method Selection** – Sent when the OK button on the “METHOD” form is tapped by a user on the instrument.

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Method Selection</Status>
```

- **Library Selection** – Sent when the OK button on the “DISPLAY” form is tapped by a user on the instrument after changing the selected grade libraries.

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Library Selection</Status>
```

- **Limitset Selection** – Sent when the OK button on the “DISPLAY” form is tapped by a user on the instrument after changing the selected limit set.

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Limitset Selection</Status>
```

- **Grade limit selection** – Sent when the OK button on the “DISPLAY” form is tapped by a user on the instrument after changing the active limit grade(s).

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status>Grade Limit Selection</Status>
```

- **Nose Door** – Sent when the filter/collimator access hatch is opened and closed.

- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Nose Door">Opened</Status>
```

```
<?xml version="1.0" encoding="utf-8"?>
<Status parameter="Nose Door">Closed</Status>
```

Error/Information Report Messages:

- **Filter/Collimator Assembly Access Hatch Open**
- **Application Hardware Configuration Requirements**
- **System Errors**

Descriptions:

- **Filter/Collimator Assembly Access Hatch Open** – Sent when the user opens filter/collimator access hatch on a Tracer i5.
 - User acknowledgement is not support, the message remains on the screen until the hatch is closed



- ** The actual message text may change and is not important. **
- Example follows

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<InfoReport TxMsgID="1" UserAckable="No">Nose Door Open. Close it to Continue.</InfoReport>
```

- **Application Hardware Configuration Requirements** – Sent when the active application is changed or the user adjusts the settings in the Spectrometer Mode setup screen. It displays the hardware configuration required by the active instrument setup.
 - User acknowledgement is supported
 - ** The actual message text may change and is not important. **
 - Example follows

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<InfoReport TxMsgID="1" UserAckable="Yes">Application hardware configuration...</InfoReport>
```

- **System Errors** – Sent when a system level error is encountered .
 - User acknowledgement is supported
 - ** The actual message text varies depending on the system error encountered. **
 - Example follows

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<ErrorReport TxMsgID="1" UserAckable="Yes">Random System Error...</ErrorReport>
```

Acknowledge Messages:

Acknowledge messages provide a synchronization and positive feedback mechanism for the important system error and information report messages. Two acknowledgement mechanisms are built into the messages, they are described below:

- **Receipt Acknowledgement** –

Each Info/Error includes the attribute TXMsgID which is assigned a positive integer value. This is an ID associated with the message. The instrument expects to receive an acknowledge message with this ID assigned to the attribute RXMsgID. If an acknowledgement message is not received within 5 seconds of the initial transmission the message will be retransmitted. This process continues until an acknowledge is received or the message is transmitted 5 times.

Example:

The following system error message is transmitted

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<ErrorReport TxMsgID="1" UserAckable="Yes">Random System Error...</ErrorReport>
```

The receiving device would send the following acknowledge message

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Acknowledge RxMsgID="1" UserAked="No"></Acknowledge>
```

If a user had acknowledged the error message on the controlling device the acknowledge message would be as follows, with the UserAked attribute assigned a Yes value.

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Acknowledge RxMsgID="1" UserAked="Yes"></Acknowledge>
```

- **User Acknowledgement** –



Each Info/Error includes the attribute UserAckable. This attribute indicates whether the user can dismiss the message by acknowledging it on the instrument or the controlling device.

Yes - User acknowledgement is supported

No - User acknowledgment is not supported

Example:

The following system error message is transmitted

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<ErrorReport TxMsgID="1" UserAckable="Yes">Random System Error...</ErrorReport>
```

If a user had acknowledged the error message on the controlling device the acknowledge message would be as follows, with the UserAked attribute assigned a Yes value.

```
<?xml version="1.0" encoding="utf-8"?>
```

```
<Acknowledge RxMsgID="1" UserAked="Yes"></Acknowledge>
```

***** The receiving device should send a receipt acknowledge message as soon as possible, this prevents unnecessary retransmissions. The user acknowledgement message can be transmitted at a later time and must include the TxMsgID of the message being acknowledged. *****

***** If a user acknowledgeable message is displayed and acknowledged on the instrument screen there is no requirement to transmit a user acknowledge message from the receiving device. In this scenario the instrument will still be expecting a receipt acknowledgement message. Status messages associated with the display and hiding of the message window will be transmitted from the instrument. *****

***** If a receipt acknowledgement message is not transmitted before a user acknowledge message the user acknowledgement satisfies the receipt acknowledge requirement. *****

Example XML encoding of calculated results produced in analyzer mode:

This data packet is transmitted after each calculation cycle is complete and when the assay is complete if the instrument is configured to transmit it.

It consists of records made up of tags that contain Grade Id search or Limit Set processing results followed by all elemental concentrations reported by the calculation engine. This data is not produced or transmitted if the instrument is in spectrometer mode.

- The following tags have been added to the grades data **(2.3.42.194 (OEM Beta) and later)**
 - Date time – Time stamp captured at the beginning of the assay (yyyy-mm-dd hh:mm:ss)
 - Analysis Mode, will be one of the following values
 - LIBRARY SEARCH – Active when a grade library is searched for the best match to the element concentrations.
 - LIBRARY SEARCH PASSFAIL – Active when a list of grades is compared to the best matching library entry to generate a PASS response.
 - PassFail tag is added to grades data
 - LIMITS CHECK – Active when element concentrations are compared to a list of allowed min and max limits.
 - Limitset tag replaces grade and MatchValue tags
 - PassFail tag is added to grade structure and each element structure
 - Nominal and TrampResidual tags are not present
 - CONCENTRATIONS – Element concentrations are returned.
 - Nominal and TrampResidual tags are not present



- MinRange and MaxRange tags are not present
- The PassFail tags may contain the following values
 - PASS – indicates the test conditions were met (match a grade in the list or met all Limit ranges)
 - FAIL – Did not match a grade in the list or one or more elements where outside the defined limit set range (accounting for +- the statistical error).
 - POSSIBLE – For Grade Pass/Fail the best grade match was not in the PASS list but the second was and the difference in the match number of the 2 grades is < .075 and the Match Quality of the second grade exceeded the Match Quality threshold. For Limits Check no elements FAIL and one or more elements fall outside the defined range but inside the range +- the statistical error.
 - NONE – Indicates no active grade list or no elements have defined ranges.

```
<?xml version="1.0" encoding="utf-8"?>
<Data>
  <Version>1.2</Version>
  <DateTime>2015-04-30 08:32:15</DateTime>
  <AnalysisMode>LIBRARY SEARCH</AnalysisMode>
  <Grades>
    <GradeData>
      <Version>1.1</Version>
      <Grade Index="1">2205SS</Grade>
      <MatchValue>000010</MatchValue>
    </GradeData>
    .
    .
    <GradeData>
      <Version>1.1</Version>
      <Grade Index="3">2207SS</Grade>
      <MatchValue>08.565</MatchValue>
    </GradeData>
  </Grades>
  <Elements>
    <ElementData>
      <Version>1.1</Version>
      <AtomicNumber Index="1">12</AtomicNumber>
      <Compound>Mg</Compound>
      <Concentration>0</Concentration>
      <Error>100</Error>
      <MaxRange>0</MaxRange>
      <MinRange>0</MinRange>
      <Nominal>No</Nominal>
      <TrampResidual>No</TrampResidual>
    </ElementData>
    .
    .
    <ElementData>
      <Version>1.1</Version>
      <AtomicNumber Index="6">26</AtomicNumber>
      <Compound>Fe</Compound>
```

```

    <Concentration>65.8589</Concentration>
    <Error>0.246356</Error>
    <MaxRange>73</MaxRange>
    <MinRange>62</MinRange>
    <Nominal>No</Nominal>
    <TrampResidual>No</TrampResidual>
  </ElementData>
  .
  .
  <ElementData>
    <Version>1.1</Version>
    <AtomicNumber Index="25">92</AtomicNumber>
    <Compound>U</Compound>
    <Concentration>0</Concentration>
    <Error>100</Error>
    <MaxRange>0</MaxRange>
    <MinRange>0</MinRange>
    <Nominal>No</Nominal>
    <TrampResidual>No</TrampResidual>
  </ElementData>
</Elements>
</Data>

<?xml version="1.0" encoding="utf-8"?>
<Data>
  <Version>1.2</Version>
  <DateTime>2015-04-30 08:32:15</DateTime>
  <AnalysisMode>LIBRARY SEARCH PASSFAIL</AnalysisMode>
  <Grades>
    <GradeData>
      <Version>1.1</Version>
      <Grade Index="1">2205SS</Grade>
      <MatchValue>000010</MatchValue>
      <PassFail>PASS</PassFail>
    </GradeData>
    .
    .
    <GradeData>
      <Version>1.1</Version>
      <Grade Index="3">2207SS</Grade>
      <MatchValue>08.565</MatchValue>
      <PassFail>NONE</PassFail>
    </GradeData>
  </Grades>
  <Elements>
    <ElementData>
      <Version>1.1</Version>
      <AtomicNumber Index="1">12</AtomicNumber>
      <Compound>Mg</Compound>
      <Concentration>0</Concentration>
      <Error>100</Error>

```

```

    <MaxRange>0</MaxRange>
    <MinRange>0</MinRange>
    <Nominal>No</Nominal>
    <TrampResidual>No</TrampResidual>
  </ElementData>
  .
  .
<ElementData>
  <Version>1.1</Version>
  <AtomicNumber Index="6">26</AtomicNumber>
  <Compound>Fe</Compound>
  <Concentration>65.8589</Concentration>
  <Error>0.246356</Error>
  <MaxRange>73</MaxRange>
  <MinRange>62</MinRange>
  <Nominal>No</Nominal>
  <TrampResidual>No</TrampResidual>
</ElementData>
.
.
<ElementData>
  <Version>1.1</Version>
  <AtomicNumber Index="25">92</AtomicNumber>
  <Compound>U</Compound>
  <Concentration>0</Concentration>
  <Error>100</Error>
  <MaxRange>0</MaxRange>
  <MinRange>0</MinRange>
  <Nominal>No</Nominal>
  <TrampResidual>No</TrampResidual>
</ElementData>
</Elements>
</Data>

<?xml version="1.0" encoding="utf-8"?>
<Data>
  <Version>1.2</Version>
  <DateTime>2015-04-30 08:32:15</DateTime>
  <AnalysisMode>LIMITS CHECK</AnalysisMode>
  <Grades>
    <GradeData>
      <Version>1.1</Version>
      <LimitSet>IEC Limits</LimitSet>
      <PassFail>PASS</PassFail>
    </GradeData>
  </Grades>
  <Elements>
    <ElementData>
      <Version>1.1</Version>
      <AtomicNumber Index="1">12</AtomicNumber>
      <Compound>Mg</Compound>

```



```

    <Concentration>0</Concentration>
    <Error>100</Error>
    <MaxRange>0</MaxRange>
    <MinRange>0</MinRange>
    <PassFail>PASS</PassFail>
  </ElementData>
  .
  .
<ElementData>
  <Version>1.1</Version>
  <AtomicNumber Index="6">26</AtomicNumber>
  <Compound>Fe</Compound>
  <Concentration>65.8589</Concentration>
  <Error>0.246356</Error>
  <MaxRange>73</MaxRange>
  <MinRange>62</MinRange>
  <PassFail>PASS</PassFail>
</ElementData>
.
.
<ElementData>
  <Version>1.1</Version>
  <AtomicNumber Index="25">92</AtomicNumber>
  <Compound>U</Compound>
  <Concentration>0</Concentration>
  <Error>100</Error>
  <MaxRange>0</MaxRange>
  <MinRange>0</MinRange>
  <PassFail>PASS</PassFail>
</ElementData>
</Elements>
</Data>

<?xml version="1.0" encoding="utf-8"?>
<Data>
  <Version>1.2</Version>
  <DateTime>2015-04-30 08:32:15</DateTime>
  <AnalysisMode>CONCENTRATIONS</AnalysisMode>
  <Elements>
    <ElementData>
      <Version>1.1</Version>
      <AtomicNumber Index="1">12</AtomicNumber>
      <Compound>Mg</Compound>
      <Concentration>0</Concentration>
      <Error>100</Error>
    </ElementData>
    .
    .
  </ElementData>
  <Version>1.1</Version>
  <AtomicNumber Index="6">26</AtomicNumber>

```

```

    <Compound>Fe</Compound>
    <Concentration>65.8589</Concentration>
    <Error>0.246356</Error>
  </ElementData>
  .
  .
  <ElementData>
    <Version>1.1</Version>
    <AtomicNumber Index="25">92</AtomicNumber>
    <Compound>U</Compound>
    <Concentration>0</Concentration>
    <Error>100</Error>
  </ElementData>
</Elements>
</Data>

```

Binary Data layout descriptions:

The spectrum data is stored and transmitted in a binary format. The following C/C++ statements define the layout:

```

#define SPECCHANNELS      8192

typedef struct {
    float  sngHVADC;           // Requested HV in kV
    float  sngCurADC;          // Requested Current in µA
    byte   bytVolt;            // Ignore - legacy support
    byte   bytCurrent;         // Ignore - legacy support
    byte   bytToggle;          // Scaler selected
    byte   bytPulseLength;     // Ignore - legacy support
    byte   bytPulsePeriod;     // Ignore - legacy support
    byte   bytFilter;          // Ignore - legacy support
    byte   bytExtActual;       // Ignore - legacy support
    byte   bytTimes2;          // Ignore - legacy support
} XRAY, *PXRAY;

typedef struct {
    short   bElement;          // layer element atomic number
    short   sThickness;        // layer thickness (in µm)
} FILTERLAYER, *PFILTERLAYER;

typedef struct {
    int      iFilterNum;        // filter identifier in wheel
    FILTERLAYER flLayer[3];     // layer description structures
} S1FILTER, *PS1FILTER;

struct
{
    byte     FPGA_Ver;          // FPGA version (Ignore)

```



```

byte          FPGA_SubVer;          // FPGA subversion (Ignore)
unsigned short iPacket_Len;         // Ignore
unsigned long  iTDur;                // Total packet duration (mS)
unsigned long  iRaw_Cnts;            // Raw counts, final packet
unsigned long  iValid_Cnts;          // valid counts, final packet
unsigned long  iValid_CntsRng;       // Ignore
unsigned long  iADur;                // packet active time (mS)
unsigned long  iADead;               // packet dead time (mS)
unsigned long  iAReset;              // packet reset time (mS)
unsigned long  iALive;               // packet live time (mS)
unsigned long  iService;             // Ignore
unsigned short iReset_Cnt;           // Ignore
unsigned short iPacket_Cnt;          // packet number
byte          Unused[20];           // Ignore
float          fXRay_ActualHV;       // Actaul HV (not valid)
float          fXRay_ActualAC;       // Actual anode current (not valid)
byte          bValidActuals;         // Ignore
byte          XRay_ActualHVDAC;      // Ignore
byte          XRay_ActualACDAC;      // Ignore
byte          Unused2;               // Ignore
byte          Xilinx_Vars[46];       // Xilinx variables (Ignore)
short         Det_Temp;              // detector temp in C
unsigned short Amb_Temp;             // ambient temp in F
byte          MCU_Ver;               // MCU version (Ignore)
byte          MCU_SubVer;            // MCU subversion (Ignore)
unsigned long  iRaw_Cnts_Acc;         // Assay Raw counts
unsigned long  iValid_Cnts_Acc;      // Assay Valid counts
unsigned long  iValid_CntsRng_Acc;   // Ignore
unsigned long  iReset_Cnt_Acc;       // Ignore
float          fTDur;                // Assay duration (seconds)
float          fADur;                // Assay active time (seconds)
float          fADead;               // Assay dead time (seconds)
float          fAReset;              // Assay reset time (seconds)
float          fALive;               // Assay live time (seconds)
unsigned long  lVacuum_Acc;           // Ignore
unsigned long  lPacket_Cnt;          // packets in assay
S1FILTER      xTubeFilter;           // beam filter structure
XRAY          XRay;                 // x-ray settings structure
} s1_cooked_head;

struct
{
    float          fEVPerChannel;      // eV per channel
    s1_cooked_head stCookedHeader;     // described above
    unsigned long  SpectrumData[SPECCHANNELS]; // spectrum data
} SpecData;

```

- Note: The size of the SpectrumData array is defined to be 8192 channels (long integers) but the actual number of channels transmitted is currently set to 2048, therefore the size of the actual data packet is smaller than these structures would seem to indicate.



Packet encapsulation:

All of the defined structures are encapsulated in a “network” packet when transmitted. The packet layout is defined as follows (again using C/C++ structures where appropriate).

The following data items are transmitted in the order listed, assumption is byte order follows Intel layout as the ARM processor used in the instrument is by default little endian just as the Intel processors are.

- Note: The structures have been carefully defined to appear as if they are packed by the compiler but actually are not. There are no gaps in the data for alignment purposes on a 32 bit computer, this may not be the case on a 64 bit system.

```
byte          cStartMark[] = {3,2,0,0};
unsigned short usWhat;      // packet type indicator
unsigned int   uiSize;      // size of data
unsigned char  ucData[uiSize]; // data
byte          cEndMark[] = {6,42,255,255};
```

The implemented packet types are:

```
// Data type identifiers (usWhat above)
typedef enum _DATATYPE
{
    COOKED_SPECTRUM = 0x8001, // cooked spectrum packet
    RESULTS_SET     = 0x8002, // calculated results packet
    RAW_SPECTRUM    = 0x8003, // raw spectrum packet
    PDZ_FILENAME    = 0x8004, // filename of just completed assay
    XMLPACKET       = 0x8017, // XML data
    STATUS_CHANGE   = 0x8018, // Status change message, XML text
}
```

There are a few other defined types that are outside the scope of this documentation.

**** The following is only documented so that the UDP packets broadcast by the instrument announcing itself to S1Sync can be used as a heartbeat signal. ****

S1Sync broadcast packet layout:

```
// broadcast port used to notify S1Sync of our presence
#define TCP_BCAST_PORT 55000 //default TCP/IP broadcast port

#define MAGIC_VERSION 0xDEADFEED
```

UDP Packet structure

```
typedef struct
{
    DWORD dwSize; // The size of the struct
    DWORD dwMagic; // The magic number (MAGIC_VERSION)
    DWORD dwMajorVersion; // Major Version of the OS
```



```
    DWORD dwMinorVersion;           // Minor Version of the OS
    char  szPlatformType[128];
    char  szOEMInfo[128];
    char  szDeviceName[32];         // HostName (instrument serial #)
} S1INFO, *PS1INFO;
```