ODI-A

Optical Data Interface - Application Programming Interface for Test and Measurement

AXIe Consortium Technical Committee

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Revision History

Date	Changes
2017-08-01	Add Directionality to Port.GetCapability and Port.Activate. Updated GetStatus bit definitions for flow control status. Updated ClasssId list. Changed PacketFormat enum to avoid 0. Updated StreamId description. Changed FlowControl enum.
2017-09-06	Added ContextClassId to Producer.Activate. Updated Class ID enums. Change SCPI DIRectionality to DIRection to meet 12 characer SCPI rule.
2017-11-27	Added DualUnidirectional to Directionality enum, and changed 3.1.1 by removing additional logical names for one physical port. Rename C structs. Added reference to VITA-49.2 Split FlowControl parameter into rxFlowControl and txFlowControl. Changed GetCapability structure field to use class id enums. Converted enums and structs to UpperCamelCase.

Date	Changes
2018-02-06	Added RxSignalLoss, RxSyncPending bits to Port Status. Added details to other bits. Added “Odi” prefix to enum type names. Removed spaces from Consumer and Producer names. Renamed EnableEvent to StatusChangedEvent. Added TimestampFormat as a parameter to Producer.Activate, Consumer.Activate, and GetCapability
2018-05-01	Added Consumer.RemoveStream, Producer.RemoveStream. Changed suggested StreamID increment from 64 to 1024. Added UTC timestamp format.

1 Introduction

This standard establishes recommendations for implementing the programming interface of the Optical Data Interface (ODI). ODI is a high-speed data transfer interface suitable for point-to-point transfer of measurement data within a solution, using multi-gigabit FPGA transceivers, multi-lane optical interfaces, Interlaken protocol, interoperable data formats, and configured through a standardized API.

This document specifies the API of ODI. The physical, protocol, and data presentation layer (data format) are specified in other documents referenced below.

1.1 Scope

This document applies to any test and measurement product implementing ODI, and applies to the programming interface used by application software on a controller directed to an ODI-compliant device. It does not specify programming interfaces internal to a device.

1.1.1 RULE vs. RECOMMENDED

The standards are categorized as RULE or RECOMMENDATION. RULE indicates a requirement aimed at providing product compatibility and/or a common customer experience. RECOMMENDATION refers to best practices for consistency, interoperability and development efficiency.

1.2 References

ODI-1: Physical Layer
http://www.axiestandard.org/odispecifications.html

ODI-2: Transport Layer
http://www.axiestandard.org/odispecifications.html

ODI-2.1: High Speed Data Formats
http://www.axiestandard.org/odispecifications.html

VITA-49.2 VITA Radio Transport (VRT) Standard,
VITA-49A Spectrum Survey Interoperability Specification
http://www.vita.com/

2 Overview

This API is partitioned into three areas, ODI Port Control, Data Producer Stream Control, and Data Consumer Stream Control.

- The ODI ***Port API*** methods configure and initialize a single optical interface (or port) of an ODI link. This API is common to all devices supporting ODI.

- The data ***Producer and Consumer Stream APIs*** configure the routing and formatting of data streams within a device. Although details of this API are device-specific, this standard provides a recommended pattern for APIs.

Devices may have multiple ports, and may support multiple producer streams and multiple consumer streams. The simplest case is a single producer, single port device sending data to a single port, single data consumer device.

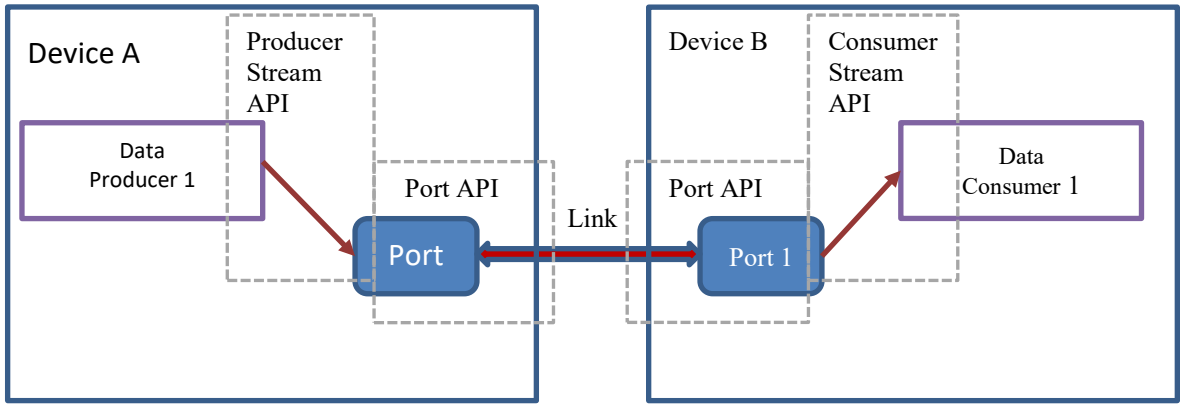


Figure 1 - Single producer to single consumer

More complex configurations include bonding multiple ports to accommodate higher data rates. The example below shows a single stream using two ports.

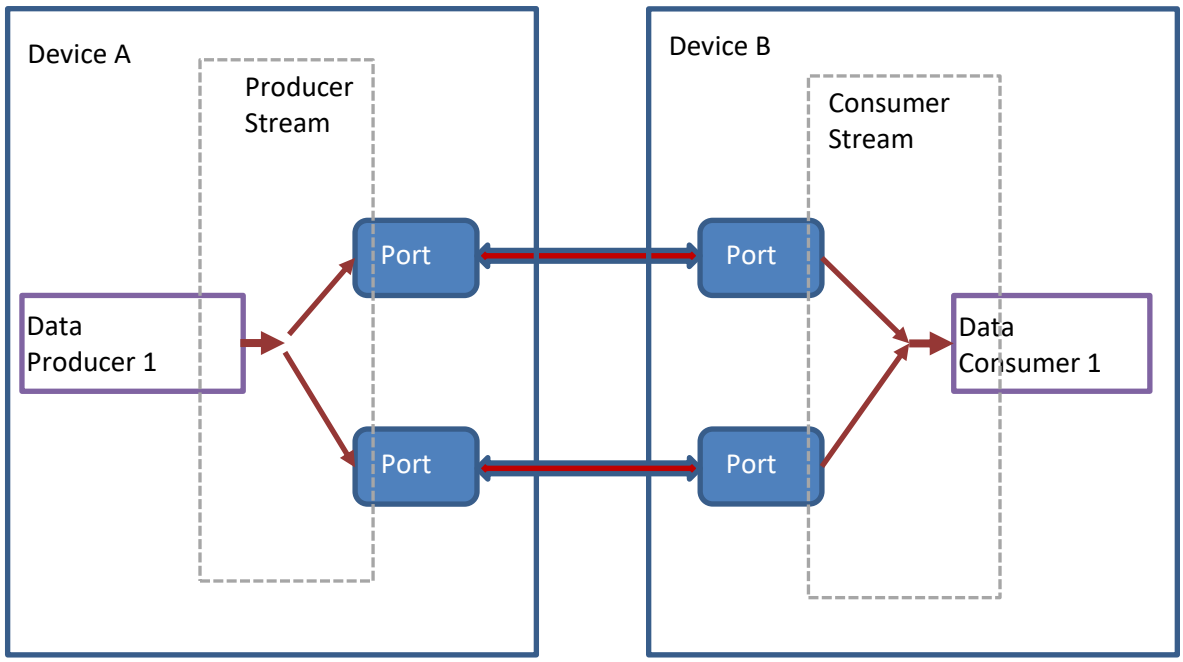


Figure 2 - Single stream using aggregated ports

Other applications may send multiple independent data streams through a single port. The example below shows how two streams might share one link.

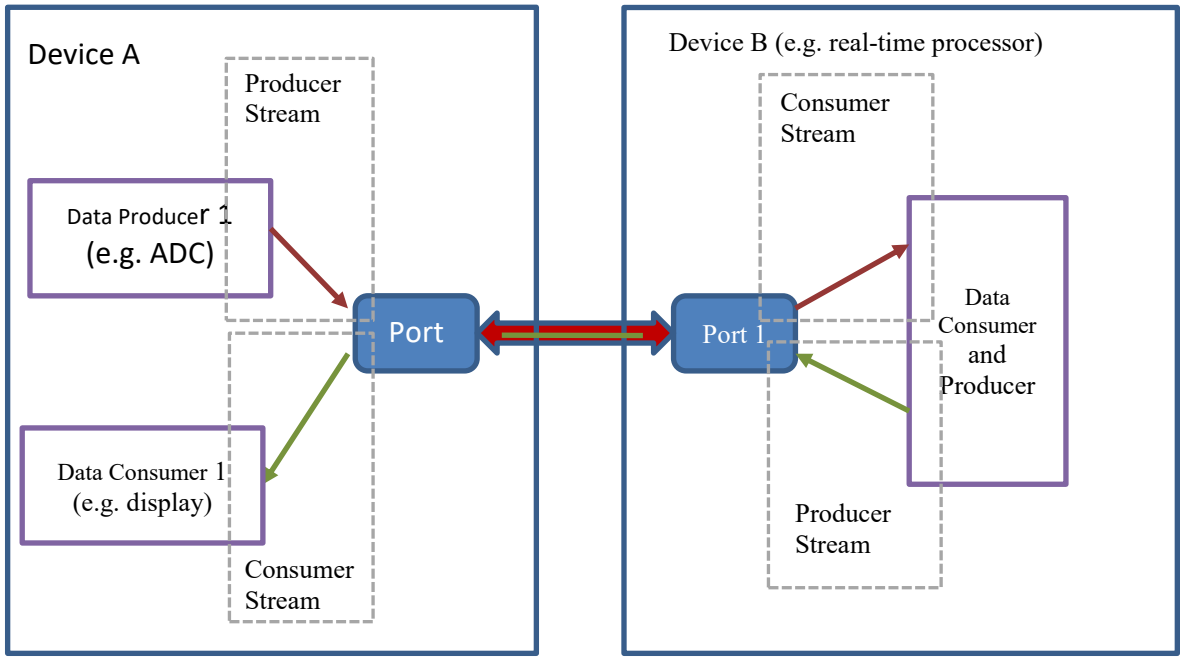


Figure 3 – Two streams over one link

2.1 Supported Programming Environments

This API document describes interfaces for .NET, C, and SCPI programming environments. The .NET interface is also intended to be a pattern for a modern C++ interface. Individual instrument drivers can choose which of these interfaces to provide depending on the programming environments they support.

The .NET API definitions documented below assume a programming environment that supports hierarchical organization of members in interfaces, and collections of repeated capabilities. These definitions may need to be "flattened" for other environments (like native C).

In method names, *Driver* is a placeholder for an instrument-specific name.

2.2 Example Implementation

An example IVI-NET and IVI-C implementation software package is available. This package was created using Pacific Mindworks Nimbus Driver Studio for creating instrument drivers.

This tool creates a Windows chm help file which can be used to browse the API. Figure 4 - IVI Help, shows how the ODI API appears as part of a hypothetical Keysight model Mxxxx instrument.

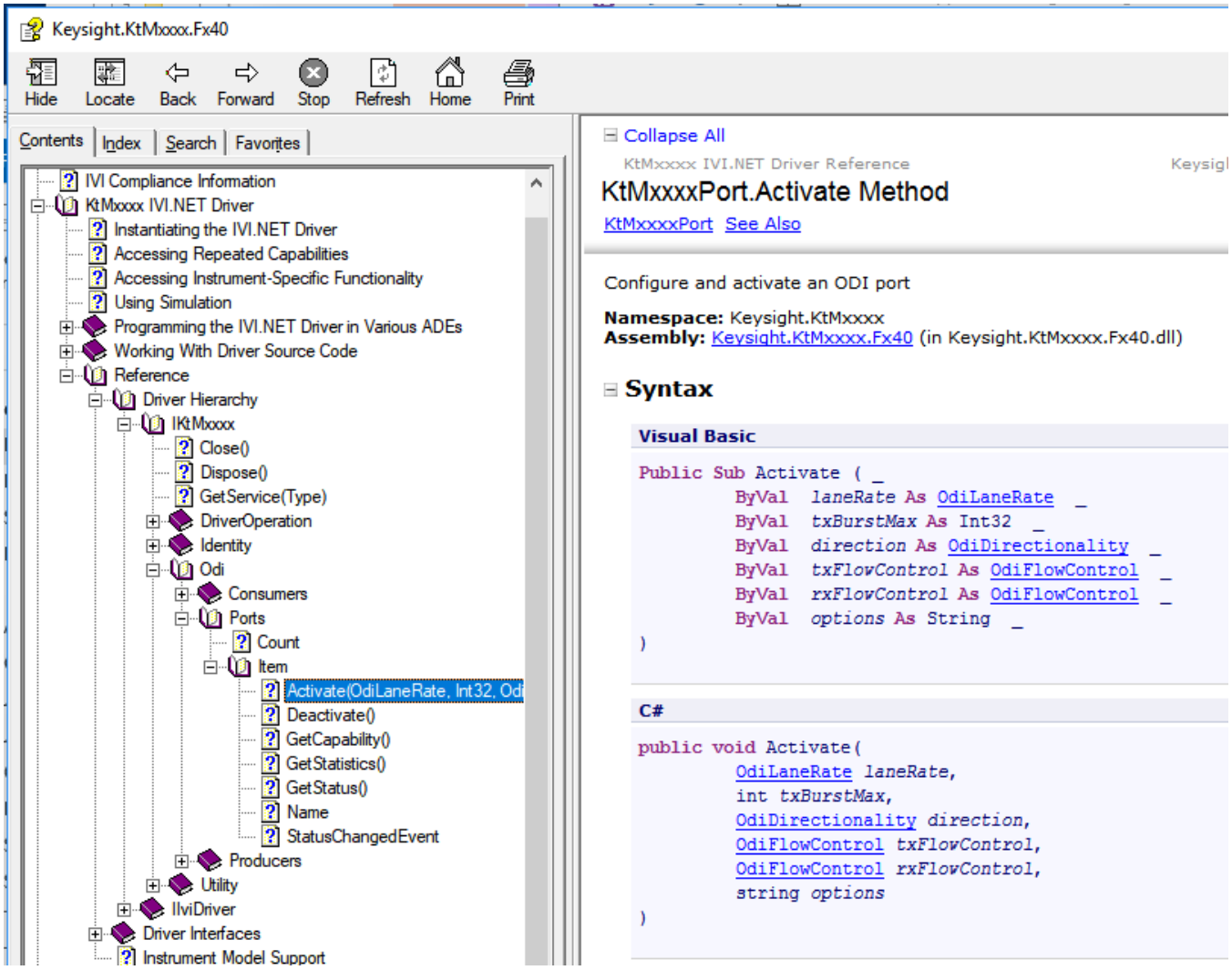


Figure 4 - IVI Help

Contact AXIe to get a copy of these files.

3 Port API

The Port API is exposed as a collection of Port objects, each has methods to configure and initialize one optical interface (or port).

3.1 Port API Structure

Driver.Odi.Ports. ...

Driver.Odi.Ports.	
Int32 Count	Returns the number of ports
String Name(int index)	Returns name of port given 0-based index
Item[portName]	Ports[] is a read-only collection with an item for each physical optical interface (or port). Ports have pre-defined names.
Driver.Odi.Ports.Item[Name], *Driver*.Odi.Ports[Name]	
String Name	Returns name. Read-only.
OdiPortCapability GetCapability()	Returns a list of capabilities of the optical port. Capability information includes lane rates supported, flow control methods supported, etc. Details below.
void Activate(LaneRate laneRate, Int32 transmitBurstMax, Directionality direction, FlowControl txFlowControl, FlowControl rxFlowControl, string options)	"Lights up" the optical port transmitters using the specified parameters. Enable the optical receivers to being clock synchronization.
void Deactivate()	Turns off the optical port
OdiPortStatus GetStatus()	Returns a status word containing bits for Active, receiver locked, CRC error, Flow Control.
OdiPortStatistics GetStatistics()	Returns error count and traffic statistics. Statistics are returned as an object (.NET) or structure (C).
StatusChangedEvent	Subscribe to an event for Status changes Implementation is language dependent: .NET event mechanism or C callback.

3.1.1 Port Names

The Ports[] collection is indexed by a Port Name strings. Port names are case insensitive and should match the connector label. Recommended names are "ODI1", "ODI2", and so on.

3.2 Example Usage

3.2.1 Example calling sequence

Data Producer (source)	Data Consumer (sink)
1. Select ports to be used, connect optical cable. Configure measurement settings.	
2. Call `Ports["ODI1"].GetCapability()` to get producer capabilities.	
	3. Call `Ports["ODI1"].GetCapability()` to get consumer capabilities.
4. Choose common capabilities for lane rate, BurstMax, flow control.	

5. Call
`Ports["ODI1"].Activate(`
`  LaneRate._14R1G, 2048,`
`  Directionality.Bidirectional,`
`  FlowControl.Inband,`
`  FlowControl.Inband, "")`
to configure the port and turn on.	

	6. Call
	`Ports["ODI1"].Activate(`
	`  LaneRate._14R1G, 2048,`
	`  Directionality.Bidirectional,`
	`  FlowControl.Inband,`
	`  FlowControl.Inband, "")`
	to configure the port and turn on.

7. Poll by calling `Ports["ODI1"].GetStatus()` until link is up and ready.	
	8. Poll by calling `Ports["ODI1"].GetStatus()` until link is up and ready.
9. Call data Producer and data Consumer methods described in the next section to configure data streams, then call instrument-specific methods to start measurement.	

3.3 Port API Reference

The Port API provides methods to report capabilities, configure, and initialize the optical link. This API is common to all devices supporting ODI.

3.3.1 Constant and Enum Definitions

```
public enum OdiLaneRate
{
    _12R5G = 1,
    _14R1G = 2,
}

public enum OdiFlowControl
{
    None = 1,
    InBand = 2,
    InBandPerChannel = 3,
    OutOfBand1Wire = 4,
    OutOfBandBackplane0 = 100,  // PXI_TRIG0 or AXIe TRIG0
    OutOfBandBackplane1 = 101,  // PXI_TRIG1 or AXIe TRIG1
…
    OutOfBandBackplane8 = 108,  // PXI_TRIG8 or AXIe TRIG8
    OutOfBandBackplane9 = 109,  // AXIe TRIG9
    OutOfBandBackplane10 = 110, // AXIe TRIG10
    OutOfBandBackplane11 = 111, // AXIe TRIG11
    OutOfBandBackplane12 = 112, // AXIe TRIG12
}
public enum OdiDirectionality
{
    Bidirectional = 1,  // Both TX and RX
    Producer = 2,       // TX only
    Consumer = 3,       // RX only
    DualUnidirectional = 4,  // Independent RX and TX
}
```

C implementations may specify enum constants using #defines, with an appropriate name prefix.

3.3.2 Odi.Ports.Count

Purpose

Returns the number of Ports in the collection.

SCPI Interface

ODI:PORT:COUNt? -> <integer>

3.3.3 Odi.Ports.Name(index)

Purpose

Returns name of port given 0-based index.

SCPI Interface

ODI:PORT[N]:NAME? -> "<name>"

3.3.4 Odi.Ports[Name].Name

Purpose

Returns name of the port. Useful if a Port object passed by reference in programming environments that allow this.

3.3.5 Odi.Ports[Name].GetCapability()

Purpose

Query capability of an ODI port.

.Net Interface

```
OdiPortCapability GetCapability();

public struct OdiPortCapability
{
    public string Name;
    string Version;          // Version of the standard supported
    OdiLaneRate[] LaneRates;    // list of supported lane rates.
    Int32[] TxBurstMaxes;    // Transmitter BurstMax values supported (bytes)
    Int32 RxBurstMax;        // Receiver BurstMax in bytes.
    OdiFlowControl[] FlowControls;  // Flow control methods supported
    Int32 ChannelMax;        // Maximum Interlaken channel number supported
    OdiDirectionality Direction[]; // list of Unidirectional/Bidirectional support
    Boolean TxRateMatching;  // Interlaken Sec 5.4.10 TX rate matching supported
}
```

C Interface

```
ViStatus Driver_OdiPortGetCapability(ViSession s, ViString port,
      ViInt32 structVersion,
      OdiPortCapability  *capability);

#define ODI_PORT_CAPABILITY_VERSION 1

struct OdiPortCapability {
    ViChar       name[64];
    ViChar       version[64];
    OdiLaneRate     laneRates[8];   // 0-terminated list of LaneRate enums
    ViUInt32     txBurstMaxes[8];   // list of Tx BurstMax values
    ViUInt32     rxBurstMax;        // Rx BurstMax
    OdiFlowControl  flowControls[32];  // flow control methods supported
    ViUInt32     channelMax;        // Maximum Interlaken channel number supported
    OdiDirectionality  directions[8];  // list of Unidirectional/bidirectional
support
    ViBoolean    txRateMatching;    // TX rate matching (limiting) supported
};
```

SCPI Interface

```
ODI:PORT[N]:CAPability:FCONtrols? -> <list of enum values>,
e.g.
NONE,IBANd,IBPC,OOBWire,OOBBackplane0,OOBBackplane8,OOBBackplane9,OOBBackplane10,OOBB
ackplane11,OOBBackplane12

ODI:PORT[N]:CAPability:NAME? -> "<name>"

ODI:PORT[N]:CAPability:RATes? -> <list of enum values>, e.g. R125,R141

ODI:PORT[N]:CAPability:RBMax? -> <integer>

ODI:PORT[N]:CAPability:TBMax? -> <list of integers>, e.g. 4096,8192

ODI:PORT[N]:CAPability:DIRection? -> <list of enum>, e.g.  BIDirectional, PRODucer,
CONSumer,DUAL

ODI:PORT[N]:CAPability:TRMatch? -> 0|1

ODI:PORT[N]:CAPability:VERSion? -> "<string>"
```

Remarks

This operation queries a capability of the optical interface port on the device.

3.3.6 Odi.Ports[Name].Activate(laneRate, txBurstMax, direction, txFlowControl, rxFlowControl, options)

Purpose

Configure and activate an ODI port

Parameters

Name	Direction	Type	Description
`laneRate`	IN	`OdiLaneRate`	Enum value specifying lane rate.
`txBurstMax`	IN	`Int32`	Maximum size in bytes of Interlaken bursts
`direction`	IN	`OdiDirectionality`	Configure port for bidirectional or unidirectional operation.
`txFlowControl`	IN	`OdiFlowControl`	Enum value specifying type of transmit flow control
`rxFlowControl`	IN	`OdiFlowControl`	Enum value specifying type of receive flow control
`options`	IN	`String`	Additional instrument-specific settings

Exceptions/Errors

"Not Supported" if the hardware does not support the specified settings.

"In Use" if the port is already active.

.Net Interface

```
void Activate(OdiLaneRate laneRate, int txBurstMax, OdiDirectionality direction,
OdiFlowControl txFlowControl, OdiFlowControl rxFlowControl, string options);
```

C Interface

```
ViStatus Driver_OdiPortActivate(ViSession s, ViString port, OdiLaneRate laneRate,
          int txBurstMax, OdiDirectionality direction, OdiFlowControl txFlowControl,
          OdiFlowControl rxFlowControl, ViString options);
```

SCPI Interface

```
ODI:PORT[N]:ACTivate <laneRate>, <txBurstMax>, <direction>, <txFlowControl>,
<rxFlowControl>, <options>
```

Remarks

This method enables transmitters to transmit empty bursts, and initiates the receiver locking process. This method does not wait for receivers to complete clock synchronization.

Reset() and ResetWithDefaults() does not affect ODI Port activation. Port activation is excluded from instrument state reset to avoid resynchronization, which may be slow.

ODI hardware does not auto-negotiate settings for laneRate, txBurstMax, flowControl. Instead, the controlling software should query capabilities of both devices, select compatible settings, then Activate using those settings.

Other settings, such as PacketFormat are set on the Producer or Consumer stream, not on the Port.

3.3.7 Odi.Ports[Name].Deactivate ()

Purpose

Turn off the optical port

.Net Interface

```
void Deactivate();
```

C Interface

```
ViStatus Driver_OdiPortDeactivate(ViSession s, ViString port);
```

SCPI Interface

ODI:PORT[N]:DEACtivate

3.3.8 Odi.Ports[Name].GetStatus()

Purpose

Query status of an optical port.

.Net Interface

```
OdiPortStatus GetStatus();
```

C Interface

```
ViStatus Driver_OdiPortGetStatus(ViSession s, ViString port, ViUInt32* portStatus);
```

SCPI Interface

```
ODI:PORT[N]:CSTAtus? -> <integer>
```

Status Bits

Name	Bits	Description
Active	0	Port activated by software. Actual readiness to send and receive will depend upon the opposite end of the link and flow control configuration.
TxReady	1	Ready to transmit and flow control allows. If flow control is disabled, transmit will always be ready to send. If flow control is enabled, the port will not be 'ready to send' until receive is ready and indicating XON via flow control. To troubleshoot TxReady not becoming set in this case, troubleshoot the receive path starting with RxSignalLoss
RxReady	2	Receiver ready. All lanes synchronized and aligned.
RxLaneError	3	Error in one or more lanes since last GetStatus.
RxBurstMaxError	4	Received too large a burst since last GetStatus.
RxCrcError	5	Received bad burst CRC since last GetStatus.
RxOverrun	6	Receiver data overrun since last GetStatus
RxSignalLoss	7	Received signal loss. Optical power too low.
RxSyncPending	8	Receiver activated but has not achieved synchronization
	9 to 15	Unused
RxFcStatus	16	Received link-level flow control status. 1 is XON, 0 is XOFF. From Interlaken idle/control word bit 55 or from an out-of-band flow control signal.
RxFcStatus0 to RxFcStatus14	17 to 31	Received per-channel flow control status bits. 1 is XON, 0 is XOFF. Bit 17 is channel 0 from bit 54 of the Interlaken idle/control word, bit 18 is channel 1 from bit 53 of the control word, and so on.

Status bits described with "since last GetStatus" are cleared by GetStatus(). All status bits will be 0 on an inactive port.

```
public  enum OdiPortStatus
{
    Active = 0x0001,    // port has been activated
    TxReady = 0x0002,   // Ready to transmit and flow control allows
    RxReady = 0x0004,   // Rx synchronized and aligned
    RxLaneError = 0x0008,     // RX error in metaframe, scrambler, ...
    RxBurstMaxError = 0x0010, // Received too large of a burst.
    RxCRCError = 0x0020,      // CRC error in Burst
    RxOverrun = 0x0040,
    RxSignalLoss = 0x0080,    // Received signal loss, optical power too low.
    RxSyncPending = 0x0100,   // Receiver activated but has not achieved
synchronization

    RxFcStatus  = 0x00010000, // Received link-level flow control status
    RxFcStatus0 = 0x00020000, // Received channel 0 flow control status
    RxFcStatus1 = 0x00040000, // Received channel 4 flow control status
…
    RxFcStatus14 = 0x80000000, // Received channel 14 flow control status
}
```

3.3.9 Odi.Ports[Name].GetStatistics()

Purpose

Query statistics of an optical port.

.Net Interface

```
OdiPortStatistics GetStatistics();

public struct OdiPortStatistics
{
    public Int64 BytesSent;         // cumulative bytes sent
    public Int64 BytesReceived;     // cumulative bytes received
    public Int64 BadBurstsReceived; // number of bursts received with bad CRC
    public Int64 TxFlowControlHoldoffs; // number of clock cycles TX was held off
}
```

C Interface

```
ViStatus Driver_OdiPortGetStatistics(ViSession s, ViString port,
      ViInt32 structVersion, OdiPortStatistics *statistics);

#define ODI_PORT_STATISTICS_VERSION 1
struct OdiPortStatistics {
    ViUInt64 bytesSent;         // cumulative bytes sent
    ViUInt64 bytesReceived;     // cumulative bytes received
    ViUInt64 badBurstsReceived; // number of bursts received with bad CRC
    ViUInt64 txFlowControlHoldoffs; // number of clock cycles TX was held off
};
```

SCPI Interface

```
ODI:PORT[N]:PSTatistics:BBURrsts? -> <integer>

ODI:PORT[N]:PSTatistics :RBYTes? -> <integer>

ODI:PORT[N]:PSTatistics :TBYTes? -> <integer>
ODI:PORT[N]:PSTatistics :THOFfs? -> <integer>
```

Remarks

This operation queries the statistics of the optical interface port on the device. Statistics are cumulative since the port was Activated.

3.3.10 Odi.Ports[Name]. StatusChangedEvent

Purpose

Enable notification of port events by reporting changes to port status.

.Net Interface

```
void StatusChangedHandler(object sender, OdiPortStatusChangedEventArgs e);

event EventHandler<OdiPortStatusChangedEventArgs>  StatusChangedEvent;
```

C Interface

```
typedef void(*PORT_EVENT_CALLBACK)(ViString port, ViPBuf context,
      ViUInt32 portStatus);

ViStatus Driver_OdiPortEnableEvent(ViSession s, ViString port,
      PORT_EVENT_CALLBACK handler, ViPBuf context);
```

SCPI Interface

This command is not available in SCPI.

Remarks

Enables reporting of status changes to the calling software. The provided Event (.NET) or callback function pointer (C language), is called when certain status bits change. Changes in Flow Control status bits are excluded.

To disable event reporting, call EnableEvent() with null for the handler.

Implementation of PortStatusChangedEvent () is optional. Some products may report Not Implemented error.

4 Producer and Consumer Stream APIs

The Producer and Consumer Stream APIs configure the routing and formatting of data streams within a device.

In this API, *Producer* is short for *Data Producer Stream*. A digitizer may implement one or more Producer streams to route and format data from one or more ADC channels to one or more ODI ports.

Consumer is short for *Data Consumer Stream*. An AWG may implement one or more Consumer streams to route and format data from one or more ODI ports to one or more DAC channels.

4.1 Producer Stream API Structure

***Driver*.Odi.Producers**	
`Int32 Count`	Returns the number of producer streams..
`String Name(int index)`	Returns name of stream, given 0-based index
`String GetDataSources()`	*(optional)* Returns a comma separated list of valid DataSources for AddStream().

`AddStream(`
`String name,`
`String dataSource,`
`String destinationPorts,`
`String options)`
	(optional)
	Dynamically add new Producer stream to the collection, connecting a data source to one or more ODI ports.
	Name is user-supplied, becomes key for Item[ ].
	DataSource names are instrument specific, and can be queried with GetDataSources().
	DestinationPorts is a comma separated list of Port names.

`RemoveStream(String Name)`	*(optional)* Disconnect a stream created by AddStream(). SCPI command: ODI:PRODucer:RSTReam <name>
`Item[Name]`	Collection of producer streams. May initially be empty, or pre-populated with pre-defined producer streams.
***Driver*.Odi.Producers.Item[Name],** ***Driver*.Odi.Producers[Name]**	
`String Name`	Returns name. Read-only.
`OdiProducerCapability GetCapability()`	Returns a list of capabilities of the data producer, including packet formats and binary data formats.

`IsFormatSupported(`
`OdiPacketFormat packetFormat,`
`Vita49ClassId classId)`
	Returns true if the combination of PacketFormat and Vita49ClassId is supported.

`void Activate(`
`  Int32 linkChannel,`
`  OdiPacketFormat  packetFormat,`
`  Vita49ClassId  ClassId,`
`  Vita49ClassId contextClassId,`
`  Int32 streamId,`
`  OdiTimestampFormat timestamp,`
`  Int32 packetSizeLimit,`
`  <device params>…`
	Configure the data producer stream and activate it for use.
	LinkChannel sets the Interlaken packet channel (not measurement channel).
	PacketFormat specifies no header, or VITA-49, or other packet formats.
	ClassId specifies the binary format of the payload data, even if not using headers or VITA-49 packets.
	ContextClassId specifies the format of context packets, or 0 if none.
	Additional <device params> specify domain-dependent parameters such as packet size.

`Void Deactivate()`	Deactivates the stream.

The ODI API does not include methods to start or stop the stream. These functions are expected to be implemented by other measurement-specific areas of the API.

4.1.1 Producer Stream Names

The Producers[] collection is indexed by a name strings. Names are case insensitive. Names are IVI repeated capability identifiers and so cannot contain space or '-' characters. The recommended format is

<source>_to_<destination>

where <source> is instrument-specific and should match channel or other names used in the product. <destination> is an "and" separated list of Port names. Some example names are

- "Ch1_to_ODI1"
- "Ch1DDC_to_ODI1"
- "Ch1_to_ODI1_and_ODI2"

4.2 Consumer Stream API Structure

Driver.Odi.Consumers	
Int32 Count	Returns the number of consumer streams.
String Name(int index)	Returns name of stream, given 0-based index
String GetDataDestinations()	*(optional)* Returns a comma separated list of valid DataDestinations for AddStream().
AddStream(String name, String dataDestination, String sourcePorts, String options)	*(optional)* Dynamically add new Consumer stream to the collection, connecting one or more ODI ports to a data destination. Name is user-supplied, becomes key for Item[ ]. DataDestination names are instrument specific, and can be queried with GetDataDestination(). Source Ports is a comma separated list of Port names.
RemoveStream(String Name)	*(optional)* Disconnect a stream created by AddStream(). SCPI command: ODI:CONSumer:RSTReam <name>
Item[Name]	Collection of consumer streams. May initially be empty, or pre-populated with pre-defined consumer streams.
Driver.Odi.Consumers.Item[Name], *Driver*.Odi.Consumers[Name]	
String Name	Returns name. Read-only.
OdiConsumerCapability GetCapability()	Returns a list of capabilities of the data consumer, including supported packet formats and binary daa formats.
IsFormatSupported(OdiPacketFormat packetFormat, Vita49ClassId classId)	Returns true if the combination of packet format and classId is supported.
void Activate(Int32 linkChannel, OdiPacketFormat packetFormat, Vita49ClassId classId OdiTimestampFormat timestamp, <device params>…	Configure the data consumer stream and activate it for use. LinkChannel specifies filtering of received packets based on Interlaken channel. PacketFormat specifies no header, or VITA-49, or other packet formats. ClassId specifies the binary format of the payload data, even if not using headers or VITA-49 packets. Additional <device params> specify domain-dependent parameters such as packet size.
Void Deactivate()	Deactivates the stream.

The ODI API does not include methods to start or stop the stream. These functions are expected to be implemented by other measurement-specific areas of the API.

4.2.1 Consumer Stream Names

The Consumers[] collection is indexed by a name strings. Names are case insensitive. The recommended format is

<source>_to_<destination>

where <source> is an "and" separated list of Port names, and <destination> is instrument-specific and should match channel or other names used in the product. Some example names are

- "ODI1_to_Ch1"
- "ODI1_to_Ch1DUC"
- "ODI1_and_ODI2_to_Ch1"

4.3 Example Usage

4.3.1 Example calling sequence

The following sequence assumes the instruments have pre-defined streams, and the Ports involved are already activated.

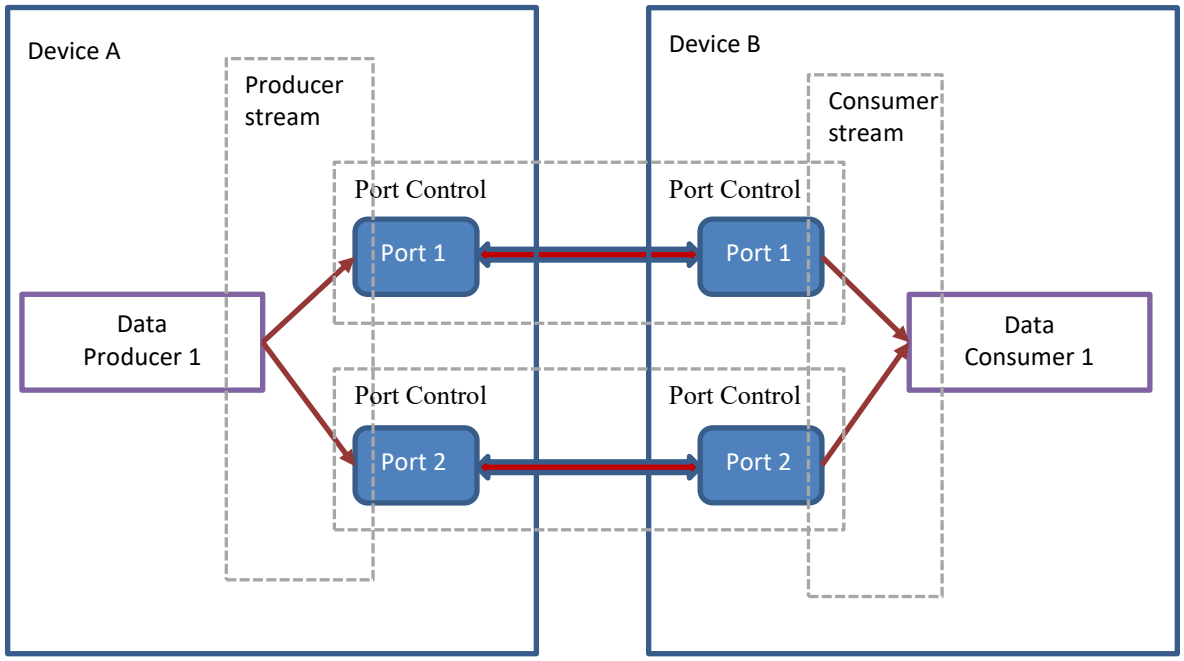
Data Producer (source)	**Data Consumer (sink)**
1. Select ports to be used, connect optical cable, Activate Ports, and check Port status. See Port Example calling sequence	
2. Get Producer names and capabilities by consulting documentation, or by iterating through each Producer and calling `.GetCapability()`.	
	3. Get Consumer names and capabilities by consulting documentation, or by iterating through each Consumer and calling `.GetCapability()`.
4. Choose common PacketFormat and Vita49ClassId.	
	5. Call `Consumers["ODI1_to_Ch1"].Activate( 0, Vita49Data, Iq16Bit1Ch, … )` to configure and activate the stream.

Data Producer (source)	Data Consumer (sink)

6. Call
`Producers["Ch1_to_ODI1"].Activate(`
`  0, Vita49Data, Iq16Bit1Ch, … )`
to configure and activate the stream.	

	7. Call instrument-specific method to start signal generation or processing from stream, e.g. *Driver*.Play(). It will stall waiting for data.
8. Call instrument-specific method to start digitizing or other data-producing activity, e.g. *Driver*.Arm(). This step starts the flow of data.	
9. Use instrument-specific methods to determine when a finite-length stream is complete, or to stop an indefinite-length stream.	
10. Call `Producers["ODI1_to_Ch1"].Deactivate();`	
	11. Call `Consumers["ODI1_to_Ch1"].Deactivate();`

4.3.2 Example of aggregating multiple ports



An instrument may allow aggregation of multiple ports to achieve higher data bandwidth. In this case a single stream is associated multiple ports. Below are the steps to configure.

1. Activate the Ports in the Port1-to-Port1 link.
2. Activate the Ports in the Port2-to-Port2 link.
3. On device A, find (or AddStream) the Producer stream. A typical name for this producer stream might be “Ch1_to_ODI1_and_ODI2”. Activate() it.
4. On device B, find (or AddStream) the Consumer stream. A typical name for this consumer stream might be “ODI1_and_ODI2_to_Ch1”. Activate() it.
5. On device B, start Data Consumer 1.
6. On device A, start Data Producer 1.

4.4 Producer Stream API Reference

4.4.1 Constant and Enum Definitions

```
public enum OdiPacketFormat
{
   NoHeader = 1,     // raw binary samples with no header.
   Vita49Data = 2,   // VITA-49 Signal Data packets.
   Vita49WithContext = 3,  // VITA-49 Signal Data and Context packets.
   Vita49Extension = 4,    // VITA-49 Extension packets.

   ProductSpecific = 1000, // Starting enum for other non-standard formats.
   Vita49Once = 1001,      // Single preamble VITA-49 Context, then NO_HEADER.
}

// ClassId enums define common ClassIds, per VITA-49.2
// This enum includes common formats for 1 or 2 channels.  It is not a complete list of valid classIds.
// To form class ids for higher channel counts, set the least significant byte to channelCount-1.
public enum Vita49ClassId : UInt64
{
    Unknown = 0,
    // ClassIds with org Id 24-5C-CB are defined by ODI.
    //  The following processing efficient formats are patterned after VITA-49A
    Re8Bit1Ch = 0x00245CCB00020000,  // Real (baseband), 8-bit signed, 1 channel
    Re8Bit2Ch = 0x00245CCB00020001,  // Real (baseband), 8-bit signed, 2 channel
    Re16Bit1Ch = 0x00245CCB00030000,  // Real (baseband), 16-bit signed, 1 channel
    Re16Bit2Ch = 0x00245CCB00030001,  // Real (baseband), 16-bit signed, 2 channel
    Re16Bit4Ch = 0x00245CCB00030003,  // Real (baseband), 16-bit signed, 4 channel
    Re32BitFloat1Ch = 0x00245CCB00060000, // Real (baseband), 32-bit float, 1 channel
    Iq8Bit1Ch = 0x00245CCB00120000,  // Complex (IQ), 8-bit signed, 1 channel
    Iq16Bit1Ch = 0x00245CCB00130000,  // Complex (IQ), 16-bit signed, 1 channel
    Iq32BitFloag1Ch = 0x00245CCB00160000, // Complex (IQ), 32-bit float, 1 channel

    // The following link-efficient ClassIds are not patterned after VITA-49A
    Re9BitPacked1Ch = 0x00245CCB00002000,   // Real, 9-bit link efficient, 1 ch
```

```
    Re10BitPacked1Ch = 0x00245CCB00004000,  // Real, 10-bit link efficient, 1 ch
    Re11BitPacked1Ch = 0x00245CCB00006000,  // Real, 11-bit link efficient, 1 ch
    Re12BitPacked1Ch = 0x00245CCB00008000,  // Real, 12-bit link efficient, 1 ch
    Re13BitPacked1Ch = 0x00245CCB0000A000,  // Real, 13-bit link efficient, 1 ch
    Re14BitPacked1Ch = 0x00245CCB0000C000,  // Real, 14-bit link efficient, 1 ch
    Re15BitPacked1Ch = 0x00245CCB0000E000,  // Real, 15-bit link efficient, 1 ch
    Iq9BitPacked1Ch = 0x00245CCB00102000,   // Complex, 9-bit link efficient, 1 ch
    Iq10BitPacked1Ch = 0x00245CCB00104000,  // Complex, 10-bit link efficient, 1 ch
    Iq11BitPacked1Ch = 0x00245CCB00106000,  // Complex, 11-bit link efficient, 1 ch
    Iq12BitPacked1Ch = 0x00245CCB00108000,  // Complex, 12-bit link efficient, 1 ch
    Iq13BitPacked1Ch = 0x00245CCB0010A000,  // Complex, 13-bit link efficient, 1 ch
    Iq14BitPacked1Ch = 0x00245CCB0010C000,  // Complex, 14-bit link efficient, 1 ch
    Iq15BitPacked1Ch = 0x00245CCB0010E000,  // Complex, 15-bit link efficient, 1 ch

    // ClassIds using Event Bits
    Re14Bit2Event1Ch = 0x00245CCB00830000,  // Real, 14-bit + 2 marker bits, 1 ch
    Iq14Bit2Event1Ch = 0x00245CCB00930000,  // Complex, 14-bit + 2 marker bits, 1 ch
}

// Context Packet ClassId enums define common ClassIds, per VITA-49.2
public enum Vita49ContextClassId : UInt64
{
    None = 0,
    // ClassIds with org ID 24-5C-CB are defined by ODI.
    OdiStandardizedContext = 0x00245CCB20170010,  // ODI standard 96 byte context packet
}

public enum OdiTimestampFormat
{
   NoTimestamp = 1,         // Timestamp not used.
   Gps = 2,                 // GPS seconds and pico-seconds per VITA-49.
   Relative = 3,            // Seconds and pico-seconds.
   SampleCount = 4,         // 64-bit sample count in Fractional Seconds field.
   Utc = 5,                 // UTC seconds and ps (not ODI recommended).
}
```

4.4.2 Odi.Producers.Count

Purpose

Returns the number of Producers currently in the collection.

SCPI Interface

ODI:PRODucer:COUNt? -> <integer>

4.4.3 Odi.Producers.Name(index)

Purpose

Returns name of producer given 0-based index.

SCPI Interface

ODI:PRODucer[N]:NAME? -> "<string>"

4.4.4 Odi.Producers.GetDataSources()

Purpose

Returns a comma separated list of data source names, each valid as the dataSource parameter of AddStream().

.Net Interface

```
string GetDataSources();
```

C Interface

```
ViStatus Driver_OdiProducerGetDatasources(ViSession s,  int bufferSize,
       ViString *buffer);
```

SCPI Interface

```
ODI:PRODucer:DSOurces? -> <comma separated list>, e.g. "cha1,cha2"
```

4.4.5 Odi.Producers.AddStream(name, dataSource, destinationPorts)

Purpose

Dynamically add new Producer stream to the collection, connecting a data source to one or more ODI ports.

Parameters

Name	Direction	Type	Description
name	IN	String	User-supplied handle, becomes key for Item[ ].
dataSource	IN	String	Specifies the data source. Source names are instrument specific, and can be queried with GetDataSources(). Although a stream can have only one source name, the name can represent a set of measurement channels.
destinationPorts	IN	String	DestinationPorts is a comma separated list of Port names.
options	IN	String	Additional instrument-specific settings

.Net Interface

```
void AddStream(string name, string dataSource, string destinationPorts, string
options);
```

C Interface

```
ViStatus Driver_OdiProducerAddStream(ViSession s, ViString name,
       ViString dataSource, ViString destinationPorts, ViString options);
```

SCPI Interface

```
ODI:PRODucer:ASTReam <name>, <dataSource>, <destinationPorts>, <options>
```

Remarks

Implementation of this method is optional. Instruments with a limited number of dataSource and destinationPort combinations can instead pre-define each of those Producer streams.

4.4.6 Odi.Producers.RemoveStream(name)

Purpose

Removes a dynamically added Producer stream from the collection.

Parameters

Name	Direction	Type	Description
`name`	IN	`String`	Name supplied during AddStream.

.Net Interface

```
void Removetream(string name);
```

C Interface

```
ViStatus Driver_OdiProducerRemoveStream(ViSession s, ViString name);
```

SCPI Interface

```
ODI:PRODucer:RSTReam <name>
```

Remarks

Implementation of this method is optional.

4.4.7 Odi.Producers[Name].Name

Purpose

Returns name of the producer. Useful if a Port object passed by reference in programming environments that allow this.

SCPI Interface

ODI:PRODucer[N]:NAME? -> "<string>"

4.4.8 Odi.Producers[Name].GetCapability()

Purpose

Query capability of a producer stream.

.Net Interface

```
OdiProducerCapability GetCapability();

public struct OdiProducerCapability
{
    public string Name;
    public string Version;          // Version of the standard supported
    public OdiPacketFormat[] PacketFormats;  // all packet header formats supported
    public Vita49ClassId[] Vita49ClassIds; // all binary formats supported
    public Vita49ContextClassId[] ContextClassIds; // all context packets supported
    public OdiTimestampFormat[] TimestampFormats; // all timestamp formats supported
}
```

C Interface

```
ViStatus Driver_OdiProducerGetCapability(ViSession s, ViString name,
      ViInt32 structVersion, OdiProducerCapability *capability);

#define ODI_PRODUCER_CAPABILITY_VERSION 1
struct OdiProducerCapability {
    ViChar       name[64];
    ViChar       version[64];
    OdiPacketFormat packetFormats[64]; // list of data formats supported.  0-
terminated
    Vita49ClassId  classIds[64];// list of VITA-49 formats supported. 0-terminated
    Vita49ContextClassId  contextClassIds[64];// list of Context packets supported. 0-
terminated
    OdiTimestampFormat timestampFormats[64];// list of timestamps supported. 0-
terminated
};
```

SCPI Interface

```
ODI:PRODucer[N]:CAPability:CLIDs? -> <list of integers values>, e.g. 2,3,5,7,11

ODI:PRODucer[N]:CAPability:NAME? -> "<string>"

ODI:PRODucer[N]:CAPability:PFORmats? -> <list of enum values>,
e.g. NHEader,IDATa,CONText,ONCE

ODI:PRODucer[N]:CAPability:VERSion? -> "<string>"

ODI:PRODucer[N]:TIMestamp:TFORmats? -> <list of enum values>,
e.g. NOTimestamp,GPS,RELative,SAMPlecount
```

Remarks

This operation queries a capability of the data producer stream.

The returned lists of OdiPacketFormats and Vita49ClassIds does not imply all combinations are supported. Call IsFormatSupported() to determine support for a combination.

4.4.9 Odi.Producers[Name].IsFormatSupported(packetFormat, classId)

Purpose

Returns true if the combination of PacketFormat and binary data format (ClassId) is supported.

.Net Interface

```
Boolean IsFormatSupported(OdiPacketFormatEnum PacketFormat,
      Vita49ClassIdEnum Vita49ClassId);
```

C Interface

```
ViStatus Driver_OdiProducerIsFormatSupported(ViSession s,
      OdiPacketFormatEnum PacketFormat, Vita49ClassIdEnum Vita49ClassId,
      ViBoolean *supported);
```

SCPI Interface

ODI:PRODucer[N]:IFSupported? <packetFormat>, <ClassId> -> 0|1

4.4.10 Odi.Producers[Name].Activate(linkChannel, packetFormat, classId, contextClassId, streamId, ...)

Purpose

Configure the data producer stream and activate it for use.

Parameters

Name	Direction	Type	Description
`linkChannel`	IN	`Int32`	Interlaken channel tag to apply to stream (not the measurement channel).
`packetFormat`	IN	`OdiPacketFormat enum`	Specifies format of any packet header and meta-data. Select No header, VITA-49 header, or other.
`classId`	IN	`Vita49ClassId enum`	Enum (or #defined) value specifying the binary data format of the packet payload, using VITA-49 Class Id as defined in VITA-49.2 and the ODI data format standard.

contextClassId	IN	Vita49ContextClassId enum	Enum (or #defined) value specifying the format of context packets, or 0 if not using context packets.
streamId	IN	Int32	Specifies VITA-49 Stream Identifier value to be placed in the IF Data Packet when using VITA-49 packet format. Typically 4096. When aggregating ports, this value is used on the first port, and incremented by 1024 for each additional port.
timestampFormat	IN	OdiTimestampFormat enum	Specifies format of the timestamp field sent in the VITA-49 prolog.
packetSizeLimit	IN	Int32	Specifies a maximum size for packets, in bytes. 0 indicates default of 262144.
...	IN		Additional instrument-specific settings for properties such as packet length.

Exceptions/Errors

"Not Supported" if the stream does not support the specified settings.

"In Use" if the stream or resources are already in use.

.Net Interface

```
void Activate(Int32 linkChannel, OdiPacketFormat packetFormat, Vita49ClassId classId,
          Vita49ContextClassId contextClassId, Int32 streamId,
          OdiTimestampFormat timestampFormat, Int32 packetSizeLimit,...);
```

C Interface

```
ViStatus Driver_OdiProducerActivate(ViSession s, Int32 linkChannel,
       OdiPacketFormat packetFormat, Vita49ClassId classId,
       Vita49ContextClassId contextClassId, Int32 streamId,
       OdiTimestampFormat timestampFormat, Int32 packetSizeLimit,  ...);
```

SCPI Interface

```
ODI:PRODucer[N]:ACTivate <linkChannel>, <packetFormat>, <classId>, <contextClassId>,
<streamId>,
   <packetSizeLimit>,  ...
```

Remarks

Configures and activates the producer stream. On return the stream is ready to flow data, but in most case another instrument-specific method must be called to start the flow.

Calling this method may result in reconfiguration of an FPGA in the instrument, which may take several seconds.

4.4.11 Odi.Producers[Name].Deactivate()

Purpose

Deactivate the stream, stop any data flow, and free resources.

.Net Interface

```
void Deactivate();
```

C Interface

```
ViStatus Driver_OdiProducerDeactivate(ViSession s, ViString name);
```

SCPI Interface

```
ODI:PRODucer[N]:DEACtivate
```

4.5 Consumer Stream API Reference

4.5.1 Constant and Enum Definitions

Same as defined for producer streams. See 4.4.1 Constant and Enum Definitions

4.5.2 Odi. Consumers.Count

Purpose

Returns the number of Consumers currently in the collection.

SCPI Interface

ODI:CONSumer:COUNt? -> <integer>

4.5.3 Odi. Consumers.Name(index)

Purpose

Returns name of consumer given 0-based index.

SCPI Interface

ODI:CONSumer[N]:NAME? -> "<string>"

4.5.4 Odi.Consumers.GetDataDestinations()

Purpose

Returns a comma separated list of data destination names, each valid as the dataDestination parameter of AddStream().

.Net Interface

```
string GetDataDestinations();
```

C Interface

```
ViStatus Driver_OdiConsumerGetDataDestinations(ViSession s, int bufferSize,
       ViString *buffer);
```

SCPI Interface

ODI:CONSumer:DESTination? -> <comma separated list >, e.g. "ch1,ch2"

4.5.5 Odi.Consumers.AddStream(name, dataDestination, sourcePorts)

Purpose

Dynamically add new Consumer stream to the collection, connecting one or more ODI ports to a data destination.

Parameters

Name	Direction	Type	Description
`name`	IN	`String`	User-supplied handle, becomes key for Item[ ].
`dataDestination`	IN	`String`	Specifies the data destination. Destination names are instrument specific, and can be queried with GetDataDestinations(). Although a stream can have only one destination name, the name can represent a set of channels.
`sourcePorts`	IN	`String`	SourcePorts is a comma separated list of ODI Port names.
`options`	IN	`String`	Additional instrument-specific settings

.Net Interface

```
void AddStream(string name, string dataDestination, string sourcePorts, string
options);
```

C Interface

```
ViStatus Driver_OdiProducerAddStream(ViSession s, ViString name,
      ViString dataDestination, ViString sourcePorts, ViString options);
```

SCPI Interface

```
ODI:CONSumer:ASTReam <name>, <dataDestination>, <sourcePorts>, <options>
```

Remarks

Implementation of this method is optional. Instruments with a limited number of dataDestination and destinationPort combinations can instead pre-define each of those Consumer streams.

4.5.6 Odi.Consumers.RemoveStream(name)

Purpose

Remove a dynamically added Consumer stream from the collection.

Parameters

Name	Direction	Type	Description
name	IN	String	User-supplied handle, becomes key for Item[ ].

.Net Interface

```
void RemoveStream(string name);
```

C Interface

```
ViStatus Driver_OdiProducerRemoveStream(ViSession s, ViString name);
```

SCPI Interface

```
ODI:CONSumer:RSTReam <name>
```

Remarks

Implementation of this method is optional.

4.5.7 Odi.Consumers[Name].Name

Purpose

Returns name of the consumer. Useful if a Port object passed by reference in programming environments that allow this.

SCPI Interface

ODI:CONSumer[N]:NAME? -> "<string>"

4.5.8 Odi.Consumers[Name].GetCapability()

Purpose

Query capability of a consumer stream.

.Net Interface

```
OdiConsumerCapability GetCapability();

public sruct OdiConsumerCapability
{
    public string Name;
    public string Version;          // Version of the standard supported
    public OdiPacketFormat[]PacketFormats;  // all packet header formats supported
    public Vita49ClassId[] Vita49ClassIds; // all binary formats supported
    public Vita49ContextClassId[] ContextClassIds; // all context packets supported
    public OdiTimestampFormat[] TimestampFormats; // all timestamp formats supported
    public Boolean  HasLinkChannelFilter;  // true if can support linkChannelFilter
    public UInt32[] MaxPacketSize;  // maximum packet size in bytes

}
```

C Interface

```
ViStatus Driver_OdiConsumerGetCapability(ViSession s, ViString name,
      ViInt32 structVersion, OdiConsumerCapability *capability);

#define ODI_CONSUMER_CAPABILITY_VERSION 1
struct OdiConsumerCapability {
    ViChar       name[64];
    ViChar       version[64];
    OdiPacketFormat packetFormats[64]; // list of data formats supported.  0-
terminated
    Vita49ClassId classIds[64]; // list of VITA-49 formats supported. 0-terminated
    Vita49ContextClassId contextClassIds[64];// list of Context packets supported. 0-
terminated
    OdiTimestampFormat timestampFormats[64];// list of timestamps supported. 0-
terminated
    ViBoolean    hasLinkChannelFilter; // true if can support linkChannelFilter
    ViUInt32     maxPacketSize;  // maximum packet size in bytes
} ;
```

SCPI Interface

```
ODI:CONSumer[N]:CAPability:CLIDs? -> <list of integers values>, e.g. 1,4,6,8,9
ODI:CONSumer[N]:CAPability:LFILter? -> 0|1
ODI:CONSumer[N]:CAPability:NAME? -> "<string>"
ODI:CONSumer[N]:CAPability:PFORmats? <list of enum values>, e.g.
NHEader,IDATa,CONText,ONCE
ODI:CONSumer[N]:CAPability:VERSion? -> "<string>"
ODI:CONSumer[N]:CAPability:MAXPacket?
ODI:PRODucer[N]:CAPability:TIMestamp:TFORmats? -> <list of enum values>, e.g.
NOTimestamp,GPS,RELative,SAMPlecount,UTC
```

Remarks

This operation queries a capability of the data consumer stream.

The returned lists of PacketFormats and Vita49ClassIds does not imply all combinations are supported. Call IsFormatSupported() to determine support for a combination.

HasLinkChannelFilter indicates the data consumer has the capability to filter received packets based on Interlaken channel number.

4.5.9 Odi.Consumers[Name].IsFormatSupported(packetFormat, classId)

Purpose

Returns true if the combination of OdiPacketFormat and binary data format (ClassId) is supported.

.Net Interface

```
Boolean IsFormatSupported(OdiPacketFormatEnum PacketFormat,
      Vita49ClassIdEnum Vita49ClassId);
```

C Interface

```
ViStatus Driver_OdiConsumerIsFormatSupported(ViSession s,
      OdiPacketFormatEnum PacketFormat, Vita49ClassIdEnum Vita49ClassId,
      ViBoolean *supported);
```

SCPI Interface

```
ODI:CONSumer[N]:IFSupported? <packetFormat>, <classId> -> 0|1
```

4.5.10 Odi.Consumers[Name].Activate(linkChannel, packetFormat, classId, ...)

Purpose

Configure the data Consumer stream and activate it for use.

Parameters

Name	Direction	Type	Description
`linkChannel`	IN	`Int32`	Specifies filtering of packets by Interlaken channel. If set the stream accepts only packets with matching channel number. -1 to disable.
`packetFormat`	IN	`OdiPacketFormat enum`	Specifies expected format of received packets. Select No header, VITA-49 header, or other.
`classId`	IN	`Vita49ClassId enum`	Specifies expected binary data format of received packet payload, using VITA-49 Class Id as defined in VITA-49.2 and the ODI data format standard.

timestampFormat	IN	OdiTimestampFormat enum	Specifies expected format of the received timestamps in the VITA-49 prolog.
...	IN		Additional instrument-specific settings for properties such as packet length.

Exceptions/Errors

"Not Supported" if the stream does not support the specified settings.

"In Use" if the stream or resources are already in use.

.Net Interface

```
void Activate(Int32 linkChannel, OdiPacketFormat packetFormat, Vita49ClassId classId,
OdiTimestampFormat timestampFormat, ...);
```

C Interface

```
ViStatus Driver_OdiConsumerActivate(ViSession s, Int32 linkChannel,
      OdiPacketFormat packetFormat, Vita49ClassId classId,
      OdiTimestampFormat timestampFormat,  ...);
```

SCPI Interface

```
ODI:CONSumer[N]:ACTivate <linkChannel>, <packetFormat>, <classId>, ...
```

Remarks

Configures and activates the Consumer stream. On return the stream is ready to flow data, but in most case another instrument-specific method must be called to start the data destination so it accepts data.

Calling this method may result in reconfiguration of an FPGA in the instrument, which may take several seconds.

Although the ClassId of the expected binary data is specified as a parameter, ContextClassId is not a parameter because the consumer is expected to accept all of the context packet types it is capable of interpreting.

4.5.11 Odi.Consumers[Name].Deactivate()

Purpose

Deactivate the stream, stop any data flow, and free resources.

.Net Interface

```
void Deactivate();
```

C Interface

```
ViStatus Driver_OdiConsumerDeactivate(ViSession s, ViString name);
```

SCPI Interface

```
ODI:CONSumer[N]:DEACtivate
```