



Dynamic Exports Test Procedure

Remote Updating & Export Limitation Methods Guidelines

17/1/2023 – Consolidated

Contents

1. Document Control	3
1.1 Version	3
1.2 Abbreviations	3
1.3 Definitions	3
2. Introduction	4
2.1 Background.....	4
2.2 Scope.....	4
3. Testing process	5
3.1 Test environment	5
3.1.1 Communications Test Setup	5
3.1.2 Electrical Test Setup	6
3.2 Test Execution	6
3.3 Test Configuration.....	6
3.3.1 Requirements.....	6
3.3.2 Supported Functions	6
3.3.3 Defaults	7
3.3.4 Communications	8
4. Communications Software Client Test Procedure.....	10
4.1 Registration	10
4.1.1 Discovery	10
4.1.2 Site Registration	10
4.2 Monitoring	10
4.2.1 Readings	10
4.2.2 Batched Readings	11
4.2.3 Connect Status	11
4.2.4 Operational Mode Status.....	12
4.2.5 Capabilities/Settings.....	12
4.2.6 Update Post Rates	12
4.3 Control	13
4.3.1 Polled	13
4.3.1.1 Active Controls.....	13
4.3.1.1.1 Export Limit.....	13
4.3.1.1.2 Generation Limit.....	13
4.3.1.1.3 Energize/ De-energize	14
4.3.1.2 Default Controls	14
4.3.1.2.1 Export Limit.....	14
4.3.1.2.2 Ramp Rate.....	14
4.3.2 Subscription/Notification	15

4.3.2.1	Subscribe	15
4.3.2.2	Active Controls.....	15
4.3.2.2.1	Export Limit	15
4.3.2.2.2	Generation Limit.....	16
4.3.2.2.3	Energize	16
4.3.2.3	Default Controls	16
4.3.2.3.1	Export Limit	16
4.3.2.3.2	Ramp Rate.....	17
4.3.3	Control Responses.....	17
4.3.4	Poll Rates	18
4.3.5	Scheduling	18
4.3.6	Randomization	18
4.3.7	Communications Loss	19
4.4	Extended operations	19
5.	Export Limitation Test Procedure	21
5.1	Monitoring	21
5.1.1	Validate Measurements	21
5.2	Control	21
5.2.1	Export Limit Control	21
5.2.2	Load Following	22
5.2.3	Default Control Fallback	22
5.2.4	Ramp Rates	22
5.3	Grid Reconnection	23
6.	Multiple Inverter Support	24
6.1	Electrical Test Setup	24
6.2	In-Scope Tests	24

1. Document Control

1.1 Version

Version	Date	Author	Notes
0.1	31/05/2022	SA Power Networks	Initial Draft
0.2	16/06/2022	SA Power Networks	Draft for consultation
1.0	27/07/2022	SA Power Networks	Final
1.1	28/09/2022	SA Power Networks	Consolidated following feedback
1.2	17/01/2023	SA Power Networks	Refined ramp rate validation

1.2 Abbreviations

Document name	Document description
DER	Distributed Energy Resource
CSIP-AUS	<u>Common Smart Inverter Profile – Australia v1.1</u> This document is a companion document to the Common Smart Inverter Profile (CSIP) designed to outline minimal changes to support Australian use cases.
IEEE 2030.5:2018	The standard communication protocol used to communicate between Server and Client
PV	Photovoltaic
OEM	Original Equipment Manufacturer
TP	Technology Provider
XML	Extensible Markup Language
HTTPS	Hypertext Transfer Protocol Secure
UTF	Unicode Transformation Format
REST	Representational State Transfer

1.3 Definitions

Document name	Document description
Utility Server	Server entity as described in CSIP-AUS
2030.5 Client	Communications software client to receive commands and send measurements
Direct Client	Defined as Client in CSIP-AUS, where the 2030.5 client is hosted for the individual DER and connects directly to the Utility Server
Gateway	On site hardware providing communications and control functionality to DER on site acting as a Direct Client
Aggregator	Cloud system representing multiple downstream DER as defined in CSIP-AUS, acts as the Client for these DER
Site-Level Measurement	Net reading of all generation and load at the grid connection point

2. Introduction

2.1 Background

All new and upgraded exporting Electricity Generating Plant (EGP) installed from 1 December 2022 will need to be meet the new [SA Government Dynamic Exports Requirements](#) making them compatible with SA Power Networks Flexible Exports connection option. These requirements are specified in two technical regulator guidelines:

- Remote Update Methods Guideline
- Export Limiting Methods Guideline

This document has been produced to test and assess whether EGP are compatible with these new requirements in lieu of national CSIP-AUS certification.

The test procedure has been designed to focus on functional outcomes rather than protocol level details. To ensure protocol level interoperability, all testing will be performed against a reference test Utility Server provided by SA Power Networks. It is intended that Original Equipment Manufacturer (OEM) and Technology Provider (TP) development and integration activities are performed in regular communication with test server so integration issues can be rectified as development progresses.

2.2 Scope

This test document is designed to assess whether a given Electricity Generating Plant (EGP) is compliant with the SA Government Dynamic Exports requirements, and therefore compatible with SA Power Networks Flexible Exports connection option.

Testing is split into two to distinct test procedures which align to two technical regulator guidelines that make up the dynamic export requirements. The scope of the two guidelines and test procedures is shown in the diagram below.

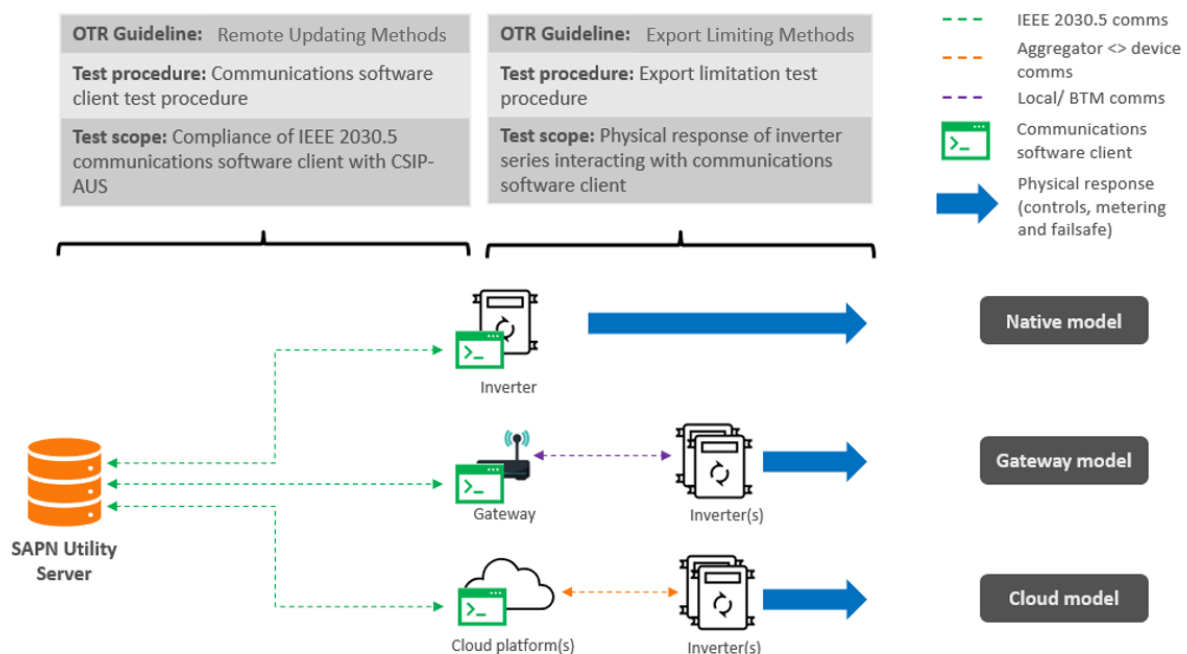


Figure 1 – Split of Guidelines and Testing

Separation of the communications software client testing allows for the testing of several inverter series underneath a single approved client where supported, to reduce testing of duplicate features. Only one inverter capacity needs to be tested to achieve certification of a whole series.

Note that some tests are only applicable to aggregator implementations and not required for software clients using the native and gateway models.

3. Testing process

3.1 Test environment

3.1.1 Communications Test Setup

SA Power Networks will make available a test server to support development, integration and execution of this test procedure. It will have a normal state operation for development purposes and will incorporate test cases for each of the tests contained in this procedure for self-service execution. An example of the test environment for testing a communications software client and compatible inverter series is shown below.

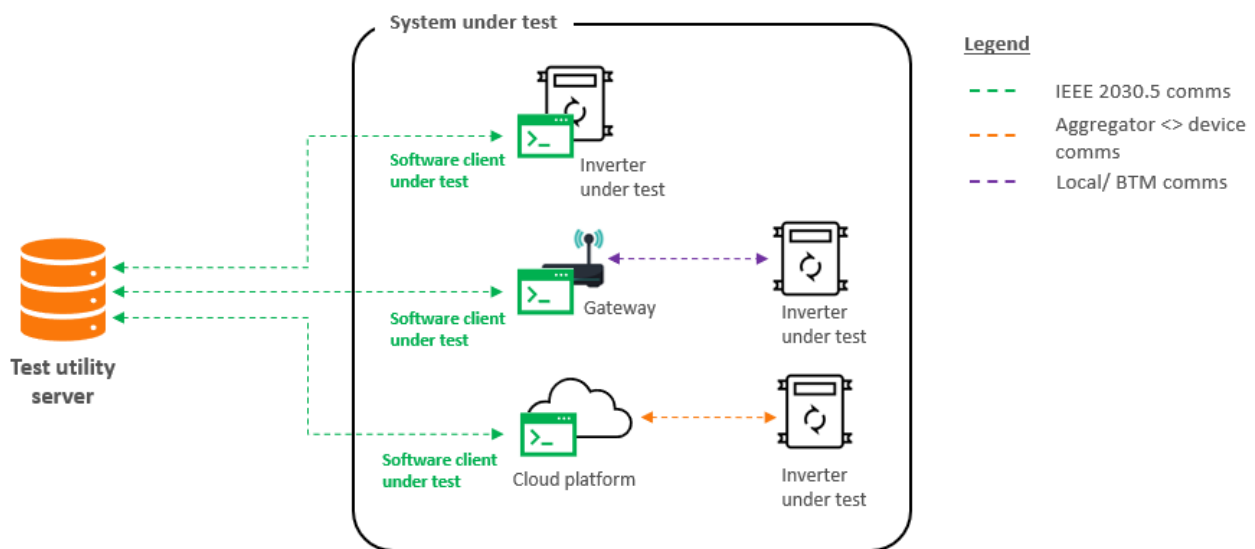


Figure 2 – Example Test Environment for Communications Software Client Test Procedure

For an OEM or TP who wishes to test additional inverter series against an already certified communications software client (e.g. aggregator or gateway client) will need to include the certified software client in the test setup as shown below. For execution of the test procedure, the gateway model is classified as a Direct Client, not an Aggregator.

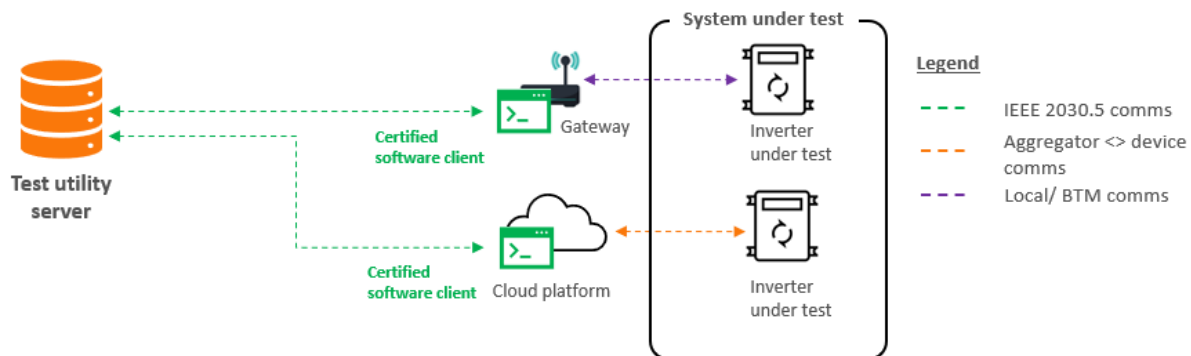
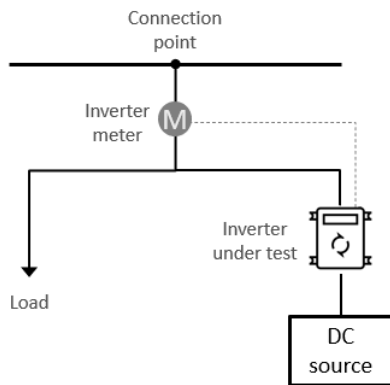


Figure 3 – Example Test Environment for Export Limitation Test Procedure

IEEE 2030.5 test certificates and test server access details will be provided on request to SA Power Networks.

3.1.2 Electrical Test Setup

Any execution of these test procedures will require an electrical test setup as shown in the diagram and table below:



Component	Additional requirement
Inverter	Configured to receive commands from a communications software client (native, gateway or cloud)
Inverter meter	Measures or enables calculation of net export
DC source	PV panels or DC Supply of at least 2kW DC during test execution. (Inverters less than 2kW in capacity will be handled individually)
Load	At least 500W of switchable load

Figure 4 – Example Electrical Test Setup

The party undertaking the test is responsible for ensuring such a test setup is available during test execution.

3.2 Test Execution

The test server will be always online to enable OEM and TP development, integration and testing.

Formal execution of the communications software client test procedure can be performed anytime against the test server by initiating the automated procedure through the provided user interface. The server will validate expected behaviors against responses and measurements received by the server. Successful completion of the test will create a record that will be reviewed by SA Power Networks before certification is granted.

Completion of the export limit test procedure for the inverter will require witnessing of specific tests by SA Power Networks to assess the physical device response meets stated functional outcomes.

SA Power Networks will provide more information on this process when an OEM or TP is onboarded for testing.

3.3 Test Configuration

3.3.1 Requirements

In addition to adherence to standard IEEE 2030.5 communications, the following requirements apply to all test procedures:

- Payloads are communicated in XML via HTTPS
 - XML version 1.0 with UTF-8 encoding
- Resources contain links to their subordinate resources
- Aggregator clients will need to support REST paging techniques to process lists from the Server that may be incomplete
- Resources use the standard IEEE 2030.5 namespace of: <http://ieee.org/2030.5>
 - CSIP-AUS extensions use namespace of: <http://csipaus.org/ns>

3.3.2 Supported Functions

To support Dynamic Exports, the below functions from CSIP-AUS and IEEE 2030.5:2018 are required to be supported in addition to any other common functionality required to support the following:

- DeviceCapability
- Time
- EndDevice
- FunctionSetAssignments
- DER
 - DERList
 - DERSettings
 - DERStatus
 - DERCapability
 - DERProgram
 - DERControlList
 - DefaultDERControl
 - Randomisation
 - Scheduling
- Response
 - DERControlResponse
- Metering Mirror
 - MirrorUsagePoint
 - MirrorMeterReadingList
 - MirrorMeterReading
 - MirrorReadingSet
 - Reading
- Subscription/Notification
- ConnectionPoint Extension

3.3.3 Defaults

Upon initial discovery, the Utility Server will configure the following poll and post rates for resources:

Please note these values are for testing purposes and do not reflect steady state operations.

Resource	Type	Value (secs)
DeviceCapability	Poll	300
EndDeviceList	Poll	300
FunctionSetAssignmentsList	Poll	300
DERProgramList	Poll	60
DERList <ul style="list-style-type: none"> • DERStatus • DERSettings • DERCapability 	Poll	60
MirrorUsagePoint	Post	60

3.3.4 Communications

The below diagrams highlight the core client-initiated interactions that support the above functions, using a polled client as an example. XML payload examples can be found in the resource files of the [IEEE 2030.5 Model download](#). Examples for CSIP-AUS extensions are found in CSIP-AUS.

Figure 5 shows core client-initiated interactions to support the discovery process.

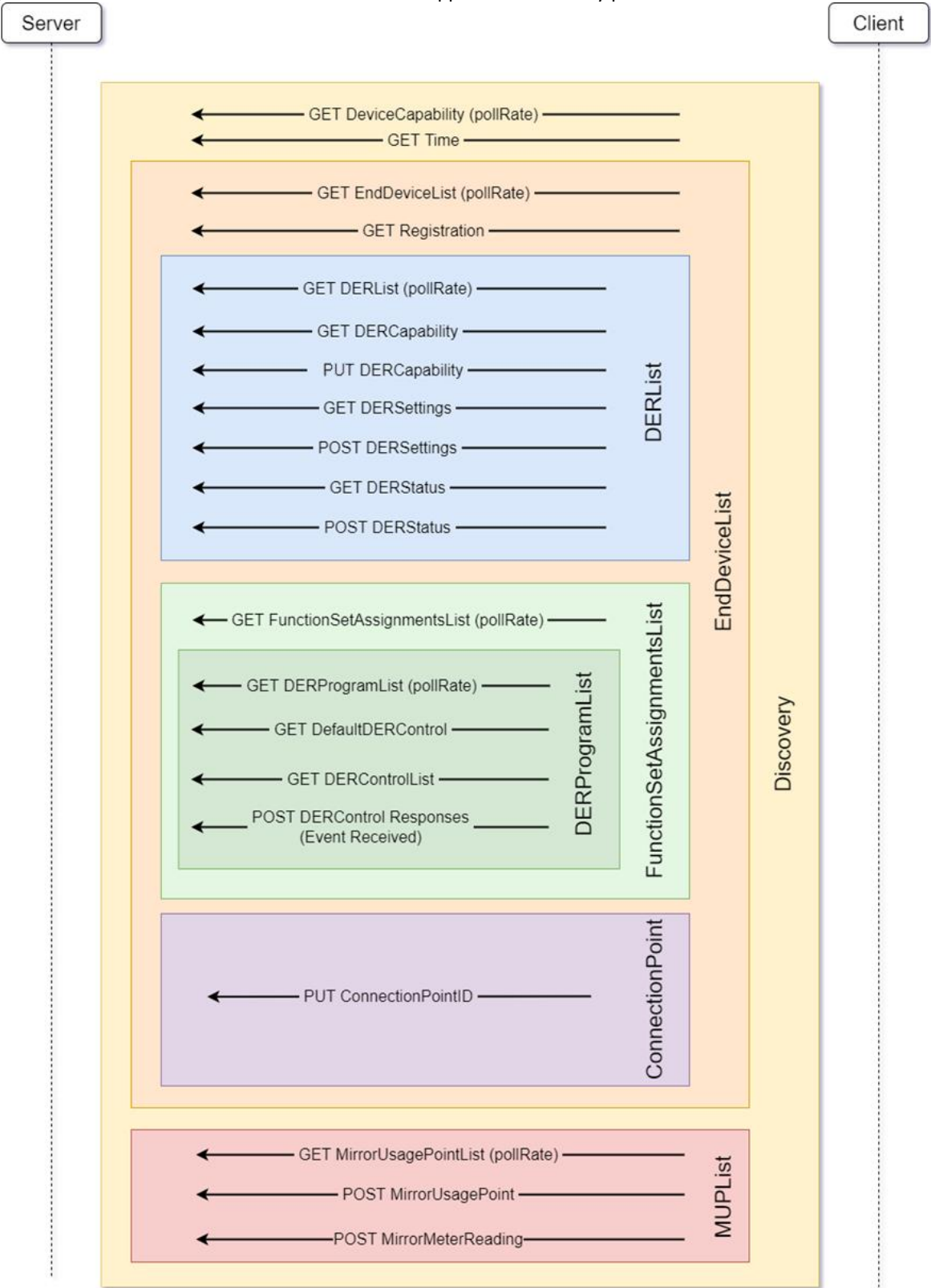


Figure 5 – Client Interactions (Discovery)

Figure 6 show core client-initiated interactions to support the ongoing operations.

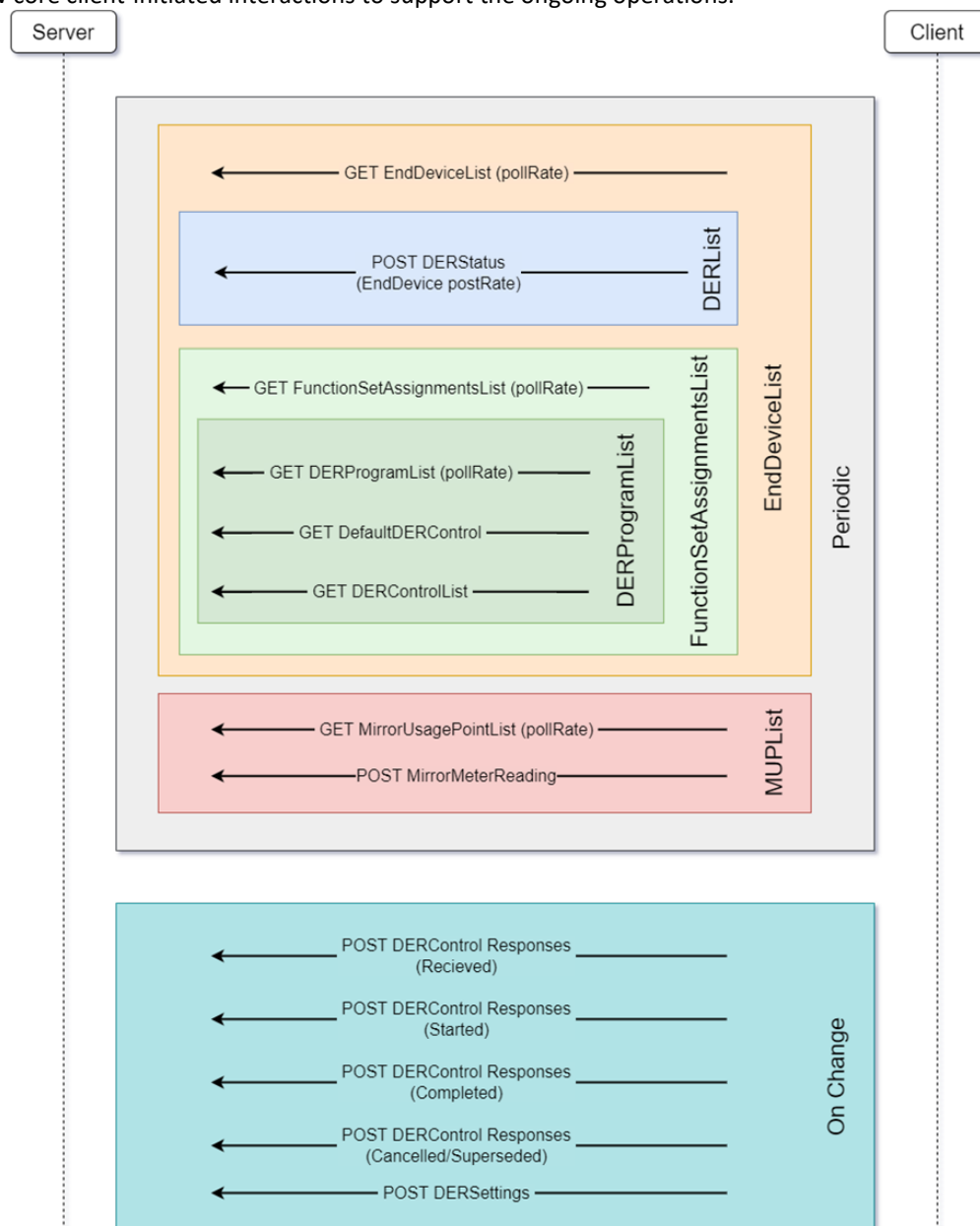


Figure 6 – Client Interactions (Ongoing)

4. Communications Software Client Test Procedure

4.1 Registration

4.1.1 Discovery

Purpose

Test the Client's ability to perform DER discovery and time synchronisation with the Server.

Procedure

Step(s)	Result(s)
Client performs discovery against published Server information	Client receives relevant function set resource links
Client receives new resource links and requests resource information from DeviceCapability endpoint	Client receives resource information from Server
Client requests the EndDevice resource from the Server	Server responds with EndDevice contents
After discovery of DeviceCapability the Client requests Time resource	Server validates Client time is synced through validating timestamps of ongoing control responses

Failures

- Client is unable to access Server at published address
- Client is unable to access function set links
- Client is unable to sync time to Server

4.1.2 Site Registration

Purpose

Test the Client's ability to register the ConnectionPoint (NMI) of the site to the Server.

Procedure

Step(s)	Result(s)
Server exposes ConnectionPointLink to Client during discovery	Client discovers ConnectionPoint resource
Client sends ConnectionPointID to the ConnectionPoint resource on the Server*	Server confirms that the ConnectionPointID is valid

*SA Power Networks will provide guidance on valid ConnectionPointIDs at testing onboard

Failures

- Client is unable to discover ConnectionPoint resource
- Client provides an invalid ConnectionPoint ID (NMI)

4.2 Monitoring

4.2.1 Readings

Purpose

Test the Client's ability to post averages of the following readings using the MirrorMeterReadings:

- Site Real Power
- Site Reactive Power
- DER Real Power

- DER Reactive Power
- Site/DER Voltage

Procedure

Step(s)	Result(s)
Client posts readings to Server at the MirrorUsagePoint postRate	Server receives readings
Another set of readings are posted to the Server	Server receives readings

Failures

- Client is unable to post any of the readings

4.2.2 Batched Readings

Purpose

This test is optional and only required if an aggregator client wishes to optimise ongoing provision of measurements using 'batching' of MirrorMeterReadings.

Test the Client's ability to post averages of the following readings to a MirrorMeterReadingList using the MirrorReadingSets:

- Site Real Power
- Site Reactive Power
- DER Real Power
- DER Reactive Power
- Site/DER Voltage

Procedure

Step(s)	Result(s)
Server changes MirrorUsagePoint postRate to 3600 seconds	Client receives new MirrorUsagePoint postRate
Client posts MirrorMeterReadingList to Server at the MirrorUsagePoint postRate	Server receives MirrorMeterReadingList containing 12 readings from each reading type with 300 seconds granularity

Failures

- Client is unable to post any of the readings to a MirrorMeterReadingList using MirrorReadingSets

4.2.3 Connect Status

Purpose

Test the Client's ability to post ConnectStatusType to the Server

Precondition

Client is online and inverter is in connected state

Procedure

Step(s)	Result(s)
Inverter AC is physically disconnected	Client posts genConnectStatus = 0 to the Server on change
Inverter AC is physically reconnected	Client posts genConnectStatus = 7 to the Server on change

Failures

- Client is unable to post status reading upon disconnection

- Client is unable to post status reading upon reconnection

4.2.4 Operational Mode Status

Purpose

Test the Client's ability to post OperationalModeStatusType to the Server

Precondition

Client is online and inverter is in connected state

Procedure

Step(s)	Result(s)
Inverter stops generating	Client posts OperationalModeStatus = 1 to the Server on change
Inverter resumes generating	Client posts OperationalModeStatus = 2 to the Server on change

Failures

- Client is unable to post status readings

4.2.5 Capabilities/Settings

Purpose

Test the Client's ability to post inverter(s) ratings and settings. Where more than one inverter is present, their values are to be aggregated.

Procedure

Step(s)	Result(s)
Client provides device capabilities and settings periodically to the Server	Server receives device capabilities and settings

Failures

- Client is unable to post capabilities or settings

4.2.6 Update Post Rates

Purpose

Change postRate of Metering Mirror function set

Procedure

Step(s)	Result(s)
Server updates post rate value from default of 60s to 300s	Direct Client: Upon next poll of the MirrorUsagePointList the Client updates its new postRate Aggregator Client: On change, the Client receives its new postRate
Next mirror meter reading is posted to Server after 300s	Server receives mirror meter reading
Server updates post rate value to 60s	Direct Client: Upon next poll of the MirrorUsagePointList the Client updates its new postRate Aggregator Client: On change, the Client receives its new postRate

Next mirror meter reading is posted to the Server after 60s	Server receives mirror meter reading
---	--------------------------------------

Failures

- Client is unable to update post rates

4.3 Control

4.3.1 Polled

Aggregator clients implementing Subscription/Notification must still complete this section of the test procedure as polling is required as a fallback method of control. This section also includes tests for other ancillary control functions such as control responses.

4.3.1.1 Active Controls

4.3.1.1.1 Export Limit

Purpose

Client can receive and respond to Active Controls using OpModExpLimW

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Procedure

Step(s)	Result(s)
Server configures Active Control with OpModExpLimW = 0W	Upon next poll of the EndDevice the Client receives the Active Control
Client starts the Active Control	Server validates export measurements are reported as 0W (+/- 4%)

Failures

- Client is unable to reduce exports in response to OpModExpLimW control

4.3.1.1.2 Generation Limit

Purpose

Client can receive and respond to Active Controls using OpModGenLimW

Precondition

Client must be generating at least 2000W

Procedure

Step(s)	Result(s)
Server configures Active Control with OpModGenLimW = 0W	Upon next poll of the DERProgramList the Client receives the Active Control
Client starts the Active Control	Server validates generation measurement is reduced to 0W (+/- 4%)

Failures

- Client is unable to reduce generation in response to OpModGenLimW control

4.3.1.1.3 Energize/ De-energize

Purpose

Client can receive and respond to Active Controls using opModEnergize

Precondition

Client must have opModEnergize set to true

Procedure

Step(s)	Result(s)
Server configures Active Control with opModEnergize = false	Upon next poll of the DERProgramList the Client receives the Active Control
Client starts the Active Control	Server validates DER is de-energized with DERStatus and generation measurement is reduced to 0W (+/- 4%)
Server configures Active Control without opModEnergize = false	Upon next poll of the DERProgramList the Client receives the Active Control
Client starts the Active Control	Server validates DER is re-energized with DERStatus

Failures

- Client is unable to de-energize DER

4.3.1.2 Default Controls

4.3.1.2.1 Export Limit

Purpose

Client can receive and adhere to DefaultDERControls

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Procedure

Step(s)	Result(s)
Server configures DefaultDERControl with OpModExpLimW = 0W	Upon next poll of the DERProgramList the Client receives the new DefaultDERControl
Server cancels all Active Controls	Upon next poll of the DERProgramList the Client receives cancellation instruction
Client cancels all Active Controls	Server validates that the Client falls back to DefaultDERControl with export limit measurement of 0W (+/- 4%)

Failures

- Client is unable to fall back and adhere to DefaultDERControl

4.3.1.2.2 Ramp Rate

Purpose

Client can receive updates to the setGradW value

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Server has current DefaultDERControl with setGradW = 0.27% per second

Procedure

Step(s)	Result(s)
Server configures DefaultDERControl with setGradW = 1% per second	Upon next poll of the DERProgramList the Client receives the new DefaultDERControl
Client configures setGradW	Server confirms update to setGradW in DERSettings

Failures

- Client is unable to receive update to setGradW value

4.3.2 Subscription/Notification

This section only applies to Aggregator clients wishing to support Subscription/Notification. Subscription/Notification is not supported for Direct clients. Direct clients can skip to section 4.3.3

4.3.2.1 Subscribe**Purpose**

Client can subscribe to updates to:

- EndDeviceList
- DERControlList
- DefaultDERControl

Procedure

Step(s)	Result(s)
Client subscribes to Server resource	Client is subscribed to Server
Client provides resource to the Server for notifications	Server receives notification resource

Failures

- Client is unable to subscribe to the Server

4.3.2.2 Active Controls**4.3.2.2.1 Export Limit****Purpose**

Client can receive and respond to Active Controls using OpModExpLimW

Precondition

Client must be generating at least 2000W

Procedure

Step(s)	Result(s)
Server notifies of new Active Control with OpModExpLimW = 0W	Client receives the Active Control
Client starts the Active Control	Server validates exports measurements are reduced to 0W (+/- 4%)

Failures

- Client is unable to reduce exports in response to OpModExpLimW control

4.3.2.2.2 Generation Limit**Purpose**

Client can receive and respond to Active Controls using OpModGenLimW

Precondition

Client must be generating at least 2000W

Procedure

Step(s)	Result(s)
Server notifies of new Active Control with OpModGenLimW = 0W	Client receives the Active Control
Client starts the Active Control	Server validates generation measurements are reduced to 0W (+/- 4%)

Failures

- Client is unable to reduce generation in response to OpModGenLimW control

4.3.2.2.3 Energize**Purpose**

Client can receive and respond to Active Controls using OpModEnergize

Precondition

Client must have OpModEnergize set to true

Procedure

Step(s)	Result(s)
Server notifies of new Active Control with OpModEnergize = false	Client receives the Active Control
Client starts the Active Control	Server validates DER is de-energized with DERStatus
Server notifies of new Active Control with OpModEnergize = true	Client receives the Active Control
Client starts the Active Control	Server validates DER is energized with DERStatus

Failures

- Client is unable to de-energize or re-energize DER

4.3.2.3 Default Controls**4.3.2.3.1 Export Limit****Purpose**

Client can receive and adhere to DefaultDERControls

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Procedure

Step(s)	Result(s)
Server notifies of new DefaultDERControl with opModExpLimW = 0W	Client receives the new DefaultDERControl
Server notifies of cancellation to all Active Controls	Client receives cancellation instruction
Client cancels all Active Controls	Client falls back to DefaultDERControl with export limit of 0W

Failures

- Client is unable to fall back and adhere to DefaultDERControl

4.3.2.3.2 Ramp Rate**Purpose**

Client can receive updates to the setGradW value

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Server has current DefaultDERControl with setGradW = 0.27% per second

Procedure

Step(s)	Result(s)
Server notifies of new DefaultDERControl with setGradW = 1% per second	Client receives the new DefaultDERControl
Client configures setGradW	Server confirms update to setGradW in DERSettings

Failures

- Client is unable to receive update to setGradW value

4.3.3 Control Responses**Purpose**

Client can provide control responses for control events:

- Received
- Started
- Completed
- Cancelled
- Superseded

Procedure

Step(s)	Result(s)
Server configures Active Control with OpModExpLimW = 10000W	Upon next poll of the DERProgramList the Client receives the Active Control
Client receives the Active Control	Client posts back control response = 1 (received)
Client starts the Active Control	Client posts back control response = 2 (started)
Client completed the Active Control	Client posts back control response = 3 (completed)
After completion (control response = 3) of the previous Active Control and after the Client has started (control response = 2) the next Active Control, it is cancelled by the Server	Upon next poll of the DERProgramList the Client receives the cancellation
Client receives cancellation	Client posts back control response = 6 (cancelled)

After the client has started the next Active Control, a new control with an overlapping control window is sent	Upon next poll of the DERProgramList the Client receives the new Active Control
Client begins new control	Client posts back control response = 7 (superseded)

Failures

- Client is unable to provide control responses

4.3.4 Poll Rates**Purpose**

Change pollRate of FunctionSetAssignmentsList

Procedure

Step(s)	Result(s)
Server updates pollRate value from default of 300s to 60s	Upon next poll of the FunctionSetAssignmentsList the Client updates its new pollRate
Next FunctionSetAssignmentsList poll is made to Server after 60s	Server receives poll from Client after 60s

Failures

- Client is unable to update poll rates

4.3.5 Scheduling**Purpose**

Test Clients ability to receive a schedule of controls

Procedure

Step(s)	Result(s)
Server generates a schedule of 24 sequential controls	Client receives schedule of controls by notification or by polling
Client provides control responses for schedule of controls	Server receives corresponding control responses (1 = received) for each control
Client progresses through schedule of controls	Server validates each control in the schedule is started at correct time using control responses (2 = started)

Failures

- Client is unable receive and respond to a schedule of controls

4.3.6 Randomization**Purpose**

Client can support randomization using the randomizeStart attribute

Procedure

Step(s)	Result(s)
Server configures a schedule of 5 active controls each with: <ul style="list-style-type: none"> duration = 120s randomizeStart = 60s 	Client receives schedule of controls

• opModExpLimW = 10000W	
Client executes entire control schedule	Server validates randomness of start times through control responses

Failures

- Client is unable to start controls in a random manner

4.3.7 Communications Loss

Purpose

Inverter(s) can ramp to a DefaultDERControl when communications are lost with the Utility Server

Precondition

Client must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Procedure

Step(s)	Result(s)
Server configures DefaultDERControl with OpModExpLimW of 0W	Client receives the new DefaultDERControl
Communications between Server and Client are lost	Client completes current schedule of controls
Upon completion of Active Control schedule, Inverter(s) begins ramping down to DefaultDERControl	Inverter(s) are operating at zero export
Communications between Server and Client are re-established 1 minute after the expiry of the current schedule. Active control is issued with OpModExpLimW = 10000W	Client receives and ramps to new Active Control using setGradW (0.27% per second)

Failures

- Inverter(s) ramp down immediately on loss of communications
- Inverter(s) continue to export at a higher level than the DefaultDERControl after the Active Control schedule expires with
- Inverter(s) generation ramps up immediately on restoration of communications

4.4 Extended operations

Purpose

Confirm that clients can maintain compliant communications and operations over an extended period

Precondition

Clients that cannot be configured to be always online due to reliance on generation (sunlight) will not need to maintain communications outside of daylight hours

Procedure

Step(s)	Result(s)
Client maintains connection and communications to the Server for 3 consecutive days (72 hours)	Server maintains log of communications for this period
Communications during this time are validated offline by SA Power Networks	Validity of results are confirmed during certification

Failures

- Communications are not maintained throughout the specified period

5. Export Limitation Test Procedure

This section defines tests for an inverter behind a communications software client to test the intended functional behaviours and physical responses in response to commands from the communications software client.

5.1 Monitoring

5.1.1 Validate Measurements

Purpose

Inverter(s) measurements are correctly being communicated to the Server

Procedure

Step(s)	Result(s)
Client periodically posts measurements to the Server	Client readings align with Inverter(s) readings Tester provides evidence that measurements provided to the server are +/- 10% of measurements taken by independent means (vendor portal, inverter panel or independent measurement device)

Failures

- Inverter(s) readings are not aligned with Client communications to the Server

5.2 Control

5.2.1 Export Limit Control

Purpose

Inverter(s) can follow export limit that is provided from the Client

Precondition

Inverter(s) must be generating at least 2000W

Procedure

Step(s)	Result(s)
Client receives and begins an Active Control opModExpLimW = 10000W	Exports are below the limit within 15s soft limit (AS4777.2:2020 Section 6.2.2)
Inverter(s) keep exports below the limit for 2 minutes	Inverter(s) are operating at export limit (+/- 4%)
Repeat above steps with descending Export Limit values of: <ul style="list-style-type: none"> 7500W 5000W 1500W 500W 0W 	Inverter(s) continue to follow export limit values (+/- 4%) Tester provides evidence that inverter response is +/- 4% shown by independent measurement source (vendor portal, inverter panel or independent measurement device)

Failures

- Inverter(s) are unable to comply with export limit within the 15s timeframe once the control is received
- Inverter(s) are unable to maintain export limit for entire 5 minutes

5.2.2 Load Following

Purpose

Inverter(s) can adjust generation to compensate for load whilst adhering to export limit

Precondition

Inverter(s) must be generating at least 2000W;

Load is 0W

Procedure

Step(s)	Result(s)
Client receives and begins an Active Control opModExpLimW = 1000W	Exports are below the limit within 15s soft limit (AS4777.2:2020 Section 6.2.2)
Load is increased to at least 500W	Inverter increase generation to service loads and stay beneath export limit
Load is decreased to 0W	Inverter decreases generation to keep below the limit within 15s soft limit (AS4777.2:2020 Section 6.2.2) Tester provides evidence that inverter response is within +/- 4% shown by independent measurement source (vendor portal, inverter panel or independent measurement device)

Failures

- Inverter(s) are unable to adjust generation to changes in load

5.2.3 Default Control Fallback

Purpose

Inverter(s) can fallback to DefaultDERControl in the absence of DERControl

Precondition

Inverter(s) must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Server has current DefaultDERControl with OpModExpLimW of 1500W

Procedure

Step(s)	Result(s)
Server cancels all Active Controls	Client receives cancellation instruction
Client cancels all Active Controls	Inverter(s) fall back to DefaultDERControl with export limit of 1500W (+/- 4%) Tester provides evidence that inverter response is within +/- 4% shown by independent measurement source (vendor portal, inverter panel or independent measurement device)

Failures

- Client is unable to fall back to DefaultDERControl in the absence of DERControl

5.2.4 Ramp Rates

Purpose

Inverter(s) can adhere to the ramp rate from setGradW

Precondition

Inverter(s) must be generating at least 2000W;

Server has current Active Controls operating at OpModExpLimW of 10000W

Procedure

Step(s)	Result(s)
Server configures DefaultDERControl with setGradW = 0.27% per second and OpModExpLimW of 0W	Inverter(s) receive the new DefaultDERControl
Server cancels all Active Controls	Client receives cancellation instruction
Client cancels all Active Controls	<p>Inverter(s) fall back to DefaultDERControl with export limit of 0W (+/- 4%) at a rate of 0.27% per second (defined as %setWMax/second)</p> <p>Tester provides evidence that inverter response is within +/- 4% shown by independent measurement source (vendor portal, inverter panel or independent measurement device)</p>

Failures

- Client is unable to fall back and adhere to rate of change specified by setGradW

5.3 Grid Reconnection

Purpose

Inverter(s) can persist DefaultDERControl through restart and ramp to DefaultDERControl upon reconnection to the grid

Precondition

Inverter(s) must be generating at least 2000W;

Inverter(s) must be disconnected to begin;

No Active Controls present from the Server

DefaultDERControl set to opModExpLimW = 1500W and setGradW = **0.27% per second**

Procedure

Step(s)	Result(s)
Inverter(s) reconnect and begin ramping to the DefaultDERControl of OpModExpLimW = 1500W	Client starts ramping using setGradW (0.27% per second)
Inverter(s) complete ramping to DefaultDERControl	Server validates Client is operating at OpModExpLimW = 1500W (+/- 4%)

Failures

- Inverter(s) ramp to unconstrained generation

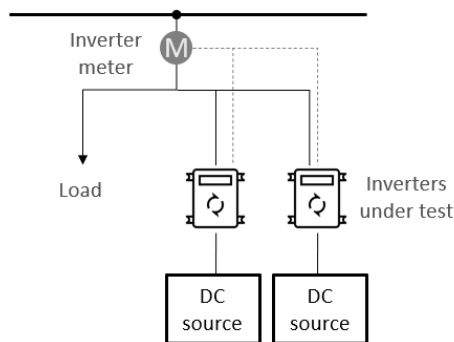
6. Multiple Inverter Support

This section outlines optional tests for communications software clients that intend to manage multiple downstream inverters. A subset of the test procedure must be repeated with a multiple inverter test setup to validate a communication software client's capability to support multiple downstream devices. Multiple inverter support will be flagged against the communication software client CEC listing.

Compliance to these tests will be validated during a witnessing for the Export Limitation Test Procedure.

6.1 Electrical Test Setup

Multiple inverter support tests will require an electrical test setup as shown in the diagram and table below:



Component	Additional requirement
Inverters (minimum 2)	Configured to receive commands from a communications software client (native, gateway or cloud). Both inverters to be below the same common metering point
Inverter meter	Measures or enables calculation of net export
DC source	PV panels or DC Supply of at least 2kW DC per inverter during test execution
Load	At least 500W of switchable load

Figure 7 – Example Electrical Test Setup for Multiple Inverter Support

The party undertaking the test is responsible for ensuring such a test setup is available during test execution.

6.2 In-Scope Tests

The following tests must be repeated with multiple inverters present to achieve certification for multiple inverter support.

- 5.1 Monitoring
 - 5.1.1 Validate Measurements
- 5.2 Control
 - 5.2.1 Export Limit Control
 - 5.2.2 Load Following
 - 5.2.3 Default Control Fallback
 - 5.2.4 Ramp Rates