# naqslab\_devices

Release 0.2.7

dihm

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### **CHAPTER**

# ONE

# **INSTALLATION**

Prerequiste: labscript\_devices >= 2.2.0

Clone this repository into the labscript\_suite directory. Typically into userlib or the main directory level.

Next, modify your labconfig.ini file to recognize the module by adding the following entry to the <code>[DEFAULT]</code> block:

user\_devices = naqslab\_devices

If more than one module of 3rd party devices are used, put all module names as a comma separated list.

# **CHAPTER**

# **TWO**

# **USAGE**

Invoke in labscript scripts just like other labscript devices:

```
from naqslab_devices import ScopeChannel
from naqslab_devices.KeysightXSeries.labscript_device import KeysightXScope
```

Details for how to use each device are contained in the *detailed documentation* listings.

6 Chapter 2. Usage

### **DEVICES**

Directory of all device classes in this repository.

The labscript primitive subclasses are derivatives of the labscript-provided children classes used by devices in this repository.

There are two parent classes that are not directly used, but rather provide templates for creating new devices. First is the *VISA* class that templates communication with devices through the VISA communication protocol. This uses the PyVISA python wrapper. The second is the *SignalGenerator* class that uses the *VISA* class to template CW frequency generators.

There are two thin subclasses of the labscript\_devices.PulseBlaster\_No\_DDS class: *PulseBlasterESRPro300* and *PulseBlaster\_No\_DDS\_200*. They exist simply to enforce the correct core clock frequency and clock limits without any other change in functionality from the parent.

Other device classes control particular series of devices and implement functional control of their hardward to varying degrees. In general, the design philosophy is that if the device class does not set an option, it will not be interfered with when using the device class to control the instrument. This means that custom settings and configurations of each device can be used by setting them manually at the device front panel without the device class interfering.

# 3.1 labscript Primitive Subclasses

#### 3.1.1 Overview

These are subclasses of labscript primitive objects for specific use with the devices in this module.

StaticFreqAmp is used by the NovaTechDDS devices. ScopeChannel is used by the KeysightXSeries and TektronixTDS oscilloscope classes. CounterScopeChannel is used exclusively by the KeysightXSeries oscilloscopes.

StaticFreqAmp	This instatiates a static frequency output channel.
ScopeChannel	This instantiates a scope channel to acquire during a
	buffered shot.
CounterScopeChannel	This instantiates a counter scope channel to acquire
	during a buffered shot.

### 3.1.2 Detailed Documentation

class naqslab\_devices.ScopeChannel (name, parent\_device, connection)

 $Bases: \verb|labscript.labscript.AnalogIn| \\$ 

This instantiates a scope channel to acquire during a buffered shot.

#### **Parameters**

• name (str) – Name to assign channel

- parent\_device (ob j) Handle to parent device
- **connection** (*str*) Which physical scope channel is acquiring. Generally of the form 'Channel n' where n is the channel label.

```
description = 'Scope Acquisition Channel Class'
acquire()
     Inform BLACS to save data from this channel.
     Note that the parent device controls when the acquisition trigger is sent.
add device(device)
allowed_children = None
generate_code (hdf5_file)
get_all_children()
get_all_outputs()
get_properties (location=None)
    Get all properties in location
    If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init device group(hdf5 file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
     Add one or a bunch of properties packed into properties_dict
    property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
         to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
```

property t0

The earliest time output can be commanded from this device at the start of the experiment. This is

```
class naqslab_devices.CounterScopeChannel (name, parent_device, connection)
    Bases: naqslab_devices.ScopeChannel
```

This instantiates a counter scope channel to acquire during a buffered shot.

nonzeo on secondary pseudoclock devices due to triggering delays.

#### **Parameters**

- name (str) Name to assign channel
- parent\_device (obj) Handle to parent device
- **connection** (*str*) Which physical scope channel is acquiring. Generally of the form 'Channel n' where n is the channel label.

```
description = 'Scope Acquisition Channel Class with Pulse Counting' count (typ,pol)
```

Register a pulse counter operation for this channel.

#### **Parameters**

- typ (str) count 'pulse' or 'edge'
- pol (str) reference to 'pos' or 'neg' edges

```
acquire()
     Inform BLACS to save data from this channel.
     Note that the parent_device controls when the acquisition trigger is sent.
add device(device)
allowed children = None
generate code (hdf5 file)
get_all_children()
get_all_outputs()
get_properties (location=None)
     Get all properties in location
     If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock(times)
set_properties (properties_dict, property_names, overwrite=False)
     Add one or a bunch of properties packed into properties_dict
     property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
         to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
     nonzeo on secondary pseudoclock devices due to triggering delays.
```

The earliest time output can be commanded from this device at the start of the experiment. This is

```
class naqslab_devices.StaticFreqAmp (name, parent_device, connection, freq_limits=None,
                                           freq_conv_class=None,
                                                                   freq_conv_params={},
                                           amp_limits=None,
                                                                   amp_conv_class=None,
                                            amp_conv_params={})
     Bases: labscript.labscript.StaticDDS
```

This instatiates a static frequency output channel.

Frequency and amplitude limits set here will supercede those dictated by the device class, but only when compiling a shot with runmanager. Static update limits are enforced by the BLACS Tab for the parent device.

#### **Parameters**

- name (str) Name to assign output channel
- parent\_device (ob j) Handle to parent device
- **connection** (str) Which physical channel to use on parent device. Typically only 'Channel 0' is available.
- freq\_limits (tuple) Set (min,max) output frequencies in BLACS front panel units.
- freq\_conv\_class (ob j) Custom conversion class to use
- **freq\_conv\_params** (dict) Parameters to conversion class
- amp\_limits (tuple) Set (min,max) output amplitude in BLACS front panel units.
- amp\_conv\_class (ob j) Custom convsersion class to use

```
• amp_conv_params (dict) - Parameters to conversion class
description = 'Frequency Source class for Signal Generators'
allowed_children = [<class 'labscript.labscript.StaticAnalogQuantity'>]
setphase (value, units=None)
    Overridden from StaticDDS so as not to provide phase control, which is generally not supported by
     SignalGenerator devices.
enable()
    overridden from StaticDDS so as not to provide time resolution - output can be enabled or disabled
    only at the start of the shot
disable()
    overridden from StaticDDS so as not to provide time resolution - output can be enabled or disabled
    only at the start of the shot
add_device (device)
generate_code (hdf5_file)
get_all_children()
get_all_outputs()
get_properties (location=None)
    Get all properties in location
    If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
    Add one or a bunch of properties packed into properties_dict
    property_names is a dictionary {key:val, ...} where each val is a list [var1, var2, ...] of variables
        to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
setamp (value, units=None)
setfreq(value, units=None)
property t0
    The earliest time output can be commanded from this device at the start of the experiment. This is
```

### **3.2 VISA**

#### 3.2.1 Overview

This parent class establishes the standard communication protocol for all devices that use the VISA communication library. It relies on the PyVISA python wrapper.

nonzeo on secondary pseudoclock devices due to triggering delays.

naqslab_devices.VISA.blacs_tab	Boiler plate blacs_tab for VISA instruments.
naqslab_devices.VISA.blacs_worker	Boiler plate BLACS_worker for VISA instruments.
	Continued on post page

Continued on next page

Table 2 – continued from previous page

	· · · · · · · · · · · · · · · · · · ·
naqslab_devices.VISA.	Boiler plate labscript_device for VISA instruments.
labscript_device	
naqslab_devices.VISA.	Sets which BLACS_tab belongs to each labscript de-
register_classes	vice.

### 3.2.2 Detailed Documentation of naqslab\_devices.VISA

#### VISA.blacs\_tab

Boiler plate blacs\_tab for VISA instruments.

connect\_restart\_receiver (function)

continue\_restart(currentpage)

Defines the common STBstatus.ui widget all devices use to report their current status.

```
class naqslab_devices.VISA.blacs_tab.VISATab(*args, **kwargs)
    Bases: blacs.device_base_class.DeviceTab
```

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
status_byte_labels = {'bit 0': 'bit 0 label', 'bit 1': 'bit 1 label', 'bit 2': 'l
status_widget = 'STBstatus.ui'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
status_monitor(*args, **kwargs)
send_clear(*args, **kwargs)
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check time()
clean_ui_on_restart()
close_tab (finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
    minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
    to perform these potentially blocking operations
```

Calls subsequent GUI operations in the main thread once finished blocking.

create\_analog\_outputs (analog\_properties)

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.

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```
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a fully qualified import path to a worker. The latter is useful if the worker class is in a separate file with global imports or other import-time behaviour that is undesirable to have run in the main process, for example if the imports may not be available to the main process (as may be the case once remote worker processes are implemented and the worker may be on a separate computer). The worker process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide error()
initialise workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
```

```
queue_work (worker_process, worker_function, *args, **kwargs)
     restart (*args)
     restore_builtin_save_data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
     restore_save_data(data)
     set tab icon and colour()
          Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set terminal visible (visible)
     shutdown_workers(*args, **kwargs)
     start_run (*args, **kwargs)
     property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
     statemachine_timeout_remove(statefunction)
     statemachine_timeout_remove_all()
     supports_remote_value_check (support)
     supports_smart_programming(support)
     transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
VISA.blacs worker
Boiler plate BLACS_worker for VISA instruments.
Inheritors use the same communication protocol, but override the command syntax.
class naqslab_devices.VISA.blacs_worker.VISAWorker(*args, **kwargs)
     Bases: blacs.tab_base_classes.Worker
     init()
         Initializes basic worker and opens VISA connection to device.
         Default connection timeout is 2 seconds
     check_remote_values()
     convert_register(register)
          Converts returned register value to dict of bools
              Parameters register (int) – Status register value returned from read_stb
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     check_status()
          Reads the Status Byte Register of the VISA device.
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     program_manual (front_panel_values)
          Over-ride this method if remote programming is supported.
```

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```
Returns VISAWorker.check_remote_values()
```

clear(value)

Sends standard \*CLR to clear registers of device.

**Parameters value** (bool) – value of Clear button in STBstatus.ui widget

#### transition\_to\_buffered(device\_name, h5file, initial\_values, fresh)

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- h5file (str) path to shot h5\_file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

#### abort\_transition\_to\_buffered()

Special abort shot configuration code belongs here.

#### abort\_buffered()

Special abort shot code belongs here.

#### transition\_to\_manual (abort=False)

Simple transition\_to\_manual method where no data is saved.

#### shutdown()

Closes VISA connection to device.

#### interrupt\_startup(reason='Process.interrupt\_startup() called')

Called from the parent process. Interrupt all blocking operations on starting the child process, causing Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was interrupted before the child was started, otherwise self.child will be the child Popen object, which could be at any stage of setting up its connection with the parent. This method may be called multiple times without raising an exception, it will simply do nothing if startup has previously been interrupted

#### mainloop()

```
run (worker_name, device_name, extraargs)
```

The method that gets called in the subprocess. To be overridden by subclasses

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

#### VISA.labscript\_device

Boiler plate labscript\_device for VISA instruments.

Bases: labscript.labscript.Device

Base VISA labscript\_device class.

Inheritors should call VISA.\_\_init\_\_() in their own \_\_init\_\_() method. Generate\_code must be overridden.

#### Parameters

• name (str) – name of device in connectiontable

```
• parent_device (obj) - Handle to any parent device.
          • VISA_name (str) - Can be full VISA connection string or NI-MAX alias.
description = 'VISA Compatible Instrument'
allowed_children = []
generate_code (hdf5_file)
    Method to generate instructions for blacs worker to program device.
    Must be over-ridden.
add_device (device)
get_all_children()
get_all_outputs()
get_properties (location=None)
    Get all properties in location
    If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set properties (properties dict, property names, overwrite=False)
    Add one or a bunch of properties packed into properties_dict
    property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
        to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
```

The earliest time output can be commanded from this device at the start of the experiment. This is nonzeo on secondary pseudoclock devices due to triggering delays.

#### VISA.register\_classes

Sets which BLACS\_tab belongs to each labscript device.

# 3.3 SignalGenerator

### 3.3.1 Overview

This is a parent class for static RF Signal Generators with frequency and amplitude control and use the IEEE 488 or SCPI command protocols. Device communication is handled using the VISA communication protocol.

```
naqslab_devices.SignalGenerator.
Models
naqslab_devices.SignalGenerator.
blacs_tab
naqslab_devices.SignalGenerator.
blacs_worker
```

Continued on next page

Table 3 – continued from previous page

```
naqslab_devices.SignalGenerator.
labscript_device
naqslab_devices.SignalGenerator.
register_classes

Configures which BLACS_tab goes to which labscript_device.
```

#### 3.3.2 Models

Currently covered models include:

HP_8642A			
HP_8643A			
HP_8648			
RS_SMF100A			
RS_SMHU			

## 3.3.3 Adding a Signal Generator

In order to add a new model of signal generator one must:

abort\_transition\_to\_buffered(\*args, \*\*kwargs)

- 1. Add a subclass SignalGenerator.labscript\_device in SignalGenerator.Models which provides the operational limits.
- 2. Subclass SignalGenerator.blacs\_tab and SignalGenerator.blacs\_worker with the operational details for communicating with the device (namely command syntax and status byte definitions).
- 3. Add an entry in SignalGenerator.register\_classes that links the labscript\_device to the correct blacs\_tab. Note that multiple labscript\_devices can use the same blacs\_tab/blacs\_worker.

#### 3.3.4 Detailed Documentation

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
base_units = {'amp': 'dBm', 'freq': 'MHz'}
base_min = {'amp': -140, 'freq': 0.1}
base_max = {'amp': 20, 'freq': 1057.5}
base_step = {'amp': 0.1, 'freq': 1}
base_decimals = {'amp': 1, 'freq': 6}
status_byte_labels = {'bit 0': 'End of Sweep', 'bit 1': 'Hardware Error', 'bit 2'
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort_buffered(*args, **kwargs)
```

```
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check time()
clean_ui_on_restart()
close_tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
     to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
    Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create digital outputs (digital properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets(device_properties)
create_worker (name, WorkerClass, workerargs=None)
     Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
    fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
    running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
     Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
```

```
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
send_clear(*args, **kwargs)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown_workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine timeout add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_monitor(*args, **kwargs)
status_widget = 'STBstatus.ui'
supports_remote_value_check (support)
supports_smart_programming(support)
transition_to_buffered(*args, **kwargs)
transition_to_manual(*args, **kwargs)
update_from_settings(settings)
```

```
class naqslab_devices.SignalGenerator.BLACS.HP_8642A.HP_8642AWorker(*args,
                                                                                           **kwargs)
     Bases: naqslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker
     scale_factor = 1000000.0
     amp_scale_factor = 1.0
     freq_write_string = 'FR {:.0f} HZ'
     freq_query_string = 'FROA'
     freq_parser (freq_string)
          Frequency Query string parser for HP8642A freq_string format is FR sdddddddddd.0 HZ Returns float
          in instrument units, Hz (i.e. needs scaling to base_units)
     amp_write_string = 'AP {:.1f} DM'
     amp_query_string = 'APOA'
     amp_parser(amp_string)
          Amplitude Query string parser for HP8642A amp_string format is AP sddd.d DM Returns float in
          instrument units, dBm
     abort_buffered()
          Special abort shot code belongs here.
     abort transition to buffered()
          Special abort shot configuration code belongs here.
     check_remote_values()
     check_status()
          Reads the Status Byte Register of the VISA device.
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     clear(value)
          Sends standard *CLR to clear registers of device.
              Parameters value (bool) – value of Clear button in STBstatus.ui widget
     convert_register(register)
          Converts returned register value to dict of bools
              Parameters register (int) - Status register value returned from read_stb
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     init()
          Initializes basic worker and opens VISA connection to device.
          Default connection timeout is 2 seconds
     interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
     program_manual (front_panel_values)
          Over-ride this method if remote programming is supported.
              Returns VISAWorker.check_remote_values()
```

```
run (worker_name, device_name, extraargs)
```

The method that gets called in the subprocess. To be overridden by subclasses

#### shutdown()

Closes VISA connection to device.

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

#### transition\_to\_buffered(device\_name, h5file, initial\_values, fresh)

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- h5file (str) path to shot h5\_file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

#### transition to manual(abort=False)

Simple transition\_to\_manual method where no data is saved.

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
base_units = {'amp': 'dBm', 'freq': 'MHz'}
base_min = {'amp': -137, 'freq': 0.26}
base_max = {'amp': 13, 'freq': 1030}
base_step = {'amp': 0.1, 'freq': 1}
base_decimals = {'amp': 2, 'freq': 8}
status_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Qu
ICON BUSY = ':/qtutils/fuque/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values (*args, **kwargs)
check_time()
```

```
clean_ui_on_restart()
close_tab(finalise=True)
```

Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not terminate subprocesses or join the mainloop. In this case, callers must manually call finalise\_close\_tab() to perform these potentially blocking operations

```
connect_restart_receiver (function)
continue_restart (currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a fully qualified import path to a worker. The latter is useful if the worker class is in a separate file with global imports or other import-time behaviour that is undesirable to have run in the main process, for example if the imports may not be available to the main process (as may be the case once remote worker processes are implemented and the worker may be on a separate computer). The worker process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
```

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```
hide_error()
     initialise_GUI()
         Loads the standard STBstatus.ui widget and sets the worker defined in __init__
     initialise_workers()
    mainloop()
    property mode
    on_force_full_buffered_reprogram()
    on_resolve_value_inconsistency()
    property primary_worker
    program_device(*args, **kwargs)
    program_device_properties (*args, **kwargs)
    queue_work (worker_process, worker_function, *args, **kwargs)
     restart (*args)
     restore_builtin_save_data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
     restore_save_data(data)
     send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set_terminal_visible(visible)
     shutdown_workers(*args, **kwargs)
     start_run (*args, **kwargs)
    property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
     statemachine_timeout_remove (statefunction)
     statemachine_timeout_remove_all()
     status_monitor(*args, **kwargs)
     status_widget = 'STBstatus.ui'
     supports_remote_value_check (support)
     supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings (settings)
class nagslab_devices.SignalGenerator.BLACS.HP_8643A.HP_8643AWorker(*args,
    Bases: nagslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker
     scale_factor = 1000000.0
     amp_scale_factor = 1.0
     init()
         Calls parent init and sends device specific initialization commands
```

```
freq_write_string = 'FREQ:CW {:.2f} HZ'
freq_query_string = 'FREQ:CW?'
freq_parser (freq_string)
     Frequency Query string parser for HP8643A freq_string format is float, in Hz Returns float in instru-
     ment units, Hz (i.e. needs scaling to base_units)
amp_write_string = 'AMPL:LEV {:.2f} DBM'
amp_query_string = 'AMPL:LEV?'
amp parser(amp string)
     Amplitude Query string parser for HP8643A amp string format is float in configured units (dBm by
     default) Returns float in instrument units, dBm
check_status()
     Reads the Status Byte Register of the VISA device.
         Returns Status byte dictionary as formatted in VISATab
         Return type dict
abort_buffered()
     Special abort shot code belongs here.
abort_transition_to_buffered()
     Special abort shot configuration code belongs here.
check_remote_values()
clear(value)
     Sends standard *CLR to clear registers of device.
         Parameters value (bool) – value of Clear button in STBstatus.ui widget
convert_register(register)
     Converts returned register value to dict of bools
         Parameters register (int) – Status register value returned from read_stb
         Returns Status byte dictionary as formatted in VISATab
         Return type dict
interrupt_startup(reason='Process.interrupt_startup() called')
     Called from the parent process. Interrupt all blocking operations on starting the child process, causing
     Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
     interrupted before the child was started, otherwise self.child will be the child Popen object, which
     could be at any stage of setting up its connection with the parent. This method may be called multiple
     times without raising an exception, it will simply do nothing if startup has previously been interrupted
mainloop()
program_manual (front_panel_values)
     Over-ride this method if remote programming is supported.
         Returns VISAWorker.check_remote_values()
run (worker_name, device_name, extraargs)
     The method that gets called in the subprocess. To be overridden by subclasses
shutdown()
     Closes VISA connection to device.
start (*args, **kwargs)
     Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
```

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

```
transition_to_buffered(device_name, h5file, initial_values, fresh)
```

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- **h5file** (str) path to shot h5 file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

```
transition_to_manual(abort=False)
```

Simple transition\_to\_manual method where no data is saved.

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
base_units = {'amp': 'dBm', 'freq': 'MHz'}
base_min = {'amp': -136, 'freq': 0.1}
base_max = {'amp': 20, 'freq': 1000}
base_step = {'amp': 1, 'freq': 1}
base_decimals = {'amp': 1, 'freq': 9}
status_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Q
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values (*args, **kwargs)
check_time()
clean_ui_on_restart()
close tab(finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
    minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
```

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to perform these potentially blocking operations

connect\_restart\_receiver (function)

```
continue_restart(currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a fully qualified import path to a worker. The latter is useful if the worker class is in a separate file with global imports or other import-time behaviour that is undesirable to have run in the main process, for example if the imports may not be available to the main process (as may be the case once remote worker processes are implemented and the worker may be on a separate computer). The worker process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get child from connection table (parent device name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
```

```
on_force_full_buffered_reprogram()
    on_resolve_value_inconsistency()
    property primary_worker
    program_device (*args, **kwargs)
    program_device_properties (*args, **kwargs)
    queue_work (worker_process, worker_function, *args, **kwargs)
    restart (*args)
    restore builtin save data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
    restore_save_data(data)
     send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set_terminal_visible(visible)
    shutdown_workers (*args, **kwargs)
     start_run (*args, **kwargs)
    property state
    statemachine_timeout_add (delay, statefunction, *args, **kwargs)
    statemachine_timeout_remove(statefunction)
    statemachine_timeout_remove_all()
     status_monitor(*args, **kwargs)
     status_widget = 'STBstatus.ui'
    supports_remote_value_check (support)
    supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
class nagslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648BTab(*args,
    Bases: nagslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648ATab
    You MUST override this method in order to define the device worker. You then call this parent method to
    finish initialization.
    base_min = {'amp': -136, 'freq': 0.009}
    base_max = { 'amp': 20, 'freq': 2000}
    ICON_BUSY = ':/qtutils/fugue/hourglass'
    ICON_ERROR = ':/qtutils/fugue/exclamation'
    ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
    ICON_OK = ':/qtutils/fugue/tick'
    STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
     abort_buffered(*args, **kwargs)
```

```
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
base decimals = {'amp':
                                1, 'freq':
base_step = {'amp': 1, 'freq':
                           'dBm', 'freq':
base_units = {'amp':
                                                 'MHz'}
check remote values (*args, **kwargs)
check_time()
clean_ui_on_restart()
close_tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
     to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
     Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create analog widgets (channel properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets(channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets(device_properties)
create_worker (name, WorkerClass, workerargs=None)
    Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
     fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
     running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
```

get\_all\_save\_data()

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```
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program device(*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
send_clear(*args, **kwargs)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2':
status_monitor(*args, **kwargs)
status_widget = 'STBstatus.ui'
supports_remote_value_check (support)
supports_smart_programming(support)
```

```
transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
class naqslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648CTab(*args,
                                                                            **kwargs)
     Bases: nagslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648ATab
     You MUST override this method in order to define the device worker. You then call this parent method to
     finish initialization.
    base_min = { 'amp': -136, 'freq': 0.009}
    base_max = {'amp': 20, 'freq': 3200}
     ICON_BUSY = ':/qtutils/fugue/hourglass'
     ICON_ERROR = ':/qtutils/fugue/exclamation'
     ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
     ICON OK = ':/qtutils/fuque/tick'
     STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
     abort_buffered(*args, **kwargs)
     abort_transition_to_buffered(*args, **kwargs)
     add_secondary_worker(worker)
     auto_create_widgets()
     auto_place_widgets(*args)
    base_decimals = {'amp': 1, 'freq':
    base_step = {'amp': 1, 'freq': 1}
    base_units = {'amp': 'dBm', 'freq': 'MHz'}
     check_remote_values (*args, **kwargs)
     check_time()
     clean_ui_on_restart()
     close tab (finalise=True)
         Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
         minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
         to perform these potentially blocking operations
     connect_restart_receiver (function)
     continue_restart(currentpage)
         Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
         Calls subsequent GUI operations in the main thread once finished blocking.
     create_analog_outputs (analog_properties)
     create_analog_widgets(channel_properties)
     create_dds_outputs (dds_properties)
     create_dds_widgets (channel_properties)
     create_device_properties (device_properties)
     create_digital_outputs (digital_properties)
     create_digital_widgets (channel_properties)
     create_image_outputs (image_properties)
```

```
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a fully qualified import path to a worker. The latter is useful if the worker class is in a separate file with global imports or other import-time behaviour that is undesirable to have run in the main process, for example if the imports may not be available to the main process (as may be the case once remote worker processes are implemented and the worker may be on a separate computer). The worker process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get child from connection table (parent device name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
```

```
send_clear(*args, **kwargs)
          set_tab_icon_and_colour()
                   Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
                   respectively
          set_terminal_visible(visible)
          shutdown_workers (*args, **kwargs)
          start_run (*args, **kwargs)
          property state
          statemachine_timeout_add(delay, statefunction, *args, **kwargs)
          statemachine_timeout_remove (statefunction)
          statemachine_timeout_remove_all()
          status_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2': 'Queen's tatus_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 1': 'RQC',
          status_monitor(*args, **kwargs)
          status_widget = 'STBstatus.ui'
          supports_remote_value_check (support)
          supports_smart_programming(support)
          transition_to_buffered(*args, **kwargs)
          transition_to_manual(*args, **kwargs)
          update from settings(settings)
class naqslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648DTab(*args,
          Bases: nagslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648ATab
          You MUST override this method in order to define the device worker. You then call this parent method to
          finish initialization.
         base_min = {'amp': -136, 'freq': 0.009}
         base_max = { 'amp': 20, 'freq': 4000}
          ICON_BUSY = ':/qtutils/fugue/hourglass'
          ICON_ERROR = ':/qtutils/fugue/exclamation'
          ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
          ICON OK = ':/qtutils/fuque/tick'
          STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
          abort_buffered(*args, **kwargs)
          abort_transition_to_buffered(*args, **kwargs)
          add_secondary_worker(worker)
          auto_create_widgets()
          auto_place_widgets(*args)
         base_decimals = {'amp': 1, 'freq':
         base_step = {'amp': 1, 'freq': 1}
          base_units = {'amp': 'dBm', 'freq': 'MHz'}
          check_remote_values (*args, **kwargs)
          check time()
```

```
clean_ui_on_restart()
close_tab(finalise=True)
```

Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not terminate subprocesses or join the mainloop. In this case, callers must manually call finalise\_close\_tab() to perform these potentially blocking operations

```
connect_restart_receiver (function)
continue_restart (currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a fully qualified import path to a worker. The latter is useful if the worker class is in a separate file with global imports or other import-time behaviour that is undesirable to have run in the main process, for example if the imports may not be available to the main process (as may be the case once remote worker processes are implemented and the worker may be on a separate computer). The worker process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
```

```
hide_error()
    initialise_GUI()
        Loads the standard STBstatus.ui widget and sets the worker defined in __init__
    initialise_workers()
    mainloop()
    property mode
    on_force_full_buffered_reprogram()
    on_resolve_value_inconsistency()
    property primary_worker
    program_device(*args, **kwargs)
    program_device_properties (*args, **kwargs)
    queue_work (worker_process, worker_function, *args, **kwargs)
    restart (*args)
    restore_builtin_save_data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
    restore_save_data(data)
     send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
    set_terminal_visible(visible)
     shutdown_workers(*args, **kwargs)
    start_run (*args, **kwargs)
    property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
    statemachine_timeout_remove (statefunction)
    statemachine_timeout_remove_all()
     status_byte_labels = {'bit 0': 'Operation Complete', 'bit 1': 'RQC', 'bit 2':
    status_monitor(*args, **kwargs)
    status widget = 'STBstatus.ui'
    supports_remote_value_check(support)
    supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
class naqslab_devices.SignalGenerator.BLACS.HP_8648.HP_8648Worker(*args,
                                                                             **kwargs)
    Bases: naqslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker
    scale_factor = 1000000.0
    amp_scale_factor = 1.0
```

```
init()
     Calls parent init and sends device specific initialization commands
freq_write_string = 'FREQ:CW {:.3f} HZ'
freq_query_string = 'FREQ:CW?'
freq_parser (freq_string)
     Frequency Query string parser for HP8648 freq_string format is float, in Hz Returns float in instrument
     units, Hz (i.e. needs scaling to base units)
amp_write_string = 'POW:AMPL {:.1f} DBM'
amp query string = 'POW:AMPL?'
amp_parser(amp_string)
     Amplitude Query string parser for HP8648 amp_string format is float in configured units (dBm by
     default) Returns float in instrument units, dBm
check_status()
     Reads the Status Byte Register of the VISA device.
         Returns Status byte dictionary as formatted in VISATab
         Return type dict
abort_buffered()
     Special abort shot code belongs here.
abort_transition_to_buffered()
     Special abort shot configuration code belongs here.
check remote values()
clear(value)
     Sends standard *CLR to clear registers of device.
         Parameters value (bool) – value of Clear button in STBstatus.ui widget
convert_register(register)
     Converts returned register value to dict of bools
         Parameters register (int) - Status register value returned from read_stb
         Returns Status byte dictionary as formatted in VISATab
         Return type dict
interrupt_startup(reason='Process.interrupt_startup() called')
     Called from the parent process. Interrupt all blocking operations on starting the child process, causing
     Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
     interrupted before the child was started, otherwise self.child will be the child Popen object, which
     could be at any stage of setting up its connection with the parent. This method may be called multiple
     times without raising an exception, it will simply do nothing if startup has previously been interrupted
mainloop()
program_manual (front_panel_values)
     Over-ride this method if remote programming is supported.
         Returns VISAWorker.check_remote_values()
run (worker_name, device_name, extraargs)
     The method that gets called in the subprocess. To be overridden by subclasses
shutdown()
     Closes VISA connection to device.
start (*args, **kwargs)
     Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
```

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

```
transition_to_buffered(device_name, h5file, initial_values, fresh)
```

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- **h5file** (str) path to shot h5 file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

#### transition\_to\_manual(abort=False)

Simple transition\_to\_manual method where no data is saved.

Bases: naqslab\_devices.SignalGenerator.blacs\_tab.SignalGeneratorTab

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
base_units = {'amp': 'dBm', 'freq':
                                         'GHz'}
base_min = {'amp': -26, 'freq': 1e-06}
base_max = {'amp': 18, 'freq': 22}
base_step = {'amp': 1, 'freq': 0.1}
base_decimals = {'amp': 1, 'freq': 6}
status_byte_labels = {'bit 0': 'Unused', 'bit 1': 'Unused', 'bit 2': 'Error Queu
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values (*args, **kwargs)
check_time()
clean_ui_on_restart()
close tab(finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
    minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
```

connect\_restart\_receiver (function)

to perform these potentially blocking operations

```
continue_restart(currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get child from connection table (parent device name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
```

```
on_force_full_buffered_reprogram()
     on_resolve_value_inconsistency()
    property primary_worker
    program_device (*args, **kwargs)
    program_device_properties (*args, **kwargs)
     queue_work (worker_process, worker_function, *args, **kwargs)
    restart (*args)
     restore builtin save data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
     restore_save_data(data)
     send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set_terminal_visible(visible)
     shutdown_workers (*args, **kwargs)
     start_run (*args, **kwargs)
    property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
     statemachine_timeout_remove(statefunction)
     statemachine_timeout_remove_all()
     status_monitor(*args, **kwargs)
     status_widget = 'STBstatus.ui'
     supports_remote_value_check (support)
     supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
class naqslab_devices.SignalGenerator.BLACS.RS_SMF100A.RS_SMF100AWorker(*args,
    Bases: naqslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker
     scale_factor = 1000000000.0
     amp_scale_factor = 1.0
     freq_write_string = 'FREQ:CW {:.0f}HZ'
     freq_query_string = 'FREQ?'
     freq_parser (freq_string)
         Frequency Query string parser for SMF100A freq_string format is ddddddddddd Returns float in in-
         strument units, Hz (i.e. needs scaling to base_units)
     amp_write_string = 'POW:POW {:.2f}dBm'
     amp_query_string = 'POW?'
     amp parser(amp string)
         Amplitude Query string parser for SMF100A Returns float in instrument units, dBm
```

```
check_status()
Reads the Statu
Returns 5
```

Reads the Status Byte Register of the VISA device.

Returns Status byte dictionary as formatted in VISATab

Return type dict

#### abort\_buffered()

Special abort shot code belongs here.

#### abort\_transition\_to\_buffered()

Special abort shot configuration code belongs here.

```
check_remote_values()
```

#### clear(value)

Sends standard \*CLR to clear registers of device.

Parameters value (bool) – value of Clear button in STBstatus.ui widget

#### convert\_register (register)

Converts returned register value to dict of bools

Parameters register (int) - Status register value returned from read\_stb

Returns Status byte dictionary as formatted in VISATab

Return type dict

#### init()

Initializes basic worker and opens VISA connection to device.

Default connection timeout is 2 seconds

#### interrupt\_startup(reason='Process.interrupt\_startup() called')

Called from the parent process. Interrupt all blocking operations on starting the child process, causing Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was interrupted before the child was started, otherwise self.child will be the child Popen object, which could be at any stage of setting up its connection with the parent. This method may be called multiple times without raising an exception, it will simply do nothing if startup has previously been interrupted

#### mainloop()

# program\_manual (front\_panel\_values)

Over-ride this method if remote programming is supported.

```
Returns VISAWorker.check_remote_values()
```

```
run (worker_name, device_name, extraargs)
```

The method that gets called in the subprocess. To be overridden by subclasses

## shutdown()

Closes VISA connection to device.

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

# transition\_to\_buffered(device\_name, h5file, initial\_values, fresh)

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

• **device\_name** (str) – Name of device from connectiontable

```
• h5file (str) – path to shot h5_file
```

- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

```
transition_to_manual(abort=False)
```

Simple transition\_to\_manual method where no data is saved.

```
class nagslab devices.SignalGenerator.BLACS.RS SMHU.RS SMHUTab (*args,
    Bases: nagslab_devices.SignalGenerator.blacs_tab.SignalGeneratorTab
```

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

```
base_units = {'amp': 'dBm', 'freq': 'MHz'}
base_min = {'amp': -140, 'freq': 0.1}
base_max = {'amp': 13, 'freq': 4320}
base_step = {'amp': 0.1, 'freq': 1}
base_decimals = {'amp': 1, 'freq': 7}
status_byte_labels = {'bit 0': 'OPC', 'bit 1': 'SRQ', 'bit 2': 'Query Error', 'b.
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check_time()
clean_ui_on_restart()
close tab (finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
    minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
```

to perform these potentially blocking operations

```
connect_restart_receiver (function)
continue_restart(currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets(channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
```

```
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get builtin save data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
```

```
restore_builtin_save_data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
     restore_save_data(data)
     send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set_terminal_visible(visible)
     shutdown workers(*args, **kwargs)
     start_run (*args, **kwargs)
     property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
     statemachine_timeout_remove (statefunction)
     statemachine_timeout_remove_all()
     status_monitor(*args, **kwargs)
     status_widget = 'STBstatus.ui'
     supports_remote_value_check(support)
     supports_smart_programming(support)
     transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
class nagslab_devices.SignalGenerator.BLACS.RS_SMHU.RS_SMHUWorker(*args,
     Bases: nagslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker
     scale factor = 1000000.0
     amp_scale_factor = 1.0
     init()
         Calls parent init and sends device specific initialization commands
     freq_write_string = 'RF {:.1f}HZ'
     freq_query_string = 'RF?'
     freq_parser (freq_string)
         Frequency Query string parser for RS SMHU freq_string format is sddddddddddd Returns float in
         instrument units, Hz (i.e. needs scaling to base_units)
     amp_write_string = 'LEVEL:RF {:.1f}DBM'
     amp_query_string = 'LEVEL:RF?'
     amp_parser(amp_string)
         Amplitude Query string parser for RS SMHU amp_string format is sddd.d Returns float in instrument
         units, dBm
     check_status()
         Reads the Status Byte Register of the VISA device.
             Returns Status byte dictionary as formatted in VISATab
             Return type dict
```

```
abort_buffered()
```

Special abort shot code belongs here.

#### abort\_transition\_to\_buffered()

Special abort shot configuration code belongs here.

```
check_remote_values()
```

clear(value)

Sends standard \*CLR to clear registers of device.

**Parameters value** (bool) – value of Clear button in STB status.ui widget

#### convert\_register (register)

Converts returned register value to dict of bools

Parameters register (int) - Status register value returned from read\_stb

Returns Status byte dictionary as formatted in VISATab

Return type dict

## interrupt\_startup(reason='Process.interrupt\_startup() called')

Called from the parent process. Interrupt all blocking operations on starting the child process, causing Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was interrupted before the child was started, otherwise self.child will be the child Popen object, which could be at any stage of setting up its connection with the parent. This method may be called multiple times without raising an exception, it will simply do nothing if startup has previously been interrupted

#### mainloop()

```
program_manual (front_panel_values)
```

Over-ride this method if remote programming is supported.

```
Returns VISAWorker.check_remote_values()
```

run (worker\_name, device\_name, extraargs)

The method that gets called in the subprocess. To be overridden by subclasses

#### shutdown()

Closes VISA connection to device.

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

## transition\_to\_buffered(device\_name, h5file, initial\_values, fresh)

Stores various device handles for use in transition to manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- **h5file** (str) path to shot h5\_file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart\_programming should be refreshed this shot

# transition\_to\_manual(abort=False)

Simple transition\_to\_manual method where no data is saved.

```
class nagslab_devices.SignalGenerator.Models.RS_SMF100A(name, VISA_name)
```

Bases: nagslab\_devices.SignalGenerator.labscript\_device.SignalGenerator

```
VISA_name can be full VISA connection string or NI-MAX alias
     description = 'Rhode & Schwarz SMF100A Signal Generator'
     scale_factor = 1000000000.0
     freq_limits = (100000.0, 22000000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-26, 18)
     add_device (device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
          Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
         Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
         Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
         Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
         Add one or a bunch of properties packed into properties_dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
             to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
         The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
class nagslab devices. Signal Generator. Models. RS SMHU (name, VISA name)
     Bases: nagslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'RS SMHU Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (100000.0, 4320000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-140, 13)
     add_device (device)
```

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```
allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
         Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
         Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group(hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
         Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
         Add one or a bunch of properties packed into properties dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
             to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
         The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
class naqslab_devices.SignalGenerator.Models.HP_8643A(name, VISA_name)
     Bases: nagslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8643A Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (260000.0, 1030000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-137, 13)
     add device(device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
         Must be over-ridden.
     get_all_children()
     get_all_outputs()
```

```
get_properties (location=None)
          Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
          Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
             to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
          The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
class nagslab_devices.SignalGenerator.Models.HP_8642A(name, VISA_name)
     Bases: nagslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8642A Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (100000.0, 1057500000.0)
     amp_scale_factor = 1.0
     amp_limits = (-140, 20)
     add device(device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
         Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
          Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
```

```
quantise_amp (data, device)
          Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
          property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
              to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
          The earliest time output can be commanded from this device at the start of the experiment. This is
          nonzeo on secondary pseudoclock devices due to triggering delays.
class naqslab_devices.SignalGenerator.Models.HP_8648A(name, VISA_name)
     Bases: naqslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8648A Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (100000.0, 1000000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-136, 20)
     add device(device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
          Method to generate instructions for blacs_worker to program device.
          Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
          Get all properties in location
          If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
          Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
```

```
to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
          The earliest time output can be commanded from this device at the start of the experiment. This is
          nonzeo on secondary pseudoclock devices due to triggering delays.
class naqslab_devices.SignalGenerator.Models.HP_8648B(name, VISA_name)
     Bases: nagslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8648B Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (9000.0, 200000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-136, 20)
     add device(device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
          Method to generate instructions for blacs_worker to program device.
          Must be over-ridden.
     get all children()
     get_all_outputs()
     get_properties (location=None)
          Get all properties in location
          If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
          Quantize the amplitude in units of dBm and check it's within bounds
     quantise freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
          property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
              to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
          The earliest time output can be commanded from this device at the start of the experiment. This is
          nonzeo on secondary pseudoclock devices due to triggering delays.
```

property\_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables

```
class naqslab_devices.SignalGenerator.Models.HP_8648C(name, VISA_name)
     Bases: naqslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8648C Signal Generator'
     scale_factor = 1000000.0
     freq_limits = (9000.0, 3200000000.0)
     amp_scale_factor = 1.0
     amp_limits = (-136, 20)
     add device(device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
         Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
         Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
         Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
         Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
         Add one or a bunch of properties packed into properties_dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2, ...] of variables
             to be pulled from properties dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
    property t0
         The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
class naqslab_devices.SignalGenerator.Models.HP_8648D(name, VISA_name)
     Bases: nagslab_devices.SignalGenerator.labscript_device.SignalGenerator
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'HP 8648D Signal Generator'
     scale factor = 1000000.0
     freq_limits = (9000.0, 4000000000.0)
     amp_scale_factor = 1.0
```

```
amp_limits = (-136, 20)
     add_device (device)
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     generate_code (hdf5_file)
         Method to generate instructions for blacs_worker to program device.
         Must be over-ridden.
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
         Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
    property pseudoclock_device
     quantise_amp (data, device)
         Quantize the amplitude in units of dBm and check it's within bounds
     quantise_freq(data, device)
         Quantize the frequency in units of Hz and check it's within bounds
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
         Add one or a bunch of properties packed into properties_dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
             to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
         The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
class nagslab_devices.SignalGenerator.blacs_tab.SignalGeneratorTab(*args,
                                                                                   **kwargs)
     Bases: nagslab devices.VISA.blacs tab.VISATab
     You MUST override this method in order to define the device worker. You then call this parent method to
     finish initialization.
    base_units = {'amp':
                               'dBm', 'freq': 'MHz'}
    base_min = {'amp': -140, 'freq': 0.1}
    base_max = {'amp': 20, 'freq': 1057.5}
     base_step = { 'amp': 0.1, 'freq': 1}
    base_decimals = {'amp': 1, 'freq': 6}
     status_byte_labels = {'bit 0': 'bit 0 label', 'bit 1': 'bit 1 label', 'bit 2':
     initialise_GUI()
         Loads the standard STBstatus.ui widget and sets the worker defined in __init__
     ICON_BUSY = ':/qtutils/fugue/hourglass'
     ICON_ERROR = ':/qtutils/fugue/exclamation'
```

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```
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check_time()
clean_ui_on_restart()
close_tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
     to perform these potentially blocking operations
connect_restart_receiver (function)
continue restart(currentpage)
     Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets(channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
     Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
    fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
    running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
```

```
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
send_clear(*args, **kwargs)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_monitor(*args, **kwargs)
status_widget = 'STBstatus.ui'
supports_remote_value_check (support)
supports_smart_programming(support)
transition_to_buffered(*args, **kwargs)
```

```
transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
class naqslab_devices.SignalGenerator.blacs_worker.SignalGeneratorWorker(*args,
                                                                                              **kwargs)
     Bases: nagslab_devices.VISA.blacs_worker.VISAWorker
     scale_factor = 1000000.0
     amp_scale_factor = 1.0
     freq_write_string = ''
     freq_query_string = ''
     freq_parser (freq_string)
          Frequency Query string parser Needs to be over-ridden
     amp_write_string = ''
     amp_query_string = ''
     amp parser(amp string)
          Amplitude Query string parser Needs to be over-ridden
     init()
          Initializes basic worker and opens VISA connection to device.
          Default connection timeout is 2 seconds
     check_remote_values()
     program_manual (front_panel_values)
          Over-ride this method if remote programming is supported.
              Returns VISAWorker.check_remote_values()
     transition_to_buffered(device_name, h5file, initial_values, fresh)
          Stores various device handles for use in transition_to_manual method.
          Automatically called by BLACS. Should be over-ridden by inheritors.
              Parameters
                  • device_name (str) – Name of device from connectiontable
                  • h5file (str) – path to shot h5_file
                  • initial_values (dict) - Contains the start of shot values
                  • fresh (bool) – Indicates if smart_programming should be refreshed this shot
     abort buffered()
          Special abort shot code belongs here.
     abort_transition_to_buffered()
          Special abort shot configuration code belongs here.
     check_status()
          Reads the Status Byte Register of the VISA device.
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     clear(value)
          Sends standard *CLR to clear registers of device.
              Parameters value (bool) – value of Clear button in STBstatus.ui widget
     convert_register (register)
          Converts returned register value to dict of bools
```

```
Returns Status byte dictionary as formatted in VISATab
              Return type dict
     interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
     run (worker_name, device_name, extraargs)
          The method that gets called in the subprocess. To be overridden by subclasses
     shutdown()
          Closes VISA connection to device.
     start (*args, **kwargs)
          Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
     terminate (wait_timeout=None, **kwargs)
          Interrupt process startup if not already done, ensuring self.child exists or is None if startup was in-
          terrupted before the process was created. Then if the child is not None, call Popen.terminate() and
          Popen.wait() on it.
     transition_to_manual (abort=False)
          Simple transition_to_manual method where no data is saved.
class naqslab_devices.SignalGenerator.labscript_device.SignalGenerator(name,
                                                                                                VISA name)
     Bases: nagslab_devices.VISA.labscript_device.VISA
     VISA_name can be full VISA connection string or NI-MAX alias
     description = 'Signal Generator'
     allowed_children = [<class 'naqslab_devices.StaticFreqAmp'>]
     scale factor = 1000000.0
     freq_limits = ()
     amp_scale_factor = 1.0
     amp limits = ()
     quantise_freq(data, device)
          Quantize the frequency in units of Hz and check it's within bounds
     quantise_amp (data, device)
          Quantize the amplitude in units of dBm and check it's within bounds
     generate_code (hdf5_file)
          Method to generate instructions for blacs_worker to program device.
          Must be over-ridden.
     add_device (device)
     get_all_children()
     get_all_outputs()
     get_properties (location=None)
          Get all properties in location
          If location is None we return all keys
```

Parameters register (int) - Status register value returned from read\_stb

```
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
   Add one or a bunch of properties packed into properties_dict
   property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
   The earliest time output can be commanded from this device at the start of the experiment. This is
```

nonzeo on secondary pseudoclock devices due to triggering delays.

Configures which BLACS\_tab goes to which labscript\_device.

# 3.4 PulseBlasterESRPro300

#### 3.4.1 Overview

This is a thin subclass of the PulseBlaster\_No\_DDS labscript\_device. It merely configures the correct clock speed, digital output number, and clock resolution limits.

```
naqslab_devices.
PulseBlasterESRPro300.blacs_tab

naqslab_devices.
PulseBlasterESRPro300.blacs_worker

naqslab_devices.
PulseBlasterESRPro300.
labscript_device
naqslab_devices.
PulseBlasterESRPro300.
register_classes
naqslab_devices.
PulseBlasterESRPro300.
runviewer_parser
```

# 3.4.2 Detailed Documentation of naqslab\_devices.PulseBlasterESRPro300

# PulseBlasterESRPro300.blacs\_tab

```
ICON_OK = ':/qtutils/fugue/tick'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values (*args, **kwargs)
check time()
clean_ui_on_restart()
close_tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
     to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
     Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create dds outputs(dds properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets(channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create worker(name, WorkerClass, workerargs=None)
     Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
     fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
     running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
```

get\_all\_save\_data()

```
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table(parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
initialise_workers()
labscript_device_class_name = 'PulseBlaster_No_DDS'
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
reset (*args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set terminal visible(visible)
shutdown_workers(*args, **kwargs)
start (*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_monitor(*args, **kwargs)
stop(*args, **kwargs)
supports_remote_value_check (support)
```

```
supports_smart_programming(support)
transition_to_buffered(*args, **kwargs)
transition_to_manual(*args, **kwargs)
update_from_settings (settings)
```

```
PulseBlasterESRPro300.blacs worker
class naqslab_devices.PulseBlasterESRPro300.blacs_worker.PulseBlasterESRPro300Worker(*arg
     Bases: labscript_devices.PulseBlaster_No_DDS.PulseblasterNoDDSWorker
     core_clock_freq = 300.0
     ESRPro = True
     abort_buffered()
     abort_transition_to_buffered()
     check_status()
     init()
     interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
     program_manual (values)
     run (worker_name, device_name, extraargs)
          The method that gets called in the subprocess. To be overridden by subclasses
     shutdown()
     start (*args, **kwargs)
          Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
     start_run()
     terminate (wait_timeout=None, **kwargs)
          Interrupt process startup if not already done, ensuring self.child exists or is None if startup was in-
          terrupted before the process was created. Then if the child is not None, call Popen.terminate() and
          Popen.wait() on it.
     transition_to_buffered(device_name, h5file, initial_values, fresh)
```

transition\_to\_manual()

# PulseBlasterESRPro300.labscript\_device

```
class naqslab_devices.PulseBlasterESRPro300.labscript_device.PulseBlasterESRPro300(name,
    Bases: labscript_devices.PulseBlaster_No_DDS.PulseBlaster_No_DDS
    description = 'SpinCore PulseBlaster ESR-PRO-300'
    clock_limit = 30000000.0
    clock_resolution = 4e-09
    n_flags = 24
    add_device (device)
    allowed_children = [<class 'labscript.labscript.Pseudoclock'>]
    convert_to_pb_inst (dig_outputs, dds_outputs, freqs, amps, phases)
    core_clock_freq = 100
    property direct_outputs
    do_checks (outputs)
         Basic error checking to ensure the user's instructions make sense
    flag_is_clock (flag)
    flag_valid(flag)
    generate_code (hdf5_file)
    generate_registers (hdf5_file, dds_outputs)
    get_all_children()
    get_all_outputs()
    get_direct_outputs()
         Finds out which outputs are directly attached to the PulseBlaster
    get_flag_number (connection)
    get_properties (location=None)
         Get all properties in location
         If location is None we return all keys
    get_property (name, location=None, *args, **kwargs)
    init_device_group(hdf5_file)
    property is_master_pseudoclock
    minimum_recovery_time = 0
    offset_instructions_from_trigger(outputs)
```

trigger\_de trigger\_co board firmwa programming\_s pulse\_ max\_ii time\_b time b \*\*kwa

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```
property parent_clock_line
pb_instructions = {'BRANCH': 6, 'CONTINUE': 0, 'END_LOOP': 3, 'LONG_DELAY': 7, 'LOO
property pseudoclock
property pseudoclock_device
quantise_to_pseudoclock (times)
set_initial_trigger_time(t)
set_properties (properties_dict, property_names, overwrite=False)
    Add one or a bunch of properties packed into properties_dict
    property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
        to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
    The earliest time output can be commanded from this device at the start of the experiment. This is
    nonzeo on secondary pseudoclock devices due to triggering delays.
trigger(t, duration, wait_delay=0)
    Ask the trigger device to produce a digital pulse of a given duration to trigger this pseudoclock
trigger_delay = 2.5e-07
trigger_edge_type = 'falling'
trigger_minimum_duration = 0
wait delay = 1e-07
write_pb_inst_to_h5 (pb_inst, hdf5_file)
```

# PulseBlasterESRPro300.register\_classes

# PulseBlasterESRPro300.runviewer\_parser

```
class naqslab_devices.PulseBlasterESRPro300.runviewer_parser.PulseBlasterESRPro300Parser

Bases: labscript_devices.PulseBlaster_No_DDS.PulseBlaster_No_DDS_Parser

num_flags = 24

get_traces(add_trace, parent=None)
```

```
num_dds = 0
```

labscript\_device\_class\_name = 'PulseBlaster\_No\_DDS'

# 3.5 PulseBlaster\_No\_DDS\_200

# 3.5.1 Overview

This is a thin subclass of the PulseBlaster\_No\_DDS labscript\_device. It merely configures the correct clock speed and clock resolution limits for our custom 200 MHz clocked USB PulseBlaster board.

```
naqslab_devices.
PulseBlaster_No_DDS_200.blacs_tab
```

Continued on next page

# Table 6 – continued from previous page

```
nagslab_devices.
PulseBlaster_No_DDS_200.
blacs_worker
naqslab_devices.
PulseBlaster No DDS 200.
labscript_device
nagslab_devices.
PulseBlaster_No_DDS_200.
register_classes
naqslab_devices.
PulseBlaster_No_DDS_200.
runviewer_parser
```

# 3.5.2 Detailed Documentation of nagslab devices. Pulse Blaster No DDS 200

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#### PulseBlaster\_No\_DDS\_200.blacs\_tab

```
class naqslab_devices.PulseBlaster_No_DDS_200.blacs_tab.PulseBlaster_No_DDS_200_Tab(*args
     Bases: labscript_devices.PulseBlaster_No_DDS.Pulseblaster_No_DDS_Tab
     num DO = 24
     ICON_BUSY = ':/qtutils/fugue/hourglass'
     ICON_ERROR = ':/qtutils/fugue/exclamation'
     ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
     ICON_OK = ':/qtutils/fugue/tick'
     abort_buffered(*args, **kwargs)
     abort_transition_to_buffered(*args, **kwargs)
     add_secondary_worker(worker)
     auto_create_widgets()
     auto_place_widgets(*args)
     check_remote_values (*args, **kwargs)
     check_time()
     clean_ui_on_restart()
     close_tab (finalise=True)
         Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
         minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
         to perform these potentially blocking operations
     connect_restart_receiver (function)
     continue_restart(currentpage)
         Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
         Calls subsequent GUI operations in the main thread once finished blocking.
     create_analog_outputs (analog_properties)
     create_analog_widgets (channel_properties)
     create_dds_outputs (dds_properties)
     create_dds_widgets (channel_properties)
```

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```
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise GUI()
initialise_workers()
labscript_device_class_name = 'PulseBlaster_No_DDS'
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
```

```
reset (*args, **kwargs)
     restart (*args)
     restore_builtin_save_data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
     restore_save_data(data)
     set tab icon and colour()
          Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
     set terminal visible(visible)
     shutdown_workers (*args, **kwargs)
     start (*args, **kwargs)
     start_run (*args, **kwargs)
     property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
     statemachine_timeout_remove(statefunction)
     statemachine_timeout_remove_all()
     status monitor(*args, **kwargs)
     stop(*args, **kwargs)
     supports_remote_value_check (support)
     supports_smart_programming(support)
     transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
PulseBlaster_No_DDS_200.blacs_worker
class naqslab_devices.PulseBlaster_No_DDS_200.blacs_worker.PulseblasterNoDDS200Worker(*a
     Bases: labscript_devices.PulseBlaster_No_DDS.PulseblasterNoDDSWorker
     core_clock_freq = 200.0
     abort_buffered()
     abort_transition_to_buffered()
     check_status()
     interrupt_startup(reason='Process.interrupt_startup() called')
         Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
         could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
     program_manual (values)
     run (worker_name, device_name, extraargs)
         The method that gets called in the subprocess. To be overridden by subclasses
```

```
shutdown()
     start (*args, **kwargs)
          Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
     start_run()
     terminate (wait_timeout=None, **kwargs)
          Interrupt process startup if not already done, ensuring self.child exists or is None if startup was in-
          terrupted before the process was created. Then if the child is not None, call Popen.terminate() and
          Popen.wait() on it.
     transition_to_buffered(device_name, h5file, initial_values, fresh)
     transition_to_manual()
PulseBlaster_No_DDS_200.labscript_device
class naqslab_devices.PulseBlaster_No_DDS_200.labscript_device.PulseBlaster_No_DDS_200(nass naqslab_devices.PulseBlaster_No_DDS_200)
     Bases: labscript_devices.PulseBlaster_No_DDS.PulseBlaster_No_DDS
     A thin subclass of labscript_devices.PulseBlaster_No_DDS.
     It's only purpose is to set the core clock frequency to 200 MHz for our one custom USB pulseblaster device.
     description = 'SpinCore PulseBlaster USB with 200 MHz clock'
     clock limit = 17200000.0
     clock_resolution = 1e-08
     core_clock_freq = 200
     n flags = 24
     add_device (device)
     allowed_children = [<class 'labscript.labscript.Pseudoclock'>]
     convert_to_pb_inst (dig_outputs, dds_outputs, freqs, amps, phases)
     property direct_outputs
     do_checks (outputs)
          Basic error checking to ensure the user's instructions make sense
     flag_is_clock(flag)
     flag_valid(flag)
     generate_code (hdf5_file)
     generate_registers (hdf5_file, dds_outputs)
```

```
get_all_children()
     get_all_outputs()
     get_direct_outputs()
         Finds out which outputs are directly attached to the PulseBlaster
     get_flag_number (connection)
     get properties(location=None)
         Get all properties in location
         If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group(hdf5_file)
     property is_master_pseudoclock
     minimum_recovery_time = 0
     offset_instructions_from_trigger(outputs)
    property parent_clock_line
     pb_instructions = {'BRANCH': 6, 'CONTINUE': 0, 'END_LOOP': 3, 'LONG_DELAY': 7, 'LOO
     property pseudoclock
     property pseudoclock_device
     quantise_to_pseudoclock (times)
     set_initial_trigger_time(t)
     set_properties (properties_dict, property_names, overwrite=False)
         Add one or a bunch of properties packed into properties_dict
         property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
             to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
    property t0
         The earliest time output can be commanded from this device at the start of the experiment. This is
         nonzeo on secondary pseudoclock devices due to triggering delays.
     trigger(t, duration, wait_delay=0)
         Ask the trigger device to produce a digital pulse of a given duration to trigger this pseudoclock
     trigger_delay = 2.5e-07
     trigger_edge_type = 'falling'
     trigger_minimum_duration = 0
     wait_delay = 1e-07
     write_pb_inst_to_h5 (pb_inst, hdf5_file)
PulseBlaster_No_DDS_200.register_classes
PulseBlaster No DDS 200.runviewer parser
class naqslab_devices.PulseBlaster_No_DDS_200.runviewer_parser.PulseBlaster_No_DDS_200_I
     Bases: labscript_devices.PulseBlaster_No_DDS.PulseBlaster_No_DDS_Parser
     num_flags = 24
```

```
get_traces (add_trace, parent=None)
labscript_device_class_name = 'PulseBlaster_No_DDS'
num dds = 0
```

# 3.6 KeysightXSeries

# 3.6.1 Overview

This devices covers Keysight X-series oscilloscopes. It has been explicitly tested with 1000 and 3000 series 'scopes. Other series should be simple to implement.

```
naqslab_devices.KeysightXSeries.
blacs_tab
naqslab_devices.KeysightXSeries.
blacs_worker
naqslab_devices.KeysightXSeries.
labscript_device
naqslab_devices.KeysightXSeries.
register_classes
```

# 3.6.2 Detailed Documentation of naqslab\_devices.KeysightXSeries

# KeysightXSeries.blacs\_tab

```
class naqslab_devices.KeysightXSeries.blacs_tab.KeysightXScopeTab(*args,
                                                                           **kwargs)
    Bases: nagslab_devices.VISA.blacs_tab.VISATab
    You MUST override this method in order to define the device worker. You then call this parent method to
    finish initialization.
    status_byte_labels = {'bit 0':
                                        'Operation Complete', 'bit 1': 'Unused', 'bit 2':
    initialise_GUI()
        Loads the standard STBstatus.ui widget and sets the worker defined in __init__
    ICON_BUSY = ':/qtutils/fugue/hourglass'
    ICON_ERROR = ':/qtutils/fugue/exclamation'
    ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
    ICON_OK = ':/qtutils/fugue/tick'
    STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
    abort_buffered(*args, **kwargs)
    abort_transition_to_buffered(*args, **kwargs)
    add_secondary_worker(worker)
    auto_create_widgets()
    auto_place_widgets(*args)
    check remote values (*args, **kwargs)
    check_time()
    clean_ui_on_restart()
```

```
close_tab (finalise=True)
```

Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not terminate subprocesses or join the mainloop. In this case, callers must manually call finalise\_close\_tab() to perform these potentially blocking operations

```
connect_restart_receiver (function)
continue_restart (currentpage)
```

Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread. Calls subsequent GUI operations in the main thread once finished blocking.

```
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_image_widgets (device_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
```

```
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
```

```
initialise_workers()
    mainloop()
    property mode
    on_force_full_buffered_reprogram()
    on_resolve_value_inconsistency()
    property primary_worker
    program_device (*args, **kwargs)
    program device properties(*args, **kwargs)
    queue_work (worker_process, worker_function, *args, **kwargs)
    restart (*args)
    restore_builtin_save_data(data)
        Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
    restore_save_data(data)
    send_clear(*args, **kwargs)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
    set_terminal_visible(visible)
    shutdown_workers (*args, **kwargs)
    start_run (*args, **kwargs)
    property state
     statemachine_timeout_add(delay, statefunction, *args, **kwargs)
    statemachine_timeout_remove(statefunction)
    statemachine_timeout_remove_all()
    status_monitor(*args, **kwargs)
    status_widget = 'STBstatus.ui'
     supports_remote_value_check (support)
    supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
KeysightXSeries.blacs worker
class naqslab_devices.KeysightXSeries.blacs_worker.KeysightXScopeWorker(*args,
                                                                                   **kwargs)
    Bases: nagslab_devices.VISA.blacs_worker.VISAWorker
    setup_string = '*ESE 60;*SRE 32;*CLS;:WAV:BYT MSBF;UNS ON;POIN:MODE RAW'
    esr_mask = 60
    read_analog_parameters_string = ':WAV:FORM WORD;SOUR CHAN{0:d};PRE?'
    read_dig_parameters_string = ':WAV:FORM BYTE;SOUR POD{0:d};PRE?'
    read_waveform_string = ':WAV:DATA?'
```

```
read_counter_string = ':MEAS:{0:s}{1:s}? CHAN{2:d}'
model_ident = 'SO-X'
dig_command = ':DIG'
analog_waveform_parser(raw_waveform_array, y0, dy, yoffset)
     Parses the numpy array from the analog waveform query.
digital pod parser(raw pod array)
     Unpacks the bits for a pod array Columns returned are in bit order [7,6,5,4,3,2,1,0]
error parser(error return string)
     Parses the strings returned by :SYST:ERR? Returns int code, err string
init()
     Initializes basic worker and opens VISA connection to device.
     Default connection timeout is 2 seconds
transition_to_buffered(device_name, h5file, initial_values, fresh)
     This configures counters, if any are defined, as well as optional compression options for saved data
     traces.
transition_to_manual (abort=False)
     Simple transition_to_manual method where no data is saved.
check_status()
     Periodically called by BLACS to check to status of the scope.
abort_buffered()
     Special abort shot code belongs here.
abort transition to buffered()
     Special abort shot configuration code belongs here.
check_remote_values()
clear(value)
     Sends standard *CLR to clear registers of device.
         Parameters value (bool) – value of Clear button in STBstatus.ui widget
convert_register(register)
     Converts returned register value to dict of bools
         Parameters register (int) – Status register value returned from read_stb
         Returns Status byte dictionary as formatted in VISATab
         Return type dict
interrupt_startup(reason='Process.interrupt_startup() called')
     Called from the parent process. Interrupt all blocking operations on starting the child process, causing
     Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
     interrupted before the child was started, otherwise self.child will be the child Popen object, which
     could be at any stage of setting up its connection with the parent. This method may be called multiple
     times without raising an exception, it will simply do nothing if startup has previously been interrupted
mainloop()
program_manual (front_panel_values)
     Over-ride this method if remote programming is supported.
         Returns VISAWorker.check_remote_values()
run (worker_name, device_name, extraargs)
     The method that gets called in the subprocess. To be overridden by subclasses
shutdown()
     Closes VISA connection to device.
```

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

#### KeysightXSeries.labscript device

```
class naqslab_devices.KeysightXSeries.labscript_device.KeysightXScope (name,
                                                                                         VISA_name,
                                                                                         trig-
                                                                                         ger_device,
                                                                                         trig-
                                                                                         ger connection,
                                                                                         num\_AI=4,
                                                                                         DI=True,
                                                                                         trig-
                                                                                         ger_duration=0.001,
                                                                                         com-
                                                                                         pres-
                                                                                         sion=None,
                                                                                         com-
                                                                                         pres-
                                                                                         sion_opts=None,
                                                                                         shuf-
                                                                                         fle=False,
                                                                                          **kwargs)
```

 $Bases: \ {\tt labscript.labscript.TriggerableDevice}$ 

VISA\_name can be full VISA connection string or NI-MAX alias. Trigger Device should be fast clocked device. num\_AI sets number of analog input channels, default 4 DI sets if DI are present, default True trigger\_duration set scope trigger duration, default 1ms Compression of traces in h5 file controlled by: compression: 'lzf', 'gzip', None compression\_opts: 0-9 for gzip shuffle: True/False

```
description = 'Keysight X Series Digital Oscilliscope'
allowed_children = [<class 'naqslab_devices.ScopeChannel'>]
generate_code (hdf5_file)
    Automatically called by compiler to write acquisition instructions to h5 file. Configures counters,
    analog and digital acquisitions.
acquire(start time)
    Call to define time when trigger will happen for scope.
add_device (device)
do checks()
get_all_children()
get_all_outputs()
get_properties (location=None)
    Get all properties in location
    If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
```

minimum\_recovery\_time = 0

```
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
   Add one or a bunch of properties packed into properties_dict
   property_names is a dictionary {key:val,...} where each val is a list [var1, var2, ...] of variables
        to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
   The earliest time output can be commanded from this device at the start of the experiment. This is
   nonzeo on secondary pseudoclock devices due to triggering delays.

trigger (t, duration)
   Request parent trigger device to produce a trigger at time t with given duration.

trigger_edge_type = 'rising'
```

KeysightXSeries.register classes

## 3.7 NovaTechDDS

#### 3.7.1 Overview

This modules covers the 409B-AC, 409B, and 440A DDS frequency synthesizers from Novatech.

Note that the 409B-AC class is largely interchangable with the DDS9m labscript\_devices class.

```
naqslab_devices.NovaTechDDS.
blacs_tab
naqslab_devices.NovaTechDDS.
blacs_worker
naqslab_devices.NovaTechDDS.
labscript_device
naqslab_devices.NovaTechDDS.
register_classes
naqslab_devices.NovaTechDDS.
runviewer_parser
```

## 3.7.2 Detailed Documentation of nagslab\_devices.NovaTechDDS

#### NovaTechDDS.blacs\_tab

```
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check_time()
clean ui on restart()
close tab(finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
    minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
    to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
    Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
    Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets(channel_properties)
create_dds_outputs (dds_properties)
create dds widgets(channel properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets(channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
    Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
    fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
    with global imports or other import-time behaviour that is undesirable to have run in the main process,
    for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
    process will not be started immediately, it will be started once the state machine mainloop begins
    running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
```

Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.

get\_builtin\_save\_data()

```
get_channel (channel)
     get_child_from_connection_table (parent_device_name, port)
    get_front_panel_properties()
    get_front_panel_values()
    get_property (property)
    get_save_data()
    get_tab_layout()
    hide error()
    initialise_workers()
    mainloop()
    property mode
    on_force_full_buffered_reprogram()
    on_resolve_value_inconsistency()
    property primary_worker
    program_device (*args, **kwargs)
    program_device_properties (*args, **kwargs)
    queue_work (worker_process, worker_function, *args, **kwargs)
    restart (*args)
    restore builtin save data(data)
         Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
    restore_save_data(data)
     set_tab_icon_and_colour()
         Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
         respectively
    set_terminal_visible(visible)
    shutdown_workers (*args, **kwargs)
     start_run (*args, **kwargs)
    property state
    statemachine_timeout_add(delay, statefunction, *args, **kwargs)
    statemachine_timeout_remove (statefunction)
     statemachine_timeout_remove_all()
     supports_remote_value_check (support)
    supports_smart_programming(support)
    transition_to_buffered(*args, **kwargs)
    transition_to_manual(*args, **kwargs)
    update_from_settings(settings)
class naqslab_devices.NovaTechDDS.blacs_tab.NovaTech409BTab(*args,
                                                                      **kwargs)
    Bases: naqslab_devices.NovaTechDDS.blacs_tab.NovaTech409B_ACTab
     ICON_BUSY = ':/qtutils/fugue/hourglass'
    ICON_ERROR = ':/qtutils/fugue/exclamation'
```

```
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check remote values (*args, **kwargs)
check_time()
clean_ui_on_restart()
close_tab (finalise=True)
    Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
    to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
    Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
    Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create analog widgets (channel properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets(channel_properties)
create_image_outputs (image_properties)
create_image_widgets(channel_properties)
create_property_widgets(device_properties)
create_worker (name, WorkerClass, workerargs=None)
    Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
    fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
    with global imports or other import-time behaviour that is undesirable to have run in the main process,
    for example if the imports may not be available to the main process (as may be the case once remote
    worker processes are implemented and the worker may be on a separate computer). The worker
    process will not be started immediately, it will be started once the state machine mainloop begins
    running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
disconnect_restart_receiver (function)
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
```

```
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table(parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_GUI()
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device (*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown_workers(*args, **kwargs)
start run(*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove (statefunction)
statemachine_timeout_remove_all()
supports_remote_value_check (support)
supports_smart_programming(support)
transition_to_buffered(*args, **kwargs)
transition_to_manual(*args, **kwargs)
update_from_settings(settings)
```

```
class nagslab_devices.NovaTechDDS.blacs_tab.NovaTech440ATab (*args,
                                                                             **kwargs)
     Bases: nagslab_devices.NovaTechDDS.blacs_tab.NovaTech409B_
                                                                            ACTab
     initialise_GUI()
     ICON_BUSY = ':/qtutils/fugue/hourglass'
     ICON_ERROR = ':/qtutils/fugue/exclamation'
     ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
     ICON_OK = ':/qtutils/fugue/tick'
     abort_buffered(*args, **kwargs)
     abort_transition_to_buffered(*args, **kwargs)
     add_secondary_worker(worker)
     auto_create_widgets()
     auto_place_widgets(*args)
     check_remote_values (*args, **kwargs)
     check_time()
     clean_ui_on_restart()
     close_tab (finalise=True)
         Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
          minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
         to perform these potentially blocking operations
     connect_restart_receiver (function)
     continue_restart(currentpage)
          Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
          Calls subsequent GUI operations in the main thread once finished blocking.
     create_analog_outputs (analog_properties)
     create_analog_widgets(channel_properties)
     create_dds_outputs (dds_properties)
     create_dds_widgets (channel_properties)
     create_device_properties (device_properties)
     create_digital_outputs (digital_properties)
     create_digital_widgets(channel_properties)
     create_image_outputs (image_properties)
     create_image_widgets (channel_properties)
     create_property_widgets (device_properties)
     create_worker (name, WorkerClass, workerargs=None)
          Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
          fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
          with global imports or other import-time behaviour that is undesirable to have run in the main process,
          for example if the imports may not be available to the main process (as may be the case once remote
          worker processes are implemented and the worker may be on a separate computer). The worker
```

property device\_name

disconnect\_restart\_receiver (function)

process will not be started immediately, it will be started once the state machine mainloop begins running. This way errors in startup will be handled using the normal state machine machinery.

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```
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device(*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
set_tab_icon_and_colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown_workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
supports_remote_value_check (support)
supports_smart_programming(support)
```

```
transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
NovaTechDDS.blacs worker
class nagslab devices.NovaTechDDS.blacs worker.NovaTech409B ACWorker(*args,
                                                                                              **kwargs)
     Bases: blacs.tab base classes.Worker
      init()
          Initialization command run automatically by the BLACS tab on startup. It establishes communication
          and sends initial default configuration commands
      check_connection()
          Sends non-command and tests for correct response returns tuple of connection state and reponse string
     write_check (command)
          Sends command and checks and confirms proper execution by reading 'OK' from device.
      check_error(response)
          Parse response for errors and raise appropriate error. If no error, returns response unaltered.
      check_remote_values()
          Queries device for current output settings. Return results as a dictionary to update the BLACS tab.
     program_manual (front_panel_values)
          Called within the BLACS worker during transitions. This calls program_static for each setting if it
          isn't already set.
     program_static (channel, type, value)
          General output parameter programming function. Only sends one command per use.
     transition_to_buffered(device_name, h5file, initial_values, fresh)
      abort_transition_to_buffered()
      abort_buffered()
     transition_to_manual(abort=False)
      shutdown()
      interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
      run (worker_name, device_name, extraargs)
          The method that gets called in the subprocess. To be overridden by subclasses
      start (*args, **kwargs)
          Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
```

Bases: naqslab\_devices.NovaTechDDS.blacs\_worker.NovaTech409B\_ACWorker

class nagslab\_devices.NovaTechDDS.blacs\_worker.NovaTech409BWorker(\*args,

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and

terminate (wait\_timeout=None, \*\*kwargs)

Popen.wait() on it.

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transition\_to\_manual (abort=False)

```
abort_buffered()
     abort_transition_to_buffered()
      check connection()
          Sends non-command and tests for correct response returns tuple of connection state and reponse string
      check error(response)
          Parse response for errors and raise appropriate error. If no error, returns response unaltered.
      check remote values()
          Queries device for current output settings. Return results as a dictionary to update the BLACS tab.
      init()
          Initialization command run automatically by the BLACS tab on startup. It establishes communication
          and sends initial default configuration commands
      interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
     mainloop()
     program_manual (front_panel_values)
          Called within the BLACS worker during transitions. This calls program_static for each setting if it
          isn't already set.
     program static(channel, type, value)
          General output parameter programming function. Only sends one command per use.
     run (worker_name, device_name, extraargs)
          The method that gets called in the subprocess. To be overridden by subclasses
      shutdown()
     start (*args, **kwargs)
          Call in the parent process to start a subprocess. Passes args and kwargs to the run() method
     terminate (wait_timeout=None, **kwargs)
          Interrupt process startup if not already done, ensuring self.child exists or is None if startup was in-
           terrupted before the process was created. Then if the child is not None, call Popen.terminate() and
          Popen.wait() on it.
     transition_to_buffered(device_name, h5file, initial_values, fresh)
     write check(command)
          Sends command and checks and confirms proper execution by reading 'OK' from device.
class naqslab_devices.NovaTechDDS.blacs_worker.NovaTech440AWorker(*args,
     Bases: naqslab_devices.NovaTechDDS.blacs_worker.NovaTech409BWorker
      init()
          Modified init from 409B-AC. The 440A only supports one baud rate and does not support output mode
          commands.
     program_static (channel, type, value)
           General output parameter programming function. Only sends one command per use.
     check_remote_values()
          The 440A Query command returns values in a different order and does not tell the amplitude.
      abort buffered()
```

```
abort_transition_to_buffered()
```

#### check\_connection()

Sends non-command and tests for correct response returns tuple of connection state and reponse string

#### check\_error(response)

Parse response for errors and raise appropriate error. If no error, returns response unaltered.

```
interrupt_startup(reason='Process.interrupt_startup() called')
```

Called from the parent process. Interrupt all blocking operations on starting the child process, causing Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was interrupted before the child was started, otherwise self.child will be the child Popen object, which could be at any stage of setting up its connection with the parent. This method may be called multiple times without raising an exception, it will simply do nothing if startup has previously been interrupted

#### mainloop()

```
program_manual (front_panel_values)
```

Called within the BLACS worker during transitions. This calls program\_static for each setting if it isn't already set.

```
run (worker_name, device_name, extraargs)
```

The method that gets called in the subprocess. To be overridden by subclasses

#### shutdown()

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

```
transition_to_buffered(device_name, h5file, initial_values, fresh)
```

```
transition_to_manual (abort=False)
```

```
write_check (command)
```

Sends command and checks and confirms proper execution by reading 'OK' from device.

#### NovaTechDDS.labscript\_device

```
class naqslab_devices.NovaTechDDS.labscript_device.NovaTech409B_AC (name,
```

```
par-
ent_device,
com_port=",
baud_rate=19200,
up-
date_mode='synchronous',
syn-
chronous_first_line_repeat=Fa
phase_mode='continuous',
ext_clk=False,
clk_freq=None,
clk_mult=None,
R option=False,
```

\*\*kwargs)

Bases: labscript.labscript.IntermediateDevice

Labscript device class for NovaTech 409B-AC variant DDS. This device has two dynamic channels (0,1) and two static channels (2,3). If an external clock frequency is enabled, and /R option is not being used, clk\_freq (in MHz) and clk\_mult (int) must also be defined.

```
description = 'NT-DDS409B-AC'
```

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```
allowed_children = [<class 'labscript.labscript.DDS'>, <class 'labscript.labscript.
     clock_limit = 9990
     clock_check()
          Checks to make sure clk_mult and clk_freq have valid values, as determined by the Novatech docu-
          mentation. Returns the correct frequency scaling factor to account for different clocking options.
     add_device(device)
     get_default_unit_conversion_classes(device)
          Child devices call this during their __init__ (with themselves as the argument) to check if there are
          certain unit calibration classes that they should apply to their outputs, if the user has not otherwise
          specified a calibration class
     quantise_freq(data, device)
          Provides bounds error checking and scales input values to instrument units (0.1 Hz) before ensuring
          uint32 integer type.
     quantise_phase (data, device)
          Ensures phase is wrapped about 360 degrees and scales to instrument units before type casting to
          uint16.
     quantise_amp (data, device)
          Ensures amplitude is within bounds and scales to instrument units (between 0 and 1023) before type-
          casting to uint16
     generate_code (hdf5_file)
     get_all_children()
     get all outputs()
     get_properties (location=None)
          Get all properties in location
          If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group(hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
          property names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
              to be pulled from properties dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
     property t0
          The earliest time output can be commanded from this device at the start of the experiment. This is
          nonzeo on secondary pseudoclock devices due to triggering delays.
class nagslab_devices.NovaTechDDS.labscript_device.NovaTech409B(name,
                                                                                     com_port=",
                                                                                     baud_rate=19200,
                                                                                     phase_mode='default',
                                                                                     R_option=False,
                                                                                     ext_clk=False,
                                                                                     clk_freq=None,
                                                                                     clk_mult=None,
                                                                                      **kwargs)
```

```
Bases: naqslab_devices.NovaTechDDS.labscript_device.NovaTech409B_AC
Labscript class for NovaTech 409B DDS. This device has four static DDS output channels.
description = 'NT-DDS409B'
allowed_children = [<class 'labscript.labscript.StaticDDS'>]
clock limit = 1
generate_code (hdf5_file)
     Modified version of 409B-AC generate_code that only handles static DDS outputs
add device (device)
clock check()
     Checks to make sure clk_mult and clk_freq have valid values, as determined by the Novatech docu-
     mentation. Returns the correct frequency scaling factor to account for different clocking options.
get_all_children()
get_all_outputs()
get_default_unit_conversion_classes(device)
     Child devices call this during their __init__ (with themselves as the argument) to check if there are
     certain unit calibration classes that they should apply to their outputs, if the user has not otherwise
     specified a calibration class
get_properties (location=None)
     Get all properties in location
     If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_amp (data, device)
     Ensures amplitude is within bounds and scales to instrument units (between 0 and 1023) before type-
     casting to uint16
quantise_freq(data, device)
     Provides bounds error checking and scales input values to instrument units (0.1 Hz) before ensuring
     uint32 integer type.
quantise_phase (data, device)
     Ensures phase is wrapped about 360 degrees and scales to instrument units before type casting to
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
     Add one or a bunch of properties packed into properties dict
     property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
         to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
     The earliest time output can be commanded from this device at the start of the experiment. This is
     nonzeo on secondary pseudoclock devices due to triggering delays.
```

```
class nagslab_devices.NovaTechDDS.labscript_device.NovaTech440A (name,
                                                                                     com_port=",
                                                                                     baud_rate=19200,
                                                                                     ext_clk=False,
                                                                                     clk_freq=None,
                                                                                     **kwargs)
     Bases: nagslab_devices.NovaTechDDS.labscript_device.NovaTech409B_AC
     Labscript class for Novatech 440A DDS. This is a high frequency DDS with single channel output that does
     not support amplitude control
     description = 'NT-DDS440A'
     allowed_children = [<class 'labscript.labscript.StaticDDS'>]
     clock_limit = 1
     add device(device)
     quantise_freq(data, device)
          Provides bounds error checking and scales input values to instrument units (0.1 Hz) before ensuring
          uint32 integer type.
     generate_code (hdf5_file)
          Modified generate code from 409B to only accept one channel and ignore amplitude commands which
          are not supported by the device.
     clock_check()
          Checks to make sure clk_mult and clk_freq have valid values, as determined by the Novatech docu-
          mentation. Returns the correct frequency scaling factor to account for different clocking options.
     get_all_children()
     get_all_outputs()
     get_default_unit_conversion_classes(device)
          Child devices call this during their __init__ (with themselves as the argument) to check if there are
          certain unit calibration classes that they should apply to their outputs, if the user has not otherwise
          specified a calibration class
     get_properties (location=None)
          Get all properties in location
          If location is None we return all keys
     get_property (name, location=None, *args, **kwargs)
     init_device_group (hdf5_file)
     property parent_clock_line
     property pseudoclock_device
     quantise_amp (data, device)
          Ensures amplitude is within bounds and scales to instrument units (between 0 and 1023) before type-
          casting to uint16
     quantise_phase (data, device)
          Ensures phase is wrapped about 360 degrees and scales to instrument units before type casting to
          uint16.
     quantise_to_pseudoclock (times)
     set_properties (properties_dict, property_names, overwrite=False)
          Add one or a bunch of properties packed into properties_dict
          property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
              to be pulled from properties_dict and added to the property with name key (it's location)
     set_property (name, value, location=None, overwrite=False)
```

#### property t0

The earliest time output can be commanded from this device at the start of the experiment. This is nonzeo on secondary pseudoclock devices due to triggering delays.

#### NovaTechDDS.register classes

#### NovaTechDDS.runviewer\_parser

### 3.8 SR865

#### 3.8.1 Overview

This device class controls the Stanford Research Systems 865 series Lock-in Amplifier. It only implements control functions. Data acquisition is not directly supported at this time. To get buffered data, please use a DAQ connected to the analog outputs of the 865.

```
naqslab_devices.SR865.blacs_tab
naqslab_devices.SR865.blacs_worker
naqslab_devices.SR865.
labscript_device
naqslab_devices.SR865.
register_classes
```

### 3.8.2 Detailed Documentation of naqslab\_devices.SR865

#### SR865.blacs tab

```
class naqslab_devices.SR865.blacs_tab.SR865Tab(*args, **kwargs)
    Bases: naqslab_devices.VISA.blacs_tab.VISATab

You MUST override this method in order to define the device worker. You then call this parent method to finish initialization.

status_byte_labels = {'bit 0': 'OPC', 'bit 1': 'Input Queue Overflow', 'bit 2': initialise_GUI()

Loads the standard STBstatus.ui widget and sets the worker defined in __init__
```

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```
tau_changed(*args, **kwargs)
sens_changed(*args, **kwargs)
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values (*args, **kwargs)
check_time()
clean_ui_on_restart()
close tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
     to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
     Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets (channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create worker(name, WorkerClass, workerargs=None)
     Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
     fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
     running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
```

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disconnect\_restart\_receiver (function)

```
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device(*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
send_clear(*args, **kwargs)
set tab icon and colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown_workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_monitor(*args, **kwargs)
```

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```
status_widget = 'STBstatus.ui'
     supports_remote_value_check (support)
     supports_smart_programming(support)
     transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
SR865.blacs_worker
class naqslab_devices.SR865.blacs_worker.SR865Worker(*args, **kwargs)
     Bases: nagslab_devices.VISA.blacs_worker.VISAWorker
     program_string = 'OFLT {:d}; SCAL {:d}; PHAS {:.6f}'
     read_string = 'OFLT?;SCAL?;PHAS?'
     phase_parser (phase_string)
          Phase Query string parser
     coerce_tau(tau_constant)
          Returns coerced, valid integer setting. Tau value rounds up. Returns max or min valid setting if out of
          bound.
     coerce_sens (sensitivity)
          Returns coerced, valid integer setting. Sens value rounds down. Returns max or min valid setting if
          out of bound.
     init()
          Initializes basic worker and opens VISA connection to device.
          Default connection timeout is 2 seconds
     check_remote_values()
          Queries the current settings for all three parameters. Parses results to actual numbers and returns.
     program_manual (front_panel_values)
          Performans manual updates from BLACS front panel. Tau and Sensitivity settings are coerced to
          nearest allowed value
     transition_to_buffered(device_name, h5file, initial_values, fresh)
          Stores various device handles for use in transition_to_manual method.
          Automatically called by BLACS. Should be over-ridden by inheritors.
              Parameters
                  • device_name (str) – Name of device from connectiontable
                  • h5file (str) - path to shot h5_file
                  • initial_values (dict) - Contains the start of shot values
                  • fresh (bool) – Indicates if smart_programming should be refreshed this shot
     check_status()
          Queries device state using the ESR register. Bit definitions defined in blacs_tab
     abort_buffered()
          Special abort shot code belongs here.
     abort_transition_to_buffered()
          Special abort shot configuration code belongs here.
     clear(value)
```

Sends standard \*CLR to clear registers of device.

**Parameters value** (bool) – value of Clear button in STBstatus.ui widget

```
convert_register(register)
```

Converts returned register value to dict of bools

Parameters register (int) - Status register value returned from read\_stb

Returns Status byte dictionary as formatted in VISATab

Return type dict

```
interrupt_startup(reason='Process.interrupt_startup() called')
```

Called from the parent process. Interrupt all blocking operations on starting the child process, causing Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was interrupted before the child was started, otherwise self.child will be the child Popen object, which could be at any stage of setting up its connection with the parent. This method may be called multiple times without raising an exception, it will simply do nothing if startup has previously been interrupted

#### mainloop()

```
run (worker_name, device_name, extraargs)
```

The method that gets called in the subprocess. To be overridden by subclasses

#### shutdown()

Closes VISA connection to device.

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate (wait_timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

```
transition_to_manual(abort=False)
```

Simple transition\_to\_manual method where no data is saved.

### SR865.labscript\_device

```
class naqslab_devices.SR865.labscript_device.SR865 (name, VISA_name)
    Bases: naqslab_devices.VISA.labscript_device.VISA

    VISA_name can be full VISA connection string or NI-MAX alias

    description = 'SR865 Lock-In Amplifier'
    allowed_children = None
    tau = None
    sens = None
    phase = None
```

Set the time constant in seconds. Uses numpy digitize to translate to int values. Using digitize corrects for round-off errors and coerces input to nearest allowed setting.

```
set_sens (sensitivity)
```

Set the sensitivity in Volts Uses numpy digitize to translate to int values. Using digitize corrects for round-off errors and coerces input to nearest allowed setting.

#### set\_phase (phase)

Set the phase reference in degrees Device auto-converts to -180,180 range

### generate\_code (hdf5\_file)

Generates the transition to buffered code in the h5 file. If parameter is not specified in shot, NaN and -1 values are set to tell worker not to change the value when programming.

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```
add_device (device)
get_all_children()
get_all_outputs()
get_properties (location=None)
     Get all properties in location
     If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group (hdf5_file)
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
set_properties (properties_dict, property_names, overwrite=False)
     Add one or a bunch of properties packed into properties_dict
     property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
         to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
     The earliest time output can be commanded from this device at the start of the experiment. This is
```

SR865.register classes

### 3.9 TektronixTDS

### 3.9.1 Overview

This covers the TDS series of Tektronix oscilloscopes.

```
naqslab_devices.TektronixTDS.
blacs_tab
nagslab_devices.TektronixTDS.
blacs worker
nagslab_devices.TektronixTDS.
labscript_device
nagslab_devices.TektronixTDS.
register_classes
```

## 3.9.2 Detailed Documentation of naqslab\_devices.TektronixTDS

nonzeo on secondary pseudoclock devices due to triggering delays.

#### TektronixTDS.blacs\_tab

```
class naqslab_devices.TektronixTDS.blacs_tab.TDS_ScopeTab(*args, **kwargs)
    Bases: naqslab_devices.VISA.blacs_tab.VISATab
     You MUST override this method in order to define the device worker. You then call this parent method to
     finish initialization.
     status_byte_labels = {'bit 0':
                                           'Unused', 'bit 1':
                                                                  'Unused', 'bit 2':
                                                                                          'Query Erro:
```

```
initialise_GUI()
    Loads the standard STBstatus.ui widget and sets the worker defined in __init__
ICON_BUSY = ':/qtutils/fugue/hourglass'
ICON_ERROR = ':/qtutils/fugue/exclamation'
ICON_FATAL_ERROR = ':/qtutils/fugue/exclamation-red'
ICON_OK = ':/qtutils/fugue/tick'
STBui_path = 'C:\\labscript_suite\\naqslab_devices\\VISA\\STBstatus.ui'
abort_buffered(*args, **kwargs)
abort_transition_to_buffered(*args, **kwargs)
add_secondary_worker(worker)
auto_create_widgets()
auto_place_widgets(*args)
check_remote_values(*args, **kwargs)
check_time()
clean_ui_on_restart()
close_tab (finalise=True)
     Close the tab, terminate subprocesses and join the mainloop thread. If finalise=False, then do not ter-
     minate subprocesses or join the mainloop. In this case, callers must manually call finalise_close_tab()
    to perform these potentially blocking operations
connect_restart_receiver (function)
continue_restart(currentpage)
     Called in a thread for the stages of restarting that may be blocking, so as to not block the main thread.
     Calls subsequent GUI operations in the main thread once finished blocking.
create_analog_outputs (analog_properties)
create_analog_widgets(channel_properties)
create_dds_outputs (dds_properties)
create_dds_widgets (channel_properties)
create_device_properties (device_properties)
create_digital_outputs (digital_properties)
create_digital_widgets (channel_properties)
create_image_outputs (image_properties)
create_image_widgets (channel_properties)
create_property_widgets (device_properties)
create_worker (name, WorkerClass, workerargs=None)
    Set up a worker process. WorkerClass can either be a subclass of Worker, or a string containing a
    fully qualified import path to a worker. The latter is useful if the worker class is in a separate file
     with global imports or other import-time behaviour that is undesirable to have run in the main process,
     for example if the imports may not be available to the main process (as may be the case once remote
     worker processes are implemented and the worker may be on a separate computer). The worker
     process will not be started immediately, it will be started once the state machine mainloop begins
     running. This way errors in startup will be handled using the normal state machine machinery.
property device_name
```

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disconnect\_restart\_receiver (function)

```
property error_message
finalise_close_tab(currentpage)
finalise_restart(currentpage)
property force_full_buffered_reprogram
get_all_save_data()
get_builtin_save_data()
    Get builtin settings to be restored like whether the terminal is visible. Not to be overridden.
get_channel (channel)
get_child_from_connection_table (parent_device_name, port)
get_front_panel_properties()
get_front_panel_values()
get_property (property)
get_save_data()
get_tab_layout()
hide_error()
initialise_workers()
mainloop()
property mode
on_force_full_buffered_reprogram()
on_resolve_value_inconsistency()
property primary_worker
program_device(*args, **kwargs)
program_device_properties (*args, **kwargs)
queue_work (worker_process, worker_function, *args, **kwargs)
restart (*args)
restore_builtin_save_data(data)
    Restore builtin settings to be restored like whether the terminal is visible. Not to be overridden.
restore_save_data(data)
send_clear(*args, **kwargs)
set tab icon and colour()
    Set the tab icon and the colour of its text to the values of self._tab_icon and self._tab_text_colour
    respectively
set_terminal_visible(visible)
shutdown_workers(*args, **kwargs)
start_run (*args, **kwargs)
property state
statemachine_timeout_add(delay, statefunction, *args, **kwargs)
statemachine_timeout_remove(statefunction)
statemachine_timeout_remove_all()
status_monitor(*args, **kwargs)
```

```
status_widget = 'STBstatus.ui'
     supports_remote_value_check (support)
     supports_smart_programming(support)
     transition_to_buffered(*args, **kwargs)
     transition_to_manual(*args, **kwargs)
     update_from_settings(settings)
TektronixTDS.blacs_worker
class naqslab_devices.TektronixTDS.blacs_worker.TDS_ScopeWorker(*args,
                                                                                   **kwargs)
     Bases: naqslab_devices.VISA.blacs_worker.VISAWorker
     setup_string = ':HEADER OFF; *ESE 60; *SRE 32; *CLS; :DAT:ENC RIB; WID 2; '
     read_y_parameters_string = ':DAT:SOU CH%d;:WFMPRE:YZE?;YMU?;YOFF?'
     read_x_parameters_string = ':WFMPRE:XZE?;XIN?'
     read_waveform_string = 'CURV?'
     waveform_parser (raw_waveform_array, y0, dy, yoffset)
          Parses the numpy array from the CURV? query.
     init()
          Initializes basic worker and opens VISA connection to device.
          Default connection timeout is 2 seconds
     transition_to_manual(abort=False)
          Simple transition_to_manual method where no data is saved.
     check_status()
          Uses the more informative ESR register.
     abort_buffered()
          Special abort shot code belongs here.
     abort_transition_to_buffered()
          Special abort shot configuration code belongs here.
     check_remote_values()
     clear(value)
          Sends standard *CLR to clear registers of device.
              Parameters value (bool) – value of Clear button in STBstatus.ui widget
     convert_register (register)
          Converts returned register value to dict of bools
              Parameters register (int) – Status register value returned from read_stb
              Returns Status byte dictionary as formatted in VISATab
              Return type dict
     interrupt_startup(reason='Process.interrupt_startup() called')
          Called from the parent process. Interrupt all blocking operations on starting the child process, causing
          Process.start() to raise Interrupted(reason). After interruption, self.child may be None if startup was
          interrupted before the child was started, otherwise self.child will be the child Popen object, which
          could be at any stage of setting up its connection with the parent. This method may be called multiple
          times without raising an exception, it will simply do nothing if startup has previously been interrupted
```

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mainloop()

```
program_manual (front_panel_values)
    Over-ride this method if remote programming is supported.
        Returns VISAWorker.check_remote_values()
```

run (worker\_name, device\_name, extraargs)

The method that gets called in the subprocess. To be overridden by subclasses

shutdown()

Closes VISA connection to device.

```
start (*args, **kwargs)
```

Call in the parent process to start a subprocess. Passes args and kwargs to the run() method

```
terminate(wait timeout=None, **kwargs)
```

Interrupt process startup if not already done, ensuring self.child exists or is None if startup was interrupted before the process was created. Then if the child is not None, call Popen.terminate() and Popen.wait() on it.

```
transition_to_buffered(device_name, h5file, initial_values, fresh)
```

Stores various device handles for use in transition\_to\_manual method.

Automatically called by BLACS. Should be over-ridden by inheritors.

#### **Parameters**

- **device\_name** (str) Name of device from connectiontable
- **h5file** (str) path to shot h5\_file
- initial\_values (dict) Contains the start of shot values
- **fresh** (bool) Indicates if smart programming should be refreshed this shot

#### TektronixTDS.labscript device

get\_all\_outputs()

```
class nagslab devices. Tektronix TDS. labscript device. TDS Scope (name,
                                                                          VISA name,
                                                                          trig-
                                                                          ger_device,
                                                                          trig-
                                                                          ger_connection,
                                                                          **kwargs)
    Bases: labscript.labscript.TriggerableDevice
     VISA_name can be full VISA connection string or NI-MAX alias. Trigger Device should be fast clocked
     device.
    description = 'Tektronics TDS Series Digital Oscilliscope'
     allowed_children = [<class 'naqslab_devices.ScopeChannel'>]
    trigger_duration = 0.001
    generate_code (hdf5_file)
     acquire (start_time)
         Call to define time when trigger will happen for scope.
     add_device (device)
     do_checks()
     get_all_children()
```

```
get_properties (location=None)
     Get all properties in location
     If location is None we return all keys
get_property (name, location=None, *args, **kwargs)
init_device_group(hdf5_file)
minimum_recovery_time = 0
property parent_clock_line
property pseudoclock_device
quantise_to_pseudoclock (times)
\verb|set_properties| (properties_dict, property_names, overwrite=False)|
     Add one or a bunch of properties packed into properties_dict
     property_names is a dictionary {key:val,...} where each val is a list [var1, var2,...] of variables
         to be pulled from properties_dict and added to the property with name key (it's location)
set_property (name, value, location=None, overwrite=False)
property t0
     The earliest time output can be commanded from this device at the start of the experiment. This is
     nonzeo on secondary pseudoclock devices due to triggering delays.
trigger(t, duration)
     Request parent trigger device to produce a trigger at time t with given duration.
trigger_edge_type = 'rising'
```

TektronixTDS.register classes

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**CHAPTER** 

**FOUR** 

### BUILDING DOCUMENTATION

The API documentation for this library leverages the Sphinx automatic python documenation generator. The general structure is to use the Sphinx-apidoc infrastucture to read source code docstrings to automatically build the function/class reference documentation for each device. Hand-written ReStructedText files (quick syntax guide) are then used to provide high-level documentation that imports the auto-generated documentation. A makefile is provided to run the correct apidoc and sphinx-build commands.

## 4.1 Sphinx Environment

In order to build the documentation from scratch, a functioning labscript environment is needed with sphinx also installed. Because sphinx require a large amount of dependencies, it is recommended to copy your local labscript environment then install and use sphinx from there.

Sphinx can be installed into the labscript environment by installing the packages: sphinx>=2.2 and sphinx\_rtd\_theme. This will allow building of the html documentation.

If you also wish to build the pdf documentation, you must also install perl and a latex environment (such as MikTeX for windows). The latex build is controlled using the latexmk latex package and requires a great many other latex packages. A partial list of required latex packages is: cmap, fncychap, tabulary, parskip, capt-of.

## 4.2 Sphinx Build

The documentation build is automated through makefiles. All commands are run from the doc subfolder.

The automated documentation build is perfored using

```
make apidoc
```

The auto-generated files are placed in the \_apidoc subfolder of doc and are given the import name of the module with the file suffix .inc.

The complete documentation is built using sphinx-build and currently supports two targets: html and latex-pdf. They are run using

```
make html
#or
make latexpdf
```

## 4.3 Adding Documentation

The main documentation tree is found in index.rst. New devices should be added using devices.rst. Each device should have it's own rst file that provides some high-level documentation and includes the autogenerated apidoc file. All modules and submodules in the top-level directory of the library will have documenta-

tion auto-generated using apidoc. It is up to the user to include those files where appropriate in the documenation. The include statement is of the form:

.. include:: \_apidoc\naqslab\_devices.NovaTechDDS.inc

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# **FIVE**

# **INDICES AND TABLES**

- genindex
- modindex
- search

## CHAPTER

# SIX

# **CREDITS**

Authors David Meyer Zac Castillo
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Version 0.2.7

100 Chapter 6. Credits

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                       method), 21
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                                                                                                                                                               lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648BTab
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                       method), 25
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                       method), 27
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                       lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648@Tethod), 32
                       method), 29
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                       lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648Dnlabod), 36
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                       lab_devices.SignalGenerator.BLACS.RS_SMHU.RS_SMHibiatiblod), 50
                       method), 39
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                                                                                                                                                              lab_devices.SR865.blacs_tab.SR865Tab
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                       lab_devices.SignalGenerator.blacs_tab.SignalGeneratorTabethod), 84
                                                                                                                                       create_dds_widgets()
                       method), 50
create_dds_outputs()
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                       lab_devices.SR865.blacs_tab.SR865Tab
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                       method), 84
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                                                                                                                                                              lab\_devices.VISA.blacs\_tab.VISATab
create_dds_outputs()
                                                                                                                   (naqs-
                       lab\_devices. Tektronix TDS.blacs\_tab. TDS\_Scope Tab
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                       method), 89
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                                                                                                                                                                                                                                                          (nags-
create_dds_outputs()
                                                                                                                   (nags-
                                                                                                                                                               lab_devices.KeysightXSeries.blacs_tab.KeysightXScopeTab
                       lab_devices.VISA.blacs_tab.VISATab
                                                                                                                                                               method), 66
                       method), 12
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create_dds_widgets()
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                       lab_devices.KeysightXSeries.blacs_tab.KeysightXScopeTabnethod), 71
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create_dds_widgets()
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                                                                                                                                                               lab_devices.NovaTechDDS.blacs_tab.NovaTech409BTab
                       lab_devices.NovaTechDDS.blacs_tab.NovaTech409B_ACTabthod), 73
                       method), 71
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                  method), 75
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create_device_properties()
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                  lab_devices.PulseBlaster_No_DDS_200.blacs_tab.PulseBlasterdNo5DDS_200_Tab
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                                                                                                        create_digital_outputs()
create_device_properties()
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                                                                                                                          lab_devices.SignalGenerator.BLACS.HP_8642A.HP_8642ATal
                  lab_devices.PulseBlasterESRPro300.blacs_tab.PulseBlastaeESRPro300Tab
                  method), 55
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create_device_properties()
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                  lab_devices.SignalGenerator.BLACS.HP_8642A.HP_8642AAFhbd), 21
                  method), 17
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create_device_properties()
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                  lab_devices.SignalGenerator.BLACS.HP_8643A.HP_8643A4Pbd), 25
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                  method), 21
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create_device_properties()
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                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648ATedbod), 27
                  method), 25
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                                                                                                                          lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648CTab
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                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648BiTetlhod), 29
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create_device_properties()
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                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648@Tethod), 32
                                                                                                        create_digital_outputs()
                  method), 29
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create_device_properties()
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                                                                                                                          lab_devices.SignalGenerator.BLACS.RS_SMF100A.RS_SMF10
                  lab\_devices. Signal Generator. BLACS. HP\_8648. HP\_8648 \textit{DrWath} od),\,36
                  method), 32
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create_device_properties()
                                                                                                                          lab_devices.SignalGenerator.BLACS.RS_SMHU.RS_SMHUTab
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                  lab_devices.SignalGenerator.BLACS.RS_SMF100A.RS_SMEth00A_Tab
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                  method), 36
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create_device_properties()
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                  lab_devices.SignalGenerator.BLACS.RS_SMHU.RS_SMHibiatibled), 50
                  method), 39
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                  lab_devices.SignalGenerator.blacs_tab.SignalGeneratorTabethod), 84
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                  method), 50
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create_device_properties()
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                  lab_devices.SR865.blacs_tab.SR865Tab
                                                                                                                          method), 89
                  method), 84
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create_device_properties()
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                  lab\_devices. TektronixTDS.blacs\_tab.TDS\_ScopeTab
                                                                                                                          method), 12
                                                                                                        create_digital_widgets()
                  method), 89
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create_device_properties()
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                  lab_devices.VISA.blacs_tab.VISATab
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                  method), 12
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create_digital_outputs()
                                                                                        (naqs-
                  lab\_devices. \textit{KeysightXSeries.blacs\_tab.KeysightXScopeTab} nethod), 71
                  method), 66
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create_digital_outputs()
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                  lab\_devices. Nova Tech DDS. blacs\_tab. Nova Tech 409B\_AC \textit{Tab} thod), 73
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                  lab_devices.NovaTechDDS.blacs_tab.NovaTech409BTab_method), 75
                  method), 73
                                                                                                        create_digital_widgets()
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create_digital_outputs()
                                                                                        (nags-
                                                                                                                          lab_devices.PulseBlaster_No_DDS_200.blacs_tab.PulseBlaste
                  lab_devices.NovaTechDDS.blacs_tab.NovaTech440ATab_method), 61
                  method), 75
                                                                                                        create_digital_widgets()
                                                                                                                                                                                                 (naqs-
                                                                                                                          lab\_devices. Pulse Blaster ESR Pro 300. blacs\_tab. Pulse Blaster ESR Pro 300. black\_tab. Pulse Blaster ESR
create_digital_outputs()
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lab\_devices.PulseBlaster\_No\_DDS\_200.blacs\_tab.PulseBhastlavdNo55DDS\_200\_Tab

lab\_devices.SignalGenerator.BLACS.HP\_8648.HP\_8648ATab

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lab_devices.SignalGenerator.BLACS.HP_8643A.HP_8643ATab
create_digital_widgets()
                                                                                           (nags-
                  lab_devices.SignalGenerator.BLACS.HP_8642A.HP_8642AAFhbd), 21
                                                                                                           create_image_outputs()
                  method), 17
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create_digital_widgets()
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                  lab_devices.SignalGenerator.BLACS.HP_8643A.HP_8643A4Flabd), 25
                  method), 21
                                                                                                           create_image_outputs()
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create_digital_widgets()
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                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648ArTedhod), 27
                  method), 25
                                                                                                           create_image_outputs()
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create_digital_widgets()
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                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648BiTedbod), 29
                  method), 27
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create_digital_widgets()
                                                                                           (nags-
                  lab_devices.SignalGenerator.BLACS.HP_8648.HP_8648GTethod), 32
                  method), 29
                                                                                                           create_image_outputs()
                                                                                                                                                                                                      (nags-
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