Effective: June, 2023
Supersedes: MSG33-5021-M3, Ed. 07/01/2021

PHD User Guide

API Reference

Parker

ENGINEERING YOUR SUCCESS.

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Publication History

The following table provides an overview of the changes made to this document over the course of its publication history.

Release	Description of Change, Date
Rev. 001	First release of this document, 10/19/2017
Rev. 002	Edits throughout 09/11/2018
Rev. 003	Add encoder information, update images, 10/23/2018
Rev. 004	USB cable note, update images, 06/4/2019
Rev. 005	Add deinterlace notes to Chapter 3, 7/30/2019
Rev. 006	Add cos.ext_od_result responses to Appendix B, 9/5/2019
Rev. 007	Change nxs.adc *TEMP_SENSE* key value range, 10/15/2019
Rev. 008	Add to nxs.rtc note, and receive DTC note, 11/1/2019
Rev. 009	Fix *update_interval* parameter in section 3.1, 11/20/2019
Rev. 010	Changes to Auto-Installer section 2.7, 2/17/2020
Rev. 011	Fix *year* parameter in section 2.5.11, 4/7/2020
Rev. 012	Fix *nxs.adc* key values in section 2.5.1, change *publish_unmatched_filename* to *publish_all_filename* and add USB stick notes in Section 2.7.1-2.7.3, 4/16/2020
Rev. 013	Add *nxs.set_auto_brightness* notes on ambient light sensor in section 2.5.12, 4/20/2020
Rev. 014	Add *nxs.din* GPIO09 notes for PHD50 in section 2.5.3, 4/29/2020
Rev. 015	Add Section 3.1.1 Camera Settings, 4/15/2021
Rev. 015	Restructure of entire document, Edits through section 5.1 and beyond 7/1/2021

1. Introduction

These instructions are to be used as a reference tool for the vehicle manufacturer's design, production, and service personnel.
The user of these instructions should have basic knowledge in the handling of electronic equipment.

1.1. Overview

The PHD family of displays are general purpose color displays with capacitive touchscreens suitable for a wide range of industry applications.

The PHD software platform consists of various levels of software that support each other to create a complete working system. Access to the lower level functionality of this system is provided to end users via the Dynamic Communications Platform (DCP).

This document details the events provided to the Crank Storyboard Engine via the PHD API events.evt file. This file, when placed into a Crank Storyboard Designer project's events folder makes those events available to application developers working within the Crank Storyboard Designer.

This document also details all the events available to UI developers for interacting with the system. They are grouped by Storyboard Engine IO channel which also serves to divide them into functional groups.

Simple Lua function examples are provided. For most of these examples, validation of input parameters is not given, as this is simple to do. Any Lua variables referenced in sample functions that are not defined in the function can be assumed to be defined at a higher scope. There would also be opportunity, in a larger project, to combine a lot of these Lua functions into more generic event sending or receiving functions with logic to handle multiple events.

The platform software is consistent across PHD28, PHD50 and PHD70. Where it is not, those differences are called out. In all cases, all events are available across all platforms, but may never occur (for externally generated events) or may be ignored when sent on platforms where they are not supported.

1.2. Definitions

The terminology used in this manual are defined in the following table.

Abbreviation	Explanation
Channel	A channel is an input mechanism for Storyboard IO applications, via which they can receive events.
Crank Storyboard Designer	A desktop development suite that enables user interface designers to easily prototype the look and feel of a product and then deploy it to a target equipped with the Crank Storyboard Engine.
Crank Storyboard Engine	The runtime component that runs on the target device and presents the content developed in Crank Storyboard Designer.

Abbreviation	Explanation
Crank Storyboard IO or Storyboard IO	This is a library and API provided by Crank Software that allows other processes to send events to, and receive events from, the Crank Storyboard Engine, or any other process using the Crank Storyboard IO library. Crank Storyboard IO was previously known as, and often still referred to as “greio”. Every Crank Storyboard IO process creates a named channel for listening and can send events to named channels created by other Crank Storyboard IO processes.
DCP	Dynamic Communications Platform This is an API that abstracts a platform or OS-specific IPC protocol. It is the IPC mechanism via which all of the Parker middleware communicates. It is also the method by which system data is converted into Crank Storyboard IO events for use by the user application.
Event	An identifier used by the Storyboard IO library and the Storyboard Engine to trigger an action. Events contain an event name and an event payload.
Event payload	Data associated with an event. The event payload is described using a format string.
Format string	Provides a description of how to interpret an event payload. The format string uses the format: [number of bytes][signed/unsigned][number of elements][ ] [name] For example, standard C data types would be formatted as follows: **1s0 --> Special null terminated string** **1s1|1u1 --> 1 byte integer (int8_t uint8_t)** **2s1|2u1 --> 2 byte integer (int16_t uint16_t)** **4s1|4u1 --> 4 byte integer (int32_t uint32_t)** **4f1 --> 4 byte floating point (IEEE754 float)** **8s1|8u1 --> 8 byte integer (int64_t uint64_t)** So a structure such as: **struct {** **int32_t itemA;** **uint16_t itemB;** **}** would have the format string: *4s1 itemA 2u1 itemB.* When using numeric values, this API has, where ever possible, adopted a 32-bit signed or unsigned value. This is because ARM processors are more efficient when using 32-bit quantities than other data sizes.
GPL	The GNU General Public License, the license under which Linux kernel source code and ancillary GPL utilities are released.
IPC	Inter-Process Communications. A mechanism for moving a data between two (or more) processes that may reside in separate address spaces.
Key	An identifier paired with a value, attached to an event. A key-value pair is represented in this document as (key, value). Those parentheses serve to delimit the text and are not used during programming.
NCC	Non-volatile customer configuration (or ncc) is the component that handles access to the non-volatile memory available on the system. It uses Storyboard I/O channel “ncc”.

Abbreviation	Explanation
Nexus	Nexus (or nxs) is the system hardware interface component that bundles together much of the low-level functionality (ADC, backlight, RTC) for presentation to Crank via DCP. It uses Storyboard I/O channel “nxs”.
Storyboard application	An application developed using the Crank Storyboard Designer that can run on a target using the Crank Storyboard Engine. The Storyboard application communicates with lower-level functionality via DCP using the events described in this API.
UI	User Interface. This is the graphical component of a Storyboard application used to interact with the device.
Value	Data associated with a key. Supported types are signed and unsigned integers (8, 16, 32 or 64 bits), floats (32-bit only), arrays of integers or floats, and null-terminated strings. A key-value pair is represented in this document as (key, value). Those parentheses serve to delimit the text and are not used during programming.

1.3. Product documentation

The following publications are relevant for users of this product.

- PHD Catalog datasheets MSG33-5021/US thru MSG33-5023/US
- PHD User Guide/Instruction book MSG33-5021-IB/US
- PHD Application Packager manual MSG33-5021-M1/US
- PHD J1939 Stack Generation manual MSG33-5021-M4/US

All documentation may be found on our web pages, located at www.parker.com/ecd.

Contact the manufacturer if there is anything you are not sure about or if you have any questions regarding the product and its handling or maintenance.

The term “manufacturer” refers to Parker-Hannifin Corporation.

2. Application Programming Interface

2.1. Description

This section describes the events available to Storyboard Designer for sending data to and receiving data from the rest of the system.

The API definitions are divided into functional blocks, although there are a number of DCP management events that are available across all I/O channels. Those are described first, in the next section.

All DCP-related content is sent from the Storyboard application via events.

For many events, multiple keys are supported. When sending a multiple key event, not all keys need to be specified, only those of interest.

For example, if sending an nxs.set_dout message to set DOUTs GPIO2 and P5V0, only those two keys, along with their values, would need to be sent. Any keys not specified would retain their current state.

PHD specific events should not be subscribed to in the gre.init event. It is recommended that PHD specific events be subscribed to in the gre.screenshow.post event for whatever the main entry screen into the application is during startup.

In some conditions, Lua script allows for direct access to certain registers on the microprocessor. Writing to registers in this fashion bypasses the API set and is strongly discouraged. Doing so may result in undocumented and undesirable effects in the operation and performance of the PHD.

2.2. DCP Management Events

2.2.1. phd.subscribe

Event	*phd.subscribe*
Event Data	
Keys	Values
event	<event_name>
receiver	<IO channel>
Direction	Output
Channel	any
Notes	Sent by the application to tell DCP it wishes to subscribe to a particular event or class of events. For example, to subscribe to the system hardware interface backlight events, send the *phd. subscribe* event to the system hardware interface channel (“nxs”) with data containing the event name and the IO channel name of the receiver (usually the Storyboard application name). (“event”, “<event_name>”) (“receiver”, “storyboard_app.gapp”) If the application does not subscribe to a class of events, it does not receive them. This avoids the problem of DCP flooding the application with every DCP message in the system. Subsystems can communicate with each other via DCP without disturbing the application. Please note that Lua examples for received events assume that the Storyboard application has subscribed to the event via this mechanism and reception of the event is set to trigger a Lua function. Also note you do not need to subscribe to a channel to send events to it.

Lua Example	**function register**(mapargs)
	    local data = {}
	    data[“event”] = “nxs.backlight”
	    data[“receiver”] = “storyboard_app_name.gapp”
	    gre.send_event_data(“**phd.subscribe**”,
	                    “1s0 event 1s0 receiver”,
	                    data, “nxs”)
	end

2.3. Non-volatile customer configuration channel events

2.3.1. ncc.command

Event	*ncc.command*	
Event Data		
Keys	**Values**	**Description**
cmd	“read” or “write”	Desired command for non-volatile memory.
addr	<0..32767>	Address, in bytes, from which to read or write.
len	<1..4096>	Number of bytes to read or write.
fmt	“string”	A Crank-style format specifier, e.g. 1s0, 4u1 used to pack the values.
data	value	Used when writing only. Size and format of the data depends on size and format being written.
Direction	output	
Channel	ncc	
Notes	Sent by the application to issue a command to the non-volatile memory. “read” command: Assuming all keys are present and their values are valid, the data is extracted from memory and the *ncc.response* event is posted. You would need to subscribe to this event to see the result of your “read” command. The read example below demonstrates a request to read 4 bytes of data from offset 1024. Note that *fmt* is set to 4u1, so *ncc.response* returns 1 element of 4 bytes. “write” command: The write example below demonstrates modifying a 4-byte value in the non-volatile memory at offset 0.	

Lua Example	function **request_read**(mapargs)
	    local data = {}
	    data[“cmd”] = “read”
	    data[“addr”] = 1024
	    data[“len”] = 4
	    data[“fmt”] = “4u1”
	    gre.send_event_data(“ncc.command”,
	                    “1s0 cmd 4u1 addr 4u1 len 1s0 fmt”, data, “ncc”)
	end
	function **write_ncc**(mapargs)
	    local data = {}
	    data[“cmd”] = “write”
	    data[“addr”] = 1024
	    data[“len”] = 4
	    data[“fmt”] = “4u1”
	    data[“data”] = 0xDEADBEEF
	    gre.send_event_data(“ncc.command”,
	                    “1s0 cmd 4u1 addr 4u1 len 1s0 fmt”, data, “ncc”)
	end	

2.3.2. ncc.response

Event	*ncc.response*	
Event Data		
Keys	**Values**	**Description**
addr	<0..32767>	The returned data’s address in the non-volatile memory.
data	<0..4095>	The returned data from the non-volatile memory.
Direction	input	
Channel	ncc	
Notes	Received by the application in response to an *ncc.command* “read” command. The example below assumes the Storyboard application is set up to call Lua function **ncc_response** when the *ncc.response* event occurs. It further assumes a simple 4-byte integer value was requested. Event data is available through the *mapargs* argument.	

Lua Example	`function ncc_response(mapargs)`
	`    local ev = mapargs.context_event_data`
	`    local addr = ev[“addr”]`
	`    local data = ev[“data”]`
	`    if (addr ~= nil and data ~= nil) then`
	`        print(“Read data ”..data..“ from address ”..addr)`
	`    end`
	`end`	

2.4. Version supervisor events

2.4.1. serial

Event	*serial*	
Event Data		
Keys	**Values**	**Description**
name	<string>	Name of device (e.g. PHD28, PHD50, PHD70).
pcb_serial	<string>	Serial number of circuit board.
pcb_mfgdate	<string>	Manufacturing date of circuit board, in YYYYMMDD format.
serial	<string>	Serial number of the device.
mfgdate	<string>	Manufacturing date, in YYYYMMDD format.
sap	<string>	SAP number of the device.
variant	<string>	Model and revision of the device
Direction	input	
Channel	version	
Notes	Received by the application when subscribed to. The *serial* event contains the name, serial number and manufacturing date for the device. The key names are *name, pcb_serial, pcb_mfgdate, serial, and mfgdate*. The example below assumes the Storyboard application is set up to call Lua function **serial_receive** when the *serial* event occurs. Event data is available through the *mapargs* argument.	

Lua Example

```
function serial_receive(mapargs)
    local ev = mapargs.context_event_data
    local name = ev[“name”]
    local serial = ev[“serial”]
    local mfgdate = ev[“mfgdate”]
    local pcb_serial = ev[“pcb_serial”]
    local pcb_mfgdate = ev[“pcb_mfgdate”]

    if (name ~= nil and serial ~= nil and mfgdate ~= nil
        and pcb_serial ~= nil and pcb_mfgdate ~= nil) then
        print(“Model: “. . ev[“name”])
        print(“PCB serial number: “. . ev[“pcb_serial”])
        print(“PCB manufactured: “. . ev[“pcb_mfgdate”])
        print(“Serial number: “. . ev[“serial”])
        print(“Manufactured: “. . ev[“mfgdate”])
    end
end
```

2.4.2. Version

Event	*version*	
Event Data		
Keys	**Values**	**Description**
count	<0..100>	Number of version items in message.
partnumX	<0..4294967295>	Software part number for entry X.
nameX	<string>	Software name for entry X.
majorX	<0..4294967295>	Software major version number for entry X.
minorX	<0..4294967295>	Software minor version number for entry X.
Direction	input	
Channel	version	
Notes	Received by the application when subscribed to. The *version* event contains count version items, each consisting of the four keys, *partnumX*, *nameX*, *majorX* and *minorX*, where X is a number from 0 to count. The example below assumes the Storyboard application is set up to call Lua function **version_receive** when the *version* event occurs. Event data is available through the *mapargs* argument. Note that Lua “for loops” are inclusive, so the example below is written to loop from 0 through count -1.	

Lua Example	function version_receive(mapargs)
	    local ev = mapargs.context_event_data
	    local count = ev[“count”] - 1
	    local i
	    for i = 0,count do
	        print(“Name: “. . ev[“name”..i])
	        print(“Part number: “. . ev[“partnum”..i])
	        print(“Version: V”..ev[“major”..i]..”.”..
	            string.format(“%02d”, ev[“minor”..i]))
	    end
	-- Input validation of partnumX against nil left as an exercise
	end	

2.4.3. version.set

Event	*version.set*	
Event Data		
Keys	**Values**	**Description**
partnum	<0..4294967295>	Software part number. This key is required.
name	<string>	Friendly name of the software. This key is optional. “unknown” will be substituted if name is not provided.
major	<0..4294967295>	Software major version number. This key is optional. 0 will be substituted if *major* is not provided.
minor	<0..4294967295>	Software minor version number. This key is optional. 0 will be substituted if *minor* is not provided.
Direction	output	
Channel	version	
Notes	Sent by a program to register its part number, name and version information with the version supervisor. The *version.set* event consists of four keys, *partnum*, *name*, *major* and *minor*. While this event can certainly be used by a Crank application to register its own part number, name and version with the version supervisor, it will primarily be used by other applications on the system to register themselves. This will enable Crank to read the device’s complete version information by registering for the *version* event.	
Lua Example	function register_version(mapargs) local data = {} data[“partnum”] = 1042699 data[“name”] = “Heavy Lift App” data[“major”] = 1 data[“minor”] = 3 gre.send_event_data(“version.set”, “4u1 partnum 1s0 name 4u1 major 4u1 minor”, data, “version”) -- Output data left as an exercise end	

2.5. System hardware interface channel events

2.5.1. nxs.adc

Event	*nxs.adc*	
Event Data		
Keys	**Values**	**Description**
AMB_LIGHT	<0..1023> PHD70 <0..4095> PHD28/50	Ambient light sensor.
DISPBKLT_VOUT	<0..36000>	Display backlight voltage, millivolts. Only available on PHD70.
OUTPUT1_SENSE	<0..VBATT in mV>	Low-side output 1sense, millivolts.
OUTPUT2_SENSE	<0..VBATT in mV>	Low-side output 2 sense, millivolts.
P12V0_OUT_SENSE	<0..12000>	12V output sense, millivolts.
P5V0_OUT_SENSE	<0..5000>	5V output sense, millivolts.
TEMP_SENSE	<-40000..130000>	Temperature, millidegrees Celsius.
VBATT_SENSE	<0..36000>	Battery voltage, millivolts.
GPIOx	<0..5000>	GPIO1 – GPIO10 input voltage, millivolts. Replace x with the GPIO number of interest. Not all GPIOs may be present or enabled on all platforms.
Direction	input	
Channel	nxs	
Notes	Received by the application in response to an *nxs.request_adc* event. The example below assumes the Storyboard application is set up to call Lua function **adc_receive** when the *nxs.adc* event occurs. Event data is available through the *mapargs* argument. The state of every ADC channel is returned with every response to an *nxs.request_adc* event.	

Lua Example	`function adc_receive(mapargs)`
	`    local ev = mapargs.context_event_data`
	`    local temperature = ev[“TEMP_SENSE”]`
	`        print(“Received ADC update: “. . temperature)`
	`    -- Other values left as an exercise`
	`end`	

2.5.2. nxs.backlight

Event	*nxs.backlight*	
Event Data		
Keys	**Values**	**Description**
display_level	<0..100>	0 = 0% backlight, 100 = 100% backlight.
Direction	input	
Channel	nxs	
Notes	Received by the application whenever the backlight level changes. The values range from 0 to 100. The example below assumes the Storyboard application is set up to call Lua function **backlight_receive** when the *nxs.backlight* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function backlight_receive(mapargs)
	local ev = mapargs.context_event_data
	local level = ev[“display_level”]
	if (level ~= nil) then
	print(“Received brightness: “..level)
	end
	end	

2.5.3. nxs.din

Event	*nxs.din*	
Event Data		
Keys	**Values**	**Description**
GPIOx	<0..10>	Digital input GPIOx, where x is a number from 1 to 11 representing the digital input number. Key names are GPIO1 through GPIO11 for platforms with 11 digital inputs. Not all GPIOs may be present or enabled on all platforms.
GPIO9	<0..Max Hz>	If the FIN is enabled on the PHD50 for GPIO9, the GPIO09 key will return the frequency value. When the FIN for GPIO9 is enabled, the values will be sent out Analog input Sample Rate value setup in the PHD Packager during load time GPIO09 key will return the frequency value. **PHD50 only.**
Direction	input	
Channel	nxs	
Notes	Received by the application when initially subscribed to, and whenever the DIN states change. The example below assumes the Storyboard application is set up to call Lua function **din_receive** when the *nxs.din* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	`function din_receive(mapargs)`
	`    local ev = mapargs.context_event_data`
	`    local gpio1 = ev[“GPIO1”]`
	`    if (gpio1 ~= nil) then`
	`        print(“Received DIN update: “..gpio1)`
	`    end`
	`    -- Values GPIO2 through GPIO10 left as an exercise`
	`end`	

2.5.4. nxs.dout

Event	*nxs.dout*	
Event Data		
Keys	**Values**	**Description**
OUTPUT1	<0..1>	Low side output 1. 0 = disabled. 1 = enabled.
OUTPUT2	<0..1>	Low side output 2. 0 = disabled. 1 = enabled.
P12V0	<0..1>	12V output. 0 = disabled. 1 = enabled.
P5V0	<0..1>	5V output. 0 = disabled. 1 = enabled.
GPIOx	<0..1>	Digital output *GPIOx* where *x* is a number from 2 to 10 representing the digital output number. Key names are GPIO2 through GPIO10 for platforms with 9 digital outputs. Not all GPIOs may be present or enabled on all platforms. Keypad configuration may mean some GPIOs are not available as DOUTs.
HOLDPWR	<0..1>	Only available on PHD50 with enhanced power manaagement circuit. 0 = disabled. 1 = enabled (i.e. PHD50 will continue operation when GPIO1 goes low.
Direction	input	
Channel	nxs	
Notes	Received by the application when subscribed to. Used to query the status of the douts The example below assumes the Storyboard application is set up to call Lua function **dout_receive** when the *nxs.dout* event occurs. Event data is available through the *mapargs* argument.	

Lua Example

```
function dout_receive(mapargs)
    local ev = mapargs.context_event_data
    local output1 = ev[“OUTPUT1”]
    if (output1 ~= nil) then
        print(“State of OUTPUT1 is”)
      if (output1 == 0) then
          print(“disabled”)
      else
          print(“enabled”)
      end
    end
    -- Other DOUT values left as an exercise
end
```

2.5.5. nxs.dout_errors

Event	*nxs.dout_errors*	
Event Data		
Keys	**Values**	**Description**
dout_errors	0x0004 – OUTPUT1_SHORT_BATT 0x0008 – OUTPUT1_SHORT_GND 0x0010 – OUTPUT2_SHORT_BATT 0x0020 – OUTPUT2_SHORT_GND 0x0040 – P5V0_SHORT_BATT 0x0080 – P5V0_SHORT_GND 0x0100 – P12V0_SHORT_BATT 0x0200 – P12V0_SHORT_GND	A 16-bit value with each bit flagging a different dout error.
Direction	input	
Channel	nxs	
Notes	Received by the application in response to an *nxs.dout_errors* event. More than one bit may be set at a time. The bit field is only published when it changes; this includes when there is no longer an error condition. The example below assumes the Storyboard application is set up to call Lua function **dout_errors_receive** when the *nxs.dout_errors* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function **dout_errors_receive**(mapargs)
	local ev = mapargs.context_event_data
	local errors = ev[“dout_errors”]
	if (errors ~= nil) then
	if (**bit32**.band(errors,0x0004) ~= 0x0000) then
	print(“OUTPUT1_SHORT_BATT error bit set.”)
	end
	end
	-- Other DOUT errors left as an exercise
	end	

2.5.6. nxs.encoder_val

Event	*nxs.encoder_val*	
Event Data		
Keys	**Values**	**Description**
encoder_value	<0..4294967295>	Encoder value.
Direction	input	
Channel	nxs	
Notes	Received by the application when the encoder is rotated clockwise or counter-clockwise. For each clockwise “click” of the encoder, the value increases by one. For each counter-clockwise “click” of the encoder, the value decreases by one. The initial Encoder value is 0xFFFFFFFF / 2 or 2147483647. This value minimizes the likelihood of a roll over or roll under of the count, but the possibility of a roll over or roll under should still be accounted for. The example below assumes the Storyboard application is set up to call Lua function **encoder_receive** when the *nxs.encoder_value* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	**function encoder_receive**(mapargs)
	local ev = mapargs.**context_event_data**
	if (ev[“encoder_value”] ~= **nil**) **then**
	print(“Encoder updated to value” ..ev[“encoder_value”])
	end
	end	

** NOTE ** Only the PHD50 and PHD70 support encoder input.		

2.5.7. nxs.key_press

Event	*nxs.key_press*	
Event Data		
Keys	**Values**	**Description**
keypress	<key_string>	A string containing the name of the key that was pressed.
Direction	input	
Channel	nxs	
Notes	Received by the application when a keypad key is pressed. The key_string published is read from the keypad configuration XML file. The example below assumes the Storyboard application is set up to call Lua function **key_press** when the *nxs.key_press* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function **key_press**(mapargs)
	    local ev = mapargs.context_event_data
	    local key = ev[“keypress”]
	    if (key ~= nil) then
	        print(“Key pressed:”..key)
	    end
	end	

2.5.8. nxs.key_release

Event	*nxs.key_release*	
Event Data		
Keys	**Values**	**Description**
keyrelease	<key_string>	A string containing the name of the key that was released.
Direction	input	
Channel	nxs	
Notes	Received by the application when a keypad key is released. The key_string published is read from the keypad configuration XML file. The example below assumes the Storyboard application is set up to call Lua function **key_release** when the *nxs.key_release* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function **key_release**(mapargs)
	    local ev = mapargs.context_event_data
	    local key = ev[“keyrelease”]
	    if (key ~= nil) then
	        print(“Key released: ”..key)
	    end
	end	

2.5.9. nxs.request_adc

Event	*nxs.request_adc*	
Event Data		
Keys	**Values**	**Description**
adc	<string>	Any data can be provided
Direction	output	
Channel	nxs	
Notes	Sent by the application to request ADC values. The example below assumes the Storyboard application is set up to call Lua function *request_adc* periodically to request ADC values. Note that the “adc” key merely has to be provided to confirm that you are interested in the ADC data. The value provided for the key is not relevant, as all ADCs are returned with each *nxs.adc* event.	

Lua Example	function **request_adc**(mapargs)
	    local data = {}
	    data[“adc”] = “1”
	    gre.send_event_data(“nxs.request_adc”, “1s0 adc”, data, “nxs”)
	end	

2.5.10. nxs.request_rtc

Event	*nxs.request_rtc*	
Event Data		
Keys	**Values**	**Description**
rtc_get	*<string>*	Real time clock.
Direction	output	
Channel	nxs	
Notes	Sent by the application to request the RTC values. The example below assumes the Storyboard application is set up to call Lua function **request_rtc** periodically to request RTC values. Note that the value of rtc_get is not used therefore it can be any string.	

Lua Example	function **request_rtc**(mapargs)
	    local data = {}
	    data[“rtc_get”] = “1”
	    gre.send_event_data(“**nxs.request_rtc**”, “**1s0 rtc_get**”, data, “**nxs**”)
	end	

** NOTE ** Only the standard PHD70 supports RTC, not the reduced memory PHD70.		

2.5.11. nxs.rtc

Event	*nxs.rtc*	
Event Data		
Keys	**Values**	**Description**
seconds	<0..59>	
minutes	<0..59>	
hours	<0..23>	
day	<1..31>	
month	<0..11>	January=0. . December=11
year	<2000..2099>	
timezone	<string>	
Direction	input	
Channel	nxs	
Notes	Received by the application in response to an *nxs.request_rtc* event. Note that if subscribed to, this event generates a new value every second. In addition, the application is not expected to use the RTC to keep track of time. Rather, it should use the system time, which is set by the PHD using the RTC on each startup. The example below assumes the Storyboard application is set up to call Lua function **rtc_receive** when the *nxs.rtc* event occurs. Event data is available through the *mapargs* argument.	
Lua Example	function **rtc_receive**(mapargs) local ev = mapargs.context_event_data local sec = ev[“second”] local min = ev[“minute”] local hr = ev[“hour”] local day = ev[“day”] local mon = ev[“month”] + 1 local yr = ev[“year”] local tz = ev[“timezone”] **print**(yr..“-”..mon..“-”..day..” “..hr..“:”..min..“:”..sec) **print**(“Time zone: ”..tz) end	
** NOTE ** Only the standard PHD70 supports RTC, not the reduced memory PHD70. VBATT must stay on to the PHD to maintain the RTC settings. It is recommended to use the wake/sleep functionality to turn “Off” the PHD rather than cycle power to maintain the RTC settings.		

2.5.12. nxs.set_auto_brightness

Event	*nxs.set_auto_brightess*	
Event Data		
Keys	**Values**	**Description**
auto_brightness	<on..off>	'on' means auto brightness is enabled, 'off' means auto brightness is disabled.
Direction	output	
Channel	nxs	
Notes	Sent by the application when the application wishes to control the auto brightness feature. Using the value 'on' will enable the auto brightness feature and using the value 'off' will disable it. The auto brightness feature is 'off' by default. If set, the auto brightness will automatically dim the backlight per the following: **PHD28, PHD50**: If the ambient light sensor returns a value above 3840, then the backlight will adjust to 20% If the ambient light sensor returns a value below 1024, then the backlight will adjust to 100%. **PHD70:** If the ambient light sensor is above 800, then the backlight will adjust to 20%. If the ambient light sensor is below 800, then the backlight will adjust to 90%.	

Lua Example	`function enable_auto_brightness(mapargs)`
	`    local data = {}`
	`    data["auto_brightness"] = "on"`
	`    gre.send_event_data("nxs.set_auto_brightness",`
	`                        "1s0 auto_brightness", data, "nxs")`
	`end`	

2.5.13. nxs.set_backlight

Event	*nxs.set_backlight*	
Event Data		
Keys	**Values**	**Description**
display_level	<0..100>	0 = 0% backlight, 100 = 100% backlight.
Direction	output	
Channel	nxs	
Notes	Sent by the application to adjust the backlight level. The values range from 0 to 100. The example below assumes that the Storyboard application has, based on user interaction with a screen brightness control, called a Lua function called **set_backlight** with an argument of value and a number from 0 to 100.	

Lua Example

```
function set_backlight(mapargs)
      local level = mapargs["value"]
      local data = {}
      if (level ~= nil) then
          print("Set brightness: "..level)
          data["display_level"] = level
          gre.send_event_data("nxs.set_backlight",
                             "4u1 display_level", data, "nxs")
      end
end
```

** NOTE ** If nxs.set_auto_brightness is set to “on”, this value won’t be set.

2.5.14. nxs.set_dout

Event	*nxs.set_dout*	
Event Data		
Keys	**Values**	**Description**
OUTPUT1	<0..1>	Low side output 1. 0 = disabled. 1 = enabled.
OUTPUT2	<0..1>	Low side output 2. 0 = disabled. 1 = enabled.
P12V0	<0..1>	12V output. 0 = disabled. 1 = enabled.
P5V0	<0..1>	5V output. 0 = disabled. 1 = enabled.
GPIO2	<0..1>	GPIO output 2. 0 = disabled. 1 = enabled.
GPIO3	<0..1>	GPIO output 3. 0 = disabled. 1 = enabled.
GPIO4	<0..1>	GPIO output 4. 0 = disabled. 1 = enabled.
GPIO5	<0..1>	GPIO output 5. 0 = disabled. 1 = enabled.
GPIO6	<0..1>	GPIO output 6. 0 = disabled. 1 = enabled.
HOLDPWR	<0..1>	Only available on the PHD50 with enhanced power management circuit. Set to 1 to allow the PHD50 to continue operating after GPIO1 goes low.
Direction	output	
Channel	nxs	
Notes	Sent by the application to set the state of digital outputs. The example below assumes the Storyboard application has called the function **enable_outputs** which set enables OUTPUT1 and disables OUTPUT2. Note that all digital outputs need not be present in every *nxs.set_dout* event. Only those digital outputs specified in the message are set. A “1” enables an output and a “0” disables it.	

Lua Example	function **enable_outputs**(mapargs)
	    local data = {}
	    data[“OUTPUT1”] = “1”
	    data[“OUTPUT2”] = “0”
	    gre.send_event_data(“**nxs.set_dout**”,
	                    “4u1 OUTPUT1 4u1 OUTPUT2”, data, “nxs”)
	end

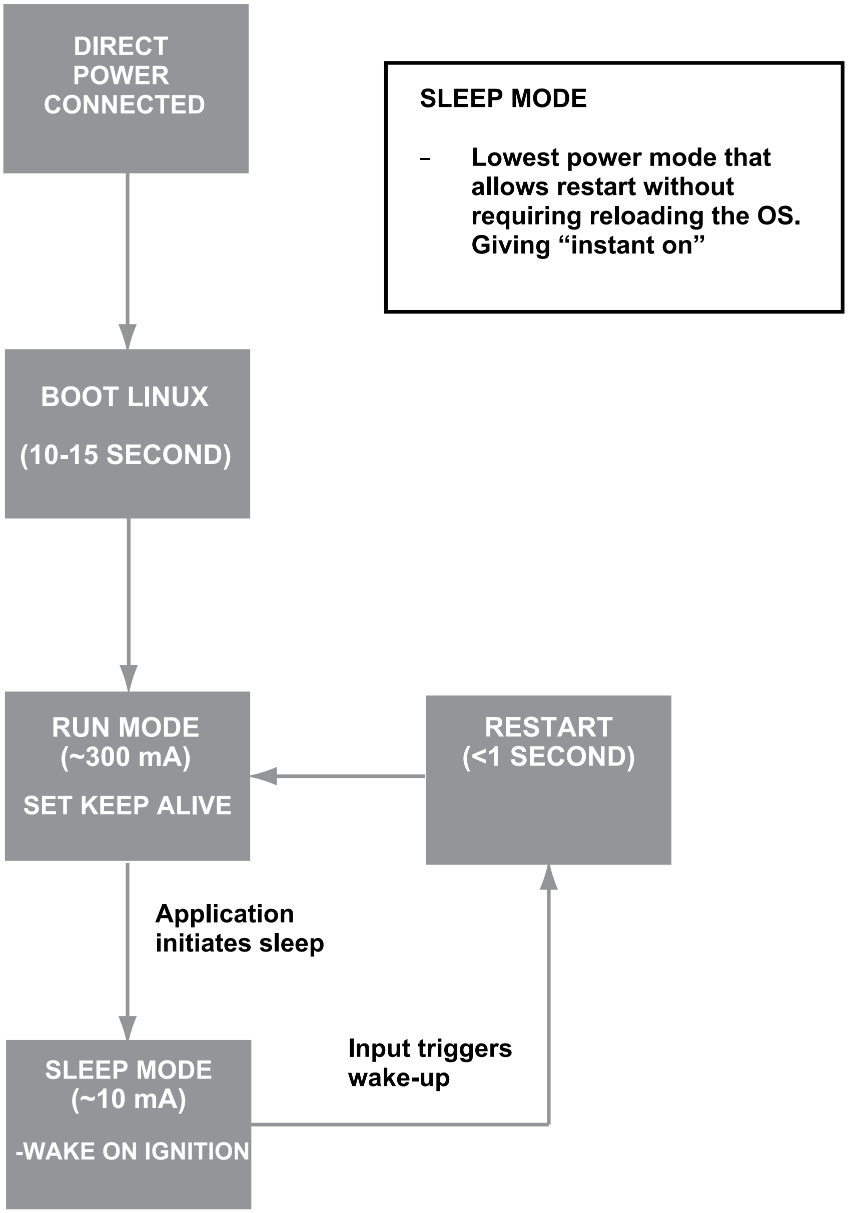
2.5.15. nxs.set_heater

Event	*nxs.set_heater*	
Event Data		
Keys	**Values**	**Description**
heater_level	<0..100>	0 = 0% heater, 100 = 100% heater.
Direction	output	
Channel	nxs	
Notes	Sent by the application to adjust the heater level. The values range from 0 to 100. The example below assumes that the Storyboard application has, based on user interaction with a heater level control, called a Lua function called **set_heater_level** with an argument of value and a number from 0 to 100.	

Lua Example	function **set_heater_level**(mapargs)
	    local level = mapargs[“**value**”]
	    local data = {}
	    if (level ~= nil) then
	      print(“**Set heater level:** “..level)
	      data[“**heater_level**”] = level
	      gre.send_event_data(“**nxs.set_heater**”,
	                    “4u1 heater_level”, data, “nxs”)
	    end
	end	

** NOTE ** Only the PHD28 and PHD50 support the internal heater.		

Standard PHD50 power management states and transitions

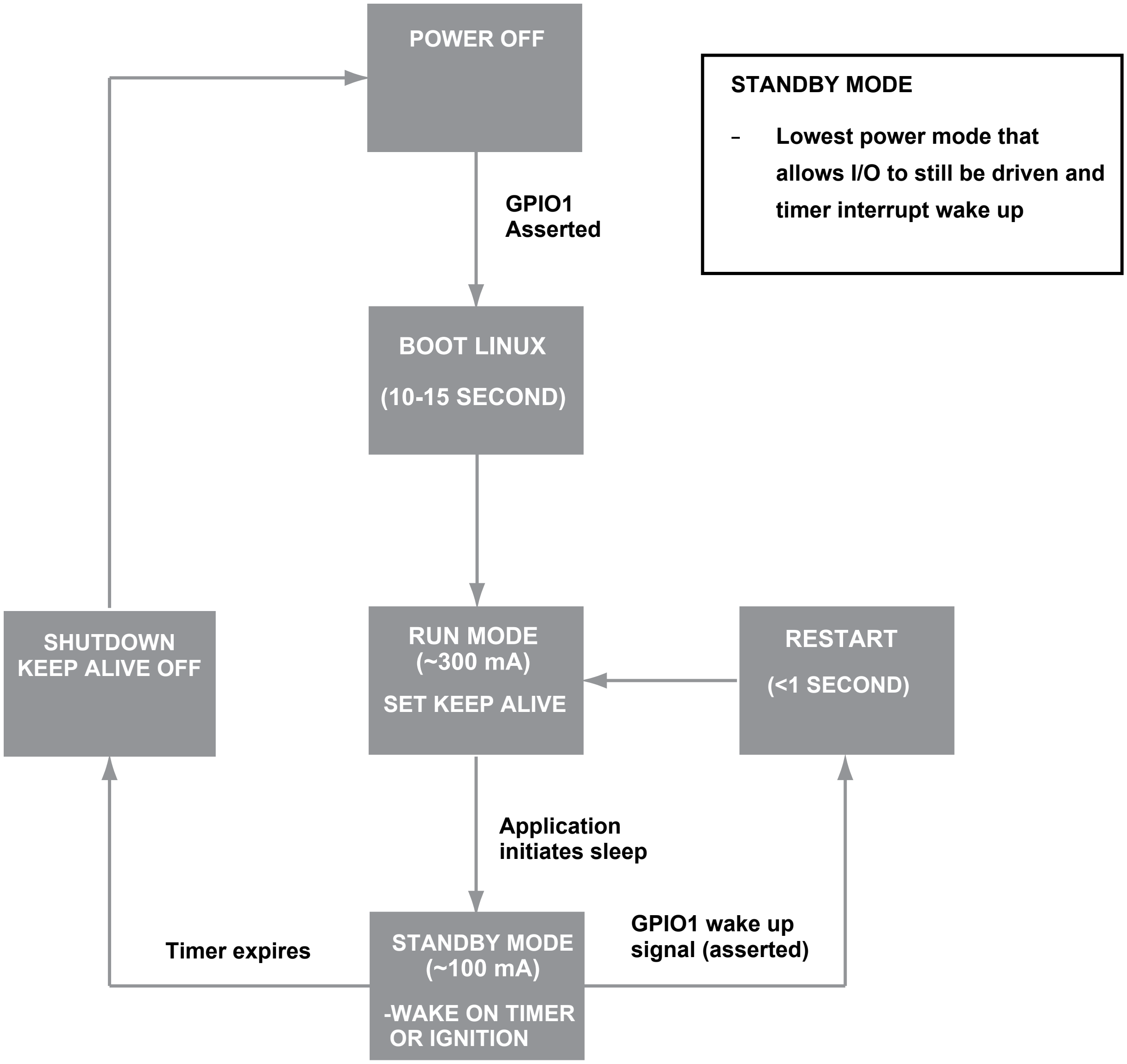


SLEEP MODE

- **Lowest power mode that allows restart without requiring reloading the OS. Giving "instant on"**

The PHD50 with Enhanced Power Management Circuitry (EPMC) supports a second low-power mode (standby). In this mode, the display consumes more power while asleep, but it can be awoken by an externaltrigger or an internal timer. If the timer wakes the display it will then transition to OFF.

PHD50 with EPMC power management states and transitions


POWER OFF
STANDBY MODE
- Lowest power mode that allows I/O to still be driven and timer interrupt wake up
GPIO1 Asserted
BOOT LINUX
(10-15 SECOND)
SHUTDOWN KEEP ALIVE OFF
RUN MODE
(~300 mA)
SET KEEP ALIVE
RESTART
(<1 SECOND)
Application initiates sleep
Timer expires
STANDBY MODE
(~100 mA)
-WAKE ON TIMER OR IGNITION
GPIO1 wake up signal (asserted)

2.5.16. nxs.set_rtc

Event	*nxs.set_rtc*	
Event Data		
Keys	**Values**	**Description**
seconds	<0..59>	
minutes	<0..59>	
hours	<0..23>	
day	<1..31>	
month	<0..11>	January=0. . December=11
year	<1900..no limit>	
timezone	<string>	
Direction	output	
Channel	nxs	
Notes	Sent by the application to set the real-time clock. The example below assumes that the Storyboard application has, based on user interaction with a screen RTC control, called a Lua function called **set_rtc** with arguments of *seconds, minutes, hours, day, month, year* and *timezone*. Time zone must always be provided even if you don't wish to change it. The example below forces the time zone to "US/Eastern". Other time zone strings may be substituted. Please see Appendix C.	

Lua Example	**function** **set_rtc**(mapargs)
	    local data = {}
	    data["seconds"] = mapargs["seconds"]
	    data["minutes"] = mapargs["minutes"]
	    data["hours"] = mapargs["hours"]
	    data["day"] = mapargs["day"]
	    data["month"] = mapargs["month"]
	    data["year"] = mapargs["year"]
	    data["timezone"] = "US/Eastern"
	    gre.send_event_data("**nxs.set_rtc**",
	                    "4u1 seconds 4u1 minutes 4u1 hours
	                    4u1 day 4u1 month 4u1 year 1s0 timezone",
	                    data, "nxs")
	end	

** NOTE ** Only the standard PHD70 supports RTC, not the reduced memory PHD70.		

2.5.17. nxs.set_timezone

Event	*nxs.set_timezone*	
Event Data		
Keys	**Values**	**Description**
timezone	<string>	
Direction	output	
Channel	nxs	
Notes	Sent by the application to set the time zone. The example below sets the time zone to “US/Eastern”. Other time zone strings may be substituted. Please see Appendix C. Note that setting the time zone will result in the reported system time changing to reflect the new time zone.	
Lua Example	function **set_timezone**(mapargs) local data = {} data[“timezone”] = “US/Eastern” **gre**.send_event_data(“**nxs.set_timezone**”, “1s0 timezone”, data, “nxs”) end	

2.5.18. nxs.sleep

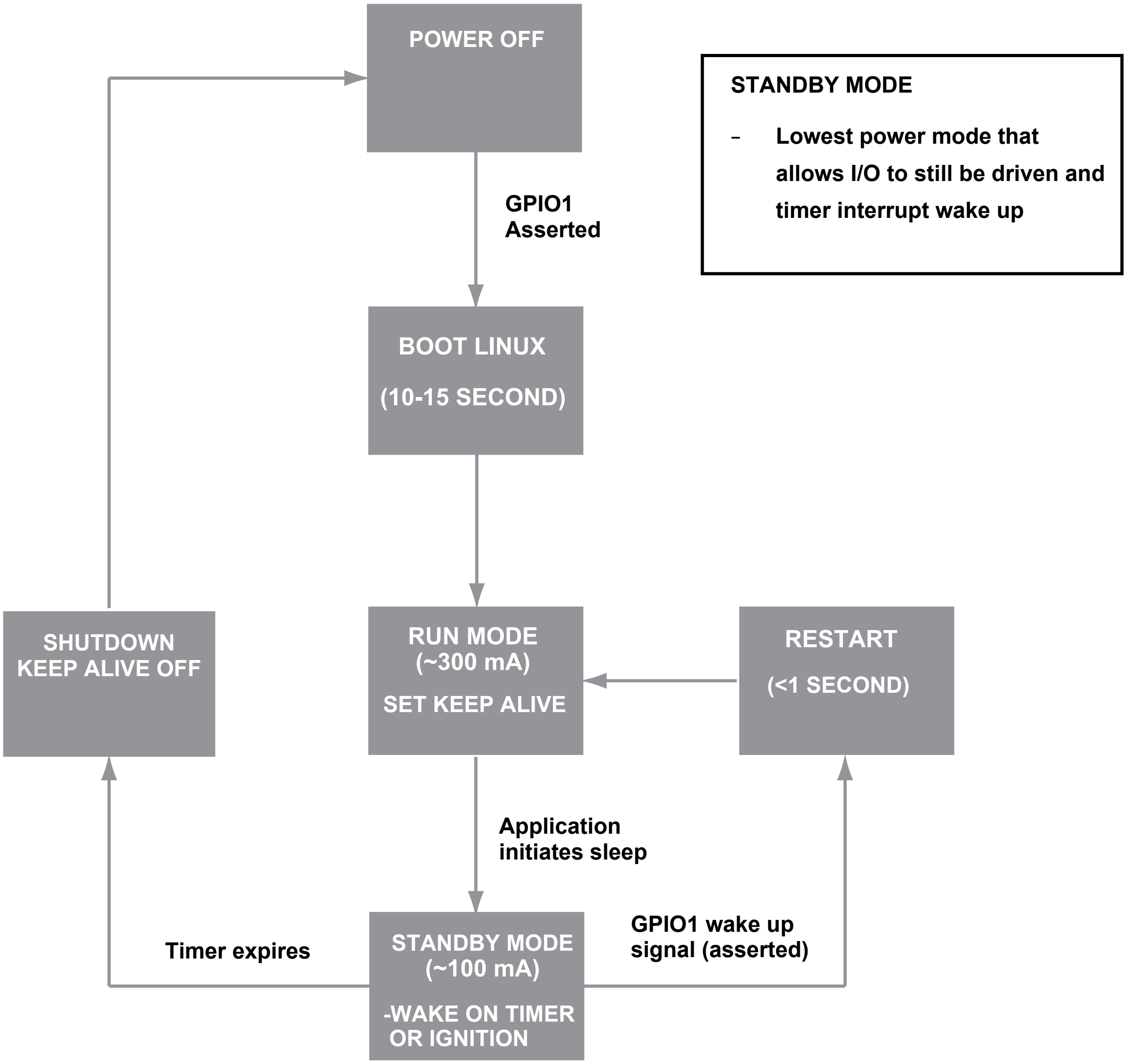
Event	*nxs.sleep*	
Event Data		
Keys	**Values**	**Description**
sleep_mode	<string>	String which sets the type of sleep to put the unit into. A value of “mem” puts the unit into memory sleep, which is the standard sleep mode without any timeout. Any other value puts the unit into enhanced sleep mode, which is only available on hardware with the enhanced power management circuit. After the timer runs out, the unit will power off.
Direction	output	
Channel	nxs	
Notes	Sent by the application to put the display into sleep mode.	

Lua Example	-- put the display into memory sleep
	function **suspend**(mapargs)
	    local data = {}
	    data[“sleep_mode”] = “mem”
	    gre.send_event_data(“**nxs.sleep**”,
	                        “1s0 sleep_mode”, data, “nxs”)
	end	

** NOTE ** It is the user’s responsibility to ensure that the application puts the system outputs into the desired state on resume from sleep. This means setting DOUTs, PWMs and so on to desired levels upon resume. Camera playback may not start automatically on resume, so camera playback should be disabled using *gra.media.stop* command before issuing the *nxs.sleep* command. When the application is being updated, and loaded to flash, the current application in RAM is still running. The application programmer needs to take care that the application does not go to sleep while an updated application is being received by checking the ai.install.state event. When the PHD enters sleep mode, the 5VDC and 12VDC power supplies will turn off so devices that are intended to wake the PHD should not use these power supplies as they will be powered off when the PHD is in sleep mode.		

Enhanced Sleep Mode Operation

Enhanced sleep mode offers a latent power down feature after the PHD enters sleep mode and a timer has elapsed. It is activated only on GPIO1 and is usually used as the Ignition input from the key switch. Vehicle power should still be applied to the VBATT pins to power the PHD. The state of GPIO1 must be monitored by the PHD application. When GPIO1 goes low, a nxs.sleep() event should be sent to put the PHD into enhanced sleep mode. Any corresponding clean up and application sleep preparation steps need to be taken before the nxs.sleep() event is sent. The enhanced sleep operation is shown in the block diagram below. While in enhanced sleep mode, before the timer runs out, the PHD can be woken through GPIO1 going high. After the timer runs out, the PHD will be rebooted through GPIO1 going high.


POWER OFF
GPIO1 Asserted
BOOT LINUX
(10-15 SECOND)
STANDBY MODE
- Lowest power mode that allows I/O to still be driven and timer interrupt wake up
SHUTDOWN
KEEP ALIVE OFF
RUN MODE
(~300 mA)
SET KEEP ALIVE
RESTART
(<1 SECOND)
Application initiates sleep
Timer expires
STANDBY MODE
(~100 mA)
-WAKE ON TIMER OR IGNITION
GPIO1 wake up signal (asserted)

2.5.19. nxs.timezone

Event	*nxs.timezone*	
Event Data		
Keys	**Values**	**Description**
timezone	<string>	
Direction	input	
Channel	nxs	
Notes	Received by the application when subscribed to and upon change. This event contains the current system time zone. The example below assumes the Storyboard application is set up to call Lua function **tz_receive** when the *nxs.timezone* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function **tz_receive**(mapargs)
	    local ev = mapargs.**context_event_data**
	    local tz = ev[“timezone”]
	
	    print(“Time zone: ”**..**tz)
	end	

2.5.20. nxs.wakeup_reason

Event	*nxs.wakeup_reason*	
Event Data		
Keys	**Values**	**Description**
wakeup_reason	0x0000 – Wake aborted 0x0001 – GPIO6 0x0002 – GPIO2 0x0004 – GPIO3 0x0008 – GPIO4 0x0010 – GPIO5 0x0020 – GPIO1 0x0040 – GPIO7 0x0080 – GPIO8 0x0200 – TOUCH 0x0400 – CAN1_RX 0x0800 – CAN2_RX	A 16-bit value with each bit representing the wakeup source.
Direction	input	
Channel	nxs	
Notes	Received by the application in response to being woken up. The example below assumes the Storyboard application is set up to call Lua function **wakeup_reason_receive** when the *nxs.wakeup_reason* event occurs. Event data is available through the *mapargs* argument.	

Lua Example

```lua
function wakeup_reason_receive(mapargs)
    local ev = mapargs.context_event_data
    local wakeup = ev[“wakeup_reason”]
    if (wakeups ~= nil) then
        if (bit32.band(wakeup,0x0001) ~= 0x0000) then
            print(“Woken up by GPIO6.”)
        end
    end
    -- Other Wakeup reasons left as an exercise
end
```

2.6. Persistent data storage (PDS)

2.6.1. pds.command

Event	*pds.command*	
Event Data		
Keys	**Values**	**Description**
command	“save” or “restore”	Desired command for PDS.
key	“string”	The key you wish to save or restore from.
value	value	If saving, the value you wish to save to PDS. If restoring, the default value to use if the data does not exist in PDS. Can be any valid Crank data type.
Direction	output	
Channel	pds	
Notes	Sent by the application to issue a command to the PDS module. “save” command: Saves the value in the key *value* into PDS under the key *key*. “restore” command: Retrieves a value from PDS using the key *key*. If the key does not exist in PDS, it will be created and saved with the value provided in *value*. A **pds.response** event containing the restored key and value will be sent in either case. Note that flooding PDS with **pds.command** requests may fill up its input queue or the Crank application’s queue with responses. We recommend limiting PDS commands to bursts of 100 requests of 32-bit sized data at a time. If the keys requested are typically larger than 32-bits, the burst size should be reduced accordingly. The example below shows an attempt to restore a saved backlight value from key “backlight”.	

Lua Example	**function restore_values**(mapargs)
	    local data = {}
	    data[“command”] = “restore”
	    data[“key”] = “backlight”
	    data[“value”] = 60 -- Provide a default level
	    gre.send_event_data(“pds.command”,
	                “1s0 command 1s0 key 4u1 value”, data, “pds”)
	end	

2.6.2. pds.response

Event	*pds.response*	
Event Data		
Keys	**Values**	**Description**
command	“string”	The command this response is meant for. This tells you if the response is the result of a save or restore command.
key	“string”	The key that is being returned
value	value	The restored value as read from PDS.
Direction	input	
Channel	pds	
Notes	Received by the application in response to a pds.command “restore” command. The example below assumes the Storyboard application is set up to call Lua function **pds_response** when the *pds.response* event occurs. Event data is available through the *mapargs* argument. The example demonstrates the result of restoring a PDS key of “backlight”.	

Lua Example	function pds_response(mapargs)
	  local ev = mapargs.context_event_data
	  if (ev[“key”] ~= nil and ev[“value”] ~= nil
	    and ev[“command”] ~= nil) then
	   if (ev[“key”] == “backlight”) then
	    if (ev[“command”] == “save”) then
	     print(“Saved backlight value of ”
	        ..tostring(ev[“value”]))
	  elseif (ev[“command”] == “restore”) then
	     print(“Restored backlight value of ”
	        ..tostring(ev[“value”]))
	     g_backlight = ev[“value”]
	   end
	  end
	 end
	end	

2.7. Auto-installer channel events

Autoinstaller is a DCP-based program that watches for notification of updates (via USB, CAN or other mechanisms) and allows the installation of updated software on the unit. It uses DCP to provide feedback to a user application if desired.

For USB device configurations, autoinstaller updates consist of getting a package file into the right location (/tmp) with the proper name (by default, usb_archive.file).

For USB host configurations, autoinstaller publishes a list of files that match a mask set in the autoinstaller XML configuration file via the *ai.available_releases* event. It then expects to be notified of a selected file via the *ai.selected_release* event.

2.7.1. ai.set_option

Event	*ai.set_option*	
Event Data		
Keys	**Values**	**Description**
publish_all_filename	<0. . 1>	Set to 1 to enable or set to 0 to disable the option to publish the filenames of the files that do not match the auto install filename format (filename mask).
Direction	output	
Channel	ai	
Notes	Sent by the application to the autoinstaller option **publish_all_filename**. By default, this option is disabled. If enabled, the autoinstaller will publish the filename of all the files found on the USB stick. In addition, if the USB stick doesn't contain any files that match the auto install filename format (mask), the USB stick will not be automatically unmounted. In this case, the application **must** send a "STATE_CANCEL" event to unmount the USB stick. The example below assumes the application calls the function set_ai_options when needed.	

Lua Example	`function set_ai_options(mapargs)`
	`local data = {}`
	`data[“publish_all_filename”] = 1`
	`gre.send_event_data(“ai.set_option”,`
	`“4u1 publish_all_filename”, data, “ai”)`
	`end`	

2.7.2. ai.available_releases

Event	*ai.available_releases*	
Event Data		
Keys	**Values**	**Description**
count	<0. . n>	A value from 0 to n representing the number of files found on the USB stick that match the autoinstaller file mask.
filenameX	<string>	A string representing the filename associated with the count value X. Note that the key *count* value X, is appended to the key *filename*.
unmatched_count	<0. . n>	Shown if **ai.set_option** is enabled. A value from 0 to n representing the number of files found on the USB stick that do not match the auto install filename format (mask)
unmatched_FilenameX	<string>	Shown if **ai.set_option** is enabled. A string containing the filename of the file found on the USB stick that does not match the auto install filename format (mask) where X is from 0 to (unmatchedCount – 1).
Direction	input	
Channel	ai	
Notes	Received by the application when subscribed to. Applications can use this to display a filename menu when configured for USB host for packager updates. The *ai.available_releases* event contains the key *count* for the number of filenames, and the key *filenameX* containing the string of the filename for the X count element. Note that the key *count* value X, is appended to the key *filename*. For example, assume there are 2 files available on the USB stick. The first file is FILEABC and the second is FILEXYZ. The key *count* would be 2. The key *filename0* would contain the string FILEABC and the key *filename1* would contain the string FILEXYZ. If the autoinstall option “**publish_all_filename**” in the *ai.set_option* event is enabled, the ai.available_releases event will also contain a nonzero unmatchedCount value and the unmatchedFileNameX string. The USB stick must be inserted after the ai.set_option, publish_all_filenames is enabled. If **publish_all_filename** is disabled, or if the USB stick is inserted before the publish_all_filename is enabled, then unmatchedCount will be zero. Note the mount path for the USB stick on the PHD is “/media/sda1”. The example below assumes the Storyboard application is set up to call Lua function **pop_releases** when the *ai.available_releases* event occurs. Event data is available through the mapargs argument. The example also assumes that list is a global table that maintains a list of the packages available on the USB stick. The *pop_table* function shown is assumed to populate an on-screen control with the data from the list table. The variable *tcount* is a global that tracks the number of items in the file list table.	

Lua Example	function **pop_releases**(mapargs)
	local ev = mapargs.context_event_data
	local i
	if ev[“count”] ~= nil then
	tcount = ev[“count”]
	
	for i = 1,tcount do
	if ev[“fileName”..i-1] ~= nil then
	list[i] = ev[“fileName”..i-1]
	end
	end
	pop_table()
	end
	end	

2.7.3. ai.install_state

Event	*ai.install_state*	
Event Data		
Keys	**Values**	**Description**
ai.install_state	<0. . 12>	A value from 0 to 12 representing the current autoinstaller state.
Direction	input	
Channel	ai	
Notes	Received by the application to read the installer state information. Applications can use this to display status or progress on the application screen during installs. 0 = STATE_FILE_CHECK 1 = STATE_USB_FILE_DETECTED 2 = STATE_CAN_FILE_DETECTED 3 = STATE_INVALID_FILE 4 = STATE_INSTALLING 5 = STATE_INSTALL_SUCCESS 6 = STATE_INSTALL_FAILED 7 = STATE_USB_QUERY 8 = STATE_USB_MOUNT_FAIL 9 = STATE_USB_NO_FILES_FOUND 10 = STATE_USB_WAITING_FOR_FILE_SELECTION 11 = STATE_CANCEL 12 = STATE_FILE_SELECTED States 7 through 12 are particular to the USB host update method. States 1 and 2 are specific to USB device or CAN update methods. States 3 through 6 are common to all. If the USB stick does not contain any filenames matching either the autoinstaller filename format (mask), or if the **publish_all_filename** option in the *ai.set_option* event is not enabled, then the USB stick will be unmounted immediately. If the **publish_all_filename** option is enabled, the state will automatically change from STATE_USB_QUERY to STATE_USB_WAITING_FOR_FILE_SELECTION when only unmatched files are detected. While in the STATE_USB_WAITING_FOR_FILE_SELECTION state, the application must either send the STATE_CANCEL event to unmount the USB Stick, or the filename selected for installation with the *ai. selected release* event. Note the USB stick must be reinserted to start a new installer session after receiving the STATE_CANCEL request. The example below assumes the Storyboard application is set up to call Lua function **ai_state** when the *ai.install_state* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	function ai_state(mapargs)
	  local ev = mapargs.context_event_data
	  local state = ev[“ai_install_state”]
	  if (state ~= nil) then
	    print(“Installing, state is “.. state)
	  end
	end	

2.7.4. ai.selected_release

Event	*ai.selected_release*	
Event Data		
Keys	**Values**	**Description**
fileName	<string>	A file release name selected from a USB stick that the user has chosen to install.
Direction	output	
Channel	ai	
Notes	Sent by the application to inform autoinstaller which file from the available releases has been selected by the user. Autoinstaller will attempt to install the selected file. In the Lua example below, “fileName” is a global variable that contains a file selected by the application for installation.	

Lua Example	function send_release(mapargs)
	local data = {}
	
	if (fileName ~= nil and fileName ~= “ ”) then
	data[“fileName”] = fileName
	gre.send_event_data(“ai.selected_release”,
	“1s0 fileName”, data, “ai”)
	end
	end	

3. Enabling a Camera via Crank

For devices with camera capabilities (PHD50 and PHD70), we rely on Linux's gstreamer service in order to enable and disable the camera feed. Crank's Storyboard Engine supports integration with gstreamer, which means that the cameras can be manipulated by sending built-in Crank events.

3.1. Requirements for enabling the camera

The basic Crank actions to use in your Crank application are used for starting and stopping the video stream.

First, make sure that the area in which you wish to display the camera image is transparent in Crank. This is so that the video, which runs "lowest" in the vertical stacking of Crank elements, is visible "through" the Crank application. Make sure any background images show up as transparent in that area rather than any type of image or solid colour background. Any images or text which are displayed over the camera area (and not hidden or set to an alpha of 0) will display over the camera feed. Transparent areas show up in Crank Storyboard Designer with a checkboard pattern, as demonstrated below.

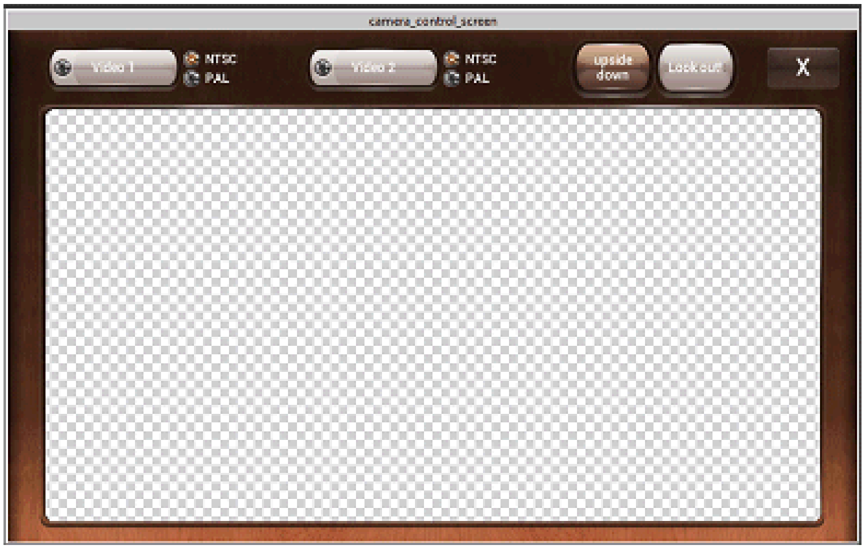


Figure 3.1. Sample camera layout

Next, using Crank's "Add" menu item, add a render extension to your project. This render extension should be of type "external". Give its Object Path parameter a unique name (e.g. "/video"). Set the size of the extension to your desired video size. This extension will create a solid pink rectangle within Crank. This pink rectangle will not appear when running. You can use this as a visual reminder of where your camera will display, but you must still set axis-left, axis-top, disp-width and disp-height in the extra_data field to place and size your camera view. The following image shows the same camera layout as above but with the external render object added in. Note that behind the pink rectangle, Crank is still transparent.

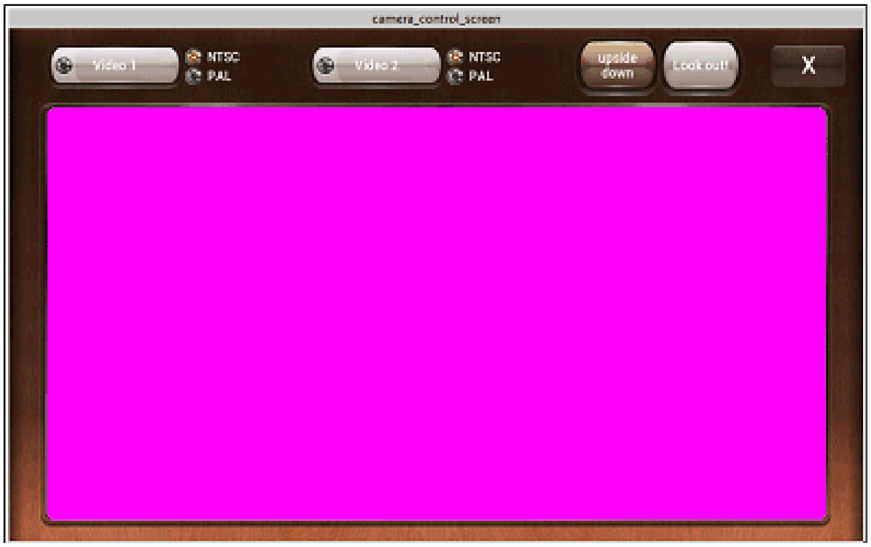


Figure 3.2. Camera layout with external render extension

For the PHD50 only, also add a Crank "fill" render extension over top, with its color set to #FF00FF. This will also appear as a pink box. The size of this pink fill object controls how much of the video is visible in Crank. Any Crank objects placed over top of this pink fill will partially obscure the video.

Starting a new video stream requires sending of the *gra.media.new.video* action. This action must be initiated when the application wishes to start video.

This action contains a number of built-in parameters which must be set as shown below.

Notes:
- For PHD50*, output_depth set to 2, this indicates 16-bit depth.*
- *the object_name parameter must match the external render extension's Object Path parameter (e.g. "/video").*
- media.sbat *must be present in the Crank project's templates folder.*

channel_name	**video1**
media_name	
volume	**0**
update_interval	**1000**
emit_time_events	**0**
external_buffer_name	**video**
object_name	**/video**
output_width	**0**
output_height	**0**
output_depth	**2**

For the PHD50, the camera input is always used full-size. The PHD50 extra_data value should be left blank. Whether the camera type is PAL or NTSC does not matter, the PHD50 will auto-detect the camera type. The camera must be powered at start up for auto-detect to work.

The *extra_data* parameter differs from PHD70 to PHD50 as the pipeline to construct the camera feed is different.
For the PHD70, match the width and height to the output_width and output_height you specified earlier. These should both match the size you used for the external render object in the Crank GUI.

Notes:
- the extra_data parameter should be all on one line. Substitute spaces for the linebreaks shown for that item.
- the extra_data parameter contains the Gstreamer pipeline and this can be setup to show different cameras or enable different options
- ***For PHD70****, output_width and output_height values can be zero. Instead, disp-width and disp-height in the extra_data parameter are used to control the output size of the video on the screen.*

PHD70 extra_data value:
"pipeline:imxv4l2src device=/dev/video0 capture-mode=0 ! mfw_isink rotation=X axis-top=102 axis-left=35 disp-width=546 disp-height=364 disp-deinterlace=X " Note the space after X, before the closing quotation mark.
Valid options for the "rotation" setting are:
0: NONE
1: VERTICAL FLIP
2: HORIZONTAL FLIP
3: ROTATE 180
4: ROTATE 90 RIGHT
5: ROTATE 90 RIGHT VFLIP
6: ROTATE 90 RIGHT HFLIP
7: ROTATE 90 LEFT

Valid options for the "capture-mode" setting are:
0: NTSC Format camera
1: PAL Format camera

Valid options for the "disp-deinterlace" setting are:
0: Disable deinterlacing
1: Enable deinterlacing

- Camera input selection: device=/dev/video0 declares video input #1 and device=/dev/video1 declares video input #2.

To halt a video stream, the *gra.media.stop* action must be sent. The *channel_name* specified must match the channel_name for the *gra.media.new_media* stream you wish to stop.

channel_name	**video1**
emit_state_event	**0**

3.1.1. Camera Settings

The PHD50 camera implementation includes a component that takes advantage of features of the Vybrid chip to allow reading and setting of key camera controls via the gre.media.settings event.
This event can be both sent by the user's Crank application to set or request the camera controls, and is also received by the user's Crank application in reply.

gre.media.settings **Event**	***gre.media.settings***	
Event data:		
Keys	**Values**	**Description**
channel	<IO channel>	Storyboard IO channel to receive these events. You must provide this parameter so that the media settings component knows where to send a reply. *Channel* needs to be sent only the first time you communicate with the media settings component. We recommend an initial "query" of the settings to provide the channel name.

action_result	<0..1>	Tells the media settings component if you wish to set or retrieve media settings. 0 = set, 1 = get. Crank 4s1 value.
contrast	<1..255>	Provides the camera contrast level to set. For output, only applicable if *action_result* is 0. Crank 4s1 value.
hue	<-128..+127>	Provides the camera hue level to set. Only applicable if *action_result* is 0. Crank 4s1 value.
saturation	<0..255>	Provides the camera saturation level to set. Only applicable if *action_result* is 0. Crank 4s1 value.
brightness	<-128..+127>	Provides the camera brightness level to set. Only applicable if *action_result* is 0. Crank 4s1 value.
mirror_h	<0..1>	Enables or disables camera horizontal mirroring. 0 = disable, 1 = enable. Only applicable if *action_result* is 0. Crank 4s1 value.
Direction	Output	
Channel	com.crank.media_backend	
Notes	Sent by the application to set or query the values of the PHD50 media settings. The first example below assumes the Storyboard application is set up to call Lua function **gre_media_query** on startup. Substitute your application's IO channel name for *my_camera_app.gapp.* The second example below assumes that the Crank application has called the sat_adjust function with the parameter *value* representing a new desired saturation value. *Channel* is not sent in the second example, as it assumes that has already been communicated via a call to gre_media_query.	

Lua example

```
-- This function queries the media settings.
function gre_media_query()
    local data = {}
  data["action_result"] = 0
  data["channel"] = "my_camera_app.gapp"
  print("gre_media_query: querying settings")
  gre.send_event_data("gre.media.settings", "4s1 action_result 1s0
  channel", data, "com.crank.media_backend")
end

-- This function sets saturation to the provided value.
function sat_adjust(mapargs)
  local value = tonumber(mapargs.value)
  local data = {}
  data["action_result"] = 1
  data["saturatio   n"] = value
  gre.send_event_data("gre.media.settings", "4s1 action_result 4s1
saturation", data, "com.crank.media_backend")
end
```

3.2. Contents of media.sbat

If you do not have media.sbat in your Crank Storyboard Suite “Samples” directory, you should be able to cut and paste the following into a text editor such as Notepad and save it to your application’s template folder as “media.sbat”. Use Notepad or a similar text editor, not a word processor like Word or Wordpad.

```
<actiontemplates>
       <template name=”gra.media.new.audio”>
    <arguments>
      <element name=”channel_name” type=”string” />
        <element name=”media_name” type=”string” />
        <element name=”volume” type=”integer” />
        <element name=”update_interval” type=”integer” />
        <element name=”emit_time_events” type=”integer” />
        <element name=”extra_data” type=”string” />
    </arguments>
  </template>
  <template name=”gra.media.new.video”>
    <arguments>
      <element name=”channel_name” type=”string” />
        <element name=”media_name” type=”string” />
        <element name=”volume” type=”integer” />
        <element name=”update_interval” type=”integer” />
        <element name=”emit_time_events” type=”integer” />
        <element name=”external_buffer_name” type=”string” />
        <element name=”object_name” type=”string” />
        <element name=”output_width” type=”integer” />
        <element name=”output_height” type=”integer” />
        <element name=”output_depth” type=”integer” />
        <element name=”extra_data” type=”string” />
    </arguments>
  </template>
  <template name=”gra.media.volume”>
    <arguments>
      <element name=”channel_name” type=”string” />
        <element name=”volume” type=”integer” />
        <element name=”emit_volume_event” type=”integer” />
        </arguments>
    </template>
    <template name=”gra.media.seek”>
        <arguments>
            <element name=”channel_name” type=”string” />
                <element name=”seek_num” type=”integer” />
                <element name=”emit_state_event” type=”integer” />
        </arguments>
    </template>
    <template name=”gra.media.stop”>
        <arguments>
            <element name=”channel_name” type=”string” />
                <element name=”emit_state_event” type=”integer” />
        </arguments>
    </template>
    <template name=”gra.media.playpause”>
        <arguments>
            <element name=”channel_name” type=”string” />
                <element name=”emit_state_event” type=”integer” />
        </arguments>
    </template>
    <template name=”gra.media.connect”>
    </template>
</actiontemplates>
```

4. RTC and time zone support

For devices with RTC capabilities (PHD70 standard), we rely on Linux's time zone database support to handle local clocks and daylight savings changes.

There are two clocks in an RTC-capable PHD70 device. There is the hardware RTC and there is the Linux system time.

Time zones are also supported and the time zone can be set or retrieved via API events. The device ships configured for the UTC time zone. This is effectively the Greenwich Mean Time zone, but the UTC time zone never shifts for daylight savings.

To set a different time zone, you would send the nxs.set_timezone event along with one of the accepted time zone strings (see Appendix C).

When you send the nxs.set_rtc event, the system assumes that you are specifying a local time that you wish to set, along with the desired time zone. It sets the time you specify as the system time and then adjusts the time to UTC and writes it into the RTC. If you issue a nxs.request_rtc event, you will receive the RTC value expressed in local time. Ideally though, you should use the Lua os.date() function to retrieve the system time, as it is set in lockstep with the RTC and always expressed relative to your set time zone.

The RTC is set in UTC so that the RTC time does not change during daylight savings time. If the RTC is correct, you can change time zones at any time, whether in or out of daylight savings and the system will automatically account for local daylight savings conditions.

The following list of 37 zones are the most commonly-used ones, for the full list, see Appendix C.

4.1. Most commonly used time zones

CET	Iceland	Poland
CST6CDT	Iran	Portugal
Cuba	Israel	ROC
EET	Jamaica	ROK
EST5EDT	Japan	Singapore
Egypt	Kwajalein	Turkey
Eire	Libya	UTC
GB	MST7MDT	Universal
GB-Eire	NZ	W-SU
GMT	NZ-CHAT	WET
Greenwich	Navajo	Zulu
HST	PRC	
Hongkong	PST8PDT	

5. Crank Storyboard Best Practices

5.1. Introduction

When developing and simulating a Crank Storyboard application on a Windows host, the simulator is actually running the Crank Storyboard engine. As a result, simulated applications may have much more resources available to them (RAM, processor speed, graphics acceleration) than on the target platforms.

As a result, application design choices may perform fine under the simulator but perform poorly on the target platforms.
In order to reduce this discrepancy, there are certain design guidelines to consider during development.

5.2. Crank Storyboard design guidelines

5.2.1. Application color depth

Make sure to choose an appropriate color depth for your application. This can be specified when creating a new application in Crank Storyboard Designer. It can also be changed on an existing application by selecting the Application from the Application Model window and then modifying the properties.

The best color depth depends on the target platform.
For PHD28 and PHD50, 16-bit (565) color depth must be used.
For PHD70, 32-bit (8888) color depth must be used.

5.2.2. Image color depth

When adding images to the user interface it is always preferable to create them in the desired color depth. If the application will be running in 16-bit color then the most efficient image to render will be a 16-bit image. If alpha blending/transparency is not required when this image is rendered then it is advisable to create images in the application color depth or at least remove the alpha channel in the image. If alpha blending is desired for an image, it should be left as a 32-bit image.

5.2.3. Image rotation and scaling

Image rotation and scaling can cause performance issues, as they require extra processing and memory allocations to perform these operations. If an image does not require real-time scaling while the application is running, then it should be resized externally and used at the target resolution. For example, if you have a 64x64 sized telltale control in the application, use a 64x64 image. Likewise, if an image does not require real-time rotation while the application is running, but is simply loaded at an angle, rotate it outside of Storyboard Designer so that it can be loaded without the need to rotate it inside Storyboard Designer. Also keep in mind the maximum size of the target displays, as both the resolution and the physical display size may dictate what size of images to use.

The PHD70 is a 7” 800x480 screen. This means there are 133 pixels per inch, or in other words, an image that is 48 pixels wide will take up less than 3/8 of an inch on the screen.

The PHD50 is a 5” 800x480 screen. This translates to 188 pixels per inch, so, an image that is 48 pixels wide will take up about ¼ of an inch on the screen. The PHD28 is a 2.8” 240x320 screen. This means there are 141 pixels per inch, or in other words, an image that is 48 pixels wide will take up less than 3/8 of an inch on the screen—however, for the PHD28, this would represent 15 – 20% of the screen width, depending on whether it’s used in portrait or landscape orientation.

5.2.4. Image cropping and positioning

In order to reduce unnecessary processing, make sure to create all images with as tight a border as possible. For example, do not create a large full-screen image composed of transparency with a small 48x48 icon in the middle, as this will result in waste of memory and processing power when the image is loaded, even if it’s not being rotated.

In general, the dimensions of the image file should be very close to the dimensions of the visible portion of the image. For images that will need alpha-blending with other elements, leave one row of absolutely blank pixels around its perimeter. Most image tools like GIMP or Photoshop will do this when using the autocrop or trim feature.

For any images that will be rotated in real-time, make sure the original source image is drawn at 0, 90, 180 or 270 degrees. Using an arbitrary angle in the original source image will result in more empty space around the image.

To picture this, please see the two images below. This needle will be rotated during application use, so one might assume that bringing it in at an angle doesn’t matter. However, the number of transparent pixels that have to be alpha-blended in each case is quite different. The non-rotated image is 42x119 pixels (4,998 pixels total), but the source image that is pre-rotated is 114x114 pixels (12,996 pixels total). Note that the images have had a black background added to them simply to illustrate the extent of the transparent pixels.

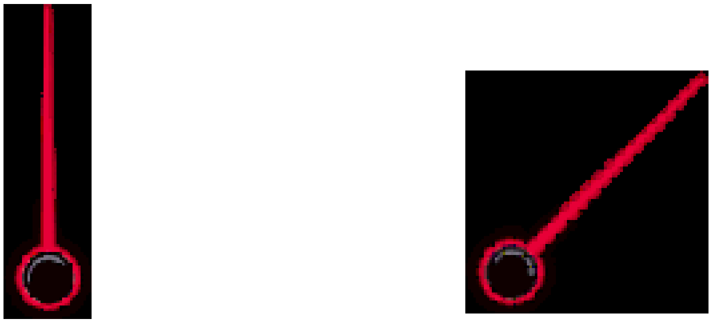


Figure 5.1. Needle image example

5.2.5. Image transparency

If an image does not require transparency then create it opaque, i.e. with the alpha channel removed. When this image is loaded by Storyboard Engine, it converts it to the color depth of the application, which allows Storyboard Engine to optimize its rendering to the framebuffer.

Further improvements may also be made by taking icons and screen elements that do not change and flattening them with the background color or image to create an opaque image.

Most popular images tool like GIMP or Photoshop support removing the alpha channel from an image. To do this, load the image into the tool and choose the option to Flatten the image. This will remove the transparency from the image. In most cases, the image transparency will be replaced by the active foreground color. You could then change it to an appropriate color for your background, or even combine it directly with the background image first, and then flatten both together.

5.2.6. Fill or circle control replacements for graphics

Any graphics that are simple box or circle shapes of a single color should not be used as images. Instead, remove the images from the project and replace them with Crank fill controls. This will reduce both the size of the application and its memory usage while running.

5.2.7. Polygon replacement for graphics

In some cases, some images could be replaced by Crank's polygon control. With the polygon control, shapes can be drawn by specifying drawing points.

Even images that must be rotated in real-time can be replaced in this way.

The images below show screenshots from two slightly different Crank applications. One screenshot is from an application using images for the four needles on the screen and the other uses Crank's polygon control for each needle.

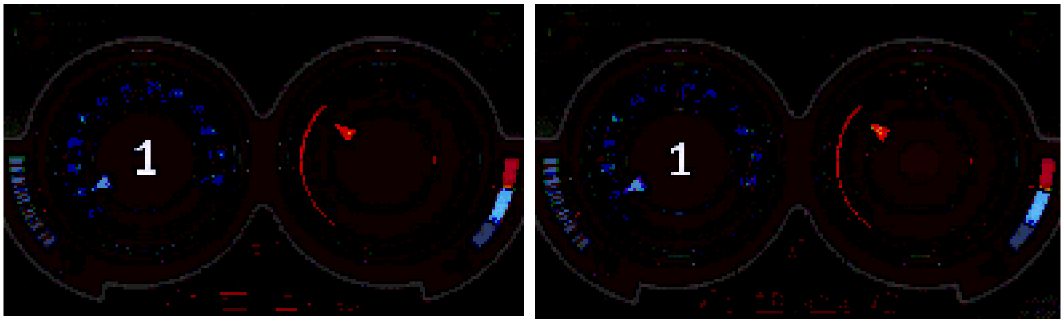


Figure 5.2. The image on the left uses the polygon controls for the four needles.

Note:

Make sure to close the polygon shape when intending to use it for rotation. This can be accomplished by repeating the initial x,y point of the polygon as the final point.

For example, here's a polygon defined with points (x,y) 190:200 205:200 200:20. It looks okay on the left screen. But when rotated, as shown on the right, it goes out of bounds.

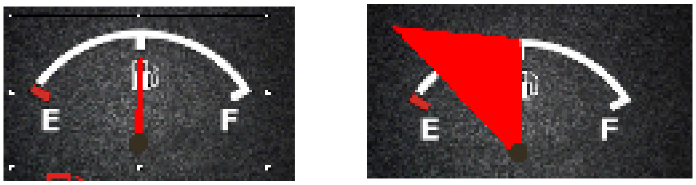


Figure 5.3. Polygon out of bounds.

By defining the polygon with points (x,y) 190:200 205:200 200:20 190:200. It made the problem go away.

5.2.8. Layer alpha blending

Modifying an entire layer's alpha property to make it visible or invisible is a very expensive operation and should be avoided.
It is better to have each image on the layer tied to a single alpha variable. That way, when the variable is modified, all those elements will adjust their alpha. This is less demanding on the device than blending the whole layer.

If using alpha to fade from one layer to another layer on a screen, it is more efficient to create an additional screen and use the "Screen Fade" action to fade between the screens.

For example, for a logo screen that fades in, use an initial screen with a background color and a second screen with the logo and background color. The initial screen can transition to the logo screen using screen fade and it will have the same appearance as using the alpha on the logo and fading it in.

5.2.9. Animation rate

The system may not be able to keep up with multiple animations with high frames per second rates. If this happens, Storyboard Engine will drop frames, doing extra work to do so. The end result may be an animation with even lower frames per second than could have been achieved by just choosing an appropriate frames per second. An animation rate of 14 frames per second will look good enough on most simple animations, though the results may vary depending on the target of the animation, the length of the animation, and the over- or under-laying screen components.

Different animation frame rates should be tested on the target hardware to strike a balance between animation appearance and performance.

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6.1. Licensing

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zlib.h -- interface of the 'zlib' general purpose compression library version 1.2.8, April 28th, 2013

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The data format used by the zlib library is described by RFCs (Request for Comments) 1950 to 1952 in the files http://tools.ietf.org/html/rfc1950 (zlib format), rfc1951 (deflate format) and rfc1952 (gzip format).

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7. Appendix A

7.1. J1939 Service

The PHD J1939 service exists to provide the system with access to one or more J1939 CAN buses. Inter-process communication is provided via DCP to permit access from other system services.

7.1.1. Features

- Send and receive of 8-byte messages
- Send and receive of long messages (up to and including 1785 byte payloads) using the following mechanisms.
  - Point to point - Long message exchange between precisely two connected parties.
  - Broadcast - Long message exchange to all interested parties within the broadcast domain of the local network segment.
- J1939 network management, including address claim concession and defense.
- Support for SOFT (software identification) message.
- Automatic handling of RQST (request) messages.

7.2. Architecture

The service is formed of two primary components:

- The J1939 library (1042616, libj1939). This connects to the CAN device drivers to provide send and receive communications with multiple CAN buses. The library provides a full abstraction of the lower level interfaces to present an external interface at the J1939 level in the protocol stack. Both C++ (native) and C (wrapper) interfaces are provided.
- The J1939 service (1042618, j1939d). This component is the daemon which provides the front end communication service and is the point of interaction for other communicating processes. Operation is driven by a configuration file, allowing per-application customization without recompilation of the core executable.

To promote code reuse, a common shared component is employed between the J1939 library and the J1939 service. This contains a library of common “helper” functions and common definitions to be used by both components.

The J1939 service also requires the use of an external library to allow the user configuration file to be read. The user configuration is specified in the form of a JavaScript Object Notation (JSON) file and so a library capable of reading this is necessary; this is currently implemented in libjson using JsonCpp which is released into the public domain under the MIT license with only a requirement to include the author’s copyright information.

7.3. Components

The J1939 service/library introduces several implementation-specific components.

7.3.1. J1939 Interface

A J1939 Interface represents a single physical CAN interface on the target device. Its operation is managed by a J1939 Interface Manager and is described in the configuration file by an interface descriptor. The interface manager acts as the single flow control point for all messages entering (received by) the interface, and all messages exiting (sent from) the interface.

7.3.2. J1939 Controller Application (CA)

A J1939 Controller Application is a logical component which resides within an interface. Multiple controller applications are permitted within a single interface. Each controller application owns a single J1939 source address and must have an associated NAME field. A controller application has a list of messages which it will receive, and a list of messages which it is permitted to transmit.

7.4. Usage

The J1939 service can be invoked from the command line. A number of switches can be specified to modify its operation, as shown in the table below.

Argument	Function
--help	Prints usage information to the console.
--ver	Prints version information to the console.
-c	Specifies the configuration file to use. If no file is specified, the service will use the file at /usr/local/parker/config/j1939.json. Example: **j1939 –c /root/testconfig.json** will cause the configuration file 'testconfig.json' located in /root/ to be used
-a	Specifies the DCP channel name to use for communication. If no channel name is specified, the service will fail to start. Example: **j1939d –a test** will cause the service to use 'test' as the channel name.
-v	Sets the debug verbosity level. A higher value results in more verbose debug messages. Example: **j1939d – v 5**
-d	Instructs the service to configure the CAN devices specified in the configuration file appropriately.

7.5. J1939 Configuration

The J1939 service is configured at runtime using a text-based configuration file. This allows the service to be customized without requiring recompilation. The file is defined in JavaScript Object Notation (JSON) format, a data-oriented hierarchical data description language based around JavaScript with simple translation to object-oriented systems.

7.5.1. File Structure

An overview of the J1939 configuration file structure is shown below.

- Configuration File Root
  - interfaces
    - deviceName
    - controllerApplications
      - address
      - name
        - arbAddressCapable
        - identityNumber
        - industryGroup
        - vehicleSystemInstance
        - vehicleSystem
        - function
        - functionInstance
        - ecuInstance
        - manufacturerCode
      - receiveDM1s
        - sa
        - spn
        - fmi
        - priority
        - user1
        - user2
      - transmitDM1s
        - id
        - spn
        - fmi
      - receiveMessages
        - pgn
        - ignoreSourceAddress
        - sourceAddress
        - notifyStale
        - staleTimeoutPeriod
        - length
        - rateLimit
        - parameters
          - name
          - startPosition
          - length
          - datatype
          - endian

- transmitMessages
    - pgn
    - destinationAddress
    - transmitMode
    - transmitRate
    - length
    - priority
    - parameters • name
        - startPosition
        - length
        - datatype
        - endian

7.5.2. File Components

7.5.3. File Root

Object	*File Root*	**Parent**	***None***
Attributes	**Type**	**Required**	**Description**
interfaces	Interface array	Yes	An array of physical CAN interface descriptions.
Notes	The top level of the document may only contain an array of interface descriptors. Each physical interface must only be described once.		

JSON Example	{
	“interfaces” : [
	{
	… interface description
	}
	]
	}		

7.5.4. Interfaces

Object	*Interface*	**Parent**	*Root*
Attributes	**Type**	**Required**	**Description**
deviceName	String	Yes	The name of the device as it is identified by the operating system.
controllerApplications	Controller application array	Yes	An array of controller applications which operate on the current interface.
Notes	An interface description object.		

JSON Example	{
	“interfaces” : [
	{
	“deviceName” : “can0”,
	“controllerApplications” : [
	… controller applications
	]
	}
	]
	}		

7.5.5. Controller Application

Object	*controllerApplication*	**Parent**	*interface*
Attributes	**Type**	**Required**	**Description**
address	Number	Yes	The J1939 source address of the controller application in decimal notation.
Name	Array	Yes	The J1939 NAME field. See section X for child attributes.
DM1	String	Yes	The fully-qualified path and filename to the DM1 config file for this controller application.
receiveMessages	Message array	Yes	An array of J1939 messages which should be received by this CA.
transmitMessages	Message array	Yes	An array of J1939 messages which should be transmitted by this CA.
Notes	A controller application description object.		
JSON Example	“controllerApplications” : [“address” : 72, “name” : [… J1939 NAME field attributes], “DM1” : “/root/app/config/dm1_ca40.json”, “receiveMessages” : [… receive messages], “transmitMessages” : [… transmit messages]]		

7.5.6. Message - receiveMessages

Object	*message*	**Parent**	*controllerApplication*
Attributes	**Type**	**Required**	**Description**
pgn	Number	Yes	The J1939 Parameter Group Number in decimal format. Valid values are 0 - 65535.
ignoreSourceAddress	Boolean	Yes	A Boolean value indicating whether the source address of the messages should be ignored. If set to 'true', *sourceAddress* property must be present.
sourceAddress	Number	No	The J1939 source address of the message. If *ignoreSourceAddress* is set to 'false', the message is filtered on source address as well as PGN.
notifyStale	Boolean	Yes	A Boolean value indicating whether the subscriber will be notified if the message becomes stale. Requires *staleTimeoutPeriod*. Only valid for receive type messages.
staleTimeoutPeriod	Number	No	Sets the stale timeout period for the message. The subscriber will be notified if the specified period of time elapses following the last valid receipt of the message. Required if *notifyStale* is set to 'true'. Specified in milliseconds.
length	Number	Yes	The length of the message in bytes.
rateLimit	Number	No	Sets the rate at which new values for the receive message are published. Setting the value to 0 or not specifying this attribute removes the rate limit. Specified in milliseconds.
ignoreDuplicate	Boolean	Yes	When set to true, an update to a message that does not change the contents of any SPNs will not cause an event to be emitted (for a received message) or a J1939 message to be sent over CAN (for a transmitted message).
parameters	Boolean array	Yes	An array of parameter objects which form the message data.
Notes	A message description object.		

JSON Example	{
	"pgn" : **54528**,
	"ignoreSourceAddress" : false,
	"sourceAddress" : **36**,
	"length" : **8**,
	"rateLimit" : **200**,
	"notifyStale" : false,
	
	"parameters" : [
	{
	… parameter definition
	}
	]
	}		

7.5.7. Message - transmitMessages

Object	*message*	Parent	*controllerApplication*
Attributes	**Type**	**Required**	**Description**
pgn	Number	Yes	The J1939 Parameter Group Number in decimal format. Valid values are 0 - 65535.
destinationAddress	Number	Yes	The J1939 destination address of the message.
length	Number	Yes	The length of the message in bytes.
priority	Number	Yes	Sets the priority of the message to be transmitted.
ignoreDuplicate	Boolean	Yes	When set to true, an update to a message that does not change the contents of any SPNs will not cause an event to be emitted (for a received message) or a J1939 message to be sent over CAN (for a transmitted message).
transmitMode	Enumeration	Yes, for transmit	Sets the mode by which a message will be transmitted. Only valid for transmit messages. Permitted values are: “periodic : The message will be sent at the interval defined in the period property. “periodicOnChange : The message will be sent at the interval defined in the period property in addition to being sent when the message data changes. “onRequest : The message is only sent upon request. “onChange : The message is sent when the message data is changed.
transmitRate	Number	Yes, for transmit	The rate at which the transmit message is sent, should *transmitMode* be set to an appropriate mode. Specified as a period, in milliseconds.
parameters	Boolean array	Yes	An array of parameter objects which form the message data.
Notes	A message description object.		

JSON Example	{
	“pgn” : **54528**,
	“ignoreSourceAddress” : false,
	“sourceAddress” : **36**,
	“length” : **8**,
	“rateLimit” : **200**,
	“notifyStale” : false,
	“parameters” : [
	{
	… parameter definition
	}
	]
	}		

7.5.8. Parameter

Object	*parameter*	**Parent**	*message*
Attributes	**Type**	**Required**	**Description**
Name	Number	Yes	The identifying name of the parameter. A special paremeter name of “multiplexor” is also supported. If the first paremeter for a message is named “mulitplexor” then it definies the bits, starting at 0, where the multiplexor ID is stored. Subsequent parameters must have the “mux’ keyword specified to indicate which variant of the message it is associated with.
startPosition	Number	Yes	The bit position (0 indexed) at which the parameter starts. The start position and length combination must be within the bounds of the parent message length. The special multiplexor must have a start position of 0.
length	Number	Yes	The length of the parameter, in bits. For raw and string types, this must be byte aligned (length % 8 = 0). For integer types, this must be 0 < length < 64. The special multiplexor must have a length of 8.
endian	Enumeration	Yes	The endianness of the parameter. Must be one of the following: “big “little
dataType	Enumeration	Yes	The data type of the parameter. Must be one of the following: “integer : The parameter represents an unsigned single primitive type whose size is described by the rule 2(3,6). “raw : The parameter represents a consecutive series (array) of bytes. “string : The parameter represents an ASCII string with or without a NULL terminator.
Notes	A parameter description object.		

JSON Example	“parameters” : [
	{
	“name” : “spn190”,
	“startPosition” : 24,
	“length” : 16,
	“endian” : “little”,
	“dataType” : “integer”
	}
	]
	In the multiplexor example below, this PGN is a multiplexed message that consists of parameters Device and Failure for mux 0, and parameters Function and Store for mux 1. We do not change the PGN definition, merely the parameters:		

JSON Example (Cont.)

```
{
"parameters":
    [
            {
"name":"multiplexor",
"startPosition":0,
"length":8,
"endian":"little",
"dataType":"integer"

},
{
"name":"Device",
"mux":0,
"startPosition":8,
"length":8,
"dataType":"integer","endian":"little"
 },
 {
"name":"Function","mux":1,
"startPosition":8,
"length":8,
"dataType":"integer","endian":"little"
},
{
"name":"Failure",
"mux":0,
"startPosition":16, "length":8,
"dataType":"integer","endian":"little"
},
{
"name":"Store",
"mux":1,
"startPosition":16, "length":16,
"dataType":"integer","endian":"little"
}
   ]
},
```

7.5.9. J1939 NAME

Object	*parameter*	**Parent**	*message*
Attributes	**Type**	**Required**	**Description**
arbAddressCapable	Number	Yes	The address arbitration capable field. The J1939 service does not support address arbitration, so this should always be set to 0.
identityNumber	Number	Yes	The identity number field.
industryGroup	Number	Yes	The industry group field.
vehicleSystemInstance	Number	Yes	The vehicle system field.
vehicleSystem	Number	Yes	The vehicle system instance field.
function	Number	Yes	The function field
functionInstance	Number	Yes	The function instance field.
manufactureCode	Number	Yes	The manufacturer code field.
ecuInstance	Number	Yes	The ECU instance field.
Notes	A J1939 NAME field description.		
JSON Example	**“name” :** **{** **“arbAddressCapable”** : 0, **“identityNumber” :** 1244, **“industryGroup” :** 3, **“vehicleSystemInstance” :** 1, **“vehicleSystem” :** 0, **“function” :** 24, **“functionInstance” :** 0, **“ecuInstance” :** 1, **“manufacturerCode” :** 71 **}**		

7.6. DM1 File Structure

- Configuration File Root
  - receiveDM1s
    - sa
    - spn
    - fmi
    - priority
    - user1
    - user2
  - transmitDM1s
    - id
    - spn
    - fmi

7.7. DM1 File Components

7.7.1. File Root

Object	*File Root*	**Parent**	*none*
Attributes	**Type**	**Required**	**Description**
receiveDM1s	Receive DTC array	Yes	An array of fault codes and descriptions.
transmitDM1s	Transmit DTC array	Yes	An array of fault codes and identifiers.
Notes	The top level of the document must contain exactly one instance of the receiveDM1s and transmitDM1s sections. The array for each of these sections is allowed to be empty.		

JSON Example	{
	  "receiveDM1s" : [
	    {
	      … receive DTC
	    }
	  ],
	  "transmitDM1s" : [
	    {
	      … transmit DTC
	    }
	  ]
	}		

7.7.2. Receive DTC

Object	*receiveDTC*	**Parent**	*receiveDM1s*
Attributes	**Type**	**Required**	**Description**
sa	Number	Yes	The source address of the device emitting the DM1 message.
spn	Number	Yes	The spn field of a dtc code in the DM1 message (see SAE J1939-73 specification document for details).
fmi	Number	Yes	The fmi field of a dtc code in the DM1 message (see SAE J1939-73 specification document for details).
priority	Number	Yes	The importance of this dtc. 0 = highest, 31 = lowest.
user1	string	No	User-defined text.
user2	string	No	User-defined text.
Notes	The top level of the document must contain exactly one instance of the receiveDM1s and transmitDM1s sections. The array for each of these sections is allowed to be empty. Only Conversion Method 4, CM bit set to 0, is supported in parsing the DTC parameters.		

JSON Example	{
	“sa” : 0
	“spn” : 1076
	“fmi” : 5
	“priority” : 4
	“user1” : “S1076F5”
	“user2” : “Engine Problem”
	}		

7.7.3. Transmit DTC

Object	*transmitDTC*	**Parent**	*transmitDM1s*
Attributes	**Type**	**Required**	**Description**
id	Number	Yes	The unique identifier for this fault code.
spn	Number	Yes	The spn field of a dtc code in the DM1 message (see SAE J1939-73 specification document for details).
fmi	Number	Yes	The fmi field of a dtc code in the DM1 message (see SAE J1939-73 specification document for details).
Notes	The combination of spn and fmi must be unique. The id field should be a short unique text for this error.		
JSON Example	**{** “id” : **PHD1-7** “spn” : **1** “fmi” : **7** **}**		

8. External Interface

Inter-process communication is provided by a common DCP layer employed across the Parker middleware. For Crank-based display systems, the underpinning layer is Storyboard I/O. Inter-process communication hinges around two major components:

- Publisher - a publisher exposes data in the current processes' address space which enables it to be accessed from other processes
- Subscriber- A subscriber exposes data in teh address space of one process, allowing it to be accessed from another

A more in-depth description of DCP may be found in document 1042F26.

The J1939 service publishes and subscribes to data using strict, pre-defined paths. The following text provides examples of these. Note that the examples are provided in Luo form (for use within Crank Storyboard) and assume that the application channel name is set to 'j1939'. The path names still hold for other C/C++ based services and may be adjusted to suit.

8.1. Enabling J1939

Before any J1939 data can be sent or received, an external application must enable J1939 using the following mechanism.

8.1.1. j1939.canX.caZZ.setmode

Event	*j1939.canX.caZZ.setmode*	
Event Data		
Keys	**Values**	**Description**
mode	<0. . 1>	0 = J1939 transmission and reception disabled. 1 = J1939 transmission and reception enabled.
Direction	output	
Channel	J1939	
Notes	Sent from the application to the J1939 service. The path is described generically where: "canX" is the name of the interface "caZZ" is the source address of the target CA. Note that all PGN and CA values must be specified in decimal notation (base 10). When *mode* is set to 1, the timers for all stale messages will be reset to avoid immediately flooding the application with "stale" events, followed shortly thereafter with "fresh" events. Whenever *mode* is set to 1, the interface will send out an address claim message.	
Lua Example	**function enable_J1939**(mapargs) **local** data = {} data["**mode**"] = 1 **gre.send_event_data**("**j1939.can0.ca40.setmode**", "4u1 mode", data, "j1939") **end**	

8.1.2. Receive subscriptions

An external application may obtain J1939 message data using the following mechanism.

8.1.3. j1939.canx.pgnYYYYY.[muxAAA][saZZZ]

Event	*j1939.canx.pgnYYYYY.[muxAAA][saZZZ]*	
Event Data		
Keys	**Values**	**Description**
parameters	<parameter data>	Each parameter in the message is accessible using the parameter name as the key.
rawCanId	,<0..1073741823>	Unparsed CAN identifier of the message
Direction	input	
Channel	J1939	
Notes	Sent by the J1939 service to other services which have subscribed to the event. The path is described generically where: • “canX” is the name of the interface • “pgnYYYYYY” is the PGN of interest • muxAAA represents the multiplexor ID of the message • “saZZZ” is the address of the sender The square brackets ([ ]) in the event name represent optional items. When using those optional items, the square brackets should be left off of the event name. For example, data for PGN 61444 from source address 0 on interface can0, the path would be: j1939.can0.pgn61444.sa0. Note that it is possible to exclude the ‘saZZ’ argument in order to receive PGN YYYYYY from any source address. Be aware however that this requires a corresponding message entry in the J1939 CAN configuration file structure where the *‘ignoreSourceAddress’* attribute has been set to ‘true’. The muxAAA value only needs to be provided for PGNs that are defined with a multiplexor parameter. The AAA values should be a 4u1 parameter field named "multiplexor" containing the AAA value. For each multiplexor ID defined in the configuration file, a corresponding event will be created. Note that all PGN, MUX and SA values must be specified in decimal notation (base 10). The rawCanId identifier is returned with every message in the raw, unparsed form. The application will need to parse the value as needed. Note that the example below assumes the application has been configured to call cb_update_rpm upon receipt of PGN 61444.	

Lua Example	function cb_update_rpm(mapargs)
	  local ev = mapargs.context_event_data
	  local data = {}
	  local rpm = ev[“spn190”] / 8
	  local rpm_rot = (rpm / 10000) * 49
	
	  data[“tach_exterior.pointer_tach_exterior.rot”] = rpm_rot
	
	  gre.set_data(data)
	end	

8.1.4. Transmit message data

The application is able to control the data transmitted by defined messages using the following mechanism.

8.1.5. j1939.canX.pgnYYYYYY.daZZ

Event	*j1939.canX.pgnYYYYYY.daZZ*	
Event Data		
Keys	**Values**	**Description**
parameter	<parameter data>	Each parameter in the message is accessible using the parameter name as the key.
Direction	output	
Channel	J1939	
Notes	Sent from the application to the J1939 service. The path is described generically where: "canX" is the name of the interface "pgnYYYYYY" is the PGN of interest "daZZ" is the address of the receiver. For example, data for PGN 61444 being sent to address 0 on interface can0, the path would be: j1939.can0.pgn61444.da0. Note that all PGN and DA values must be specified in decimal notation (base 10). Note that the example adjusts the testParameter parameter of PGN 65535. testParameter is an unsigned 32-bit value.	
Lua Example	function cb_update_65535(mapargs) local data = {} data["test"] = sendData gre.send_event_data("j1939.can1.pgn65535.da10", "4u1 test", data, "j1939") sendData = sendData + 1 end	

8.1.6. Send Message

The application is able to send pre-defined J1939 CAN messages using the following mechanism.

8.1.7. j1939.canX.caZZ.send

Event	*j1939.canX.caZZ.send*	
Event Data		
Keys	**Values**	**Description**
pgnList	<0. .65535>	An array of the PGNs to transmit.
Direction	output	
Channel	J1939	
Notes	Sent from the application to the J1939 service. The path is described generically where: • “canX” is the name of the interface • “caZZ” is the address of the receiver. For example for SA 0x00 on interface can0, the path would be: j1939.can0.sa0. Note that all PGN and SA values must be specified in decimal notation (base 10).	

Lua Example	function **cb_send_ffff**(mapargs)
	  local data = **{}**
	  data[“**pgnList**”] = 65535
	  gre.send_event_data(“**j1939.can1.sa72.send**”,
	        “**4u1 pgnList**”, data, “j1939”)
	end	

8.1.8. Receive Status Information

The application can obtain status information from an interface using the following mechanism.

8.1.9. j1939.canX.caZZ.status

Event	*j1939.canX.caZZ.status*	
Event Data		
Keys	**Values**	**Description**
sa	<0. .255>	The source address of the pgn whose state has changed. This key will report 254 if the receive message was defined with ignoreSourceAddress set to "true".
pgn	<0. .65535>	The PGN of the message
status	<0. .1>	0 = message has gone stale. 1 = message was stale, has now been received.
Direction	input	
Channel	J1939	
Notes	Sent by the J1939 service to other services which have subscribed to the event. The path is described generically where: • "canX" is the name of the interface • "caZZ" is the address of the CA defined in the json configuration file. For example, status information for CA 0x00 on interface can0, the path would be: j1939.can0.ca0.status. Note that all PGN and SA values must be specified in decimal notation (base 10).	
Lua Example		

8.1.10. Version Information

The application can publish its version information to the J1939 service using the following mechanism.

8.1.11. j1939.set_app_version_info

Event	*j1939.set_app_version_info*	
Event Data		
Keys	**Values**	**Description**
appVersionMajor	<ascii string>	The application major version number. Should be numeric for full compliance with Flashloader version information.
appVersionMinor	<ascii string>	The application minor version number. Should be numeric for full compliance with Flashloader version information.
appVersionBuildNumber	<ascii string>	The application build number. Should be numeric for full compliance with Flashloader version information.
appPartNumber	<ascii string>	The application part number. Should be numeric for full compliance with Flashloader version information.
appManufacturer	<ascii string>	The manufacturer of the application. Should be 5 characters or less for J1939 CI message compliance.
appModel	<ascii string>	The application model.
appUnitNumber	<ascii string>	The application unit number.
kernelPartNumber	<ascii string>	The kernel part number.
coproPartNumber	<ascii string>	The part number of the Co-processor software.
coproVersion	<ascii string>	The version string for the Co-processor software.
faultTablePartNumber	<ascii string>	The part number of the fault table.
faultTableVersion	<ascii string>	The version string for the fault table.
imagesPartNumber	<ascii string>	The part number of the images application.
imagesVersion	<ascii string>	The version string of the images application.
parametersPartNumber	<ascii string>	The part number for the parameters project.
parametersVersion	<ascii string>	The version string for the parameters project.
Direction	output	
Channel	J1939	
Notes		
Lua Example	function set_app_ver_info(mapargs) print(“Sending app version information...”) local data = {} data[“appVersionMajor”] = “2” data[“appVersionMinor”] = “48” data[“appVersionBuildNumber”] = “2401” data[“appPartNumber”] = “1042618” data[“appManufacturer”] = “PHC” data[“appModel”] = “J1939 daemon test” data[“appUnitNumber”] = “54” data[“kernelPartNumber”] = “1042605” gre.send_event_data(“j1939.set_app_version_info”, “1s0 appVersionMajor 1s0 appVersionMinor 1s0 appVersionBuildNumber 1s0 appPartNumber 1s0 appManufacturer 1s0 appModel 1s0 appUnitNumber 1s0 kernelPartNumber”, data, “j1939”) end	

8.1.12. DM1 Receive Information

The application can obtain DM1 information from the J1939 service using the following mechanism.

8.1.13. j1939.canX.dm1_dtc.caZZ

Event	*j1939.canX.dm1_dtc.caZZ*	
Event Data		
Keys	**Values**	**Description**
sa	<0. .255>	Address of the device that sent the DM1
spn	<0. .524287>	The SPN field
fmi	<0. .31>	The FMI field
dtc	<0. .16777215>	The combined value of the spn and fmi fields.
status	<0. .1>	1 = dtc is active, 0 = dtc inactive.
priority	<0. .31>	The importance of the dtc. 0 = highest, 31 = lowest.
oc	<0. .127>	The occurrence count of the dtc.
user1	<text string>	The “user1” string from the configuration file.
user2	<text string>	The “user2” string from the configuration file.
Direction	input	
Channel	J1939	
Notes	Sent by the J1939 service to other services which have subscribed to the event. The path is described generically where: “canX” is the name of the interface “caZZ” is the source address of the controller application that received the DM1. If the sa is set to 255, all DTC will be reviewed. For example, if the controller application is defined as using address 40 on can0, the event name would be path would be: j1939.can0.dm1_dtc.ca40. Note that the example assumes the application has been configured to call cb_update_faults upon receipt of j1939.can0.dm1_dtc.ca40.	

Lua Example	function cb_update_faults(mapargs)
	local ev = mapargs.context_event_data
	local dtc = ev[“dtc”]
	local oc = ev[“oc”]
	local status = ev[“status”]
	
	if (status == 1) then
	data[dtc] = oc
	else
	data[dtc] = nil
	end
	end	

8.1.14. j1939.canX.dm1_lamp_status.caZZ

Event	j1939.canX.dm1_lamp_status.caZZ	
Event Data		
Keys	Values	Description
awl	<0..3>	Amber Warning Light, 0 = off, 1 = on, 2 = reserved, 3 = no data
rsl	<0..3>	Red Safety Light, 0 = off, 1 = on, 2 = reserved, 3 = no data
mil	<0..3>	Malfunction Ind. Light, 0 = off, 1 = on, 2 = reserved, 3 = no data
protect	<0..3>	Engine Protect Light, 0 = off, 1 = on, 2 = reserved, 3 = no data
awl_fl	<0..3>	Amber Warning Light Flash, 0 = off, 1 = on, 2 = reserved, 3 = no data
rsl_fl	<0..3>	Red Safety Light Flash, 0 = off, 1 = on, 2 = reserved, 3 = no data
mil_fl	<0..3>	Malfunction Ind. Light Flash, 0 = off, 1 = on, 2 = reserved, 3 = no data
protect_fl	<0..3>	Engine Protect Light Flash, 0 = off, 1 = on, 2 = reserved, 3 = no data
sa	<0..255>	The source address of the pgn whose state has changed. This key will report 254 if the receive message was defined with ignoreSourceAddress set to "true".
Direction	input	
Channel	J1939	
Notes	Sent by the J1939 service to other services which have subscribed to the event. The path is described generically where: "canX" is the name of the interface "caZZ" is the source address of the controller application that received the DM1. For example, if the controller application is defined as using address 40 on can0, the event name would be path would be: j1939.can0.dm1_dtc.ca40. Note that the example assumes the application has been configured to call cb_update_lamps upon receipt of j1939.can0.dm1_lamp_status.ca40.	

Lua Example	function cb_update_lamps(mapargs)
	 local data = {}
	 local ev = mapargs.context_event_data local awl = ev["awl"]
	 local awl_fl = ev["awl_fl"] if (awl = 1) then
	  if (awl_fl = 3) then
	   print("Amber Warning Lamp ON")	

8.1.15. DM1 Transmit Information

The application is able to send DM1 information using the following mechanism.

8.1.16. j1939.canX.caZZ.alarm

Event	*j1939.canX.caZZ.alarm*	
Event Data		
Keys	**Values**	**Description**
id	<text string>	An identifier defined in the dm1 configuration json file.
status	<0. .1>	1 = fault is active, 0 = fault is inactive.
Direction	output	
Channel	J1939	
Notes	Sent to other services which have subscribed to the event. The path is described generically where: “canX” is the name of the interface “caZZ” is the source address of the controller application that received the DM1. For example, if the controller application is defined as using address 40 on can0, the event name would be path would be: j1939.can0.dm1_dtc.ca40. Note that the example assumes the application has been configured to call cb_update_faults upon receipt of j1939.can0.dm1_dtc.ca40.	
Lua Example	function **cb_set_fault**(mapargs) local data= {} data[“id”] = mapargs[“id”] data[“status”] = mapargs[“status”] gre.send_event_data(“j1939.can0.ca40.alarm”, “1s0 id 4u1 status”, data, “j1939”) end	

9. Appendix B

9.1. CANopen Service

The PHD CANopen service exists to provide the system with access to one or more CANopen CAN buses. Inter-process communication is provided via DCP to permit access from other system services.

Standard PHDs support J1939 only. Units must be special ordered to support CANopen.

9.2. CANopen file transfer support

9.2.1. Introduction

The CANopen stack includes a block transfer feature to allow files to the sent to or from the PHD. With this feature, one or more SDOs can be used to transfer files to and/or from the PHD (SDO block download and upload).
The SDO object's index must be in the manufacturer-specific range (0x2000 to 0x5FFF) or the device-specific range (0x6000 to 0x9FFF).
Upon successful reception of a file, the CANopen stack will signal the appropriate cos.rxNNNN event.

9.2.2. Feature constraints

- The SDOs used for file transfer must have their data type set to DOMAIN in the EDS file (i.e. DataType = 0x000F). They must also have a Filename parameter set to a valid file in the EDS file.
- The maximum supported file-size is 64kB.
- The PHD will abort a file transfer if the file is not accessible, too large or there is not enough space available at the destination.
- The PHD acts only as a CANopen slave for file transfers.
- The CANopen stack will not allow executable files to be transferred.
- The default destination path will be /usr/local/parker/data.

An example of an object in the EDS file that can receive a CDF file is shown belo using the object index 5000, but you can use any index from 2000 to AFFF.

```
[5000]
ParameterName=CDF Data
ObjectType=0x7
DataType=0x000F
AccessType=rww
DefaultValue=0
PDOMapping=0
```

After the CDF has been transferred to the PHD, the contents are available for reading by a Crank application

9.2.3. EDS file transfer example

Here are some sample EDS elements detailing file transfer support. This EDS file specifies 5 possible file transfer targets, defining them within SDO index 0x4444.

```
[4444]
ParameterName=File Transfer Test Objects
ObjectType=0x8
SubNumber=4
ObjFlags=0x0

[4444sub0]
ParameterName=Number of subindexes
ObjectType=0x7
DataType=0x0005
AccessType=ro
DefaultValue=3
PDOMapping=0
ObjFlags=0x0

[4444sub1]
ParameterName=File Transfer 1 read-write
ObjectType=0x7
DataType=0x000F
AccessType=rww
DefaultValue=0
PDOMapping=0
ObjFlags=0x0
Filename=fx_444401.txt
[4444sub2]
ParameterName=File Transfer 2 write-only
ObjectType=0x7
DataType=0x000F
AccessType=wo
DefaultValue=0
PDOMapping=0
LowLimit=0
HighLimit=100
ObjFlags=0x0
Filename=fx_444402.txt

[4444sub3]
ParameterName=File Transfer 3 read-only
ObjectType=0x7
DataType=0x000F
AccessType=ro
DefaultValue=0
PDOMapping=0
LowLimit=0
HighLimit=100
ObjFlags=0x0
Filename=fx_444403.txt

[4445]
ParameterName=File Transfer 4 no subs
ObjectType=0x7
DataType=0x000F
AccessType=rww
DefaultValue=0
PDOMapping=0
Filename=fx_444500.txt
```

9.3. CANopen channel events

9.3.1. cos.ext_od_access

<table>
<tr><td><b>Event</b></td><td colspan="2"><i>cos.ext_od_access</i></td></tr>
<tr><td colspan="3"><b>Event Data</b></td></tr>
<tr><td><b>Keys</b></td><td><b>Values</b></td><td><b>Description</b></td></tr>
<tr><td><i>access</i></td><td><0..65535></td><td>0 = read request from other node.
Non-zero = write value to other node.</td></tr>
<tr><td><i>index</i></td><td><0..65535></td><td>Index of the item in the external object dictionary</td></tr>
<tr><td><i>subindex</i></td><td><0..65535></td><td>Subindex of the item in the external object dictionary</td></tr>
<tr><td><i>value</i></td><td><0..4294967295></td><td>Value to write to the external object dictionary. Ignored for reads.</td></tr>
<tr><td><b>Direction</b></td><td colspan="2">output</td></tr>
<tr><td><b>Channel</b></td><td colspan="2">cos</td></tr>
<tr><td><b>Notes</b></td><td colspan="2">Sent by the application to read or write an external object dictionary entry by index and subindex.
The examples below assume the Storyboard application is set up to call the given Lua functions with arguments of <i>index</i> and <i>subindex</i>. The <b>canopen_write_ext_od</b> takes an additional argument of <i>value</i>.</td></tr>
<tr><td><b>Lua Example</b></td><td colspan="2">

```
function canopen_read_ext_od(mapargs)
    local index = mapargs[“index”]
    local subindex = mapargs[“subindex”]
    if (index ~= nil and subindex ~= nil) then
    -- This is a READ access.
    data[“access”] = 0
    data[“index”] = index
    data[“subindex”] = subindex
    gre.send_event_data(“cos.ext_od_access”,
                        “4u1 access 4u1 index 4u1 subindex”, data, “cos”)
    end
end
function canopen_write_ext_od(mapargs)
    local data = {}
    if (mapargs[“index”] ~= nil and mapargs[“subindex”] ~= nil
    and mapargs[“value”] ~= nil) then
    -- This is a WRITE access.
    data[“access”] = 1
    data[“index”] = mapargs[“index”]
    data[“subindex”] = mapargs[“subindex”]
    data[“value”] = mapargs[“value”]
    gre.send_event_data(“cos.ext_od_access”,
                        “4u1 access 4u1 index 4u1 subindex 4s1 value”,
                          data, “cos”)
    end
end
```

</td></tr>
</table>

9.3.2. cos.ext_od_result

Event	*cos.ext_od_result*	
Event Data		
Keys	**Values**	**Description**
access	<0..65535>	0 = this is a read request result. Non-zero = this is a write request result.
index	<0..65535>	Index of the item in the external object dictionary
result	<0..65535>	The result of the previous cos.ext_od_access operation. A value of 0 inidicates the previous operation was successful. A non-zero result indicates that the SDO transfer was not successful. Supported responses: COP_k_OK - 0 (Success) COP_k_ERR - 1 (Error) COP_k_NO - 2 (Unsupported SDO) COP_k_TIMEOUT - 255 (Timeout) This list does not include all of the possible error/abort codes defined in the CANopen spec, but they do represent the possible results at the DCP layer.
subindex	<0..65535>	Subindex of the item in the external object dictionary
value	<0..4294967295>	Contains the value returned from the other node in response to a read operation if it was successful. This parameter should be ignored for successful write operations. If the operation was unsuccessful where the value in result is non-zero, this parameter will contain either the CANopen SDO abort error code or an internal error code.
Direction	input	
Channel	cos	
Notes	Received by the application in response to a *cos.ext_od_access* event. If external object dictionary data was written, this result will merely be the ACK or NACK of that data. *Value* will be 0 if the data was written successfully and non-zero if the write failed. The example below assumes the Storyboard application is set up to call Lua function **canopen_ext_od_receive** when the *cos.ext_od_result* event occurs. Event data is available through the *mapargs* argument.	

Lua Example

```
function canopen_ext_od_receive(mapargs)
    local ev = mapargs.context_event_data
    if (ev[“access”] ~= nil and ev[“access”] ~= 0) then
        print(“Data written successfully to external OD.”)
    elseif (ev[“access”] == 0) then
        print(“Read ”..ev[“value”]..“from external OD: ”
                    ..ev[“index”]..”, “..ev[“subindex”]..“.”)
    end
end
```

9.3.3. cos.info

<table>
<tr><td><b>Event</b></td><td colspan="2"><i>cos.info</i></td></tr>
<tr><td colspan="3"><b>Event Data</b></td></tr>
<tr><td><b>Keys</b></td><td><b>Values</b></td><td><b>Description</b></td></tr>
<tr><td><i>version</i></td><td>&lt;version string&gt;</td><td>A string containing the CANopen stack version.</td></tr>
<tr><td><b>Direction</b></td><td colspan="2">input</td></tr>
<tr><td><b>Channel</b></td><td colspan="2">cos</td></tr>
<tr><td><b>Notes</b></td><td colspan="2">Received by the application to read the CANopen version information.
The example below assumes the Storyboard application is set up to call Lua function <b>canopen_info_receive</b> when the <i>cos.info</i> event occurs. Event data is available through the <i>mapargs</i> argument.</td></tr>
<tr><td><b>Lua Example</b></td><td colspan="2"><pre><code>function canopen_info_receive(mapargs)
    local ev = mapargs.context_event_data
    local version = ev[“version”]
    if (version ~= nil) then
        print(“Received CANopen version: ”..version)
    end
end</code></pre></td></tr>
</table>

9.3.4. cos.od

Event	*cos.od*	
Event Data		
Keys	**Values**	**Description**
index	<0..65535>	Index of the object dictionary element
subindex	<0..65535>	Subindex of the object dictionary element
datatype	<0..65535>	Data type of the object dictionary element
access	<0..65535>	Access level of the object dictionary element
value	<0..4294967295>	Value of the object dictionary element
Direction	input	
Channel	cos	
Notes	Received by the application in response to a *cos.request_od* event. The example below assumes the Storyboard application is set up to call Lua function **canopen_receive_od** when a *cos.od* event occurs. Event data is available through the mapargs argument.	

Lua Example	**function canopen_receive_od**(mapargs)
	    local ev = mapargs.context_event_data
	    local index = ev[“index”]
	    local subindex = ev[“subindex”]
	    local value = ev[“value”]
	    if (ev[“index”] ~= **nil and** ev[“subindex”] ~= **nil and** ev[“value”] ~= **nil**)
	    then
	        print(“Received ”..ev[“value”]..“from OD: ”
	                        ..ev[“index”]..”, “..ev[“subindex”]..“.”)
	    end
	end	

9.3.5. cos.request_od

Event	*cos.request_od*	
Event Data		
Keys	**Values**	**Description**
index	<0..65535>	Index of the desired object dictionary element
subindex	<0..65535>	Subindex of the desired object dictionary element
Direction	output	
Channel	cos	
Notes	Sent by the application to request an object dictionary entry by index and subindex. The example below assumes the Storyboard application is set up to call Lua function **canopen_request_od** with arguments of *index* and *subindex* with values of 0 through 65535.	
Lua Example	function **canopen_request_od**(mapargs) local data = {} local index = mapargs["index"] local subindex = mapargs["subindex"] if (index ~= nil and subindex ~= nil) then data["index"] = index data["subindex"] = subindex **gre**.send_event_data("cos.request_od", "4u1 access 4u1 index 4u1 subindex", data, "cos") end end	

9.3.6. cos.rxNNNN

Event	*cos.rxNNNN* where *NNNN* is equal to the object dictionary item's index in hexadecimal.	
Event Data		
Keys	**Values**	**Description**
index	<0..65535>	Index of the object dictionary element
subindex	<0..65535>	Subindex of the object dictionary element
value	<0..4294967295>	New value of the object dictionary element.
Direction	input	
Channel	cos	
Notes	Received by the application when an item in the object dictionary is updated by an SDO or a PDO message.	
Lua Example	**function cos_rx6000**(mapargs) -- This event handler is called when this application receives the -- cos/cos.rxNNNN event – in this case object 6000. **local** ev = mapargs.context_event_data **local** index = mapargs[“index”] **local** subindex = mapargs[“subindex”] **local** value = mapargs[“value”] **if** (ev[“index”] ~= nil and ev[“subindex”] ~= **nil and** ev[“value”] ~= **nil**) **then** index = ev[“index”] subindex = ev[“subindex”] value = ev[“value”] **print**(“Rcvd [“..index..“:”..subindex..”]“..”=”..value) -- Now do something with the new data if needed. **end** **end**	

9.3.7. cos.rx_emcy

Event	*cos.rx_emcy*	
Event Data		
Keys	**Values**	**Description**
error_code	<0..65535>	Error code
error_reg	<0..255>	Error register
count	<0..255>	Occurrence count
value	<0..65535>	Data for the EMCY message.
Direction	input	
Channel	cos	
Notes	EMCY Receive Event. This event is published by cos when an EMCY message is received from the VSM using COB-ID 0x083. The example below assumes the Storyboard application is set up to call Lua function **canopen_rx_emcy** when the *cos.rx_emcy* event is received.	

Lua Example	`function canopen_rx_emcy(mapargs)`
	`    local ev = mapargs.context_event_data`
	`    local code = ev[“error_code”]`
	`    local reg = ev[“error_reg”]`
	`    local count = ev[“count”]`
	`    local value = ev[“value”]`
	`        print(“Received EMCY message.”)`
	`        print(“__Error code: ”. . code)`
	`        print(“Error register: ”. . reg)`
	`        print(“Occurrences: ”. . count)`
	`        print(“__.___Value: ”. . value)`
	`end`	

9.3.8. cos.set_error

Event	*cos.set_error*	
Event Data		
Keys	**Values**	**Description**
error_code	<0..65535>	Error code
error_reg	<0..255>	Error register
count	<0..255>	Occurrence count
value	<0..65535>	Data for the EMCY message.
Direction	output	
Channel	cos	
Notes	EMCY Send Event. This event is sent by the application to set the error code in the CANopen stack for the PHD. The example below assumes the Storyboard application is set up to call Lua function **canopen_set_error** with arguments of *code, reg*, count and *value*.	
Lua Example	function **canopen_rx_emcy**(mapargs) local ev = mapargs.context_event_data local code = ev[“error_code”] local reg = ev[“error_reg”] local count = ev[“count”] local value = ev[“value”] local data = {} if (code ~= nil and reg ~= nil and count ~= nil and value ~= nil) then data[“code”] = code data[“reg”] = reg data[“count”] = count data[“value”] = value **gre.**send_event_data(“cos.set_error”, “2u1 error_code 1u1 error_reg 1u1 count 2u1 value”, data, “cos”) end end	

9.3.9. cos.set_od

Event	*cos.set_od*	
Event Data		
Keys	**Values**	**Description**
index	<0..65535>	Index of the object dictionary element
subindex	<0..65535>	Subindex of the object dictionary element
value	<0..4294967295>	New value of the object dictionary element.
Direction	output	
Channel	cos	
Notes	Sent by the application to set the value of a given object dictionary item. The example below assumes the Storyboard application is set up to call Lua function **canopen_set_od** with arguments of **index** and **subindex** with values of 0 through 65535 and *value* with values of 0 through 4294967295.	

Lua Example	`function canopen_set_od(mapargs)`
	`    local index = mapargs[“index”]`
	`    local subindex = mapargs[“subindex”]`
	`    local value = mapargs[“value”]`
	`    local data = {}`
	`    if (index ~= nil and subindex ~= nil and value ~= nil) then`
	`    data[“index”] = index`
	`    data[“subindex”] = subindex`
	`    data[“value”] = value`
	`    gre.send_event_data(“cos.set_od”,`
	`                    “4u1 index 4u1 subindex 4u1 value”, data, “cos”)`
	`    end`
	`end`	

9.3.10. cos.state

Event	*cos.state*	
Event Data		
Keys	**Values**	**Description**

state	0x0001 – Rx queue overflow 0x0002 – CAN overrun 0x0004 – CAN BUS-OFF 0x0008 – CAN error 0x0010 – CAN error 0x0020 – Tx queue overflow 0x0040 – Rx queue overflow 0x0100 – CANopen node started 0x0200 – CANopen node stopped 0x0400 – CANopen guard error 0x0800 – CANopen guard error 0x1000 – CANopen node pre-operational 0x2000 – CANopen node reset comm. request 0x4000 – CANopen node reset request 0x8000 – CANopen PDO error	A 16-bit value with each bit representing a different CANopen state.
app_state	0x0000 – Reset state - cos will reinitialize its internalstate machines and the object dictionary, but manufacturer objects (0x2000 to 0x5fff) are only initialized once 0x0001 – Init state - cos is waiting for init to finish 0x0002 – Init finished - transitions directly to state 3 from here 0x0003 – Check CAN bus - cos is actively looking for a working CAN bus -- if an error occurrs while waiting it transitions to state 0 0x0004 – CAN bus connected 0x0005 – Initialize application - CSDO channel and Emergency Message handler are reinitialized 0x0006 – Application is running normally 0x0007 – Reserved 0x0008 – Prepare for reset - this is triggered when a NMT reset command is received -- cos flushes buffers 0x0009 – Resetting 0x000A – Reinitialize 0x0010 – Connected after BUS OFF - successful BUS OFF handling here prevents entire cos reinitialization 0x00FF – CANopen Error	A 16-bit value with each bit representing a different CANopen application state.
Direction	input	
Channel	cos	
Notes	Received by the application to read the CANopen network state information. The example below assumes the Storyboard application is set up to call Lua function **canopen_state** when the *cos.state* event occurs. Event data is available through the *mapargs* argument.	

Lua Example	`function canopen_state(mapargs)`
	`    local ev = mapargs.context_event_data`
	`    local state = ev[“state”]`
	`    if (state ~= nil) then`
	`        if (bit32.band(state,0x0001) ~= 0x0000) then`
	`            print(“COS: Rx queue overflow.”)`
	`        end`
	`    end`
	`    -- Other COS states left as an exercise`
	`end`	

9.3.11. Reprogramming over CAN

The CANopen stack on the PHDs is able to receive files for reprogramming the display when transmitted over CAN. This feature uses the CANopen standard objects as defined in specification CiA DSP-302, where the PHD implements the objects in the table below. The transfer from the PC is a 2 stage process where the PHD package is transferred first and then the MD5hash of the project is transferred to subindex 3.

Index	Subindex	Data Type	Description
1F50	1	8-bit	Contains the number of programs; set to 2.
1F50	2	DOMAIN variable size with max of 16MB	This entry is for receiving the package for reprogramming the PHD. This file transfer needs to be completed before sending the MD5 hash/ checksum for subindex 3.
1F50	3	DOMAIN (16 bytes)	This entry is for receiving the MD5 hash of the file in subindex 2. When the 16-byte hash is received,the file transferred in subindex 2 will be verified and if the hash matches, the file will be installed.

The PHD's CANopen stack can receive the reprogramming package in either operational or non-operational mode. It may prove easier to reprogram the device if the PHD is in a known predetermined state. If this is the case, there will be a requirement to enter non-operational mode when reprogramming.

10. Appendix C

10.1. DCPCAN, Generic CAN service

The PHD DCPCAN service exists to provide the system with access to any 11 or 29 bit ID message on the bus. This allows all CAN messages to be interpreted by the application. Inter-process communication is provided via DCP to permit access from other system services.

10.1.1. DCPCAN Features

Send and receive of 8-byte messages using 11 or 29 bit IDs regardless of identifier or SA.
Currently, the DCPCAN functionality is only available on the first CAN port.

10.1.2. Bus Loading Constraints

Since the DCPCAN service allows all CAN messags to be passed to the application, all CAN messages will generate a corresponding event and the need to process the message in the application itself. Care must be taken to ensure that the application is not overloaded by Bus traffic.

10.1.3. dcpcan.can1rx

Event	*dcpcan.can1rx*	
Event Data		
Keys	**Values**	**Description**
id	<0..2047> <2147483648..4294967295>	0 = read request from other node. Non-zero = write value to other node.
length	<0..8>	Index of the item in the external object dictionary
data_lo	<0..4294967295>	Subindex of the item in the external object dictionary
data_high	<0..4294967295>	Value to write to the external object dictionary.
Direction	input	
Channel	dcpcan	
Notes	Received by the application when a CAN message is received. The example below assumes the Storyboard application is set up to call Lua function **can_receive** when a *dcpcan.can1rx* event occurrs. Event data is available through the *mapargs* argument.	

Lua Example

```
function can_receive(mapargs)
  local ev = mapargs.context_event_data
  local id = ev[“id”]
  local data_size = ev[“length”]
  local data_lo = ev[“data_lo”]
  local data_hi = ev[“data_hi”]
  if (id ~= nil and data_size ~= nil) then
    print(“Received from ID: ”. . id)
    print(“Length: ”. . data_size)
    if (data_size > 0) then
      print(“data_lo: ”. . data_lo)
    end
    if (data_size > 4) then
      print(“data_hi: ”. . data_hi)
    end
  end
end
```

10.1.4. dcpcan.can1tx

Event	*dcpcan.can1tx*	
Event Data		
Keys	**Values**	**Description**
id	<0..2047> <2147483648..4294967295>	0 = read request from other node. Non-zero = write value to other node.
length	<0..8>	Index of the item in the external object dictionary
data_lo	<0..4294967295>	Subindex of the item in the external object dictionary
data_high	<0..4294967295>	Value to write to the external object dictionary.
Direction	output	
Channel	dcpcan	
Notes	Sent by the application to cause a CAN message to be emitted. The example below assumes the Storyboard application is set up to call Lua function **can_send** when a *dcpcan.can1tx* event occurrs. Event data is available through the *mapargs* argument.	
Lua Example	function can_send(mapargs) local data = {} local id = mapargs[“id”] local data_size = mapargs[“length”] local data_lo = mapargs[“data_lo”] local data_hi = mapargs[“data_hi”] if (id ~= nil and data_size ~= nil and data_lo ~= nil and data_hi ~= nil) then data[“id”] = id data[“length”] = data_size data[“data_lo”] = data_lo data[“data_hi”] = data_hi gre.send_event_data(“dcpcan.can1tx”, “4u1 id 4u1 length 4u1 data_lo 4u1 data_hi”, data, “dcpcan”) end end	

11. Appendix D

11.1. Time zones

The following is a list of settable time zones on the PHD70 platform. You can choose to support as many or as few of these time zones as you wish, but this list represents all the valid strings that can be passed to the nxs.set_timezone and nxs.set_rtc events. Sending the nxs.set_timezone event with one of these strings will cause the device to adhere to the time zone and daylight savings rules for that time zone. Setting the time zone will also cause the system time to update to reflect the time zone.

We recommend choosing a small subset of time zones to support that meets your market needs. As the device ships configured for UTC, we suggest you support that time zone as well. It is useful for cases where users do not wish to have the device autocorrect for daylight savings time.

11.1.1. List of time zones

Africa/Abidjan
Africa/Accra
Africa/Addis_Ababa
Africa/Algiers
Africa/Asmara
Africa/Asmera
Africa/Bamako
Africa/Bangui
Africa/Banjul
Africa/Bissau
Africa/Blantyre
Africa/Brazzaville
Africa/Bujumbura
Africa/Cairo
Africa/Casablanca
Africa/Ceuta
Africa/Conakry
Africa/Dakar
Africa/Dar_es_Salaam
Africa/Djibouti
Africa/Douala
Africa/El_Aaiun
Africa/Freetown
Africa/Gaborone
Africa/Harare
Africa/Johannesburg
Africa/Juba
Africa/Kampala
Africa/Khartoum
Africa/Kigali
Africa/Kinshasa
Africa/Lagos
Africa/Libreville
Africa/Lome
Africa/Luanda
Africa/Lubumbashi
Africa/Lusaka
Africa/Malabo
Africa/Maputo
Africa/Maseru
Africa/Mbabane
Africa/Mogadishu
Africa/Monrovia
Africa/Nairobi
Africa/Ndjamena
Africa/Niamey
Africa/Nouakchott
Africa/Ouagadougou
Africa/Porto-Novo
Africa/Sao_Tome
Africa/Timbuktu
Africa/Tripoli
Africa/Tunis
Africa/Windhoek
America/Adak
America/Anchorage
America/Anguilla
America/Antigua
America/Araguaina
America/Argentina/Buenos_Aires
America/Argentina/Catamarca
America/Argentina/ComodRivadavia
America/Argentina/Cordoba
America/Argentina/Jujuy
America/Argentina/La_Rioja
America/Argentina/Mendoza
America/Argentina/Rio_Gallegos
America/Argentina/Salta
America/Argentina/San_Juan
America/Argentina/San_Luis
America/Argentina/Tucuman
America/Argentina/Ushuaia
America/Aruba
America/Asuncion
America/Atikokan
America/Atka
America/Bahia
America/Bahia_Banderas
America/Barbados
America/Belem
America/Belize
America/Blanc-Sablon
America/Boa_Vista
America/Bogota
America/Boise
America/Buenos_Aires
America/Cambridge_Bay
America/Campo_Grande
America/Cancun

List of time zones continued

America/Caracas
America/Catamarca
America/Cayenne
America/Cayman
America/Chicago
America/Chihuahua
America/Coral_Harbour
America/Cordoba
America/Costa_Rica
America/Creston
America/Cuiaba
America/Curacao
America/Danmarkshavn
America/Dawson
America/Dawson_Creek
America/Denver
America/Detroit
America/Dominica
America/Edmonton
America/Eirunepe
America/El_Salvador
America/Ensenada
America/Fort_Wayne
America/Fortaleza
America/Glace_Bay
America/Godthab
America/Goose_Bay
America/Grand_Turk
America/Grenada
America/Guadeloupe
America/Guatemala
America/Guayaquil
America/Guyana
America/Halifax
America/Havana
America/Hermosillo
America/Indiana/Indianapolis
America/Indiana/Knox
America/Indiana/Marengo
America/Indiana/Petersburg
America/Indiana/Tell_City
America/Indiana/Vevay
America/Indiana/Vincennes
America/Indiana/Winamac
America/Indianapolis
America/Inuvik
America/Iqaluit
America/Jamaica
America/Jujuy
America/Juneau
America/Kentucky/Louisville
America/Kentucky/Monticello
America/Knox_IN
America/Kralendijk
America/La_Paz
America/Lima
America/Los_Angeles
America/Louisville
America/Lower_Princes
America/Maceio
America/Managua
America/Manaus
America/Marigot
America/Martinique
America/Matamoros
America/Mazatlan
America/Mendoza
America/Menominee
America/Merida
America/Metlakatla
America/Mexico_City
America/Miquelon
America/Moncton
America/Monterrey
America/Montevideo
America/Montreal
America/Montserrat
America/Nassau
America/New_York
America/Nipigon
America/Nome
America/Noronha
America/North_Dakota/Beulah
America/North_Dakota/Center
America/North_Dakota/New_Salem
America/Ojinaga
America/Panama
America/Pangnirtung
America/Paramaribo
America/Phoenix
America/Port-au-Prince
America/Port_of_Spain
America/Porto_Acre
America/Porto_Velho
America/Puerto_Rico
America/Rainy_River
America/Rankin_Inlet
America/Recife
America/Regina
America/Resolute
America/Rio_Branco
America/Rosario
America/Santa_Isabel
America/Santarem
America/Santiago
America/Santo_Domingo
America/Sao_Paulo
America/Scoresbysund
America/Shiprock
America/Sitka
America/St_Barthelemy
America/St_Johns
America/St_Kitts
America/St_Lucia
America/St_Thomas
America/St_Vincent
America/Swift_Current
America/Tegucigalpa
America/Thule
America/Thunder_Bay
America/Tijuana
America/Toronto
America/Tortola
America/Vancouver
America/Virgin
America/Whitehorse
America/Winnipeg
America/Yakutat
America/Yellowknife
Antarctica/Casey
Antarctica/Davis
Antarctica/DumontDUrville
Antarctica/Macquarie
Antarctica/Mawson
Antarctica/McMurdo
Antarctica/Palmer
Antarctica/Rothera
Antarctica/South_Pole

List of time zones continued

Antarctica/Syowa
Antarctica/Troll
Antarctica/Vostok
Arctic/Longyearbyen
Asia/Aden
Asia/Almaty
Asia/Amman
Asia/Anadyr
Asia/Aqtau
Asia/Aqtobe
Asia/Ashgabat
Asia/Ashkhabad
Asia/Baghdad
Asia/Bahrain
Asia/Baku
Asia/Bangkok
Asia/Beirut
Asia/Bishkek
Asia/Brunei
Asia/Calcutta
Asia/Chita
Asia/Choibalsan
Asia/Chongqing
Asia/Chungking
Asia/Colombo
Asia/Dacca
Asia/Damascus
Asia/Dhaka
Asia/Dili
Asia/Dubai
Asia/Dushanbe
Asia/Gaza
Asia/Harbin
Asia/Hebron
Asia/Ho_Chi_Minh
Asia/Hong_Kong
Asia/Hovd
Asia/Irkutsk
Asia/Istanbul
Asia/Jakarta
Asia/Jayapura
Asia/Jerusalem
Asia/Kabul
Asia/Kamchatka
Asia/Karachi
Asia/Kashgar
Asia/Kathmandu
Asia/Katmandu
Asia/Khandyga
Asia/Kolkata
Asia/Krasnoyarsk
Asia/Kuala_Lumpur
Asia/Kuching
Asia/Kuwait
Asia/Macao
Asia/Macau
Asia/Magadan
Asia/Makassar
Asia/Manila
Asia/Muscat
Asia/Nicosia
Asia/Novokuznetsk
Asia/Novosibirsk
Asia/Omsk
Asia/Oral
Asia/Phnom_Penh
Asia/Pontianak
Asia/Pyongyang
Asia/Qatar
Asia/Qyzylorda
Asia/Rangoon
Asia/Riyadh
Asia/Saigon
Asia/Sakhalin
Asia/Samarkand
Asia/Seoul
Asia/Shanghai
Asia/Singapore
Asia/Srednekolymsk
Asia/Taipei
Asia/Tashkent
Asia/Tbilisi
Asia/Tehran
Asia/Tel_Aviv
Asia/Thimbu
Asia/Thimphu
Asia/Tokyo
Asia/Ujung_Pandang
Asia/Ulaanbaatar
Asia/Ulan_Bator
Asia/Urumqi
Asia/Ust-Nera
Asia/Vientiane
Asia/Vladivostok
Asia/Yakutsk
Asia/Yekaterinburg
Asia/Yerevan
Atlantic/Azores
Atlantic/Bermuda
Atlantic/Canary
Atlantic/Cape_Verde
Atlantic/Faeroe
Atlantic/Faroe
Atlantic/Jan_Mayen
Atlantic/Madeira
Atlantic/Reykjavik
Atlantic/South_Georgia
Atlantic/St_Helena
Atlantic/Stanley
Australia/ACT
Australia/Adelaide
Australia/Brisbane
Australia/Broken_Hill
Australia/Canberra
Australia/Currie
Australia/Darwin
Australia/Eucla
Australia/Hobart
Australia/LHI
Australia/Lindeman
Australia/Lord_Howe
Australia/Melbourne
Australia/NSW
Australia/North
Australia/Perth
Australia/Queensland
Australia/South
Australia/Sydney
Australia/Tasmania
Australia/Victoria
Australia/West
Australia/Yancowinna
Brazil/Acre
Brazil/DeNoronha
Brazil/East
Brazil/West
CET
CST6CDT

List of time zones continued

Canada/Atlantic
Canada/Central
Canada/East-Saskatchewan
Canada/Eastern
Canada/Mountain
Canada/Newfoundland
Canada/Pacific
Canada/Saskatchewan
Canada/Yukon
Chile/Continental
Chile/EasterIsland
Cuba
EET
EST
EST5EDT
Egypt
Eire
Etc/GMT
Etc/GMT+0
Etc/GMT+1
Etc/GMT+10
Etc/GMT+11
Etc/GMT+12
Etc/GMT+2
Etc/GMT+3
Etc/GMT+4
Etc/GMT+5
Etc/GMT+6
Etc/GMT+7
Etc/GMT+8
Etc/GMT+9
Etc/GMT-0
Etc/GMT-1
Etc/GMT-10
Etc/GMT-11
Etc/GMT-12
Etc/GMT-13
Etc/GMT-14
Etc/GMT-2
Etc/GMT-3
Etc/GMT-4
Etc/GMT-5
Etc/GMT-6
Etc/GMT-7
Etc/GMT-8
Etc/GMT-9
Etc/GMT0
Etc/Greenwich
Etc/UCT
Etc/UTC
Etc/Universal
Etc/Zulu
Europe/Amsterdam
Europe/Andorra
Europe/Athens
Europe/Belfast
Europe/Belgrade
Europe/Berlin
Europe/Bratislava
Europe/Brussels
Europe/Bucharest
Europe/Budapest
Europe/Busingen
Europe/Chisinau
Europe/Copenhagen
Europe/Dublin
Europe/Gibraltar
Europe/Guernsey
Europe/Helsinki
Europe/Isle_of_Man
Europe/Istanbul
Europe/Jersey
Europe/Kaliningrad
Europe/Kiev
Europe/Lisbon
Europe/Ljubljana
Europe/London
Europe/Luxembourg
Europe/Madrid
Europe/Malta
Europe/Mariehamn
Europe/Minsk
Europe/Monaco
Europe/Moscow
Europe/Nicosia
Europe/Oslo
Europe/Paris
Europe/Podgorica
Europe/Prague
Europe/Riga
Europe/Rome
Europe/Samara
Europe/San_Marino
Europe/Sarajevo
Europe/Simferopol
Europe/Skopje
Europe/Sofia
Europe/Stockholm
Europe/Tallinn
Europe/Tirane
Europe/Tiraspol
Europe/Uzhgorod
Europe/Vaduz
Europe/Vatican
Europe/Vienna
Europe/Vilnius
Europe/Volgograd
Europe/Warsaw
Europe/Zagreb
Europe/Zaporozhye
Europe/Zurich
GB
GB-Eire
GMT
GMT+0
GMT-0
GMT0
Greenwich
HST
Hongkong
Iceland
Indian/Antananarivo
Indian/Chagos
Indian/Christmas
Indian/Cocos

Indian/Comoro
Indian/Kerguelen
Indian/Mahe
Indian/Maldives
Indian/Mauritius
Indian/Mayotte
Indian/Reunion
Iran
Israel
Jamaica
Japan
Kwajalein

List of time zones continued

Libya
MET
MST
MST7MDT
Mexico/BajaNorte
Mexico/BajaSur
Mexico/General
NZ
NZ-CHAT
Navajo
PRC
PST8PDT
Pacific/Apia
Pacific/Auckland
Pacific/Bougainville
Pacific/Chatham
Pacific/Chuuk
Pacific/Easter
Pacific/Efate
Pacific/Enderbury
Pacific/Fakaofo
Pacific/Fiji
Pacific/Funafuti
Pacific/Galapagos
Pacific/Gambier
Pacific/Guadalcanal
Pacific/Guam
Pacific/Honolulu
Pacific/Johnston
Pacific/Kiritimati
Pacific/Kosrae
Pacific/Kwajalein
Pacific/Majuro
Pacific/Marquesas
Pacific/Midway
Pacific/Nauru
Pacific/Niue
Pacific/Norfolk
Pacific/Noumea
Pacific/Pago_Pago
Pacific/Palau
Pacific/Pitcairn
Pacific/Pohnpei
Pacific/Ponape
Pacific/Port_Moresby
Pacific/Rarotonga
Pacific/Saipan
Pacific/Samoa
Pacific/Tahiti
Pacific/Tarawa
Pacific/Tongatapu
Pacific/Truk
Pacific/Wake
Pacific/Wallis
Pacific/Yap
Poland
Portugal
ROC
ROK
Singapore
Turkey
UCT
US/Alaska
US/Aleutian
US/Arizona
US/Central
US/East-Indiana
US/Eastern
US/Hawaii
US/Indiana-Starke
US/Michigan
US/Mountain
US/Pacific
US/Pacific-New
US/Samoa
UTC
Universal
W-SU
WET
Zulu

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