Vertical Power
VP-X Pro & VP-X Sport
(Gen 2)

Interface Control Document

VP-G2_ICD.docx

Version 2.0.8

VP-X Pro/Sport Software Release 1.1

4/12/2011

Revisions

Version	Authors	Description of Version	Date
2.0	John Haynes	Initial version of VP-X Gen 2 ICD. Adding DEVICE_NAME, DEVICE_NAME_QUERY, and DEVICE_ENABLE messages. Corrected bit flag descriptions for SYSTEM_SPEC and DEVICE_STATUS messages.	8/3/2010
2.0.1	John Haynes	Removing example screens from Appendix. Examples now included in implementation guide only. Fixed typos in SYSTEM_SPEC message description.	8/9/2010
2.0.2	John Haynes	Adding new bit flags to SYSTEM_STATUS message. Removed section on serial boot-loader.	9/24/2010
2.0.3	John Haynes	Adding note to DEVICE_NAME command.	11/20/2010
2.0.4	John Haynes	Adding bit flags to System Status message for startup checks for flap and trims.	12/13/2010
2.0.5	John Haynes	Changing roll trim up/down to right/left in flap/trim status message.	1/4/2011
2.0.6	John Haynes	Removed reference to “system” device in DEVICE_CLEAR message description.	1/10/2011
2.0.7	John Haynes	Adding new ADVANCED _SETTINGS mes-sage.	2/28/2011
2.0.8	John Haynes	Fixing typo in Data Integrity Error Code table.	4/12/2011

Contents

List of Tables

List of Figures

1 Introduction

1.1 Scope

This document describes the RS-232 serial interface and associated message definitions for the Vertical Power VP-X.

1.2 Overview

This document is organized into 11 sections. Section 1 provides a document overview and lists referenced documents, definitions, and acronyms. Section 3 describes the message protocol used by the VP-X serial interface. Sections 4, 5 and 6 describe the detailed message formats for the VP-X message set. Section 7 provides example usage scenarios for basic commands from the VP-X message set.

1.3 Referenced Documents

Document	Date/Version No.	Description
VP-X Installation and Operating Manual	January 1, 2010	VP-X Installation and Operations Manual

1.4 Definition and Acronyms

External System – the system connected to the VP-X through its serial port

Circuit – In the context of the VP-X system, the terms 'device' and 'circuit' are synonymous.

Device – an output pin on the VP-X connected to a specific device (e.g., landing light, alternator, EFIS, GPS, etc.) Synonymous with the term 'circuit.'

Request Message – a message sent from the external system to the VP-X

Response Message – a message sent from the VP-X to the external system in response to a request

Broadcast Message – a message sent from the VP-X to the external system a specified transmit frequency

IAS – Indicated airspeed (typically in knots)

Ground Speed – GPS ground speed, or ground speed as calculated by a GPS

2 Implementation Recommendations

2.1 General Recommendations for EFIS Developers

There are several ways in which to implement the feature set described in this document. The VP-X is designed, for the most part, to work autonomously from the EFIS. While the EFIS is needed for setup and to clear faults, the VP-X provides switching functions, trim and flap control and circuit protection on its own.

There is a lot of latitude in implementing the electrical system "page" of the EFIS. You can choose to make it a fairly basic page that only shows faults and allows the user to clear those faults, or you can make a more elaborate page that displays a diagram and provides details about each device. Further, you can allow the user to control each device individually, 9ro-cessing moving the trim and flaps from the EFIS as a backup control.

In future releases, messages may be added to the VP-X ICD, so external system developers should implement support for the VP-X so that new messages do not cause existing message support to either cease to function or function incorrectly.

A complete set of implementations recommendations and guidelines can be found in the VP-X Implementation Guide document found on the VP-X Developer's web site.

3 Message Protocol

3.1 General Protocol

The VP-X provides a single RS-232 interface bus for connection to external systems.

3.2 RS-232 Interface

3.2.1 Bit-Level Protocol

The VP-X RS-232 serial interface bus operates at a speed of 57600 bits per second. Each byte is transferred as a 9-bit byte using 8 data bits, 1 stop bit, and no parity (8N1). When multiple bytes are required for a given parameter (e.g., 16 or 32 bit data values) then the most significant byte shall be transferred first.

3.2.2 Message Level Protocol

Each message shall consist of an eight byte header and single byte footer. In between the message header and footer is the message payload section. The size of the payload section varies and is dependent on the message type. Detailed descriptions of the message header and footer formats are given in Section 4.1. Detailed descriptions of message payload formats are given in Section 6.

4 Basic Message Structure

4.1 Message Structure

The overall message structure for the VP-X serial interface is shown in Table 1. Each message consists of an eight byte header followed by a variable-length message payload section. Each message ends with a single byte checksum as described in Section 4.1.3.

Table 1: Serial Data Format

Byte	Value	Description
1	0xE7	Header byte #1
2	0x7E	Header byte #2
3	<major>	Major Command ID
4	<minor>	Minor Command ID
5	<cnt>	Command number (0-255)
6	<src>	0x00 – VP-X 0x01 – External System (e.g., EFIS) 0xFE – Unknown 0xFF – Broadcast
7	<dst>	0x00 – VP-X 0x01 – External System (e.g., EFIS) 0xFE – Unknown 0xFF – Broadcast
8	<len>	Data length, in **bytes**
9+	<data>	Data bytes; <len> number of **bytes**
<last>	<cksum>	Checksum

4.1.1 Header

Each message begins with a message header of 8 bytes as shown in Table 2. The first 2 bytes are constant (0xE7 and 0x7E) and never change. Bytes three and four specify the major and minor command number, respectively. Byte five defines the command number which is used to indentify individual messages sent between systems. Bytes six and seven specify the source and destination of the message, and byte eight contains the length of the payload section in bytes.

Table 2. Message Header

Byte	Value	Description
1	0xE7	Header byte #1
2	0x7E	Header byte #2
3	<major>	Major Command ID (0x10 – 0x13)
4	<minor>	Minor Command ID (0-255)
5	<cnt>[1]	Command number. (0-255)
6	<src>	0x00 – VP-X 0x01 – External System (e.g., EFIS) 0xFE – Unknown 0xFF – Broadcast
7	<dst>	0x00 – VP-X 0x01 – External System (e.g., EFIS) 0xFE – Unknown 0xFF – Broadcast
8	<len>	Data length in bytes

Notes:

1. The command number is assigned by the external system when sending a request message where a response from the VP-X is expected. The VP-X will use the request command number when sending a response to a specific request message. The manner in which command numbers are assigned to request messages is left up to the developer of the external system.

4.1.2 Payload

The payload section of the message varies with message type both in content and length. Detailed payload formats for each message type are described in Section 6.

4.1.3 Footer

The message footer consists of a one byte checksum computed as follows. The checksum is calculated by first Exclusive OR'ing all bytes (header and payload) in the packet. Then the summed value is inverted. The code below is one implementation of the checksum algorithm:

```
for (i=0, csum=0; i<cnt; i++)
    csum = csum ^ data[i];
csum = ~csum;
```


5 Message Summary

The following sections provide a summary of each message by message group. Table 3 provides an overview of all message groups defined for the VP-X serial interface.

Table 3. VP-X Message Groups

Message Groups	Description
System Messages	General system messages.
Device Messages	Messages to set and retrieve device configurations.
Status Messages	Messages to provide system and device status to external systems.
Power Messages	Messages to power devices on and off.
Fault Messages	Message to handled device faults.
Data Messages	Messages for sending external data to the VP-X.

5.1 System Messages

The System Messages group contains messages that are required for general system operation and updating the VP-X system software through the serial interface. Messages from this group are summarized in Table 4.

Table 4. System Message Group Summary

Major	Minor	Name	Brief Description
0x10	0x00	PING	Ping message; used to check connectivity on the serial interface.
0x10	0x01	VERSION	Version message; used to retrieve the hardware and software version numbers from the VP-X.
0x10	0x02	SOFTWARE_UPDATE	Software update message; used for updating the VP-X system software through the bootloader.
0x10	0x03	EEPROM_ERASE[1]	EEPROM erase command; erases the entire contents of the EEPROM on the VP-X. Used prior to restoring settings from an external system or when returning VP-X settings to system defaults.

Notes:

1. The EEPROM is separate and distinct from the processor flash program memory..

5.2 Device Messages

The Device Messages group contains messages that are used for setting and retrieving device configurations. Messages from this group are summarized in Table 5.

Table 5. Device Message Group Summary

Major	Minor	Name	Brief Description
0x11	0x00	DEVICE_SPEC	Device specification message; used to specify the configuration for a device.
0x11	0x01	SYSTEM_SPEC	System specification message; used to specify the value of system-wide 14ro-cess14etion parameters.
0x11	0x02	TRIM_SPEC	Trim specification message; used to define the configuration for the pitch and/or roll trims.
0x11	0x03	FLAP_SPEC	Flap specification message; used to define the configuration for the flaps.
0x11	0x04	WIG_WAG_SPEC	Wig-wag specification message; used to define the wig-wag device configuration.
0x11	0x05	DEVICE_SPEC_QUERY	Device specification query message; used to retrieve the configuration for a device.
0x11	0x06	SPEC_ACK	Device specification acknowledgement; sent by the VP-X to acknowledge a device specification request.
0x11	0x07	DEVICE_NAME	Used to store the device name in EEPROM.
0x11	0x08	DEVICE_NAME_QUERY	Device name query message; used to retrieve the device name stored in EEPROM.
0x11	0x09	DEVICE_ENABLE	Device enable message; used to store or query the enabled/disabled state for the device.
0x11	0x0A	ADVANCED_SETTINGS	Advanced settings message; used to configure system systems via the VP-X configurator application.

5.3 Status Messages

The Status Messages group contains messages that are used to report VP-X device status to the external system. Messages from this group are summarized in Table 6.

Table 6. Status Message Group Summary

Major	Minor	Name	Brief Description
0x12	0x00	SYSTEM_STATUS	System status message; provides general system status information to the external system at a constant rate of 1Hz.
0x12	0x01	DEVICE_STATUS	Device status message; provides device status information to the external system at a constant rate of 1Hz.
0x12	0x02	FLAP_TRIM_STATUS	Flap/Trim status message; provides flap and trim status to the external system at a constant rate of 10Hz.
0x12	0x03	FAULT_STATUS	Fault status message; provides device fault status to the external system at a constant rate of 1Hz.

5.4 Power Messages

The Power Messages group contains messages that are used to power devices on and off and to run the trim and flap motors. Messages from this group are summarized Table 7.

Table 7. Power Message Group Summary

Major	Minor	Name	Brief Description
0x13	0x00	DEVICE_POWER	Device power message; used to turn device power on or off.
0x13	0x01	TRIM_MOVE	Trim move message; used to run and stop the trim motor(s).
0x13	0x02	FLAP_MOVE	Flap move message; used to run and stop the flap motor.
0x13	0x03	WIG_WAG_MODE	Set wig-wag mode to either AUTO or STEADY; used for temporarily overriding device wig-wagging from the external system.

5.5 Fault Messages

The Fault Messages group contains messages that are used for handling device faults. Messages from this group are summarized in Table 8.

Table 8. Fault Message Group Summary

Major	Minor	Name	Brief Description
0x14	0x00	DEVICE_CLEAR	Device clear message; used to clear a device fault.

5.6 Data Messages

The Data Messages group contains messages that are used for send data to the VP-X from the external system. Messages from this group are summarized in Table 9.

Table 9. Data Message Group Summary

Major	Minor	Name	Brief Description
0x15	0x00	EXTERNAL_DATA	External data message; used to send data from the external system to the VP-X.

6 Detailed Message Descriptions

The sections that follow provide a detailed description of the payload section for each message in the VP-X message set, organized by message group. Payload length is the size in bytes of the message payload, and total length is the size in bytes of the message header, payload section, and footer checksum byte. In cases where message payloads are variable length, payload size and total message size represent the maximum size for the message.

6.1 System Messages

6.1.1 PING

The PING message is used to check communication connectivity with the VP-X serial data link. When sent by the external system the VP-X responds with a response PING message with the ACK flag set. The detailed payload format for the PING message is shown in Table 10.

Name: PING

Major/Minor ID: 0x10 / 0x00

Type: Request message & response message

Source: External System (request) or VP-X (response)

Destination: VP-X (request) or External System (response)

Transmit Rate: As required

Payload Size: 1

Total Size: 9

Table 10. PING Message Payload Format

Byte	Field Name	Description	Type	Range
1	ACK flag	Ping acknowledgement flag. Zero when sending a ping request, one when sending a ping response.	Unsigned byte	0-1

6.1.2 VERSION

The VERSION message is used by the external system to verify the hardware and software version numbers on the VP-X. Payload data sent by the external system is ignored by the VP-X. The VP-X will return the VERSION message with both the hardware and software fields populated. The detailed payload format for the VERSION message is shown in Table 11.

Name: VERSION

Major/Minor ID: 0x10 / 0x01

Type: Request message & response message

Source: External System (request) or VP-X (response)

Destination: VP-X (request) or External System (response)

Transmit Rate: As required

Payload Size: 3

Total Size: 11

Table 11. VERSION Message Payload Format

Byte	Field Name	Description	Type	Range
1	Hardware Version	Hardware version number.	Unsigned byte	1-3[1]
2	Software Major	Software major version number.	Unsigned byte	0-255
3	Software Minor	Software minor version number.	Unsigned byte	0-255

Notes:

1. A value of 1 for the hardware version number indicates VP-X Gen 1, a value of 2 indicates VP-X Pro, and a value of 3 indicates VP-X Sport.

6.1.3 SOFTWARE_UPDATE

The SOFTWARE_UPDATE message is sent by the external system to initiate a VP-X system software update via the VP-X bootloader protocol. Upon receipt of this message the VP-X will transition program control to the bootloader and the system will await bootloader commands. Note that the VP-X Gen 2 does not support the serial bootloader protocol of the VP-X Gen 1. This command is not expected to be used by external system developers with the VP-X Gen 2.

Name: SOFTWARE_UPDATE

Major/Minor ID: 0x10 / 0x02

Type: Request message

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 0

Total Size: 8

6.1.4 EEPROM_ERASE

The EEPROM_ERASE message is sent by the external system to erase the contents of the EEPROM on the VP-X. As this command erases the entire contents of the system EEPROM and sets all configuration parameters back to their defaults, it is recommended that this command be used with care. This command should only be used when the external system wishes to set all settings to their system default values (for example, prior to restoring all configuration settings from the EFIS as part of a 'settings import' operation).

When this message is received by the VP-X is will erase the contents of the system EEPROM, set all system and device configuration settings to their default values, and respond with a EEPROM_ERASE message with the result code set. A result code other than zero indicates that the operation did not complete successfully. The detailed payload format for the EEPROM_ERASE message is shown in Table 12.

Issuing the EEPROM_ERASE command will cause the DATA_INTEGRITY bit to be set in the SYSTEM_STATUS message. This is normal and should clear automatically after resetting or cycling power on the VP-X after issuing the EEPROM_ERASE command.

Name: EEPROM_ERASE

Major/Minor ID: 0x10 / 0x03

Type: Request message & response message

Source: External System (request) or VP-X (response)

Destination: VP-X (request) or External System (response)

Transmit Rate: As required

Payload Size: 1

Total Size: 9

Table 12. EEPROM_ERASE Message Payload Format

Byte	Field Name	Description	Type	Range
1	Response Code	Response error code. Value other than zero indicates failure.	Unsigned byte	0-1

6.2 Device Messages

6.2.1 DEVICE_SPEC

The DEVICE_SPEC message is sent by the external system to specify configuration settings for a given device. When received by the VP-X the system will attempt to configure the device as requested and then respond with a SPEC_ACK message. If any of the requested settings values are invalid or out of range, the VP-X will set the error flag in the SPEC_ACK response message and the requested device settings will be ignored. The detailed payload format for the DEVICE_SPEC message is shown in Table 12.

Name: DEVICE_SPEC

Major/Minor ID: 0x11 / 0x00

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 4

Total Size: 12

Table 13. DEVICE_SPEC Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID[1]	Device identifier.	Unsigned byte	0-30
2	Circuit Breaker[2]	Value for electronic circuit breaker.	Unsigned byte	0-15
3	Switch ID[3,4, 5,6]	External switch identifier.	Unsigned byte	0-11
4	Current Fault	Current fault enable flag. Zero indicates current fault checking is disabled, one indicates checking is enabled.	Unsigned byte	0-1

Notes:

1. See Appendix B – System Device Table for a list of valid configuration settings for each device.
2. Maximum and minimum circuit breaker values depend on the device. For a complete list of devices and their corresponding circuit breaker values see Appendix B – System Device Table.

3. Valid range for the external switch identifier field is 0-11. Zero indicates the device is always off, while a value of 11 indicates that device is always on. Values 1-10 indicate the device is controlled by the state of the external switch to which it is assigned. Invalid settings will be flagged in the SPEC_ACK message returned by the VP-X.
4. Switch ID for EFIS device (0x02) must not be zero (i.e., EFIS device cannot be always off).
5. If a device is currently set as a wig-wag device and the external system attempts to reconfigure the switch ID to either 0 or 11, a configuration error (SPEC_ACK_WIG_WAG_CONFIG) will be generated. The external system must first remove the device from the wig-wag configuration in order to change the switch ID to 0 or 11.
6. The primary and secondary alternators cannot have the same switch ID. If a device is currently assigned as the secondary alternator and the switch setting is changed to same switch setting as the primary alternator an error will be generated (SPEC_ACK_SEC_ALT_CONFIG). Conversely, if the primary alternator switch setting is changed to be the same as the device assigned as the secondary alternator, an error will result.

6.2.2 SYSTEM_SPEC

The SYSTEM_SPEC message is sent by the external system to specify system-wide configuration settings. When received by the VP-X the system will attempt to apply the system configurations as requested and then respond with a SPEC_ACK message. If any of the requested settings values are invalid or out of range, the VP-X will set the error flag in the SPEC_ACK response message and the request system settings will be ignored. The detailed payload format for the SYSTEM_SPEC message is shown in Table 14.

Name:	SYSTEM_SPEC
Major/Minor ID:	0x11 / 0x01
Type:	Request
Source:	External System
Destination:	VP-X
Transmit Rate:	As required
Payload Size:	2
Total Size:	10

Table 14. SYSTEM_SPEC Message Payload Format

Byte	Field Name	Description	Type	Range
1	Overvoltage Limit[1, 2]	The system overvoltage limit. Zero indicates an overvoltage limit of 16 volts; one indicates an overvoltage limit of 32 volts.	Unsigned byte	0-1
2	Secondary Alternator[3, 4, 5]	The device id assigned to the secondary alternator.	Unsigned byte	4-25 27-28 255

Notes:

1. The VP-X will set the overvoltage flag in the SYSTEM_STATUS message when the system voltage is above this level. The system will also turn off the active alternator when an overvoltage condition occurs.
2. Be sure to include support for both 16 and 32 volt overvoltage limits, even if your EFIS supports only 14 volt systems. This is because the aircraft may use a 28v bus but use a voltage converter to power the EFIS.
3. Device ids 0-3, 26, 29, and 30 are not assignable as the secondary alternator. Assigning the secondary alternator to any of these pins will result in an error. A value of 255 indicates secondary alternator is disabled.
4. If a device is currently assigned as a wig-wag device then it cannot be assigned as the secondary alternator. If the external system attempts to assign a wig-wag device as the secondary alternator then a configuration error will result (SPEC_ACK_WIG_WAG_CONFIG). The device must first be removed from the wig-wag configuration in order to be assigned as the secondary alternator.
5. The secondary alternator device cannot be assigned to the same switch as the primary alternator. If the external system attempts to specify a secondary alternator device assigned to the same switch as the primary alternator an error is generated (SPEC_ACK_SEC_ALT_CONFIG).

6.2.3 TRIM_SPEC

The TRIM_SPEC message is sent by the external system to specify configuration settings for the trim system (both pitch and roll axes). When received by the VP-X the system will attempt to apply the trim configuration as requested and then respond with a SPEC_ACK message. If any of the requested settings values are invalid or out of range, the VP-X will set the error flag in the SPEC_ACK response message and the requested trim settings will be ignored. The detailed payload format for the TRIM_SPEC message is shown in Table 15.

Name: TRIM_SPEC

Major/Minor ID: 0x11 / 0x02

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 7

Total Size: 15

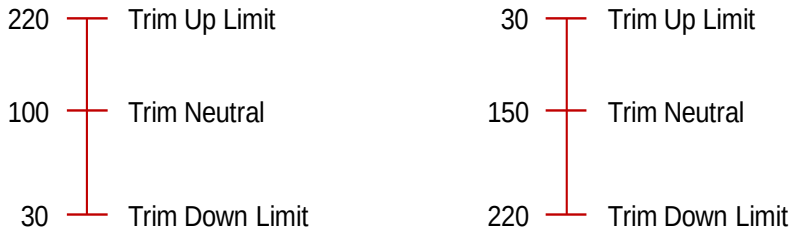
Table 15. TRIM_SPEC Message Payload Format

Byte	Field Name	Description	Type	Range
1	Trim Flags	Trim type flag[1] (pitch/roll)	Bit (MSB)	0-1
		Trim enable flag[2] (enabled/disabled)	Bit	0-1
		Trim polarity flag[3] (standard/inverted)	Bit	0-1
		Unused		
		Unused		
		Unused		
		Unused		
		Unused	(LSB)	
2	Up	Trim up endpoint[4]	Unsigned byte	0-255
3	Down	Trim down endpoint	Unsigned byte	0-255
4	Neutral	Trim neutral point	Unsigned byte	0-255
5	Power[5]	% power setting for variable speed trim (pitch trim only)	Unsigned byte	40-90
6	Speed[6]	IAS/GS above which the power to the trim motor is reduce to the value specified in the Power field.	Unsigned 16-bit word	0-300
7				

Notes:

1. Trim type is either pitch or roll. The external system must send a separate TRIM_SPEC message for each type of trim (pitch or roll).
2. Trim enable flag is set to disabled (0) if the system does not have trim of that type. For example, if an airplane does not have roll trim then the roll trim enable flag is set to zero when the TRIM_SPEC message is sent for the roll trim.
3. Trim polarity is either standard or inverted and controls the direction in which the trim motor runs.
4. The trim position sensor range is 0 to 255. The limits are set numerically based on actual feedback from your sensor. The limits can be used to set the maximum travel of the trim. For example, you may want to limit the down travel of the trim and you can

do so by configuring a value that is within the mechanical travel limits. The limits can be used to set the maximum travel of the trim. For example, you may want to limit the down travel of the trim and you can do so by configuring a value that is within the mechanical travel limits. These limits apply only to the external trim switches and not to trim movement initiated with the TRIM_MOVE message.



5. The variable speed trim setting allows the speed of the trim motor to be coupled to either indicated airspeed or ground speed. If the speed is below the value specified in the Speed field, the trim motor runs at 100% speed. If the speed is above this value, then the trim motor runs as the % power specified in the Power field. Note that indicated airspeed is the preferred data source and will be used if available and valid. If IAS is not available or is invalided then ground speed will be used. If neither IAS nor ground speed is available or valid, then variable speed trim is automatically disabled by the VP-X. This value is ignored if roll trim is selected as the trim type.
6. This value is ignored if roll trim is selected as the trim type. Variable speed trim is supported for the pitch trim axis only.

6.2.4 FLAP_SPEC

The FLAP_SPEC message is sent by the external system to specify configuration settings for the flap system. When received by the VP-X the system will attempt to apply the flap configuration as requested and then respond with a SPEC_ACK message. If any of the requested settings values are invalid or out of range, the VP-X will set the error flag in the SPEC_ACK response message and the requested flap settings will be ignored. The detailed payload format for the FLAP_SPEC message is shown in Table 16.

Name:	FLAP_SPEC
Major/Minor ID:	0x11 / 0x03
Type:	Request
Source:	External System
Destination:	VP-X
Transmit Rate:	As required
Payload Size:	11
Total Size:	19

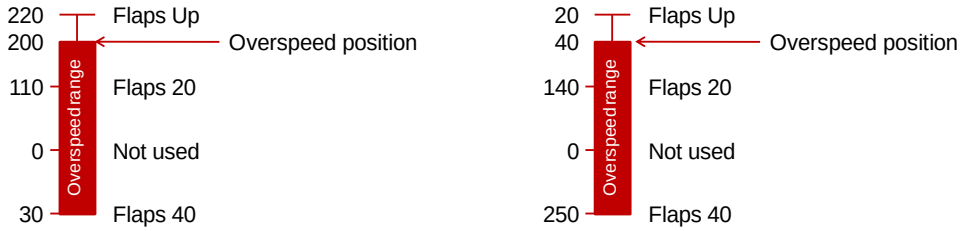
Table 16. FLAP_SPEC Message Payload Format

Byte	Field Name	Description	Type	Range
1	Flap Flags	Flap momentary/position-based flag[1] (mom/pos)	Bit (MSB)	0-1
		Flap enable flag[2] (enabled/disabled)	Bit	0-1
		Flap polarity flag[3] (standard/inverted)	Bit	0-1
		Unused		
		Unused		
		Unused		
		Unused		
		Unused	(LSB)	
2	Up	Flap up endpoint	Unsigned byte	0-255
3	Down	Flap down endpoint	Unsigned byte	0-255
4	Midpoint 1[4]	Flap midpoint #1	Unsigned byte	0-255
5	Midpoint 2	Flap midpoint #2	Unsigned byte	0-255
6	Circuit Breaker	Circuit breaker value for flap circuit (amps).	Unsigned byte	1-10
7	Overspeed Position[5]	Flap overspeed position setting. Used to specify maximum "down" position of the flaps for the max speed function.	Unsigned byte	0-255
8	Max Speed	Maximum flap speed setting. The speed above which the flap down switch is disabled and the flap over speed alarm is triggered.[6]	Unsigned 16-bit word	0-500
9				
10	Endpoint Duration[6]	The flap endpoint duration setting controls how long the flap motor continues to run after reaching its endpoint. Specified in units of tenths of seconds.	Unsigned 16-bit word	0-300
11				

Notes:

1. Flaps can be either momentary or position-based. In momentary mode, the flaps motor runs when the flap switch (up or down) is on and stops running when the flap switch is off. In position-based mode, the flaps move from position to position when the flap down switch is pressed. When the up switch is pressed in position-based mode, the flap motor continues to run until the flaps are fully retracted. Note that movement initiated with the FLAP_MOVE message will always be "momentary" and limits or intermediate points do not apply in this case.

2. Flap enable flag is set to disabled (0) if flaps if the flaps are not configured.
3. Flap polarity is either standard or inverted and controls the direction in which the flap motor runs.
4. If both flap midpoints are non-zero then they must be in the correct order with regard to the up and down endpoints. If they are not in the correct order then a SPEC_ACK_BAD_ORDER error code will be return in the SPEC_ACK message.
5. The flap position below which the flap over speed alarm is triggered (see the flap overspeed flag in the FLAP_TRIM_STATUS message). If the flaps are BELOW this setting and the IAS is higher than the Max Flap Speed, the Flap Over speed alarm is activated. Since each aircraft is different, this speed may correspond to 10° of flaps, or maybe 30°. We recommend you set it somewhere just a bit BELOW the flap up setting. When we say BELOW we mean the actual physical flap position, not the numerical value used to show the position. Here are some examples:



6. Time in seconds that the flaps will run extra when at the top and bottom travel limits. This is to eliminate the slop inherent in the position sensor, which is used to stop the flaps at the top, bottom and intermediate position. We recommend this is set to about 0.5 seconds.

6.2.5 WIG_WAG_SPEC

The WIG_WAG_SPEC message is sent by the external system to specify configuration settings for device wig-wag. When received by the VP-X the system will attempt to configure the device wig-wag function as requested and then respond with a SPEC_ACK message. If any of the requested settings values are invalid or out of range, the VP-X will set the error flag in the SPEC_ACK response message and the requested wig-wag settings will be ignored. The detailed payload format for the WIG_WAG_SPEC message is shown in Table 17.

Name:	WIG_WAG_SPEC
Major/Minor ID:	0x11 / 0x04
Type:	Request
Source:	External System
Destination:	VP-X
Transmit Rate:	As required

Payload Size: 4

Total Size: 12

Table 17. WIG_WAG_SPEC Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device One[1]	The device identifier for wig-wag device #1.	Unsigned byte	4-28, 255[2]
2	Device Two[3]	The device identifier for wig-wag device #2.	Unsigned byte	4-28, 255
3	Warm Up Period	Device warm up period, specified in seconds.	Unsigned byte	5-60
4	Speed[4]	The speed at which the wig-wag function is engaged.	Unsigned byte	0-200

Notes:

1. A device must be assigned to switch 1-10 in order to be assigned as a wig-wag device. If either device one or device two is assigned to switch 0 or switch 11 a configuration error (SPEC_ACK_BAD_CONFIG) will result.
2. The starter, primary alternator, EFIS, flap, and trim may not be set as a wig-wag device. Additionally, if a device is assigned as the secondary alternator it cannot be used as a wig-wag device and an error will result (SPEC_ACK_SEC_ALT_CONFIG). A value of 255 (0xFF) indicates that the wig-wag device is disabled.
3. Device one must be set to a non-zero value in order to specify device two. Setting device two to a non-zero value when device one is zero will generate a configuration error (SPEC_ACK_BAD_CONFIG).
4. The preferred data source for speed is indicated airspeed (IAS). If IAS is not available or is invalid, then ground speed will be used. If both IAS and ground speed are not available or invalid, then the wig-wag functionality will be disabled.

6.2.6 DEVICE_SPEC_QUERY

The DEVICE_SPEC_QUERY message is sent by the external system to query the 27rocess27etion settings for a specified device. When received by the VP-X the system will return the corresponding specification message with the current configuration settings for the device. The detailed payload format for the DEVICE_SPEC_QUERY message is shown in Table 18.

Name: DEVICE_SPEC_QUERY

Major/Minor ID: 0x11 / 0x05

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 1

Total Size: 9

Table 18. DEVICE_SPEC_QUERY Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID[1]	The device identifier. Requests with invalid device id values are ignored.	Unsigned byte	0-30, 253, 254, 255

Notes:

1. Sending a device ID of 253 (0xFD) will result in a SYSTEM_SPEC message being returned by the VP-X. Sending a device ID of 254 (0xFE) will return a WIG_WAG_SPEC message. The device ID 255 (0xFF) is unused and reserved for future use.

6.2.7 SPEC_ACK

The SPEC_ACK message is returned by the VP-X in response to a specification request message. The detailed payload format for the SPEC_ACK message is shown in Table 19.

Name: SPEC_ACK

Major/Minor ID: 0x11 / 0x06

Type: Request

Source: VP-X

Destination: External System

Transmit Rate: As required

Payload Size: 2

Total Size: 10

Table 19. SPEC_ACK Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID[1]	The device identifier used when sending the specification request.	Unsigned byte	0-30, 253, 254
2	Error Code[2]	Error code; if non-zero, indicates an error occurred when attempting to configure the device.	Unsigned byte.	0-5

Notes:

1. A device ID of 253 (0xFD) is used when responding to a SYSTEM_SPEC message. A device ID of 254 (0xFE) is used when responding to a WIG_WAG_SPEC message. The value 255 (0xFF) is unused and reserved for future use.
2. SPEC_ACK error codes are shown in Table 20.

Table 20. SPEC_ACK Error Codes

Error Code	Description
0x01	Parameter value out of range
0x02	Invalid device identifier
0x03	Invalid circuit breaker value
0x04	Invalid switch ID
0x05	Invalid configuration
0x06	EEPROM write failure
0x07	Parameters out of order
0x08	Wig-Wag configuration error
0x09	Secondary alternator 29ro-cess29etion error

6.2.8 DEVICE_NAME

The DEVICE_NAME message is used to store a device name up to 16 bytes long in the VP-X system EEPROM. The VP-X will respond with a SPEC_ACK message and return a non-zero error code (EEPROM write failure) if the system was unable to store the name in EEPROM. The detailed payload format for the DEVICE_NAME message is shown in Table 21.

Name: DEVICE_NAME

Major/Minor ID: 0x11 / 0x07

Type: Request

Source: VP-X

Destination: External System

Transmit Rate: As required

Payload Size: 17

Total Size: 25

Table 21. DEVICE_NAME Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID	The device identifier used when sending the request.	Unsigned byte	0-30
2-17	Device Name	Device name; string of ASCII characters up to 16 bytes long. Names shorter than 16 bytes should be null-terminated.	Unsigned byte	0-255

6.2.9 DEVICE_NAME_QUERY

The DEVICE_NAME_QUERY message is used to retrieve a previously stored name for a device. The VP-X will respond with a DEVICE_NAME message with the currently stored device name. If no device name has been stored the device name string will contain zeros. The detailed payload format for the DEVICE_NAME_QUERY message is shown in Table 22.

Name: DEVICE_NAME_QUERY

Major/Minor ID: 0x11 / 0x08

Type: Request

Source: VP-X

Destination: External System

Transmit Rate: As required

Payload Size: 1

Total Size: 9

Table 22. DEVICE_NAME_QUERY Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID[1]	The device identifier used when sending the request.	Unsigned byte	0-30

1. Note that all devices, with the exception of flaps and trims, can be assigned a name with DEVICE_NAME command. This includes the starter, EFIS, and primary alternator.

6.2.10 DEVICE_ENABLE

The DEVICE_ENABLE message is used to set the enable/disable state for a device. The VP-X system will ignore power requests for any device that has been disabled. If the external system sends a DEVICE_ENABLE message with an enable flag of 2, the VP-X will respond with a DEVICE_ENABLE message containing the current enable/disable state for the device. The detailed payload format for the DEVICE_ENABLE message is shown in Table 23.

Name: DEVICE_ENABLE

Major/Minor ID: 0x11 / 0x09

Type: Request

Source: VP-X

Destination: External System

Transmit Rate: As required

Payload Size: 2

Total Size: 10

Table 23. DEVICE_ENABLE Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID	The device identifier used when sending the request.	Unsigned byte	4-28[1]
2	Enable Flag	Enable flag; 0 for disabled, 1 for enabled, 2 to query current enable/disable state for device	Unsigned byte	0-2

Notes:

1. The Starter (0x01), EFIS (0x02), and Field_Pri (0x03) devices are always enabled and cannot be disabled.
2. To disable enable/disable the flaps and trim, use the enable field in the FLAP_SPEC and TRIM_SPEC messages respectively.
3. Devices that are not available on the VP-X Sport are disabled by default and cannot be enabled.

6.2.11 ADVANCED_SETTINGS

The ADVANCED_SETTINGS message is used to configure various advanced system settings via the VP-X configurator application. The detailed payload format for the ADVANCED_SETTINGS message is shown in Table 23.

Name:	ADVANCED_SETTINGS
Major/Minor ID:	0x11 / 0x0A
Type:	Request
Source:	VP-X
Destination:	External System
Transmit Rate:	As required
Payload Size:	16
Total Size:	24

Table 24. ADVANCED_SETTINGS Message Payload Format

Byte	Field Name	Description	Type	Range
1	Set/Query	Set/Query field.[1]	Unsigned byte	0/1
2	Flap Flags	Flap Slow Retract	Bit (MSB)	0/1
		Reserved		
		Reserved		
		Reserved		
		Reserved		
		Reserved		
		Reserved		
		Reserved		
3	Reserved			
4	Reserved			
5	Reserved			
6	Reserved			
7	Reserved			
8	Reserved			
9	Reserved			
10	Reserved			
11	Reserved			
12	Reserved			
13	Reserved			
14	Reserved			
15	Reserved			
16	Reserved			

Notes:

1. A value of zero indicates that the VP-X should update the advanced system settings with the values that follow. A value of 1 results in the VP-X returning an ADVANCED_SETTINGS message with the current set of advanced settings. When this field is set to 1, all other fields in the message are ignored.

6.3 Status Messages

6.3.1 SYSTEM_STATUS

The SYSTEM_STATUS message is sent by the VP-X to external system at a continuous rate of 1Hz and contains data describing the overall system state. The detailed payload format for the SYSTEM_STATUS message is shown in Table 25.

Name:	SYSTEM_STATUS
Major/Minor ID:	0x12 / 0x00
Type:	Broadcast
Source:	VP-X
Destination:	External System
Transmit Rate:	1 Hertz
Payload Size:	12
Total Size:	20

Table 25. SYSTEM_STATUS Message Payload Format

Byte	Field Name	Description	Type	Range
1	System Current	Total system current in tenths of amps.	Unsigned 16-bit word	0-65536
2				
3	Main Bus Volts	Total voltage on the main system bus in tenths of volts.	Signed 16-bit word	-32767 to 32767
4				
5	Aux Battery Volts	Aux battery voltage in tenths of volts.	Unsigned 16-bit word	0-65536
6				
7	Internal Temp	VP-X internal temperature in whole degrees Celsius.	Unsigned 8-bit byte	0-255
8	External Switch State	Roll Trim Down Switch (off/on)	Bit (MSB)	0/1
		Roll Trim Up Switch (off/on)	Bit	0/1
		Pitch Trim Down Switch (off/on)	Bit	0/1
		Pitch Trim Up Switch (off/on)	Bit	0/1
		Flap Down Switch (off/on)	Bit	0/1
		Flap Up Switch (off/on)	Bit	0/1
		Switch 10 (off/on)	Bit	0/1
		Switch 9 (off/on)	Bit	0/1
9		Switch 8 (off/on)	Bit	0/1
		Switch 7 (off/on)	Bit	0/1
		Switch 6 (off/on)	Bit	0/1
		Switch 5 (off/on)	Bit	0/1
		Switch 4 (off/on)	Bit	0/1
		Switch 3 (off/on)	Bit	0/1
		Switch 2 (off/on)	Bit	0/1
		Switch 1 (off/on)	Bit (LSB)	0/1
10	Misc Flags	Starter Annunciator Active (no/yes)	Bit (MSB)	0/1
		Wig-Wag Mode (auto/steady)	Bit	0/1
		Software Update[1]	Bit	0/1
		Wig-Wag Active (no/yes)	Bit	0/1
		Flaps Self Checks Failed	Bit	0/1
		Pitch Trim Self Checks Failed	Bit	0/1
		Roll Trim Self Checks Failed	Bit	0/1
		Unused	(LSB)	

10	System Fault Flags	Current > 48A[2]	Bit (MSB)	0/1
		Current > 60A[3]	Bit	0/1
		Starter Annunciator Max Voltage Difference Exceeded[7]	Bit	0/1
		CU Warm Reset[4]	Bit	0/1
		Data Integrity Failure[5]	Bit	0/1
		Bus Voltage Max Difference Exceeded[8]	Bit	0/1
		X-Bus Communications Failure[9]	Bit	0/1
		External Data Missing[6]	Bit (LSB)	0/1
11	Data Integrity Error Code[10]	Error code indicated which EEPROM area failed data integrity checking.	Unsigned 8-bit byte	0-7

Notes:

1. This bit is set if the system detected that system entered the bootloader and software was updated during the last power cycle. This bit is automatically cleared during the next power cycle assuming software is not installed again.
2. This bit is set when the VP-X detects a total system current greater than 48A, and is automatically cleared once the total system current falls below 48A.
3. This bit is set when the VP-X detects a total system current greater than 60A, and is automatically cleared once the total system current falls below 48A.
4. This bit is set when VP-X detects a warm reset during system start up. The bit is automatically cleared on the next full power-cycle (not warm reset).
5. This bit is set when any area of EEPROM data storage fails its internal integrity check during system start up. If this bit is set the Data Integrity Error Code will be non-zero indicating which part of the system failed data integrity checking. This bit is cleared on power cycle if data is reset and all internal integrity checks pass.
6. This bit is set if the VP-X has not received an EXTERNAL_DATA message from the external system for more than two seconds. This bit is cleared if the VP-X receives an EXTERNAL_DATA message at least every two seconds.
7. This bit indicates that the voltage level for the starter annunciator has exceeded the maximum allowable difference between Bank A and Bank B. This bit indicates a potential problem with this analog-to-digital conversion channel on one or both processors.
8. This bit indicates that the voltage level for the bus voltage reading has exceeded the maximum allowable difference between Bank A and Bank B. This bit indicates a potential problem with this analog-to-digital conversion channel on one or both processors.

9. This bit indicates that the Bank A processor has lost communication with the processor on Bank B.
10. Data integrity error codes are listed in Table 26.

Table 26. Data Integrity Error Codes

Error Code	Description
0x00	No Error
0x01	General EEPROM error
0x02	System configuration error
0x03	Device configuration error
0x04	Flap configuration error
0x05	Trim configuration error
0x06	Wig-Wag configuration error
0x07	X-Bus communication error

6.3.2 DEVICE_STATUS

The DEVICE_STATUS message is sent by the VP-X to the external system at a continuous rate of 1Hz and contains data describing the state of each device (on/off and current draw). The detailed payload format for the DEVICE_STATUS message is shown in Table 27.

Name: DEVICE_STATUS

Major/Minor ID: 0x12 / 0x01

Type: Broadcast

Source: VP-X

Destination: External System

Transmit Rate: 1 Hertz

Payload Size: 66

Total Size: 74

Table 27. DEVICE_STATUS Message Payload Format

Byte	Field Name	Description	Type	Range
1	Devices 0-7	Device 7 State (off/on)	Bit (MSB)	0/1
		Device 6 State (off/on)	Bit	0/1
		Device 5 State (off/on)	Bit	0/1
		Device 4 State (off/on)	Bit	0/1
		Device 3 State (off/on)	Bit	0/1
		Device 2 State (off/on)	Bit	0/1
		Device 1 State (off/on)	Bit	0/1
		Device 0 State (off/on)	Bit (LSB)	0/1
2	Devices 8-15	Bits 0-7 correspond to devices 15-8 (as above).	Bit Field	0/1
3	Devices 16-23	Bits 0-7 correspond to devices 23-16 (as above).	Bit Field	0/1
4	Devices 24-30	Bits 0-6 correspond to devices 30-24 (as above, last bit unused).	Bit Field	0/1
5 6	Device 0 Current	Current drawn by device 0 in tenths of amps.	Unsigned 16-bit word	0-65536
…				
65 66	Device 30[1] Current	Current drawn by device 30 in tenths of amps.	Unsigned 16-bit word	0-65536

Note:

1. Devices 1 through 29 omitted from table for brevity.

6.3.3 FLAP_TRIM_STATUS

The FLAP_TRIM_STATUS message is sent by the VP-X to the external system at a continuous rate of 10Hz and contains data describing the state of the flap and trim devices. The detailed payload format for the FLAP_TRIM_STATUS message is shown in Table 28.

Name: FLAP_TRIM_STATUS

Major/Minor ID: 0x12 / 0x02

Type: Broadcast

Source: VP-X

Destination: External System

Transmit Rate: 10 Hertz

Payload Size: 18

Total Size: 26

Table 28. FLAP_TRIM_STATUS Message Payload Format

Byte	Field Name	Description	Type	Range
1	Flap Flags	Flaps Enabled (no/yes)	Bit (MSB)	0/1
		Flap Motor Running (no/yes)	Bit	0/1
		Flap Fault (no/yes)	Bit	0/1
		Flap Overspeed Alarm (no/yes)	Bit	0/1
		Flap Down Switch Inhibited (no/yes)	Bit	0/1
		Unused		
		Unused		
		Unused	(LSB)	
2	Trim Flags	Pitch Trim Enabled (no/yes)	Bit (MSB)	0/1
		Pitch Trim Motor Running (no/yes)	Bit	0/1
		Pitch Trim Fault (no/yes)	Bit	0/1
		Roll Trim Enabled (no/yes)	Bit	0/1
		Roll Trim Motor Running (no/yes)	Bit	0/1
		Roll Trim Fault (no/yes)	Bit	0/1
		Unused		
		Unused	(LSB)	
3	Flap Position	Current flap position.	Unsigned byte	0-255
4	Pitch Trim Position	Current pitch trim position.	Unsigned byte	0-255
5	Roll Trim Position	Current roll trim position.	Unsigned byte	0-255
6	Flap Fault	Flap fault code (zero if no fault)	Unsigned byte	Appendix E
7	Pitch Trim Fault	Pitch trim fault code (zero if no fault)	Unsigned byte	Appendix E
8	Roll Trim Fault	Roll trim fault code (zero if no fault)	Unsigned byte	Appendix E
9	Flap Up	Flap up position as defined in flap specification.	Unsigned byte	0-255
10	Flap Down	Flap down position as defined in flap specification.	Unsigned byte.	0-255
11	Flap Midpoint #1	Flap midpoint #1 as defined in flap specification.	Unsigned byte	0-255
12	Flap Midpoint	Flap midpoint #2 as defined in flap	Unsigned	0-255

	#2	specification.	byte	
13	Pitch Trim Up	Pitch trim up position as defined in pitch trim specification (zero if pitch trim not enabled).	Unsigned byte	0-255
14	Pitch Trim Down	Pitch trim down position as defined in pitch trim specification (zero if pitch trim not enabled).	Unsigned byte	0-255
15	Pitch Trim Neutral	Pitch trim neutral position as defined in pitch trim specification (zero if pitch trim not enabled).	Unsigned byte	0-255
16	Roll Trim Right	Roll trim right position as defined in roll trim specification (zero if roll trim not enabled).	Unsigned byte	0-255
17	Roll Trim Left	Roll trim left position as defined in roll trim specification (zero if roll trim not enabled).	Unsigned byte	0-255
18	Roll Trim Neutral	Roll trim neutral position as defined in pitch trim specification (zero if roll trim not enabled).	Unsigned byte	0-255

6.3.4 FAULT_STATUS

The FAULT_STATUS message is sent by the VP-X when at least one device has a fault condition. When a fault condition exists this message is sent by the VP-X at a rate of 1Hz to the external system. Note that this is a variable length message and the payload size will depend on the number of faults present in the system at any given time. The detailed payload format for the FAULT_STATUS message is shown in Table 29.

Name: FAULT_STATUS

Major/Minor ID: 0x12 / 0x03

Type: Broadcast

Source: VP-X

Destination: External System

Transmit Rate: 1 Hertz

Payload Size: 35 bytes

Total Size: 43 bytes

Table 29. FAULT_STATUS Message Payload Format

Byte	Field Name	Description	Type	Range
1	Devices 0-7	Device 7 Fault (no/yes)	Bit (MSB)	0/1
		Device 6 Fault (no/yes)	Bit	0/1
		Device 5 Fault (no/yes)	Bit	0/1
		Device 4 Fault (no/yes)	Bit	0/1
		Device 3 Fault (no/yes)	Bit	0/1
		Device 2 Fault (no/yes)	Bit	0/1
		Device 1 Fault (no/yes)	Bit	0/1
		Device 0 Fault (no/yes)	Bit (LSB)	0/1
2	Devices 8-15	Bits 0-7 correspond to devices 8-15 (as above).	Bit Field	0/1
3	Devices 16-23	Bits 0-7 correspond to devices 16-23 (as above).	Bit Field	0/1
4	Devices 24-30	Bits 0-6 correspond to devices 24-30 (as above), last bit used to flag system fault.	Bit Field	0/1
5	Device 0 Fault Code[1]	Fault code for device ID # 0	8-bit byte	0-255
6	Device 1 Fault Code	Fault code for device ID #1	8-bit byte	0-255
…				
35	Device 30 Fault Code	Fault code for device ID #30	8-bit byte	0-255

Notes:

1. See Table 39 in Appendix E for a complete list of system fault codes.

6.4 Power Messages

6.4.1 DEVICE_POWER

The DEVICE_POWER message is sent by the external system to power a device on or off. The detailed payload format for the DEVICE_POWER message is shown in Table 30.

Name: DEVICE_POWER

Major/Minor ID: 0x13 / 0x00

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As Required

Payload Size: 2

Total Size: 10

Table 30. DEVICE_POWER Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID	The device identifier used when sending the power request.	Unsigned byte	0-30
2	Power State	Power state for the device (zero for off, one for on).	Unsigned byte.	0-1

6.4.2 TRIM_MOVE

The TRIM_MOVE message is sent by the external system to start or stop the pitch or roll trim motor. Note that the TRIM_MOVE message must be sent by the external system at a frequency of at least 4Hz in order to run the trim motor steadily. (This is a safety requirement implemented to prevent a runaway trim condition in the event that a power-off message is dropped.) The detailed payload format for the TRIM_MOVE message is shown in Table 30.

Name: TRIM_MOVE

Major/Minor ID: 0x13 / 0x01

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: 4Hz

Payload Size: 3

Total Size: 11

Table 31. TRIM_MOVE Message Payload Format

Byte	Field Name	Description	Type	Range
1	Trim Type	Trim type, either pitch or roll (0 for pitch, 1 for roll).	Unsigned byte	0-1
2	Power State[1]	Power state for the trim motor (0 for off, 1 for on).	Unsigned byte.	0-1
3	Direction[2]	Direction of motor travel (right/down=0, left/up=1).	Unsigned byte.	0-1

Notes:

1. When sending the TRIM_MOVE message at a constant one 4Hz rate the power state should be set to on (1).
2. For pitch trim, down = 0 and up = 1. For roll trim, right = 0 and left = 1.

6.4.3 FLAP_MOVE

The FLAP_MOVE message is sent by the external system to start or stop the flap motor. Note that the FLAP_MOVE message must be sent by the external system at a frequency of 4Hz in order to run the flap motor steadily. (This is a safety requirement implemented to prevent a runaway flap condition.) The detailed payload format for the FLAP_MOVE message is shown in Table 32.

Name: FLAP_MOVE

Major/Minor ID: 0x13 / 0x02

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: 4Hz

Payload Size: 2

Total Size: 10

Table 32. FLAP_MOVE Message Payload Format

Byte	Field Name	Description	Type	Range
1	Power State[1]	Power state for the flap motor (0 for off, 1 for on).	Unsigned byte.	0-1
2	Direction	Direction of flap motor travel (0=up, 1=down).	Unsigned byte.	0-1

Notes:

1. When sending the FLAP_MOVE message at a constant one 4Hz rate the power state should be set to on (1).

6.4.4 WIG_WAG_MODE

The WIG_WAG_MODE message is sent by the external system to override the current wig-wag state. If wig-wag is engaged and a WIG_WAG_MODE message is sent with a value of 1 (steady), then the wig-wag devices will stop flashing and remain on. If another WIG_WAG_MODE message with a value of 0 (auto) is sent then the wig-wag devices will

resume flashing. This message provides an easy way for the external system to temporarily stop wig-wag devices from flashing without changing the wig-wag configuration. The detailed payload format for the WIG_WAG_MODE message is shown in Table 33.

Name: WIG_WAG_MODE

Major/Minor ID: 0x13 / 0x03

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 1

Total Size: 9

Table 33. WIG_WAG_MODE Message Payload Format

Byte	Field Name	Description	Type	Range
1	Wig-Wag Mode	Wig-wag mode (0 for auto, 1 for steady).	Unsigned byte.	0-1

6.5 Fault Messages

6.5.1 DEVICE_CLEAR

The DEVICE_CLEAR message is sent by the external system to clear a device fault. Once the VP-X has cleared the fault status for the device upon receipt of a DEVICE_CLEAR message, the next FAULT_STATUS message will reflect the cleared status for the device. If the fault was successfully cleared, the fault bit and fault code will be cleared in the next FAULT_STATUS message. If the fault was not cleared, then the next FAULT_STATUS message will have the fault bit and error code set for the device.

The detailed payload format for the DEVICE_CLEAR message is shown in Table 34.

Name: DEVICE_CLEAR

Major/Minor ID: 0x14 / 0x00

Type: Request

Source: External System

Destination: VP-X

Transmit Rate: As required

Payload Size: 1

Total Size: 10

Table 34. DEVICE_CLEAR Message Payload Format

Byte	Field Name	Description	Type	Range
1	Device ID[1]	The device identifier for the faulted device to be cleared.	Unsigned byte	0-30

Notes:

1. Devices controlled by an external switch will be automatically set to the current switch state when a device fault is cleared. For example, if a device is controlled by an external switch and that switch is in the "on" position, then the device will automatically be powered on when the device fault is cleared. Also, all devices assigned to switch 11 (always on) will automatically be powered on when clearing a fault.

6.6 Data Messages

6.6.1 EXTERNAL_DATA

The EXTERNAL_DATA message is sent by the external system to the VP-X at a constant rate of 1Hz. The detailed payload format for the EXTERNAL_DATA message is shown in Table 35.

Name: EXTERNAL_DATA

Major/Minor ID: 0x15 / 0x00

Type: Broadcast

Source: External System

Destination: VP-X

Transmit Rate: 1Hz

Payload Size: 13

Total Size: 21

Table 35. EXTERNAL_DATA Message Payload Format

Byte	Field Name	Description	Type	Range
1 2	Indicated Air-speed (IAS)[1]	Indicated airspeed.	Unsigned 16-bit word	0-500
3 4	Ground Speed[1]	Ground speed.	Unsigned 16-bit word	0-500
5 6 7 8	Baro Altitude	Baro-corrected altitude in feet.	Signed 32-bit word	-1000 to 50000
9 10	Fuel Pressure	Fuel pressure in pounds per square inch.	Signed 16-bit word	-100 to 100
11 12	RPM	Engine RPM.	Unsigned 16-bit word	0 to X
13	Validity Flags	Indicated airspeed valid (no/yes)	Bit (MSB)	0/1
		Ground speed valid (no/yes)	Bit	0/1
		Baro altitude valid (no/yes)	Bit	0/1
		Fuel pressure valid (no/yes)	Bit	0/1
		RPM valid (no/yes)	Bit	0/1
		Unused		
		Unused		
		Unused	(LSB)	

Notes:

1. Units for this quantity are maintained by the external system and must be consistent with the units used when setting speed limits with the FLAP_SPEC and TRIM_SPEC messages. The VP-X does not perform unit checking or conversion for these values.

7 Usage Scenarios

The following section contains several detailed scenarios that show how the VP-X serial interface and associated message set are typically used. While these examples are not exhaustive, they should provide the external system developer with sufficient information to implement support for most VP-X functionality.

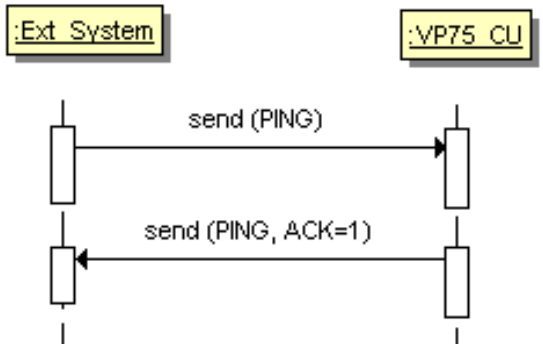
For brevity and clarity in non-error cases, message contents are not called out in the sequence diagrams. Only in those cases where a specific value results in an error will that field be specifically called out in the diagram.

7.1 System

7.1.1 Ping

The simplest and most basic scenario is the one in which the external system sends a single PING message. This scenario is show in Figure 1. The VP-X responds with a single PING message with the ACK flag set.

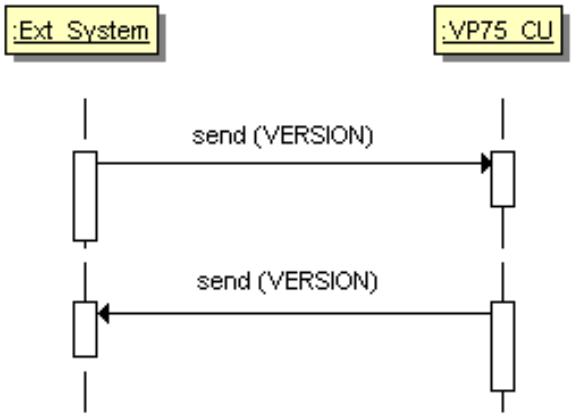
Figure 1. Ping Sequence Diagram



7.1.2 Retrieving VP-X Version Numbers

In this simple scenario, the external system requests the software and hardware version numbers from the VP-X using the SOFTWARE_VERSION message. The VP-X responds to the VERSION message by sending a VERSION message back with the hardware and software version information. This scenario is shown in Figure 2.

Figure 2. Version Request Sequence Diagram

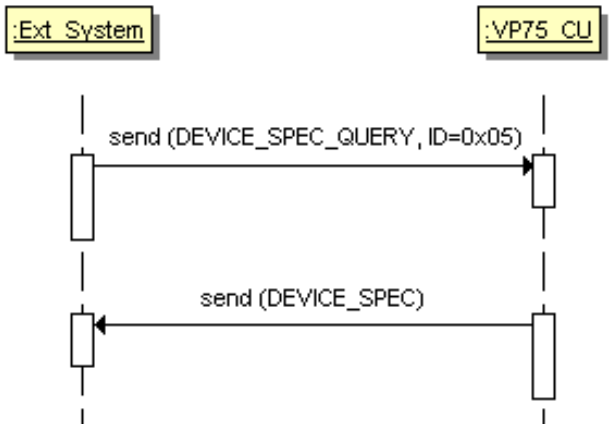


7.2 Device Configuration

7.2.1 Retrieve Device Settings – Device 0x05

In this scenario, a device configuration is retrieved for a single device, in this case device 0x05 which is 5 amp pin 2 (5A-2). The external system sends a DEVICE_SPEC_QUERY message specifying device identifier 0x05 and the VP-X responds with the DEVICE_SPEC message for the specified device. This scenario is shown in Figure 3.

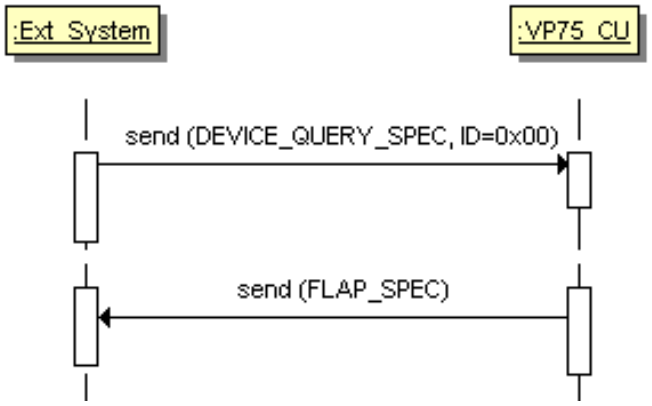
Figure 3. Retrieve Device Settings (0x05) Sequence Diagram



7.2.2 Retrieve Flap Settings

In this scenario, the external system queries the VP-X for the device settings for the flaps (device id = 0x00). The VP-X responds with a FLAP_SPEC message containing the current flap configuration values. This scenario is shown in Figure 4.

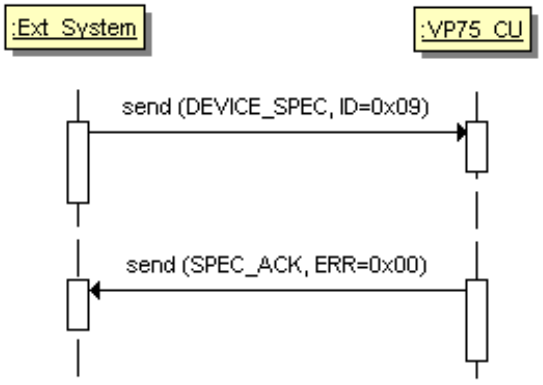
Figure 4. Retrieve Flap Settings Sequence Diagram



7.2.3 Configure Device 0x09

In this scenario, the external system configures a device by sending the DEVICE_SPEC message for device 0x09. The VP-X responds with a SPEC_ACK message with an error code of 0x00 (no error). This scenario is shown in Figure 5.

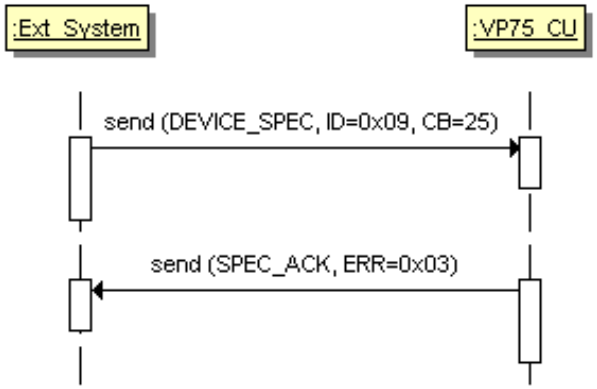
Figure 5. Configure Device Sequence Diagram



7.2.4 Configure Device 0x09 – Configuration Error

In this scenario, the external system configures a device by sending the DEVICE_SPEC message for device 0x09 with an invalid circuit breaker setting. The VP-X responds to this request by returning a SPEC_ACK message with the error code set to 0x03 (invalid circuit breaker). This scenario is shown in Figure 6.

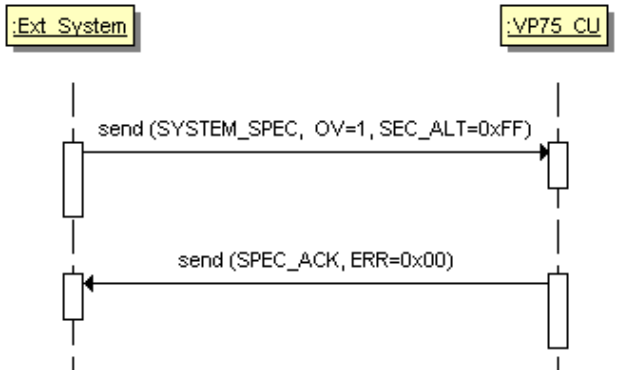
Figure 6. Configure Device with Error Sequence Diagram



7.2.5 Configure System Parameters

In this scenario, the external system configures system parameters by sending a SYSTEM_SPEC message. The system overvoltage limit is set to 32.0 volts by setting the overvoltage flag to 1, and the secondary alternator is disabled by specifying a device id of 0xFF. The VP-X responds to this request by return a SPEC_ACK message with an error code of 0x00. This scenario is show in Figure 7.

Figure 7. Configure System Parameters Sequence Diagram

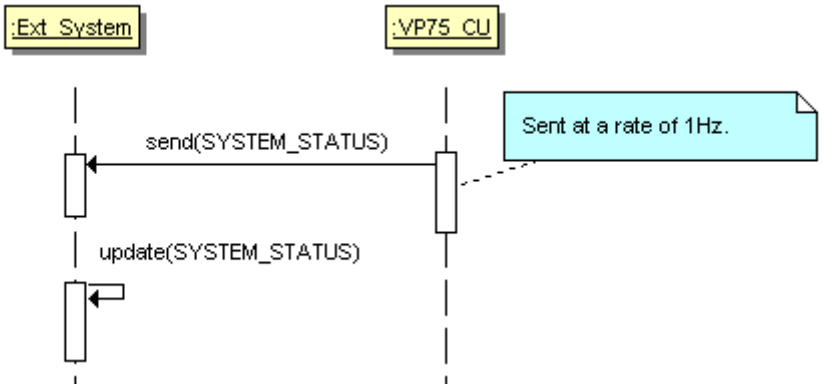


7.3 Status Monitoring

7.3.1 Monitor System Status

The VP-X sends an updated system status message every second to the external system. This scenario is shown in Figure 8.

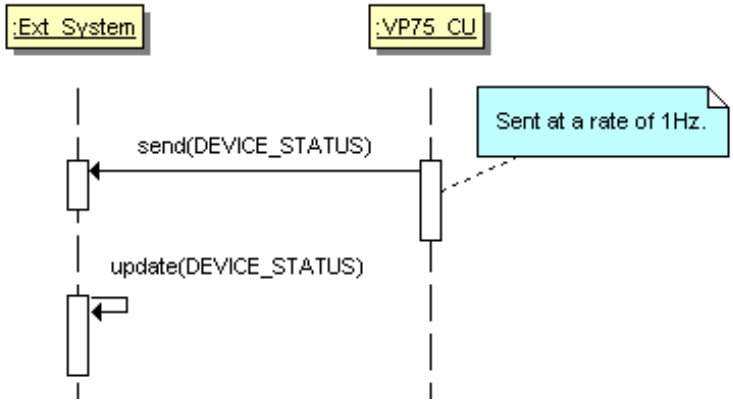
Figure 8. System Status Message Sequence Diagram



7.3.2 Monitor Device Status

As with the system status message, the VP-X also sends a device status message once a second to the external system. This message includes both the power state (on/off) for each device along with amount of current drawn by each device that is currently powered. This scenario is shown in Figure 9.

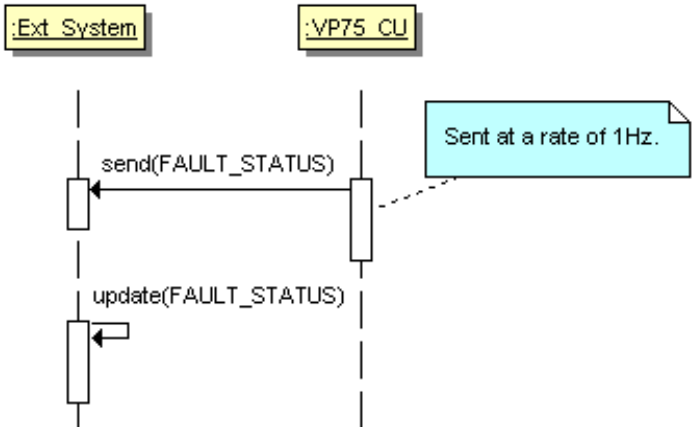
Figure 9. Device Status Message Sequence Diagram



7.3.3 Monitor Fault Status

As with the system status and devices status messages, the VP-X sends a fault status message once a second to the external system. This message includes the fault state for each device (faulted/not faulted) and the fault code for each faulted device. This scenario is shown in Figure 10.

Figure 10. Fault Status Message Sequence Diagram

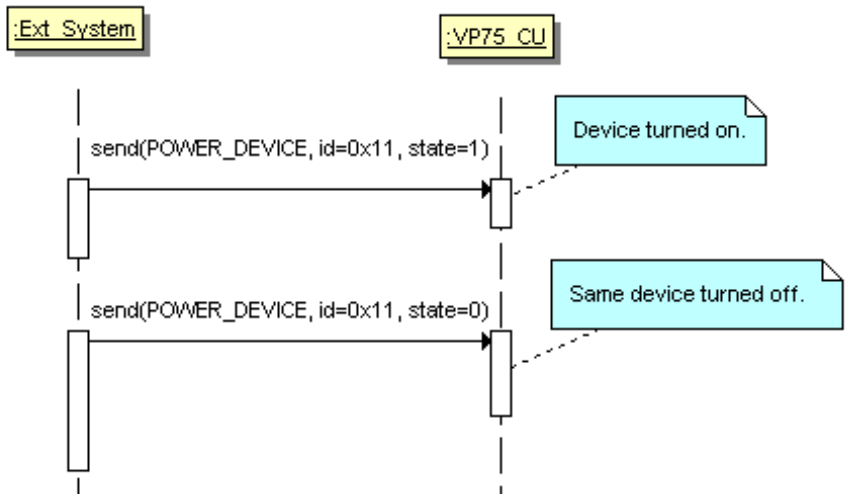


7.4 Powering Devices

7.4.1 Power Device – Single

Individual devices may be powered on and off with the device power message. A simple scenario in which a single device is powered on and then off is shown in Figure 11. Note that the VP-X does not send an acknowledgement message when a device power message is received. The new state of the device will be reflected in the next device status message sent by the VP-X.

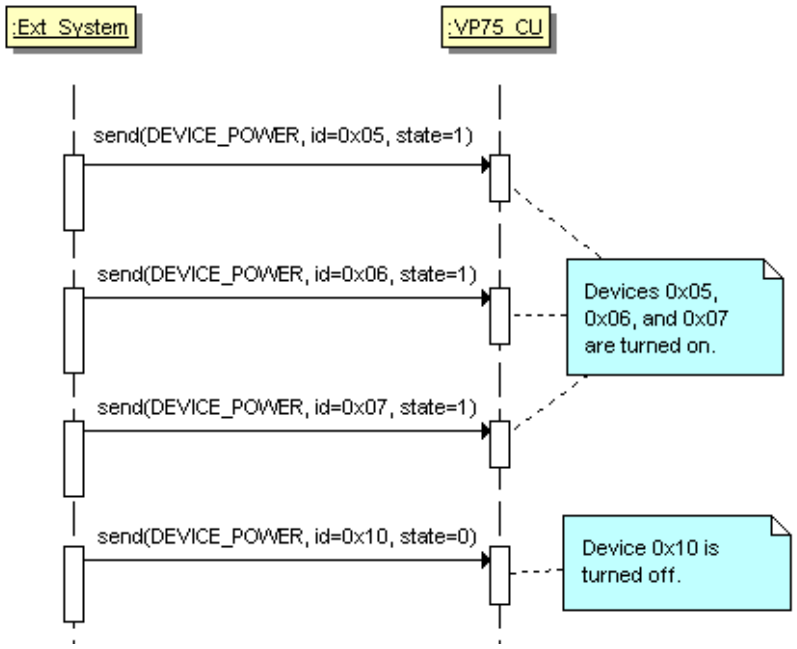
Figure 11. Power Single Device Sequence Diagram



7.4.2 Power Device – Multiple Devices

Power multiple devices is a simple extension of the scenario in which a single device is powered. The external system sends a device power message for each device to be powered on or off, and the state of the device will be updated in the next device status message sent out by the VP-X. This scenario is shown in Figure 12.

Figure 12. Power Multiple Devices Sequence Diagram

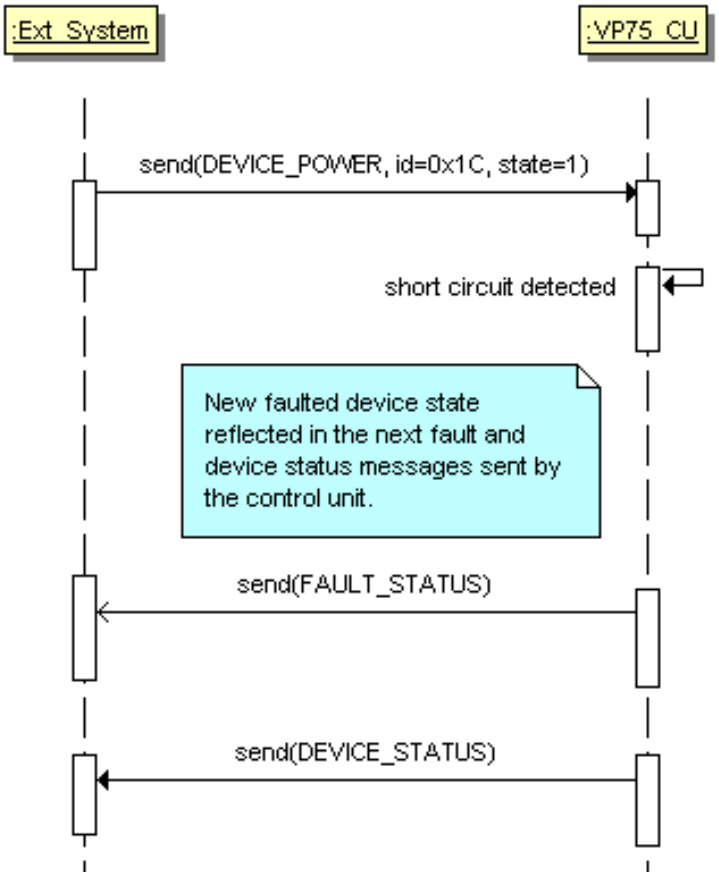


7.5 Fault Handling

7.5.1 Device Short Circuit

In this scenario the external system attempts to power on a device but is unable due to a short circuit. The VP-X detects a short circuit when powering the device on and takes appropriate steps to handle the fault. This includes making sure the device is turned off and updating the fault status for the devices (include the fault code). The new fault status for the device will be reflected in the next fault status message sent by the VP-X to the external system, and the power state in the device message will be zero of 'off'. This scenario is shown in Figure 13.

Figure 13. Device Short Circuit Sequence Diagram



8 Appendix A – Example Electrical System Screens

Please see the Implementation Guide for electrical system screen examples.

9 Appendix B – System Device Table

Table 36. VP-X System Device Table

Device ID	System Name	Amps	Default Circuit Breaker	Current Fault Support	Switch	Notes
0x00	Flaps	1-10	7	No	Flaps	Switch not assignable.
0x01	Starter[1]	1-10	5	No	Always On	Switch not assignable.
0x02	EFIS	1-5	2	Yes	Any	Switch defaults to always on.
0x03	Field_Pri	1-5	5	No	Any	Switch defaults to always off.
0x04	5A-1	1-5	2	Yes	Any	Switch defaults to always off.
0x05	5A-2	1-5	2	Yes	Any	Switch defaults to always off.
0x06	5A-3	1-5	2	Yes	Any	Switch defaults to always off.
0x07	5A-4	1-5	2	Yes	Any	Switch defaults to always off.
0x08	5A-5	1-5	2	Yes	Any	Switch defaults to always off.
0x09	5A-6	1-5	2	Yes	Any	Switch defaults to always off.
0x0A	5A-7	1-5	2	Yes	Any	Switch defaults to always off.
0x0B	5A-8	1-5	2	Yes	Any	Switch defaults to always off.
0x0C	5A-9	1-5	2	Yes	Any	Switch defaults to always off.
0x0D	5A-10	1-5	2	Yes	Any	Switch defaults to always off.
0x0E	5A-11	1-5	2	Yes	Any	Switch defaults to always off.
0x0F	5A-12	1-5	2	Yes	Any	Switch defaults to always off.
0x10	5A-13	1-5	2	Yes	Any	Switch defaults to always off.
0x11	10A-1	1-10	2	Yes	Any	Switch defaults to always off.
0x12	10A-2	1-10	2	Yes	Any	Switch defaults to always off.
0x13	10A-3	1-10	2	Yes	Any	Switch defaults to always off.
0x14	10A-4	1-10	2	Yes	Any	Switch defaults to always off.
0x15	10A-5	1-10	2	Yes	Any	Switch defaults to always

						off.
0x16	10A-6	1-10	2	Yes	Any	Switch defaults to always off.
0x17	15A-1	5-15	2	Yes	Any	Switch defaults to always off.
0x18	15A-2	5-15	2	Yes	Any	Switch defaults to always off.
0x19	15A-3	5-15	2	Yes	Any	Switch defaults to always off.
0x1A	3A-1	1-3	2	Yes	Any	Switch defaults to always off.
0x1B	2A-1	1-2	2	Yes	Any	Switch defaults to always off.
0x1C	2A-2	1-2	2	Yes	Any	Switch defaults to always off.
0x1D	Trim_R	2	2	No	Roll Trim	Switch not assignable, circuit breaker value not changeable.
0x1E	Trim_P	2	2	No	Pitch Trim	Switch not assignable, circuit breaker value not changeable.

Notes:

1. The starter circuit is “always on” with regard to the outside system’s ability to control it. It cannot be turned off by the external system. The VP-X turns off power to this pin when engine RPM is valid and above 500 RPM. The status of the starter circuit is accurate when queried and in the status data stream.

10 Appendix C – Pre-Defined Pin Names

Below are examples of pin names that can be used if implementing a pre-defined list of names. This is not all-inclusive, and the EFIS developer may modify the list as appropriate.

Table 37. Pre-Defined Pin Names

EFIS 1	Strobe Lt	Gear
EFIS 2	Nav Lt	Flaps
EFIS 3	Beacon	Trim
PFD	Landing Lt	Seat Heat 1
PFD 1	Taxi Light	Seat Heat 2
PFD 2	Cabin Lt	Defrost
MFD	Baggage Lt	Fan
Backup AI	Map Lt	Fan 1
HSI	Wing Tim R	Fan 2
CDI	Wing Tip R	Fan 3
CO Detect	Headset	Misc 1
Autopilot	Headset 2	Misc 2
Audio	Glow Strip	Misc 3
Audio Panel	Panel Lt	Aux 1
Comm 1	Alternator	Aux 2
Comm 2	Alternator 1	Aux 3
Nav 1	Alternator 2	Smoke
Nav 2	Main Alt	Starter
Comm/Nav 1	Standby Alt	Boost
Comm/Nav 2	De-Ice	Boost L
GPS 1	Brake	Boost H
GPS 2	Canopy	Boost Pump
Transponder	Ignition L	Pitot
AHRS	Ignition R	
Weather	Warning	
ADC		
429 Conv		
EIS		
Eng Mon		
AOA		
Intercom		
Ethernet		
Annunciator		

11 Appendix D – Message Summary

Table 38. VP-X Message Set Summary

Group	Major	Minor	Name
System	0x10	0x00	PING
System	0x10	0x01	VERSION
System	0x10	0x02	SOFTWARE_UPDATE
System	0x10	0x03	EEPROM_ERASE
Device	0x11	0x00	DEVICE_SPEC
Device	0x11	0x01	SYSTEM_SPEC
Device	0x11	0x02	TRIM_SPEC
Device	0x11	0x03	FLAP_SPEC
Device	0x11	0x04	WIG_WAG_SPEC
Device	0x11	0x05	DEVICE_SPEC_QUERY
Device	0x11	0x06	SPEC_ACK
Device	0x11	0x07	DEVICE_NAME
Device	0x11	0x08	DEVICE_NAME_QUERY
Device	0x11	0x09	DEVICE_ENABLE
Device	0x11	0x0A	ADVANCED_SETTINGS
Status	0x12	0x00	SYSTEM_STATUS
Status	0x12	0x01	DEVICE_STATUS
Status	0x12	0x02	FLAP_TRIM_STATUS
Status	0x12	0x03	FAULT_STATUS
Status	0x12	0x04	DEVICE_STATUS_QUERY
Power	0x13	0x00	DEVICE_POWER
Power	0x13	0x01	TRIM_MOVE
Power	0x13	0x02	FLAP_MOVE
Power	0x13	0x03	WIG_WAG_MODE
Fault	0x14	0x00	DEVICE_CLEAR
Data	0x15	0x00	EXTERNAL_DATA

12 Appendix E – System Fault Codes

Table 39. System Fault Codes

Fault Code	Name	Description	Action	Clears
0x00	NO FAULT	No device fault.	N/A	N/A
0x01	RESERVED			
0x02	RESERVED			
0x03	RESERVED			
0x04	RESERVED			
0x05	RESERVED			
0x06	OVER_VOLTAGE[1]	Device over voltage.	Device faulted and disabled, FAULT_STATUS message broadcast.	The faulted pin remains off until cleared by the external system.
0x07	SHORT_CIRCUIT	Device short circuit.	Device faulted and disabled, FAULT_STATUS message broadcast.	The faulted pin remains off until cleared by the external system.
0x08	OVER_CURRENT	Device overcurrent.	Device faulted and disabled, FAULT_STATUS message broadcast.	The faulted pin remains off until cleared by the external system.
0x09	CURRENT_FAULT	Device current fault.	Device faulted and disabled, FAULT_STATUS message broadcast.	The faulted pin remains off until cleared by the external system.
0x0A	FLAP_RUNAWAY	Runaway condition on the flaps.	Flaps faulted and disabled, FAULT_STATUS message broadcast.	The flaps remain off until cleared by the external system.
0x0B	FLAP_ACTIVE	Flaps active when clearing fault. Indicates fault could not be cleared because flap switch is active.	Flaps faulted and disabled, FAULT_STATUS message broadcast.	The flaps remain off until cleared by the external system.
0x0C	FLAP_DISABLED	Flaps disabled. Occurs when both flap switches simultaneously active on system start.	Flap input switches are disabled.	When system is power cycled and condition no longer exists.
0x0D	RESERVED			

0x0E	TRIM_RUNAWAY	Runaway condition on the pitch or roll trim circuit.	Pitch or roll trim faulted and disabled, FAULT_STATUS message broadcast.	The faulted trim remains off until cleared by the external system.
0x0F	TRIM_DISABLED	Trim disabled. Occurs when both pitch trim switches or both roll trim switches are simultaneous active on system start.	Trim input switches are disabled.	When system is power cycled and condition no longer exists.
0x10	TRIM_ACTIVE	Trim active when clearing fault. Indicates fault could not be cleared because trim switch(es) is active.	Trim faulted and disabled, FAULT_STATUS message broadcast.	The trim remain off until cleared by the external system.

Notes:

1. This fault condition is only applicable to the primary alternator and the device assigned as the secondary alternator.

13 Appendix F – System Default Values

The table below shows the default values for all fields that are user-configurable through all specification messages. The system will revert to these default values when the EEPROM is cleared or when the system fails an EEPROM data integrity check on start up.

Table 40. System Default Values

Group	Field Name	Default	Notes
System	Overvoltage Limit	0	System default overvoltage limit of 16 volts.
System	Secondary Alternator	255	Secondary alternator disabled by default.
Generic Device	Circuit Breaker	2	Generic device Includes all pins with the exception of pins 0-3, 29 and 30
Generic Device	Switch ID	0	External device switches are disabled by default.
Generic Device	Current Fault	0	Current fault checking is disabled by default.
Flap	Flap Type	Momentary	
Flap	Flap Enable	FALSE	Flaps disabled by default.
Flap	Flap Motor Polarity	Std	
Flap	Flap Up Endpoint	0	
Flap	Flap Down Endpoint	0	
Flap	Flap Midpoint #1	0	
Flap	Flap Midpoint #2	0	
Flap	Circuit Breaker	7	
Flap	Max Run Time	30	Max flap runtime in seconds.
Flap	Overspeed	0	
Flap	Max Speed	0	
Flap	Endpoint Duration	0	
Pitch Trim	Pitch Trim Enable	FALSE	Pitch trim disabled by default.
Pitch Trim	Pitch Trim Motor Polarity	Std	
Pitch Trim	Pitch Trim Up Endpoint	0	
Pitch Trim	Pitch Trim Down Endpoint	0	
Pitch Trim	Pitch Trim Neutral Point	0	
Pitch Trim	Pitch Trim Variable Speed % Power Setting	100	
Pitch Trim	Pitch Trim Variable Speed Setting	0	
Roll Trim	Roll Trim Enable	FALSE	Roll Trim disabled by default.
Roll Trim	Roll Trim Motor Polarity	Std	
Roll Trim	Roll Trim Up Endpoint	0	
Roll Trim	Roll Trim Down Endpoint	0	
Roll Trim	Roll Trim Neutral Point	0	
Roll Trim	Roll Trim Variable Speed % Power Setting	100	

Roll Trim	Roll Trim Variable Speed Setting	0	
Starter	Circuit Breaker	5	Starter device ID = 0x01
Primary Alternator	Circuit Breaker	5	Primary alternator device ID = 0x03
Primary Alternator	Switch ID	0	
EFIS	Circuit Breaker	5	EFIS device ID = 0x02
EFIS	Switch ID	11	EFIS device always on by default.
EFIS	Current Fault	FALSE	
Wig-Wag	Device1	255	Disabled = 255
Wig-Wag	Device2	255	Disabled = 255
Wig-Wag	Warm-Up Period	5	Warm-up period in seconds
Wig-Wag	Speed	70	Default speed to start wig-wag when enabled.

14 Appendix G – License