3J Series VDC Module

Programmers Manual

Grayhill PN: 3JUM1115-1

Revisions

A	Original Release	7/16/2009
B	Added joystick 8-way explanation. Added Figure 1	8/27/2009
C	Added explanation of commands needed to be send from a diagnostic tool source address	04/15/2010
D	Corrected description of Name fields in section 4.6	10/26/2011
E	Corrected priority value in Sec 3.5.1, Corrected PGN value in Sec 3.5.2. Add section 6, 6.1, and 6.2. ECN412968 RAL 10/31/2017	JJS/JLF 11/6/2017

Table of Contents

1. Overview

This document describes the functionality and communication of the Grayhill Video Display Controller (VDC) Module.

1.1. Reference Documents

The following documents are referenced within this document.

- SAE-J1939
- SAE-J1939/11
- SAE-J1939/21
- SAE-J1939/71
- SAE-J1939/81

2. Functionality

An example encoder/joystick module is illustrated in Figure 1. Modules with the encoder push button have the button mapped to button 6 of the CAN message. For modules with a joystick, the joystick is an 8-way where, for example, moving the joystick to the upper right will cause the bit fields for the X-axis and Y-axis to both have a value of 0b01. Refer to section 3.5.1.

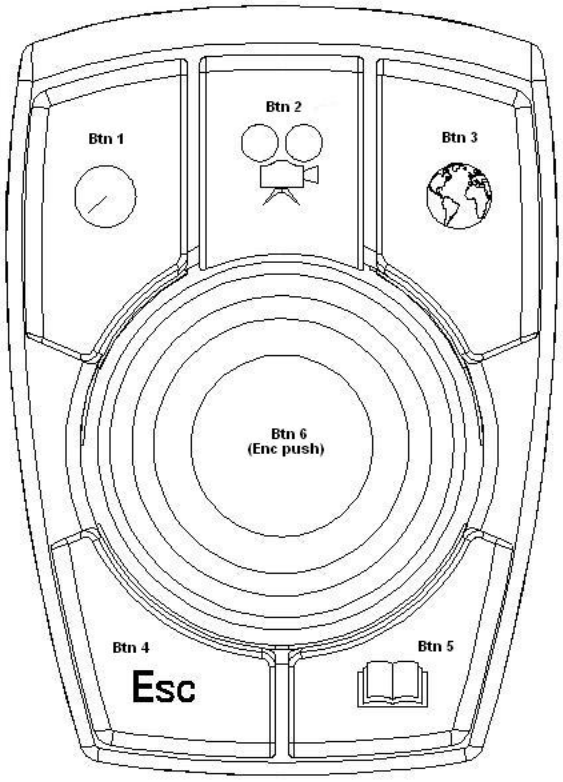

Figure 1.

2.1. Power Up Sequence

Upon first power up, the backlights are illuminated at full brightness for one second. This serves as a visual test that the module is powered and functional. Then the VDC module sends out an Address Claimed message. If there is a Name contention and the VDC module loses arbitration, it will either send another Address Claimed message with a new source address if the VDC module is using Dynamic Addressing otherwise it will send out the Cannot Claim Address message. If the VDC module is using Dynamic Addressing and cannot find an unused source address it will then send the Cannot Claim Address message. If a VDC module sends out the Cannot Claim Address message it will not enter Run Mode (it will not transmit or act upon any messages).

2.2. Run Mode

2.2.1. Joystick, Encoder, Keypress Data - Transmit

Joystick, encoder, and key information are sent on a single message every 100ms or upon a change in status with a minimum period of 20ms. The VDC's PGN, priority and transmission period are configurable at runtime.

2.2.2. Backlights - Received

The VDC module constantly monitors the backlight message and adjusts the brightness accordingly.

3. Communications

3.1. Message Header Description

The following illustrates the format of the CAN message ID. A brief description of each field follows.

SOF	Identifier 11 Bits											SRR	IDE	Identifier Extension 18 Bits																		RTR
SOF	Priority			R	DP	PDU Format (PF) 6 Bits (MSB)						SRR	IDE	PF (cont.)		PDU Specific (PS) (Destination Address, Group Extension or Proprietary)								Source Address								RTR
	3	2	1			8	7	6	5	4	3			2	1	8	7	6	5	4	3	2	1	8	7	6	5	4	3	2	1	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	23	25	26	27	28	29	30	31	32	33
	28	27	26	25	24	23	22	21	20	19	18			17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	

Figure 2

3.1.1. Priority

This 3-bit field is used to define the priority during arbitration. '000' is the highest priority and is usually associated with high-speed control messages. Low priority is used for non-critical configuration and information messages.

3.1.2. Data Page

This 1-bit field defines on which data page (0 or 1) the message is defined in the J1939 specification. Page 0 contains the messages that are presently defined, while Page 1 is for future expansion according to J1939.

3.1.3. Protocol Data Unit (PDU), PDU Format (PF), PDU Specific (PS)

This 8-bit field determines the format of the message and is one of the fields that determine the Parameter Group Number of the message (see Figure 2). If the value is between 0 and 239, the message is a PDU 1 Format message. These messages are sent to specific addresses. The PDU Specific (PS) field is the Destination Address (DA). If the value is between 240 and 255, the message is a PDU 2 Format message. These messages are not sent to a specific address, but are instead broadcast to the entire network. The PS then becomes the Group Extension (GE) field.

3.1.4. Source Address

This 8-bit field is the source address of the device that sent the message.

3.1.5. Data Length

The number of data bytes in the message.

3.1.6. Data

Up to 8 bytes of data. The first five items are placed into the CAN 29-bit extended identifier in the format shown in figure 2. Most messages are intended to be broadcast messages, or PDU 2 Format, where the message is not sent to a particular address. The J1939 specification defines PDU Format and PDU Specific values for many messages by specifying the message Parameter Group Numbers.

3.1.7. Parameter Group Number

J1939 defines allowable messages by their Parameter Group Number (PGN). The Parameter Group Number is a 3-byte value that uniquely defines the message purpose. A PGN has the following format: If the PDU Format value for a message is less than 240, then the last 8 bits of the PGN are set to '0'. The specification gives the decimal equivalent of the PGNs. To obtain the PF and PS values to use for a specific message, convert the decimal value from the specification to hexadecimal and use the last two bytes. These values can then be used to either send messages on the network or to request messages from other source addresses.

3.2. Bitfield Location and Byte Ordering

The byte and bit ordering and location within the data field are the same as to what's called out in J1939. The first data byte is sent first and is referenced as Byte 1, 0x01 in the example below. The LSB of the data bytes are on the right and are referenced as Bit 1.

The convention used to locate a parameter in the data field is the same as specified in SAE-J1939/71. The format used is "Rx" where R is the byte number and x is the starting bit number within the byte. The length is the number of bits starting at this point.

In the event of a byte or a multi-byte length parameter the format becomes “R-S” where R is the start byte location and the data occupies bytes R through S.

Examples:

Start	Length	Description
4.3	3 bits	Ex. Parameter between 0..6, where 7 is ‘don’t care”

Location 4.3 with a length of 3 bits would have the value of 1 as illustrated below using the above data frame example.

Byte 4 = 0x67 = 0b011**001**11. The bold value is the three bit field holding a value of 0b001

A 16 bit word starting at byte location 2 would be represented by the following example.

Start	Length	Description
2-3	2 bytes	Ex. Parameter between 0..65534, where 65535 is ‘don’t care’

3.3. VDC Source Address

The source address of the Grayhill standard VDC module shall default to 241 (F1h). This may be modified either dynamically if the VDC module is Self Configurable and with the Commanded Address message in accordance with J1939-81. The new source address value shall be stored in non-volatile memory. The ability to change the source address will allow multiple standard VDC modules to coexist in the same system.

3.4. Physical Layer

The bit rate and signal lines shall comply with J1939/11 with a bit rate of 250kbps using an 82C251 or equivalent CAN transceiver. The connector shall be a 4 pin Deutsch equivalent with the following pin out:

1. Power
2. Ground
3. CAN_H
4. CAN_L

3.5. Standard Messages

Most of the VDC module’s functionality is done using only two PGNs. These are the VDC Data Message, and the Control PGN using Proprietary A PDU1 format (PF = 239). The Control PGN uses byte 1 of the data field to determine the meaning of the rest of the data.

3.5.1. VDC Data Message

PF – 255
PS - 3
PGN – 65283 (FF03h)
Direction - Transmit
Priority – 6
Data Length - 8
Transmission Rate – 100ms or on change, not to exceed 20ms

Start	Length	Description	Value
1.1	2 bits	Joystick 1 X-Axis Right	00 - Not pushed right 01 – Pushed right 10 - Unused 11 - Not available
1.3	2 bits	Joystick 1 X-Axis Left	00 - Not pushed left 01 – Pushed left 10 - Unused 11 - Not available
1.5	2 bits	Joystick 1 Y-Axis Up	00 – Not pushed up 01 – Pushed up 10 - Unused 11 - Not available
1.7	2 bits	Joystick 1 Y-Axis Down	00 – Not pushed down 01 – Pushed down 10 - Unused 11 - Not available
2-3	2 bytes	Encoder data	Value between 0 and TOP, inclusive. See Encoder Configuration in Sec 4.10 for definition of TOP. 65,535 – Not available
4.1	2 bits	Button 1 Status	00 - Button not pressed 01 - Button pressed 10 - Unused 11 - Not available
4.3	2 bits	Button 2 Status	Same
4.5	2 bits	Button 3 Status	Same
4.7	2 bits	Button 4 Status	Same
5.1	2 bits	Button 5 Status	Same
5.3	2 bits	Button 6 Status	Same
5.5	4 bits	Unused	All bits set
6-8	3 bytes	Unused	All bits set

Diagonal pushes of the joystick will cause both the corresponding X and Y directions to indicate a push.

Bits of unused buttons shall default to 0b11.

See Encoder Configuration in Sec. 4.10 for definition of TOP.

3.5.2. Backlight Intensity

PF – 239, Proprietary A PDU1 Format
PS – DA, The Source Address of the VDC module. Default value: 241 (F1h)
PGN = (PF * 256) = 61184
Direction - Receive
Data Length – 8

Start	Length	Desc.	Value
1.1	1 Byte	Backlight Intensity	128
2.1	1 Byte	Unused	255 – Not Available
3.1	1 Byte	Backlight Intensity	0 – Off 254 - Brightest 255 – Not Available
4.1	6 bytes	Unused	255 – Not Available

3.5.3. Configuration and Control

PF – 239, Proprietary A PDU1 Format
PS – DA, The Source Address of the VDC module. Default value: 241 (F1h)
PGN = (PF * 256) = 61184
Direction - Receive
Data Length – 8

Start	Length	Desc.	Values
1.1	1 Byte	Configuration and Control Command	224 – 254 Control Byte Command as described in Sec. 4
2.1	5 Bytes	Configuration and Control Data	0 – 255
7.1	1 Byte	Key Byte 1	0x55
8.1	1 Byte	Key Byte 2	0xAA

*note – If either Key Byte is incorrect the command will be ignored.

**note – Commands marked with an asterisk require the message be send from a source address of 249 (0xF9).

3.5.4. Proprietary ID Message

PGN – 65408 (FF80h), Proprietary B PDU2 Format
Priority – 7
Data Length - 8
Transmission Rate – Upon request

Start	Length	Desc.	Values
1.1	8 Byte	Proprietary Unit ID Message	0 – 255. If all eight bytes are 255 then the ID is considered unprogrammed.

4. Configuration and Control

Changing the configuration and how the VDC module behaves is done with the Configuration and Control message described in Sec 3.5.3. The first byte serves as the command byte. Where applicable, changes take effect immediately and are stored in non-volatile memory unless otherwise noted.

*All data indicated as 'xx' is 'Don't Care'

4.1. Backlight Intensity 128 (80h)

Data Field

Start	Length	Desc.	Value
1.1	1 Byte	Backlight Intensity	128 (80h)
2.1	1 Byte	Unused	255 – Not Available
3.1	1 Byte	Backlight Intensity	0 – Off 254 – Brightest 255 – Not Available
4.1	6 bytes	Unused	255 – Not Available

Example: Sending the following message to a module having an address of 0x85 will set the backlight brightness to 50%.

ID=18EF8521, LEN=8, Data=0x80, 0xFF, 0x80, 0xFF, 0xFF, 0xFF, 0xFF, 0xFF

4.2. Set Source Address 224 (E0h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E0h	dd	xx	xx	xx	xx	55h	AAh

dd - Has a value between 0 and 255 and is the new source address
xx – Don't Care. Should be FFh following J1939 convention
55h – Low byte of 16 bit key
AAh – High byte of 16 bit key

4.3. Set PGN for Encoder Data 225 (E1h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E1h	aa	bb	xx	xx	xx	55h	AAh

aa – The least significant byte of the new PGN. Valid Range: 0.255
bb - The most significant byte of the new PGN. Valid Range: 0.255
xx – Don't Care. Should be FFh following J1939 convention
55h – Low byte of 16 bit key
AAh – High byte of 16 bit key

4.4. Set VDC Transmit Data Priority 226 (E2h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E2h	New Pri	xx	xx	xx	xx	55h	AAh

New Pri – The new priority. Valid Range: 0.7
xx – Don't Care. Should be FFh following J1939 convention
55h – Low byte of 16 bit key
AAh – High byte of 16 bit key

4.5. Set VDC Data Transmission Period 227 (E3h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E3h	dd	xx	xx	xx	xx	55h	AAh

dd – The value multiplied by 10ms, Valid range: 2.255 yielding between 20ms to 2.54 seconds. A value of zero disables the message from being sent periodically and is only sent upon a status change.
xx – Don't Care. Should be FFh following J1939 convention
55h – Low byte of 16 bit key
AAh – High byte of 16 bit key

4.6. Changing J1939 NAME Fields* 228 (E4h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E4h	subcmd	db0	db1	db2	xx	55h	AAh

sub cmd – Represents the field within the name to change.
db0, db1, db2 – Data bytes associated with the sub command, LSB to MSB respectively.
xx – Don't Care. Should be FFh following J1939 convention
55h – Low byte of 16 bit key
AAh – High byte of 16 bit key

Sub Commands

Sub Cmd	Field	Description
0	ID	21 bits of db0.2
1	ECU Instance	Bits 3..1 of Byte 5 (Most Significant at 3)
2	Function Instance	Bits 8..4 of Byte 5 (Most Significant at 8)
3	Function	Bits 8..1 of Byte 6 (Most Significant at 8)
5	Vehicle System	Bits 8..2 of Byte 7 (Most Significant at 8)
4	Vehicle System Instance	Bits 4..1 of Byte 8 (Most Significant at 4)
6	Industry Group	Bits 7..5 of Byte 8 (Most Significant at 7)
7	Arbitrary Addr. Capable	Bit 8 of Byte 8

Refer to J1939 base document for field value ranges and relationships.

*Must be send using a source address of 249 (0xF9).

4.7. Change ECUID Command* 229 (E5)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E5h	0..2	dd	xx	xx	xx	55h	AAh

0 – Selects ECUID Part Number to change
1 – Selects ECUID Location to change
2 – Selects ECUID Type to change
dd – Number of ASCII characters in the field, max of 64

*Must be send using a source address of 249 (0xF9).

4.8. Change ECUID Field Data* 230 (E6h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E6h	1 to 7 bytes of ASCII Data						

* No Key used in bytes 7 and 8

*Must be send using a source address of 249 (0xF9).

4.9. Backlight Diagnostics* 232 (E8h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E8h	DIAG	xx	xx	xx	xx	55h	AAh

DIAG – A non-zero value, with the exception of FFh, causes the module to blink all of the backlights on for about one second to serve as a visual tool that the module is powered up and the backlights are functioning properly. A value of zero bypasses this routine and, in turn, speeds up the bootup process. If the value is equal to FFh the command is ignored.

Bytes 3 through 6 should be set to FFh for possible future expandability.

*Must be send using a source address of 249 (0xF9).

4.10. Encoder Configuration* 233 (E9h)

Data field

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7	Byte 8
E9h	PARAM	ROLL OVR	xx	DATA		55h	AAh

PARAM –

- **SET VAL (Param = 0):** Manually sets the encoder value to the value in Data. Must be in the range from 0 to TOP. If value is greater than TOP then the value of TOP is used. This data is not stored in non-volatile memory
- **TOP (Param = 1):** TOP is the maximum value the encoder will count up to. Values range from 4 to 65534 with the default = 255.
- **INIT VAL (Param = 2):** Changes the initial value after boot to the value in Data. This data is stored in non-volatile memory. It does not manually change the encoder's value.
- **ROLL OVR** – A non-zero value, with the exception of FFh, causes the value to roll over back to zero when incremented passed TOP or from zero to TOP when decremented below zero, otherwise the count remains at zero or TOP.
- **DATA -** Input data used in setting of the parameters.

*Must be send using a source address of 249 (0xF9).

5. J1939 Messages

The following messages are defined in the J1939 documents and are implemented in the VDC module.

5.1. Address Claimed

PF – 238, Address Claimed
PS – 255, The destination address should always be the Global Address
PGN = (PF * 256) = 60928
Direction - Transmit
Data Length – 8
Transmission Rate – Upon boot or whenever requested

Start	Length	Desc.	Values
1.1	21 Bits	Identity Number	0 to 2^{21}-1
3.6	11 Bits	Manufacturers Code	294 (Assigned to Grayhill by SAE)
5.1	3 Bits	ECU Instance	0 (Default)
5.4	5 Bits	Function Instance	0 (Default)
6.1	8 Bits	Function	135 (VDC module, Default) *
7.1	1 Bit	Reserved	0 (Defined by SAE)
7.2	7 Bits	Vehicle System	0 (Default) *
8.1	4 Bits	Vehicle System Instance	0 (Default)

8.5	3 Bits	Industry Group	0 = Global (Default) * 1 = On-Highway Equipment 2 = Agricultural and Forestry Equipment 3 = Construction Equipment 4 = Marine 5 = Industrial-Process Control-Stationary 6 & 7 = Reserved
8.8	1 Bit	Arbitrary Address Capable	0 = Not Capable 1 = Capable (Default)

*Refer to J1939 base document for the Function value based on the Industry Group and Vehicle System combinations

5.2. PGN Request

PF – 234, PGN Request
PS – DA, The Source Address of the VDC module to respond or the Global Address
PGN = (PF * 256) = 59904
Direction - Receive
Data Length – 3

Start	Length	Desc.	Values
1.1	1 Byte	Byte 1 of PGN being requested (LSB)	0 to 255
2.1	1 Byte	Byte 2 of PGN being requested	0 to 255
3.1	1 Byte	Byte 3 of PGN being requested (MSB)	0

The following are the supported PGN's that can be requested from the VDC module. If the request is unsupported the VDC module shall respond with a NACK (Refer to J1939-21).

5.2.1. ECU Identification Information

PGN = 64965
Direction - Transmit
Data Length – Variable
Transmission Rate – Upon Request
Multi Packet Transerred – Yes

Start	Length	Desc.	Values *
A	<=200	ECU Part Number	Ex. "3JYY1001-1"
B	<=200	ECU Serial Number	Ex. "123456"
C	<=200	ECU Location	Ex. "CAB"
D	<=200	ECU Type	"VDC MODULE"

*All fields asterisk delimited

5.2.2. Software Identification

PGN = 65242 (0xFEDA)
Direction - Transmit
Data Length – Variable
Transmission Rate – Upon Request
Multi Packet Transferred – Yes

Start	Length	Desc.	Values
1	1 Byte	Number of software fields	1 to 125
2-N	Variable	Software ID field	ASCII characters. Each field delimited with an asterisk and up to 200 characters

5.3. Acknowledgement Message

PF = 232 (0xE8)
PS = DA
PGN = 64965 (0xE800)
Direction - Transmit
Data Length – 8
Transmission Rate – Upon appropriate response

Start	Length	Desc.	Values *
1	1 Byte	Control Byte	0 = Postive Acknowledgement 1 = Negative Acknowledgement 2 = Access Denied 3 = Cannot Respond
2	1 Byte	Group Function	Refer to SAE-J1939-21
3-5	3 Bytes	Reserved by SAE	
6-8	3 Bytes	Parameter Group being Acknowledged	

This message is send in response to a PGN Request of an unsupported PGN with the Control Byte having a value of one.

6. Errata

6.1. Data page and Key Byte Issues

Per section 4.5, the key bytes 7 & 8 were supposed to be set as 55h AAh to set the transmission period. However, it has been determined that the key press data transmission rate will change with any value for key bytes 7 & 8.

Per section 3.1.2, messages with data page 1 were to be ignored. It has been determined that the product will respond to messages with the data page set as 0 or 1.

6.2. Data Page filtering and TX Period Key Byte Update

All new custom configured 3J keypad part numbers created on or after November 15, 2017 will be produced with updated firmware that ignores messages with the data page set as 1 and responds correctly to key bytes 7 & 8 for the data transmission period. Legacy part numbers created prior to the effective date will not be updated and will continue to ship with the legacy firmware. Grayhill catalog standard 3K part numbers will include this update.