11 Jan 1999

PDIUSBH11A / H12

Hub / Monitor Firmware
Application Notes

PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

This document describes the programming features of the PDIUSBH11A. Examples of how to program any C51-based micro-controller to control the hub and embedded function are provided in the following sections:

- Main control loop;
- Hub control subroutine;
- Embedded function control subroutine.

0 Introduction

Philips Semiconductors' PDIUSBH11A is a compound Universal Serial Bus (USB) hub IC (hub plus embedded function) that supports 4 downstream devices. (Figure 1). The embedded function appears as PORT1 to the host and the four downstream ports are numbered 2 through 5.

It is used in a micro-controller-based system and communicates with the system micro-controller over the I^{2}C serial bus. This modular approach to implementing a hub and embedded function allows the designer to maintain the system micro-controller of choice and retain the existing architecture. This cuts down development time and offers the most cost-effective solution.

Ideal applications for the IC include computer monitors and keyboards.

The PDIUSBH11A conforms to the USB specification 1.1 and I^{2}C serial interface specification. It is also compliant with the USB Human Input Device and Monitor Control Class specifications.
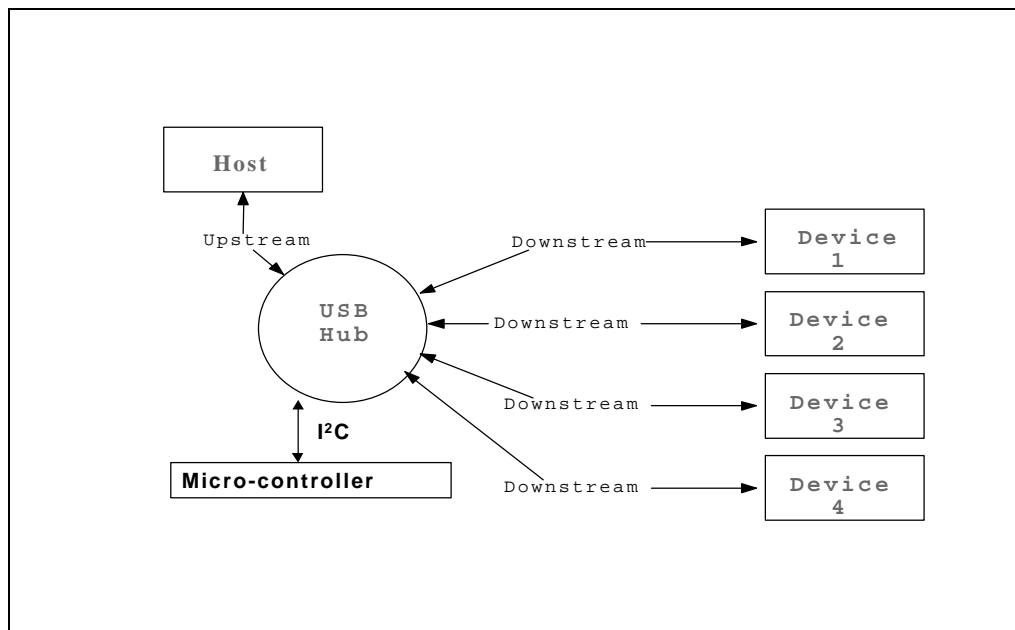

Figure 1: Application Diagram

0.1 I^{2}C Interface

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An external micro-controller is used to control the operation of the hub using the I²C bus. To reduce costs, the target system micro-controller can be shared and utilised for this purpose. The PDIUSBH11A implements a slave I²C interface. When the PDIUSBH11A needs to communicate with the micro-controller, it asserts an interrupt signal. The micro-controller services this interrupt by reading the appropriate status register on the PDIUSBH11A through the I²C bus. (Figure 2).
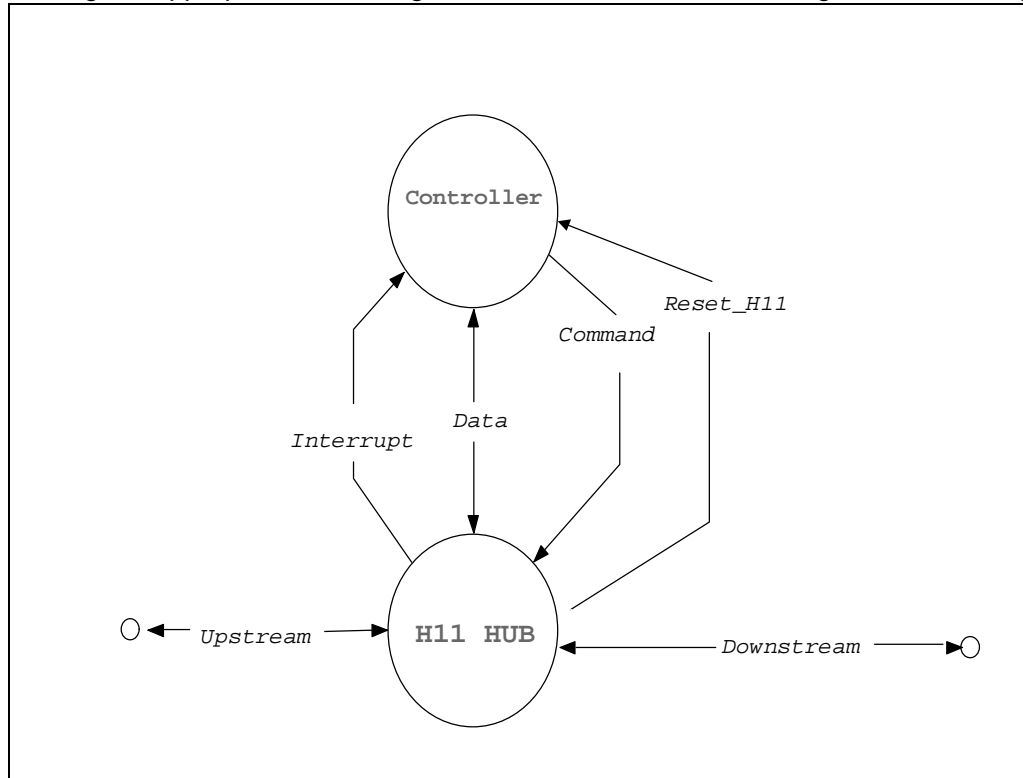

Figure 2: Interactions between micro-controller and hub

0.2 Programming Methodology

The I²C interface on the PDIUSBH11A defines two types of transactions:

- **Command transaction**.
  A command transaction is used to define which data (e.g. status byte, buffer data…) will be read from / written to the USB interface in the next data transaction. A data transaction usually follows a command transaction.

- **Data transaction**.
  A data transaction reads data from / writes data to the USB interface. The meaning of the data is dependent on the command transaction that was sent before the data transaction.

Different addresses are used for command and data transactions. Writing to the command address is interpreted as a command, while reading from / writing to the data address is used to transfer data between the PDIUSBH11A and the controller.

Address Table:

Type of Address	Physical Address (MSB to LSB)

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Command	0011011 (binary)
Data	0011010 (binary)

Programming the PDIUSBH11A consists of two steps:

Command Phase – Write the command code to the Command Address
Data Phase – Write data to or read data from the Data Address.

Command codes are listed in the PDIUSBH11A data sheet.

1 Initialization

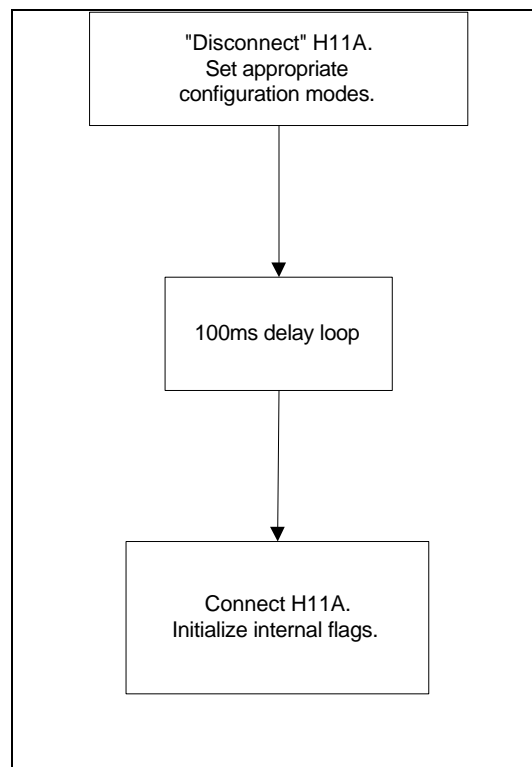The initialization of the PDIUSBH11A is described in the following flowchart:

Figure 3 Flowchart of initialization

2 Main Control Loop

Upon finishing initialization, the program goes into the so-called main loop waiting for the interrupt pin of the PDIUSBH11A to go low, signalling that a request has been initiated. The micro-controller then reads the interrupt register to determine the origin of the interrupt. Control is then passed to the appropriate endpoint subroutine for further processing. (Figure 3).

After a bus reset, an interrupt will also be generated. However all bits in the interrupt register will be zeroes. The firmware must enable the hub, set its address to 0 and disable the embedded function.

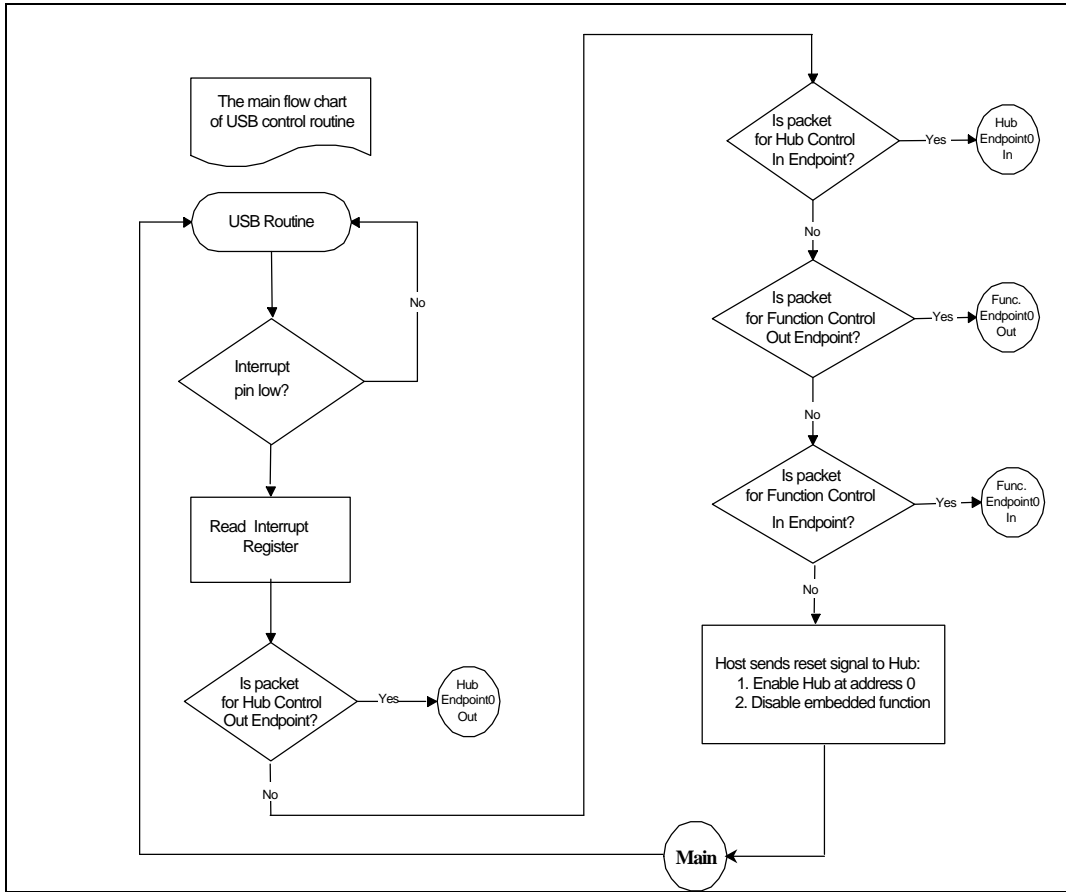# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

Figure 4: Main Control Loop

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3 Hub Control Subroutine

3.1 Hub Control In Endpoint
Data to be sent to the host are written to the IN buffer and will be transferred when the next IN token is received. A Read Last Transaction Status command is sent to reset the interrupt flag before issuing a Select Endpoint command which initialises the internal pointer to the start of the selected buffer. Previous data in the buffer must be transferred before further processing can take place. If the last request is a Set Address command, the new address is written to the device. (Figure 4).
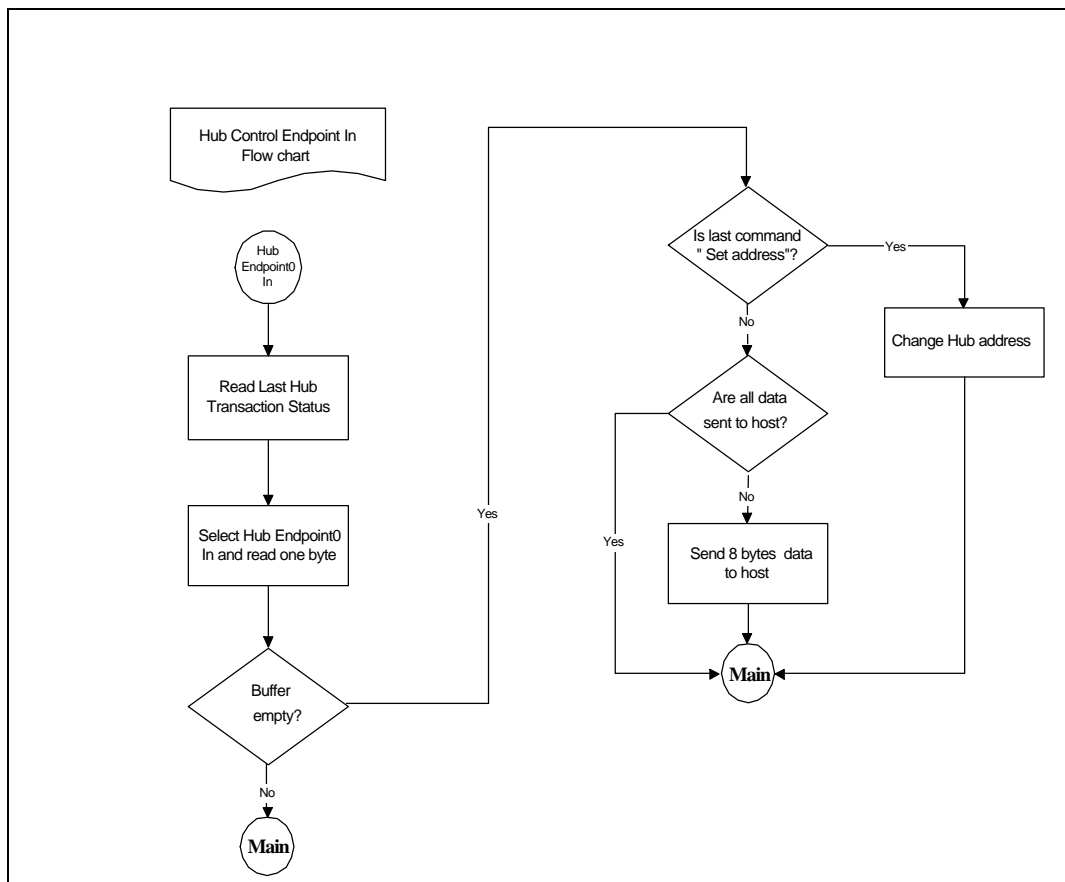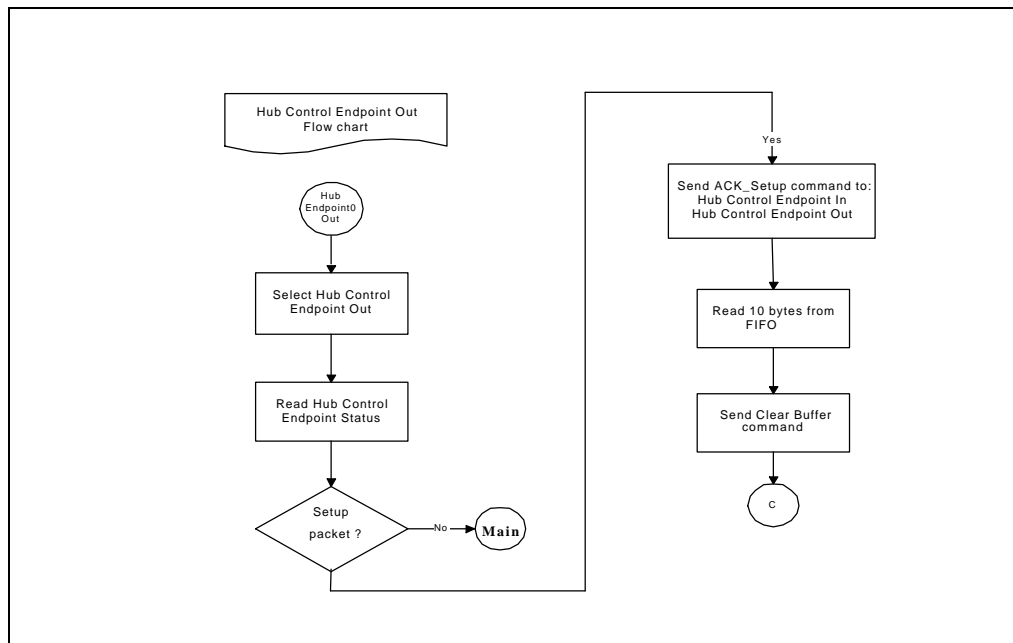
Figure 5: Hub Control In Endpoint Flow Chart

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3.2 Hub Control Out Endpoint

A packet consisting of a SETUP token precedes all requests. After selecting the hub endpoint, the Read Endpoint Status command ensures that a SETUP token has been received. The Acknowledge Setup command is given to unlock both the IN and OUT buffers before the next packet, which contains the actual request, is read. (Figure 5).

Control is then transferred to the appropriate routine where the request is carried out. (Figure 6 & Figure 7). When an unsupported command is encountered, a stall status is returned to the host.

There are two types of commands:
Hub Standard Commands
Hub Class Commands

3.3 Standard Commands

Flow charts for supported standard commands are shown as follows:
➢ Clear Feature (Figure 8)
➢ Set Feature (Figure 9)
➢ Get Status (Figure 10)
➢ Set Address (Figure 11)
➢ Get Descriptor (Figure 12)
➢ Get Configuration (Figure 13)
➢ Set Configuration (Figure 14)
➢ Get Interface (Figure 15)
➢ Set Interface (Figure 15)

Figure 5: Hub Control Out Endpoint Flow Chart...(1)

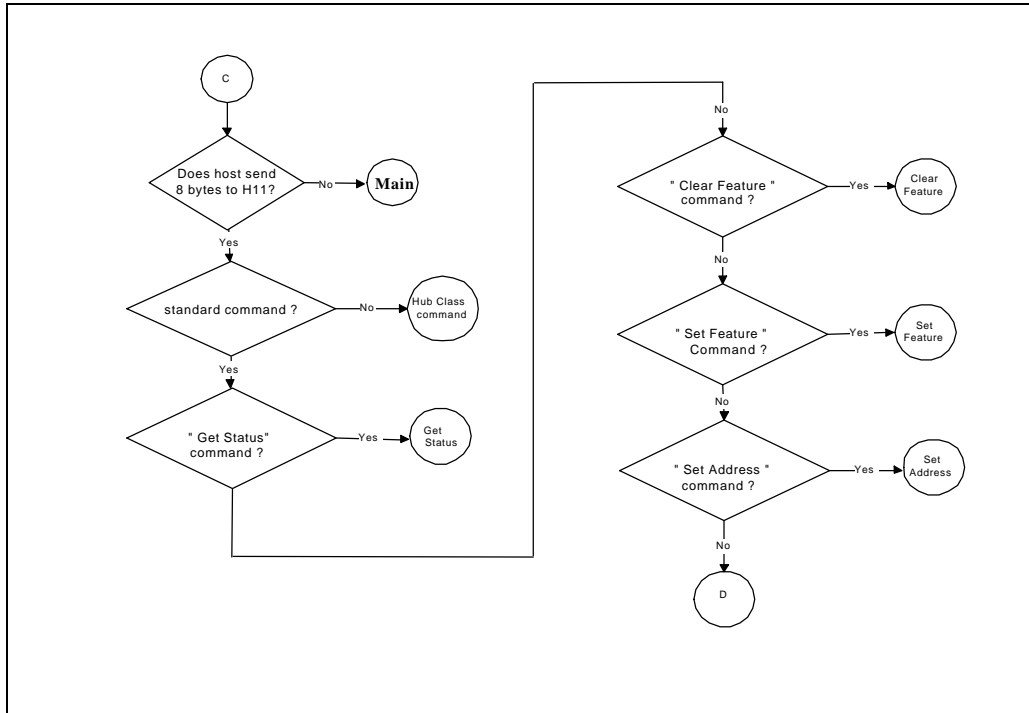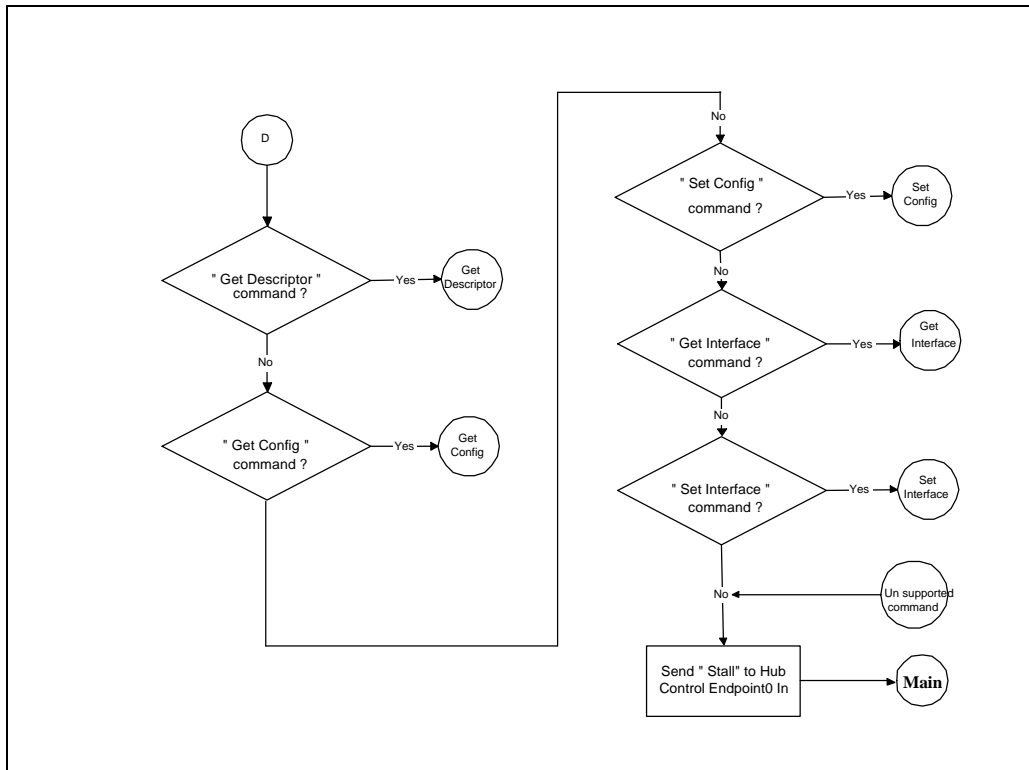# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

Figure 6: Hub Control Out Endpoint Flow Chart...(2)

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Figure 7: Hub Control Out Endpoint Flow Chart...(3)

Feature selectors are used when enabling or disabling features specific to a device, interface or endpoint. The values for the feature selectors are given below.

Feature Selector	Recipient	Value
DEVICE_REMOTE_WAKEUP	Device	1
ENDPOINT_STALL	Endpoint	0

3.3.1 Clear Feature

This command is used to clear or disable a specific feature.

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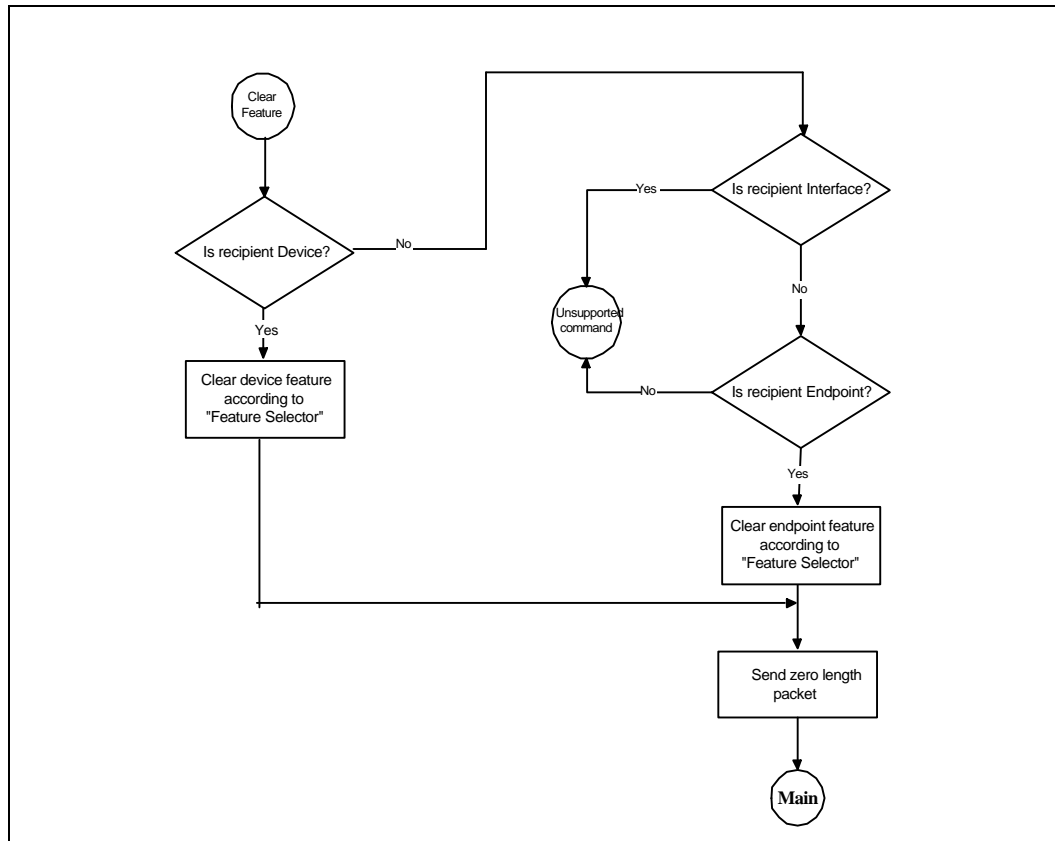
Figure 8: Hub Clear Feature Standard Command

3.3.2 Set Feature

This command is used to set or enable a specific feature.

PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes
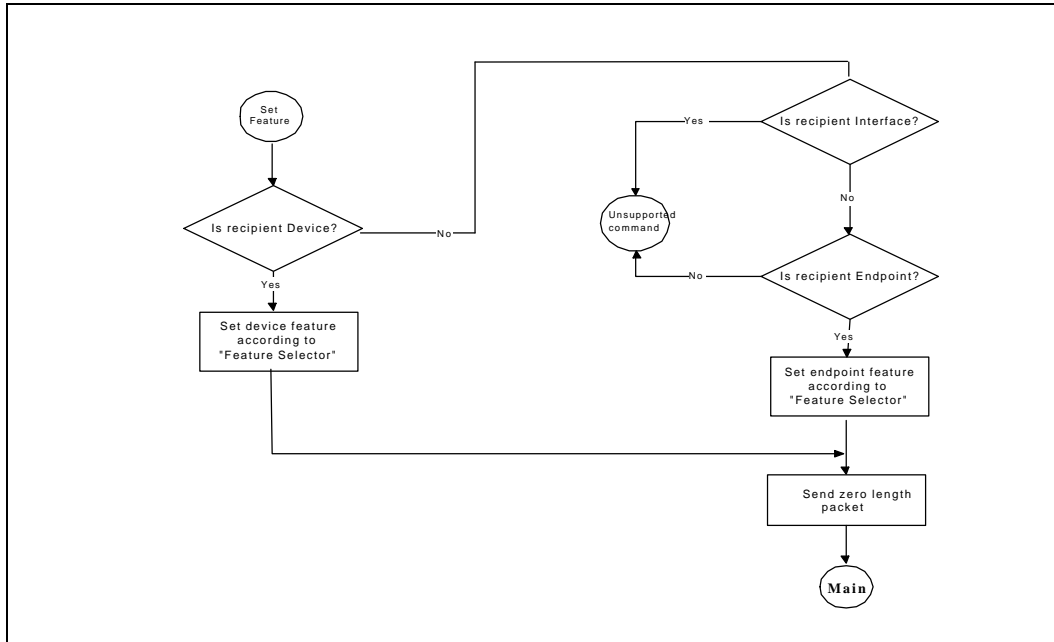
Figure 9: Hub Set Feature Standard Command

3.3.3 Get Status
This command returns status for the specified recipient.
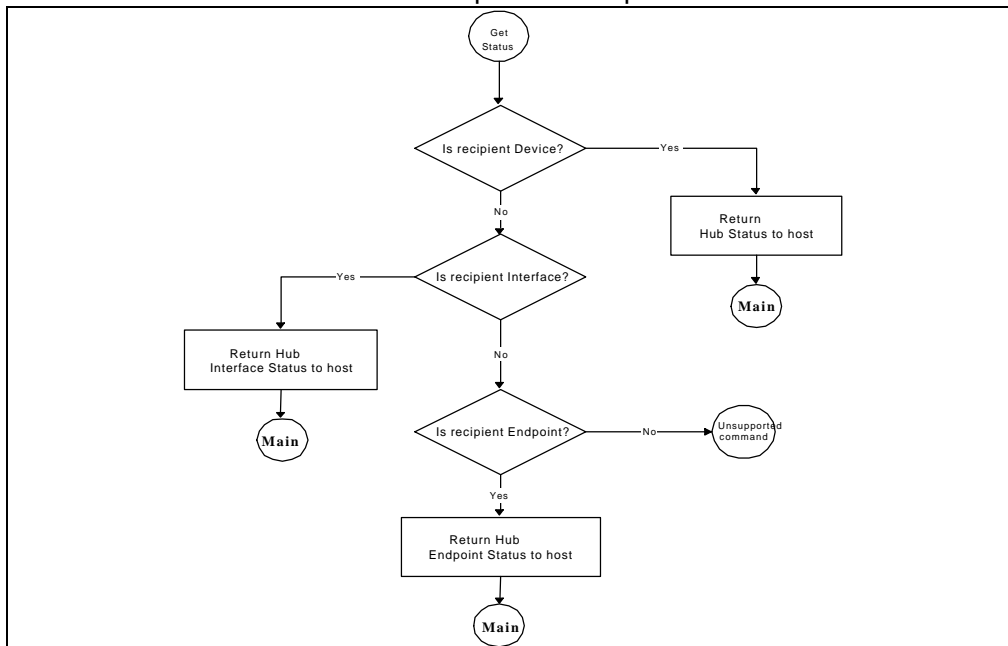
Figure 10: Hub Get Status Standard Command

3.3.4 Set Address
This command sets the device address for all future device accesses.

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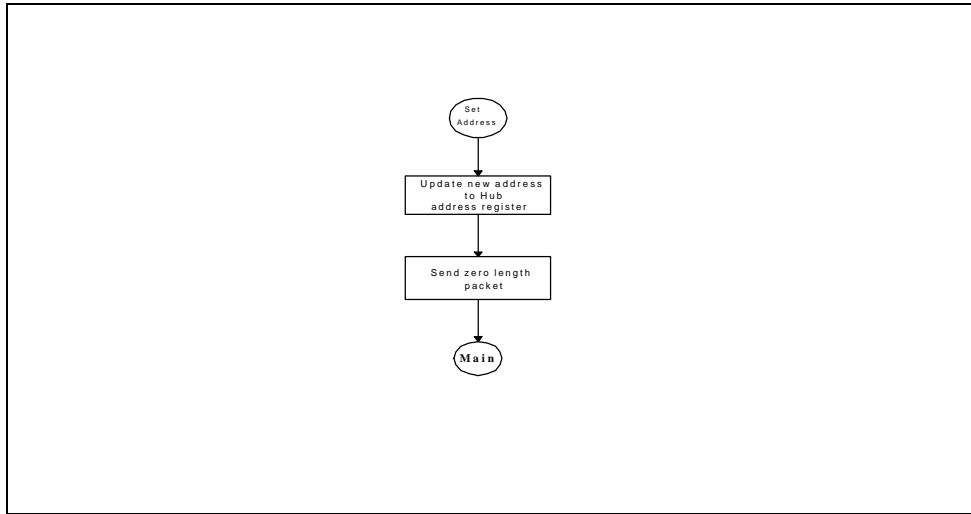
Figure 11: Hub Set Address Standard Command

3.3.5 Get Descriptor
This command returns the specified descriptor if the descriptor exists.
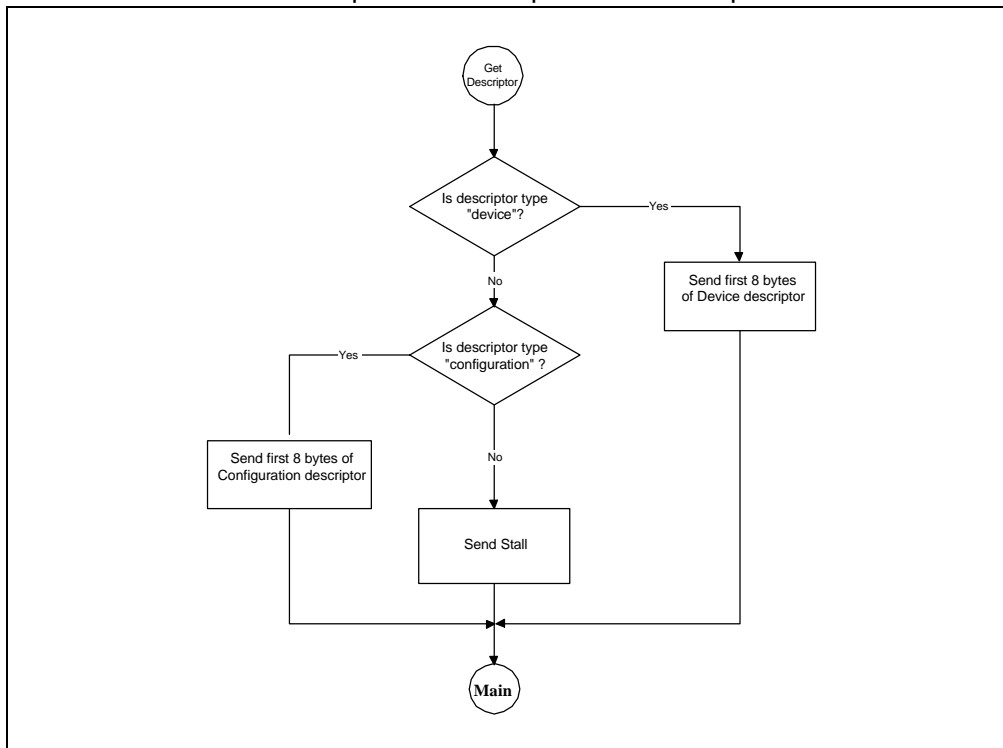
Figure 12: Hub Get Descriptor Standard Command

3.3.6 Get Configuration
This command returns the current device configuration.

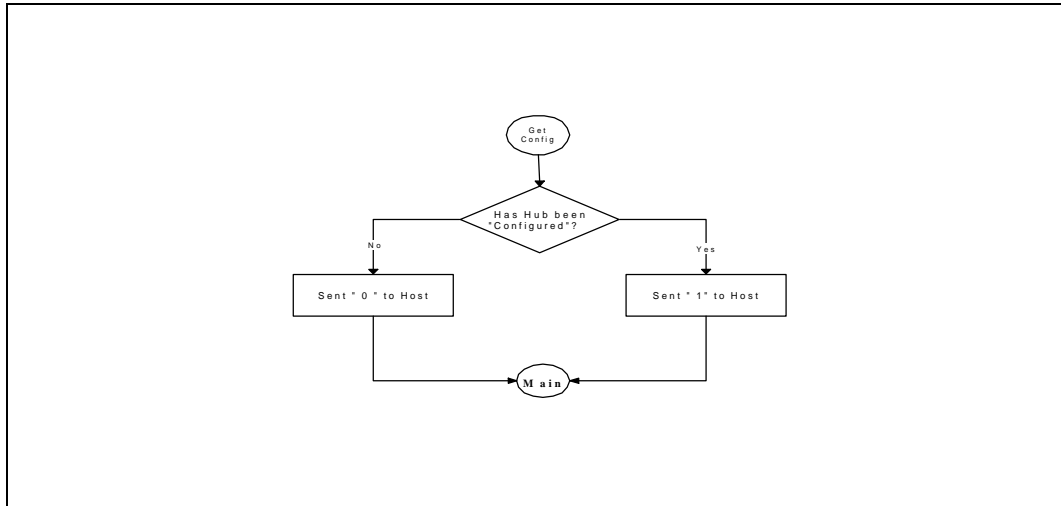# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

Figure 13: Hub Get Configuration Standard Command

3.3.7 Set Configuration

This command sets the device configuration.
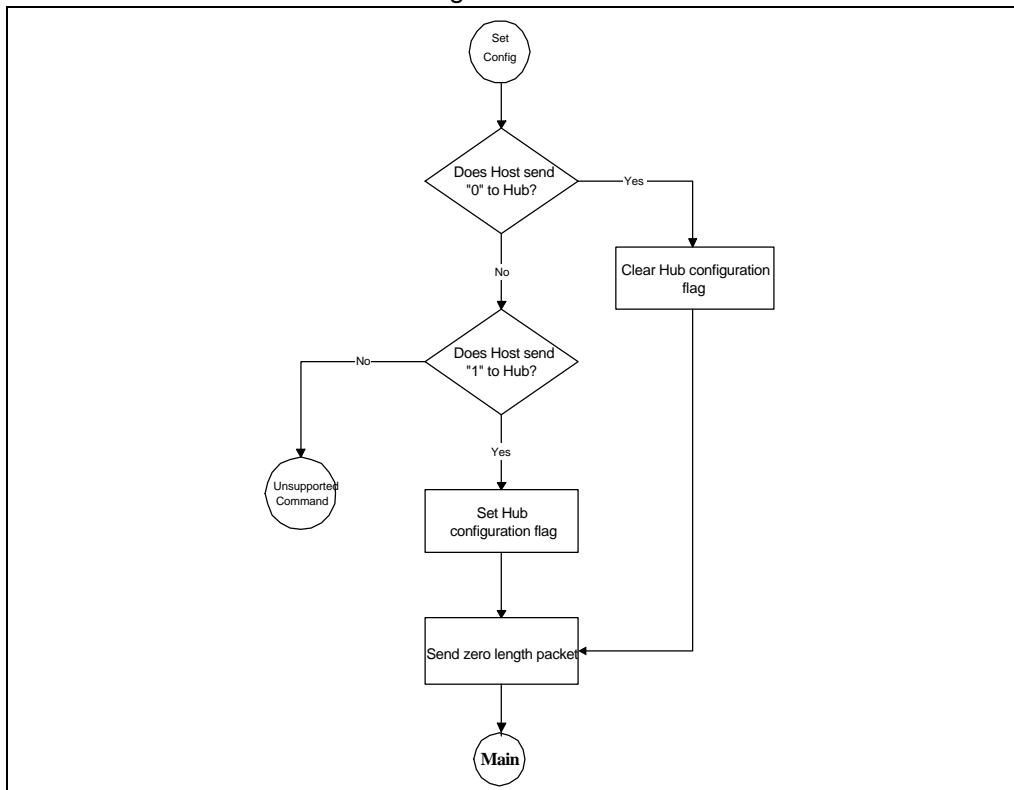
Figure 14: Hub Set Configuration Standard Command

3.3.8 Set Interface

This command allows the host to select an alternate setting for the specified interface.

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3.3.9 Get Interface
This command returns the selected alternate setting for the specified interface
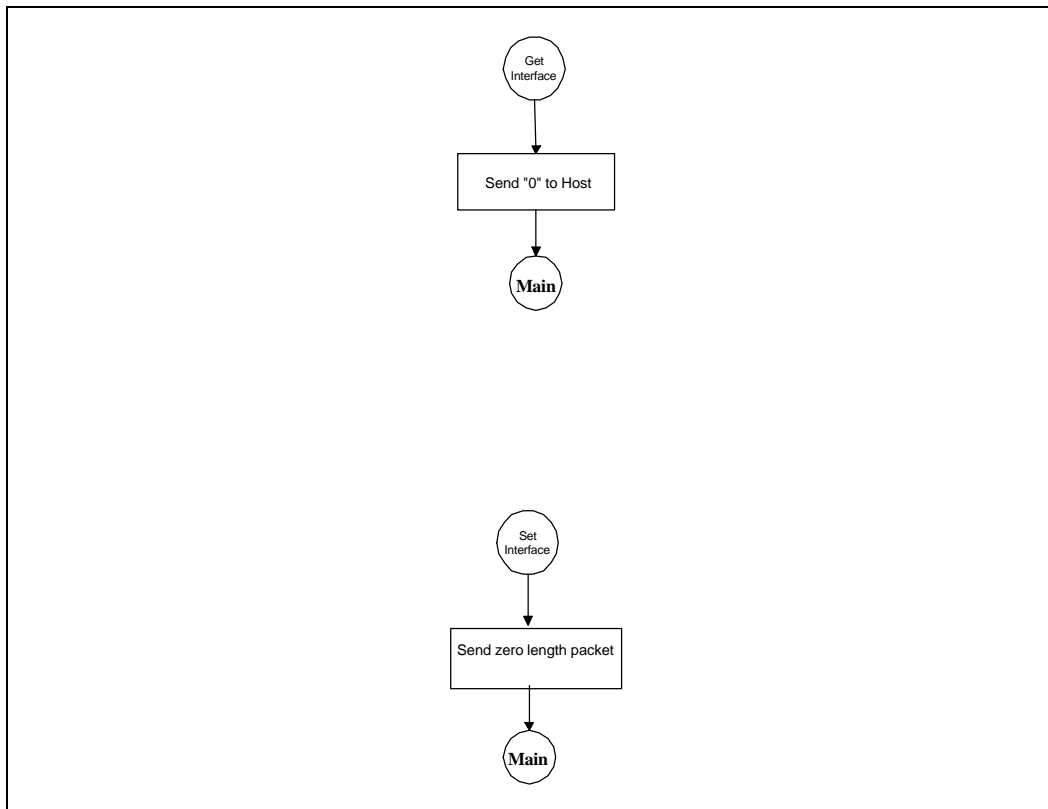
Figure 15: Hub Get & Set Interface Standard Commands

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3.4 Hub Class Commands

Hub class commands are commands that are only applicable to the hub and are processed as shown in Figure 16.

Flow charts for the supported class commands are shown as follows:
➢ Clear Hub/Port Feature (Figure 17)
➢ Set Hub/Port Feature (Figure 18)
➢ Get Hub/Port Status (Figure 19)
➢ Get Hub Descriptor (Figure 20)
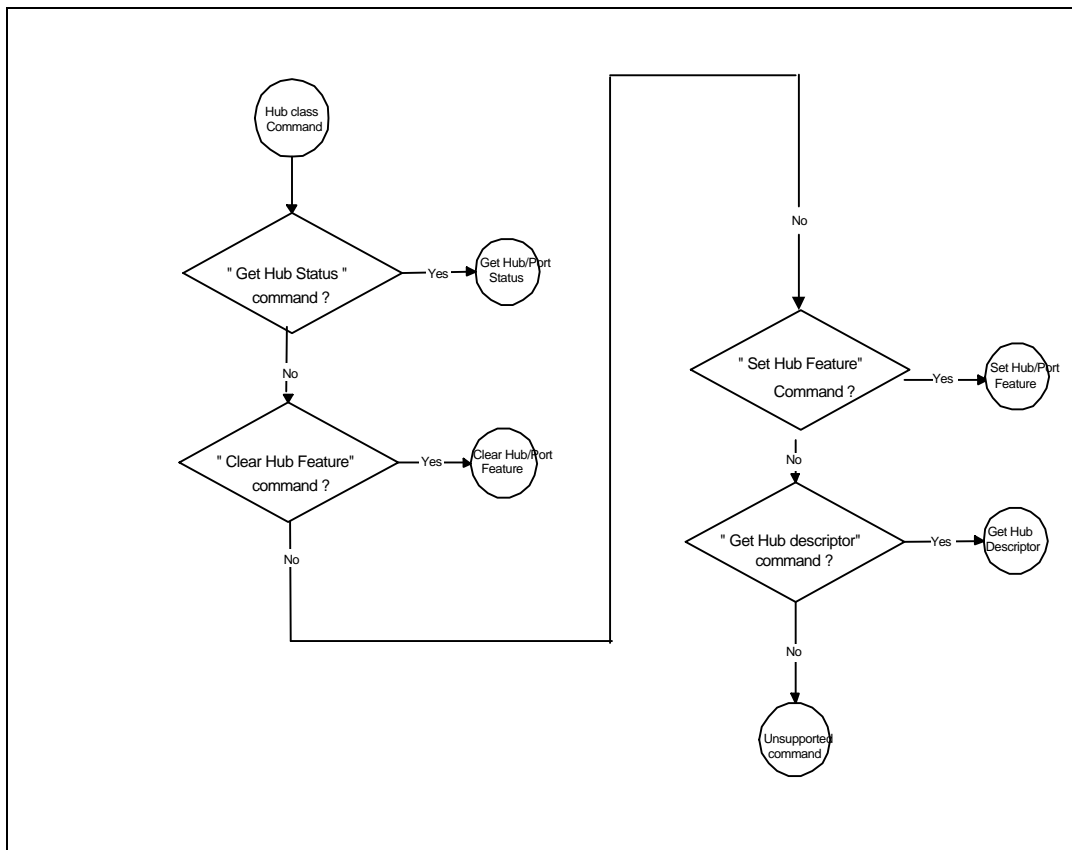
Figure 16: Hub Class Command Flow Chart

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Feature selectors are also used when enabling or disabling features specific to a hub or port. The following are the valid feature selectors for the hub class.

Feature Selector	Recipient	Value
C_HUB_LOCAL_POWER	Hub	0
C_HUB_OVER_CURRENT	Hub	1
PORT_CONNECTION	Port	0
PORT_ENABLE	Port	1
PORT_SUSPEND	Port	2
PORT_OVER_CURRENT	Port	3
PORT_RESET	Port	4
PORT_POWER	Port	8
PORT_LOW_SPEED	Port	9
C_PORT_CONNECTION	Port	16
C_PORT_ENABLE	Port	17
C_PORT_SUSPEND	Port	18
C_PORT_OVER_CURRENT	Port	19
C_PORT_RESET	Port	20

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3.4.1 Clear Hub/Port Feature
This command resets a value reported in the hub/port status.
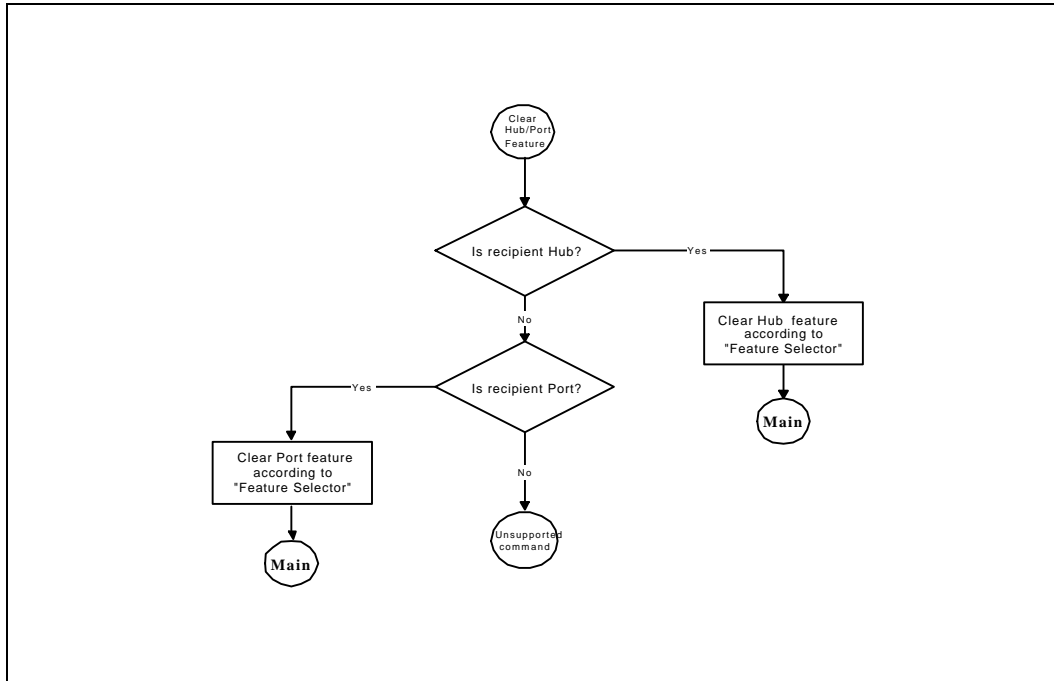
Figure 17: Clear Hub/Port Feature Command

3.4.2 Set Hub/Port Feature

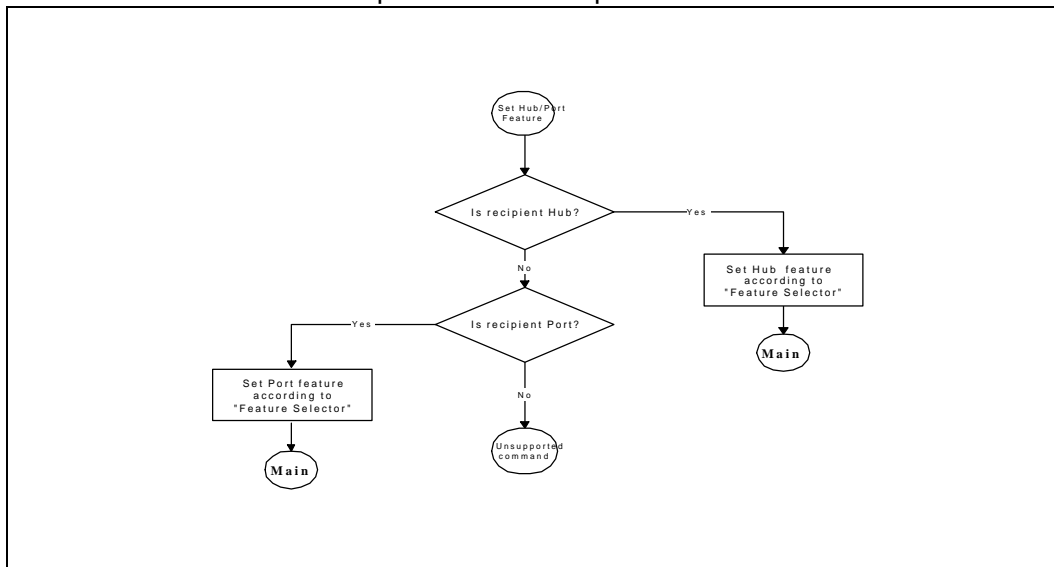This command sets a value reported in the hub/port status.

Figure 18: Set Hub/Port Feature Command

3.4.3 Get Hub/Port Status

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This command returns the current hub/port status and the states that have changed since the previous acknowledgment.
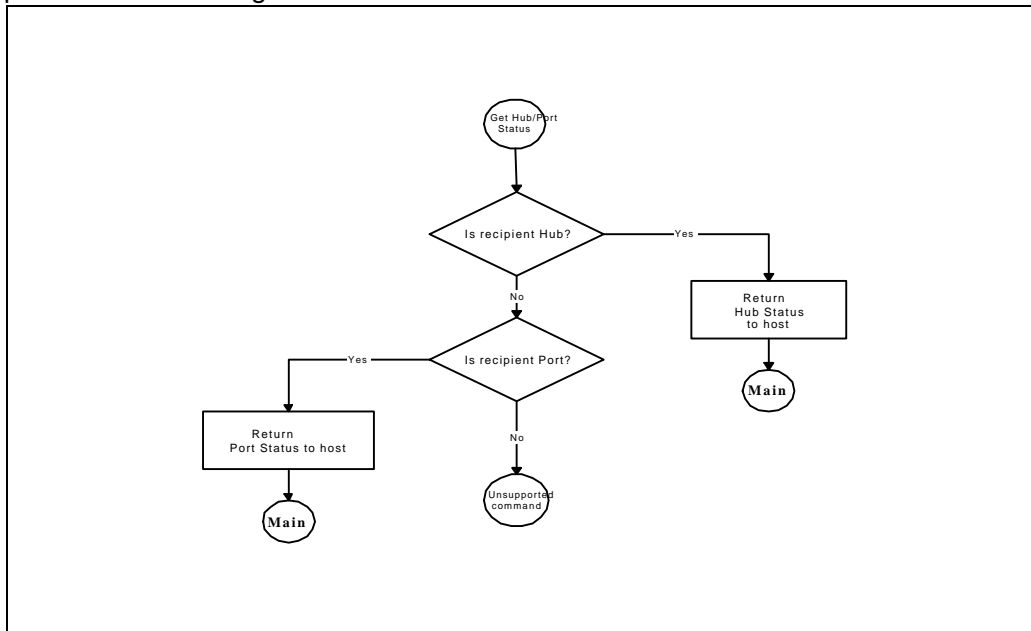
Figure 19: Get Hub/Port Status Command

3.4.4 Get Hub Descriptor

This command returns the hub descriptor.
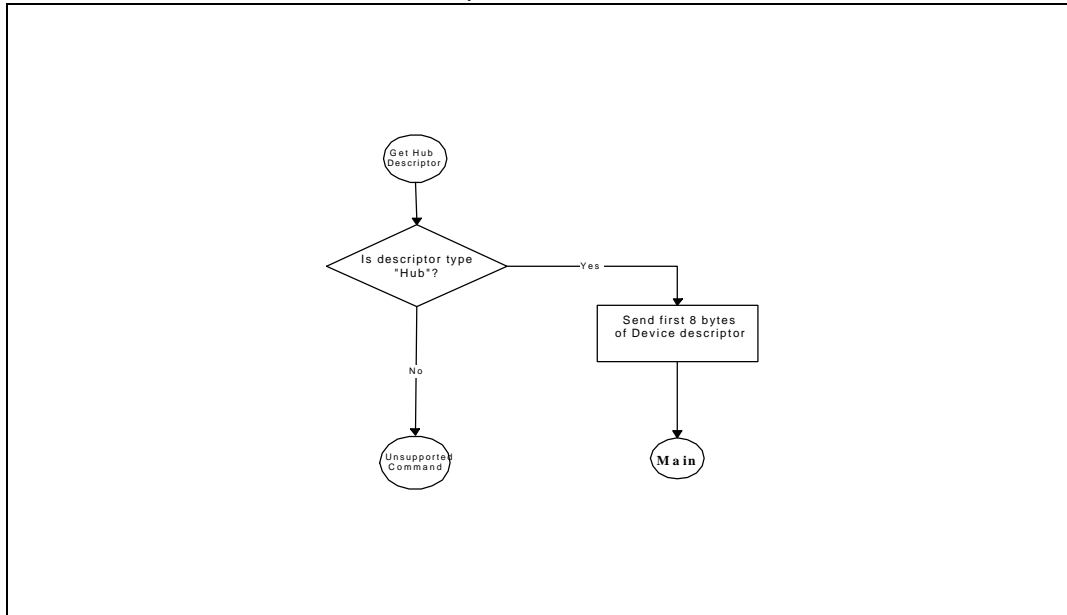
Figure 20: Get Hub Descriptor Command

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4 Embedded Function Control Subroutine
The host sees no difference between the embedded function and a function connected to one of the downstream ports. Some of the port commands sent by the host must be handled appropriately by the embedded function to appear as any other downstream port.

The examples in this section assume the use of an embedded function in a display monitor. Packets sent to the embedded function control endpoints are processed in a similar manner as those sent to the endpoints of the hub.

4.1 Function Control In Endpoint
Data to be sent to the host from the embedded function follows the same procedure as that for the hub control in endpoint. (Figure 21).
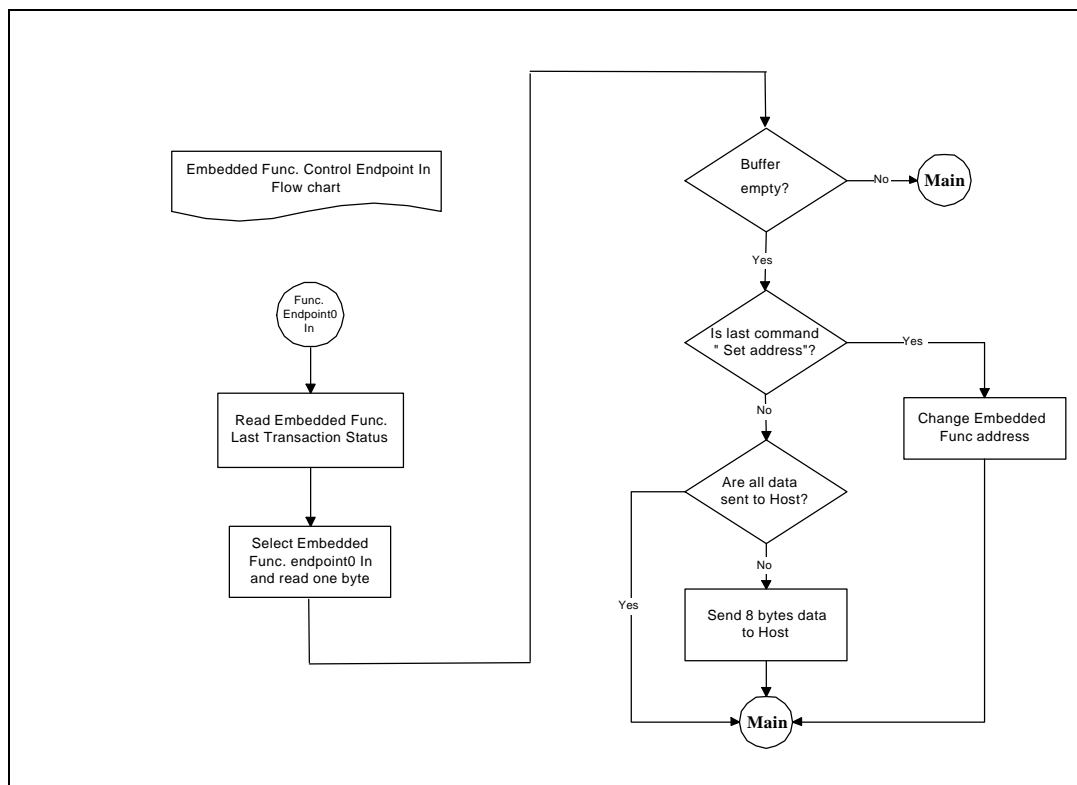
Figure 21: Embedded Function Control In Endpoint Flow Chart

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4.2 Function Control Out Endpoint

Besides processing the SETUP token, the OUT token, which sends updated data to the display monitor control program, is also processed.

Embedded function commands are grouped as follows:
- ❑ Embedded Function Standard Commands
- ❑ Embedded Function Class Commands

Commands that are not supported will return a stall status.

4.3 Standard Commands

Figure 22 – Figure 24 show the processing of standard commands.
Flow charts for the supported standard commands are shown as follows:
- ➢ Get Function Status (Figure 25)
- ➢ Clear Function Feature (Figure 26)
- ➢ Set Function Feature (Figure 27)
- ➢ Set Function Address (Figure 28)
- ➢ Get Function Descriptor (Figure 29)
- ➢ Get Function Configuration (Figure 30)
- ➢ Set Function Configuration (Figure 31)
- ➢ Get Function Interface (Figure 32)
- ➢ Set Function Interface (Figure 32)
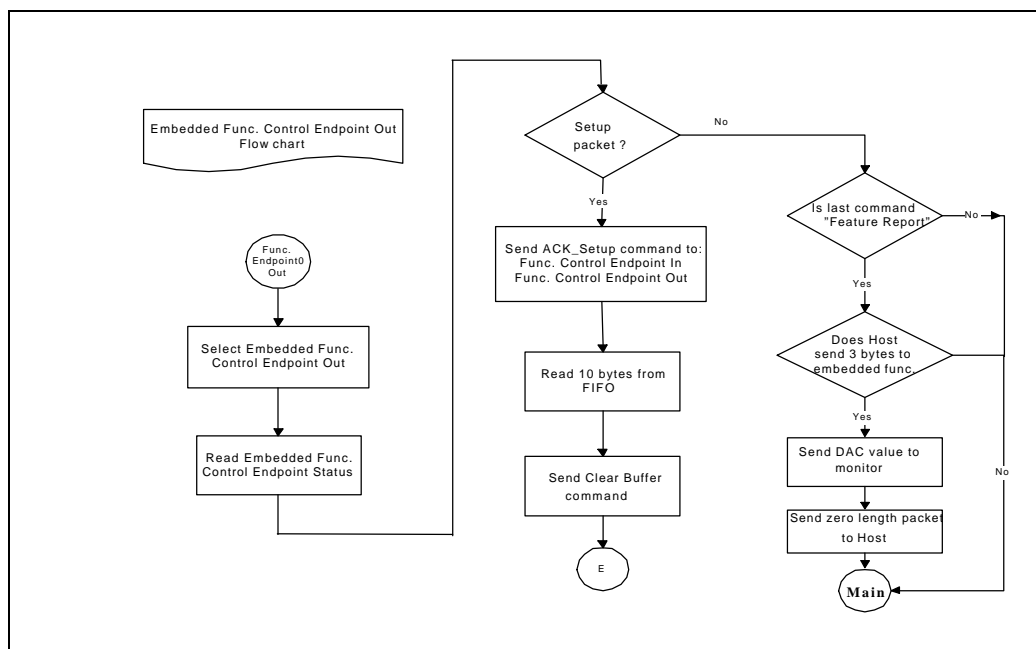
Figure 22: Embedded Function Control Out Endpoint Flow Chart...(1)

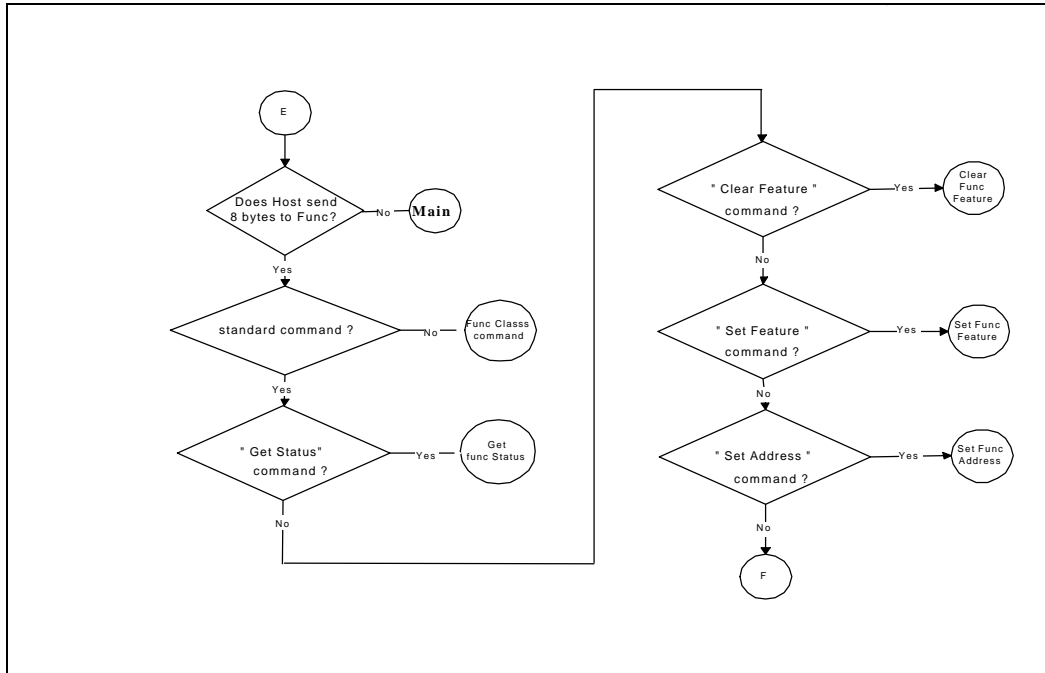# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

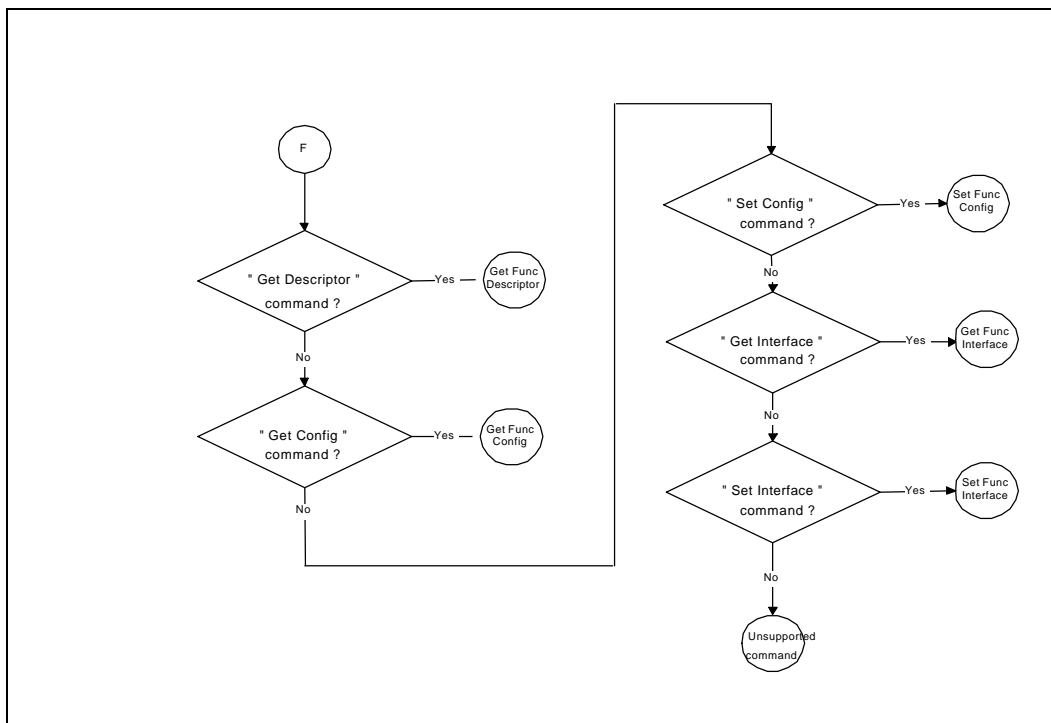**Figure 23: Embedded Function Control Out Endpoint Flow Chart...(2)**

Figure 24: Embedded Function Control Out Endpoint Flow Chart...(3)

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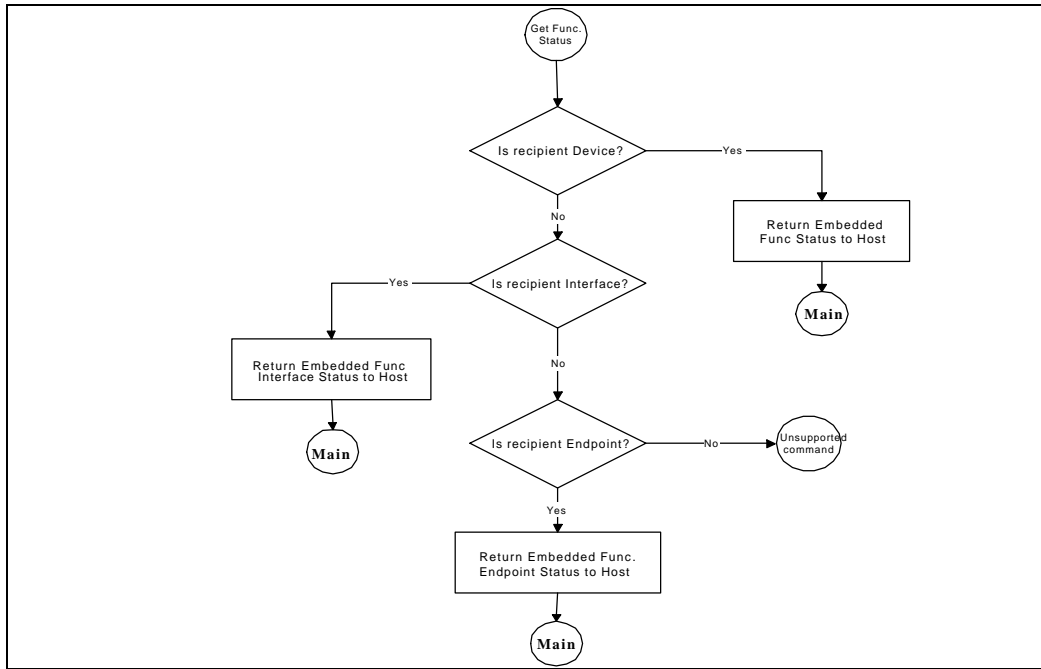
4.3.1 Get Function Status

Figure 25: Embedded Function Get Status Standard Command
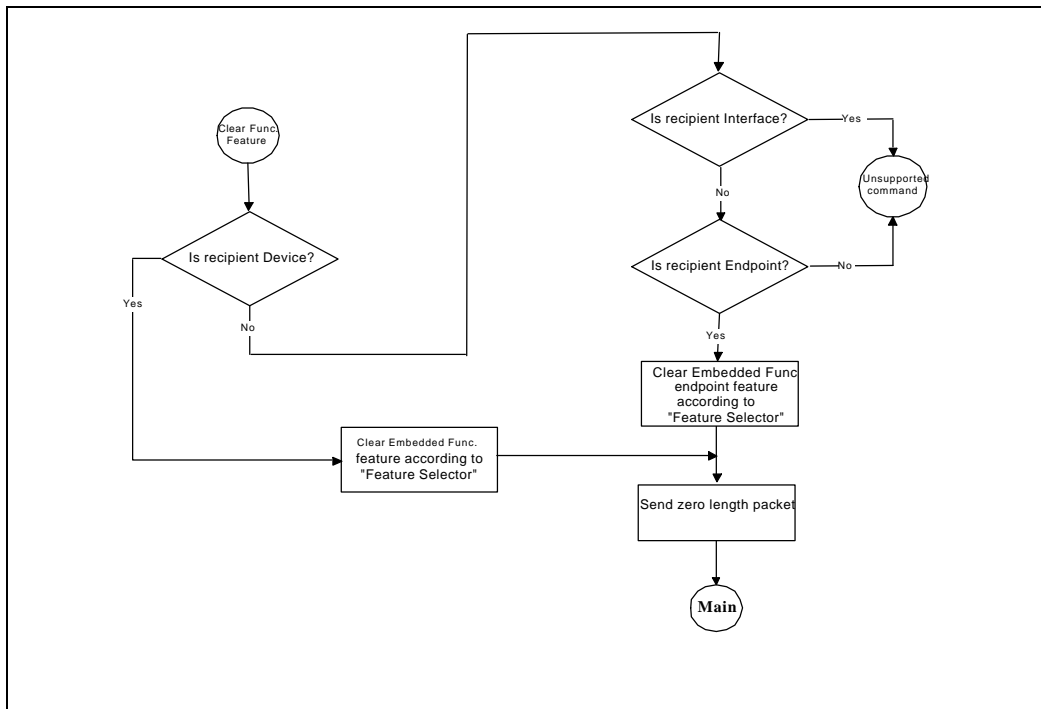
4.3.2 Clear Function Feature

Figure 26: Embedded Function Clear Feature Standard Command

4.3.3 Set Function Feature

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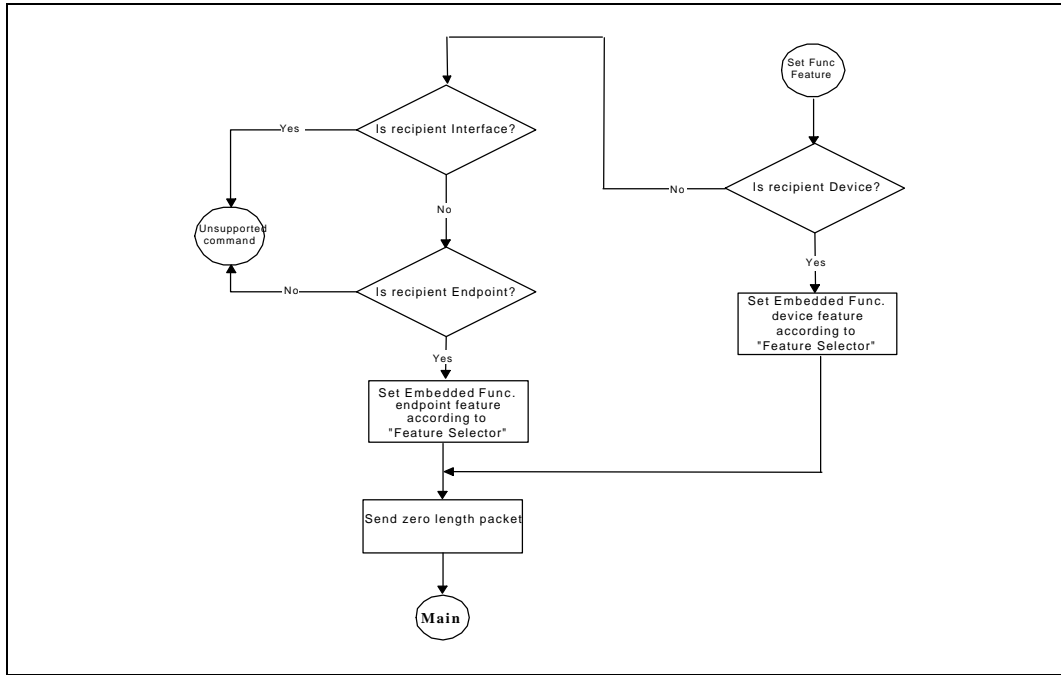
Figure 27: Embedded Function Set Feature Standard Command
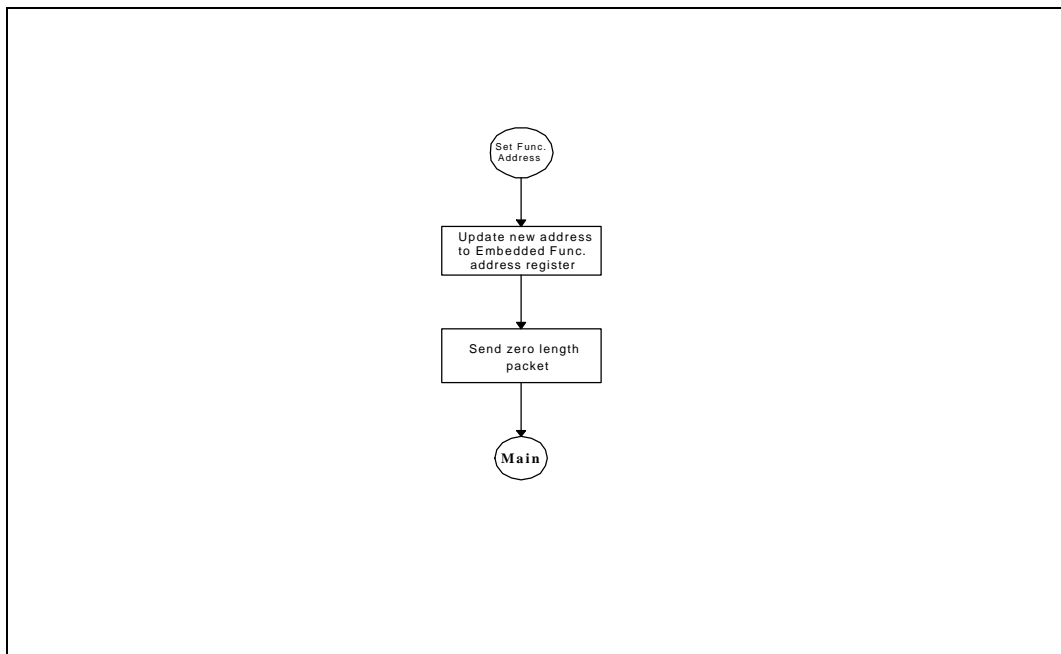
4.3.4 Set Function Address

Figure 28: Embedded Function Set Address Standard Command

4.3.5 Get Function Descriptor

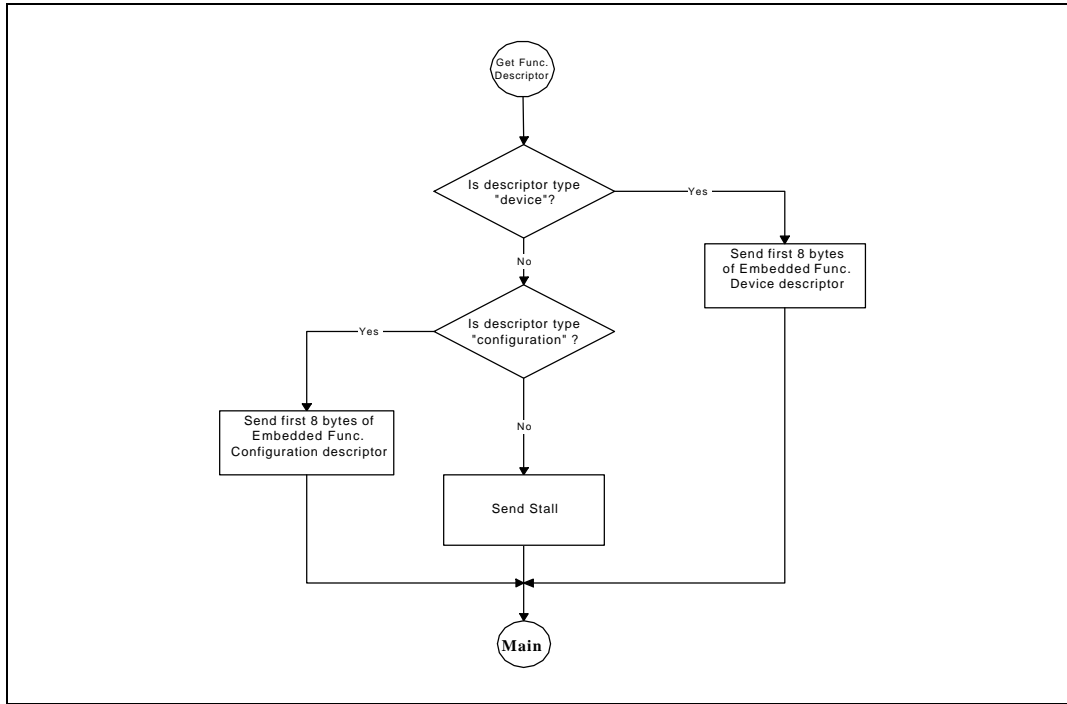# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

Figure 29: Embedded Function Get Descriptor Standard Command
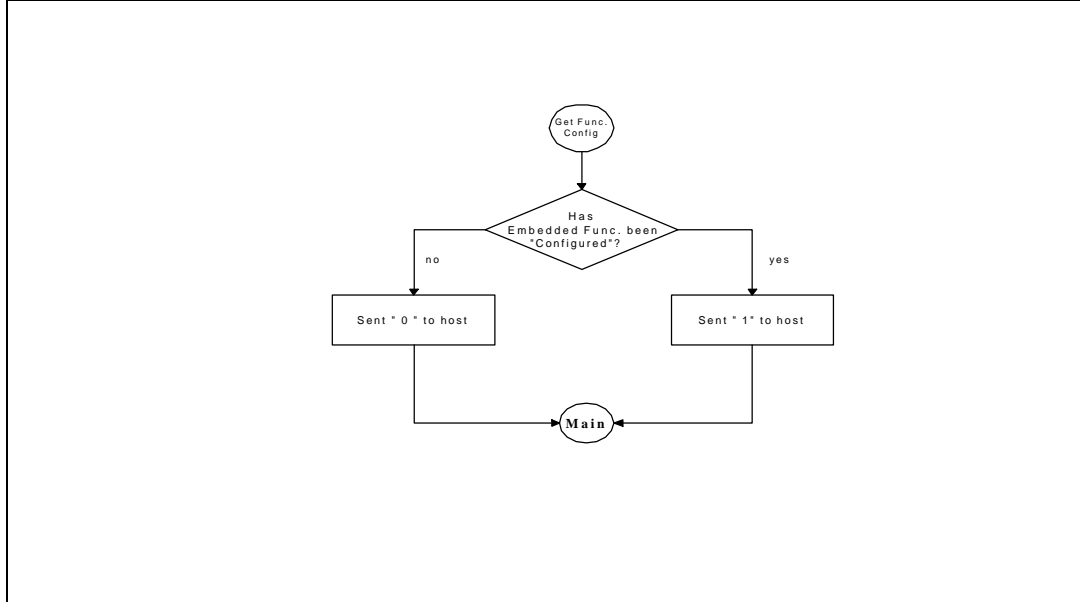
4.3.6 Get Function Configuration

Figure 30: Embedded Function Get Configuration Standard Command

4.3.7 Set Function Configuration

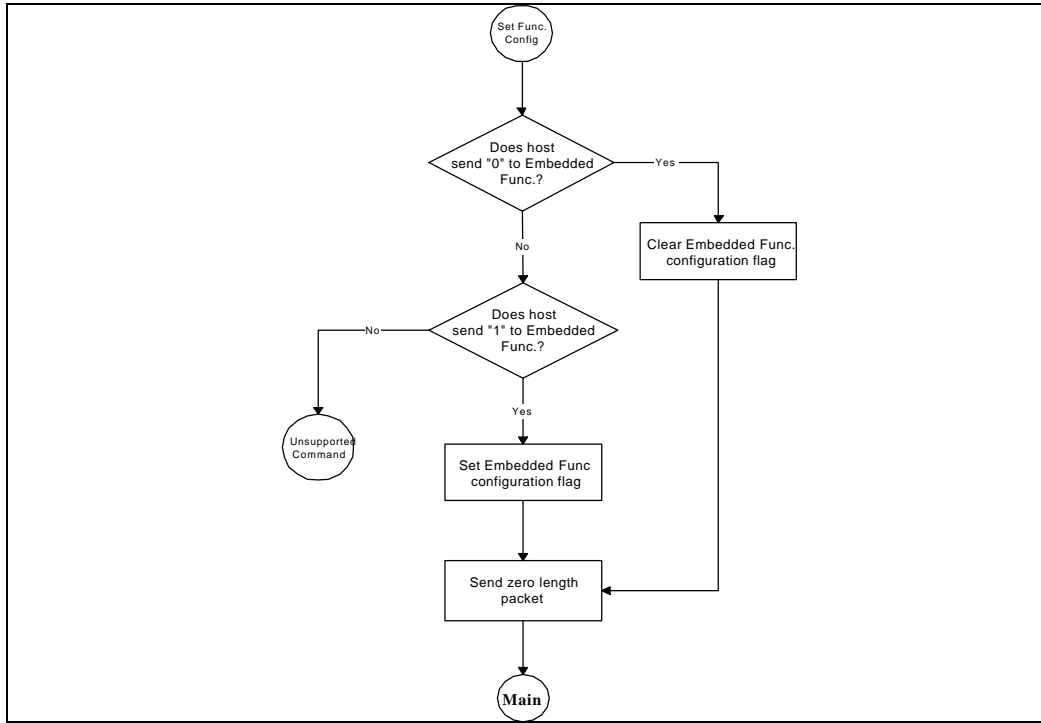# PDIUSBH11A / H12 - Hub / Monitor Firmware Application Notes

Figure 31: Embedded Function Set Configuration Standard Command
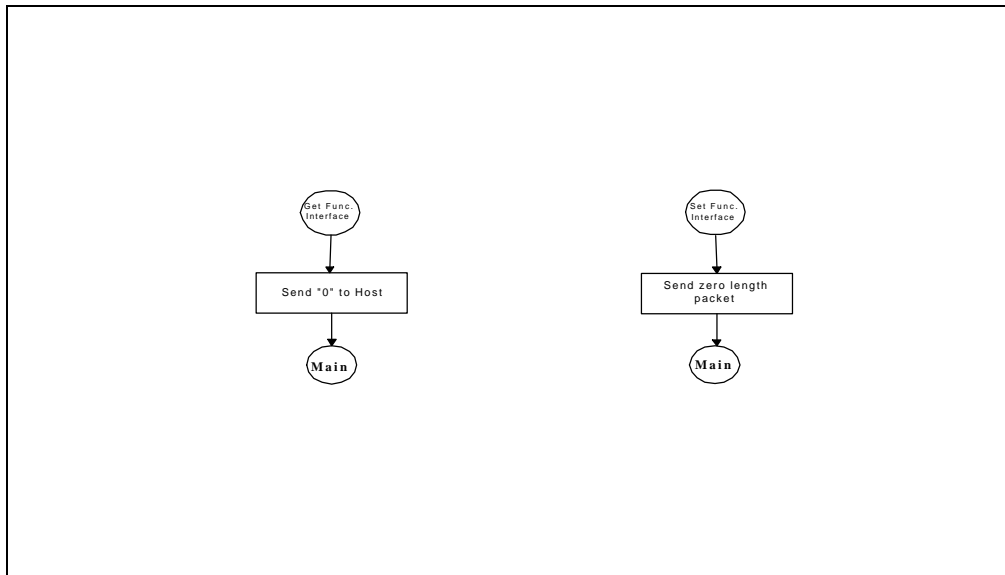
4.3.8 Get/Set Function Interface

Figure 32: Embedded Function Get/Set Interface Standard Command

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4.4 Examples of Class Commands

Figure 33 and Figure 34 show the flow charts for the following supported monitor class commands:
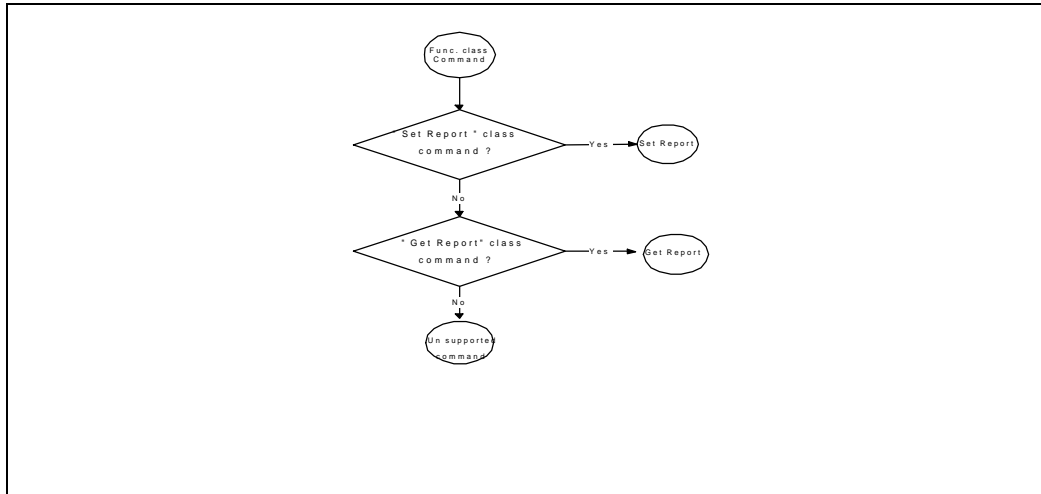- ➢ Set Report
- ➢ Get Report

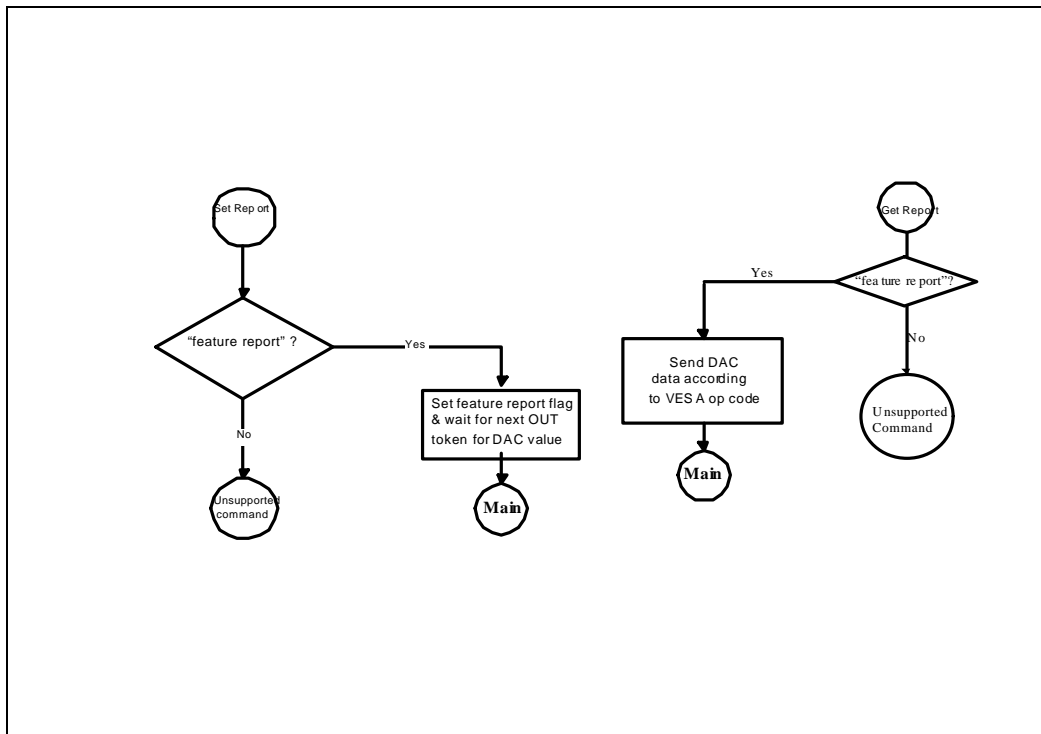**Figure 33: Embedded Function Class Command Flow Chart**

Figure 34: Embedded Function Monitor Class Command