PASSMARK® SOFTWARE

USB Power Delivery Tester

Communication Protocol Guide

Model PM110 & PM125

Note: This document is only applicable to the latest firmware release of the USB Power Delivery Tester Model.

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Table of Contents

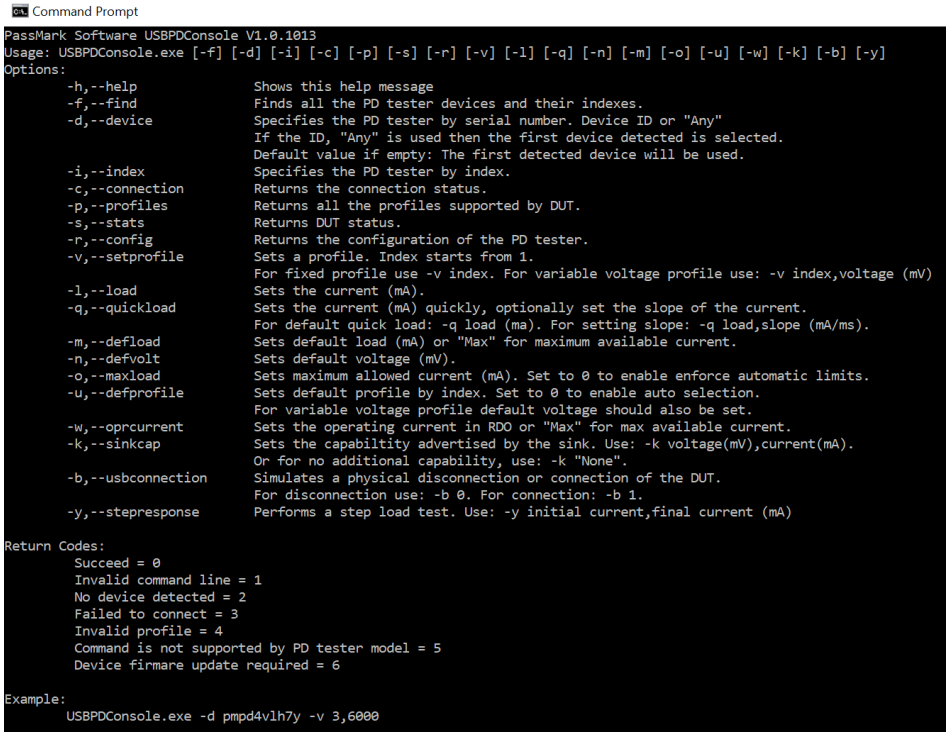
Introduction

This document will demonstrate how to communicate with Passmark USB Power Delivery testers while using the FTDI D2XX Interface. You may need to update device firmware as the information in this document only applies to firmware version 2.5 and later.

Details about the Passmark USB Power Delivery tester can be found here,
https://www.passmark.com.au/products/usb-power-delivery-tester.htm

High level languages can access to the Passmark USB Power Delivery tester using the FTDI's proprietary "direct" driver interface. This interface, D2XX, is provided via a proprietary DLL (FTD2XX.DLL) and a static library (ftd2xx.lib). Please refer to the "D2XX Programmer's Guide" for detailed explanation of the functions available in the library.
http://www.ftdichip.com/Support/Documents/ProgramGuides.htm

The executable file for the example project is located under "Release" directory.
To find a short description of all command line options run the executable with -h option. The below screenshot is taken from the USBPDConsole application version V1.0.1013.



System Requirements

To compile the example, you will need;

Microsoft Visual Studio 2019
FTDI D2XX driver (2.12.28 or later) which can be downloaded from:
http://www.ftdichip.com/Drivers/D2XX.htm

Linking to the FTDI DLL

When using Visual Studio "VC++ Directories" need to be edited to point the location where the FTDI library is copied. The FTDI library is inside the driver zip file.

Include Directories
Need to add "Driver folder"
Library Directories
Need to add "Driver folder\Static\i386"
Or
for 64 bit projects "Driver folder\Static\amd64"

In the **Linker** settings for the project you will need to add "ftd2xx.lib" to the **Additional Dependencies**

In the project's Property Pages, expand Configuration Properties > C/C++ > Preprocessor, add FTD2XX_STATIC to the Preprocessor Definitions

Search in D2XX devices

D2XX driver allows you to get a list of all FTDI devices connected. Below is an example code for searching in D2XX devices to find the Passmark USB Power Delivery testers:

```
DWORD       devcount = 0;
UCHAR       serial[50];
FT_STATUS   ftStatus;

ftStatus = FT_ListDevices(&devcount, NULL, FT_LIST_NUMBER_ONLY);
for (DWORD curDevice = 0; curDevice < devcount; curDevice++)
{
        ftStatus = FT_ListDevices((PVOID)curDevice, serial, FT_LIST_BY_INDEX
        | FT_OPEN_BY_SERIAL_NUMBER);
        if(ftStatus == FT_OK)
        {
                if(!strncmp((char*)serial, "PMPD" , 4))
                {
                        // Add this serial number to the list of testers.
                }
        }
}
```

Open a device

The below code opens a device by its serial number and returns a handle that will be used for subsequent accesses.

```
FT_HANDLE devHandle;
FT_STATUS  ftStatus;

ftStatus = FT_OpenEx(serial, FT_OPEN_BY_SERIAL_NUMBER, &devHandle);
if(ftStatus == FT_OK)
{
        FT_SetBaudRate(devHandle, 115200);
        FT_SetDataCharacteristics(devHandle, FT_BITS_8, FT_STOP_BITS_1,
        FT_PARITY_NONE);
        FT_SetTimeouts(devHandle, 1, 100);
}
```

Send and Receive data

```
FT_STATUS  ftStatus;
ftStatus = FT_Write(devHandle, buf, len, &NumBytesWritten);
ftStatus = FT_Read(devHandle, buf, 1, &NumRecvBytes);
```

Communication Protocol

Communication Format

Following is the frame structure for the commands sent by the host and response received from the tester.

Header	Length	Command	Data	Checksum	Closing Flag

Opening Flag: This is a single byte that indicates the beginning of the frame.
Length: This byte indicates the total number of bytes between Length and Checksum.
Command: This byte is used to instruct the tester which operation to perform. For the response packets, this indicates which command's response.
Data [Payload]: Data bytes are the parameters of a command or response. The least significant byte is always sent and received first (LSB First).
Checksum: This byte is used on the host as well as the tester to check the validity of the packet and to trap any data corruption. This is calculated by XORing all the bytes except the Checksum byte.
Closing Flag: This is a single byte that indicates the end of the frame.

Commands

Command Overview

Table below summarizes the command list of USB Power Delivery Tester. Note that some config parameters can only be set on the PM125 model (See **Configuration Overview**).

Command	Description
0x01	Get Version
0x0A	Get Connection Status
0x0B	Get Capabilities
0x0C	Get Statistics
0x0D	Change Profile / Voltage
0x10	Set Current
0x11	Set Current (Fast)
0x13	Step Load Test
0x14	Set USB Internal Connection (PM125 only)
0xD1	Get Hardware Sub-Revision (PM125 only)
0xE0	Change Config (Persistent)
0xE6	Change Config (Volatile)
0xE1	Get Config
0xE2	Set Backlight
0xE7	Set Protocol Analyzer

Get Version

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x01	0x01	-	0x01	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x03
Command	1	0x01
Hardware Version	1	Hardware version
Firmware Version	1	Firmware version
Checksum	1	To be calculated
Flag	1	0x03

Example:
> Request: 02 01 01 01 03
> Response: 02 03 01 0a 19 10 03 (Hardware Ver 1.0, Firmware Ver: 2.5)

Get Connection Status

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x01	0x0A	-	0x0A	0x03

Response:

<table>
<tr><td>Header</td><td>Length (bytes)</td><td>0x02</td></tr>
<tr><td>Length</td><td>1</td><td>0x0D</td></tr>
<tr><td>Command</td><td>1</td><td>0x0A</td></tr>
<tr><td>Connection Status</td><td>1</td><td>0x00: Not Connected
0x01: Connected</td></tr>
<tr><td>Profile Index</td><td>1</td><td>Profile Index (index starts from 0)</td></tr>
<tr><td>Profile Type</td><td>1</td><td>0x00: Legacy
0x01: Proprietary Charger
0x02: Battery Charging
0x03: Quick Charge (only available on hardware rev 2)
0x04: Type-C (without PD support)
0x05: Type-C (with PD support)</td></tr>
<tr><td>Profile Sub Type</td><td>1</td><td>
<table>
<tr><td></td><td colspan="6">Profile Sub Type</td></tr>
<tr><td>Profile Type</td><td>0x00</td><td>0x01</td><td>0x02</td><td>0x03</td><td>0x04</td><td>0x05</td></tr>
<tr><td>0x00</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>0x01</td><td>Apple 0.5A</td><td>Apple 1A</td><td>Apple 2.1A</td><td>Apple 2.4A</td><td>Apple 3A</td><td>Samsung 2A</td></tr>
<tr><td>0x02</td><td>SDP</td><td>CDP</td><td>DCP</td><td></td><td></td><td></td></tr>
<tr><td>0x03</td><td>QC1</td><td>QC2</td><td>QC3</td><td></td><td></td><td></td></tr>
<tr><td>0x04</td><td>USBC 1.5A</td><td>USBC 3A</td><td></td><td></td><td></td><td></td></tr>
<tr><td>0x05</td><td>PD Fix</td><td>PD Battery</td><td>PD Variable</td><td>PD APDO</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Requested Voltage</td><td>2</td><td>Requested Voltage in millivolts</td></tr>
<tr><td>Max Current</td><td>2</td><td>Maximum current for the selected voltage</td></tr>
<tr><td>Max Power</td><td>4</td><td>Maximum power for the selected voltage</td></tr>
<tr><td>Checksum</td><td>1</td><td>To be calculated</td></tr>
<tr><td>Flag</td><td>1</td><td>0x03</td></tr>
</table>

Example:
> Request: 02 01 0a 0a 03
> Response: 02 0d 0a 01 00 05 00 88 13 60 09 e0 2e 00 00 3e 03

Port Type = Type-C (with PD support), Profile Index = 0, Profile Type = Type-C (with PD support), Profile Sub Type = PD Fix, Requested Voltage = 5000 millivolts, Max Current = 2400mA, Max Power = 12000 milliwatts

Get Capabilities

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x01	0x0B	-	0x0B	0x03

Note: If there are more than 7 Power Data Objects, then a second message with the same structure will be sent shortly after the first, containing the remaining profiles.

Response:

Header	Length (bytes)	0x02
Length	1	0x3B
Command	1	0x0B
Num Power Profiles	2	Number of power profiles
Power Data Objects	56	Profile Index (4 bits) Profile Type (4 bits) Profile Sub Type (3 bits) PDO Index (4 bits) Selectable (1 bit) Min Voltage in millivolts (2 bytes) Max Voltage in millivolts (2 bytes) Max Current in milliamperes (2 bytes) . Next Profile Data Object The values for Profile Type and Profile Sub Type fields are explained in Get Connection Status command
Checksum	1	To be calculated
Flag	1	0x03

Example:
> Request: 02 01 0b 0b 03
> Respond: 02 3b 0b 04 00 40 80 88 13 88 13 b8 0b 31 82 10 0e 88 13 dc 05 32 8a 10 0e 28 23 dc 05 33 92 10 0e e0 2e dc 05 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 75 03
Num Power Profiles = 4, Profile Index = 0, Profile Type = 4 (Type-C without PD support), Profile Sub Type = 0 (USBC 1.5A), Min Voltage = 5000mV, Max Voltage = 5000mV, Max Current = 3000mA, Profile Index = 1, Profile Type = 3 (QC), Profile Sub Type = 2 (QC3), Min Voltage = 3600mV, Max Voltage = 5000mV, Max Current = 1500mA, Profile Index = 2, Profile Type = 3 (QC), Profile Sub Type = 2 (QC3), Min Voltage = 3600mV, Max Voltage = 9000mV, Max Current = 1500mA, Profile

Index = 3, Profile Type = 3 (QC), Profile Sub Type = 2 (QC3), Min Voltage = 3600mV, Max Voltage = 12000mV, Max Current = 1500mA,

Get Statistics

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x01	0x0C	-	0x0C	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x0b
Command	1	0x0C
Data	8	Internal Temperature in Celsius (1 byte) = 0x00 Reserved Heatsink Temperature in Celsius (1 byte) Voltage in millivolts (2bytes) Set Current in milliamperes (2bytes) Current in milliamperes (2bytes) Loopback Current in milliamperes (2bytes)
Checksum	1	To be calculated
Flag	1	0x03

Example:
> Request: 02 01 0c 0c 03
> Response: 02 0b 0c 00 1c 4d 14 00 00 00 00 00 00 54 03
Internal Temperature = 0, Heatsink Temperature = 26, Voltage = 5197 millivolts, Set Current = 0mA, Current = 0mA

Change Profile / Voltage

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x04	0x0D	Profile Index (1 byte) + Voltage (2bytes)	To be calculated	0x03

Profile Indexes starts from 0 and can be optioned by sending “Get Capabilities” command.

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0x0D
Data	1	Status Byte 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example - Select Profile #3:
> Request: 02 04 0d 03 20 4e 65 03
> Response: 02 02 0d 00 0e 03
Status = Successful

Set Current

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x03	0x10	Current in milliamperes (2 bytes)	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0x10
Data	1	Status 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Set Current 1000mA:
> Request: 02 03 10 e8 03 f9 03
> Response: 02 02 10 00 13 03
Status = Successful

Set Current (Fast)

This command can be used with an optional argument that controls the slope of the current as it changes. Using this argument, the time for the load to change can be calculated as:

$$\text{Time in milliseconds} = \frac{\text{Final voltage} - \text{Initial voltage}}{\text{Slope value}}$$

Command (Default):

Header	Length	Command	Data	Checksum	Flag
0x02	0x03	0x11	Current in milliamperes (2 bytes)	To be calculated	0x03

Command (Set slope):

Header	Length	Command	Data	Checksum	Flag
0x02	0x05	0x11	Current in milliamperes (2 bytes) + Slope in milliamperes per millisecond (2 bytes)	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0x11
Data	1	Status 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Quickly Set Current 1000mA:
> Request: 02 03 11 e8 03 f8 03
> Response: 02 02 11 00 12 03
Status = Successful

Step Load Test

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x03	0x13	Initial current (2 bytes) + final current (2 bytes)	To be calculated	0x03

Note: Three responses are sent consecutively with the same structure, the measurements are to be combined to form a list containing 75 measurements. The first measurement is the voltage when the step load is applied, then the following value is the voltage measured after *Sample time*.

Response:

Header	Length (bytes)	0x02
Length	1	0x34
Command	1	0x13
Data	51	Sample time in microseconds (1 byte) Measurements in millivolts (2 bytes each x 25)
Checksum	1	To be calculated
Flag	1	0x03

Example – Step load test from 0mA to 3000mA:
> Request: 02 05 13 00 00 b8 0b a4 03
> Response 1: 02 34 13 64 0a 15 ba 14 b3 13 1 13 a5 12 80 12 7a 12 7a 12 7a 12 74 12 7a 12 7a 12 74 12 7a 12 74 12 7a 12 74 12 7a 12 74 12 74 12 74 12 74 12 7a 12 7a 12 74 12 02 03
> Response 2: 02 34 13 64 74 12 7a 12 74 12 74 12 7a 12 74 12 7a 12 7a 12 74 12 74 12 74 12 7a 12 6d 12 7a 12 74 12 74 12 74 12 7a 12 7a 12 74 12 7a 12 74 12 74 12 7a 12 7a 12 33 03

> Response 3: 02 34 13 64 7a 12 74 12 7a 12 74 12 74 12 7a 12 74 12 7a 12 7a 12 7a 12 74 12 7a 12 7a 12 74 12 7a 12 7a 12 7a 12 7a 12 74 12 74 12 74 12 7a 12 7a 12 74 12 74 12 74 12 24 03
Sample Time = 100 microseconds

Set USB Internal Connection (PM125 only)

This command can be used to simulate a physical disconnection and reconnection of the device under test.
Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x02	0x14	(1 byte) 0x00: USB Disconnected 0x01: USB Connected	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0x14
Data	1	Status 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Disconnect Device Under Test
> Request: 02 02 14 00 17 03
> Response: 02 02 14 00 17 03
Status = Successful

Get Hardware Sub-Revision (PM125 only)

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x01	0xD1	-	0xD1	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0xD1
Data	1	Sub-Revision 0x00: Hardware revision 2.0 0x01: Hardware revision 2.1 0x02: Hardware revision 2.2
Checksum	1	To be calculated
Flag	1	0x03

Example – Hardware revision 2.0
> Request: 02 01 D1 D1 03
> Response: 02 02 D1 00 D2 03
Status = Successful

Change Config (Persistent)

Warning: Performing this operation too many times can burn out the flash memory, as all configuration parameters are written to flash memory after the change operation. For this reason, it is recommended to use the volatile option when possible.

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	Depends on the parameter	0xE0	See **Configuration Guide** Section.	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0xE0
Data	1	Status 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Enable Loopback Port:
> Request: 02 03 e0 00 01 e3 03
> Response: 02 02 e0 00 e3 03
Status = Successful

Change Config (Volatile)

Warning: Configuration change will not persist after power loss, since no write to flash memory is performed.

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	Depends on the parameter	0xE6	See **Configuration Guide** Section.	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0xE6
Data	1	Status 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Enable Loopback Port:
> Request: 02 03 e6 00 01 e5 03
> Response: 02 02 e6 00 e5 03
Status = Successful

Get Config

Command

Header	Length	Command	Data	Checksum	Flag
0x02	0x02	0xE1	See **Configuration Guide** Section.	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	Depends on the parameter
Command	1	0xE1
Data	Depends on the parameter	Loopback Port: 0x00: Disabled 0x01: Enables Max SDP Current: 2 bytes LSB First
Checksum	1	To be calculated
Flag	1	0x03

Example – Loopback Port:
> Request: 02 02 e1 00 e2 03
> Response: 02 02 e1 01 e3 03
Loopback Port = Enabled

Set Backlight

Command:

Header	Length	Command	Data	Checksum	Flag
0x02	0x02	0xE2	On/Off (1 byte) 0x00: Off 0x01: On	To be calculated	0x03

Response:

Header	Length (bytes)	0x02
Length	1	0x02
Command	1	0xE2
Data	1	Status Byte 0x00: Successful 0x01: Failed
Checksum	1	To be calculated
Flag	1	0x03

Example – Turn backlight off:
> Request: 02 02 e2 00 e1 03
> Response: 02 02 e2 00 e1 03
Status = Successful

Configuration Guide

Configuration Overview

Parameter	Description	Supported	
		PM125	PM110
Loopback Port	Connect loopback port to power and data lines from device under test.	✓	✓
Current Limit	Maximum current that can be drawn from device under test.	✓	✓
Max SDP Current	The maximum current for standard downstream ports can be defined by this option.	✓	✓
Upstream VBUS Estimation	When enabled, the displayed voltage is the upstream voltage from the device under test (estimated based on set cable resistance). When disabled, displayed voltage is voltage measured downstream at test unit.	✓	✓
Cable Resistance	Resistance of the cable connecting the device under test to the test unit. Used for estimating the upstream voltage from the device under test.	✓	✓
Default Profile Index	The initial profile index selected when the device under test is connected. In “Auto mode”, selects best matching profile to the default voltage.	✓	✗
Default Voltage	The initial voltage set when the device under test is connected.	✓	✓
Default Current	The initial current set when the device under test is connected.	✓	✓
Operating Current	The value advertised by the test unit as the maximum current it will accept. If	✓	✗

	not required, set to "Max". See Section *6.4.2.8 Operating Current* from the *USB Power Delivery Specification Revision 3.1* for more details.		
Sink Capability	The second capability of the sink advertised, alongside the first which is always 5V, 5A. If not required, set to "None". This value is used when replying to a "Get Sink Capabilities" message, see Section *6.4.3.1 Sink Capabilities Message* from the *USB Power Delivery Specification Revision 3.1* for more details	✓	✗
Profile Limit	The maximum current that can be set for profiles of corresponding type (Cannot exceed limit from specifications). Can also be set to "Disabled" to turn off detection of the Profile type.	✓	✗
Hold Load (on voltage changes)	When enabled, the current set will be maintained during all voltage and profile changes. If disabled, the current will go to 0 when the voltage or selected profile is changed.	✓	✗

Configuration Commands

Parameter	Data Bytes		Example Set Command Data
	Read	Set / Response data from read	
Loopback Port	0x00	Disable: 0x00 0x00 Enable: 0x00 0x01	
Current Limit	N/A	Enforce Limits: 0x01 0x00 Allow 20% over current: 0x01 0x01 Force Limit: 0x01 0x02 *MaxCurrent* in milliamperes (2 Bytes)	Set maximum current to 3000mA: 0x01 0x02 0xB8 0x0B
Max SDP Current	0x02	0x02 *MaxCurrent* in milliamperes (2 Bytes)	Set maximum current to 900mA 0x02 0x84 0x03
Upstream VBUS Estimation	0x03	Disable: 0x03 0x00 Enable: 0x03 0x01	
Cable Resistance	0x04	0x04 *CableResistance* in ohms (2 Bytes)	Set cable resistance to 80 ohms: 0x04 0x50 0x00

Default Profile Index	0x05	0x05 *DefaultProfileIndex* (1 Byte) Or for Auto mode: 0x05 0xFF	Set default profile index to 2: 0x05 0x02
Default Voltage	0x06	0x06 *DefaultVoltage* in millivolts (2 Bytes)	Set default voltage to 2000mV: 0x06 0xD0 0x07
Default Current	0x07	0x07 *DefaultCurrent* in milliamperes (2 Bytes)	Set default current to 1500mA: 0x07 0xDC 0x05
Operating Current	0x08	0x08 *MaxOperatingCurrent* in milliamperes (2 Bytes) Or for Max: 0x08 0xFF 0xFF	Set maximum operating current to 1500mA: 0x08 0xDC 0x05
Sink Capability	0x09	0x09 *Voltage* in millivolts (2 Bytes) *Current* in milliamperes (2 Bytes) Or for None: 0x09 0xFF 0xFF 0xFF 0xFF	Set sink capability to 15V, 3A: 0x09 0x98 0x3A 0xB8 0x0B
Hold Load	0x16	Disable: 0x0A 0x00 Enable: 0x0A 0x01	