

## ZL\_PMBus API Overview

The ZL\_PMBus API enables you to write applications using the Zilker Labs PMBus Interface. The Zilker Labs PMBus Interface is a USB-to-PMBus converter available on evaluation boards such as the ZL2005EV-1 Rev. 5. A block diagram showing how data flows from your computer to a PMBus device is shown in Figure 1 below. PMBus traffic tests and GUI interfaces are some of the possible applications that can benefit from the ZL\_PMBus API.

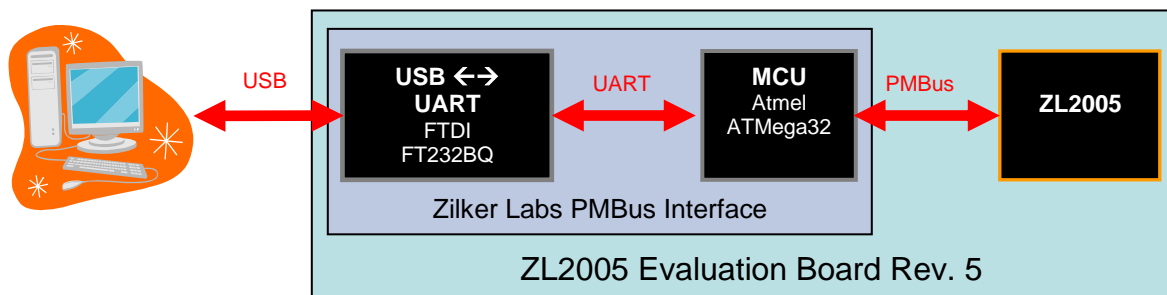


Figure 1. Data Flow Diagram of the Zilker Labs PMBus Interface

A typical application using the ZL\_PMBus API is structured as follows. The top-level application will need to link ZL\_PMBus.dll either internally using ZL\_PMBus.lib and ZL\_PMBus.h, or externally using Microsoft Dynamic-Link Library Functions. After linking, functions available in the ZL\_PMBus API can be called. It should be noted that applications using the ZL\_PMBus API must include the FTDI FTD2XX driver (FTD2XX.dll). This is because the Zilker Labs PMBus interface uses an FT232BQ USB-to-UART converter. We chose to do this such that the MCU responsible for performing PMBus transmissions can be re-used for standalone applications.

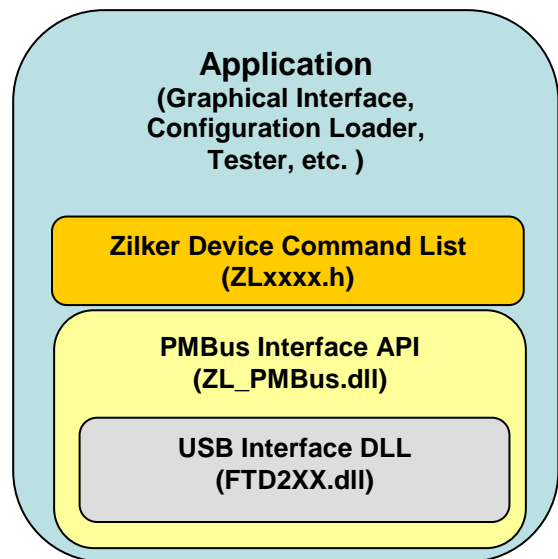


Figure 2. Hierarchy of Application and Driver Calls

---

## Table of Contents

---

<b>Function Reference</b> .....	<b>3</b>
ZL_DLLVersion.....	3
ZL_FWVersion.....	4
ZL_DeviceScan.....	5
ZL_DetectDevice.....	7
ZL_NumberOfDevices.....	8
ZL_OpenDeviceByName.....	9
ZL_OpenDeviceBySerial.....	10
ZL_CloseDevice.....	11
ZL_PMBUS_Write.....	12
ZL_PMBUS_Read.....	16
ZL_PMBUS_SetPEC.....	21
ZL_PMBUS_GetPEC.....	22
<b>ZL_PMBus Structures, Types, and Values</b> .....	<b>23</b>
PMBUS_RW_TRANSFER.....	23
ZL_HANDLE.....	24
ZL_STATUS.....	24
ZL_VERSION.....	25
ZL_FW_VERSION.....	25
ZL_SERIAL.....	25
<b>Revision History</b> .....	<b>26</b>

## Function Reference

---

Below is an explanation of all the functions currently in the ZL\_PMBus API. This includes the function parameters, return values, and usage conditions.

### ZL\_DLLVersion

Gets the version of the ZL\_PMBUS dll you are linking to.

```
ZL_VERSION ZL_DLLVersion( void )
```

#### Parameters

None.

#### Return Values

The ZL\_VERSION structure, which stores numbers for both the major and minor revision. (see “ZL\_PMBus Structures, Types, and Values” on page 21 for more details)

#### Example

```
ZL_VERSION myVersion;  
myVersion = ZL_DLLVersion();  
  
printf("ZL_PMBus version %d.%d.\n",  
       myVersion.major, myVersion.minor);
```

## ZL\_FWVersion

Gets the version of firmware running on the MCU.

NOTE: This command works only on firmware revisions 02 and greater.

```
ZL_STATUS ZL_FWVersion( const ZL_HANDLE deviceHandle,  
                        ZL_FW_VERSION *version );
```

### Parameters

deviceHandle	The handle of the device we want to retrieve it's firmware version from.
*version	The firmware version, in the format of ZL_FW_VERSION, which is a structure that contains a 3-byte long version string called versionStr.

### Return Values

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

```
ZL_HANDLE myHandle; ZL_STATUS myStatus;  
ZL_FW_VERSION fwversion;  
int i;  
  
myStatus = ZL_FWVersion( myHandle, &fwversion );  
if( myStatus == ZL_PMBUS_OK)  
{  
    printf("Firmware version: ");  
    for(i = 0; i < 3; i++)  
        printf("%c", fwversion.versionStr[i] );  
    printf("\n");  
}  
else {  
    printf("Error in reading firmware version \n");  
}
```

## ZL\_DeviceScan

Returns a listing of all Zilker Labs PMBus Interfaces attached to the computer. The list is composed of the serial numbers for each device, such that one can choose to open a specific device from the list using ZL\_OpenDeviceBySerial.

```
ZL_STATUS ZL_DeviceScan( unsigned long *numDevices,
                        ZL_SERIAL *deviceSerials,
                        const char *deviceName)
```

### Parameters

*numDevices	Pointer that returns the number of devices attached to the computer
*deviceSerials	Pointer to an array of ZL_SERIAL structures
*deviceName	C-String pointer to the name of the devices we are trying to scan

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Comments

Because ZL\_DeviceScan requires a pointer to the list of serials the function will return, one must allocate enough space to include the list of serials in the first place. We recommend calling ZL\_NumberOfDevices first to see how many devices are attached, then use the return data from the prior function to allocate memory for the list. This method is shown in the example below

### Example

```
ZL_STATUS myStatus;
ZL_SERIAL* deviceSerials; //pointer to an array of serials
unsigned long numDevices, i;

// First, see how many devices are connected
myStatus = ZL_NumberOfDevices( &numDevices,
                              "Zilker Labs PMBus Interface" );

if( numDevices == 0 ) {
    printf("No Devices Found.\n");
    return 0;
}

// Knowing the number of devices, create a list
// of device serials.
```

```
// Allocate space for device serials
deviceSerials = (ZL_SERIAL*)malloc(sizeof(ZL_SERIAL) *
                                   numDevices);

// Generate List of detected devices
myStatus = ZL_DeviceScan( &numDevices,
                          deviceSerials,
                          "Zilker Labs PMBus Interface" );

// Print List of devices
printf("Devices Found: \n");
for( i = 0; i < numDevices; i++ ) {
    printf("%s\n", deviceSerials[i].numStr);
}

// Open first device from list
myStatus = ZL_OpenDeviceBySerial( &myHandle,
                                  &deviceSerials[0] );

if(myStatus) { //Error in opening device
    printf("\nError in opening device \"%s\". \n",
          deviceSerials[0].numStr );
}
else { //Device Successfully opened
    printf("\nDevice \"%s\" Successfully Opened\n",
          deviceSerials[0].numStr );
}

// Close device
myStatus = ZL_CloseDevice( myHandle );
```

## ZL\_DetectDevice

This function is used to see if a device handle is still open, and is typically used to report an error if an invalid handle is passed, or to realize that a device needs to be re-opened.

```
ZL_STATUS ZL_DetectDevice( const ZL_HANDLE deviceHandle,  
                           const char *deviceName )
```

### Parameters

deviceHandle	The device handle you are testing
*deviceName	The device name associated with the handle you are testing

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if the device handle still exists, otherwise a defined error code is returned.

### Example

```
ZL_HANDLE myHandle;  
ZL_STATUS myStatus;  
  
//Attempt to open the device  
myStatus = ZL_OpenDeviceByName( &myHandle,  
                                "Zilker Labs PMBus Interface" );  
  
//see if device is already detected  
if( !( ZL_DetectDevice( myHandle,  
                        "Zilker Labs PMBus Interface" ) ) )  
{  
    printf("Device Detected after handle open.(expected)\n");  
}  
else {  
    printf("Device not detected after handle open!\n");  
}
```

## ZL\_NumberOfDevices

Returns the number of devices currently attached to the computer.

```
ZL_STATUS ZL_NumberOfDevices( unsigned long *numDevices,  
                             const char *deviceName)
```

### Parameters

\*numDevices           The returned number of attached devices  
\*deviceName           C-String pointer to the name of the devices we are trying to scan

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

```
ZL_STATUS myStatus;  
unsigned long numDevices;  
  
// See how many devices are connected  
myStatus = ZL_NumberOfDevices( &numDevices,  
                              "Zilker Labs PMBus Interface" );  
  
printf("%d devices found.\n", numDevices);
```



## ZL\_OpenDeviceByName

Opens the first device found that matches the provided device name.

```
ZL_STATUS ZL_OpenDeviceByName( ZL_HANDLE *deviceHandle,  
                               char *deviceName )
```

### Parameters

\*deviceHandle      Pointer to the opened device handle.  
\*deviceName        C-String pointer to the name of the device we are  
                    trying to open.

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

```
ZL_HANDLE myHandle;  
ZL_STATUS myStatus;  
  
//Attempt to open the device  
myStatus = ZL_OpenDeviceByName( &myHandle,  
                               "Zilker Labs PMBus Interface" );
```

## ZL\_OpenDeviceBySerial

Opens the device found with a matching serial number. This function is typically used after calling ZL\_DeviceScan.

```
ZL_STATUS ZL_OpenDeviceBySerial( ZL_HANDLE *deviceHandle,  
                                ZL_SERIAL *deviceSerial )
```

### Parameters

*deviceHandle	Pointer to the opened device handle.
*deviceSerial	Pointer to the ZL_SERIAL structure containing the serial number of the device we want to open.

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

See Pages 4-5.

## ZL\_CloseDevice

Closes the device associated with the provided handle.

```
ZL_STATUS ZL_CloseDevice( const ZL_HANDLE deviceHandle )
```

### Parameters

deviceHandle            The device handle we are trying to close.

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

See Pages 4-5.

## ZL\_PMBUS\_Write

Performs a PMBus transmission in the form of a Quick Command, Send Byte, Write Byte, Write Word, or Block Write transfer.

```
ZL_STATUS ZL_PMBUS_Write( const ZL_HANDLE deviceHandle,
                          const unsigned char numDevices,
                          PMBUS_RW_TRANSFER *pmTrans );
```

### Parameters

deviceHandle	The device handle we will use to perform the transmission.
numDevices	The number of devices we will be addressing. This should always be passed 1 unless a group command is being performed.
*pmTrans	Pointer to the PMBUS_RW_TRANSFER structure, which includes the PMBus device address, transfer type, command byte(s), and data we want to send.

### Return Values

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example (Quick Command)

```
ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Quick Command Write transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_QUICKCMD_WRITE;

myStatus = ZL_PMBUS_Write( deviceHandle,
                          1, //numDevices
                          &pmTrans );
```

### Example (Send Byte)

```
//PMBus Command
const unsigned char restore_user_all = 0x16;

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Send Byte transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_SEND_BYTE;
```

```
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = restore_user_all;

myStatus = ZL_PMBUS_Write( deviceHandle,
                           1, //numDevices
                           &pmTrans );
```

### Example (Write Byte)

```
const unsigned char operation = 0x01; //PMBus Command Definition
ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Write Byte transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_WRITE_BYTE;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = operation;
pmTrans.paramLength = 1;
pmTrans.paramBytes[0] = 0x40; //Perform a "Soft-Off"

myStatus = ZL_PMBUS_Write( deviceHandle,
                           1, //numDevices
                           &pmTrans );
```

### Example (Write Word)

```
const unsigned char vout_command = 0x21; //PMBus Command

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Write Word transmission
pmTrans.address = DEVICE_ADDRESS_1;
pmTrans.transferType = TTYPE_PMBUS_WRITE_WORD;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = vout_command;
pmTrans.paramLength = 2;
pmTrans.paramBytes[0] = 0x3D; // NOTE: The purpose of these
pmTrans.paramBytes[1] = 0x6A; // parameter bytes are to
                             // send 3.32 Volts = 0x6A3D.
                             // They are sent in the
                             // little-endian format as
                             // required by PMBus spec.
```

```
myStatus = ZL_PMBUS_Write( deviceHandle,  
                           1, //numDevices  
                           &pmTrans );
```

### Example (Block Write – Writing an arbitrary sequence )

```
const unsigned char ZL2005_pid_taps = 0xD5; //PMBus Command  
ZL_STATUS myStatus;  
PMBUS_RW_TRANSFER pmTrans;  
  
//Setup PMBus transfer struct for a Write Byte transmission  
pmTrans.address = 0x20;  
pmTrans.transferType = TTYPE_PMBUS_BLOCK_WRITE;  
pmTrans.cmdLength = 1;  
pmTrans.cmdBytes[0] = ZL2005_pid_taps;  
pmTrans.paramLength = 9;  
// Write PID_TAPS A=1634, B=-2799, C=1227  
pmTrans.paramBytes[0] = 0x40; //Coefficient A -  
                           // mantissa, low-byte  
pmTrans.paramBytes[1] = 0xCC; //Coefficient A -  
                           // mantissa, high-byte  
pmTrans.paramBytes[2] = 0x7B; //Coefficient A -  
                           // exponent + sign  
pmTrans.paramBytes[3] = 0xF0; //Coefficient B -  
                           // mantissa, low-byte  
pmTrans.paramBytes[4] = 0xAE; //Coefficient B -  
                           // mantissa, high-byte  
pmTrans.paramBytes[5] = 0xFC; //Coefficient B -  
                           // exponent + sign  
pmTrans.paramBytes[6] = 0x60; //Coefficient C -  
                           // mantissa, low-byte  
pmTrans.paramBytes[7] = 0x99; //Coefficient C -  
                           // mantissa, high-byte  
pmTrans.paramBytes[8] = 0x7B; //Coefficient C -  
                           // exponent + sign  
  
myStatus = ZL_PMBUS_Write( deviceHandle,  
                           1, //numDevices  
                           &pmTrans );
```

**Example (Block Write – Writing an ASCII string)**

```
const unsigned char mfr_id = 0x99; //PMBus Command

char asciiData[] = "hello world!";
ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Write Byte transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_BLOCK_WRITE;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = mfr_id;
strcpy( &pmTrans.paramBytes, &asciiData[0] );
pmTrans.paramLength = (unsigned char)
                      strlen( &asciiData[0] );

myStatus = ZL_PMBUS_Write( deviceHandle,
                          1, //numDevices
                          &pmTrans );
```

## ZL\_PMBUS\_Read

Performs a PMBus transmission in the form of a Receive Byte, Read Byte, Read Word, or Block Read transfer type.

```
ZL_STATUS ZL_PMBUS_Read( const ZL_HANDLE deviceHandle,
                        PMBUS_RW_TRANSFER *pmTrans );
```

### Parameters

deviceHandle	The device handle we will use to perform the transmission.
*pmTrans	Pointer to the PMBUS_RW_TRANSFER structure, which includes the PMBus device address, transfer type, command byte(s), and stores the data we will receive.

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example (Receive Byte)

```
#define ALERT_RESPONSE_ADDRESS  0x0C
ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for Receive Byte transmission
pmTrans.address = ALERT_RESPONSE_ADDRESS;
pmTrans.transferType = TTYPE_PMBUS_RECV_BYTE;

myStatus = ZL_PMBUS_Read( deviceHandle,
                        &pmTrans );

if(myStatus) { //Exit if error occurred
    printf("Error in Receive Byte Example.\n");
    printf("(This is likely due to no faults\
           present on any devices)\n\n");
    return;
}

//Otherwise, Print byte contents
printf("Receive Byte Contents: %#02x,\
       meaning a device at address %#02x has a fault.\n",
       pmTrans.paramBytes[0],
       (pmTrans.paramBytes[0]>>1) & ~(0x80) );
```



**Example (Read Byte)**

```
const unsigned char operation = 0x01; //PMBus Command

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Read Byte transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_READ_BYTE;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = operation;

myStatus = ZL_PMBUS_Read( deviceHandle,
                          &pmTrans );

if(myStatus) { //Exit if error occurred
    printf("Error in Read Byte Example.\n\n");
    return;
}

//Otherwise, Print byte contents
printf("Read Byte Contents: %#02x.\n",
       pmTrans.paramBytes[0]);
```

**Example (Read Word)**

```
const unsigned char vout_command = 0x21; //PMBus Command

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Read Word transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_READ_WORD;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = vout_command;

myStatus = ZL_PMBUS_Read( deviceHandle,
                        &pmTrans );

if(myStatus) { //Exit if error occurred
    printf("Error in Read Word Example.\n\n");
    return;
}

//Otherwise, Print byte contents
//NOTE: I print the second byte first since
//      the data for VOUT_COMMAND is sent and received
//      in little-endian.
printf("Read Word Contents: %#02x%02x.\n",
       pmTrans.paramBytes[1], pmTrans.paramBytes[0]);
```

**Example (Block Read of Arbitrary bytes)**

```
const unsigned char ZL2005_pid_taps = 0xD5; //PMBus Command
const unsigned char ZL2005_pid_taps_length = 9;

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;

//Setup PMBus transfer struct for a Read Word transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_BLOCK_READ;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = ZL2005_pid_taps;

myStatus = ZL_PMBUS_Read( deviceHandle,
                        &pmTrans );

if(myStatus) { //Exit if error occurred
    printf("Error in Block Read Example.\n\n");
    return;
}
else if(pmTrans.paramLength != ZL2005_pid_taps_length) {
    printf("Invalid parameter length returned.\n\n");
    return;
}

//Print out pid_taps coefficients
printf("Block Read Demo One - PID_TAPS readout:\n");
printf(" Coefficient A: %#02x%02x%02x\n",
       pmTrans.paramBytes[6],
       pmTrans.paramBytes[7],
       pmTrans.paramBytes[8] );
printf(" Coefficient B: %#02x%02x%02x\n",
       pmTrans.paramBytes[3],
       pmTrans.paramBytes[4],
       pmTrans.paramBytes[5] );
printf(" Coefficient C: %#02x%02x%02x\n",
       pmTrans.paramBytes[0],
       pmTrans.paramBytes[1],
       pmTrans.paramBytes[2] );
```

**Example (Block Read of ASCII Characters)**

```
//PMBus Command
const unsigned char ZL2005_device_id = 0xE4;

ZL_STATUS myStatus;
PMBUS_RW_TRANSFER pmTrans;
unsigned char i;

//Setup PMBus transfer struct for a Read Word transmission
pmTrans.address = 0x20;
pmTrans.transferType = TTYPE_PMBUS_BLOCK_READ;
pmTrans.cmdLength = 1;
pmTrans.cmdBytes[0] = ZL2005_device_id;

myStatus = ZL_PMBUS_Read( deviceHandle,
                        &pmTrans );

if(myStatus) { //Exit if error occurred
    printf("Error in Block Read Example.\n\n");
    return;
}

//print non null-terminated ASCII string
printf("Block Read Output: ");
for(i = 0; i < pmTrans.paramLength; i++) {
    printf("%c", pmTrans.paramBytes[i]);
}
```

## ZL\_PMBUS\_SetPEC

Enables or disables Packet Error Checking (PEC) on the device.

NOTE: This command works only on firmware revisions 03 and greater.

```
ZL_STATUS ZL_PMBUS_SetPEC( const ZL_HANDLE deviceHandle,  
                           const unsigned char PECFlagIn );
```

### Parameters

deviceHandle	The device handle we will use to enable/disable PEC.
PECFlagIn	Flag which takes on the definitions of either PEC_ENABLE or PEC_DISABLE

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

```
ZL_HANDLE myHandle;  
ZL_STATUS myStatus;  
  
myStatus = ZL_PMBUS_SetPEC( myHandle, PEC_ENABLE );  
if( myStatus == ZL_PMBUS_OK )  
{  
    printf("Set pec\n");  
}  
else  
{  
    printf("Error in setting pec.\n");  
}
```

## ZL\_PMBUS\_GetPEC

Tells whether Packet Error Checking (PEC) is enabled/disabled.

NOTE: This command works only on firmware revisions 03 and greater.

```
ZL_STATUS ZL_PMBUS_GetPEC( const ZL_HANDLE deviceHandle,
                          unsigned char * PECFlagOut );
```

### Parameters

deviceHandle	The device handle we will use to enable/disable PEC.
*PECFlagOut	Pointer to unsigned character that returns with either PEC_ENABLE or PEC_DISABLE

### Return Value

ZL\_STATUS is 0 (ZL\_PMBUS\_OK) if successful, otherwise a defined error code is returned.

### Example

```
ZL_HANDLE myHandle;
ZL_STATUS myStatus;
unsigned char pecEnable;

myStatus = ZL_PMBUS_GetPEC( myHandle, &pecEnable ) == 0
if( myStatus == ZL_PMBUS_OK )
{
    printf("Pec set to: %d\n", pecEnable);
}
else {
    printf("Error in reading pec.\n");
}
```

## ZL\_PMBus Structures, Types, and Values

The ZL\_PMBus API makes use of a few special structures to make it easy to send and receive the data you need. Below is a list of the structures and a description of how they work.

### PMBUS\_RW\_TRANSFER

The PMBUS\_RW\_TRANSFER is a structure used with the ZL\_PMBUS\_Write and ZL\_PMBUS\_Read commands. It contains the transfer type, address, command byte(s), and parameter byte(s) that will be used to communicate with the device.

```
typedef struct PMBusRWStruct {
    unsigned char transferType;
    unsigned char address;
    unsigned char cmdLength;
    unsigned char cmdBytes[2];
    unsigned char paramLength;
    unsigned char paramBytes[256];
} PMBUS_RW_TRANSFER;
```

The transferType variable should be set to one of the predefined transfer types found in ZL\_PMBus.h. The transfer types are also listed below:

```
// Transfer Types used by ZL_PMBUS_Write
#define TTYPE_PMBUS_QUICKCMD_READ    1
#define TTYPE_PMBUS_QUICKCMD_WRITE  2
#define TTYPE_PMBUS_SEND_BYTE       4
#define TTYPE_PMBUS_WRITE_BYTE      7
#define TTYPE_PMBUS_WRITE_WORD      8
#define TTYPE_PMBUS_BLOCK_WRITE     10
// Transfer Types used by ZL_PMBUS_Read
#define TTYPE_PMBUS_RECV_BYTE       3
#define TTYPE_PMBUS_READ_BYTE      5
#define TTYPE_PMBUS_READ_WORD      6
#define TTYPE_PMBUS_BLOCK_READ     11
// Transfer Types used with ZL_PMBUS_ProcessCall
#define TTYPE_PMBUS_PROC_CALL       9
#define TTYPE_PMBUS_BLKWR_BLKRD_PROC 12
```

The address variable is passed as just the lower 7 bytes of an address byte in a PMBus transmission. This means that for an address of 0x20 in PMBUS\_RW\_TRANSFER, 0x40 or 0x41 will be sent in an Address+Write or Address+Read, respectively. The address is shifted left in the MCU code.

The `cmdLength` variable describes how many command bytes need to be sent. This value is typically 1 unless you are doing an extended command transfer, in which case it should be 2.

The `cmdBytes` array holds the command byte to be sent as well as an extended command byte. The bytes must be put in the array in the order that they are sent. This means that for non-extended command transmissions the command byte must be placed in `cmdByte[0]`.

The `paramLength` variable is used to either describe the number of bytes to be sent, or to read the number of bytes that were received.

The `paramBytes` array holds the parameter bytes we want to send, but can also contain the parameter bytes we received. Parameter bytes should be put in the order they are sent.

## ZL\_HANDLE

The `ZL_HANDLE` type is a pointer that points to the instance of the FTDI USB-UART converter attached to the computer.

## ZL\_STATUS

`ZL_STATUS` is a signed long variable that is typically used to return whether a command was successful or not. DLL Versions 0.4 and greater include the following status codes:

### API-Wide Error Codes

<code>ZL_PMBUS_OK</code>	0	<code>// No Error</code>
<code>ZL_PMBUS_ERR_GENERIC</code>	-1	
<code>ZL_PMBUS_ERR_DEVHANDLE</code>	-2	
<code>ZL_PMBUS_ERR_TRANS_DATA_INV</code>	-3	
<code>ZL_PMBUS_ERR_TRANS_DATA_UNDERRUN</code>	-4	
<code>ZL_PMBUS_ERR_TRANS_DATA_OVERRUN</code>	-5	
<code>ZL_PMBUS_ERR_TRANS_TIMEOUT</code>	-6	

### Error codes related to sending PMBus data

<code>ZL_PMBUS_ERR_SEND_START</code>	-100
<code>ZL_PMBUS_ERR_SEND_REP_START</code>	-101
<code>ZL_PMBUS_ERR_SEND_ADR</code>	-102
<code>ZL_PMBUS_ERR_SEND_REP_ADR</code>	-103
<code>ZL_PMBUS_ERR_SEND_CMD</code>	-104
<code>ZL_PMBUS_ERR_SEND_PARAMLEN</code>	-105
<code>ZL_PMBUS_ERR_SEND_PARAM</code>	-106
<code>ZL_PMBUS_ERR_SEND_PEC</code>	-107
<code>ZL_PMBUS_ERR_SEND_STOP</code>	-108



### Error codes related to receiving PMBus data

ZL_PMBUS_ERR_RECV_PARAMLEN	-140
ZL_PMBUS_ERR_RECV_PARAM	-141
ZL_PMBUS_ERR_RECV_PEC	-142

### PMBus-specific user input errors

ZL_PMBUS_ERR_BAD_TTYPE	-170
ZL_PMBUS_ERR_BAD_CMDLEN	-171
ZL_PMBUS_ERR_NUMDEVICES_IS_ZERO	-172

More information on these error codes can be found in the ZL\_PMBus.h API header file.

## ZL\_VERSION

ZL\_VERSION is a structure that contains the major and minor release numbers. The version of the dll you are linking to can be found via the ZL\_DLLVersion command.

```
typedef struct revision {
    long major;
    long minor;
} ZL_VERSION;
```

## ZL\_FW\_VERSION

ZL\_FW\_VERSION is a structure that contains the firmware version. The version of firmware your MCU is using can be found via the ZL\_FWVersion command.

```
typedef struct fwRevision {
    char versionStr[3];
} ZL_FW_VERSION;
```

## ZL\_SERIAL

ZL\_SERIAL contains a C-String buffer that holds a series of ASCII characters that serve as each device's serial number. The serial numbers retrieved via ZL\_DeviceScan are stored in a small EEPROM used by the FTDI USB-UART converter.

## Revision History

---

Date	Rev. #	
5/25/06	2.0	Initial Release
6/6/07	3.0	Added ZL_FWVersion, ZL_SetPEC, & ZL_GetPEC. Added ZL_STATUS Error Codes
5/01/09	AN2018.0	Assigned file number AN2018 to app note as this will be the first release with an Intersil file number. Replaced header and footer with Intersil header and footer. Updated disclaimer information to read "Intersil and it's subsidiaries including Zilker Labs, Inc." No changes to application note content.

## Notice

1. Descriptions of circuits, software and other related information in this document are provided only to illustrate the operation of semiconductor products and application examples. You are fully responsible for the incorporation or any other use of the circuits, software, and information in the design of your product or system. Renesas Electronics disclaims any and all liability for any losses and damages incurred by you or third parties arising from the use of these circuits, software, or information.
2. Renesas Electronics hereby expressly disclaims any warranties against liability for infringement or any other claims involving patents, copyrights, or other intellectual property rights of third parties, by or arising from the use of Renesas Electronics products or technical information described in this document, including but not limited to, the product data, drawings, charts, programs, algorithms, and application examples.
3. No license, express, implied or otherwise, is granted hereby under any patents, copyrights or other intellectual property rights of Renesas Electronics or others.
4. You shall not alter, modify, copy, or reverse engineer any Renesas Electronics product, whether in whole or in part. Renesas Electronics disclaims any and all liability for any losses or damages incurred by you or third parties arising from such alteration, modification, copying or reverse engineering.
5. Renesas Electronics products are classified according to the following two quality grades: "Standard" and "High Quality". The intended applications for each Renesas Electronics product depends on the product's quality grade, as indicated below.  
"Standard": Computers; office equipment; communications equipment; test and measurement equipment; audio and visual equipment; home electronic appliances; machine tools; personal electronic equipment; industrial robots; etc.  
"High Quality": Transportation equipment (automobiles, trains, ships, etc.); traffic control (traffic lights); large-scale communication equipment; key financial terminal systems; safety control equipment; etc.  
Unless expressly designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not intended or authorized for use in products or systems that may pose a direct threat to human life or bodily injury (artificial life support devices or systems; surgical implantations; etc.), or may cause serious property damage (space system; undersea repeaters; nuclear power control systems; aircraft control systems; key plant systems; military equipment; etc.). Renesas Electronics disclaims any and all liability for any damages or losses incurred by you or any third parties arising from the use of any Renesas Electronics product that is inconsistent with any Renesas Electronics data sheet, user's manual or other Renesas Electronics document.
6. When using Renesas Electronics products, refer to the latest product information (data sheets, user's manuals, application notes, "General Notes for Handling and Using Semiconductor Devices" in the reliability handbook, etc.), and ensure that usage conditions are within the ranges specified by Renesas Electronics with respect to maximum ratings, operating power supply voltage range, heat dissipation characteristics, installation, etc. Renesas Electronics disclaims any and all liability for any malfunctions, failure or accident arising out of the use of Renesas Electronics products outside of such specified ranges.
7. Although Renesas Electronics endeavors to improve the quality and reliability of Renesas Electronics products, semiconductor products have specific characteristics, such as the occurrence of failure at a certain rate and malfunctions under certain use conditions. Unless designated as a high reliability product or a product for harsh environments in a Renesas Electronics data sheet or other Renesas Electronics document, Renesas Electronics products are not subject to radiation resistance design. You are responsible for implementing safety measures to guard against the possibility of bodily injury, injury or damage caused by fire, and/or danger to the public in the event of a failure or malfunction of Renesas Electronics products, such as safety design for hardware and software, including but not limited to redundancy, fire control and malfunction prevention, appropriate treatment for aging degradation or any other appropriate measures. Because the evaluation of microcomputer software alone is very difficult and impractical, you are responsible for evaluating the safety of the final products or systems manufactured by you.
8. Please contact a Renesas Electronics sales office for details as to environmental matters such as the environmental compatibility of each Renesas Electronics product. You are responsible for carefully and sufficiently investigating applicable laws and regulations that regulate the inclusion or use of controlled substances, including without limitation, the EU RoHS Directive, and using Renesas Electronics products in compliance with all these applicable laws and regulations. Renesas Electronics disclaims any and all liability for damages or losses occurring as a result of your noncompliance with applicable laws and regulations.
9. Renesas Electronics products and technologies shall not be used for or incorporated into any products or systems whose manufacture, use, or sale is prohibited under any applicable domestic or foreign laws or regulations. You shall comply with any applicable export control laws and regulations promulgated and administered by the governments of any countries asserting jurisdiction over the parties or transactions.
10. It is the responsibility of the buyer or distributor of Renesas Electronics products, or any other party who distributes, disposes of, or otherwise sells or transfers the product to a third party, to notify such third party in advance of the contents and conditions set forth in this document.
11. This document shall not be reprinted, reproduced or duplicated in any form, in whole or in part, without prior written consent of Renesas Electronics.
12. Please contact a Renesas Electronics sales office if you have any questions regarding the information contained in this document or Renesas Electronics products.  
(Note 1) "Renesas Electronics" as used in this document means Renesas Electronics Corporation and also includes its directly or indirectly controlled subsidiaries.  
(Note 2) "Renesas Electronics product(s)" means any product developed or manufactured by or for Renesas Electronics.

(Rev.4.0-1 November 2017)



### SALES OFFICES

Renesas Electronics Corporation

<http://www.renesas.com>

Refer to "<http://www.renesas.com/>" for the latest and detailed information.

#### **Renesas Electronics America Inc.**

1001 Murphy Ranch Road, Milpitas, CA 95035, U.S.A.  
Tel: +1-408-432-8888, Fax: +1-408-434-5351

#### **Renesas Electronics Canada Limited**

9251 Yonge Street, Suite 8309 Richmond Hill, Ontario Canada L4C 9T3  
Tel: +1-905-237-2004

#### **Renesas Electronics Europe Limited**

Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, U.K  
Tel: +44-1628-651-700, Fax: +44-1628-651-804

#### **Renesas Electronics Europe GmbH**

Arcadiastrasse 10, 40472 Düsseldorf, Germany  
Tel: +49-211-6503-0, Fax: +49-211-6503-1327

#### **Renesas Electronics (China) Co., Ltd.**

Room 1709 Quantum Plaza, No.27 ZhichunLu, Haidian District, Beijing, 100191 P. R. China  
Tel: +86-10-8235-1155, Fax: +86-10-8235-7679

#### **Renesas Electronics (Shanghai) Co., Ltd.**

Unit 301, Tower A, Central Towers, 555 Langao Road, Putuo District, Shanghai, 200333 P. R. China  
Tel: +86-21-2226-0888, Fax: +86-21-2226-0999

#### **Renesas Electronics Hong Kong Limited**

Unit 1601-1611, 16/F., Tower 2, Grand Century Place, 193 Prince Edward Road West, Mongkok, Kowloon, Hong Kong  
Tel: +852-2265-6688, Fax: +852 2886-9022

#### **Renesas Electronics Taiwan Co., Ltd.**

13F, No. 363, Fu Shing North Road, Taipei 10543, Taiwan  
Tel: +886-2-8175-9600, Fax: +886 2-8175-9670

#### **Renesas Electronics Singapore Pte. Ltd.**

80 Bendemeer Road, Unit #06-02 Hyflux Innovation Centre, Singapore 339949  
Tel: +65-6213-0200, Fax: +65-6213-0300

#### **Renesas Electronics Malaysia Sdn.Bhd.**

Unit 1207, Block B, Menara Amcorp, Amcorp Trade Centre, No. 18, Jln Persiaran Barat, 46050 Petaling Jaya, Selangor Darul Ehsan, Malaysia  
Tel: +60-3-7955-9390, Fax: +60-3-7955-9510

#### **Renesas Electronics India Pvt. Ltd.**

No.777C, 100 Feet Road, HAL 2nd Stage, Indiranagar, Bangalore 560 038, India  
Tel: +91-80-67208700, Fax: +91-80-67208777

#### **Renesas Electronics Korea Co., Ltd.**

17F, KAMCO Yangjae Tower, 262, Gangnam-daero, Gangnam-gu, Seoul, 06265 Korea  
Tel: +82-2-558-3737, Fax: +82-2-558-5338