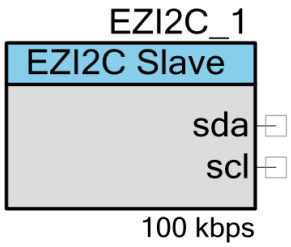
EZI2C Slave
1.90



Features

- Industry standard NXP® I²C bus interface
- Emulates common I²C EEPROM interface
- Only two pins (SDA and SCL) required to interface to I²C bus
- Standard data rates of 50/100/400/1000 kbps
- High level APIs require minimal user programming
- Supports one or two address decoding with independent memory buffers
- Memory buffers provide configurable Read/Write and Read Only regions

General Description

The EZI2C Slave component implements an I²C register-based slave device. It is compatible [1] with I²C Standard-mode, Fast-mode, and Fast-mode Plus devices as defined in the NXP I2C-bus specification. The master initiates all communication on the I²C bus and supplies the clock for all slave devices. The EZI2C Slave supports standard data rates up to 1000 kbps and is compatible with multiple devices on the same bus.

The EZI2C Slave is a unique implementation of an I²C slave in that all communication between the master and slave is handled in the ISR (Interrupt Service Routine) and requires no interaction with the main program flow. The interface appears as shared memory between the master and slave. Once the EZI2C_Start() function is executed, there is little need to interact with the API.

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1 The I²C peripheral is non-compliant with the NXP I²C specification in the following areas: analog glitch filter, I/O V_{OL}/I_{OL}, I/O hysteresis. The I²C Block has a digital glitch filter (not available in sleep mode). The Fast-mode minimum fall-time specification can be met by setting the I/Os to slow speed mode. See the I/O Electrical Specifications in "Inputs and Outputs" section of device datasheet for details.

When to Use an EZI2C Slave

Use this component when you want a shared memory model between the I²C Slave and I²C Master. You may define the EZI2C Slave buffers as any variable, array, or structure in your code without worrying about the I²C protocol. The I²C master may view any of the variables in this buffer and modify the variables defined by the EZI2C_SetBuffer1() or EZI2C_SetBuffer2() functions.

Input/Output Connections

This section describes the various input and output connections for EZI2C Slave.

sda – In/Out

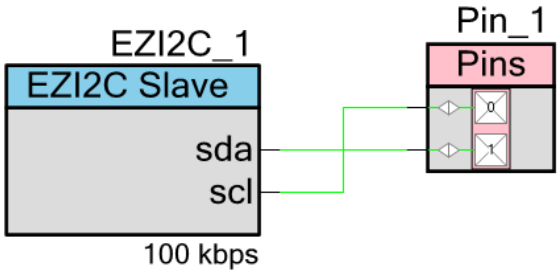
Serial data (SDA) is the I²C data signal. It is a bidirectional data signal used to transmit or receive all bus data.

scl – In/Out

Serial clock (SCL) is the master generated I²C clock. Although the slave never generates the clock signal, it may hold it low stalling the bus until it is ready to send data or NAK/ACK the latest data or address.

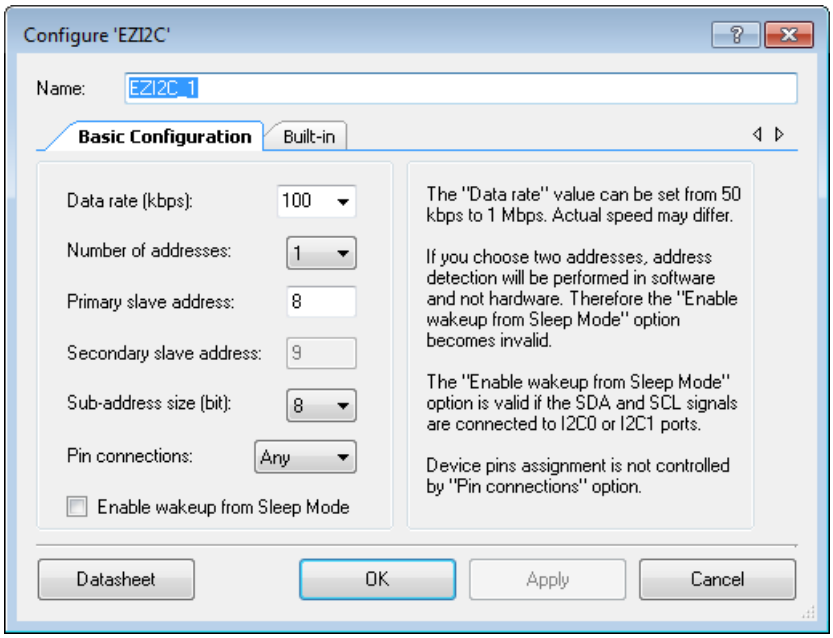
Schematic Macro Information

The default EZI2C Slave in the Component Catalog is a schematic macro using an EZI2C Slave component with default settings. The EZI2C Slave component is connected to a Pins component, which is configured as an SIO pair.



Component Parameters

Drag an EZI2C component onto your design and double-click it to open the **Configure** dialog.



The EZI2C component provides the following parameters.

Data rate

This parameter is used to set the I²C data rate value up to 1000 kbps; the actual rate may differ, based on available clock speed and divider range. The standard data rates are 50, 100 (default), 400, and 1000 kbps.

Number of addresses

This option determines whether **1** (default) or **2** independent I²C slave addresses are recognized. If two addresses are recognized, address detection will be performed in software, not hardware; therefore, the **Enable wakeup from Sleep Mode** option is not available.

Primary slave address

This is the primary I²C slave address (default is **8**). This value can be entered in decimal or hexadecimal format. For hexadecimal, type ‘0x’ before the number. This address is the 7-bit right-justified slave address and does not include the R/W bit.

Secondary slave address

This is the secondary I²C slave address (default is **9**). This value can be entered in decimal and hexadecimal format. For hexadecimal, type ‘0x’ before the number. This second address is only valid when the **Number of addresses** parameter is set to **2**. The primary and secondary slave

addresses must be different. This address is the 7-bit right-justified slave address and does not include the R/W bit.

Sub-address Size

This option determines what range of data can be accessed. You can select a sub-address of **8** bits (default) or **16** bits. If you use an address size of 8 bits, the master can only access data offsets between 0 and 255. You may also select a sub-address size of 16 bits. That will allow the I^2C master to access data arrays of up to 65,536 bytes at each slave address.

Pin connections

This parameter determines which type of pin to use for SDA and SCL signal connections. This option is supplemental for the **Enable wakeup from Sleep Mode** option and is available only if single I^2C address is selected in the **Number of addresses** option. There are three possible values: **Any**, **I2C0**, and **I2C1**. The default is **Any**.

Any means general-purpose I/O (GPIO).

- If **Enable wakeup from Sleep Mode** is not required, **Any** should be used for SDA and SCL.
- If you need **Enable wakeup from Sleep Mode**, you must use the pairs of pins I2C0 (P12[4], P12[5]) or I2C1 (P12[0], P12[1]), which allows you to configure the device for wakeup on I^2C address match.

Enable wakeup from Sleep Mode

This parameter allows the device to be awakened from sleep mode on slave address match. This option is disabled by default. The wake up on address match option is valid if a single I^2C address is selected and the SDA, and SCL signals are connected to SIO ports (pin pairs I2C0 or I2C1). **Enable wakeup from Sleep Mode** will be supported in PSoC 3 and PSoC 5LP.

Application Programming Interface

Application Programming Interface (API) routines allow you to configure the component using software. The following table lists and describes the interface to each function. The subsequent sections cover each function in more detail.

By default, PSoC Creator assigns the instance name “EZI2C_1” to the first instance of a component in a given design. You can rename it to any unique value that follows the syntactic rules for identifiers. The instance name becomes the prefix of every global function name, variable, and constant symbol. For readability, the instance name used in the following table is “EZI2C.”

Basic Functions

Function	Description
EZI2C_Start()	Starts responding to I²C traffic. Enables interrupt.
EZI2C_Stop()	Stops responding to I²C traffic. Disables interrupt.
EZI2C_EnableInt()	Enables interrupt, which is required for most I²C operations.
EZI2C_DisableInt()	Disables interrupt. The EZI2C_Stop() API does this automatically.
EZI2C_SetAddress1()	Sets the primary I²C address.
EZI2C_GetAddress1()	Returns the primary I²C address.
EZI2C_SetBuffer1()	Sets the buffer pointer for the primary I²C.
EZI2C_GetActivity()	Checks component activity status.
EZI2C_Sleep()	Stops I²C operation and saves I²C configuration. Disables interrupt.
EZI2C_Wakeup()	Restores I²C configuration and starts I²C operation. Enables interrupt.
EZI2C_Init()	Initializes I²C registers with initial values provided from customizer.
EZI2C_Enable()	Activates the hardware and begins component operation.
EZI2C_SaveConfig()	Saves the current user configuration of the EZI2C component.
EZI2C_RestoreConfig()	Restores nonretention I²C registers.

void EZI2C_Start(void)

Description: This is the preferred method to begin component operation. EZI2C_Start() sets the initVar variable, calls the EZI2C_Init() function, and then calls the EZI2C_Enable() function. It must be executed before I²C bus operation.

After EZI2C_Start() calls EZI2C_Enable(), EZI2C_Enable() calls the EZI2C_EnableInt(), which enables the I²C interrupt.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_Stop(void)

Description: Disables I²C hardware and disables I²C interrupt. Disables Active mode power template bits or clock gating as appropriate.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_EnableInt(void)

Description: Enables I²C interrupt. Interrupts are required for most operations. Called when calling the EZI2C_Start() API.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_DisableInt(void)

Description: Disables I²C interrupts. This function is not normally required because the Stop function disables the interrupt.

Parameters: None

Return Value: None

Side Effects: If the I²C interrupt is disabled while the I²C is still running, the I²C bus may lock up.

void EZI2C_SetAddress1(uint8 address)

Description: This function sets the I²C address for the primary memory buffer. This value can be any value between 0 and 127.

Parameters: address: The 7-bit slave address between 0 and 127. The address is right justified and does not include the R/W bit.

Return Value: None

Side Effects: None

uint8 EZI2C_GetAddress1(void)

Description: Returns the I²C slave address for the primary memory buffer.

Parameters: None

Return Value: The same I²C slave address set by SetAddress1 or the default I²C address.

Side Effects: None

void EZI2C_SetBuffer1(uint16 bufSize, uint16 rwBoundry, volatile uint8 * dataPtr)

Description: This function sets the buffer pointer, size, and read/write area for the slave data. This is the data that is exposed to the I²C Master.

Parameters: bufSize: Size of the buffer in bytes.

rwBoundry: Sets how many bytes are writable in the beginning of the buffer. This value must be less than or equal to the buffer size. Data located at offset rwBoundry and greater are read only.

dataPtr: Pointer to the data buffer.

Return Value: None

Side Effects: The EZI2C_Start() must be called before this function.

uint8 EZI2C_GetActivity(void)

Description: This function returns a nonzero value if an I²C read or write cycle has occurred since the last time this function was called. The activity flag resets to zero at the end of this function call.

The Read and Write busy flags are cleared when read, but the “BUSY” flag is only cleared by an I²C Stop.

Parameters: A nonzero value is returned if activity is detected.

Return Value: Status of I²C activity.

Constant	Description
EZI2C_STATUS_READ1	Set if Read sequence is detected for first address. Cleared when status is read.
EZI2C_STATUS_WRITE1	Set if Write sequence is detected for first address. Cleared when status is read.
EZI2C_STATUS_READ2	Set if Read sequence is detected for second address (if enabled). Cleared when status is read.
EZI2C_STATUS_WRITE2	Set if Write sequence is detected for second address (if enabled). Cleared when status is read.
EZI2C_STATUS_BUSY	Set if Start is detected. Cleared when stop is detected.
EZI2C_STATUS_ERR	Set when I²C hardware error is detected. Cleared when status is read.

Side Effects: None

void EZI2C_Sleep(void)

Description: This is the preferred API to prepare the component for sleep if **Enable wakeup from Sleep Mode** is not selected. The EZI2C_Sleep() API saves the current component state. Then it calls the EZI2C_Stop() function and calls EZI2C_SaveConfig() to save the hardware configuration.

Call the EZI2C_Sleep() function before calling the CyPmSleep() or the CyPmHibernate() function. Refer to the PSoC Creator *System Reference Guide* for more information about power-management functions.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_Wakeup(void)

Description: This is the preferred API to restore the component to the state when EZI2C_Sleep() was called. The EZI2C_Wakeup() function calls the EZI2C_RestoreConfig() function to restore the hardware configuration. If the component was enabled before the EZI2C_Sleep() function was called, the EZI2C_Wakeup() function will also re-enable the component.

Parameters: None

Return Value: None

Side Effects: Calling this function before EZI2C_SaveConfig() or EZI2C_Sleep() may produce unexpected behavior.

void EZI2C_Init(void)

Description: Initializes or restores the component according to the Configure dialog settings. It is not necessary to call EZI2C_Init() because the EZI2C_Start() API calls this function, which is the preferred method to begin component operation.

Parameters: None

Return Value: None

Side Effects: All registers will be set to values according to the Configure dialog

void EZI2C_Enable(void)

Description: Activates the hardware and begins component operation. It is not necessary to call EZI2C_Enable() because the EZI2C_Start() API calls this function, which is the preferred method to begin component operation. Calls EZI2C_EnableInt() to enable the I^2C interrupt.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_SaveConfig(void)

Description: This function saves the component configuration and nonretention registers. It also saves the current component parameter values, as defined in the Configure dialog or as modified by appropriate APIs. This function is called by the EZI2C_Sleep() function.

Parameters: None

Return Value: None

Side Effects: None

void EZI2C_RestoreConfig(void)

Description: This function restores the component configuration and nonretention registers. It also restores the component parameter values to what they were prior to calling the EZI2C_Sleep() function.

Parameters: None

Return Value: None

Side Effects: Calling this function before EZI2C_Sleep() or EZI2C_SaveConfig() may produce unexpected behavior.

Optional Second Address APIs

These commands are present only if two I²C addresses are enabled.

Function	Description
EZI2C_SetAddress2()	Sets the secondary I²C address.
EZI2C_GetAddress2()	Returns the secondary I²C address.
EZI2C_SetBuffer2()	Sets the buffer pointer for the secondary I²C.

void EZI2C_SetAddress2(uint8 address)

Description: Sets the I²C slave address for the secondary memory buffer. This value may be any value between 0 and 127. This function is only provided if two I²C addresses have been selected in the user parameters.

Parameters: address: The 7-bit slave address between 0 and 127. The address is right justified and does not include the R/W bit.

Return Value: None

Side Effects: None

uint8 EZI2C_GetAddress2(void)

Description: Returns the I²C slave address for the secondary memory buffer. This function is only provided if two I²C addresses have been selected in the user parameters.

Parameters: None

Return Value: The same I²C slave address set by SetAddress2 or the default I²C address.

Side Effects: None

void EZI2C_SetBuffer2(uint16 bufSize, uint16 rwBoundry, volatile uint8 * dataPtr)

Description: This function sets the buffer pointer, size, and read/write area for the second slave data. This is the data that is exposed to the I²C Master for the second I²C address. This function is only provided if two I²C addresses have been selected in the user parameters.

Parameters: bufSize: Size of the buffer exposed to the I²C master.

rwBoundry: Sets how many bytes are readable and writable by the I²C master. This value must be less than or equal to the buffer size. Data located at offset rwBoundry and greater are read only.

dataPtr: This is a pointer to the data array or structure that is used for the I²C data buffer.

Return Value: None

Side Effects: The EZI2C_Start() must be called before this function.

Global Variables

Knowledge of these variables is not required for normal operations.

Function	Description
EZI2C_initVar	Indicates whether the EZI2C has been initialized. The variable is initialized to 0 and set to 1 the first time EZI2C_Start() is called. This allows the component to restart without reinitialization after the first call to the EZI2C_Start() routine. If reinitialization of the component is required the variable should be set to 0 before the EZI2C_Start() routine is called. Alternatively, the EZI2C can be reinitialized by calling the EZI2C_Init() and EZI2C_Enable() functions.
EZI2C_dataPtrS1	Stores pointer to the data exposed to an I²C master for the first slave address.
EZI2C_rwOffsetS1	Stores offset for read and write operations. It is set at each write sequence of the first slave address.
EZI2C_rwIndexS1	Stores pointer to the next value to be read or written for the first slave address.
EZI2C_wrProtectS1	Stores offset where data is read only for the first slave address.
EZI2C_bufSizeS1	Stores size of data array exposed to an I²C master for the first slave address.
EZI2C_dataPtrS2	Stores pointer to the data exposed to an I²C master for the second slave address.
EZI2C_rwOffsetS2	Stores offset for read and write operations, is set at each write sequence of the second slave device.
EZI2C_rwIndexS2	Stores pointer to the next value to be read or written for the second slave address.
EZI2C_wrProtectS2	Stores offset where data is read only for the second slave address.
EZI2C_bufSizeS2	Stores size of data array exposed to an I²C master for the second slave address.
EZI2C_curState	Stores current state of an I²C state machine.
EZI2C_curStatus	Stores current status of the component.

Sample Firmware Source Code

PSoC Creator provides numerous example projects that include schematics and example code in the Find Example Project dialog. For component-specific examples, open the dialog from the Component Catalog or an instance of the component in a schematic. For general examples, open the dialog from the Start Page or **File** menu. As needed, use the **Filter Options** in the dialog to narrow the list of projects available to select.

Refer to the “Find Example Project” topic in the PSoC Creator Help for more information.

MISRA Compliance

This section describes the MISRA-C:2004 compliance and deviations for the component. There are two types of deviations defined:

- project deviations – deviations that are applicable for all PSoC Creator components
- specific deviations – deviations that are applicable only for this component

This section provides information on component-specific deviations. Project deviations are described in the MISRA Compliance section of the *System Reference Guide* along with information on the MISRA compliance verification environment.

The EZI2C component has the following specific deviations:

Rule	Class [2]	Rule Description	Description of Deviation(s)
17.4	R	Array indexing shall be the only allowed form of pointer arithmetic.	Component uses array indexing operation to access buffers. The buffer size is checked before access. It is safe operation unless user provides incorrect buffer size.
19.7	A	A function should be used in preference to a function-like macro.	Deviated since function-like macros are used to allow more efficient code.

This component has the following embedded component: Interrupt. Refer to the corresponding component datasheet for information on their MISRA compliance and specific deviations.

API Memory Usage

The component memory usage varies significantly, depending on the compiler, device, number of APIs used and component configuration. The following table provides the memory usage for all APIs available in the given component configuration.

[2] Required / Advisory

The measurements have been done with associated compiler configured in Release mode with optimization set for Size. For a specific design the map file generated by the compiler can be analyzed to determine the memory usage.

Configuration	PSoC 3 (Keil_PK51)		PSoC 5LP (GCC)	
	Flash Bytes	SRAM Bytes	Flash Bytes	SRAM Bytes
One address	1265	21	1412	25
Two addresses	1751	37	1644	43

Functional Description

This component supports an I²C slave device with one or two I²C addresses. Either address may access a memory buffer defined in RAM, EEPROM, or flash data space. EEPROM and flash memory buffers are read only, while RAM buffers may be read/write. The addresses are right justified.

When using this component, you must enable global interrupts because the I²C hardware is interrupt driven. Even though this component requires interrupts, you do not need to add any code to the ISR (Interrupt Service Routine). The module services all interrupts (data transfers) independent of your code. The memory buffers allocated for this interface look like simple dual-port memory between your application and the I²C Master.

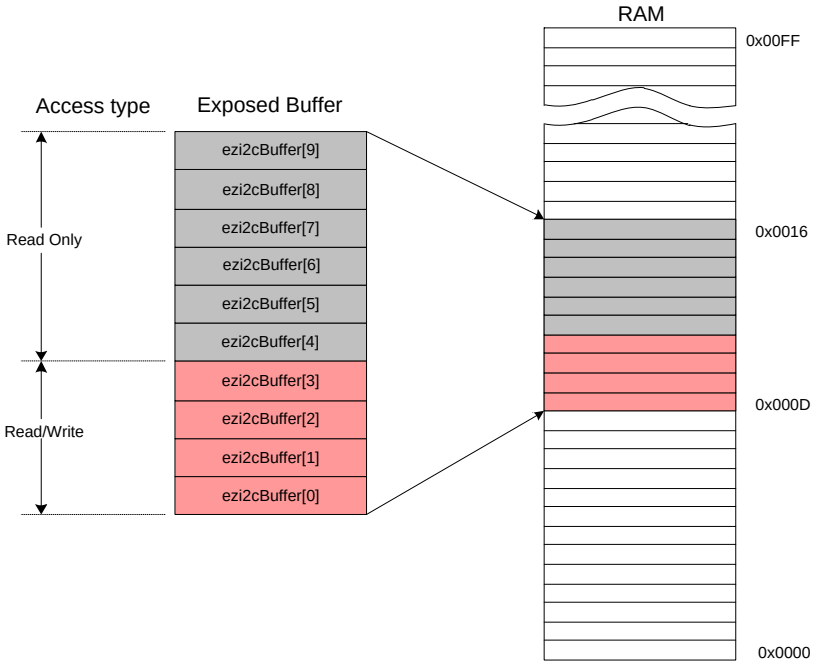
If required, you can create a higher-level interface between a master and slave by defining semaphores and command locations in the data structure.

Memory Interface

To an I²C master, the interface looks very similar to a common I²C EEPROM. The EZI2C interface can be configured as simple variables, arrays, or structures but the safer method is using arrays. In a sense it acts as one or two shared memory interfaces between your program and an I²C master through the I²C bus. The component only allows the I²C master to access the specified area of memory and prevents any reads or writes outside that area. For example, if the buffer for the primary slave address is configured as shown in the following code example, the buffer representation in memory could be represented as shown in Figure 1.

```
#define BUFFER_SIZE             (0x0Au)
#define BUFFER_RW_AREA_SIZE     (0x04u)

uint8 ezi2cBuffer[BUFFER_SIZE];


EZI2C_SetBuffer1(BUFFER_SIZE, BUFFER_RW_AREA_SIZE, ezi2cBuffer);
```

Figure 1. Memory Representation of the EZI2C Buffer Exposed to an I²C Master



To make whole buffer with read and write access the buffer size and read/write boundary need to be the same size. For example:

```
EZI2C_SetBuffer1(BUFFER_SIZE, BUFFER_SIZE, ezi2cBuffer);
```

Handle structures

The EZI2C buffer can be set up as structure. The interface (I²C Master) only sees the structure as an array of bytes, and cannot access any memory outside the defined area.

The compiler lays out structures in the memory and may add extra bytes. This is called byte padding. The compiler will add these bytes to align the fields of the structure to match the requirements of the Cortex-M3. When using a structure, the application must take this alignment into account. To avoid padding bytes the attribute “packed” should be used:

```
struct
{
    uint8 status;
    uint8 data0;
    uint32 data1;
} __attribute__ ((packed)) ezi2cBuffer;

SCB_EzI2CSetBuffer1(sizeof(ezi2cBuffer), sizeof(ezi2cBuffer),(uint8 *)
&ezi2cBuffer);
```

Handling endianess

The data is transmitted in different endianess for different architectures. Therefore, extra code must be put to send in a specific endianess. For example, the CY_GET_REGXX()/ CY_SET_REGXX() macros (XX stands for 16/24/32) can be used to match little-endian ordering regardless of device architecture. For more information about endianess, see the Register Access section of the *System Reference Guide*.

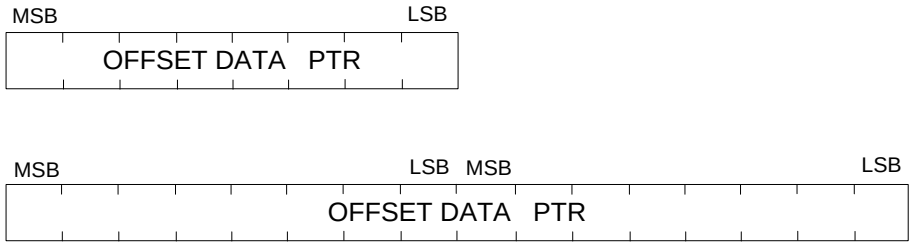
The following simple example shows only a single integer (two bytes) is exposed. Both bytes are readable and writable by the I²C master.

```
uint16 ezi2cVariable1;
CY_SET_REG16(&ezi2cVariable1, 0xABCD);
EZI2C_SetBuffer1(2u, 2u, (uint8 *) (&ezi2cVariable1));
```

Interface as Seen by External Master

The EZI2C Slave component supports basic read and write operations for the read/write area and read-only operations for the read-only area. The two I²C address interfaces contain separate data buffers that are addressed with separate offset data pointers. The offset data pointers are written by the master as the first one or two data bytes of a write operation, depending on the **Sub-address size** parameter. The sub-address size of 8-bits is used to access buffers up to 256 bytes and sub-address size of 16-bits is used for buffers up to 65536 bytes. For the rest of this discussion, we will concentrate on an 8-bit sub-address size.

Figure 2. The 8-bit and 16-bit Sub-Address Size (from top to bottom)

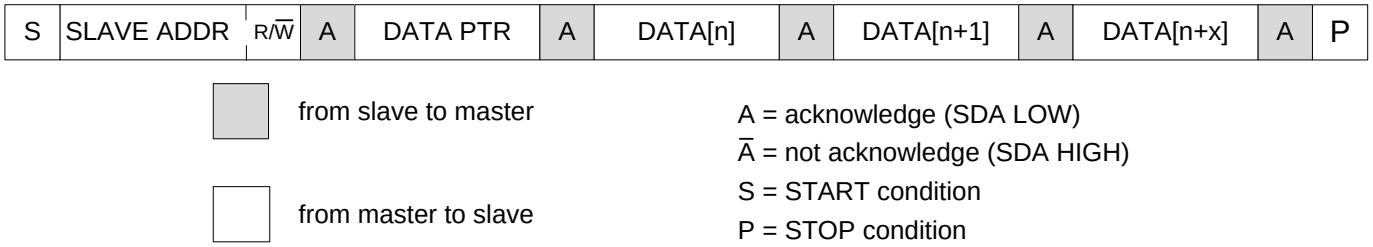


For write operations, the first data byte is always the offset data pointer (two bytes for sub-address size = 16). The byte after the offset data pointer is written into the location pointed to by the offset data pointer. The second data byte is written to the offset data pointer plus one, and so on, until the write is complete. The length of a write operation is only limited by the maximum buffer read/write region size. For write operations, the offset data pointer must always be provided.

Read operations always begin at the offset data pointer provided by the most recent write operation. The offset data pointer increments for each byte read, the same way as a write operation. A new read operation will not continue from where the last read operation stopped. A new read operation always begins to read data at the location pointed to by the last write operation offset data pointer. The length of a read operation is only limited by the maximum size of the data buffer.

Typically, a read will contain a write operation of only the offset data pointer followed by a restart (or stop/start) and then the read operation. If the offset data pointer does not require update, as in the case of repeatedly reading the same data, no additional write operations are required after the first. This greatly speeds read operations by allowing them to directly follow each other.

Figure 3. Write x Bytes to I²C Slave



For example, if the offset data pointer is set to four, a read operation begins to read data at location four and continues sequentially until the data ends or the host completes the read operation. This is true whether single or multiple read operations are performed. The offset data pointer is not changed until a new write operation is initiated.

If the I²C master tries to write data past the area specified by the EZI2C_SetBuffer1() or EZI2C_SetBuffer2() functions, the data is discarded and does not affect any RAM inside or outside the designated RAM area. Data cannot be read outside the allowed range. Any read requests by the master outside the allowed range results in the return of invalid data.

Figure 4 illustrates the data pointer write for an 8-bit offset data pointer.

Figure 4. Set Slave Data Pointer

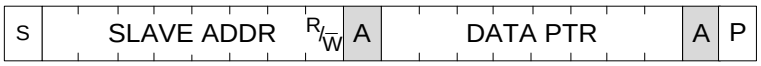
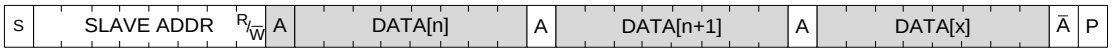


Figure 5 illustrates the read operation for an 8-bit offset data pointer. Remember that a data write operation always rewrites the offset data pointer.

Figure 5. Read x Bytes from I²C Slave



At reset, or power on, the EZI2C Slave component is configured and APIs are supplied, but the resource must be explicitly turned on using the EZI2C_Start() function.

Detailed descriptions of the I²C bus and the implementation are available in the complete I²C specification available on the Philips website, and by referring to the device datasheet.

Data Coherency

Although a data buffer may include a data structure larger than a single byte, a Master read or write operation consists of multiple single-byte operations. This can cause a data coherency problem, because there is no mechanism to guarantee that a multi-byte read or write will be synchronized on both sides of the interface (Master and Slave). For example, consider a buffer that contains a single two-byte integer. While the master is reading the two-byte integer one byte at a time, the slave may have updated the entire integer between the time the master read the first byte of the integer (LSB) and was about to read the second byte (MSB). The data read by the master may be invalid, since the LSB was read from the original data and the MSB was read from the updated value.

You must provide a mechanism on the master, slave, or both that guarantees that updates from the master or slave do not occur while the other side is reading or writing the data. The EZI2C_GetActivity() function can be used to develop an application-specific mechanism.

Wakeup from Sleep Mode

If you want to use the **Enable wake up from Sleep Mode**feature, you may need to design the I^2C Master to handle clock stretching procedure (hold SCL low).

The device clock's configuration (bus clock frequency) can be modified (by the CyPmSaveClocks() function) as part of the Sleep mode entry procedure. It must be restored (by the CyPmRestoreClocks() function) before the I^2C transaction can continue in Active mode.

To meet these requirements, the EZI2C interrupt remains enabled but interrupt handler is changed before going to sleep in EZI2C_Sleep(). Wakeup on address match triggers EZI2C interrupt and EZI2C wakeup flag is set to notify that. Call EZI2C_Wakeup() function changes interrupt handler to regular EZI2C and generates interrupt based on EZI2C wakeup flag to process in-coming transaction. The SCL line remains low after wakeup until EZI2C_Wakeup() is called.

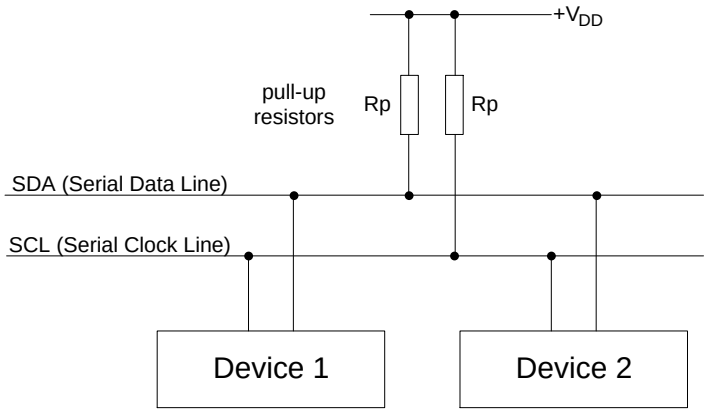
The following is the correct Sleep mode entry procedure if **Enable wake up from Sleep Mode** is enabled:

```
/* Prepares EZI2C to wake up from Sleep mode */
EZI2C_Sleep();

/* Switches to the Sleep mode */
CyPmSaveClocks();
CyPmSleep(PM_SLEEP_TIME_NONE, PM_SLEEP_SRC_I2C);
CyPmRestoreClocks();

/* Prepares EZI2C to work in Active mode */
EZI2C_Wakeup();
```

External Electrical Connections

As Figure 6 illustrates, the I²C bus requires external pull-up resistors. The pull-up resistors (R_P) are determined by the supply voltage, clock speed, and bus capacitance. Make the minimum sink current for any device (master or slave) no less than 3 mA at V_{OLmax} = 0.4 V for the output stage. This limits the minimum pull-up resistor value for a 5-V system to about 1.5 kΩ. The maximum value for RP depends upon the bus capacitance and clock speed. For a 5-V system with a bus capacitance of 150 pF, the pull-up resistors should be no larger than 6 kΩ. For more information see *The I²C-Bus Specification* on the Philips web site at www.philips.com.

Figure 6. Connection of Devices to the I²C-Bus



Note Purchase of I²C components from Cypress or one of its sublicensed Associated Companies, conveys a license under the Philips I²C Patent Rights to use these components in an I²C system, provided that the system conforms to the I²C Standard Specification as defined by Philips.

Clock Selection

The clock is tied to the system bus clock and cannot be changed by the user.

Interrupt Service Routine

The interrupt service routine is used by the component code. Do not change it.

Resources

The fixed-function I²C block and one interrupt are used for this component.

DC and AC Electrical Characteristics

Specifications are valid for –40 °C ≤ T_A ≤ 85 °C and T_J ≤ 100 °C, except where noted.
Specifications are valid for 1.71 V to 5.5 V, except where noted.

DC Specifications

Parameter	Description	Conditions	Min	Typ	Max	Units
I_{DD}	Block current consumption	Enabled, configured for 100 kbps	–	–	250	µA
		Enabled, configured for 400 kbps	–	–	260	µA
		Wake from sleep mode	–	–	30	µA

AC Specifications

Parameter	Description	Conditions	Min	Typ	Max	Units
	Bit rate		–	–	1	Mbps

Component Errata

This section lists known problems with the component.

Cypress ID	Component Version	Problem	Workaround
197653	v1.90	Within the Stop() API, the I2C fixed-function block is reset. This action requires reloading the address register value. For reliable operation of the address loading, the Stop() API needs check that the I2C fixed function block accepts the address value.	Add a routine to confirm that the proper address register value is restored. This guarantees the component to work with any Bus Clock frequency in the design. Refer to the recommendation below.

Find the Stop() function in the *EZI2C.c* file located at:

- for 64-bit operating system – c:\Program Files (x86)\Cypress\PSoC Creator\3.1\PSoC Creator\psoc\content\CyComponentLibrary\CyComponentLibrary.cylib\EZI2C_v1_90\API\
- for 32-bit operating system – c:\Program Files\Cypress\PSoC Creator\3.1\PSoC Creator\psoc\content\CyComponentLibrary\CyComponentLibrary.cylib\EZI2C_v1_90\API\

Modify the Stop() function as follows:

1. Declare variable i

```
uint8 i;
```

2. Add a routine to write and check the address register, until the value read back equals the value written to.

```
/* Reset fixed-function block */
`$INSTANCE_NAME`_CFG_REG &= ((uint8) ~`$INSTANCE_NAME`_CFG_EN_SLAVE);
`$INSTANCE_NAME`_CFG_REG |= `$INSTANCE_NAME`_CFG_EN_SLAVE;

i = 255u;
do
{
    `$INSTANCE_NAME`_ADDR_REG = `$INSTANCE_NAME`_backup.adr;
     i--;
}
while ((`$INSTANCE_NAME`_ADDR_REG != `$INSTANCE_NAME`_backup.adr) &&
  (i != 0u));
```

Component Changes

This section lists the major changes in the component from the previous version.

Version	Description of Changes	Reason for Changes / Impact
1.90.c	Minor datasheet edits.	
1.90.b	Datasheet updated to add Component Errata section.	Refer to Cypress ID 197653.
1.90.a	Updated the datasheet only.	API sections were out of order. Also updated to comply with latest template.
1.90	Updated MISRA Compliance section.	The component has specific deviations described.
	The type of global variables EZI2C_bufSizeS1, EZI2C_wrProtectS1, EZI2C_bufSizeS2 and EZI2C_wrProtectS2 were changed from uint8 to uint16.	The buffer length equal 256 bytes is supported if the Sub-Address Size is 8 bits.
	Removed mention about EZI2C_SlaveSetSleepMode() and EZI2C_SlaveSetWakeMode().	These are obsolete functions. EZI2C_Sleep() and EZI2C_Wakeup() have to be used instead of it.
	Added Handle structures section	Documentation enhancement
1.80	Added MISRA Compliance section.	The component was not verified for MISRA compliance.
	Added footnote about non-compliant with the NXP I²C specification in the some areas.	Documentation enhancement.
	Changed the control flow of the wake up sequence to avoid disabling the I²C interrupt.	PSoC 5 LP requires an I²C interrupt to be enabled in order to wake up the device at the event of an address match.
	Fixed control flow behavior when master completes reading beyond the buffer size.	The slave doesn't complete transaction correctly because NAK from master was not checked.

Version	Description of Changes	Reason for Changes / Impact
1.70.a	Corrected figure 5.	
1.70	Added PSoC 5LP support.	
1.61	Enhanced verification of the options configured within the customizer and related to the **Enable wakeup from Sleep Mode** option.	Prevents components from being configured with an unsupported mode.
	Updated EZI2C_Stop() implementation for PSoC 3 devices.	Makes EZI2C_Stop() release the bus if it was locked.
	Updated the default I^2C addresses to 8 and 9 to comply with I^2C bus specification requirements.	Previously used addresses are reserved according to the I^2C bus specification.
	Updated the component debugger tool window support.	Enhanced debug window support.
	Added the possibility to declare every function as reentrant for PSoC 3 by adding the function name to the .cyre file.	Not all APIs are truly reentrant. Comments in the component API source files indicate which functions cannot be truly reentrant. This change is required to eliminate compiler warnings for functions that are used in a safe way (protected from concurrent calls by flags or Critical Sections) and are not reentrant.
1.60.b	Datasheet corrections	
1.60.a	Updated the Pin Connections section with information about dependencies between the Enable wakeup from Sleep mode and Number of addresses options.	Explained that option is supplemental for the Enable wakeup from Sleep mode option and is also available only if a single I^2C address is selected in Number of addresses option.
	Figures 2, 3, and 5 were updated to show bit fields.	Visibility enhancement,
	Clarified the method of writing portable code regardless of the PSoC device architecture.	Documentation enhancement.
1.60	The method of working with the slave enable bit was changed: EZI2C_Stop() does not clear this bit now and setting this bit was moved from EZI2C_Enable() to EZI2C_Init(). The I^2C configuration register is now restored in EZI2C_RestoreConfig() function.	To achieve correct result of EZI2C_Start() - EZI2C_Stop() - EZI2C_Start() and EZI2C_Sleep() - EZI2C_Wakeup() sequences. No functional impact is expected.
	The label I2C Bus Speed: in the customizer was replaced with Data Rate. The Wakeup from Sleep Mode section was added to the Functional Description.	Consistency between I^2C-Bus Specification naming and I^2C/EZI2C components.
	The label "I2C pins connected to" in customizer was replaced with "Pin Connections"	The text was fixed for consistency with requirements.
	The label "Enable wakeup from the Sleep mode" in customizer was replaced with "Enable wakeup from Sleep mode"	The text was fixed for consistency with requirements.

Version	Description of Changes	Reason for Changes / Impact
	The component symbol and catalog placement name was updated: the “EZ I2C” was renamed to “EZI2C”.	The text was fixed for consistency with requirements.
	Fixed issues when global variables used in both code and ISR could potentially be optimized out by compiler.	Prevents optimization issues that could lead to unexpected result.
	Added characterization data to datasheet	
	Minor datasheet edits and updates	
1.50.a	Moved component into subfolders of the component catalog	
1.50	Standard data rate has been updated to support up to 1 Mbps.	Allows setting up I^2C bus speed up to 1 Mbps.
	Keil reentrancy support was added.	Support for PSoC 3 with the Keil compiler the capability for functions to be called from multiple flows of control.
	Added Sleep/Wakeup and Init/Enable APIs.	To support low-power modes and to provide common interfaces to separate control of initialization and enabling of most components.
	The XML description of the component has been added.	This allows PSoC Creator to provide a mechanism for creating new debugger tool windows for this component.
	Added support for the PSoC 3 Production devices.	The required changes have been applied to support hardware changes between PSoC 3 ES2 and Production devices.
	The default schematic template has been added to the component catalog.	Every component should have a schematic template.
	The EZI2C's bus speed generation was fixed. Previously it was x4 greater than should be. Added more comments in the source code to describe bus speed calculation.	The proper I^2C bus speed calculation and generation.
	Optimized form height for Microsoft Windows 7.	In Windows 7 scrollbar appeared just after customizer start.
	Added tooltips for address input boxes with 'Use 0x prefix for hexadecimals' text.	To inform user about possibility of hexadecimal input.
1.20.a	Moved component into subfolders of the component catalog.	
	Added information to the component that advertizes its compatibility with silicon revisions.	The tool reports an error/warning if the component is used on incompatible silicon. If this happens, update to a revision that supports your target device.
1.20	Updated the Configure dialog.	

Version	Description of Changes	Reason for Changes / Impact
	Changed Digital Port to Pins component in the schematic	