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## DOCUMENT REVISION HISTORY

Version	Date	Author	Description
1.0	09-Nov-21	David Gray, Bill Mensch	Initial Document Entry



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## 1. Introduction and Features

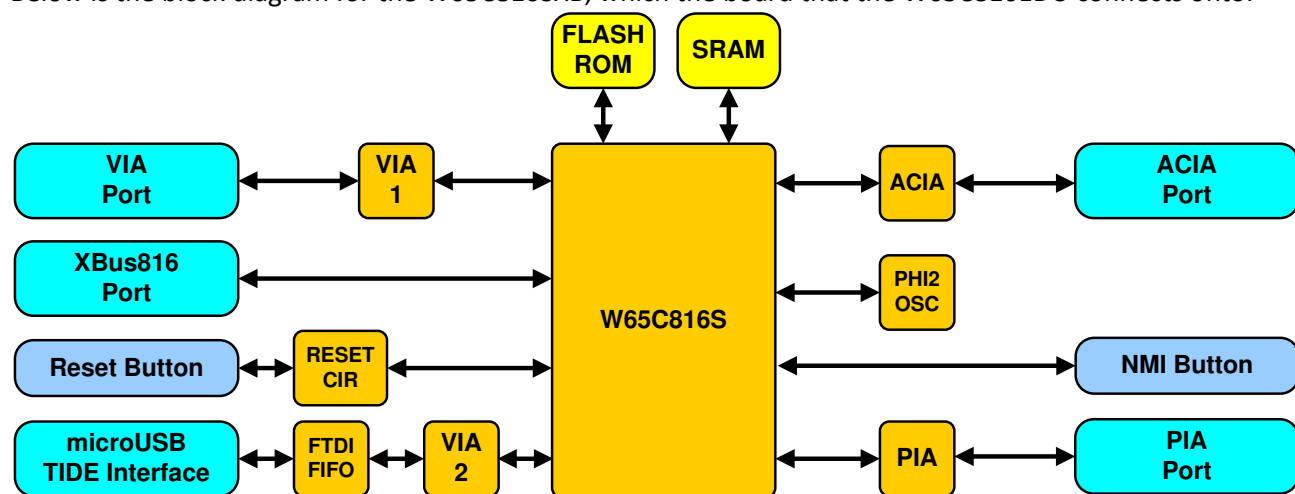
The W65C816EDU is a plugin expansion board for the W65C816SXB. The board is meant to expand functionality of WDC's chip products by through industry standard connectors and communication protocols. The W65C22 VIA is being used for I2C and SPI functionality while the W65C51N drives the UART connector. The W65C21 PIA is used to drive 8 LEDs, an active passive buzzer, and provide IO expansion. SparkFun QWIIC® (I2C), Seeed Studio Grove (I2C, UART, ADC, IO), and mikroBUS Click connectors enable access to thousands of modules for your development. On board RTC, SPI SRAM, ADC, Temperature sensor and CryptoAuthentication™ devices provide desirable features without additional expansion.

### 1.1 Feature List

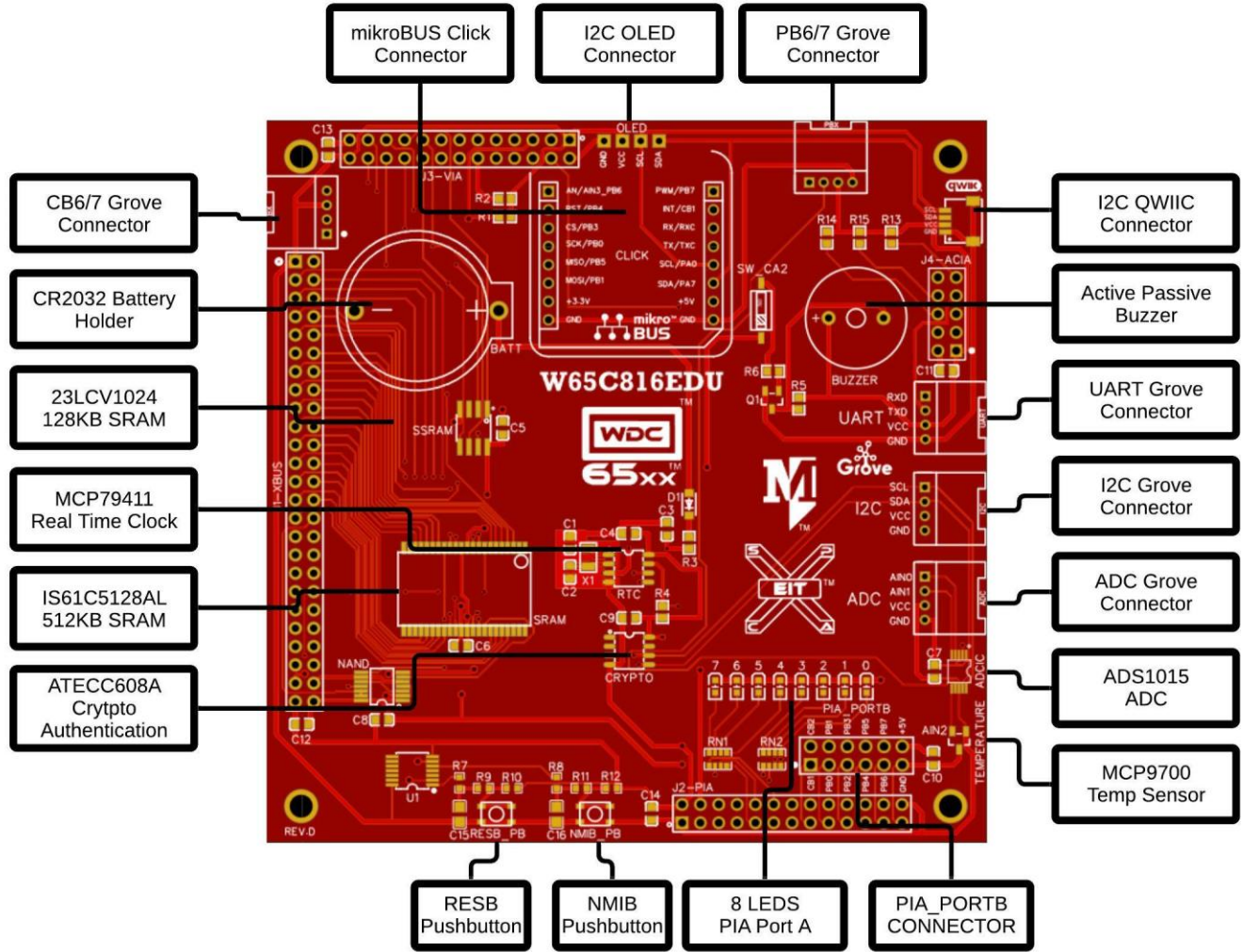
- Designed for W65C816SXB
- All IO pins are 5.0V; same compatibility as W65C816SXB.
- 1x SparkFun QWIIC connector for I2C module expansion
- 5x Seeed Studio Grove connectors for I2C, UART, Analog, and I/O (CB1/2, PB6/7) expansion
- MikroElektronika mikroBUS Click Board connector for I2C, UART, SPI, ADC, PWM, and I/O expansion
- 1x I2C Connector for I2C OLED or other general I2C modules
- CR2032 3.3V Battery holder for Real-Time Clock and Serial SRAM. Note: battery not included with the board due to shipping restrictions.
- MCP79411 Real Time Clock
- ATECC608A CryptoAuthentication™
- 23LCV1024 – 128KB Serial SRAM with battery backup (SPI)
- Active Passive Buzzer with toggle switch
- IS61C5128AL-10T – 512KB Parallel SRAM

### 1.2 Functional Block Diagram

Below is the block diagram for the W65C816SXB, which the board that the W65C816EDU connects onto.



### 1.3 Board Diagram



100mm x 100mm PCB



## 1.4 Quick Reference Guide – Memory Map

<i>W65C816SXB Memory Map with W65C816EDU SRAM</i>				
<i>Start</i>	<i>End</i>	<i>Size</i>	<i>Chip Select</i>	<i>Description</i>
(01)0x0000	(08)0xFFFF	512KB	BANK0B	512KB SRAM W65C816EDU
0x8000	0xFFFF	32 KB	CS9B	FLASH ROM (x4, 128KB used with 2 IO pins for overlays)
0x0000	0x7FFF	32 KB	CS8B	SRAM (7FFF-7F00 is Decoded for expansion)
0x7FE0	0x7FFF	32 B	CS7B	VIA-TIDE
0x7FC0	0x7FDF	32 B	CS6B	VIA Port
0x7FA0	0x7FBF	32 B	CS5B	PIA Port
0x7F80	0x7F9F	32 B	CS4B	ACIA Port
0x7F60	0x7F7F	32 B	XCS3B	XBus Chip Select 3
0x7F40	0x7F5F	32 B	XCS2B	XBus Chip Select 2
0x7F20	0x7F3F	32 B	XCS1B	XBus Chip Select 1
0x7F00	0x7F1F	32 B	XCS0B	XBus Chip Select 0

## 1.5 Quick Reference Guide – Expansion Connectors

<i>J1 – XBus816 Connector</i>			
<i>Pin</i>	<i>Signal Name</i>	<i>Pin</i>	<i>Signal Name</i>
1	VDD	2	VSS
3	D0	4	D1
5	D2	6	D3
7	D4	8	D5
9	D6	10	D7
11	A0	12	A1
13	A2	14	A3
15	A4	16	A5
17	A6	18	A7
19	A8	20	A9
21	A10	22	A11
23	A12	24	A13
25	A14	26	A15
27	A16	28	A17
29	A18	30	A19
31	A20	32	A21
33	A22	34	A23
35	XCS0B	36	XCS1B
37	XCS2B	38	XCS3B
39	VPB	40	IRQB
41	NMIB	42	RESB
43	MLB	44	VDA
45	VPA	46	BE
47	RWB	48	PHI2
49	VSS	50	VDD

<i>J2 – PIA Connector</i>			
<i>Pin</i>	<i>Signal Name</i>	<i>Pin</i>	<i>Signal Name</i>
1	VDD	2	VSS
3	CA1	4	CA2
5	PA0	6	PA1
7	PA2	8	PA3
9	PA4	10	PA5
11	PA6	12	PA7
13	NO CONNECT	14	NO CONNECT
15	CB1	16	CB2
17	PB0	18	PB1
19	PB2	20	PB3
21	PB4	22	PB5
23	PB6	24	PB7
25	VSS	26	VDD

<i>J3 – VIA Connector</i>			
<i>Pin</i>	<i>Signal Name</i>	<i>Pin</i>	<i>Signal Name</i>
1	VDD	2	VSS
3	CA1	4	CA2
5	PA0	6	PA1
7	PA2	8	PA3
9	PA4	10	PA5
11	PA6	12	PA7
13	NO CONNECT	14	NO CONNECT
15	CB1	16	CB2
17	PB0	18	PB1
19	PB2	20	PB3
21	PB4	22	PB5
23	PB6	24	PB7
25	VSS	26	VDD

<i>J4 – ACIA Connector</i>			
<i>Pin</i>	<i>Signal Name</i>	<i>Pin</i>	<i>Signal Name</i>
1	VDD	2	VSS
3	RTSB	4	DTRB
5	RXD	6	DSRB
7	TXD	8	DCDB
9	CTSB	10	RXC



## 2. Connector Descriptions

Following are descriptions of main board connectors.

### 2.1 XBus Port (J1), PIA Port (J2), VIA Port (J3), ACIA Port (J4)

The main Jx connectors from the W65C816SXB are what plug into the W65C816EDU. Not all signals from the W65C816SXB are used on the W65C816EDU. Please refer to the schematic, connector tables, and onboard chip tables for signal details and pinouts. Section 1.4 Quick Reference Guide shows the complete pinout and memory map for the W65C816SXB.

### 2.2 PIA\_PORTB Connector

The PIA\_PORTB Connector is an external connector for the Port B signals from the W65C21N PIA on the W65C816SXB. It is a 12 Pin (2 x 6; .100" spacing) male connector that provides access to the 10 I/Os (8x PB, CB1/2) of the PIA. The remaining pins serve as Power (Pin1 12) and Ground pins (Pin 11). See section 1.4 – Quick Reference Guide for a full pin listing. Refer to the [W65C21 Datasheet](#) for detailed information for that chip.

PIA_PORTB Connector			
Pin	Signal Name	Pin	Signal Name
1	CB1	2	CB2
3	PB0	4	PB1
5	PB2	6	PB3
7	PB4	8	PB5
9	PB6	10	PB7
11	GND	12	+5V

### 2.3 I2C/OLED Connector

This connector is designed for a 1x4 0.100" connector. The spacing on the board was meant for a 0.91" OLED 128x32 display, however it can be used as a general purpose I2C connector. I2C SCL signal is driven from the W65C22 VIA PA0 signal (J3 Pin5) and SDA is driven from the W65C22 VIA PA7 signal (J3 Pin 12).

I2C OLED Connector		
Pin	Signal Name	W65C816SXB Pin
1	GND	-
2	VCC	-
3	SCL	J3-5 (VIA PA0)
4	SDA	J3-12 (VIA PA7)

## 2.4 QWIIC® Connector

The QWIIC® connector is a standard JST 4 pin connector used by SparkFun. It is primarily an I2C interface connector. SparkFun has numerous modules that can be hooked to the EDU through this I2C connector. You can find more QWIIC® information, cables, modules, etc. at [SparkFun's QWIIC® page](#). The pinout is shown below, however with QWIIC® cables, you can easily hook up a board correctly each time. I2C SCL signal is driven from the W65C22 VIA PA0 signal (J3 Pin5) and SDA is driven from the W65C22 VIA PA7 signal (J3 Pin 12).

QWIIC® I2C Connector		
Pin	Signal Name	W65C816SXB Pin
1	GND	-
2	VCC	-
3	SDA	J3-12 (VIA PA7)
4	SCL	J3-5 (VIA PA0)

## 2.5 Seeed Studio Grove Connectors

Seeed has their Grove system of standard connectors for easy 4-pin connection to a wide variety of modules. They have a [comprehensive wiki page here](#). The PRO has 4 Grove connectors: 1x I2C, 1x Analog, and 2x Digital. The signal names are screen printed on board. Pins 3 and 4 for each connector are VCC and GND respectively. Below is a pinout for each Grove connector. Grove cables plug in only one way for easy board connection. The I2C SCL signal is driven from the W65C22 VIA PA0 signal (J3 Pin 5) and SDA is driven from the W65C22 VIA PA7 signal (J3 Pin 12).

Grove I2C Connector		
Pin	Signal Name	W65C816SXB Pin
1	SCL	J3-5 (VIA PA0)
2	SDA	J3-12 (VIA PA7)
3	VCC	-
4	GND	-

Grove Analog Connector (ADC)		
Pin	Signal Name	ADS1015 Signal
1	AN1	AIN0
2	AN2	AIN1
3	VCC	-
4	GND	-

Grove Digital Connector (VIAA)		
Pin	Signal Name	W65C816SX B Pin
1	PB7	J3-24
2	PB6	J3-23
3	VCC	-
4	GND	-

Grove Digital Connector (VIAB)		
Pin	Signal Name	W65C816SXB Pin
1	CB2	J3-16
2	CB1	J3-15
3	VCC	-
4	GND	-

## 2.6 mikroBUS Click Connector

The table below describes how the mikroBUS signal names correlate to the either connector pins or IC pins on the W65C816EDU.

Note 1: Pin 1 is normally an analog input, however the mikroBUS spec supports modules that use this pin as a normal IO. Therefore, WDC has chosen to make this a shared pin. It is connected to both AIN3 of the ADC and PB6 of the W65C22 VIA.

Note 2: The I2C and SPI communication lines are shared with the connectors or IC on the board. For the SPI chip select (Pin 5), this is not shared.

mikroBUS Click Connector					
Pin	Signal Name	W65C816EDU Pin	Pin	Signal Name	W65C816EDU Pin
1	AN/IO	AIN3 / J3_23 (PB6)	2	PWM	J3-24 (VIA PB7)
3	VIA_PB4_RST	J3_21 (VIA PB4)	4	INT	J3-15 (VIA CB1)
5	VIA_PB3_CS	J3-20 (VIA PB3)	6	RX	J4-7 (ACIA TXD)
7	VIA_PB0_SCK	J3-17 (VIA PB0)	8	TX	J4-5 (ACIA RXD)
9	VIA_PB5_MISO	J3-22 (VIA PB5)	10	SCL	J3-5 (VIA PA0)
11	VIA_PB1_MOSI	J3-18 (VIA PB1)	12	SDA	J3-12 (VIA PA7)
13	+3.3V/NC	NOT CONNECTED	14	+5V	-
15	GND	-	16	GND	-

### 3. On Board Device Features

Following are descriptions of W65C816EDU on board devices.

- 8 LEDs controlled by W65C21N PIA Port A
- CR2032 3.3V Battery for Real Time Clock and Serial SRAM
- Active Passive Buzzer with switch
- 23LCV1024 – 128KB Serial SRAM with battery backup (I2C)
- MCP79411 Real Time Clock
- ATECC608A CryptoAuthentication™
- ADS1015 – 12-bit, 3.3kSPS, 4-channel, delta-sigma ADC (I2C)
- MCP9700AT – Temperature sensor
- IS61C5128AL-10T – 512KB Parallel SRAM

#### 3.1 Software I2C and Software SPI Interface

For the W65C816EDU, the I2C and SPI interfaces are derived using the W65C22 device. The methods used here are based on a very good write up from Garth Wilson. His [I2C interface is documented here](#) and [SPI is here](#).

For I2C SCL signal is driven from the W65C22 VIA PA0 signal (J3 Pin5) and SDA is driven from the W65C22 VIA PA7 signal (J3 Pin 12). This matches Garth's example.

SPI is also provided through the W65C22. The SPI CLK signal is VIA PB0 (J3 Pin 17), MOSI signal is VIA PB1 (J3 Pin 18), MISO is PB5 (J3 Pin 22). PB2 (J3 Pin 19) is used as the SPI Select line for the SPI SRAM and PB3 (J3 Pin 20) is the SPI Select line for the mikroBUS click connector SPI device. These pins do not match Garth's example.

#### 3.2 8 LEDs

The 8 LEDs on the EDU board are driven by the W65C21 PIA Port A. These are wired as active high.

#### 3.3 Battery Holder

The battery holder is for a standard CR2032 coin cell battery, operating at 3.3V. You can use any brand battery you choose. Board does not come with a battery due to shipping restrictions at this time. Coin cell battery is used as the backup battery for the MCP79411 Real Time Clock and 23LCV1024 Serial SRAM chips.

#### 3.4 Active Passive Buzzer

The buzzer onboard is a continuous beeping buzzer activated when the W65C21 (PIA) CA2 signal is high. There is an inline switch that is off but default. This switch must be on to control the buzzer with CA2.

#### 3.5 23LCV1024 SPI SRAM

The Microchip Technology Inc. 23LCV1024 are 1 Mbit Serial SRAM devices. The memory is accessed via a simple Serial Peripheral Interface (SPI) compatible serial bus. The SRAM is battery backed up making the SRAM non-volatile. The device also supports unlimited read and write cycles to the array. [Complete details and datasheet can be found directly from Microchip](#). See section 3.2 for a description of the SPI interface relative to the W65C22.

### 3.6 MCP79411 I2C Real Time Clock

The MCP79411 general purpose I2C™Compatible real-time clock/calendar (RTCC) is highly integrated with nonvolatile memory and advanced features normally found in higher priced devices. These features include a battery switchover circuit for backup power, a timestamp to log power failures and digital trimming for accuracy. In addition, non-volatile memory is included along with a Unique ID in a locked section of EEPROM that is factory programmed with an EUI-48 MAC Address. [Complete details and datasheet can be found directly from Microchip.](#) See section 3.2 for a description of the I2C interface relative to the W65C22.

### 3.7 ATECC608A – I2C CryptoAuthentication

The ATECC608A is a secure element from the Microchip CryptoAuthentication™ portfolio with advanced Elliptic Curve Cryptography (ECC) capabilities. The device used on the PRO board uses an I2C interface. With ECDH and ECDSA being built right in, this device is ideal for the rapidly growing IoT market by easily supplying the full range of security such as confidentiality, data integrity, and authentication to systems with MCU or MPUs running encryption/decryption algorithms. [Complete details and datasheet can be found directly from Microchip.](#) See section 3.2 for a description of the I2C interface relative to the W65C22.

### 3.8 ADS1015 I2C ADC

The ADS1015 device is a precision, low-power, 12-bit, I2Ccompatible, analog-to-digital converter (ADC) with a low-drift voltage reference, oscillator, programmable gain amplifier (PGA) and a digital comparator. These features, along with a wide operating supply range, make the ADS1015 well suited for power- and space-constrained, sensor measurement applications. [Complete details and datasheet can be found directly from TI.](#) See section 3.2 for a description of the I2C interface relative to the W65C22.

### 3.9 MCP9700A Temperature Sensor

The MCP9700 sensor with Linear Active Thermistor Integrated Circuit (IC) comprise an analog temperature sensors that convert temperature to analog voltage with an accuracy of  $\pm 2^{\circ}\text{C}$  from  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$  while consuming  $6\ \mu\text{A}$  (typical) of operating current. Unlike resistive sensors (thermistors), the Linear Active Thermistor IC does not require an additional signal-conditioning circuit. The Voltage Output pin (VOUT) is connected to AIN2 of the ADS1015 ADC. [Complete details and datasheet can be found directly from Microchip.](#)

### 3.10 IS61C5128AL 512KB SRAM

The IS61C51281AL is a high speed (10ns access time) static RAM with 8-bit data interface providing 512KB of external memory to your W65C816SXB based system. [Complete details and datasheet can be found directly from ISSI.](#)



## 4 Notices and Ordering Information

### 4.1 FCC Compliance

The Western Design Center, Inc. (WDC) provides the enclosed product under the following conditions: This board is intended for use for Engineering Development, Educational or Evaluation Purposes ONLY and is not considered by WDC to be a finished consumer product. This board should be handled with caution using good electronics handling practices. This board is compliant per RoHS/Green directives. It does not fall within the scope of directives such as FCC, CE, and UL. It generates uses and can radiate radio frequency energy and has not been tested for compliance with the limits of computing devices pursuant to part 15 of FCC rules.

### 4.2 Ordering Information

The W65C816EDU will be available through various distributors and WDC direct. For information about WDC's distribution channels, please visit [WDC's Where to Buy page](#).