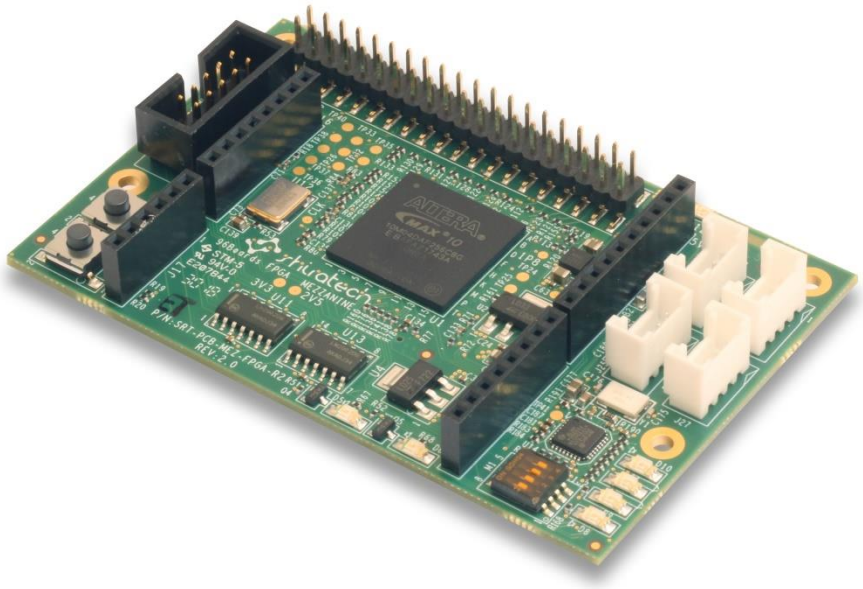
Shiratech FPGA Mezzanine for 96Boards

User Manual V0.9



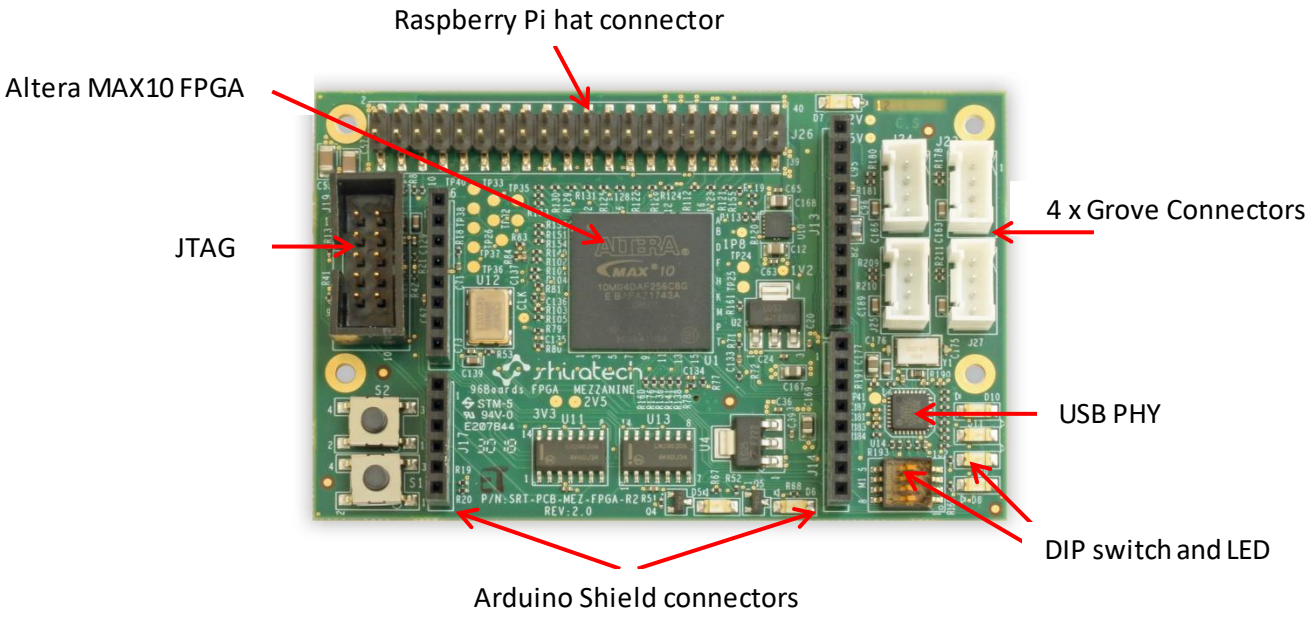
Contents

1. Introduction

Shiratech FPGA Mezzanine is a 96Boards compatible mezzanine board accommodating Intel MAX10 FPGA. It is 96Boards compatible board, both consumer addition (CE) and enterprise edition (EE). The mezzanine has Arduino, Raspberry PI and Grove connectors and can serve as HW bridge between those development platforms to 96Boards.

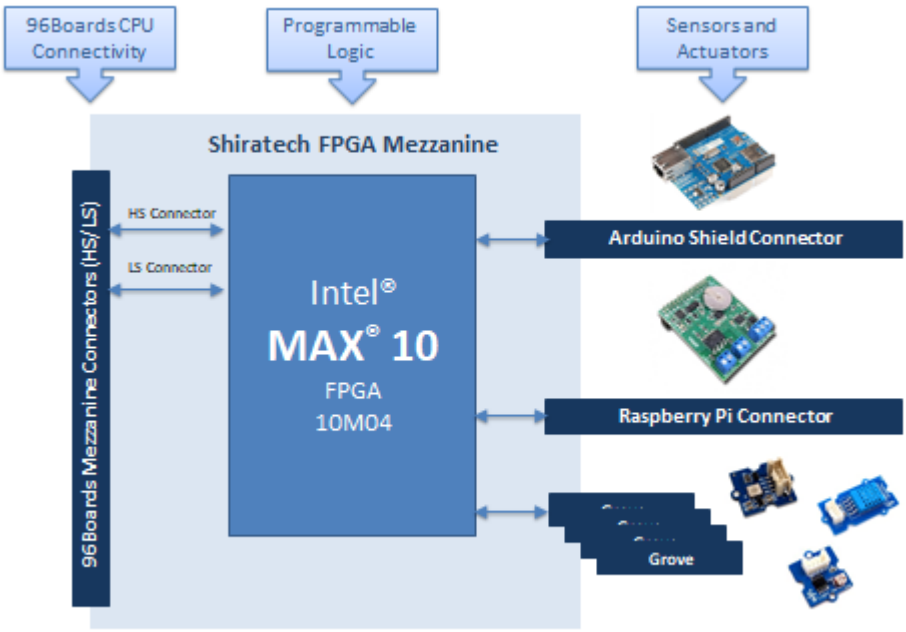
The mezzanine consists of the following key elements:

- Intel MAX10 FPGA
- Arduino shield format connector
- Raspberry PI hat format connector
- Grove connectors
- USB PHY



2. Functional Block Diagram

- The mezzanine is connected to 96Boards carrier board through Low Speed and High Speed Connectors.
- The board is connected to 1.8V and 5V power feeds. LDO regulators provide 3.3V, 2.5V and 1.2V for distribution to the different components.
- MAX10 FPGA :
    - Connected to 3.3V, 2.5V, 1.8V and 1.2V power rails.
    - Connected to 96Boards carrier board High Speed and Low speed connectors, Arduino, Raspberry Pi and grove connectors.
    - Uses JTAG connector for firmware programming.
    - 50MHz oscillator.
    - USB PHY enables USB connectivity of the FPGA to carrier board USB.
    - User defined 4 bit switch and 4 LEDs



3. Arduino Connectors Pin Information

Connectors J13, J14, J16 and J17 on top of the mezzanine are compatible with Arduino shield connector format, and the FPGA demo code provided by Shiratech implements a complete bridge between Arduino and 96Boards connectors.

Upon power up or reset event all pins are configured as input pins to avoid electrical contention between a connected shield to the FPGA IO pins. To start using the shield the user should configure the needed GPIO pins using internal registers accessible through I2C0 bus.

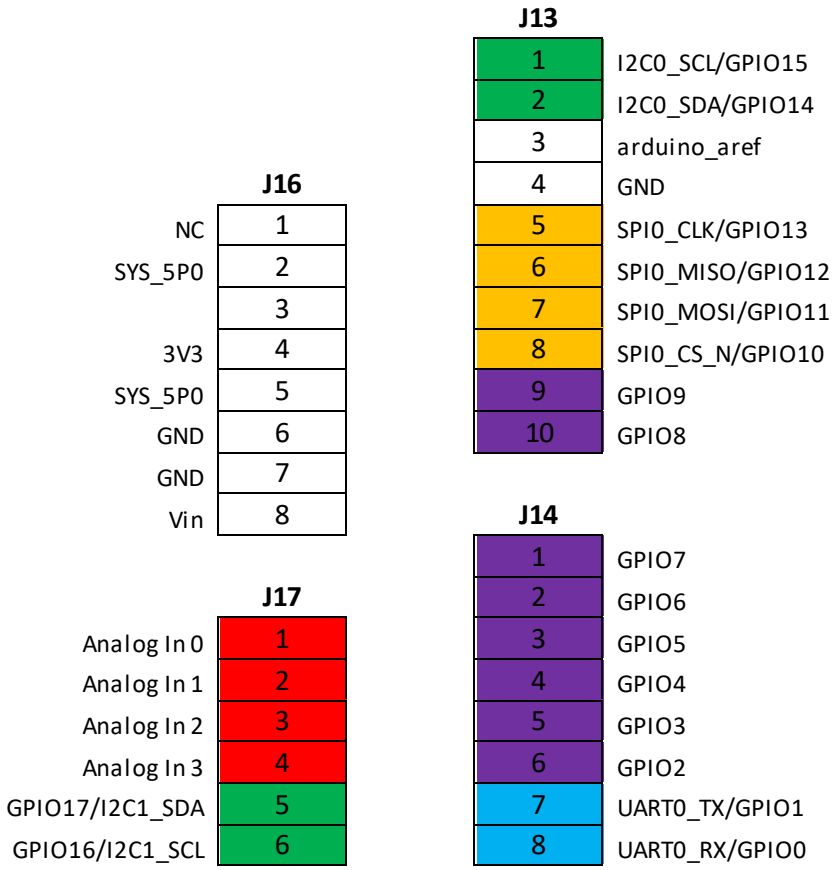
Pin configuration options:

1. Each GPIO pin (GPIO2-GPIO9) can be configured as Input or Output pin.
   Pins configured as Input pins can be read from a read only register.
   Pins configured as Output pins can be read/write from read/write register.
2. I2C, SPI and UART pins can be configured as GPIO or to their specific functionality.
   Pins configured as Input pins can be read from a read only register.
   Pins configured as Output pins can be read/write from read/write register.
3. If assigned to specific functionality the buses are connected as follows (See table below):
   A. J13 pins 1-2 connected to 96Boards I2C0.
   B. J17 pins 5-6 connected to 96Boards I2C1.
   C. J13 pins 5-8 connected to 96Boards SPI0.
   D. J14 pins 7-8 connected to 96Boards UART0.

For detailed registers description refer to chapter 6 – Control Registers

Attention: The mezzanine supports 3.3V Arduino format shields only. Do not connect 5V shields as it may damage the FPGA.

Table 1 - Arduino Connectors Pin Information



4. Raspberry Pi Connector Pin Information

Connector J26 on top of the mezzanine is compatible with Raspberry Pi connector format, and the FPGA demo code provided by Shiratech implements a complete bridge between Raspberry Pi and 96Boards connectors.

Upon power up or reset event all pins are configured as input pins to avoid electrical contention between a connected HAT to the FPGA IO pins. To start using the HAT the user should configure the needed GPIO pins using internal registers accessible through I2C0 bus.

Pin configuration options:

4. Each GPIO pin can be configured as Input or Output pin.
   Pins configured as Input pins can be read from a read only register.
   Pins configured as Output pins can be read/write from read/write register.
5. I2C, SPI and UART pins can be configured as GPIO or to their specific functionality.
   Pins configured as Input pins can be read from a read only register.
   Pins configured as Output pins can be read/write from read/write register.
6. If assigned to specific functionality the buses are connected as follows (See table below):
   E. J26 pins 27-28 are connected to 96Boards I2C0.
   F. J26 pins 3 and 5 are connected to 96Boards I2C1.
   G. J26 pins 19, 21, 23 and 24 are connected to 96Boards SPI0.
   H. J26 pins 26, 35 ,38 and 40 are connected to 96Boards SPI1.
   I. J26 pins 8 and 10 are connected to 96Boards UART0.

For detailed registers description refer to chapter 6 – Control Registers

Attention: The mezzanine supports 3.3V HATs only. Do not connect 5V HATs as it may damage the FPGA.

Table 2 - Raspberry Pi Connector Pin Information

	J26		
3.3V	1	2	5V
I2C1 SDA	3	4	5V
I2C1 SCL	5	6	GND
GPIO4	7	8	UART TXD
GND	9	10	UART RXD
GPIO17	11	12	GPIO18
GPIO27	13	14	GND
GPIO22	15	16	GPIO23
3.3V	17	18	GPIO24
SPI0 MOSI	19	20	GND
SPI0 MISO	21	22	GPIO25
SPI0 SCLK	23	24	SPI0 CE
GND	25	26	SPI1 CE
I2C0 SDA	27	28	I2C0 SCLK
GPIO5	29	30	GND
GPIO6	31	32	GPIO12
GPIO13	33	34	GND
SPI1 MISO	35	36	GPIO16
GPIO26	37	38	SPI1 MOSI
GND	39	40	SPI1 SCLK

5. Grove Connectors Pin Information

TBD

6. Configuration Registers

The firmware provided with the FPGA Mezzanine implements a bridging functionality between 96Boards to Arduino, Raspberry Pi and Grove.

The design includes I2C slave device with control and configuration register for each of the IO pins in the expansion connectors.

The I2C device is connected to 96Boards I2C0 bus at address 0x6F.

Device connected to I2C0 Bus.
Device Address:
0x6F

Address: 0x00
Register name: **REV_REG**
Reset value: 0x10
Access: Read only

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Value	0	0	0	1	0	0	0	0

FPGA firmware revision 1.0

Address: 0x01
Register name: **TEST_REG**
Reset value: 0x00
Access: Read/Write

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Name	T7	T6	T5	T4	T3	T2	T1	T0

Read/write test register.

Registers 0x10, 0x11 and 0x12 are used to control Arduino connector GPIO pins:
Use register 0x10 to configure each GPIO as input or output.

Use register 0x11 to read value of GPIO configured as input.

Use register 0x12 to write value to GPIO configured as output.

By default all GPIO pins configured as inputs after reset.

Address: 0x10

Register name: **ARD_IO_CONF_REG**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	GPIO8	GPIO9	GPIO2	GPIO3	GPIO4	GPIO5	GPIO6	GPIO7
Pin	J13.10	J13.9	J14.6	J14.5	J14.4	J14.3	j14.2	J14.1

Arduino GPIO configuration:

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x11

Register name:

ARD_IO_RD_REG

Reset value: 0xff

Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	GPIO8	GPIO9	GPIO2	GPIO3	GPIO4	GPIO5	GPIO6	GPIO7
Pin	J13.10	J13.9	J14.6	J14.5	J14.4	J14.3	j14.2	J14.1

Read value from Arduino GPIO pins configured as inputs.

Address: 0x12

Register name:

ARD_IO_WR_REG

Reset value: 0x00

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	GPIO8	GPIO9	GPIO2	GPIO3	GPIO4	GPIO5	GPIO6	GPIO7
Pin	J13.10	J13.9	J14.6	J14.5	J14.4	J14.3	j14.2	J14.1

Write to Arduino GPIO pins configured as outputs.

0 - Drive GPIO pin low

1 - Drive GPIO pin high

Registers 0x13-0x16 are used to control Arduino pins that have specific function (I2C, SPI, UART):

Use register 0x13 to select if a pin serves as GPIO or specific function (I2C, SPI, UART)

Use register 0x14 to configure each GPIO pin as input or output.

Use register 0x15 to write value to GPIO configured as output.

Use register 0x16 to read value from GPIO configured as input.

By default all GPIO pins configured as inputs after reset.

Address: 0x13

Register name: **ARD_0_FUNC_IO_SEL_REG**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	i2c0_scl	i2c0_sda	spi0_cs	ar_mosi	ar_miso	ar_sck	uart_tx	uart_rx
Pin	J13.1	J13.2	J13.8	J13.7	J13.6	J13.5	J14.7	J14.8

Select if Arduino pin is used as GPIO or specific function (I2C, SPI, UART):

0 - Pin is used for specific function (I2C, SPI, UART)

1 - Pin is used as GPIO

Default - 1 (GPIO)

Address: 0x14

Register name:

ARD_0_FUNC_IO_CONF_REG

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	i2c0_scl	i2c0_sda	spi0_cs	ar_mosi	ar_miso	ar_sck	uart_tx	uart_rx
Pin	J13.1	J13.2	J13.8	J13.7	J13.6	J13.5	J14.7	J14.8

Configuration for pins set to be used as GPIO ('1' in register 0x13):

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x15
Register name:
ARD_0_FUNC_IO_WR_REG
Reset value: 0x00
Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	i2c0_scl	i2c0_sda	spi0_cs	ar_mosi	ar_miso	ar_sck	uart_tx	uart_rx
Pin	J13.1	J13.2	J13.8	J13.7	J13.6	J13.5	J14.7	J14.8

Write to GPIO pins configured as outputs ('1' in register 0x13 and '0' in register 0x14):
0 - Drive GPIO pin low
1 - Drive GPIO pin high

Address: 0x16
Register name: **ARD_0_FUNC_IO_RD_REG**
Reset value: 0xff
Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	i2c0_scl	i2c0_sda	spi0_cs	ar_mosi	ar_miso	ar_sck	uart_tx	uart_rx
Pin	J13.1	J13.2	J13.8	J13.7	J13.6	J13.5	J14.7	J14.8

Read from GPIO pins configured as inputs ('1' in register 0x13 and '1' in register 0x14).

Registers 0x17-0x1a are used to control Arduino pins that have specific function (I2C):
Use register 0x17 to select if a pin serves as GPIO or specific function (I2C).
Use register 0x18 to configure each GPIO pin as input or output.
Use register 0x19 to write value to GPIO configured as output.
Use register 0x1a to read value from GPIO configured as input.
By default all GPIO pins configured as inputs after reset.

Address: 0x17
Register name: **ARD_1_FUNC_IO_SEL_REG**
Reset value: 0xff
Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	-	-	i2c1_scl	i2c1_sda
Pin	-	-	-	-	-	-	J17.6	J17.5

Select if Arduino pin is used as GPIO or specific function (I2C):

0 - Pin is used for specific function (I2C)

1 - Pin is used as GPIO

Default - 1 (GPIO)

Address: 0x18

Register name:

ARD_1_FUNC_IO_CONF_REG

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	-	-	i2c1_scl	i2c1_sda
Pin	-	-	-	-	-	-	J17.6	J17.5

Configuration for pins set to be used as GPIO ('1' in register 0x17):

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x19

Register name:

ARD_1_FUNC_IO_WR_REG

Reset value: 0x00

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	-	-	i2c1_scl	i2c1_sda
Pin	-	-	-	-	-	-	J17.6	J17.5

Write to GPIO pins configured as outputs ('1' in register 0x17 and '0' in register 0x18):

0 - Drive GPIO pin low

1 - Drive GPIO pin high

Address: 0x1a

Register name: **ARD_1_FUNC_IO_RD_REG**

Reset value: 0x03

Access: Read only

Bit	7	6	5	4	3	2	1	0

Name	-	-	-	-	-	-	i2c1_scl	i2c1_sda
Pin	-	-	-	-	-	-	J17.6	J17.5

Read from GPIO pins configured as inputs ('1' in register 0x17 and '1' in register 0x18).

Registers 0x30-0x35 are used to control Raspberry Pi connector GPIO pins:

Use registers 0x30-0x31 to configure each GPIO as input or output.

Use register 0x32-0x33 to read value of GPIO configured as input.

Use register 0x34-0x35 to write value to GPIO configured as output.

By default all GPIO pins configured as inputs after reset.

Address: 0x30

Register name: **RPI_IO_CONF_REG_0**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	GPIO4	GPIO24	GPIO23	GPIO22	GPIO27	GPIO17	GPIO6	GPIO5
Pin	J26.7	J26.18	J26.16	J26.15	J26.13	J26.11	J26.31	J26.29

Raspberry Pi GPIO configuration:

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x31

Register name: **RPI_IO_CONF_REG_1**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	GPIO18	GPIO25	GPIO12	GPIO16	GPIO26	GPIO13
Pin	-	-	J26.12	J26.22	J26.32	J26.36	J26.37	J26.33

Raspberry Pi GPIO configuration:

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x32
Register name: **RPI_IO_RD_REG_0**
Reset value: 0xff
Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	GPIO4	GPIO24	GPIO23	GPIO22	GPIO27	GPIO17	GPIO6	GPIO5
Pin	J26.7	J26.18	J26.16	J26.15	J26.13	J26.11	J26.31	J26.29

Read value from Raspberry Pi GPIO pins configured as inputs.

Address: 0x33
Register name: **RPI_IO_RD_REG_1**
Reset value: 0xff
Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	-	-	GPIO18	GPIO25	GPIO12	GPIO16	GPIO26	GPIO13
Pin	-	-	J26.12	J26.22	J26.32	J26.36	J26.37	J26.33

Read value from Raspberry Pi GPIO pins configured as inputs.

Address: 0x34
Register name: **RPI_IO_WR_REG_0**
Reset value: 0x00
Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	GPIO4	GPIO24	GPIO23	GPIO22	GPIO27	GPIO17	GPIO6	GPIO5
Pin	J26.7	J26.18	J26.16	J26.15	J26.13	J26.11	J26.31	J26.29

Write to Raspberry Pi GPIO pins configured as outputs.
0 - Drive GPIO pin low
1 - Drive GPIO pin high

Address: 0x35
Register name: **RPI_IO_WR_REG_1**
Reset value: 0x00
Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	GPIO18	GPIO25	GPIO12	GPIO16	GPIO26	GPIO13
Pin	-	-	J26.12	J26.22	J26.32	J26.36	J26.37	J26.33

Write to Raspberry Pi GPIO pins configured as outputs.

0 - Drive GPIO pin low

1 - Drive GPIO pin high

Registers 0x36-0x39 are used to control RPi pins that have specific function (I2C, SPI, UART):

Use register 0x36 to select if a pin serves as GPIO or specific function (I2C, SPI, UART)

Use register 0x37 to configure each GPIO pin as input or output.

Use register 0x38 to write value to GPIO configured as output.

Use register 0x39 to read value from GPIO configured as input.

By default all GPIO pins configured as inputs after reset.

Address: 0x36

Register name: **RPI_0_FUNC_IO_SEL_REG**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	SP1 CE	SPI1 MOSI	SPI1 MISO	SPI1 SCLK	UART TXD	UART RXD
Pin	-	-	J26.26	J26.38	J26.35	J26.40	J26.8	J26.10

Select if RPi pin is used as GPIO or specific function (I2C, SPI, UART):

0 - Pin is used for specific function (I2C, SPI, UART)

1 - Pin is used as GPIO

Default - 1 (GPIO)

Address: 0x37

Register name:

RPI_0_FUNC_IO_CONF_REG

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	SP1 CE	SPI1 MOSI	SPI1 MISO	SPI1 SCLK	UART TXD	UART RXD
Pin	-	-	J26.26	J26.38	J26.35	J26.40	J26.8	J26.10

Configuration for pins set to be used as GPIO ('1' in register 0x36):

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x38

Register name: **RPI_0_FUNC_IO_WR_REG**

Reset value: 0x00

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	-	-	SP1 CE	SPI1 MOSI	SPI1 MISO	SPI1 SCLK	UART TXD	UART RXD
Pin	-	-	J26.26	J26.38	J26.35	J26.40	J26.8	J26.10

Write to GPIO pins configured as outputs ('1' in register 0x36 and '0' in register 0x37):

0 - Drive GPIO pin low

1 - Drive GPIO pin high

Address: 0x39

Register name: **RPI_0_FUNC_IO_RD_REG**

Reset value: 0x3f

Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	-	-	SP1 CE	SPI1 MOSI	SPI1 MISO	SPI1 SCLK	UART TXD	UART RXD
Pin	-	-	J26.26	J26.38	J26.35	J26.40	J26.8	J26.10

Read from GPIO pins configured as inputs ('1' in register 0x36 and '1' in register 0x37).

Registers 0x3a-0x3d are used to control RPi pins that have specific function (I2C, SPI, UART):

Use register 0x3a to select if a pin serves as GPIO or specific function (I2C, SPI, UART)

Use register 0x3b to configure each GPIO pin as input or output.

Use register 0x3c to write value to GPIO configured as output.

Use register 0x3d to read value from GPIO configured as input.

By default all GPIO pins configured as inputs after reset.

Address: 0x3a

Register name: **RPI_1_FUNC_IO_SEL_REG**

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	I2C1 SCL	I2C1 SDA	I2C0 SCLK	I2C0 SDA	SPI0 CE	SPI0 MOSI	SPI0 MISO	SPI0 SCLK
Pin	J26.5	J26.3	J26.28	J26.27	J26.24	J26.19	J26.21	J26.23

Select if RPi pin is used as GPIO or specific function (I2C, SPI, UART):

0 - Pin is used for specific function (I2C, SPI, UART)

1 - Pin is used as GPIO

Default - 1 (GPIO)

Address: 0x3b

Register name:

RPI_1_FUNC_IO_CONF_REG

Reset value: 0xff

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	I2C1 SCL	I2C1 SDA	I2C0 SCLK	I2C0 SDA	SPI0 CE	SPI0 MOSI	SPI0 MISO	SPI0 SCLK
Pin	J26.5	J26.3	J26.28	J26.27	J26.24	J26.19	J26.21	J26.23

Configuration for pins set to be used as GPIO ('1' in register 0x3a):

1 - Set IO pin as Input

0 - Set IO pin as Output

Default - 1 (Input)

Address: 0x3c

Register name: **RPI_1_FUNC_IO_WR_REG**

Reset value: 0x00

Access: Read/Write

Bit	7	6	5	4	3	2	1	0
Name	I2C1 SCL	I2C1 SDA	I2C0 SCLK	I2C0 SDA	SPI0 CE	SPI0 MOSI	SPI0 MISO	SPI0 SCLK
Pin	J26.5	J26.3	J26.28	J26.27	J26.24	J26.19	J26.21	J26.23

Write to GPIO pins configured as outputs ('1' in register 0x3a and '0' in register 0x3b):

0 - Drive GPIO pin low

1 - Drive GPIO pin high

Address: 0x3d

Register name: **RPI_1_FUNC_IO_RD_REG**

Reset value: 0xff

Access: Read only

Bit	7	6	5	4	3	2	1	0
Name	I2C1 SCL	I2C1 SDA	I2C0 SCLK	I2C0 SDA	SPI0 CE	SPI0 MOSI	SPI0 MISO	SPI0 SCLK
Pin	J26.5	J26.3	J26.28	J26.27	J26.24	J26.19	J26.21	J26.23

Read from GPIO pins configured as inputs ('1' in register 0x3a and '1' in register 0x3b).

Address: 0xa0

Register name: **LED_REG**

Reset value: 0x00

Access: Read/Write

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	LED3	LED2	LED1	LED0

Turn user LED on/off:

0 - LED off

1 - LED on

Address: 0xa1

Register name: **SWITCH_REG**

Reset value: 0x00

Access: Read only

	MSB							LSB
Bit	7	6	5	4	3	2	1	0
Name	-	-	-	-	SW3	SW2	SW1	SW0

Read user DIP switch value.

7. Document Revision History

Revision	Date	Author	Status and Description
0.9	20/12/2018	Guy Zohar	Initial version