Designer Systems .co.uk
PRODUCT DESIGN AND MANUFACTURING

LED Lighting Shield

for Arduino™ and Raspberry-PI™

Technical Data

DS-RGBW.S

Features

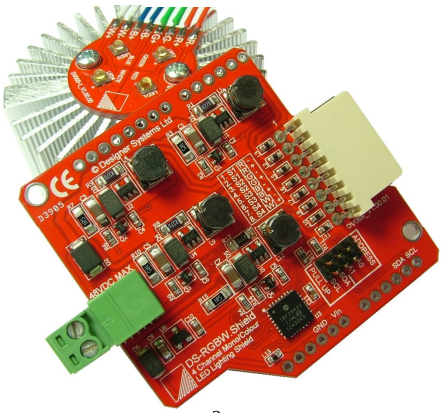
- **Arduino™ UNO Shield standard form factor for simple integration into any Arduino project**
- **I²C interface for simple connection to Arduino or Raspberry-PI**
- **A complete mono or colour lighting system for rooms, aquariums, fish ponds, external lighting etc.**
- **Four [4] high current [350mA each] LED driver channels supporting 1-12 LED's per string [1.75 to 17Watts (5-48VDC supply)].**
- **I²C address links allow up to four [4] shields to be used together**
- **Simple register based control of brightness / colour and sun-rise, sun-set and moon light simulation modes**
- **R.G.B.W high brightness LED module with heatsink supplied as standard [other modules available]**
- **LVD, RoHS and WEEE compliant product**

Description

The Designer Systems DS-RGBW.S is a four [4] channel high current LED driver shield capable of driving four [4] 1-12 LED chains.
Specifically targeted at the Arduino UNO board user [all other Arduino boards supported] and the Raspberry-PI the RGBW.S features high speed I²C communication for easy project integration and smooth brightness control.

Each of the four [4] 350mA capable channels features a 1024 step brightness control, open/short circuit protection, current monitoring and can support a LED chain of 1-12 LED's [dependant on power supply connected]. This allows the user to create RGBW lighting effects, using the supplied RGBW lamp, or driving external RGB strips /coins etc. or 4x white strips /coins for accent lighting, room lighting, aquarium lighting etc.

The built in aquarium mode provides advanced control of the supplied RGBW lamp, or external 10Watt RGBW lamp, to provide simulation of moonlight, sunrise, day and sunset cycles which run on an internal 24 hour timer.



The on-board I²C pull-ups are jumper configurable to allow disconnection when connecting to the Raspberry-PI, which has its own pull-ups.

The supplied RGBW 4W lamp features high quality OSRAM OSLON LED's, finned heatsink and has a maximum light output level of 340 lumens.

Applications

The DS-RGBW.S has many applications in domestic room lighting, outside lighting, fish ponds, accent lighting and aquarium lighting to name a few. The built in aquarium mode provides timed set and forget moonlight/sunrise/sunset simulation for large or small aquariums.

CONTROL MODULES

Selection Guide

Description	Part Number
LED Lighting Shield w. RGBW LED lamp	DS-RGBW.S
6500K Cool white LED lamp [4x White 424 lm max.]	DS-LD4.S-W
3500K Warm white LED lamp [4x White 336 lm max.]	DS-LD4.S-WW

Raspberry-PI, Arduino, NANO, UNO & MEGA are trademark
Note: A 12VDC [500mA] power supply is required

Power requirements

The DS-RGBW.S requires two power supplies for operation.

Controller power

The power necessary for on-board controller operation (approx. 2-10mA) is taken from an external battery, mains power adaptor or from the Arduino or Raspberry-PI board.

The RGBW provides three PCB pads, two marked 'GND' and one marked 'Vin' in the same format as that present on the UNO board, which should be connected to negative and positive battery/power supply terminals respectively. The input voltage range is 4.75 - 16VDC with the internal circuitry being protected against power supply reversal.

LED power

The power necessary for LED operation is taken from an external battery or mains power adaptor. Connection of the external supply to the RGBW module is through a two (2) way pluggable screw terminal block marked '48VDC MAX'. The positive connection is marked '+++++' but is internally polarity protected to prevent damage to the LED drivers.

A supply voltage should be selected dependant on the number of LED's connected in series as a chain to the LED output. A good rule of thumb is [Number of LED's in string x 4V] but a minimum input voltage of 12VDC is recommended.

Examples:

Each channel has 6x RED, BLUE and GREEN LED's connected in a series chain, therefore input supply = 6 x 4V = 24VDC.

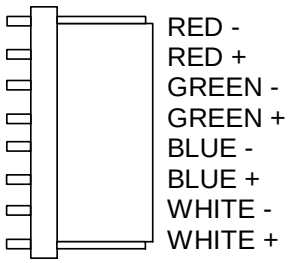
Each channel has 12x RED, BLUE and GREEN LED's connected in a series chain, therefore input supply = 12 x 4V = 48VDC.

DO NOT exceed the maximum input voltage of 48VDC !

A supply of 12VDC @ 500mA is recommended for the supplied RGBW 4W lamp.

LED connection

The LED interface is an eight (8) pin horizontal 2.54mm pitch header, pinned as follows:



The corresponding chain of coloured LED's should be connected with its CATHODE connected to '-' and its ANODE end connected to '+'.

I²C connection

The I²C connections are marked 'SDA' and 'SCL' and allow connection to the Arduino UNO board 'ANALOG IN' pins 4 and 5 or the Rasperberry-PI GPIO port pins 3 and 5 (see Fig. 2.0) or another I²C Master device.

The DS-RGBW.S is fitted with pull-up jumpers that can be configured to provide the source current necessary for I²C communication. The following jumpers should normally be set when using the UNO board, as long as the I²C bus does not have existing pull-up's provided by another device. **These jumpers <u>MUST</u> be removed when using the Raspberry-PI:**

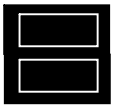
PULL UP

I²C communication

Up to four DS-RGBW.S modules may be connected to the same UNO / Raspberry-PI board or I²C bus and accessed individually using their own individual address.

The address is configured with the following jumpers:

ADDRESS



The following table shows how the jumpers are placed for the different binary addresses:

Address xx	A0	A1
00 (default)	ON	ON
01	OFF	ON
10	ON	OFF
11	OFF	OFF

The binary address (xx) above is used in conjunction with the device ID 11100xxD to form the complete device address i.e. if both jumpers are left connected (default) then the device address would be $1110000D_{binary}$.

The 'D' bit determines if a read or a write to the RGBW is to be performed. If the 'D' bit is set '1' then a register read is performed or if clear '0' a register write.

To access individual registers a device write must be undertaken by the I²C Master which consists of a Start condition, device ID ('D' bit cleared), register to start write, one or more bytes of data to be written and a stop condition (see Figure 1.0 for I²C write protocol).

There are 20 individual registers that can be written to within the RGBW that control WHITE, RGB, HSB and R.G.B.W levels, Clock, Sunrise/Sunset and Moonlight configuration as follows:

	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0
RGBW I2C address								
1.	1	1	1	0	0	X	X	0

XX = RGBW address

Register address								
R0	U	U	U	B	B	B	B	B

B..B = 0 to 20
U..U = unused on this implementation

Configuration register								
R1	U	U	U	U	U	U	X	W

W = 0 or 1 (0 = Normal mode, 1 = Aquarium mode)
X = 0 or 1 (0 = Moonlight OFF, 1 = Moonlight ON)
U..U = unused on this implementation

WHITE brightness value register								
R2	U	D	D	D	D	D	D	D

D..D = 0 to 100% (WHITE brightness value)

RGB RED value register								
R3	D	D	D	D	D	D	D	D

D..D = 0 to 255 (RED RGB value)

RGB GREEN value register								
R4	D	D	D	D	D	D	D	D

D..D = 0 to 255 (GREEN RGB value)

RGB BLUE value register								
R5	D	D	D	D	D	D	D	D

D..D = 0 to 255 (BLUE RGB value)

HSB HUE value register								
R6	D	D	D	D	D	D	D	D

D..D = 0 to 255 (Hue value)

HSB SATURATION value register								
R7	D	D	D	D	D	D	D	D

D..D = 0 to 255 (Saturation value)

HSB BRIGHTNESS value register

R8	D	D	D	D	D	D	D	D

D..D = 0 to 255 (Brightness value)

Sunrise hour value register

R9	U	U	U	D	D	D	D	D

D..D = 0 to 23 (Sunrise hour value)
U..U = unused on this implementation

Sunset hour value register

R10	U	U	U	D	D	D	D	D

D..D = 0 to 23 (Sunrise hour value)
U..U = unused on this implementation

Current time hour value register

R11	U	U	U	D	D	D	D	D

D..D = 0 to 23 (Current time hour value)
U..U = unused on this implementation

Current minute value register

R12	U	U	D	D	D	D	D	D

D..D = 0 to 59 (Current time minute value)
U..U = unused on this implementation

RED brightness MSB register

R13	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

RED brightness LSB register

R14	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

GREEN brightness MSB register

R15	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

GREEN brightness LSB register

R16	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

BLUE brightness MSB register

R17	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

BLUE brightness LSB register

R18	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

WHITE brightness MSB register

R19	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

WHITE brightness LSB register

R20	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

The RGBW also auto increments the register specified for every additional write requested by the Master I^2C device, which allows more than one register to be written in one transaction.
This allows for example Register 1 to Register 5, RGB and WHITE levels, to be written in one transaction (see Figure 1.1 for I^2C write protocol).

To read individual data and status registers a device write then read must be undertaken by the I^2C Master.
The write consists of a Start condition, device ID ('D' bit clear), register to start read and a Stop condition. This is followed by a read, which consists of a Start condition, device ID ('D' bit set), followed by data from the register specified and terminated with a Stop condition.

Status registers
There are 12 individual registers that can be read within the RGBW as follows:

	N_7	N_6	N_5	N_4	N_3	N_2	N_1	N_0
RGBW Address 1.	1	1	1	0	0	X	X	1

XX = Address select pins

Configuration register

R1	U	U	U	U	U	U	X	W

W = 0 or 1 (0 = Normal mode, 1 = Aquarium mode)
X = 0 or 1 (0 = Moonlight OFF, 1 = Moonlight ON)
U..U = unused on this implementation

RED brightness MSB register

R2	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

RED brightness LSB register

R3	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

GREEN brightness MSB register

R4	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

GREEN brightness LSB register

R5	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

BLUE brightness MSB register

R6	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

BLUE brightness LSB register

R7	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

WHITE brightness MSB register

R8	U	U	U	U	U	U	D	D

D..D = 0x00 to 0x03 (MSB of brightness value)
U..U = unused on this implementation

WHITE brightness LSB register

R9	D	D	D	D	D	D	D	D

D..D = 0x00 to 0xFF (LSB of brightness value)

Current time hours value register

R10	U	U	U	D	D	D	D	D

D..D = 0 to 23 (Current hour value)
U..U = unused on this implementation

Current time minutes value register

R11	U	U	D	D	D	D	D	D

D..D = 0 to 59 (Current minutes value)
U..U = unused on this implementation

DS-RGBW.S Firmware

R12	M	M	M	M	L	L	L	L

L..L = Firmware minor version 0-15
M..M = Firmware major version 0-15

R.G.B Colour registers…
The RGB colour registers allow a standard RED, GREEN, BLUE (sRGB) colour value to be displayed on the connected LED's. The colour values set are internally converted to the CIE1931 XYZ colour space for better visual perception.

H.S.B Colour registers…
The HSB colour registers allow a HUE, SATURATION, BRIGHTNESS [also known as VALUE] colour value to be displayed on the connected LED's. The colour values set are internally converted to the CIE1931 XYZ colour space for better visual perception.

R.G.B.W Brightness registers…
The R.G.B.W brightness registers allow individual control of the brightness level on each of the four LEDs. The output level is adjustable from zero [0x0000], or OFF, to 1023 [0x03FF], or maximum brightness, by converting the value into hexadecimal and writing the Most Significant Byte [MSB] to the first register and the Least Significant Byte [LSB] to the second register. For example if a brightness level of 589 was required the hexadecimal representation of this would be 0x024D. The $0x02_{hex}$ would be written to the first register and the $0x4D_{hex}$ to the second.
These registers may also be read to return the internally converted RGB and HSB values.

Aquarium mode…
The RGBW.S provides an aquarium mode of operation that can simulate sunrise/sunset and moonlight illumination. Aquarium mode is simply enabled by writing the current time, hour and minute, into the I^2C clock registers and then the sunrise hour, sunset hour and configuration control into the relevant I^2C registers.

Sunrise is initiated when the clock and sunrise hour (06:00 default) are the same and will continue over a period of 30 minutes until full daylight is reached (5600K).

Sunset is initiated when the clock and the sunset hour (21:00 default) are the same and will continue over a period of 30 minutes until darkness is reached.

If the moonlight flag is also set the moon will rise as darkness falls and remain constant during the night until sunrise starts once more.

See the website at www.designersystems.co.uk for sample Raspberry-PI and Arduino applications.

Electrical Characteristics (T_A = 25°C Typical)

Parameter	Minimum	Maximum	Units	Notes
Supply Voltage (LED power)	6	48	V	1
Supply Current (LED power)	0	1200	mA	2
Supply Voltage (on-board VCC)	4.75	16	V	
Supply Current (on-board VCC)	2	10	mA	
I^2C speed	-	400	kHz	
I^2C pull-up resistance	-	4700	Ω	3
LED driver output current	0	350	mA	
LED's per channel	1	12	LEDs	
LED forward voltage	3	3.8	V	4

Absolute Maximum Ratings

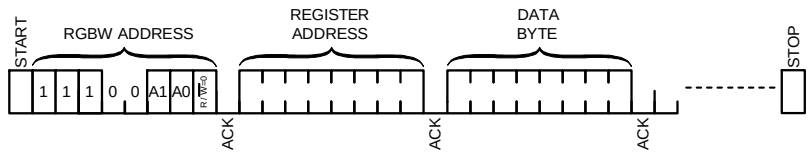
Parameter	Minimum	Maximum	Units
Supply Voltage (LED power)	-0.5	+50	V

Environmental

Parameter	Minimum	Maximum	Units
Operating Temperature	0	70	°C
Storage Temperature	-10	80	°C
Humidity	0	80	%
Dimensions	Length 56.25mm, Width 53.5mm, Height 12mm		
Weight	15g [main board] 71g [RGBW lamp]		
Immunity & emissions	See statement on page 8		

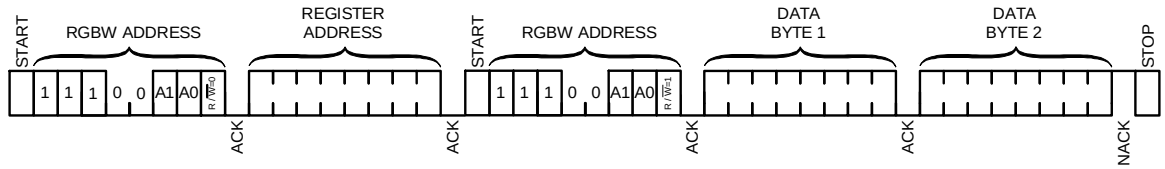
Notes:
1. Recommended minimum input voltage is 12VDC.
2. Maximum is all four channels at maximum brightness all connected to 12 LED chains with 48VDC supply.
3. Value given is to Vcc when activated with appropriate jumpers.
4. Nominal value is 3.2 to 3.5V.

Figure 1.0 (I^2C write protocol)



Multiple bytes may be written before the 'STOP' condition. Data is written into registers starting at 'REGISTER ADDRESS', then 'REGISTER ADDRESS' +1, then 'REGISTER ADDRESS' +2 etc.
Each byte transfer is acknowledged 'ACK' by the RGBW until the 'STOP' condition.

Figure 1.1 (I^2C read protocol)



'DATA BYTE 1 & 2' are register values returned from the RGBW. Each byte written is acknowledged 'ACK' by the RGBW , every byte read is acknowledged 'ACK' by the I^2C Master. A Not-acknowledge 'NACK' condition is generated by the I^2C Master when it has finished reading.

Calculating binary bit values:

The registers used above use the binary notation to configure different functions. Each register is made up of eight (8) bits, which can be set or cleared to produce the desired operation, the individual bits having a value associated with them as follows:

128	64	32	16	8	4	2	1

If we take for example the Configuration register there are two bits that are configurable:

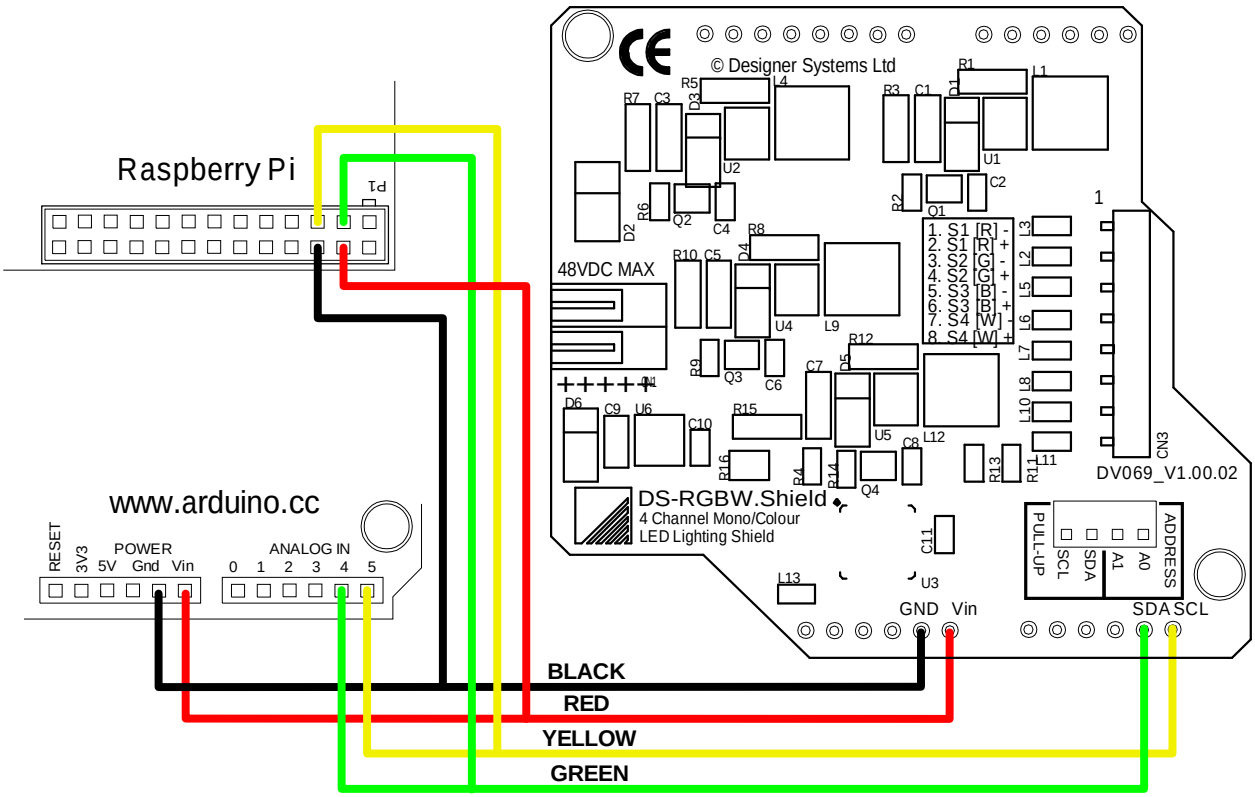
Configuration register

R1	U	U	U	U	U	U	X	W

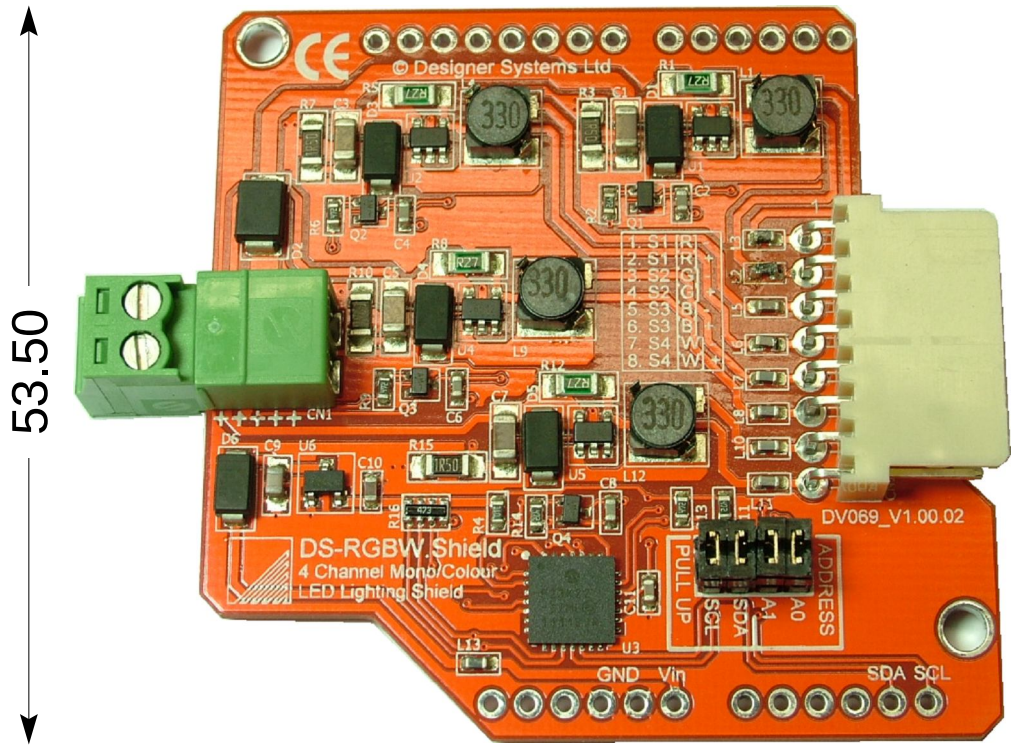
W = 0 or 1 (0 = Normal mode, 1 = Aquarium mode)
X = 0 or 1 (0 = Moonlight OFF, 1 = Moonlight ON)
U..U = unused on this implementation

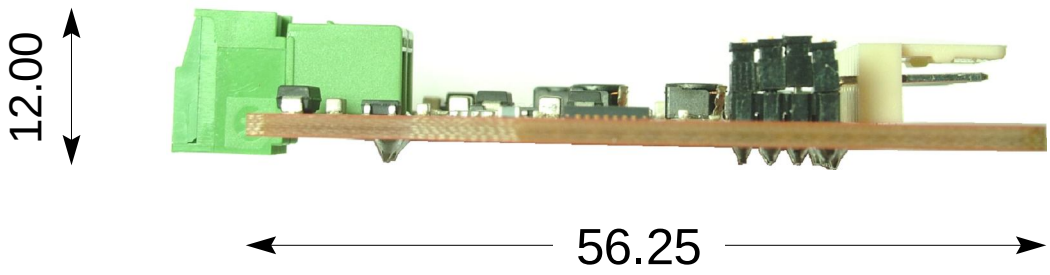
Each bit is defined to control a particular function, so if for example we wanted to enable Aquarium mode we would need to set bit 'W' which controls this function. We know from the bit values defined above that the value associated with the 'W' bit is 1, so by writing this value to register 1 we can enable Aquarium mode. If we need to enable additional features such as Moonlight - 'X' - as well, the value of this bit is added to the value written to the register i.e. 1 + 2 = 3.

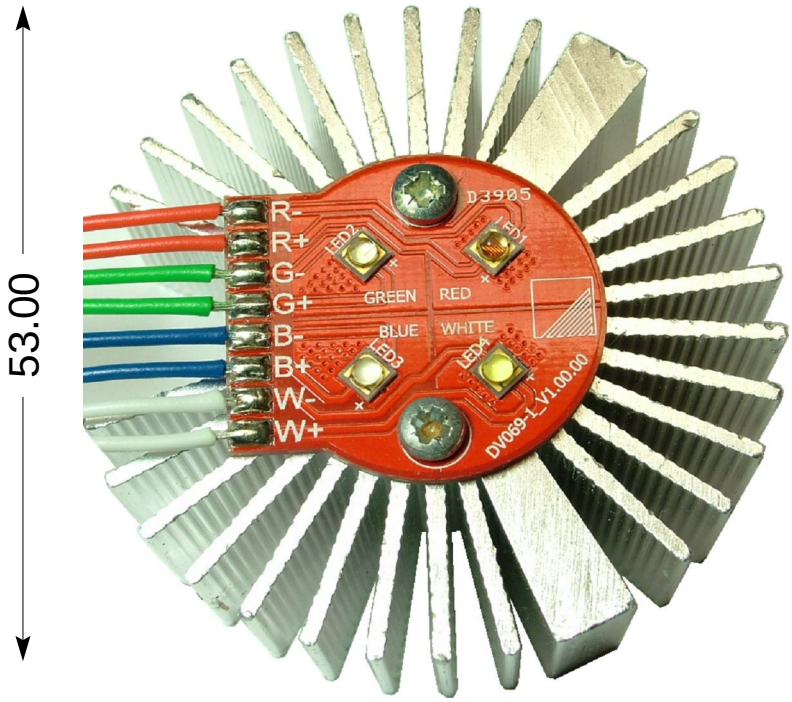
Figure 2.0 (Connection Schematic for Arduino UNO or Raspberry-Pi I^2C communication)



Mechanical Specifications – Units millimetres







Revision History:

1.00	Release version
1.01	Added Eye safety warning.

WEEE Consumer Notice

This product is subject to Directive 2002/96/EC of the European Parliament and the Council of the European Union on Waste of Electrical and Electronic Equipment (WEEE) and, in jurisdictions adopting that Directive, is marked as being put on the market after August 13, 2005, and should not be disposed of as unsorted municipal/public waste. Please utilise your local WEEE collection facilities in the disposition and otherwise observe all applicable requirements. For further information on the requirements regarding the disposition of this product in other languages please visit www.designersystems.co.uk

RoHS Compliance

This product complies with Directive 2002/95/EC of the European Parliament and the Council of the European Union on the Restriction of Hazardous Substances (RoHS) which prohibits the use of various heavy metals (lead, mercury, cadmium, and hexavalent chromium), polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE).

Eye Safety

The RGBW LED's are very bright. DO NOT look directly at the LED's when they are active. Turn the RGBW lamp away from you, or others, when operating or use a diffuser to prevent possible eye damage.

Declaration of Conformity

Apparatus name / model number DS-RGBW.S

Manufacturer Designer Systems, 11 Castle Street, Truro, Cornwall TR1 3AF, United Kingdom

Conformity via Generic Standard EN50081-1
Generic Standard EN50082-1

Description of apparatus Robotic interface peripheral

Conformity criteria For use only within commercial, residential and light industrial applications

We certify that the apparatus identified above conforms to the requirements of Council Directive 2004/108/EC & 2006/95/EC

Signed. **Date** 20/6/13

Having made this declaration the CE mark is affixed to this product, its packaging, manual or warranty.

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