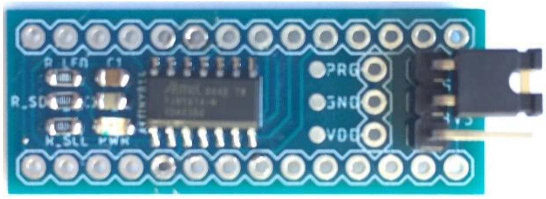
UKMARS

I^{2}C SENSOR CONTROLLER (ISC)

UKMARSBOT I^{2}C Sensor Controller Datasheet



Features

- Connects directly between UKMARSBOT and existing UKMARS sensor boards to offer an I^{2}C interface for sensors / LED indicators
- Supports UKMARS sensor boards that contain up to:
  - 5 x Analogue Sensor Inputs
  - 1 x Common Transmitter Output
  - 2 x Indicator LEDs
- Collects sensor data periodically, with configurable:
  - Ambient light removal
  - Sensor transmitter pulse length
  - ADC Resolution (8-bit / 10-bit)
  - Sensor selection – disable unused sensors for increased speed
- Threshold Comparison:
  - Compares each sensor value against a configurable threshold value with hysteresis to return Sensor state
- Configurable Interrupt Source (may be polled):
  - Rising and/or Falling Sensor state change
    - Individually Settable for each Sensor
  - Sensor board specific interrupt
- Configurable Indicator LED control:
  - Master Control (over I^{2}C)
  - Sample Frequency output
  - Slow/Fast Blink
  - Board specific indication
- Selectable Operating/ADC reference Voltage
  - 3.3V or 5V
- Sensor board specific features and Interrupts
  - Selectable over I^{2}C

Functional Block Diagram of Application

Below is a diagram showing the application in which the ISC is intended to be used.

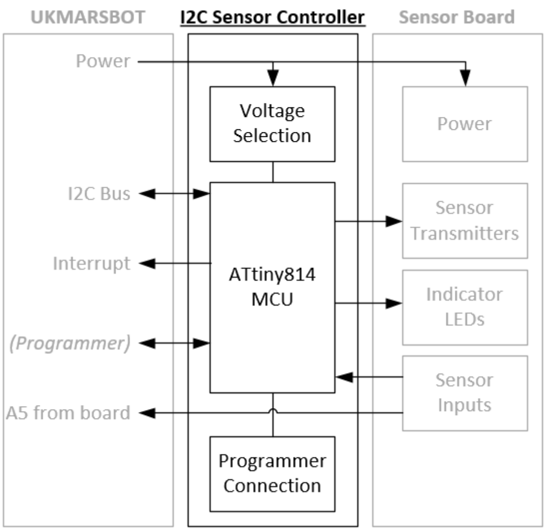


Table of Contents

1.0 PIN DESCRIPTIONS

The pin functions and recommended MCU pin configuration are listed in Table 1.

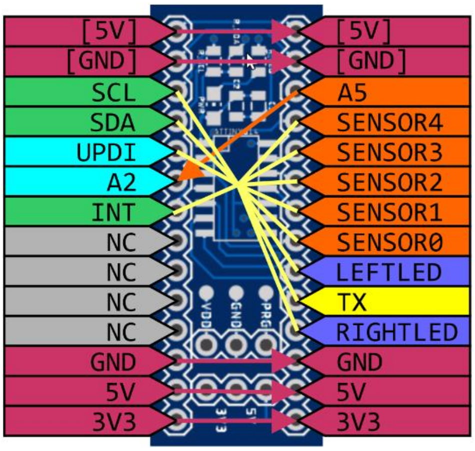


Table 1 - PINOUT DESCRIPTION

UKMARSBOT Pin Name	UKMARSBOT Pin Mode	Function
5V	Power	Provides 5V to equivalent Sensor Board pin
GND	Power	Provides Ground to equivalent Sensor Board pin
A5	I²C SCL	I²C Serial Clock (with optional pullup resistor attached)
A4	I²C SDA	I²C Serial Data (with optional pullup resistor attached)
A3	UPDI	Used only to flash program to the ISC when using Arduino as UPDI programmer
A2	Analog Input	Directly connected to A5 pin on Sensor Board
A1	Digital Input	Interrupt - configurable
A0	*NC*	*May use elsewhere on UKMARSBOT*
D11	*NC*	*May use elsewhere on UKMARSBOT*
D12	*NC*	*May use elsewhere on UKMARSBOT*
D6	*NC*	*May use elsewhere on UKMARSBOT*
GND	Power	Ground
5V	Power*	Provides 5V to equivalent Sensor Board pin
3V3	Power*	Provides 3.3V to equivalent Sensor Board pin

* The Voltage Selection jumper selects between these signals to supply power to the ISC and set the ADC reference voltage, this defines the logic levels and must match that of the MCU.

2.0 DEVICE OVERVIEW

The I²C Sensor Controller (ISC) consists of a programmed ATtiny814 microcontroller on a PCB with hardware pinouts to connect directly between the UKMARSBOT and sensor board. The device continuously samples the sensors and performs threshold comparison on these to return sensor states and may be configured to interrupt on specific state changes. Sensor values and configuration are stored in registers which are accessible to the UKMARSBOT MCU over an I²C bus.

Sensor Configuration

Sensors are configured in the SENS#SETUP register. To read the sensor, it must be Enabled. If ambient light removal is required, TX_EN must be set. The POLARITY register represents whether the sensor value increases with more reflected light or not. Finally, Rising and Falling interrupts may be configured by setting the corresponding bits.

Sensor State

Once a sensor is configured, the most recent value may be read directly from the SENS#VAL register. Furthermore, each enabled sensor is dynamically compared to the value contained in the associated threshold register (SENS#THRSH). If SENS#VAL exceeds this, the corresponding bit in SENSSTATE register is set. Hence the state of all sensors can be read as a single register for speed and convenience.

Interrupts

The interrupt pin indicates that an interrupt condition has occurred and will remain HIGH while INTERRUPTFLAGS ≠ 0. The interrupt conditions are configured in INTERRUPTCTRL register.

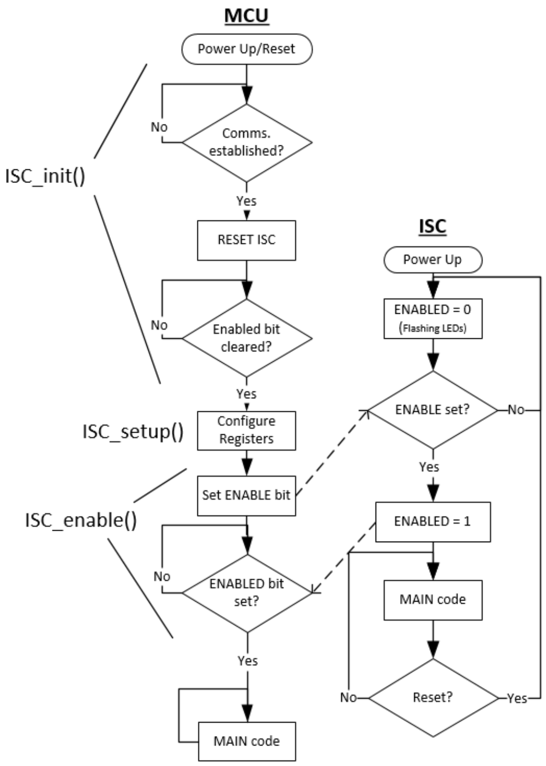
LED Indication

The built-in LED indicators on all UKMARSBOT sensor boards may be controlled by writing to the LEDCTRL register. LLED and RLED bits may be written to directly, however, the ISC offers internal control of the LEDs with the INDICATION_MODE value. When written to, the LEDs will be controlled independently of the UKMARSBOT MCU. They can be set to flash at different rates, indicate sensor state and more.

3.0 POWER-ON SEQUENCE

It is recommended that the ISC is connected to the UKMARSBOT and Sensor board prior to the supply of power. Once power is supplied, the ISC must be configured. Furthermore, any subsequent loss of power requires the configuration to be set again.

The following flow diagrams illustrate the relationship between MCU and ISC on Power-up or MCU reset.



1. When first connected to power, the ENABLED bit is LOW, indicating that registers must be configured by the MCU.
2. Once all registers have been configured, the MCU sets the ENABLE bit in the ISC.
3. The MCU waits for the ENABLED bit to be set, confirming that setup is complete.
4. MCU enters the main code.

It is recommended that the MCU always issue a RESET command after start-up in the event that the power has remained on, but the MCU has been reset. This forces the ISC back into a power-up state.

4.0 SERIAL INTERFACE (I²C)

The ISC contains individual 8-bit registers (some of which form pairs) that can be addressed through the I²C Serial Interface at address 0x50 (7-bit). An overview of these may be found in Section 6.0 ISC REGISTER SUMMARY. With further details located in Section 7.0 ISC REGISTER DESCRIPTION.

The ISC automatically increments the address pointer after sending each byte during the data transfer. This may be utilised when reading consecutive registers such as sensor values. Simply write the first register address, then read, with repeated starts to retrieve consecutive bytes. The address pointer automatically rolls over to address 0x00 after accessing the last register.

The I²C protocol requires pull-up resistors on the SCL and SDA lines, these are fitted to the ISC by default. If they are already fitted elsewhere on the bus, eg. MCU or other I²C peripheral, the resistors must be de-soldered from the ISC.

The ISC has been tested at 400 kHz clock speed with no adverse effects.

Refer to **Section 26. TWI – Two Wire Interface** of the ATTiny814 Manual for detailed requirements:

http://ww1.microchip.com/downloads/en/DeviceDoc/40001912A.pdf

Accessing 16-bit Registers

The I²C bus permits the transmission of data packets no longer than 8 bits in length. Registers permitted to contain a value exceeding 8-bits must be byte-accessed using two read or write operations.

For a write operation, the MSB of the 2-byte register pair must be written before the corresponding LSB. The MSB is stored in a temporary register until the LSB of the 2-byte register pair is written, the temporary register is then combined with this, and the 2-byte value is obtained and used by the ISC.

For a read operation, it is insignificant which of the two bytes in a 2-byte register pair is accessed first. When the LSB or MSB of a 2-byte register pair is read, the corresponding byte is copied into a temporary register in the same instruction as the initial read. When the corresponding byte is read, it is then read from the temporary register. This ensures that the low and high bytes of 16-bit registers are always accessed simultaneously when reading or writing the register.

5.0 PERFORMANCE

The following tests have been conducted to provide an indication of the performance that is to be expected from the ISC. All were performed with an Arduino Nano V3.0 Clone fitted onto a standard UKMARS Chassis with the ISC located between the UKMARSBOT and Basic Line Sensor board, operating at 5V.

The following remained constant for all experiments:

- All registers contain their default values other than what is detailed below.
- LED control was set to FREQOUT and a PicoScope2204 was connected to measure the loop frequency

5.1 Read 1 Sensor RAW value

TBD

5.2 Read 1 Sensor with Tx LED at ≥20µs

TBD

5.3 Read 6 Sensor's RAW values

TBD

5.4 Read 6 Sensors with Tx LED at ≥20µs

TBD

1 Sensor active with threshold comparison. 664us

Value / Counts per second = time (approx. 0.52ms for all 6 sensors).

6.0 ISC REGISTER SUMMARY

OFFSET	Name	Bit Pos								
0 (0x00)	FIRMVER	7:0	FIRMWARE_VERSION							
1 (0x01)	CONTROL	7:0	ENABLED			BOARD TYPE			RESET	ENABLE
2 (0x02)	LEDCTRL	7:0	LLED	RLED				INDICATION_MODE		
3 (0x03)	INTERRUPT CTRL	7:0	BRDINTEN			SENS4 INTEN	SENS3 INTEN	SENS2 INTEN	SENS1 INTEN	SENS0 INTEN
4 (0x04)	INTERRUPT FLAGS	7:0	BRDINT			SENS4 INT	SENS3 INT	SENS2 INT	SENS1 INT	SENS0 INT
5 (0x05)	SENSSTATE	7:0				SENS4 STATE	SENS3 STATE	SENS2 STATE	SENS1 STATE	SENS0 STATE
6 (0x06)	HYSTERESIS	7:0	HYSTERESIS							
7 (0x07)	PULSEDUR	7:0	PULSE_DURATION (µs)							
8 (0x08)	SENS0SETUP	7:0	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
9 (0x09)	SENS1SETUP	7:0	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
10 (0x0A)	SENS2SETUP	7:0	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
11 (0x0B)	SENS3SETUP	7:0	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
12 (0x0C)	SENS4SETUP	7:0	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
13 (0x0D)	Reserved	7:0								
14 (0x0E)	SENS0VAL	15:8	MSByte of SENS0VAL							
15 (0x0F)		7:0	LSByte of SENS0VAL							
16 (0x10)	SENS1VAL	15:8	MSByte of SENS1VAL							
17 (0x11)		7:0	LSByte of SENS1VAL							
18 (0x12)	SENS2VAL	15:8	MSByte of SENS2VAL							
19 (0x13)		7:0	LSByte of SENS2VAL							
20 (0x14)	SENS3VAL	15:8	MSByte of SENS3VAL							
21 (0x15)		7:0	LSByte of SENS3VAL							
22 (0x16)	SENS4VAL	15:8	MSByte of SENS4VAL							
23 (0x17)		7:0	LSByte of SENS4VAL							
24 (0x18)	Reserved	15:8								
25 (0x19)		7:0								
26 (0x1A)	SENS0THRSH	15:8	MSByte of SENS0THRSH							
27 (0x1B)		7:0	LSByte of SENS0THRSH							
28 (0x1C)	SENS1THRSH	15:8	MSByte of SENS1THRSH							
29 (0x1D)		7:0	LSByte of SENS1THRSH							
30 (0x1E)	SENS2THRSH	15:8	MSByte of SENS2THRSH							
31 (0x1F)		7:0	LSByte of SENS2THRSH							
32 (0x20)	SENS3THRSH	15:8	MSByte of SENS3THRSH							
33 (0x21)		7:0	LSByte of SENS3THRSH							
34 (0x22)	SENS4THRSH	15:8	MSByte of SENS4THRSH							
35 (0x23)		7:0	LSByte of SENS4THRSH							
36 (0x24)	Reserved	15:8								
37 (0x25)		7:0								
38 (0x26)	SCANTIME	15:8	MSByte of SCANTIME							
39 (0x27)		7:0	LSByte of SCANTIME							
40 (0x28)	Board Specific Registers – More details in specific board section.									
…										

7.0 ISC REGISTER DESCRIPTIONS

7.1 Firmware Version

- Name: FIRMVER
- Offset: 0x00
- Reset: 0x##

Address	7	6	5	4	3	2	1	0
0x00	FIRMWARE_VERSION[7:0]							
Access	R							
Reset	##							

Bits 7:0 – FIRMWARE_VERSION[7:0]

Firmware version installed on the ISC. See Section *8.4*

7.2 Control

- Name: CONTROL
- Offset: 0x01
- Reset: 0x00

Address	7	6	5	4	3	2	1	0
0x01	ENABLED			BOARD_TYPE[2:0]			RESET	ENABLE
Access	R			R/W			W	W
Reset	0			0			0	0

Bit 7 – ENABLED

Status of board operation:

Set HIGH when the ENABLE is HIGH

Set LOW when RESET is HIGH

Bits 4:2 – BOARD_TYPE[2:0]

Defines the board that is connected to the ISC:

Value	**Board**
0 (0x00)	Undefined
1 (0x01)	UKMARS Basic Line Sensor
2 (0x02)	UKMARS Basic Wall Sensor
3 (0x03)	S. Pithouse Line Sensor

May only be set when the board is not enabled ie. after power up or reset.

Bit 1 – RESET

Set HIGH to reset the sensor board. Clears to a 0 immediately. This sets ENABLED LOW.

Bit 0 – ENABLE

Set HIGH when to start the main sequence. Clears to a 0 immediately. This sets ENABLED HIGH.

7.3 Indicator LED Control

- Name: LEDCTRL
- Offset: 0x02
- Reset: 0x00

Address	7	6	5	4	3	2	1	0
0x02	LLED	RLED				INDICATION_MODE[2:0]		
Access	W	W				R/W		
Reset	0	0				0x00		

Bit 7 - LLED

The Left Indicator LED state may be set by writing a 0 or 1 to this bit only when *INDICATION_MODE* is set to MASTER CONTROL.

Bit 6 - RLED

The Right Indicator LED state may be set by writing a 0 or 1 to this bit only when *INDICATION_MODE* is set to MASTER CONTROL.

Bits 2:0 – INDICATION_MODE[2:0]

Value	**Description**	
0	MASTER CONTROL	Indicator LEDs are controlled by corresponding bits *LLED* and *RLED*
1	FREQOUT	Toggles LED state each sample cycle – this can be used to determine the sample rate
2	OFF	Force both indicator LEDs OFF
3	BRDCONTROL	Indicator LEDs reflect state specific to the attached Sensor board. See BRDCONFIG register for details
4	FASTBLINK	Indicator LEDs flash quickly until INDICATION MODE value is changed
5	SLOWBLINK	Indicator LEDs flash slowly until INDICATION MODE value is changed
6	ALTSLOWBLINK	As above but Left LED on when Right LED is off and vice versa

7.4 Interrupt Control

- Name: INTERRUPTCTRL
- Offset: 0x03
- Reset: 0x00

Address 0x03	7	6	5	4	3	2	1	0
	BRD INTEN			SENS4 INTEN	SENS3 INTEN	SENS2 INTEN	SENS1 INTEN	SENS0 INTEN
Access	R/W			R/W	R/W	R/W	R/W	R/W
Reset	0			0	0	0	0	0

Bit 7 – BRDINTEN

Set HIGH to enable interrupts from *BRDINTFLAG* register.

Bit 4-0 – SENS4INTEN – SENS0INTEN

Set HIGH to enable an interrupt on the corresponding sensor changing state.

NOTE that the interrupt bit must be set in *SENS#SETUP* to enable the specific sensor to trigger an interrupt.

7.5 Interrupt Flags

- Name: INTERRUPTFLAGS
- Offset: 0x04
- Reset: 0x00

Address 0x04	7	6	5	4	3	2	1	0
	BRD INT			SENS4 INT	SENS3 INT	SENS2 INT	SENS1 INT	SENS0 INT
Access	R			R/W	R/W	R/W	R/W	R/W
Reset	0			0	0	0	0	0

Bit 7 – BOARD

HIGH when a bit is set in *BRDINTFLAGS.*

LOW when all bits in *BRDINTFLAGS* are LOW.

See *BRDINTFLAGS* for details on how to clear interrupt bits.

Bit 4-0 – SENS#STATE

Set HIGH internally by the ISC if the following conditions are met:

SENS#INTEN set HIGH in INTERRUPT_CTRL		
R_INT_ENB set HIGH in SENS#SETUP SENS#VAL has risen above SENS#THRSH	OR	F_INT_ENB set HIGH in SENS#SETUP SENS#VAL has fallen below SENS#THRSH

Reset when the register is read (??changed 08/04/21??)

~~Must be reset externally. To reset, write a 1 to the corresponding bit location.~~

7.6 Sensor State

- Name: SENSSTATE
- Offset: 0x05
- Reset: 0x00

Address 0x05	7	6	5	4	3	2	1	0
				SENS4STATE	SENS3STATE	SENS2STATE	SENS1STATE	SENS0STATE
Access				R	R	R	R	R
Reset				0	0	0	0	0

Bit 4-0 – SENS#STATE

Result of most recent comparison between *SENS#VAL* and *SENS#THRSH* registers.

HIGH if SENS#VAL > SENS#THRSH.

Note that hysteresis of 25 is used to prevent jitter, potentially causing unwanted interrupts if the sensor fluctuates around the threshold value.

If the corresponding interrupt flag is on, the state remains frozen until the interrupt is cleared. This allows the state to be interrogated to determine the direction of the interrupt.

7.7 Hysteresis

- Name: HYSTERESIS
- Offset: 0x06
- Reset: 0x0A

Address	7	6	5	4	3	2	1	0
0x06	HYSTERESIS[7:0]							
Access	R/W							
Reset	0x32							

Bits 7:0 – HYSTERESIS[7:0]

Amount of Hysteresis used when determining Sensor States and threshold. See below diagram of the implementation:

???insert hysteresis diagram here??

7.8 Pulse Duration

- Name: PULSEDUR
- Offset: 0x07
- Reset: 0x0A

Address	7	6	5	4	3	2	1	0
0x07	PULSE_DURATION[7:0]							
Access	R/W							
Reset	0x1E							

Bits 7:0 – PULSE_DURATION[7:0]

Delay (in µs) before an ADC is performed. This allows light levels to stabilise. Default value of 30µs was found to work well.

7.9 Sensor Setup

- Name: SENS#SETUP
- Offset: 0x08 –> 0x0C
- Reset: 0x00

Address	7	6	5	4	3	2	1	0
0x08	R_INTENB	F_INTENB	POLARITY			TX_EN	RESOL	ENB
Access	R/W	R/W	R/W			R/W	R/W	R/W
Reset	0	0	0			0	0	0

Bit 7 – R_INTENB

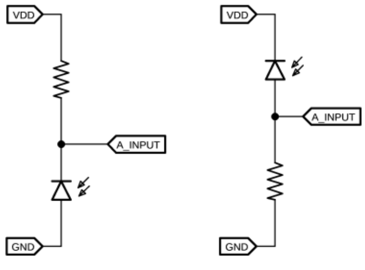
Enables ability for Sensor to trigger an interrupt on a rising edge change – note that sensor state interrupt must be enabled in *INTCTRL* Register.

Bit 6 - F_INTENB

Enables ability for sensor to trigger an interrupt on a falling edge change – note that sensor state interrupt must be enabled in *INTCTRL* Register.

Bit 5 - POLARITY

Not used when BOARD TYPE is defined. POLARITY is used to inform the ISC whether a low Analog Read value represents white or black.



Bit 2 – TX_EN

0: Disables the use of the Emitter LED when sampling the sensor. The selected sensor is sampled with the LED turned off and the result is returned in *SENS#VAL* Register.

1: Enables the use of the Sensor Transmitter. The sensors will be sampled, then the Emitter turned on for a duration (in units of µs) set by *PULSEDUR* register before being sampled again. The difference between these is returned in *SENS#VAL* Register.

Bit 1 – RESOLUTION

0: *SENS#VAL* Register pair contains 10-bit result from sensor

1: *SENS#VAL* Register pair contains 8-bit result from sensor. The ADC sample resolution remains 10-bit, it is converted to 8-bit when stored in the register.

Bit 0 - ENB

When TRUE, the sensor will be sampled each scan, set this to FALSE if sensor is not being used to reduce time between consecutive samples

7.10 Sensor Value

- Name: SENS#VAL
- Offset: 0x0E -> 0x17
- Reset: 0x0000

Address	7	6	5	4	3	2	1	0
0x0E	MSByte of SENS0VAL							
0x0F	LSByte of SENS0VAL							
0x10 – 0x17	MSByte/LSByte of SENS1-4VAL							
Access	R							
Reset	0x00							

Addresses 0x0E to 0x17 allow the most recent sensor value to be read for each sensor, starting with Sensor 0. Values are up to 10-bits long, hence are organised across two registers.

When the MSB register is read, the corresponding I2C register becomes ‘frozen’ so that the LSB register refers to the same value. This prevents the value getting updated between MSB and LSB reads.

After the LSB register has been read, the value becomes ‘unfrozen’, allowing it to update before the next read.

7.11 Sensor Threshold

- Name: SENS#THRSH
- Offset: 0x1A -> 0x23
- Reset: 0x0000

Address	7	6	5	4	3	2	1	0
0x1A	MSByte of SENS0THRSH							
0x1B	LSByte of SENS0THRSH							
0x1C - 0x23	MSByte/LSByte of SENS1-4THRSH							
Access	R/W							
Reset	0x0000							

Addresses 0x1A to 0x23 contain sensor threshold values associated with each sensor, starting with Sensor 0. Values may be up to 10-bits long, hence are organised across two registers.

Bits 15:0 – SENS0THRSH[15:0]

Threshold value which sensor value is compared against to determine the sensor state.

7.12 Scan Time

- Name: SCANTIME
- Offset: 0x26 -> 0x27
- Reset: 0x0000

Address	7	6	5	4	3	2	1	0
0x26	MSByte of SCANTIME[15:8]							
0x27	LSByte of SCANTIME[7:0]							
Access	R							
Reset	0x0000							

Bits 15:0 - SCANTIME[15:0]

Time (in µs) taken for the last complete cycle. May be used to monitor the Sensor refresh rate.

The value (0 µs to 13,107 µs) has a resolution of 0.2µs.

Note that in the event that a Timer overflow occurs, a value of 0xFFFF will be stored.

8.0 LINE SENSOR REGISTER SUMMARY

OFFSET	Name	Bit Pos								
39 (0x28)	BRDCONFIG	7:0	CALIB COMPL					BRD_INDICATION_MODE		
40 (0x29)	BRDINTCTRL	7:0							CROSS OVERINTEN	LOST LINEINTEN
41 (0x2A)	BRDINTFLAGS	7:0							CROSS OVERINT	LOST LINEINT
42 (0x2B)	LINEERROR	15:8	MSByte of Line Error							
43 (0x2C)		7:0	LSByte of Line Error							

8.1 Board Configuration

- Name: BRDCONFIG
- Offset: 0x27
- Reset: 0x00

Address 0x27	7	6	5	4	3	2	1	0
	CALIB COMPL					BRD_INDICATION_MODE		
Access	R					R/W		
Reset	0					0		

Bit 7 – CALIBCOMPL

Gets set to TRUE once the initial line sensor calibration has completed

Bits 2:0 - BRD_INDICATION_MODE

When LEDCTRL INDICATION_MODE value is set for BRDCONTROL, BRD_INDICATION_MODE value controls the status of the LEDs.

Value	**Description**	
0	SIDE	Indicator LEDs indicate the side of the line that the robot is on
1	MARKER Threshold	Indicator LEDs indicate the live state of the track marker sensors
2	L/R threshold	Left LED ON when left sensor above threshold, and right LED on when right sensor above threshold

8.2 Board Interrupt Control

- Name: BRDINTCTRL
- Offset: 0x28
- Reset: 0x00

Address 0x28	7	6	5	4	3	2	1	0
							CROSS OVRINT EN	LOST LINEINT EN
Access							R/W	R/W
Reset	0x00							

Bit 1 – CROSSOVERINTEN

Set HIGH to enable interrupts from *CROSSOVERINT* bit.

Bit 0 – LOSTLINEINTEN

Set HIGH to enable interrupts from *LOSTLINEINT* bit.

8.3 Board Interrupt Flags

- Name: BRDINTFLAGS
- Offset: 0x29
- Reset: 0x00

Address 0x29	7	6	5	4	3	2	1	0
							CROSS OVRINT	LOST LINEINT
Access							R/W	R/W
Reset							0	0

Bit 2 – CROSSOVRINT

Set to TRUE when a crossover is detected – may be used to ignore marker sensors. Reset by writing a 1 to this location

Bit 0 – LOSTLINEINT

Set TRUE when the sensor cannot detect a line. Reset by writing a 1 to this location

8.4 Line Error

- Name: Line Error
- Offset: 0x2A -> 0x2B
- Reset: 0x0000

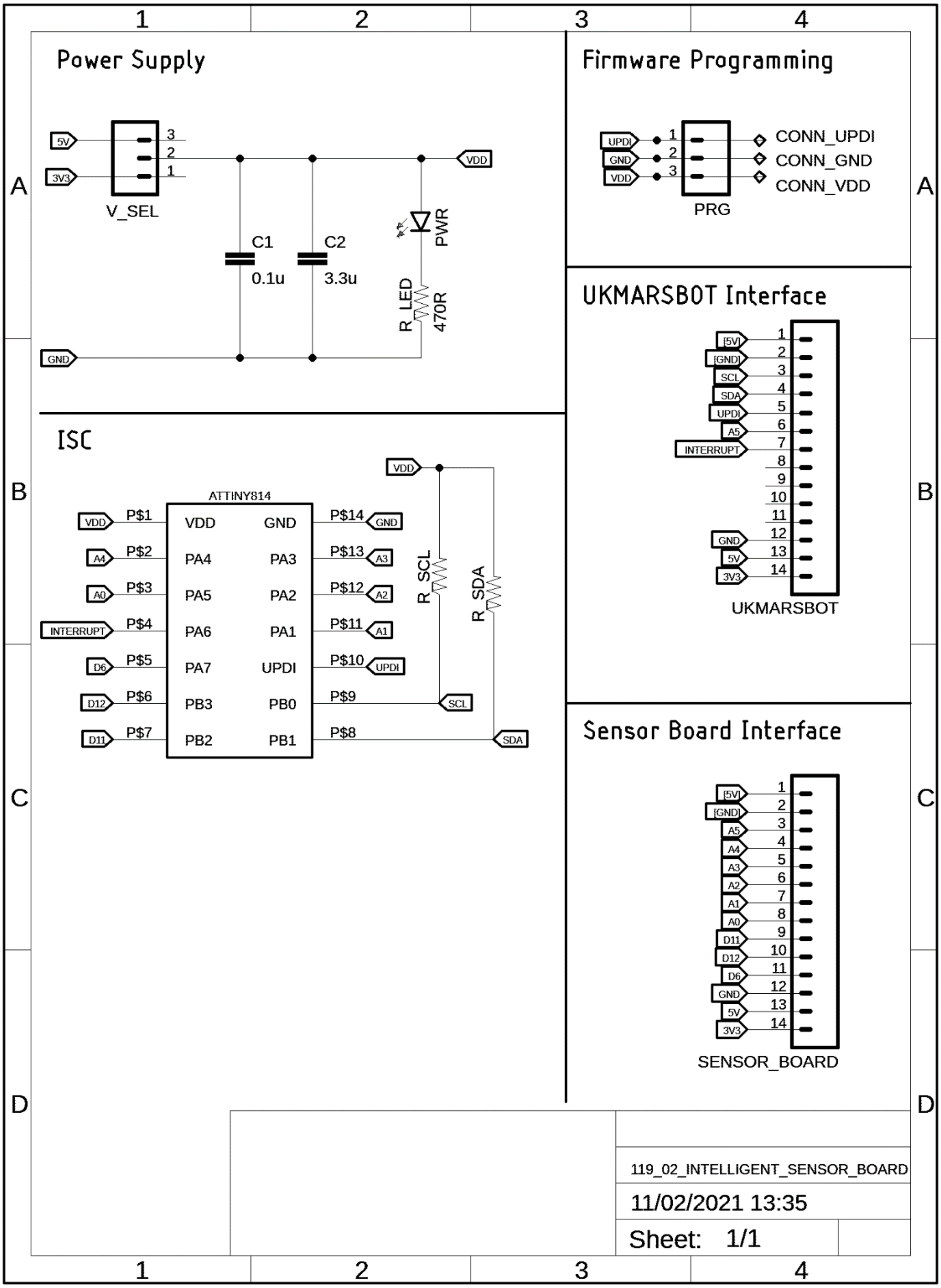
Address	7	6	5	4	3	2	1	0
0x2A	MSByte of LINEERROR[15:8]							
0x2B	LSByte of LINEERROR[7:0]							
Access	R							
Reset	0x0000							

Bits 15:0 – LINEERROR

Distance from line. Note that a value of 512 represents no error (centred on line).

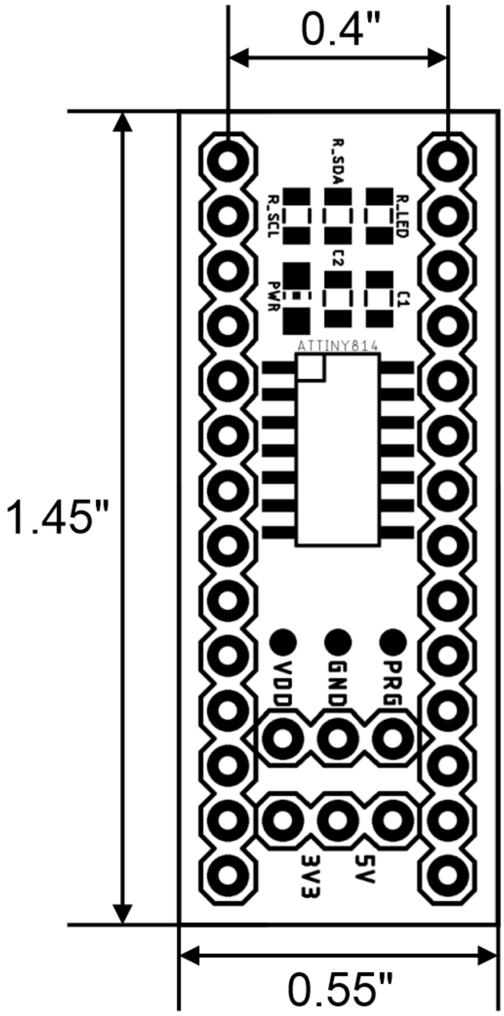
The LINEERROR[15:8] and LINEERROR[7:0] register pair represents the 16-bit value, LINEERROR. The high byte [15:8] is accessible at the original offset. The low byte [7:0] can be accessed at offset + 0x01. For more details on reading and writing 16-bit registers, refer to Accessing 16-bit Registers.

9.0 SCHEMATIC



10.0 DIMENSIONS

The below diagram details the outer board dimension and the distance between header rows. The header pitch is a standard 0.1".



11.0 FIRMWARE REVISION HISTORY

Firmware revisions are detailed in Table 2.

Table 2 - Revision History

Version	Date	Details
1	05/04/2021	Release Version
2	06/06/2021	Rewritten with OO code