Humidity and Temperature Digital Sensors BCHTS4085 Datasheet

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Introduction

This document describes BCHTC4085 integrated humidity and temperature sensor that provides high accuracy measurements with very low power consumption based on the “Texas Instruments HDC2010 IC”.

The sensing element of the BCHTC4085 is placed on the bottom part of the device, which makes the BCHTC4085 more robust against dirt, dust, and other environmental contaminants. The capacitive based sensor includes new integrated digital features and a heating element to dissipate condensation and moisture.

The BCHTC4085 digital features include programmable interrupt thresholds to provide alerts/system wakeups without requiring a microcontroller to be continuously monitoring the system. This, combined with programmable sampling intervals, low inherent power consumption, and support for 1.8V supply voltage, make the BCHTC4085 well suited for battery-operated systems.

The BCHTC4085 provides high accuracy measurement capability for a wide range of environmental monitoring applications and Internet of Things (IoT) such as smart thermostats, smart home assistants and wearables.

The BCHTC4085 can also be used to provide critical temperature and humidity data for cold chain transportation and storage of perishable goods to help ensure products like food and pharmaceuticals arrive fresh.

The BCHTC4085 is factory-calibrated to 0.2°C temperature accuracy and 2% relative humidity accuracy and includes a heating element to burn away condensation and moisture for increased reliability. The BCHTC4085 supports operation from -40°C to 125°C and from 0% to 100% relative humidity.

Features

- Typical 50nA of current consumption in sleep mode
- Typical 105nA of current consumption in 1 measurement every 10 seconds (RH+Temperature)
- The heater can be activated, allowing temperature be increased until 80°C
- programmable interrupt thresholds to provide alerts/system
- Standard I2C Digital Interface. Host system have to pull up SCL and SDA by 4k7 resistors
- 20*20 mm size
- 7 bit I2C address is decimal 64/ hex 0x40 (alternate address to be selected decimal 65/hex 0x41)
- implements temperature and humidity peak detector function. (after the power up)

Absolute Maximum Ratings

Parameter	Min.	Max.	Unit	Comments
VDD	-0.3	3.9	V	Input Voltage
GND	-0.3	3.9	V	Input Voltage
SCL	-0.3	3.9	V	Input Voltage
SDA	-0.3	3.9	V	Input Voltage
T_stg	-65	150	℃	Storage temperature

Electrical Characteristics

Parameters	Conditions	Min	Typ	Max	Unit
Supply Voltage	Operating Range	1.62		3.6	V
Supply Current	RH measurement		650	890	uA
	Temperature measurement		550	730	
	Sleep Mode		0.05	0.1	
	Average at 1 measurement/second, RH or temperature only		0.3		
	Average at 1 measurement/second, RH (11 bit) + temperature (11 bit)		0.55		
	Average at 1 measurement every 2 seconds, RH (11 bit) + temperature (11 bit)		0.3		
	Average at 1 measurement every 10 seconds, RH (11 bit) + temperature (11 bit)		0.105		
	Startup (average on startup time)		80		
Heater Current	Supply Voltage is 3.3V		90		mA
RH Accuracy			±2	±3	%RH
RH Repeatability	14 bit Resolution		±0.1		%RH
RH Hysteresis			±1		%RH
RH Response Time	Time for the RH output to change by 63% of the total RH change after a step change in environmental humidity		8		s
RH Conversion-time	9 bit accuracy		275		us
	11 bit accuracy		400		

	14 bit accuracy		660		
RH Operating Range	Non-condensing	0		100	%RH
RH Long-term Drift			±0.25		%RH/yr
TEMP Operating range		-40		125	℃
TEMP Accuracy	5℃ < Temp < 60℃		±0.2	±0.4	℃
TEMP Repeatablilty	14 bit resolution		±0.1		℃
TEMP Conversion-time	9 bit accuracy		225		us
	11 bit accuracy		350		
	14 bit accuracy		610		
I2C Clock Frequency	VDD = 1.8V	10		400	kHz
I2C Clock Low Time		1.3			us
I2C Clock High Time		0.6			us
I2C Shutdown entry delay			10	15	ms

Detailed Description

Low Power Consumption

The BCHTC4085 is low power consumption. If need save power, spends most of the time in sleep mode: with a typical 50nA of current consumption in sleep mode, the averaged current consumption is minimal. Its low consumption in measurement mode minimizes any self-heating.

Heater

The heater is an integrated resistive element that can be switched on briefly to prevent or remove any condensation that may build at high humidity environments. Additionally the heater can be used to functionally check the integrated temperature sensor. The heater can be activated using HEAT_EN, bit 3 in the Reset and DRDY/INT Configuration Register (0x0E). The current consumption of the heater is typically 130mA, allowing a temperature increase of about 80°C.

Interrupt Description

Although multiple interrupt bits may be enabled, the DRDY/INT pin can only reflect the status of one interrupt bit at a time. DRDY/INT pin DOES NOT function as the logical ‘OR’ of interrupt bits that have been enabled.

Highest priority is given to TH_ENABLE, followed by TL_ENABLE, HH_ENABLE, and HL_ENABLE in descending order. To use DRDY/INT to track HL_ENABLE would require the remaining ENABLE bits to be set to zero.

To use DRDY/INT to track HH_ENABLE would require TH_ENABLE and TL_ENABLE to be set to zero. To use DRDY/INT to track TL_ENABLE would require TH_ENABLE to be set to zero.

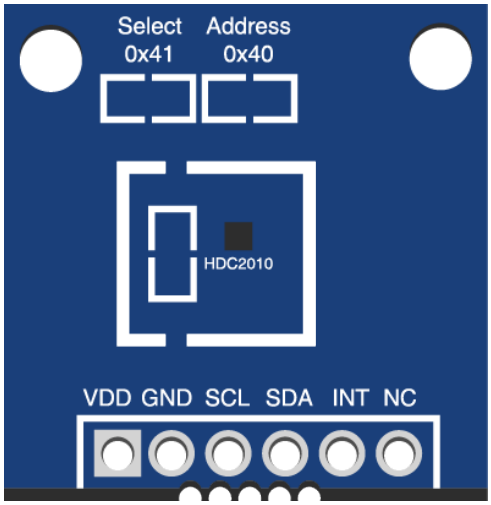
Device Function Modes

The BCHTC4085 has two modes of operation: sleep mode and measurement mode. After power up, the BCHTC4085 is in sleep mode. In this mode, the BCHTC4085 waits for I2C inputs including commands to configure the conversion times, trigger a measurement, set the ODR and read measurements. Once it receives a command to trigger a measurement, the BCHTC4085 moves from sleep mode to measurement mode. In measurement mode, the BCHTC4085 acquires the configured measurements and sets the DRDY/INT pin. After completing the measurement, the BCHTC4085 returns to sleep mode.

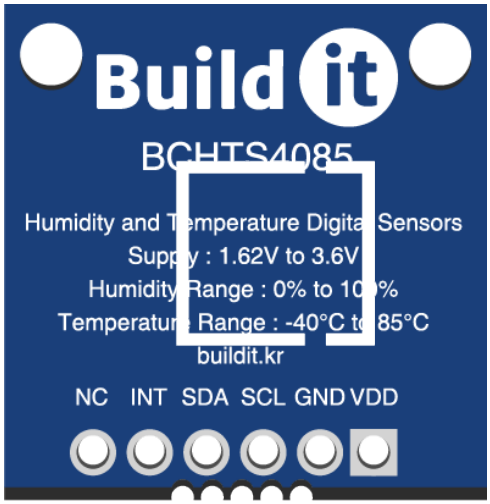
BCHTC4085 has two measurement trigger modes: On-Demand and automatic Output Data Rate.

In the On-Demand mode an I2C command triggers the conversion. In the automatic Output Data Rate a conversion frequency is configured among 7 different possibilities (from 5 samples per second down to 1 sample every 2 minutes). BCHTC4085 moves from sleep to measurement mode automatically based on the selected data rate. At the end of the conversion, the new data overwrites the previous output data.

Pin Out Description



[TOP VIEW]



[BOTTOM VIEW]

PIN	Description
VDD	Supply Voltage for operating IC
GND	Ground
SCL	SCL is used for I2C clock. Should be pulled up to VCC with 4k7 resistor
SDA	SDA is used for I2C data. Should be pulled up to VCC with 4k7 resistor
INT	Active low optional output. It is pulled low. Set threshold value has been triggered
NC	No Connection

Application Information

I2C Interface

I2C Read and Write Operations

To access a particular register on the BCHTC4085, by writing the appropriate value to the register address. The register address value is the first byte transferred after the device slave address byte with the R/W bit low. Every write operation to the BCHTC4085 requires a value for the register address.

Master	Start	Slave address(W)		Address		DATA		STOP
Slave			ACK		ACK		ACK	

When reading from the BCHTC4085, the last value stored in the register address by a write operation is used to determine which register is read by a read operation. To change the address for a read operation, a new value must be written to the pointer. This transaction is accomplished by issuing the slave address byte with the R/W bit low, followed by the pointer byte. No additional data is required.

Master	Start	Slave address(W)		Address		DATA		.....	STOP
Slave			ACK		ACK		ACK		

The master can then generate a START condition and send the slave address byte with the R/W bit high to initiate the read command. The address value is incremented automatically enabling the multibyte read and write operation. Note that register bytes are sent MSB first, followed by the LSB. A write operation in a read-only register such as (DEVICE ID, MANUFACTURER ID, SERIAL ID) returns a NACK after each data byte; read/write operation to unused address returns a NACK after the pointer; a read/write operation with incorrect I2C address returns a NACK after the I2C address.

Master	Start	Slave address(R)		Address		Start	Slave address(R)			NACK	STOP
Slave			ACK		ACK			ACK	DATA		

Master	Start	Slave address (R)		Address		Start	Slave address (R)			ACK		ACK	.....	NACK	STOP
Slave			ACK		ACK			ACK	DATA		DATA				

- Default address is hex/0x40

Application Register

Application Register overview

Address	Register Name	Reset Value	Description
0x00	TEMPERATURE LOW	0	Temperature [7:0]
0x01	TEMPERATURE HIGH	0	Temperature [15:8]
0x02	HUMIDITY LOW	0	Humidity [7:0]
0x03	HUMIDITY HIGH	0	Humidity [15:8]
0x04	INTERRUPT/DRDY	0	Data Ready and interrupt configuration
0x05	TEMPERATURE MAX	0	Max temperature value measured (Peak detector)

0x06	HUMIDITY MAX	0	Max humidity value measured (Peak detector)
0x07	INTERRUPT ENABLE	0	Interrupt Enable
0x08	TEMP_OFFSET_ADJUST	0	Temperature offset adjustment
0x09	HUM_OFFSET_ADJUST	0	Humidity offset adjustment
0x0A	TEMP_THR_L	00000000	Temperature Threshold Low
0x0B	TEMP_THR_H	11111111	Temperature Threshold High
0x0C	RH_THR_L	00000000	Humidity Threshold Low
0x0D	RH_THR_H	11111111	Humidity Threshold High
0x0E	RESET&DRDY/INT CONF	0	Soft Reset and Interrupt configuration
0x0F	MEASUREMENT CONF	0	Measurement configuration
0xFC	MANUFACTURER ID LOW	01001001	Manufacturer ID Low
0xFD	MANUFACTURER ID HIGH	01010100	Manufacturer ID High
0xFE	DEVICE ID LOW	11010000	Device ID Low
0xFF	DEVICE ID HIGH	00000111	Device ID High

Temperature LSB Register (0x00) / Temperature MSB Register (0x01)

BIT	Field	Type	Reset	Description
7:0	TEMPERATURE[7:0]	R	00000000	Temperature LSB
15:8	TEMPERATURE[15:8]	R	00000000	Temperature MSB

The temperature register is a 16-bit result register in binary format (the 2 LSBs D1 and D0 are always 0). The result of the acquisition is always a 14 bit value, while the resolution is related to one selected in Measurement Configuration register. The temperature can be calculated from the output data with:

$$\text{Temperature}(℃) = \left(\frac{TEMPERATURE[15:0]}{2^{16}}\right) \times 165 - 40$$

Humidity LSB Register (0x02) / Humidity MSB Register (0x03)

BIT	Field	Type	Reset	Description
7:0	HUMIDITY[7:0]	R	00000000	Humidity LSB
15:8	HUMIDITY[15:8]	R	00000000	Humidity MSB

The humidity register is a 16-bit result register in binary format (the 2 LSBs D1 and D0 are always 0). The result of the acquisition is always a 14 bit value, while the resolution is related to one selected in Measurement Configuration register. The humidity can be calculated from the output data with:

$$\text{Humidity}(\%RH) = \left(\frac{HUMIDITY[15:0]}{2^{16}}\right) \times 100$$

Interrupt DRDY Register(0x04)

BIT	Field	Type	Reset	Description
7	DRDY_STATUS	R/W	0	Data Ready bit status 0 = Data Not Ready 1 = Data Ready DRDY_STATUS is cleared to 0 when read
6	TH_STATUS	R/W	0	Temperature threshold HIGH Interrupt status 0 = No interrupt 1 = Interrupt TH_STATUS is cleared to 0 when read
5	TL_STATUS	R/W	0	Temperature threshold LOW Interrupt status 0 = No interrupt 1 = Interrupt TL_STATUS is cleared to 0 when read
4	HH_STATUS	R/W	0	Humidity threshold HIGH Interrupt status 0 = No interrupt 1 = Interrupt HH_STATUS is cleared to 0 when read
3	HL_STATUS	R/W	0	Humidity threshold LOW Interrupt status 0 = No interrupt

				1 = Interrupt HL_STATUS is cleared to 0 when read
2	RES		0	Reserved
1	RES		0	Reserved
0	RES		0	Reserved

DRDY_STATUS indicates that temperature and/or humidity conversion is terminated. This bit is cleared when the Interrupt/DRDY register is read or the output registers TEMPERATURE_HIGH, TEMPERATURE_LOW, HUMIDITY_HIGH and HUMIDITY_LOW are read.

The TL_STATUS indicates that the Temperature Threshold LOW value is exceeded. The behavior is defined by 0x0E Configuration register value. The bit is cleared when the register Interrupt DRDY is read.

The TH_STATUS indicates that the Temperature Threshold HIGH value is exceeded. The behavior is defined by 0x0E Configuration register value. The bit is cleared when the register Interrupt DRDY is read.

The HH_STATUS indicates that the Humidity Threshold HIGH value is exceeded. The behavior is defined by 0x0E Configuration register value. The bit is cleared when the register Interrupt DRDY is read.

The HL_STATUS indicates that the Humidity Threshold LOW value is exceeded. The behavior is defined by 0x0E Configuration register value. The bit is cleared when the register Interrupt DRDY is read.

DRDY/INT pin behaves like the STATUS bits based on the 0x0E Configuration register value.

Temperature MAX Register (0x05)

BIT	Field	Type	Reset	Description
7:0	TEMPERATUREMAX[7:0]	R/W	00000000	Temperature max value measured (peak detection) Write 0x00 to erase the last value

The temperature can be calculated from the output data with:

$$\text{Temperature}(℃) = \left(\frac{TEMPERATUREMAX[7:0]}{2^8}\right) \times 165 - 40$$

Humidity MAX Register (0x05)

BIT	Field	Type	Reset	Description
7:0	HUMIDITYMAX[7:0]	R/W	00000000	Humidity max value measured (peak detection) Write 0x00 to erase the last value

The temperature can be calculated from the output data with:

$$\text{Humidity}(\%RH) = \left(\frac{HUMIDITYMAX[7:0]}{2^8}\right) \times 100$$

Reset and DRDY/INT Configuration Register (0x0E)

BIT	Field	Type	Reset	Description
7	SOFT_RES	R/W	0	0 = Normal Operation mode, this bit is self-clear 1 = Soft Reset EEPROM value reload and registers reset
6:4	ODR[2:0]	R/W	000	Output Data Rate 000 = No repeated measurements. Trigger on demand 001 = 1/120Hz (1 samples every 2 minutes) 010 = 1/60Hz (1 samples every minute) 011 = 0.1Hz (1 samples every 10 seconds) 100 = 0.2 Hz (1 samples every 5 second) 101 = 1Hz (1 samples every second) 110 = 2Hz (2 samples every second) 111 = 5Hz (5 samples every second)
3	HEAT_EN	R/W	0	0 = Heater off 1 = Heater on
2	DRDY/INT_EN	R/W	0	DRDY/INT_EN pin configuration 0 = High Z 1 = Enable
1	INT_POL	R/W	0	Interrupt polarity 0 = Active Low 1 = Active High
0	INT_MODE		0	Interrupt mode

				0 = Level sensitive 1 = Comparator mode

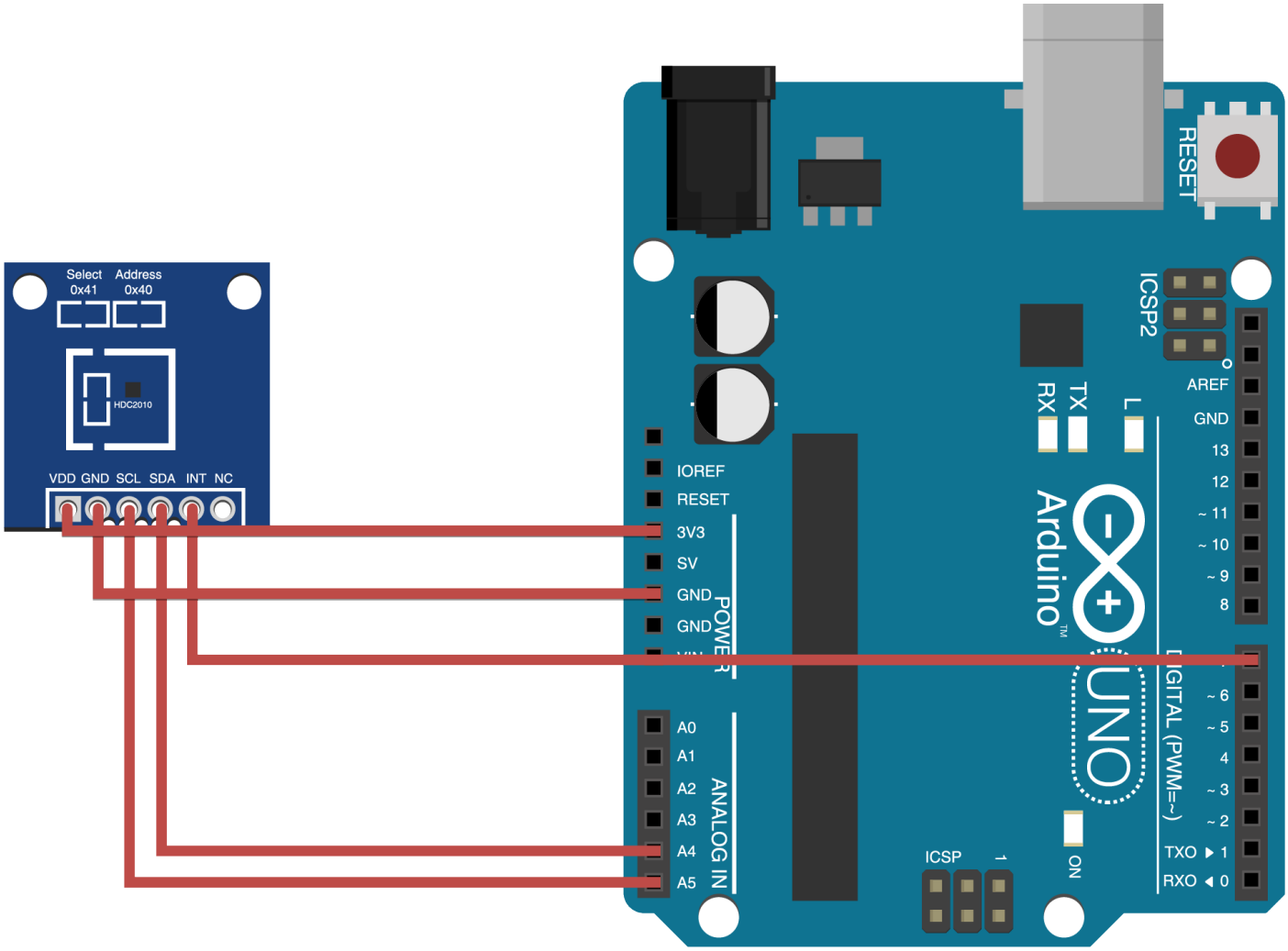
Measurement Configuration Register (0x0F)

BIT	Field	Type	Reset	Description
7:6	TRES[1:0]	R/W	00	Temperature resolution 00: 14 bit 01: 11 bit 10: 9 bit 11: NA (TBC)
5:4	HRES[1:0]	R/W	00	Humidity resolution 00: 14 bit 01: 11 bit 10: 9 bit 11: NA (TBC)
3	RES	R/W	0	Reserved
2:1	MEAS_CONF[1:0]	R/W	00	Measurement configuration 00: Humidity + Temperature 01: Temperature only 10: Humidity Only 11: NA
0	MEAS_TRIG	R/W	0	Measurement trigger 0: no action 1: Start measurement Self-clearing bit when measurement completed

ETC

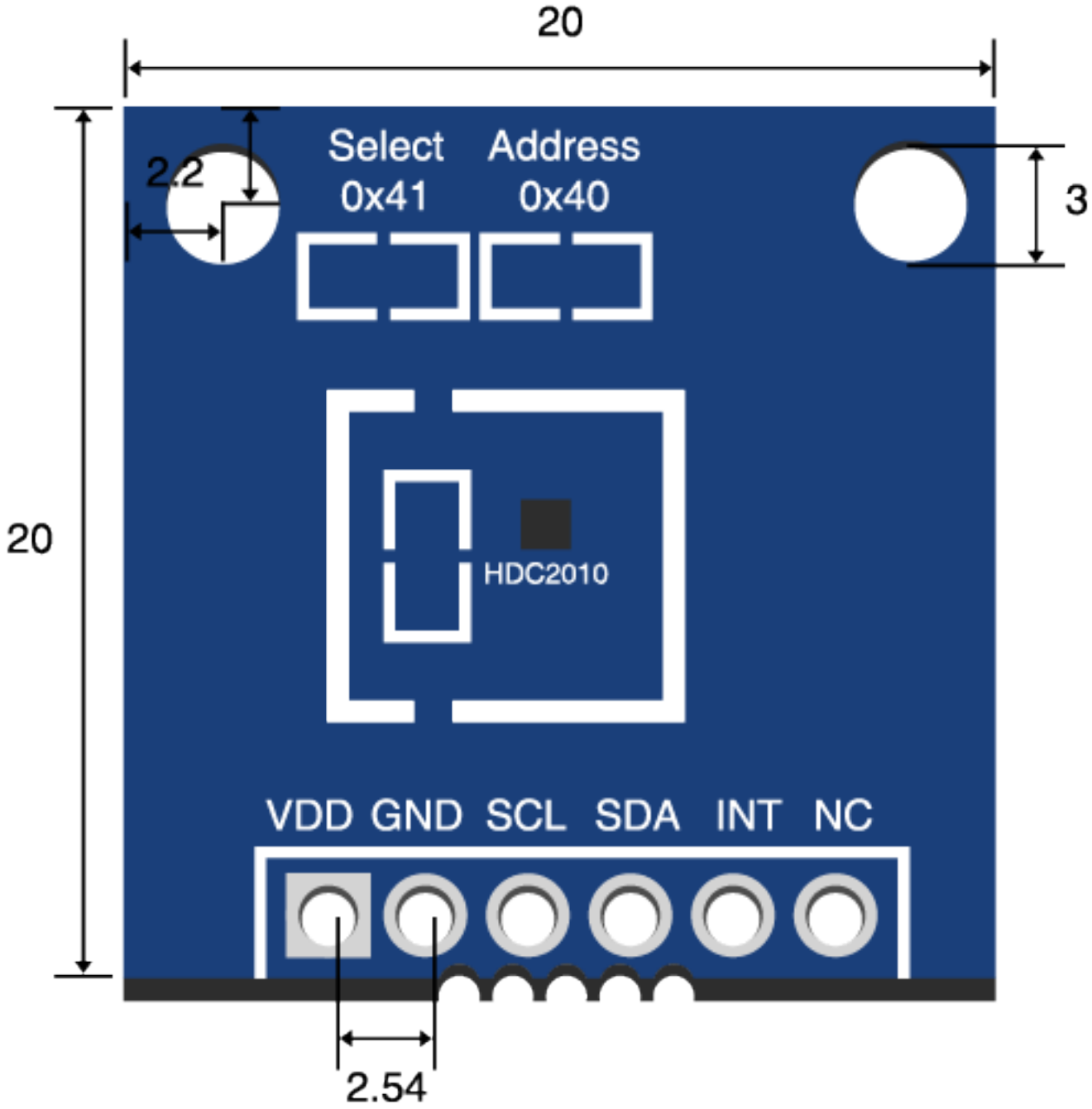
Refer to the Texas Instruments HDC2010_datasheet for a description of other Registers not listed in this datasheet.

Application Guide



Refer to the BC_Sensors_Application_Guide.pdf for a description of facilitates communication with, and configuration of, BC series Sensors for Arduino.

Dimensions


20
2.2
Select
0x41
Address
0x40
3
20
HDC2010
VDD GND SCL SDA INT NC
2.54