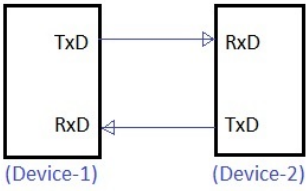
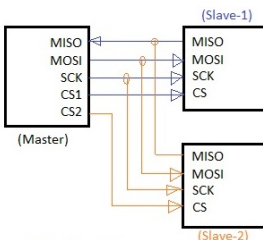
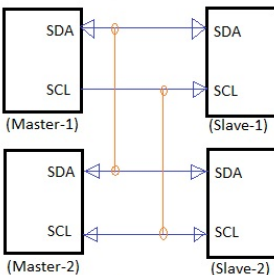


Name.: Harshavardhan Alimi

Roll No.:18EC10021

1.

Features	UART	SPI	I2C
Full-Form	Universal Asynchronous Receiver/Transmitter	Serial Peripheral Interface	Inter-Integrated Circuit
Interface Diagram			
Pin Designations	TxD: Transmit Data RDX: Receive Data	SCLK: Serial Clock MOSI: Master Output, Slave Input MISO: Master Input, Slave Output SS: Slave Select	SDA: Serial Data SCL: Serial Clock
Data rate	As this is asynchronous communication, the data rate between two devices wanting to communicate should be set to equal value. The maximum data rate supported is about 230 Kbps to 460kbps.	The maximum data rate limit is not specified in the SSPI interface. Usually supports about 10 Mbps to 20 Mbps	I2C supports 100 kbps, 400 kbps, 3.4 Mbps. Some variants also support 10 Kbps and 1 Mbps.
Distance	Lower about 50 feet	highest	Higher
Type of communication	Asynchronous	Synchronous	Synchronous
Number of masters	Not Application	One	One or more than One
Clock	No Common Clock signal is used. Both the devices will use their independent clocks.	There is one common serial clock signal between master and slave devices.	There is a common clock signal between multiple masters and multiple slaves.
Hardware complexity	lesser	less	more

Software addressing	As this is one to one connection between two devices, addressing is not needed.	Slave select lines are used to address any particular slave connected with the master. There will be 'n' slave select lines on the master device for 'n' slaves.	There will be multiple slaves and multiple masters and all masters can communicate with all the slaves. Up to 27 slave devices can be connected/addressed in the I2C interface circuit.
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2. wireless temperature measurement

Description:-

This project demonstrates highly-accurate sensing of temperature using the TMP117 high precision digital temperature sensor with CC2640R2F wireless MCU(has integrated bluetooth) and bq24030 as a power management chip.

Features:-

- High accuracy ($\pm 0.1^{\circ}\text{C}$) temperature measurement.
- 2.4-GHz RF transceiver compatible with Bluetooth® low energy (BLE) 4.2 and 5 specifications
- Integrated PCB antenna
- Flexible PCB design
- Charge Status Outputs for LED or System Interface Indicates Charge and Fault Conditions
- Integrated PCB antenna.
- Rechargeable Device.
- Thermal Regulation for Charge Control.
- IOS app for device monitoring.

Choice of components:-

TMP117 Description:-

The TMP117 is a low-power, high-precision temperature sensor that provides a 16-bit temperature result, with a resolution of $7.8125\text{ m}^{\circ}\text{C}$ and an accuracy of up to $\pm 0.1^{\circ}\text{C}$ with no calibration. The TMP117 operates from 1.8 V to 5.5 V, consuming $3.5\text{ }\mu\text{A}$ typically, and comes in both a $2.00 \times 2.00\text{ mm}$ WSON package, and a $1.53 \times 1.00\text{ mm}$ WCSP package.

The device also features integrated EEPROM, and a temperature offset register which can contain single-point calibration data.

CC2640R2F Description:-

The SimpleLink, Bluetooth low energy CC2640R2F is a wireless microcontroller (MCU) targeting Bluetooth 4.2 and Bluetooth 5 low energy applications. The low active RF and MCU currents and low-power mode current consumption can provide excellent lifetime for energy-harvesting applications or applications that require small batteries.

The CC2640R2F device contains a 32-bit Arm ® Cortex ® -M3 core that runs at 48 MHz as the main processor. The device also has a rich peripheral feature set that includes a unique ultra-low power sensor controller.

Advanced Encryption Standard (AES) Engine With 128-bit Key Support. The security core of the CC26x0 and CC13x0 devices features an AES module with 128-bit key support, local key storage, and DMA capability. Features of the AES engine are as follows: CCM, CTR, CBC-MAC, and ECB modes of operation 118-Mbps throughout

Low latency

Power Management chip(bq24030) Description:-

The bqTINY™ III-series of devices are highly integrated Li-ion linear chargers and system power path management devices targeted at space-limited portable applications. The bqTINY III-series offer integrated USB-port and DC supply (AC adapter), power-path management with autonomous power source selection, power FETs and current sensors, high accuracy current and voltage regulation, charge status, and charge termination, in a single monolithic device.

System Description:-

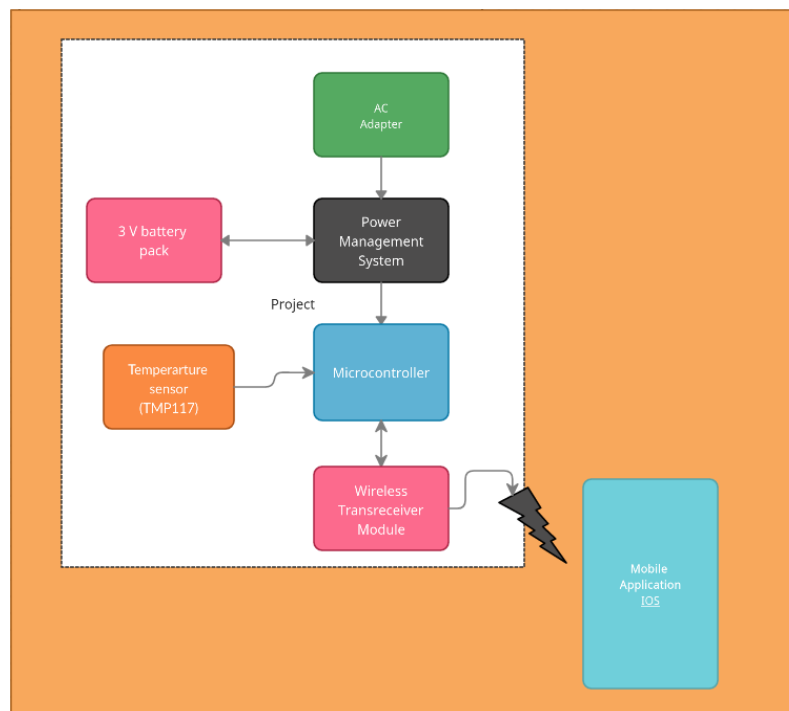
With the need to integrate sensors into newer wireless and cloud applications, the Bluetooth-enabled, high-accuracy skin temperature measurement flex patch provides a wireless solution for receiving high accuracy skin temperature measurements on a Bluetooth-capable device, such as a smart phone or any bluetooth compatible device.

Through direct contact with the skin, the TMP117 high-accuracy, low-power, digital temperature sensor can send 16-bit digital output data through the I2C to a CC2640R2F SimpleLink™ Bluetooth low energy (BLE) wireless microcontroller (MCU). After collecting this data, the CC2640R2F can use Bluetooth protocol to transmit the data to a Bluetooth-connected device.

Specifications:-

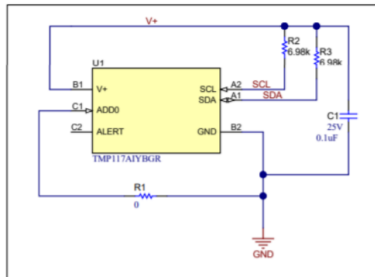
Parameter	Specifications	Details
Operating power supply range	1.8 VDC to +3.8 VDC	Limited by CC2640R2 and TMP117 supply range
Operating temperature	-40° C to +85° C	Limited by operating range of CC2640R2
Temperature accuracy	±0.1° C (max) from +35° C to +43° C	
RF range	>10 meters	BLE 4.2/5
Form factor	2-layer flexible PCB	
Adapter input	5V,2A	
Maxcharging V	4.2V	
Dynamic Power Path Management	Yes	

Genral Block Diagram:-

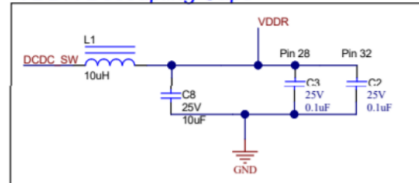


Schematic:-

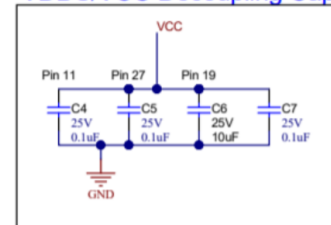
Temperature Sensing & I2C



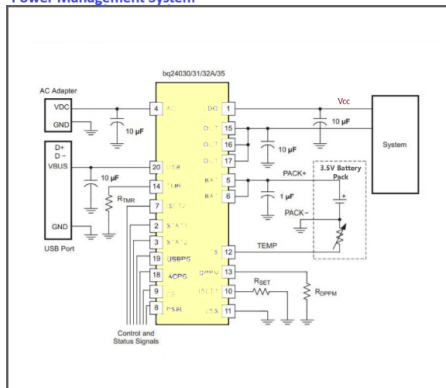
VDDR Decoupling Caps



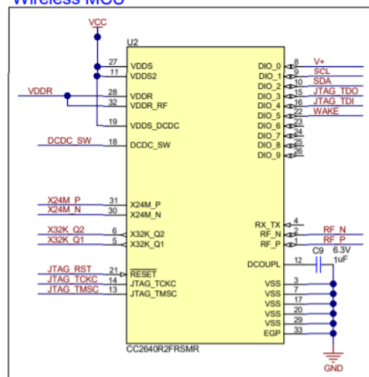
VDDS/VCC Decoupling Caps



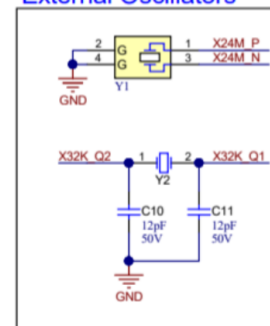
Power Management System



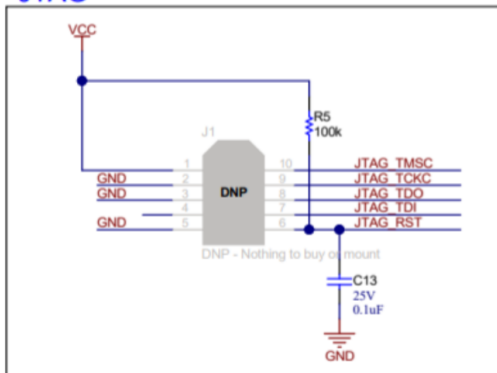
Wireless MCU



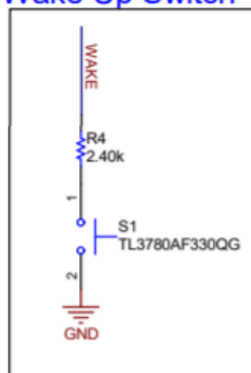
External Oscillators



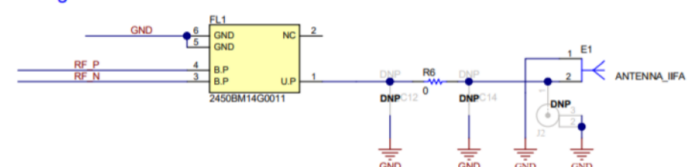
JTAG



Wake Up Switch



RF Signal Path



Schematic Description:-

- Pin 11, Pin 19 and Pin 27 are connected to the main power supply through decoupling capacitors. The decoupling capacitors help to shunt the noise caused by other circuit elements.
- 24-MHz crystal oscillator is connected between pin X24m_P and X24M_N. This oscillator frequency is further multiplied by 2 by internal frequency multipliers to provide the system clock.

- Another crystal oscillator of frequency 32.768 kHz is connected across X32K_Q1 and X32K_Q2 which provides the real time clock frequency.
- The Joint Test Action Group (JTAG) port is an IEEE standard that defines a test access port (TAP) and boundary scan architecture for digital integrated circuits. The JTAG port also provides a standardized serial interface for controlling the associated test logic.
- The RF signal path is used to provide impedance matching, which uses another IC 2450BM14G0011, to avoid loss of transmitted power.
- The I²C SCK and SDA lines were connected between the MCU and the sensor with PULL up resistors attached to them. The ADD0 pin of the TMP117 is connected to gnd to configure its address for I²C communication.

Bill of Materials(BOM):-

Item #	Designator	Quantity	Value	PartNumber	Manufacturer	Description	PackageReference
1	PCB1	1		TIDA-01624	Any	Printed Circuit Board	
2	C1, C2, C3, C4, C5, C7, C13	7	0.1uF	GRM155R71E104KE14D	MuRata	CAP, CERM, 0.1 uF, 25 V, +/- 10%, X7R, 0402	0402
3	C6, C8	2	10uF	C1608X5R1E106M080AC	TDK	CAP, CERM, 10 uF, 25 V, +/- 20%, X5R, 0603	0603
4	C9	1	1uF	GRM152R60J105ME15D	MuRata	CAP, CERM, 1 uF, 6.3 V, +/- 20%, X5R, 0402	0402
5	C10, C11	2	12pF	GRM0335C1H120JA01D	MuRata	CAP, CERM, 12 pF, 50 V, +/- 5%, C0G/NP0, 0201	0201
6	E1	1		ANTENNA_IIFA	N/A	PCB Antenna. There is nothing to buy or mount.	PCB Antenna, 2-Leads
7	FL1	1		2450BM14G0011	Johanson Technology	2.4GHz Impedance Matched Balun + embedded FCC/ETSI Band Pass Filter, SMD	1.6x0.8mm
8	L1	1	10uH	CKS2125100M-T	Taiyo Yuden	Inductor, Multilayer, Ferrite, 10 uH, 0.11 A, 0.52 ohm, SMD	0805
9	R1	1	0	RC0402JR-070RL	Yageo America	RES, 0, 5%, 0.063 W, 0402	0402
10	R2, R3	2	6.98k	RC0603FR-076K98L	Yageo America	RES, 6.98 k, 1%, 0.1 W, 0603	0603
11	R4	1	2.40k	ERJ-2RKF2401X	Panasonic	RES, 2.40 k, 1%, 0.1 W, AEC-Q200 Grade 0, 0402	0402
12	R5	1	100k	ERJ-2RKF1003X	Panasonic	RES, 100 k, 1%, 0.1 W, 0402	0402
13	R6	1	0	CRCW02010000Z0ED	Vishay-Dale	RES, 0, 5%, 0.05 W, 0201	0201
14	S1	1		TL3780AF330QG	E-Switch	Switch, SPST-NO, 0.05 A, 12 VDC, SMT	3x2mm
15	U1	1		TMP117A1YBGR	Texas Instruments	±0.1°C accurate digital temperature sensor with integrated NV memory, YBG0006AJAP (DSBGA-6)	YBG0006AJAP
16	U2	1		CC2640R2FRSMR	Texas Instruments	SimpleLink(TM) Bluetooth(R) low energy Wireless MCU, RSM0032B (VQFN-32)	RSM0032B
17	Y1	1		TSX-3225 24.0000MF15X-AC3	Epson	Crystal, 24 MHz, 10 ppm, 9 pF, SMD	SMD, 4-Leads, Body 2.65x3.35mm, Height 0.6mm
18	Y2	1		CM2012H32768DZFT	Citizen Electronics	Crystal, 32.768 kHz, SMD	2.05x1.2mm
19	C12, C14	0				CAP, CERM, 470 pF, 50 V, +/- 10%, X7R, AEC-Q200 Grade 1, 0201	0201
20	J2	0		U.FL-R-SMT-1(01)	Hirose Electric Co. Ltd.	Receptacle, Ultra Miniature Coaxial, Male Pin, 50 ohm, SMT	Ultra small CO-AX SMD
21	U3	1		bq24030	Texas Instruments	Single-Chip Charge and System Power-path Management IC (bqTINY™)	VQFN (RHL)

PCB Layout:-

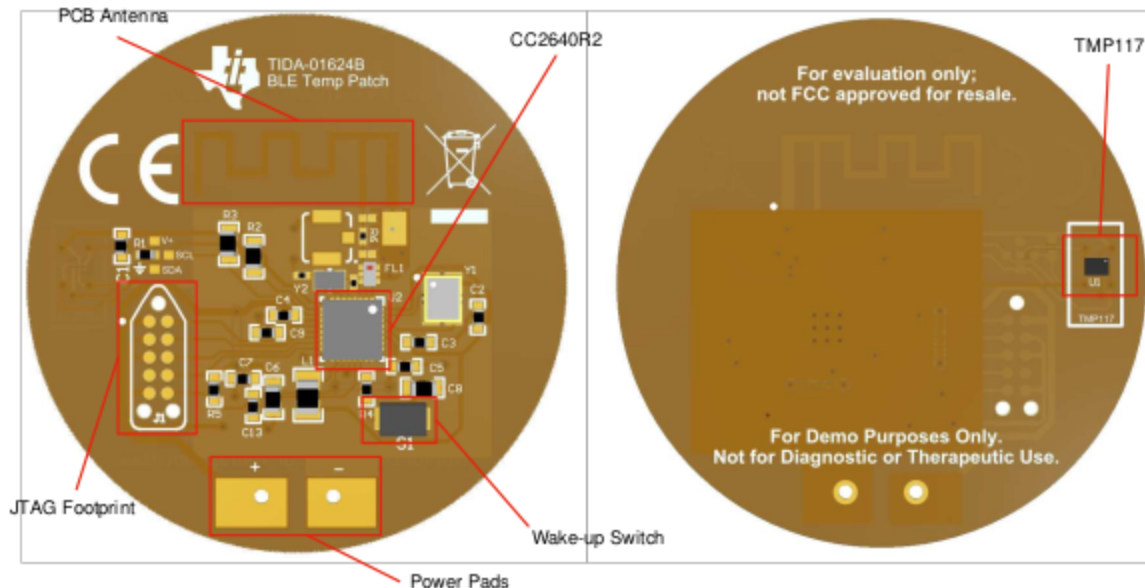


Fig.:Key Features in Design Layout

Test your Basic Functionality:-

- **Required Hardware and Software:-**The design was implemented and tested with the following battery specifications:
 - Voltage: 3.0 V
 - Min Capacity: 35 mAh
 - Max Cont. Discharge Rate: 17.5 mA
- **Hardware:-**A computer and JTAG programmer are required to program the device. A smart phone or any bluetooth compatible device.
 - Design rule checking(DRC) verifies as to whether a specific design meets the constraints imposed by the process technology to be used for its manufacturing.
 - Electrical rule checking(ERC) involves checking a design for all well and substrate areas for proper contacts and spacing thereby ensuring correct power and ground connections. ERC steps can also involve checks for unconnected inputs or shorted outputs.
- **Software:-**The design has an embedded firmware that must be programmed to the patch. To compile and load the embedded firmware, the following software is required:

- Code Composer Studio version 8.2 or above.
- SimpleLink™ CC2640R2 SDK – Bluetooth® low energy.

To view the temperature from the patch or connect to the patch, the following application is required on an iOS-enabled smart phone or tablet.

- SimpleLink™ SDK Explorer.

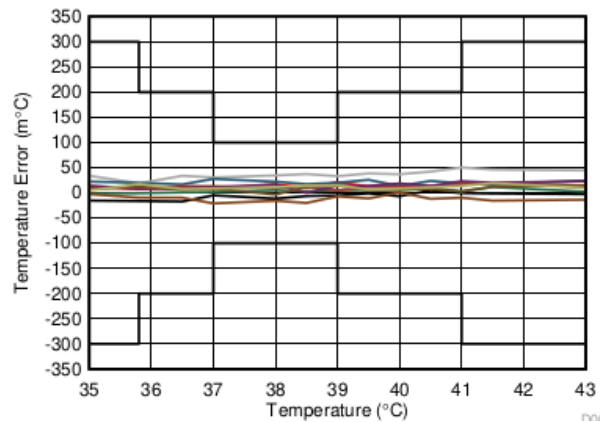
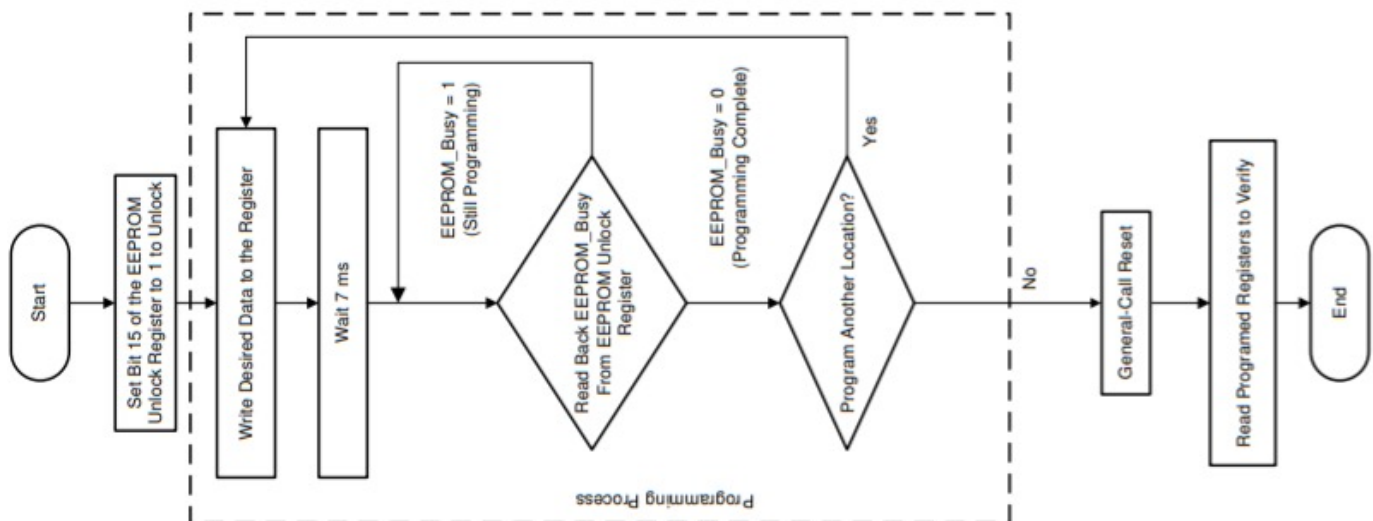


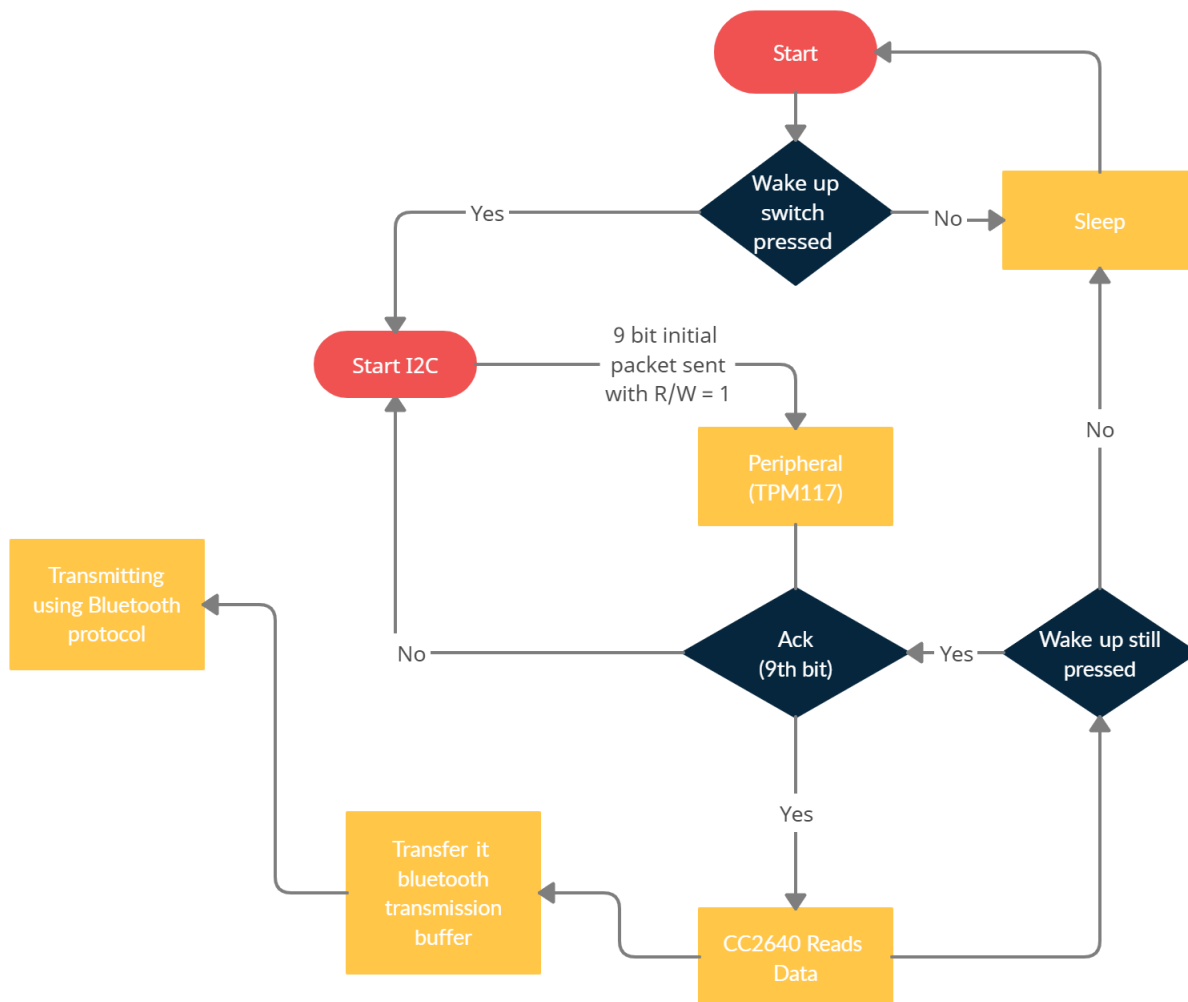
Figure : Results of Patch Temperature Accuracy Testing

MCU coding strategy:-

Flow-Chart design (for temperature sensing):-



Flow-chart design(for receiving data from sensor):-



Finalization steps:-

- Software testing: Test your code under varying scenario (e.g. input source/USB disconnected, battery disconnected, load disconnected, 'Power Good' not okay)
- Hardware-software stress testing (temperatures up to 85°C, drop (g) test, etc.)
- Encapsulate for reliability and ergonomic use
- Write a detailed report (design documentation)
- Get the product certified (e.g. FCC, FDA, etc.) if required/ demanded
- Deliver product for commercial deployment.

Design Challenges:-

With integrated features such as one-shot mode and averaging, the TMP117 provides a complete digital temperature measurement sensor in a 2 mm x 2 mm WSON (very, very thin small-outline no-lead) package with just six pins: V+ supply, ground, serial data, serial clock, serial bus address select, and the alert function. As a result, the hardware interface design requires no more effort than that required with any typical I²C serial device. In practice, however, the design challenge with this or any high-accuracy temperature sensor lies less in the hardware interface design than in devising a physical layout optimized for thermal management.

Conclusion:-

The design of user-friendly and effective clinical-grade wireless thermometers has been hampered by the need for both high measurement accuracy and long battery life. With its low power consumption and clinical-grade accuracy, the Texas Instruments TMP117 temperature sensor offers an effective solution. As demonstrated in a comprehensive reference design, developers can use the TMP117 together with the Texas Instruments CC2640R2 Bluetooth wireless microcontroller to create a complete wireless thermometer design suitable for healthcare applications.

References:-

https://www.ti.com/lit/ds/symlink/tmp117.pdf?ts=1618221772051&ref_url=https%253A%252F%252Fwww.google.com.au%252F

https://www.ti.com/lit/ug/tidudw4a/tidudw4a.pdf?ts=1618304571653&ref_url=https%253A%252F%252Fwww.ti.com%252Ftool%252FTIDA-01624

https://www.ti.com/lit/ug/snou161/snou161.pdf?ts=1618291695172&ref_url=https%253A%252F%252Fwww.ti.com%252Ftool%252FTMP117EVM

<https://www.ti.com/tool/TIDA-01624#descriptionArea>