2019

Design Data Book

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Background

Currently, there is a lack of low cost tracking solutions that can be out in the field for months at a time. Existing solutions for tracking devices rely on digital radio, such as blue tooth, or wi-fi, both of which have very limit range. Many RFID tagging systems are also used as tracking devices. This is because they're primarily meant for use inside a small space, such as a warehouse. Other industrial tracking solutions rely on expensive proprietary software packages and protocols, which often make them costly and out of the price range of small to midsize customers.

Current solutions also aren't designed for our proposed case. The items that the team wants to track could be anything from large shipping containers to toxic waste. These items will be shipped very long distances and will need to be reliably tracked over the course of several months. Right now there are no solutions that can do this that are inexpensive enough to be operated by smaller companies. This is where the Big Assent Tracker, or BAT system comes in. The BAT is a box containing a battery, 3g radio, and some electronics. Its goal is to provide reliable tracking for several months for a very low cost.

The BAT system will be able to meet customer needs in 3 major ways. It will use mostly off-the-shelf components and software; it will make use of publicly documented protocols, such as 3g and GPS; and it will be significantly cheaper to operate then nearly all of the other market solutions. Unfortunately, meeting these requirements will demand that the team come up with creative solutions to several major problems. Most of these challenges relate to reliability and life span. The operating time will be another hurdle. The team's goal is to have the BAT system in the field for about six months before requiring charging. In order to save power, the team's system will infrequently update its position with a host server. This update could occur once every few hours or a few times a minute, depending on the speed of the container being tracked or user-defined constraints. In between updates, the entire BAT system will enter a sort of hibernation mode initiated by the micro-controller. In this mode, the micro-controller will be in sleep mode, and relatively high power devices like the 3G radio and the GPS will be entirely switched off.

Impact

On average, people will spend about 153.3 days of their life time looking for lost items. This, compounded by the number of people in a company, causes the wasted time to go up exponentially. People are fantastic at losing things. At best, misplacing something could be a minor nuisance. At worst, a lost item may be extremely expensive and critical to the success of an enterprise. The goal of the Big Asset Tracker system is to provide tracking solution for large, mission critical, or even sometimes hazards assets in a safe and cost-effective way. The BAT system is designed to be a very long-lasting tracker that can be put in/on a shipping container, a job site box, or a moving vehicle.

Problem

Consolidated Electrical Distributors - (CED) Denver needs to track the location of their job site boxes. These job site boxes cost approximately $1000 each and are crucial to continued sales of electrical commodity items. The boxes currently are written up on a sales register for the customer and then are filed away. This is the only record that CED has of where the boxes are. Often the boxes will be moved from location to location by the customer without informing CED. In 2018, CED lost 5 boxes costing them approximately $5000.

Assumptions:

- Device will operate within cell phone range
- Temperature range will be room temperature or close to it
- Device will operate inside a metal box
- Battery will start with a full charge
- No unreasonable amounts of water present
- The device will operate for a maximum of six months

Requirements:

- Must be sturdy construction
- Must withstand the jobsite environment.
- Needs to fit in a 12”x12”x8” box
- Anything bigger is inconvenient
- Must be battery operated
    - Most job sites don’t have power or have only temporary power
- Needs to operate for 6 months in the field without changing or charging the battery
    - Don’t want to be constantly swapping batteries

Design Constraints:

- We have a limit budget of $1000
- We have two semesters to come up with a project and build it
- Limited experience with microcontrollers
- Limited experience building websites
- Limiting testing of design
- Limited experience designing effective printed circuit boards.
- All team member products of American Public School system.

Conceptual Design

<u>Brain Storming</u>

Method I: Mind Map

Method II: Six Hats Method

<u>White Hat: Why is asset tracking Important?</u>

A manager needs to know where his physical assets are at all times. This can improve productivity, decision making and planning, which can ultimately lead to higher profit margins. There are many different market segments that could benefit from an affordable and effective tracker

<u>Red Hat: How does Asset Tracking make you feel?</u>

Sounds expensive
Skeptical of if it will work
Skeptical if the data is useful
Nervous our project will not work

<u>Black Hat: Be critical of Asset tracking</u>

Battery Power won't last long enough
Electronics aren't durable enough
Won't be in cell phone range
User can't login to the website
Can't have enough devices on web portal

<u>Yellow Hats: Counter the Arguments made in the Black Hats Section</u>

Our preliminary calculations estimate the battery life to be 1 year
Plan to use heavy duty box and vibration insulators
Hopefully if it's out of range, the box will ping the system its last known location
Hopefully, we have smart users and may be able to create a help tab
We plan to support 4 devices on web portal

<u>Green Hat: Generate New Ideas around Asset tracking</u>

Vary the number of times the user can ping the device
Submersible option
Portable battery charger
Wireless charging
Environmental sensors
An easy to use interface

Blue Hat: Objectives and Problems

Objective: Get a working prototype by August
Objective: Figure out exact power usage
Objective: Get website up and running
Problems: Lack of web design experience
Problems: Lack of firmware design experience
Problems: Lack of PCB design/ prototype experience

Patent Search

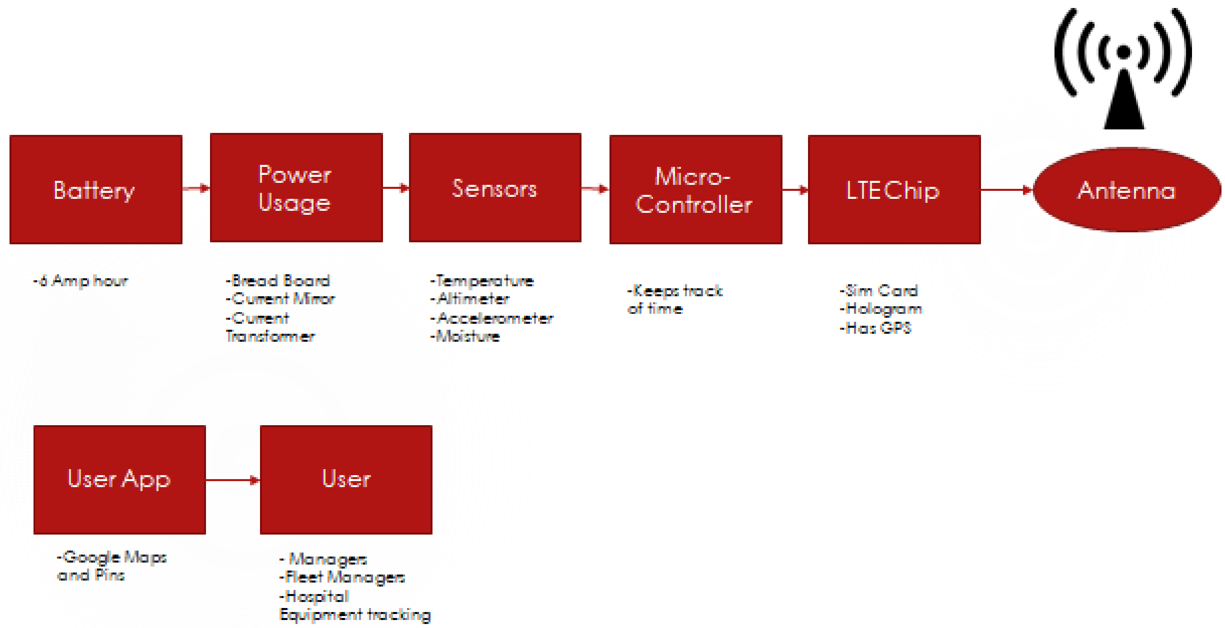
The team did a patent search on the following phrases and here are the results of the search of the US Patents office website. Our idea isn't original there are several existing tracker products on the market currently. We searched "Asset Tracker" and found 52 hits. We next searched for "GPS Tracker" and we received 287 hits. Lastly, the last search was "GPS Asset Tracker" and that searched had 0 hits. The team also used a website called Espacenet for additional patent searches. Espacenet offers a database from 80 different countries around the world for a bigger search on patents. Using the website of Espacenet, we searched for "GPS Tracker" and received 467 hits. We searched for "tracking system and gps and found a very similar patent to the design we are doing right now. The patent page bookmark is US8258941 B(1). Some differences are the use of website and components.

http://www.uspto.gov/patents-application-process/search-patents

https://worldwide.espacenet.com

Preliminary Design

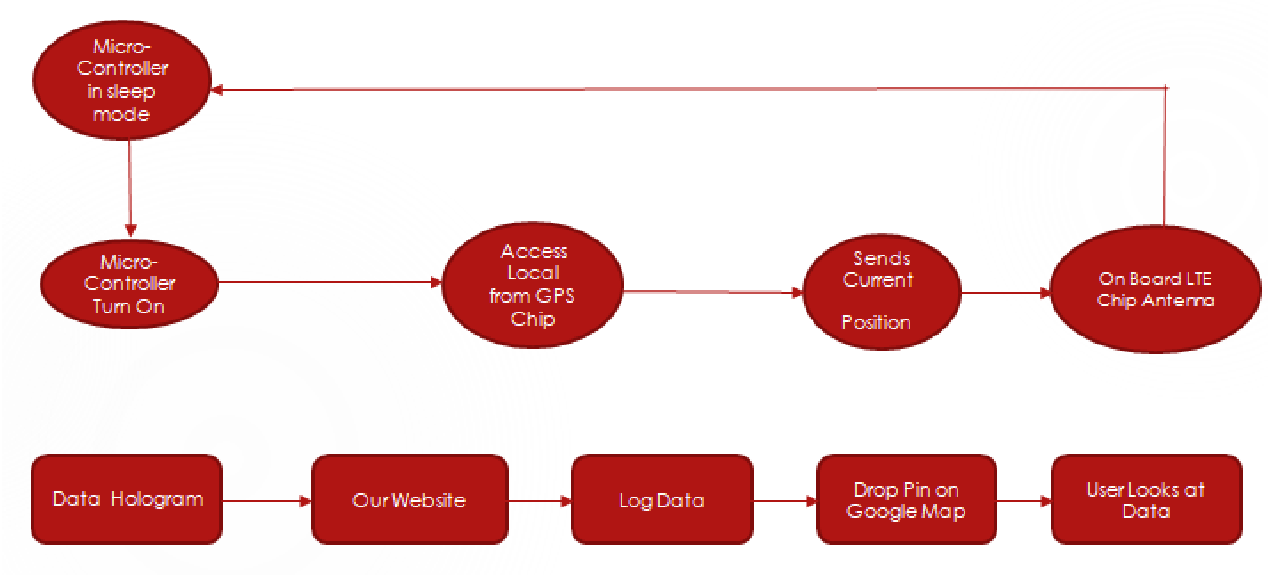
Block Diagram



Summary of Block Diagram:

We will use a 6 amp-hour battery to power our system. We have also purchased extra batteries in case the team needs to tie two batteries in series to boost the battery life. The team will then do calculation based on actual usage or we will use a current monitoring circuit to identify power usage. Some preliminary calculations have been done in the power analysis section. We plan on sending a signal to the user when the systems batteries are low. For sensors, we will only be using a temperature/ humidity sensor. The brain of our system will be our micro-controller. It will keep track of time and take our system in and out of sleep mode. The LTE chip will communicate with the GPS chip to find the location of the box and send a signal through the onboard antenna. Our signal will be received by Hologram and the team will build a web page to exact this data from Hologram. The team will write software to display the GPS coordinates of the box on a Google map. The location of the box will be updated daily at a specific set time.

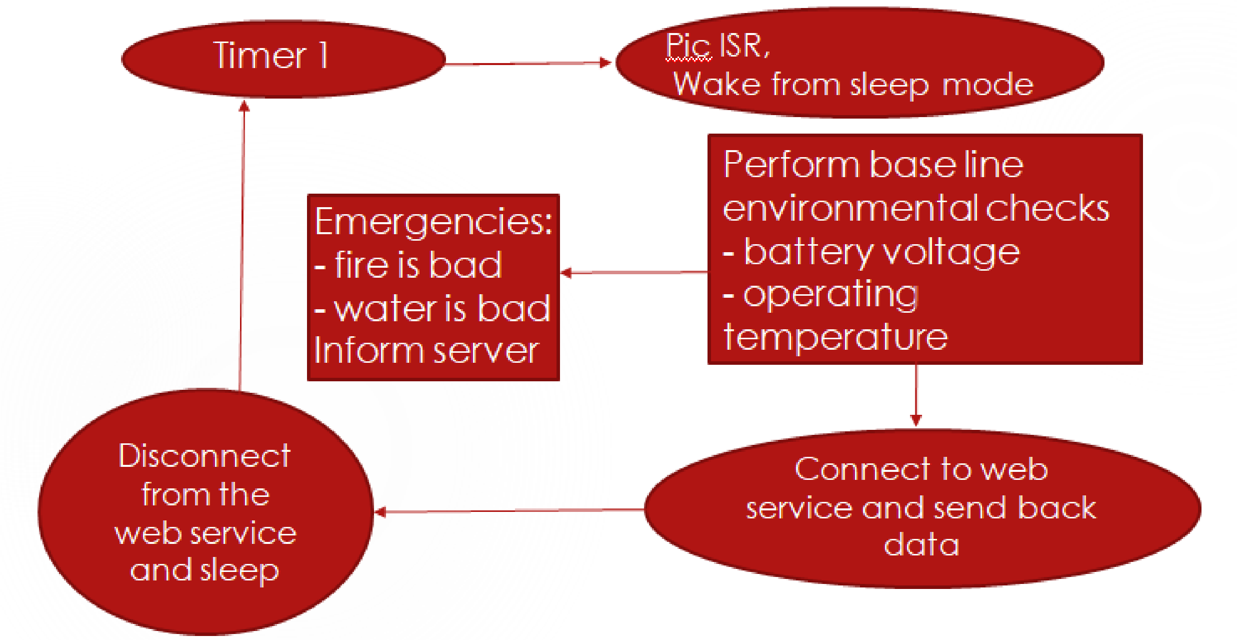
Data Flow Diagram



Summary of Data Flow Diagram:

In simplest terms, the physical box constructed for this project is merely a data acquisition system for the back-end platform. The data flow diagram (shown above), details how the relevant details of the box's location and environment is first collected, then sent to the Hologram service, the displayed as a pin on a Google maps page.

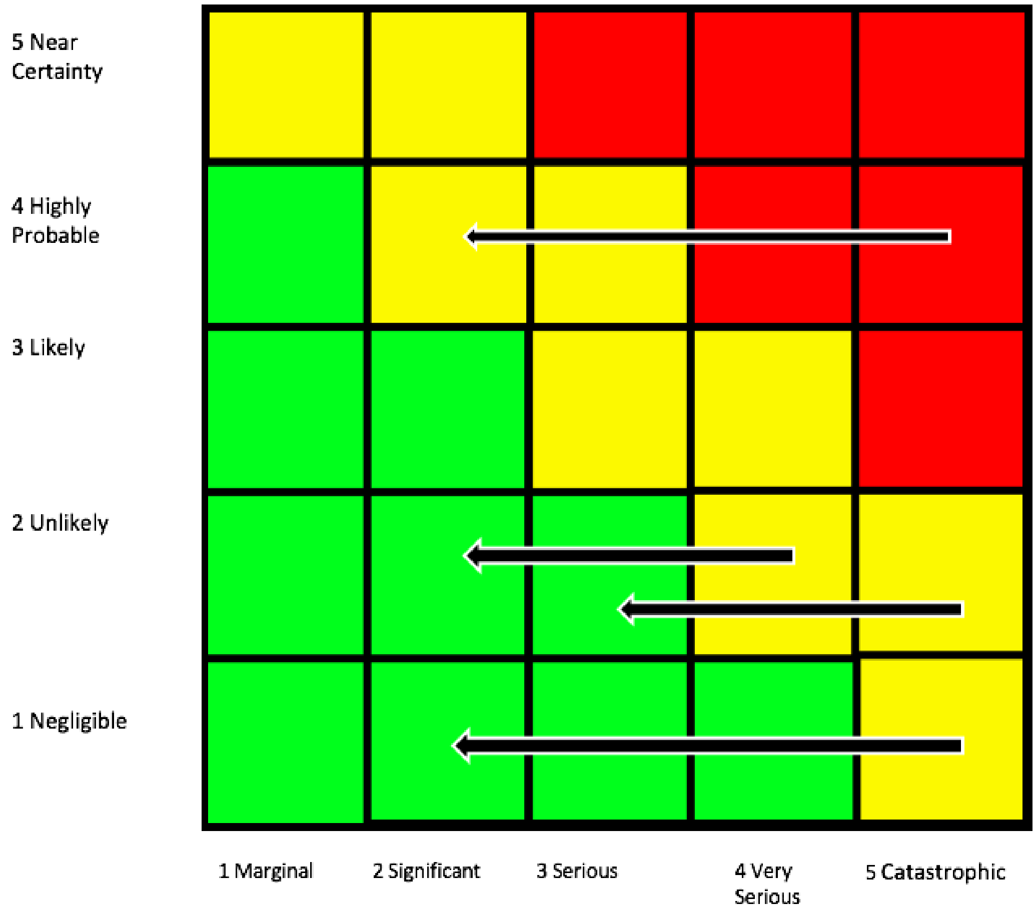
Micro-Controller Architecture



Summary of Micro-Controller Architecture:

This diagram details the various states that the microcontroller will take on as it wakes itself up, sends the data, and then goes back to sleep. During this process, the micro-controller will also have to figure out if the system is about to fail. If the microcontroller detects a possible fail condition, then it will send a signal to Hologram. This data will be displayed in the web app. In the final version of the firmware, this system will be defined using a state machine design pattern. Each state will be defined by some specific parameters.

Risk Management



Horizontal

Rows Vertical Columns

2,4 2,2 Problem 1: GPS sends out incorrect location

Solution 1: If we know the location of the first job-sight, we can have it send out a location and see if it matches which would ensure that the GPS is providing accurate location updates.

2,5 2,3 Problem 2: Battery dies completely and is moved from the location where it sent out its last location update from

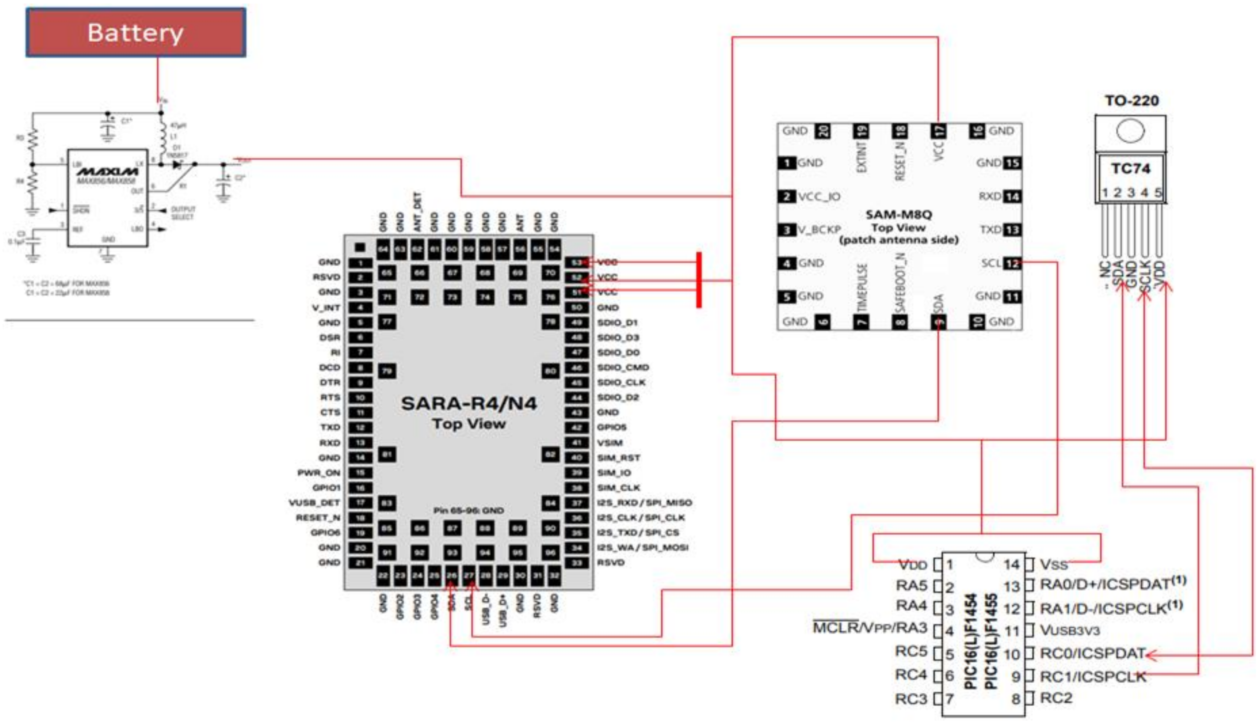
Solution 2: On the webserver, we could keep track of the rate of change of the remaining charge left in the battery from update to update, and if the rate of change was increasing, we would be notified of a possible problem with the box that was causing it to lose charge faster than expected so we could address the problem before the battery died and the box went missing.

4,5 4,2 Problem 3: Short Circuit destroys hardware

Solutions 3: The Likelihood of high probably for this potential problem is with regards to the design phase, but proper circuit analysis and testing our design should be enough to make this much less of a risk.

Design Detail

Wiring Diagram



Summary of Wiring Diagram:

This is the basic power wiring diagram for our project. Grounding wire wasn't included in this diagram to prevent confusion. The team has also included the wiring for our data ports for the I2C network.

Power Analysis

$PIC\_SLEEP := 25 \cdot 10^{-9}$ $\quad$ $PIC\_OP := 25 \cdot 10^{-6}$

$TC\_SLEEP := 5 \cdot 10^{-6}$ $\quad$ $TC\_OP := 350 \cdot 10^{-6}$

$SARA\_OFF := 6 \cdot 10^{-6}$ $\quad$ $SARA\_OP := 490 \cdot 10^{-3}$

DC-DC Converter will be in use, assuming a worst case cenario that it opperates at 75% effieciency, the operating currents are scaled by 1.25.

$BATTERY := 6 \cdot 60 \cdot 60 = 2.16 \cdot 10^{4}$ $\quad$ 6 Amp-Hour battery converted to Amp-Seconds

Current consumption per day:

$$CCPD := (PIC\_SLEEP + TC\_SLEEP + SARA\_OFF) \cdot (24 \cdot 60 \cdot 60 - 30) + (PIC\_OP + TC\_OP + SARA\_OP) \cdot (30) = 15.663$$

$$CCPD := 1.25 \cdot CCPD = 19.579$$

Projected days of opperation with single battery charge:

$$DAYS\_OF\_OPERATION := \frac{BATTERY}{CCPD} = 1.103 \cdot 10^{3}$$

With this rough current consumption calculation, we are expecting our device to be able to operate for 1103 days which is just over 3 years.

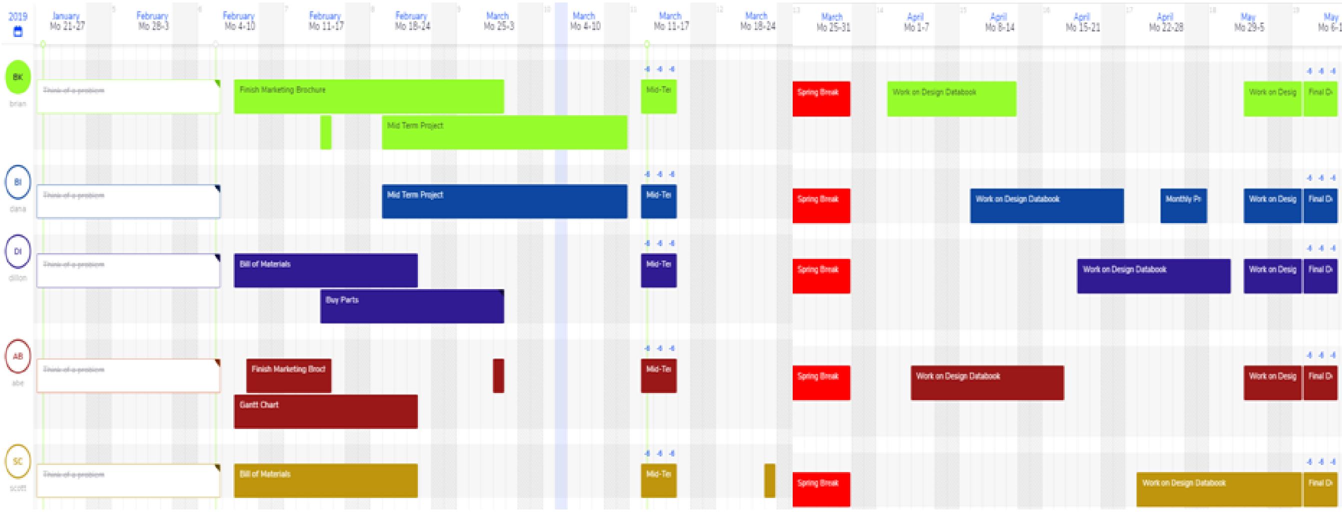
Summary of Power Consumption Calculations:

To calculate a rough estimate of our circuit's current consumption, we had to make several assumptions. The first assumption was that it would take 30 seconds or less for the device to send out its daily location update. This would mean that all the devices would be drawing their operating current for 30 seconds per day. For the rest of the day, they would be drawing their sleep current. An additional assumption was that a DC-to-DC converter included in the circuit would be operating at 75% efficiency. This means that we would be drawing 25% more current in both sleep and operating modes. From here, the Amp-hour rating of the battery was converted to Amp-Seconds. The Seconds per day that the device would be operating in both sleep mode and operating mode were tabulated and from there, the approximate lifespan per charge was determined.

Parts List

Part	Description	Manufacture	Part Number	Quantity	Cost	Data Cost	Extended Cost
LTE Chip	LTE CAT M1/NB-IoT Shield - SARA-R4	Spark Fun	CEL-14997	3	79.95		239.85
SIM Card	Hologram	Hologram		3	1.5	0.4	4.5
GPS Chip	GPS Breakout - Chip Antenna, SAM-M8Q (Qwiic)	Spark Fun	GPS-15210	3	39.95		119.85
Humity/Tempature Sensor	Budgeted			3	11		33
PIC	Microcontrollers	Microchip	PIC16F1455-I/P	16	1.62		25.92
Mosphet	Regulating Current	Fairchild	FQP30N06L	8	1.46		11.68
Battery	6 Amp Hour Battery	Spart Fun	PRT-13856	6	29.95		179.7
Enclosure	PVC Box Nema 3R	Carlon	E989N	3	18.36		55.08
PIC KIT 4	Debugging Tool	Microchip	PG164140	3	47.5		142.5
						Total	812.08

Schedule

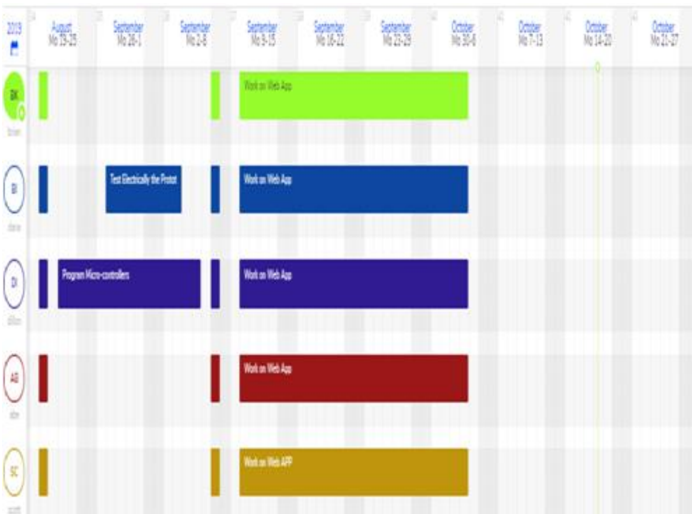


Spring 2019 Gantt Chart

Spring 2019 Gantt Chart

Summer 2019 Gantt Chart

Summer 2019 Gantt Chart



Fall 2019 Gantt Chart

Appendix

Data sheets

LTE CAT M1/NB-IoT Shield - SARA-R4

SARA-R4/N4 series - Data Sheet

1.3 Block diagram

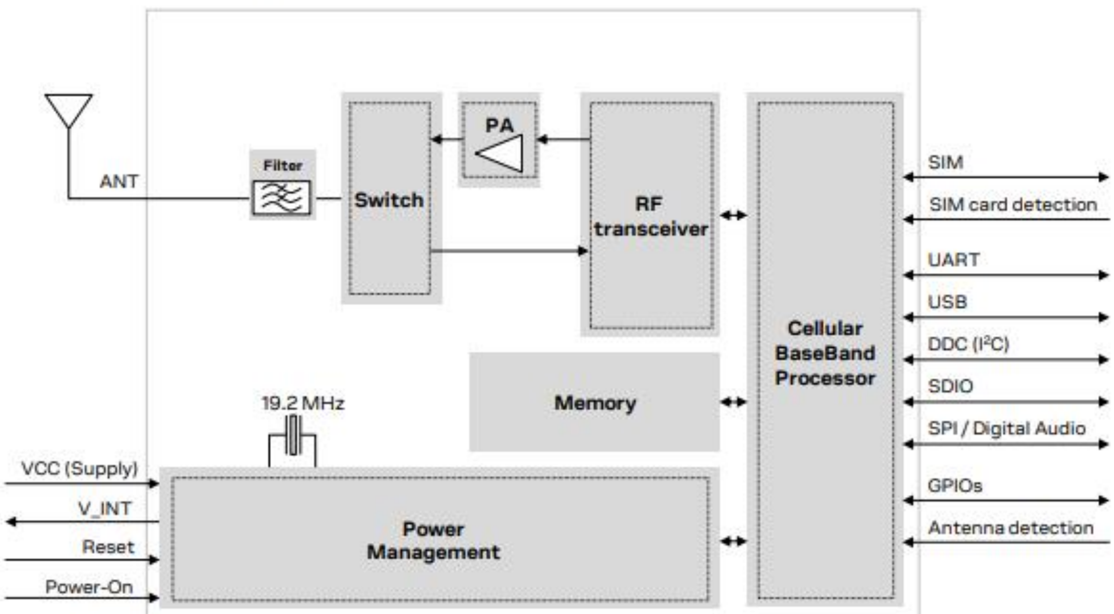


Figure 1: SARA-R4/N4 series block diagram

3 Pin definition

3.1 Pin assignment

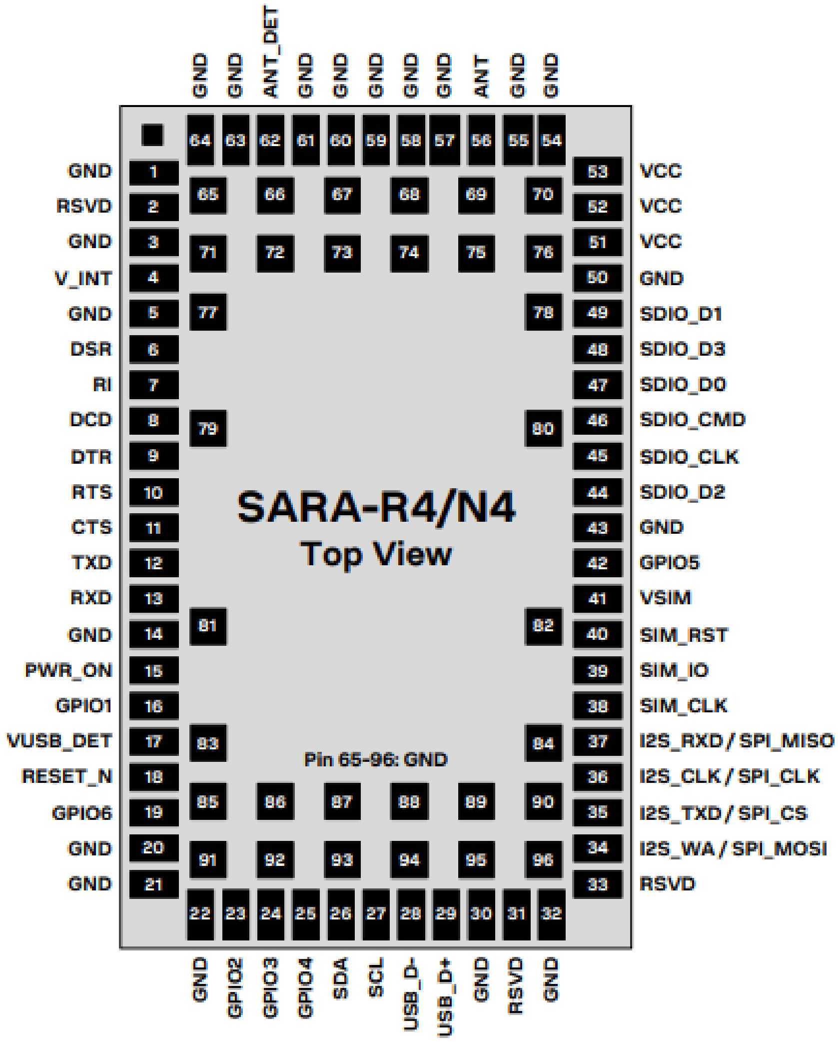


Figure 2: SARA-R4/N4 series pin assignment (top view)

No	Name	Power domain	I/O	Description	Remarks
1	GND	-	N/A	Ground	All the GND pins must be connected to ground
2	RSVD	-	N/A	RESERVED pin	Leave unconnected.
3	GND	-	N/A	Ground	All the GND pins must be connected to ground
4	V_INT	-	O	Generic Digital Interfaces supply output	V_INT = 1.8 V (typical) generated by the module when is switched on, outside low power PSM deep sleep mode. See section 4.2.3 for detailed electrical specs. Provide test point for diagnostic purposes.
5	GND	-	N/A	Ground	All the GND pins must be connected to ground
6	DSR	GDI	O	UART data set ready	Circuit 107 (DSR) in ITU-T V.24. See section 4.2.12 for detailed electrical specs.

No	Name	Power domain	I/O	Description	Remarks
7	RI	GDI	O	UART ring indicator	Circuit 125 (RI) in ITU-T V.24. See section 4.2.12 for detailed electrical specs.
8	DCD	GDI	O	UART data carrier detect	Circuit 109 (DCD) in ITU-T V.24. See section 4.2.12 for detailed electrical specs.
9	DTR	GDI	I	UART data terminal ready	Circuit 108/2 (DTR) in ITU-T V. 24. Internal active pull-up to V_INT. See section 4.2.12 for detailed electrical specs.
10	RTS	GDI	I	UART ready to send	Circuit 105 (RTS) in ITU-T V.24. Internal active pull-up to V_INT. Flow control is not supported by the "00", "01" and SARA-R410M-02B product versions See section 4.2.12 for detailed electrical specs.
11	CTS	GDI	O	UART clear to send	Circuit 106 (CTS) in ITU-T V.24. Flow control is not supported by the "00", "01" and SARA-R410M-02B product versions See section 4.2.12 for detailed electrical specs.
12	TXD	GDI	I	UART data input	Circuit 103 (TxD) in ITU-T V.24. Internal active pull-down to GND on "00", "02" versions Internal active pull-up to V_INT on "01" versions See section 4.2.12 for detailed electrical specs.
13	RXD	GDI	O	UART data output	Circuit 104 (RxD) in ITU-T V.24. See section 4.2.12 for detailed electrical specs.
14	GND	-	N/A	Ground	All the GND pins must be connected to ground
15	PWR_ON	POS	I	Power-on / power-off input	Internal 200 kΩ pull-up resistor. See section 4.2.8 for detailed electrical specs. Provide test point for diagnostic purposes.
16	GPIO1	GDI	I/O	GPIO	Configurable GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
17	VUSB_DET	USB	I	USB detect input	Input for VBUS (5 V typical) USB supply sense. See section 4.2.11 for detailed electrical specs. Provide test point for diagnostic purposes.
18	RESET_N	ERS	I	External reset input	Internal 37 kΩ pull-up resistor to V_INT. See section 4.2.9 for detailed electrical specs. Provide test point for diagnostic purposes.
19	GPIO6	GDI	I/O	GPIO	Configurable GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
20	GND	-	N/A	Ground	All the GND pins must be connected to ground
21	GND	-	N/A	Ground	All the GND pins must be connected to ground
22	GND	-	N/A	Ground	All the GND pins must be connected to ground
23	GPIO2	GDI	I/O	GPIO	Configurable GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
24	GPIO3	GDI	I/O	GPIO	Configurable GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
25	GPIO4	GDI	I/O	GPIO	Configurable GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
26	SDA	DDC	I/O	I^2C bus data line	Fixed open drain. Internal 2.2 kΩ pull-up resistor to V_INT. Not supported by "00" and "01" product versions See section 4.2.13 for detailed electrical specs.

No	Name	Power domain	I/O	Description	Remarks
27	SCL	DDC	O	I²C bus clock line	Fixed open drain. Internal 2.2 kΩ pull-up resistor to V_INT. Not supported by "00" and "01" product versions See section 4.2.13 for detailed electrical specs.
28	USB_D-	USB	I/O	USB Data Line D-	90 Ω nominal differential impedance. Pull-up, pull-down and series resistors, as required by the USB 2.0 specifications [10], are part of the USB pin driver and shall not be provided externally. See section 4.2.11 for detailed electrical specs. Provide test point for diagnostic purposes.
29	USB_D+	USB	I/O	USB Data Line D+	90 Ω nominal differential impedance. Pull-up, pull-down and series resistors, as required by USB 2.0 specifications [10], are part of the USB pin driver and shall not be provided externally. See section 4.2.11 for detailed electrical specs. Provide test point for diagnostic purposes.
30	GND	-	N/A	Ground	All the GND pins must be connected to ground
31	RSVD	-	N/A	RESERVED pin	Leave unconnected.
32	GND	-	N/A	Ground	All the GND pins must be connected to ground
33	RSVD	-	N/A	RESERVED pin	This pin can be connected to GND.
34	I2S_WA / SPI_MOSI	GDI	O / O	I²S word alignment / SPI Master Output Slave Input	I²S word alignment, alternatively configurable as SPI Master Output Slave Input Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
35	I2S_TXD / SPI_CS	GDI	O / O	I²S transmit data / SPI Chip Select	I²S transmit data out, alternatively configurable as SPI Chip Select Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
36	I2S_CLK / SPI_CLK	GDI	O / O	I²S clock / SPI clock	I²S clock, alternatively configurable as SPI clock Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
37	I2S_RXD / SPI_MISO	GDI	I / I	I²S receive data / SPI Master Input Slave Output	I²S receive data input, alternatively configurable as SPI Master Input Slave Output Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
38	SIM_CLK	SIM	O	SIM clock	See section 4.2.10 for detailed electrical specs.
39	SIM_IO	SIM	I/O	SIM data	Internal 4.7 kΩ pull-up resistor to VSIM. See section 4.2.10 for detailed electrical specs.
40	SIM_RST	SIM	O	SIM reset	See section 4.2.10 for detailed electrical specs.
41	VSIM	-	O	SIM supply output	VSIM = 1.80 V typical or 2.95 V typical generated by the module according to the external SIM card type. See section 4.2.3 for detailed electrical specs.
42	GPIO5	GDI	I	SIM detection	SIM card presence detection input, alternatively configurable as GPIO (see section 2.7). See section 4.2.12 for detailed electrical specs.
43	GND	-	N/A	Ground	All the GND pins must be connected to ground
44	SDIO_D2	GDI	I/O	SDIO serial data [2]	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
45	SDIO_CLK	GDI	O	SDIO serial clock	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
46	SDIO_CMD	GDI	I/O	SDIO command	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.

No	Name	Power domain	I/O	Description	Remarks
47	SDIO_D0	GDI	I/O	SDIO serial data [0]	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
48	SDIO_D3	GDI	I/O	SDIO serial data [3]	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
49	SDIO_D1	GDI	I/O	SDIO serial data [1]	Not supported by "00", "01" and "02" product versions See section 4.2.12 for detailed electrical specs.
50	GND	-	N/A	Ground	All the GND pins must be connected to ground
51	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. SARA-R404M, SARA-R410M and SARA-N410: supply input for all internal parts. SARA-R412M: supply input for internal BB PMU. See section 4.2.3 and 4.2.4 for detailed specs.
52	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. SARA-R404M, SARA-R410M and SARA-N410: supply input for all internal parts. SARA-R412M: supply input for internal RF PA. See section 4.2.3 and 4.2.4 for detailed specs.
53	VCC	-	I	Module supply input	All VCC pins must be connected to external supply. SARA-R404M, SARA-R410M and SARA-N410: supply input for all internal parts. SARA-R412M: supply input for internal RF PA. See section 4.2.3 and 4.2.4 for detailed specs.
54	GND	-	N/A	Ground	All the GND pins must be connected to ground
55	GND	-	N/A	Ground	All the GND pins must be connected to ground
56	ANT	-	I/O	RF input/output	50 Ω nominal impedance. See section 4.2.5 for detailed electrical specs.
57	GND	-	N/A	Ground	All the GND pins must be connected to ground
58	GND	-	N/A	Ground	All the GND pins must be connected to ground
59	GND	-	N/A	Ground	All the GND pins must be connected to ground
60	GND	-	N/A	Ground	All the GND pins must be connected to ground
61	GND	-	N/A	Ground	All the GND pins must be connected to ground
62	ANT_DET	ADC	I	Antenna detection	Antenna presence detection function. See section 4.2.7 for detailed electrical specs.
63	GND	-	N/A	Ground	All the GND pins must be connected to ground
64	GND	-	N/A	Ground	All the GND pins must be connected to ground
65-96	GND	-	N/A	Ground	All the GND pins must be connected to ground

Table 5: SARA-R4/N4 series pin-out

4.2 Operating conditions

Unless otherwise indicated, all operating condition specifications are at an ambient temperature of +25 °C.

⚠ Operation beyond the operating conditions is not recommended and extended exposure beyond them may affect device reliability.

4.2.1 Operating temperature range

Parameter	Min.	Typical	Max.	Unit	Remarks
Normal operating temperature	–20	+25	+65	°C	Normal operating temperature range (fully functional and meet 3GPP specifications)
Extended operating temperature	–40		+85	°C	Extended operating temperature range (RF performance may be affected outside normal operating range, though module is fully functional)

Table 8: Environmental conditions

4.2.2 Thermal parameters

Symbol	Parameter	Min.	Typical	Max.	Units	Remarks
Ψ_{M-A}	Module-to-Ambient thermal parameter		10		°C/W	Thermal characterization parameter $\Psi_{M-A} = (T_M - T_A) / P_H$ proportional to the temperature difference between the internal temperature sensor of the module I and the ambient temperature (T_A), produced by the module heat power dissipation (P_H), with the module mounted on a 79 x 62 x 1.41 mm 4-Layer PCB with a high coverage of copper, in still air conditions
Ψ_{M-C}	Module-to-Case thermal parameter		2		°C/W	Thermal characterization parameter $\Psi_{M-C} = -T_M - T_C) / P_H$ proportional to the temperature difference between the internal temperature sensor of the modl(T_M) and the ambient temperature (T_C), produced by the module heat power dissipation (P_H), with the module mounted on a 79 x 62 x 1.41 mm 4-Layer PCB with a high coverage of copper, with a robust aluminum heat-sink and with forced air ventilation, i.e. reducing to a value close to 0 °C/W the thermal resistance from the case of the module to the ambient

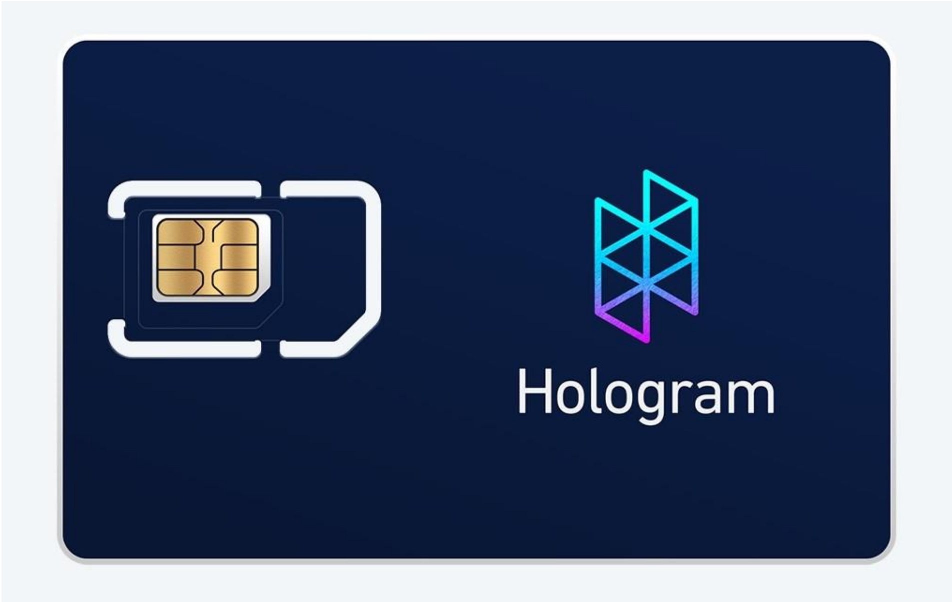
Table 9: Thermal characterization parameters of the module

4.2.4 Current consumption

Mode	Condition	Tx power	Min	Typ[11]	Max[12]	Unit
Power Off Mode (module switched off)	Averaged current value			6		µA
PSM Deep Sleep Mode (low power mode)	Averaged current value			8		µA
Active Mode (Power Saving Mode disabled, Module registered with network)	Averaged current value			9		mA
LTE Cat NB1 Connected Mode (Data Tx / Rx)	Averaged current value	Minimum		60		mA
		0 dBm		65		mA
		12 dBm		80		mA
		18 dBm		100		mA
		Maximum		140		mA
	Peak current value during Tx	Maximum			490	mA
LTE Cat M1 Connected Mode (Data Tx / Rx)	Averaged current value	Minimum		100		mA
		0 dBm		105		mA
		12 dBm		125		mA
		18 dBm		150		mA
		Maximum		190		mA
	Peak current value during Tx	Maximum			490	mA
2G Connected Mode (Data Tx / Rx)	Averaged current during a GMSK 1-slot Tx call, 850/900 MHz bands	Maximum		200		mA
	Peak current during a GMSK 1-slot Tx burst, 850/900 MHz bands	Maximum		1.5	1.9	A

Table 12: Module VCC current consumption [13]

SIM Card Hologram



https://hologram.io/

https://hologram.io/docs/reference/cloud/http/#/introduction/requests

Hologram is an IOT service that frees us from having to write our own backend to act as a middle man between the web service and the BAT box.

Examples

GET

```
curl --verbose --request GET \
'https://dashboard.hologram.io/api/1/users/me?apikey=2rjpYZZNzFAoGxAgEP2SC6moL3emyB'
```

POST with JSON body

```
curl --verbose --request POST \
--header "Content-Type: application/json" \
--data '{"deviceid": 56668, "body": "Hello device!"}' \
'https://dashboard.hologram.io/api/1/sms/incoming?apikey=2rjpYZZNzFAoGxAgEP2SC6moL3emyB'
```

POST with form-urlencoded body

```
curl --verbose --request POST \
--header "Content-Type: application/x-form-urlencoded" \
--data 'deviceid=56668&body=Hello%20device!' \
'https://dashboard.hologram.io/api/1/sms/incoming?apikey=2rjpYZZNzFAoGxAgEP2SC6moL3emyB'
```

```
var xhttp = new XMLHttpRequest();
xhttp.onreadystatechange = function() {
    if (this.readyState == 4 && this.status == 200) {
       // Typical action to be performed when the document is ready:
       document.getElementById("demo").innerHTML = xhttp.responseText;
    }
};
xhttp.open("GET", "filename", true);
xhttp.send();
```

GPS Breakout - Chip Antenna, SAM-M8Q (Qwiic)

1.3 Performance

Parameter	Specification				
Receiver type	72-channel u-blox M8 engine GPS L1C/A, SBAS L1C/A, QZSS L1C/A, QZSS L1 SAIF, GLONASS L1OF, Galileo E1B/C				
Accuracy of time pulse signal	RMS 99%	30 ns 60 ns			
Frequency of time pulse signal		0.25 Hz…10 MHz (configurable)			
Operational limits [1]	Dynamics	≤ 4 g			
	Altitude	50,000 m			
	Velocity	500 m/s			
Velocity accuracy [2]		0.05m/s			
Heading accuracy [2]		0.3 degrees			
GNSS		**GPS & GLONASS**	**GPS**	**GLONASS**	**Galileo**
Horizontal position accuracy [3]		2.5 m	2.5 m	8.0 m	TBC [4]
Max navigation update rate [5]		10 Hz	18 Hz	18 Hz	18 Hz
Time-To-First-Fix [6]	Cold start	26 s	29 s	30 s	TBC 4
	Hot start	1 s	1 s	1 s	TBC 4
	Aided starts [7]	2 s	2 s	3 s	TBC 4
Sensitivity [8]	Tracking & Navigation	–165 dBm	–164 dBm	–164 dBm	–157 dBm
	Reacquisition	–158 dBm	–158 dBm	–154 dBm	–151 dBm
	Cold start	–146 dBm	–146 dBm	–143 dBm	–136 dBm
	Hot start	–155 dBm	–155 dBm	–154 dBm	–149 dBm

Table 1: SAM-M8Q (on 50 mm x 50 mm GND plane) performance in different GNSS modes (default: concurrent reception of GPS and GLONASS incl. QZSS, SBAS)

1.4 Block diagram

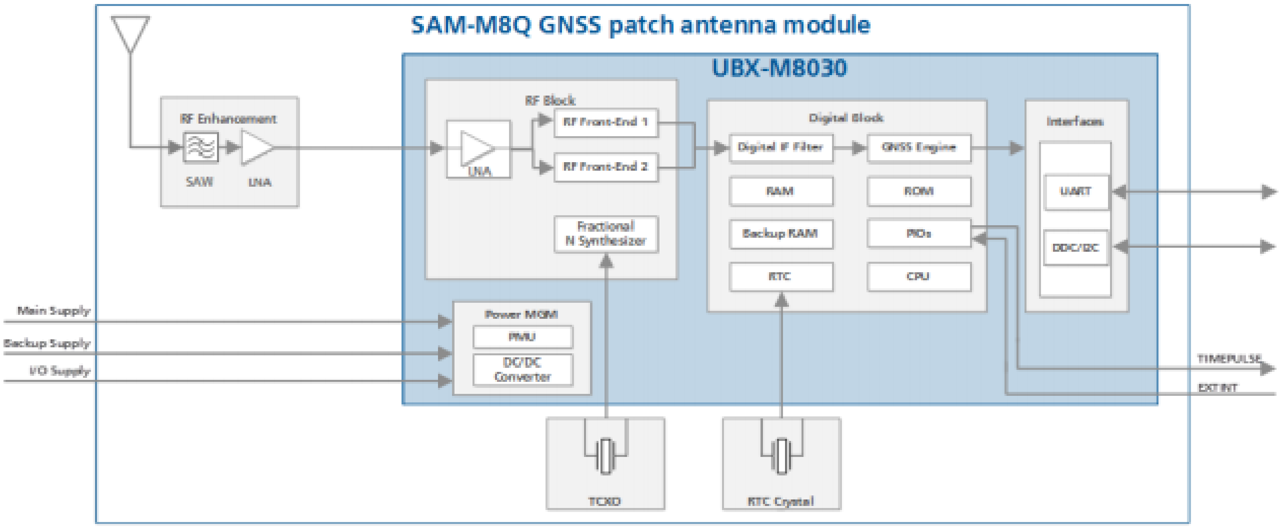


Figure 1: SAM-M8Q block diagram

2 Pin Definition

2.1 Pin assignment

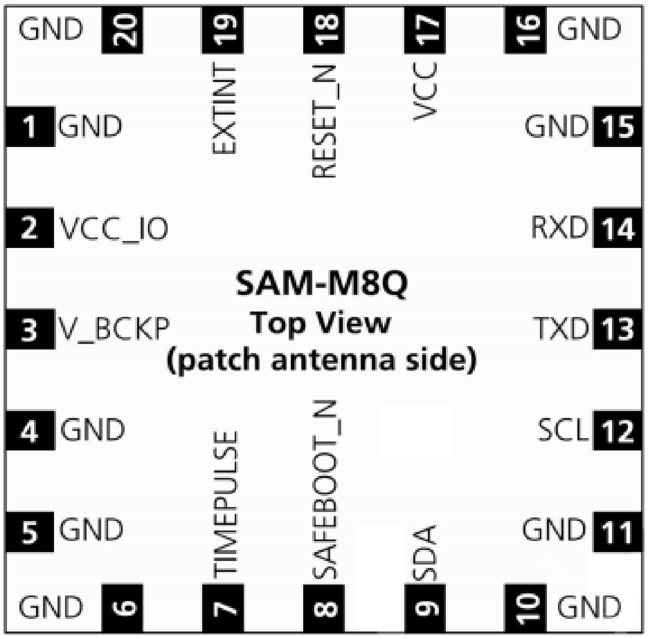


Figure 2: Pin Assignment

No	Name	I/O	Description
1	GND		
2	VCC_IO	I	Supply for IO voltage
3	V_BCKP	I	Backup supply
4	GND		
5	GND		
6	GND		
7	TIMEPULSE	O	1 PPS
8	SAFEBOOT_N	I	Reserved
9	SDA	I/O	DDC data
10	GND		
11	GND		
12	SCL	I	DDC clock
13	TxD	O	UART Tx
14	RxD	I	UART Rx
15	GND		
16	GND		
17	VCC	I	Main Supply
18	RESET_N	I	Active Low
19	EXTINT0	I	External interrupt
20	GND		

4.2 Operating conditions

All specifications are at an ambient temperature of +25 °C. Extreme operating temperatures can significantly impact specification values. Applications operating near the temperature limits should be tested to ensure the specification.

Parameter	**Symbol**	**Min**	**Typical**	**Max**	**Units**	**Condition**
Power supply voltage	VCC, VCC_IO	2.7	3.0	3.6	V	
Backup battery voltage	V_BCKP	1.4		3.6	V	
Backup battery current	I_BCKP		15		µA	V_BCKP = 1.8 V, VCC = 0 V
SW backup current at VCC_IO	I_SWBCKP		20		µA	VCC_IO = 3 V
Input pin voltage range	Vin	0		VCC_IO + 0.5	V	
Digital IO Pin Low level input voltage	Vil	0		0.2*VCC_IO	V	
Digital IO Pin High level input voltage	Vih	0.7*VCC_IO		VCC_IO + 0.5	V	
Digital IO Pin Low level output voltage	Vol			0.4	V	Iol = 4 mA
Digital IO Pin High level output voltage	Voh	VCC_IO – 0.4			V	Ioh = 4 mA
Pull-up resistor at RESET_N (internal)	Rpu		11		kΩ	
Operating temperature	Topr	–40		85	°C	

Table 7: Operating conditions

Humidity / Temperature Sensor : TC74

http://ww1.microchip.com/downloads/en/devicedoc/21462d.pdf

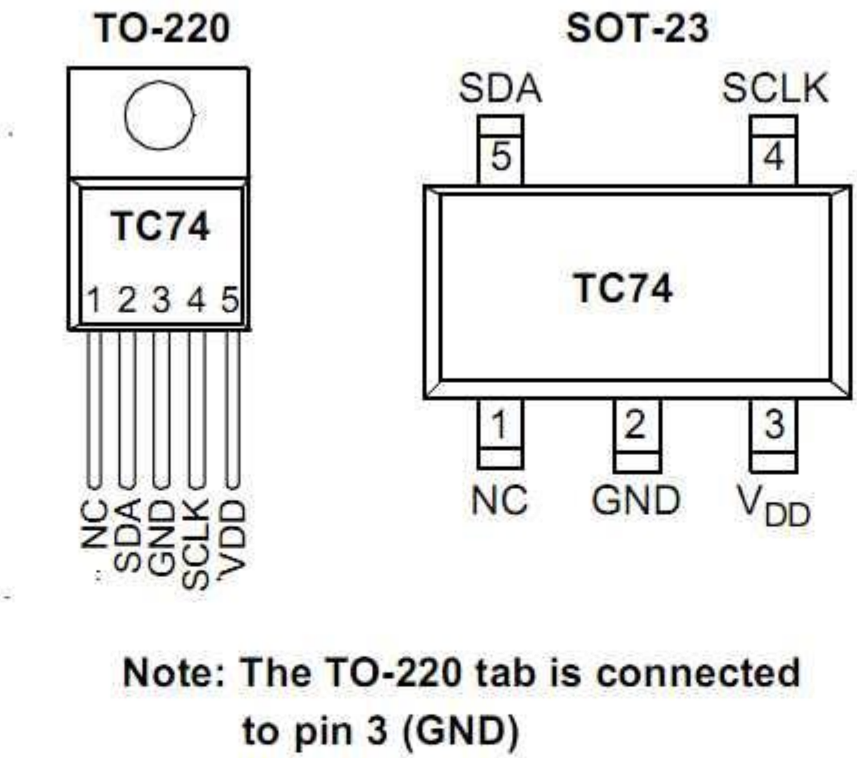
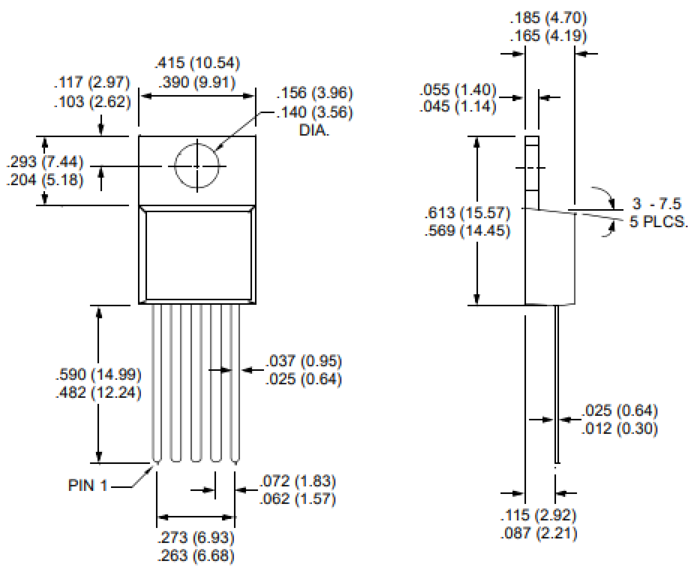


TABLE 4-4: TEMPERATURE-TO-DIGITAL VALUE CONVERSION (TEMP)

Actual Temperature	Registered Temperature	Binary Hex
+130.00°C	+127°C	0111 1111
+127.00°C	+127°C	0111 1111
+126.50°C	+126°C	0111 1110
+25.25°C	+25°C	0001 1001
+0.50°C	0°C	0000 0000
+0.25°C	0°C	0000 0000
0.00°C	0°C	0000 0000
-0.25°C	-1°C	1111 1111
-0.50°C	-1°C	1111 1111
-0.75°C	-1°C	1111 1111
-1.00°C	-1°C	1111 1111
-25.00°C	-25°C	1110 0111
-25.25°C	-26°C	1110 0110
-54.75°C	-55°C	1100 1001
-55.00°C	-55°C	1100 1001
-65.00°C	-65°C	1011 1111

Note: For the most current package drawings, please see the Microchip Packaging Specification located at http://www.microchip.com/packaging

5-Pin TO-220



Dimensions: inches (mm)

Microcontrollers

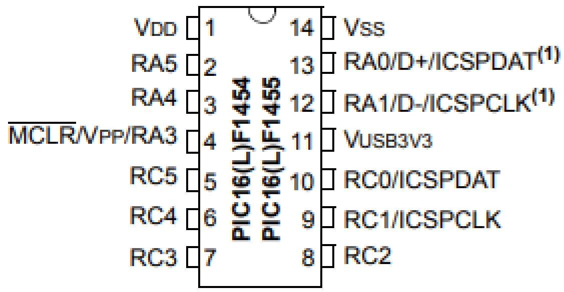


TABLE 2: 14-PIN ALLOCATION TABLE (PIC16(L)F1455)

I/O	14-Pin PDIP/SOIC/TSSOP	16-Pin QFN/UQFN	ADC	Reference	Comparator	Timer	CWG	USB	EUSART	PWM	MSSP	Interrupt	Basic
RA0	13	12	—	—	—	—	—	D+	—	—	—	IOC	ICSPDAT(3)
RA1	12	11	—	—	—	—	—	D-	—	—	—	IOC	ICSPCLK(3)
RA3	4	3	—	—	—	T1G(2)	—	—	—	—	$\overline{\text{SS}}$(2)	IOC	$\overline{\text{MCLR}}$ VPP
RA4	3	2	AN3	—	—	SOSCO T1G(1)	—	—	—	—	SDO(2)	IOC	CLKOUT OSC2 CLKR(1)
RA5	2	1	—	—	—	SOSCI T1CKI	—	—	—	PWM2(2)	—	IOC	CLKIN OSC1
RC0	10	9	AN4	VREF+	C1IN+ C2IN+	—	—	—	—	—	SCL SCK	—	ICSPDAT
RC1	9	8	AN5	—	C1IN1- C2IN1-	—	$\overline{\text{CWGFLT}}$	—	—	—	SDA SDI	INT	ICSPCLK
RC2	8	7	AN6	DACOUT1	C1IN2- C2IN2-	—	—	—	—	—	SDO(1)	—	—
RC3	7	6	AN7	DACOUT2	C1IN3- C2IN3-	—	—	—	—	PWM2(1)	$\overline{\text{SS}}$(1)	—	CLKR(2)
RC4	6	5	—	—	C1OUT C2OUT	—	CWG1B	—	TX CK	—	—	—	—
RC5	5	4	—	—	—	T0CKI	CWG1A	—	RX DT	PWM1	—	—	—
VDD	1	16	—	—	—	—	—	—	—	—	—	—	VDD
VSS	14	13	—	—	—	—	—	—	—	—	—	—	VSS
VUSB3V3	11	10	—	—	—	—	—	VUSB3V3	—	—	—	—	—

Note 1: Default location for peripheral pin function. Alternate location can be selected using the APFCON register.
2: Alternate location for peripheral pin function selected by the APFCON register.
3: LVP support for PIC18(L)F1XK50 legacy designs.

16.2.6 A/D CONVERSION PROCEDURE

This is an example procedure for using the ADC to perform an Analog-to-Digital conversion:

1. Configure Port:
   - Disable pin output driver (Refer to the TRIS register)
   - Configure pin as analog (Refer to the ANSEL register)
2. Configure the ADC module:
   - Select ADC conversion clock
   - Configure voltage reference
   - Select ADC input channel
   - Turn on ADC module
3. Configure ADC interrupt (optional):
   - Clear ADC interrupt flag
   - Enable ADC interrupt
   - Enable peripheral interrupt
   - Enable global interrupt[(1)]
4. Wait the required acquisition time[(2)].
5. Start conversion by setting the GO/$\overline{\text{DONE}}$ bit.
6. Wait for ADC conversion to complete by one of the following:
   - Polling the GO/$\overline{\text{DONE}}$ bit
   - Waiting for the ADC interrupt (interrupts enabled)
7. Read ADC Result.
8. Clear the ADC interrupt flag (required if interrupt is enabled).

Note 1:	The global interrupt can be disabled if the user is attempting to wake-up from Sleep and resume in-line code execution.
2:	Refer to **Section 16.4 "A/D Acquisition Requirements"**.

EXAMPLE 16-1: A/D CONVERSION

```
;This code block configures the ADC
;for polling, Vdd and Vss references, Frc
;clock and AN0 input.
;
;Conversion start & polling for completion
; are included.
;
BANKSEL   ADCON1       ;
MOVLW     B'11110000'  ;Right justify, Frc
                       ;clock
MOVWF     ADCON1       ;Vdd and Vss Vref+
BANKSEL   TRISA        ;
BSF       TRISA,0      ;Set RA0 to input
BANKSEL   ANSEL        ;
BSF       ANSEL,0      ;Set RA0 to analog
BANKSEL   ADCON0       ;
MOVLW     B'00000001'  ;Select channel AN0
MOVWF     ADCON0       ;Turn ADC On
CALL      SampleTime   ;Acquisiton delay
BSF       ADCON0,ADGO  ;Start conversion
BTFSC     ADCON0,ADGO  ;Is conversion done?
GOTO      $-1          ;No, test again
BANKSEL   ADRESH       ;
MOVF      ADRESH,W     ;Read upper 2 bits
MOVWF     RESULTHI     ;store in GPR space
BANKSEL   ADRESL       ;
MOVF      ADRESL,W     ;Read lower 8 bits
MOVWF     RESULTLO     ;Store in GPR space
```

22.8 Register Definitions: MSSP Control

REGISTER 22-1: SSPSTAT: SSP STATUS REGISTER

R/W-0/0	R/W-0/0	R-0/0	R-0/0	R-0/0	R-0/0	R-0/0	R-0/0
SMP	CKE	$D/\overline{A}$	P	S	$R/\overline{W}$	UA	BF
bit 7							bit 0

Legend:		
R = Readable bit	W = Writable bit	U = Unimplemented bit, read as '0'
u = Bit is unchanged	x = Bit is unknown	-n/n = Value at POR and BOR/Value at all other Resets
'1' = Bit is set	'0' = Bit is cleared	

bit 7 **SMP:** SPI Data Input Sample bit

SPI Master mode:
1 = Input data sampled at end of data output time
0 = Input data sampled at middle of data output time

SPI Slave mode:
SMP must be cleared when SPI is used in Slave mode

In I^2C Master or Slave mode:
1 = Slew rate control disabled for Standard-Speed mode (100 kHz and 1 MHz)
0 = Slew rate control enabled for High-Speed mode (400 kHz)

bit 6 **CKE:** SPI Clock Edge Select bit (SPI mode only)

In SPI Master or Slave mode:
1 = Transmit occurs on transition from active to Idle clock state
0 = Transmit occurs on transition from Idle to active clock state

In I^2C™ mode only:
1 = Enable input logic so that thresholds are compliant with SMbus specification
0 = Disable SMbus specific inputs

bit 5 **$D/\overline{A}$:** Data/$\overline{\text{Address}}$ bit (I^2C mode only)
1 = Indicates that the last byte received or transmitted was data
0 = Indicates that the last byte received or transmitted was address

bit 4 **P:** Stop bit
(I^2C mode only. This bit is cleared when the MSSP module is disabled, SSPEN is cleared.)
1 = Indicates that a Stop bit has been detected last (this bit is '0' on Reset)
0 = Stop bit was not detected last

bit 3 **S:** Start bit
(I^2C mode only. This bit is cleared when the MSSP module is disabled, SSPEN is cleared.)
1 = Indicates that a Start bit has been detected last (this bit is '0' on Reset)
0 = Start bit was not detected last

bit 2 **$R/\overline{W}$:** Read/$\overline{\text{Write}}$ bit information (I^2C mode only)
This bit holds the $R/\overline{W}$ bit information following the last address match. This bit is only valid from the address match to the next Start bit, Stop bit, or not $\overline{\text{ACK}}$ bit.

In I^2C Slave mode:
1 = Read
0 = Write

In I^2C Master mode:
1 = Transmit is in progress
0 = Transmit is not in progress
OR-ing this bit with SEN, RSEN, PEN, RCEN or ACKEN will indicate if the MSSP is in Idle mode.

bit 1 **UA:** Update Address bit (10-bit I^2C mode only)
1 = Indicates that the user needs to update the address in the SSPADD register
0 = Address does not need to be updated

REGISTER 22-1: SSPSTAT: SSP STATUS REGISTER (CONTINUED)

bit 0 **BF:** Buffer Full Status bit

Receive (SPI and I^2C modes):
1 = Receive complete, SSPBUF is full
0 = Receive not complete, SSPBUF is empty

Transmit (I^2C mode only):
1 = Data transmit in progress (does not include the $\overline{\text{ACK}}$ and Stop bits), SSPBUF is full
0 = Data transmit complete (does not include the $\overline{\text{ACK}}$ and Stop bits), SSPBUF is empty

20.1 Timer1 Operation

The Timer1 module is a 16-bit incrementing counter which is accessed through the TMR1H:TMR1L register pair. Writes to TMR1H or TMR1L directly update the counter.

When used with an internal clock source, the module is a timer and increments on every instruction cycle. When used with an external clock source, the module can be used as either a timer or counter and increments on every selected edge of the external source.

Timer1 is enabled by configuring the TMR1ON and TMR1GE bits in the T1CON and T1GCON registers, respectively. Table 20-1 displays the Timer1 enable selections.

TABLE 20-1: TIMER1 ENABLE SELECTIONS

TMR1ON	TMR1GE	Timer1 Operation
0	0	Off
0	1	Off
1	0	Always On
1	1	Count Enabled

29.0 ELECTRICAL SPECIFICATIONS

Absolute Maximum Ratings(†)

Ambient temperature under bias .... -40°C to +125°C

Storage temperature .... -65°C to +150°C

Voltage on V_{DD} with respect to V_{SS}, PIC16F1454/5/9 .... -0.3V to +6.5V

Voltage on V_{DD} with respect to V_{SS}, PIC16LF1454/5/9 .... -0.3V to +4.0V

Voltage on $\overline{MCLR}$ with respect to Vss .... -0.3V to +9.0V

Voltage on D+ and D- with respect to Vss

0Ω source impedance[2] .... -0.5V to (V_{USB3V3} + 0.5V)

Source impedance ≥ 28Ω, $V_{USB3V3} \geq 3.0V$ .... -1.0V to + 4.6V)

Voltage on all other pins with respect to V_{SS} .... -0.3V to (V_{DD} + 0.3V)

Total power dissipation[1] .... 800 mW

Maximum current out of V_{SS} pin, $-40°C \leq T_A \leq +85°C$ for industrial .... 396 mA

Maximum current out of V_{SS} pin, $-40°C \leq T_A \leq +125°C$ for extended .... 114 mA

Maximum current into V_{DD} pin, $-40°C \leq T_A \leq +85°C$ for industrial .... 292 mA

Maximum current into V_{DD} pin, $-40°C \leq T_A \leq +125°C$ for extended .... 107 mA

Clamp current, I_K (V_{PIN} < 0 or V_{PIN} > V_{DD})[3] .... ± 20 mA

Maximum output current sunk by any I/O pin .... 25 mA

Maximum output current sourced by any I/O pin .... 25 mA

Note 1: Power dissipation is calculated as follows: $P_{DIS} = V_{DD} \times \{I_{DD} - \sum I_{OH}\} + \sum \{(V_{DD} - V_{OH}) \times I_{OH}\} + \sum(V_{OI} \times I_{OL})$

2: The original USB 2.0 Specification indicated that USB devices should withstand 24-hour short circuits of D+ or D- to VBUS voltages. This requirement was later removed in an Engineering Change Notice (ECN) supplement to the USB specifications, which supersedes the original specifications. The PIC16(L)F1454/5/9 devices will typically be able to survive this short-circuit test, but it is recommended to adhere to the absolute maximum specified here to avoid damaging the device.

3: Stress rating only. For proper functional operation, non-USB I/O pins should be maintained within the -0.3V to (VDD + 0.3V) range, which will not result in injected current. See technical brief TB3013 for details.

† NOTICE: Stresses above those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at those or any other conditions above those indicated in the operation listings of this specification is not implied. Exposure above maximum rating conditions for extended periods may affect device reliability.

Battery

Section 1-Chemical Product and Company Identification

Product Identification

Lithium Ion Polymer Cell/Battery:

DTP 605068-3P_Lithium Ion Polymer Battery-

Norminal Voltage	:	3.7 V
Norminal Capacity	:	6000mAh
Equivalent Lithium content	:	22.2-Wh
Testing Period	:	January 14 ， 2016_To January 22，2016

This MSDS was prepared by Shenzhen Green Seeding Testing Technology Co., Ltd.

Item Number: GST160122007S

Referenced documents: ISO 11014:2009 Safety data sheet for chemical products;

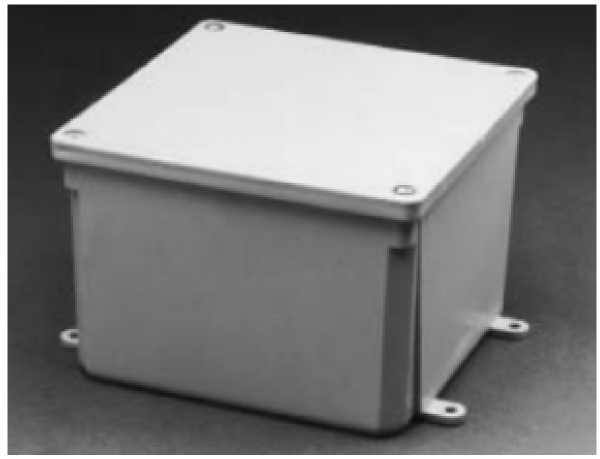
Molded Nonmetallic Junction Boxes 6P Rated

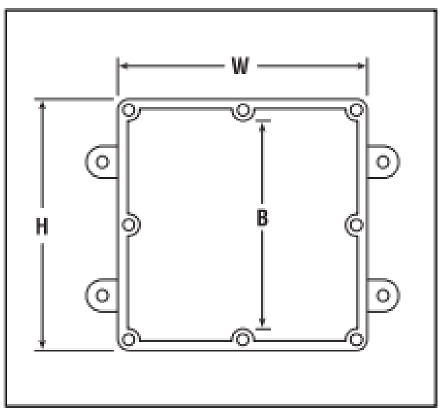
Except where noted by †

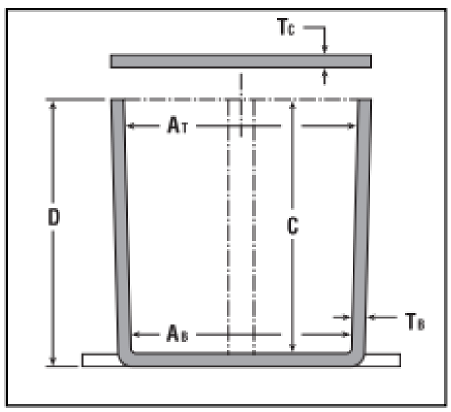
LISTED E42728

It's another first from Carlon® - the first nonmetallic junction boxes UL Listed with a NEMA 6P rating per Section 314.29, Exception of the National Electrical Code. Manufactured from PVC or PPO thermoplastic molding compound and featuring foam-in-place gasketed lids attached with stainless steel screws, these rugged enclosures offer all the corrosion resistance and physical properties you need for direct burial applications.

Type 6P enclosures are intended for indoor or outdoor use, primarily to provide a degree of protection against contact with enclosed equipment, falling dirt, hose-directed water, entry of water during prolonged submersion at a limited depth, and external ice formation.







- All Carlon Junction Boxes are UL Listed and maintain a minimum of a NEMA Type 4/4x Rating.
- Parts numbers with an asterisk (*) are UL Listed and maintain a NEMA Type 6P Rating and Type 4/4X Rating.

Part No.	Size in Inches H x W x D	Std. Ctn. Qty.	Min A_T	Min. A_B	Min. B	Min. C	Ta (Typical)	Tc (Typical)	Material: PVC	Material: Thermo-plastic	Std. Ctn. Wt. (Lbs.)
E989NNJ-CAR*	4 x 4 x 2	5	3 11/16	3 5/8	N/A	2	.160	.155	X		3
E987N-CAR*	4 x 4 x 4	5	3 11/16	3 1/2	N/A	4	.160	.155	X		4
†E989NNR-CAR*	4 x 4 x 6	4	3 11/16	3 3/8	N/A	6	.160	.200	X		5
E989PPJ-CAR*	5 x 5 x 2	4	4 11/16	4 1/2	N/A	2	.110	.150		X	3
E987R-CAR*	6 x 6 x 4	2	6	5 5/8	N/A	4	.190	.190		X	3
E989RRR-UPC*	6 x 6 x 6	8	5 5/8	5 3/8	N/A	6	.160	.150		X	14
E989N-CAR	8 x 8 x 4	1	8	8	N/A	4	.185	.190		X	2
E989SSX-UPC	8 x 8 x 7	2	7 21/32	7 5/16	N/A	7	.160	.150		X	6
E989UUN	12 x 12 x 4	3	11 5/8	11 1/2	11 1/8	4	.160	.150		X	12
E989R-UPC	12 x 12 x 6	2	11 15/16	11 7/8	11 7/16	6	.265	.185		X	10

Corrosion Resistance of Carlon Schedule 40 and Schedule 80 PVC Conduit and Fittings

Carlon Schedule 40 and Schedule 80 are generally acceptable for use in environments containing the chemicals below. These environmental resistance ratings are based upon tests where the specimens were placed in complete submergence in the reagent listed. Schedule 40 and Schedule 80 can be used in many process areas where chemicals not on this list are manufactured or used because worker safety requirements dictate that any air presence or splashing be at a very low level.

If there are any questions for specific suitability in a given environment, prototype samples should be tested under actual conditions.

- Acetic Acid 0-20%
- Acetic Acid 20-30%
- Acetic Acid 30-60%
- Acetic Acid 80%
- Acetic Acid – Glacial
- Acetic Acid Vapors
- Acetylene
- Adipic Acid
- Alum
- Aluminum Chloride
- Aluminum Fluoride
- Aluminum Hydroxide
- Aluminum Oxychloride
- Aluminum Nitrate
- Aluminum Sulfate
- Ammonia-Dry Gas
- Ammonium Bifluoride
- Ammonium Carbonate
- Ammonium Chloride
- Ammonium Hydroxide 28%
- Ammonium Metaphosphate
- Ammonium Nitrate
- Ammonium Persulfate
- Ammonium Phosphate – Neutral
- Ammonium Sulfate
- Ammonium Sulfide
- Ammonium Thiocyanate
- Amyl Alcohol
- Anthraquinone
- Anthraquinonesulfonic Acid
- Antimony Trichloride
- Aqua Regia
- Arsenic Acid 80%
- Arylsulfonic Acid
- Barium Carbonate
- Barium Chloride
- Barium Hydroxide
- Barium Sulfate
- Barium Sulfide
- Beet – Sugar Liquor
- Benzine Sulfonic Acid 10%
- Benzoic Acid
- Bismuth Carbonate
- Black Liquor (Paper Industry)
- Bleach – 12.5% Active CL_2
- Borax
- Boric Acid
- Brine
- Breeder Pellets – Dane. Fish
- Bromic Acid
- Bromine – Water
- Butane
- Butadiene
- Butyl Alcohol
- Butyl Phenol
- Butylene
- Butyric Acid
- Calcium Bisulfite
- Calcium Carbonate
- Calcium Chlorate
- Calcium Chloride
- Calcium Hydroxide
- Calcium Hypochlorite
- Calcium Nitrate
- Calcium Sulfate
- Carbonic Acid
- Carbon Dioxide Gas – Wet
- Carbon Dioxide – Aqueous Solution
- Carbon Monoxide
- Caustic Potash
- Caustic Soda
- Chloracatic Acid
- Chloral Hydrate
- Chlorine Gas (Dry)
- Chlorine Gas (Moist)
- Chlorine Water
- Chlorosulfonic Acid
- Chrome Alum
- Chromic Acid 10%
- Chromic Acid 30%
- Chromic Acid 40%
- Chromic Acid 50%
- Citric Acid
- Copper Chloride
- Copper Cyanide
- Copper Fluoride
- Copper Nitrate
- Copper Sulfate
- Cottonseed Oil
- Cresylic Acid 50%
- Crude Oil – Sour
- Crude Oil – Sweet
- Demineralized Water
- Dextrin
- Dextrose
- Diglycolic Acid
- Disodium Phosphate
- Ethyl Alcohol
- Ethylene Glycol
- Fatty Acids
- Ferric Chloride
- Ferric Nitrate
- Ferric Sulfate
- Ferrous Chloride
- Ferrous Sulfate
- Fluorine Gas – Wet
- Fluorine Gas – Dry
- Fluoroboric Acid
- Fluorosilicic Acid
- Formaldehyde
- Formic Acid
- Fructose
- Gallic Acid
- Gas – Coke Oven
- Gas – Natural (Dry)
- Gas – Natural (Wet)
- Gasoline – Sour
- Gasoline – Refined
- Glucose
- Glycerine (Glycerol)
- Glycol
- Glycolic Acid
- Green Liquor (Paper Industry)
- Heptane
- Hexanol, Tertiary
- Hydrobromic Acid 20%
- Hydrochloric Acid 0% - 25%
- Hydrochloric Acid 25% - 40%
- Hydrocyanic Acid or Hydrogen Cyanide
- Hydrofluoric Acid 10%
- Hydrofluorosilicic Acid
- Hydrogen Phosphide
- Hydrogen Sulfide – Dry
- Hydrogen Sulfide – Aqueous Solution
- Hydroquinone
- Hydroxylamine Sulfate
- Iodine
- Kerosene
- Lactic Acid 28%
- Lauric Acid
- Lauryl Chloride
- Lauryl Sulfate
- Lead Acetate
- Lime Sulfur
- Linoleic Acid
- Linseed Oil
- Lubricating Oils
- Magnesium Carbonate
- Magnesium Chloride
- Magnesium Hydroxide
- Magnesium Nitrate
- Magnesium Sulfate
- Maleic Acid
- Malic Acid
- Mercuric Chloride
- Mercuric Cyanide
- Mercurous Nitrate
- Mercury
- Methyl Sulfate
- Methylene Chloride
- Mineral Oils
- Naphthalene
- Nickel Chloride
- Nickel Nitrate
- Nitric Acid, Anydrous
- Nitric Acid 20%
- Nitric Acid 40%
- Nitric Acid 60%
- Nitrobenzene
- Nitrous Oxide
- Oils and Fats
- Oils – Petroleum – (See Type)
- Oleic Acid
- Oxalic Acid
- Palmitic Acid 10%
- Perchloric Acid 10%
- Phenylhydrazine Hydrochloride
- Phosgene, Gas
- Phosphoric Acid – 0-25%
- Phosphoric Acid – 25-50%
- Phosphoric Acid – 50-85%
- Photographic Chemicals
- Plating Solutions
- Potassium Bicarbonate
- Potassium Bichromate
- Potassium Borate
- Potassium Bromide
- Potassium Carbonate
- Potassium Chloride
- Potassium Chromate
- Potassium Cyanide
- Potassium Dichromate
- Potassium Ferricyanide
- Potassium Ferrocyanide
- Potassium Fluoride
- Potassium Hydroxide
- Potassium Nitrate
- Potassium Perborate
- Potassium Perchlorite
- Potassium Permanganate 10%
- Potassium Persulfate
- Potassium Sulfate
- Propane
- Propyl Alcohol
- Silicic Acid
- Silver Cyanide
- Silver Nitrate
- Silver Plating Solutions
- Sodium Acetate
- Sodium Arsenite
- Sodium Benzoate
- Sodium Bicarbonate
- Sodium Bisulfate
- Sodium Bisulfite
- Sodium Bromide
- Sodium Chlorate
- Sodium Chloride
- Sodium Cyanide
- Sodium Dichromate
- Sodium Ferricyanide
- Sodium Ferrocyanide
- Sodium Fluoride
- Sodium Hydroxide
- Sodium Hypochlorite
- Sodium Nitrate
- Sodium Nitrite
- Sodium Sulfate
- Sodium Sulfide
- Sodium Sulfite
- Sodium Thiosulfate (Hypo)
- Stannic Chloride
- Stannous Chloride
- Stearic Acid
- Sulfur
- Sulfur Dioxide – Gas Dry
- Sulfur Trioxide
- Sulfuric Acid – 0-10%
- Sulfuric Acid – 10-75%
- Sulfuric Acid – 75-90%
- Sulfurous Acid
- Tannic Acid
- Tanning Liquors
- Tartaric Acid
- Titanium Tetrachloride
- Triethanolamine
- Trimethyl Propane
- Trisodium Phosphate
- Turpentine
- Urea
- Vinegar
- Whiskey
- White Liquor (Paper Industry)
- Wines
- Zinc Chloride
- Zinc Chromate
- Zinc Cyanide
- Zinc Nitrate
- Zinc Sulfate

We propagate our GPS location via cellular network so you don't have to worry about our device interfering with other sensitive electronic devices running in the background

Our goal is to create an accurate and affordable tracking solutions.

Design Team:

Dillon Hall

Brian Kirchgessner

Abraham Maldonado-Sanchez

Dana Marvich

Scott Skrobel

Big Asset Tracker
1201 Larimer St.
Denver, Colorado
80204

Brian.kirchgessner@ucdenver.edu

303-315-5969

Big Asset Tracker

Big Asset Tracker

Tracking Device

Big
Asset Tracker

Asset tracking has become an integral part of business operation in today's companies

Features

- Durable Construction that can survive hazardous work environments
- Reliable location updates daily
- Extremely long last battery power

Big Asset tracker will drop a pin on a Google Map of where your tracked asset is.

How will the big Asset Tracker Benefit your Business?

Permanently losing a box containing expensive tools and/or materials is the greatest financial blunder that the Big Asset Tracker can prevent but it's not the only one.

Instead of an employee showing up to a jobsite and trying to find where another employee left the box he or she needs, a worker can use his or her smart phone to locate that box instantly and save the time they would have wasted locating the box.

Industry Testimonials:

"A long lasting tracking device that isn't outrageously expensive

CED Division Manager

"Big Asset tracking is a great product for any industry"

Potential Customer

What we Offer:

- Daily location updates
- Location updates whenever boxes are moved
- Remaining Battery Life Information
- Climate conditions in box locations

Interest Potential Clients

- Consolidated Electrical Distributors
- Rexel
- GexPro
- Hospitals
- Trucking Companies

Micro-Controller Code:

```
/*
   example state machine in C
   implements a basic moor machine
*/

#include <stdio.h>
#include <stdbool.h>
// define macros for states
#define START 1 // start up the micro
#define HOLOGRAM_CONNECT 2 // connect to hologram
#define HOLOGRAM_DISCONNECT 3  // disconnect from hologram
#define CHECK_ENVIROMENT 4  // take envrimental readings
#define SEND_FAILSTATE 5 // tell hologram that we've failed
#define SLEEP_MODE 6 // put the micro to sleep
#define CHECK_BATTERY 7 // check the battery
#define SEND_UPDATE 8 // send normal update to hologram
#define GET_FROM_HOLOGRAM 9

int main()
{
   unsigned char current_state = START;
   unsigned char next_state = 0;
   bool failing = false;

   size_t i;
   for(i=0;i<9;i++)
   {
```

```
switch(current_state)
{
  // start case
  case START:
    printf("%s\n","starting");
    next_state = CHECK_ENVIROMENT;
  break;
  // connect to hologram
  case HOLOGRAM_CONNECT:
    printf("%s\n","connecting to hologram!");
    next_state = SEND_UPDATE;
  break;
  // do an envrimental check
  case HOLOGRAM_DISCONNECT:
    printf("%s\n","disconnecting to hologram");
    next_state = SLEEP_MODE;
  break;
  // do an envrimental check
  case CHECK_ENVIROMENT:
    printf("%s\n","checking eniroment");
    if(failing) // are we faling?
      next_state = SEND_FAILSTATE;
    else
      next_state = CHECK_BATTERY;
  break;
  // check the battery
  case CHECK_BATTERY:
    printf("%s\n","doing a battery check ");
    next_state = HOLOGRAM_CONNECT;
```

```
        break;
        // send the update
        case SEND_UPDATE:
          printf("%s\n","send an update to hologram");
          next_state = HOLOGRAM_DISCONNECT;
        break;
        // enter sleep mode
        case SLEEP_MODE:
          printf("%s\n","putting micro to sleep using some assembly code b/c it's really boring and only
one guy on our team messes with that shizznazz");
          next_state = START;
        break;


      }


      current_state = next_state; // update the state after each iteration
    }


    return 0;
}
```

Resumes:

BRIAN KIRCHGESSNER

4363 South Quebec St. Denver, CO 80237, 303-877-4240, **bkirchge@gmail.com**

Electrical Engineering/Business graduate with sales, management and project experience looking for a position with an engineering and/or defense contractor.

ENGINEERING PROJECTS:

- Cellular Network Wireless Asset Tracker
- Modeled a Battery Temperature Control System
- Modeling a 2 TE 10 Wave Guides that Share a common Wall
- Created an Annealing Chamber for Thin Film Lenses

MANAGEMENT PROFILE:

- Set-up/maintained pricing matrices for electronic component sales
- Reviewed location staffing and layoff decisions
- Monthly P&L analysis
- Annual sales forecasting

SALESMAN PROFILE:

- Grew an account's total sale in one month to match the previous three years combined
- Successfully identified and brought in 3 new high-potential accounts
- Ran the Xcel rebate program for CED Grand Junction
- Rearranged store front to increase LED Sales
- Technical background focused in Electrical Engineering
- Unique combination of Marketing and Engineering

LEADERSHIP:

- Eta Kappa Nu Member
- Member of IEEE (the Electrical Engineering Association 2009 – 2019)
- Youth Soccer Coach (2014-2015)
- IEEE Chair of the Advertising Committee for SPAC
- Worked on promoting the conference and the keynote speaker for the regional IEEE conference. 2010

EDUCATION:

Bachelor of Science - Electrical Engineering, Expected Graduation 12/2019 GPA 3.12 7/2017 to Present
University of Colorado, Denver CO
Bachelor of Business Administration Degree – Marketing, GPA: 3.0 12/2014
Colorado State University, Fort Collins CO

WORK HISTORY:

Consolidated Electrical Distributors

SALES REPRESENTATIVE Denver, CO 5/2017 to Present

- Analyzed 96 commercial customer accounts for potential new sales
- Reduced the number of account and increased GP by 49% in 2018
- ABB Variable Frequency Drive start up certified
- Assisted Industrial sales team with inside sales for 10 accounts, in addition to managing my outside accounts.
- Project Management for all of my accounts, working with my in-office coordinator on bids/contracts.
- Worked full-time while completing the Engineering program.

MANAGER TRAINEE Grand Junction, CO 1/2016 to 5/2017

- Called on customers and focused on growing and new accounts
- Ran the Excel Lighting Rebate program
- Purchased items for stock and special orders
- Back office: Preformed accounts payables and accounts receivable tasks

MANAGER TRAINEE Farmington, NM 1/2015 to 12/2015

- Purchased a couple of different product lines for the location
- Worked with the outside sales reps and supported their customers
- Monthly P&L analysis, Annual sales forecasting and reviewed location staffing/layoff decisions.

Rich's Aggie Discount Liquor

MANAGER Fort Collins, CO 6/2013 to 12/2014

- Part-time position while attending Colorado State University
- Sold one of the largest selections of beverages in Fort Collins
- Researched a variety of companies and products to knowledgably market them
- Restocked product and performed annual inventory

NSF Engineering Research Center for Extreme Ultraviolet (EUV) Science and Technology

RESEARCH ASSISTANT Fort Collins, CO 6/2012 to 9/2012

- Worked with vendors sales reps to procure electronic parts for research projects
- Created an annealing cell that cooked thin film lenses for high powered lasers
- Worked with graduate students on their projects
- Machined and cleaned parts for various lab equipment

Dana Marvich

Contact Info:

Phone: 206 920-9219 Email: dana.marvich@ucdenver.edu

Education:

University of Colorado Denver

-Pursuing Bachelor's of Science in Electrical Engineering

-Expected graduation Fall 2019 Semester

North Seattle Community College

-Attended between 2014-2016, then transferred to UC Denver

Nathan Hale High School

-Graduated in 2010

Skills:

Software

-Matlab, Mathcad, Pspice, Keysight ADS, Verilog

Programming Languages

-C, Python, Ardiuno

Interests/Degree Emphasis:

-My main interests in electrical engineering are microwave circuit design and antenna theory

Work Experience:

Almost a decade of experience in the restaurant industry, worked as cashier, busser and server

Dillon Hall

Email: Dillon.hall@ucdenver.edu

Skills:

- Extensive in C/C++, Python, Rust, Java, Javascript, PIC & Atmel assembly, Verilog, and, Linux Bash
- Experience designing Analog Circuits that are designed to operate at frequencies as high as giga bands, using passive and active components, Opamps, and transmission lines.
- Extensive experience in development using 8bit microcontrollers
- Proficient in electrical design suites such as QUCS, eagle CAD ,Agilent ADS and, Spice.
- Knowledgeable about standard bench kit such as ossicopes, signal generators and VNA's

Education:

CU Denver, 2019, Electrical Engineering, concentration in radio frequency design with a minor in computer Engineering.

School Projects:

- Big assent tracker(2019), Senior design project. Designed software and electronics for a 3G assented GPS tracker. Device contains a long-lasting battery and sensors to monitor environment.
- Designed a 2.0 Ghz low pass filter for 4134: intro to microwave circuit design
- Developed a convolutional neural network base image classification algorithm for ELEC 4800
- Implemented a limited MIPS CPU in verilog for ELEC 3651: Digital hardware design.
- Developed a bandpass filter for ELEC:2500
- Designed a VGA video generator for DE1-SOC board.

Employment History:

- HDR, Summer 2019 Electrical Engineering intern.

  Designed PLC control systems and DC electronics for sensor systems

- HOSTING. Summer 2015 to Fall of 2015. Software engineering intern.

  Working on bugs for on going projects.

  Gained practical experience with mocking and Unit testing.

- Motocol LLC, Software engineering intern Fall 2014 to Summer 2015
  - Worked under direction of senior Software engineers to build UI elements for web services.
  - Wrote documentation for ongoing projects
- Analog engineering LLC: Engineering intern. Summer 2013 to Summer 2014
  - Developed firmware for PIC16F1455 microcontroller for sending telemetry to a host PC over USB.
  - Wrote documentation for board and firmware.

Abraham Maldonado Sanchez

824 S Vrain St | Denver , Colorado 80219 | maldonado580@gmail.com | (720)-492-8751

OBJECTIVE:

Dedicated and motivated college student seeking to obtain an internship position in the field of electrical engineering

EXPERIENCE

Advanced Concrete Construction Denver , Colorado June 2012 - June 2017

- As a construction worked my responsibilities were to maintain a exceptional condition of the area that the concrete was being poured.

UPS Commerce, Colorado June 25,2018 - Current

- As a package handler my responsibilities are to keep a fast pace of packages going to the conveyor belt.

EDUCATION

*High School :***CEC Middle College of Denver**

Red Rocks Community College GPA 3.20 ,

University of Colorado Denver GPA 3.17

SKILLS

- Proficiency in Microsoft Word
- Analytical
- Mathematical
- Logical Thinker
- Critical Thinker
- Electric Drives
- Control Systems (Z transform, Laplace Transform, Fourier Transform)

Languages: Bilingual in English and Spanish.

Graduate: Expected Fall 2019

Scott Skrobel
https://github.com/skeeter2100/

Email : scott.skrobel@gmail.com
Mobile : +1-303-472-6281

Education

- **University of Colorado Denver** — Denver, CO
  B.S. Electrical Engineering — *Aug. 2017 – May. 2020*

Projects

- **Big Asset Tracker**: Developed firmware and designed the electronic hardware for a GPS tracking device as a senior design capstone project.
- **Financial Analysis Portfolio**: Designed a personal financial portfolio to pull data from an API utilizing historical prices and update real time tracking data. Used python to load the data into a financial model in order to conduct personal analysis and evaluate positions. Created a GUI with TKinter and visualized the data with MatPlotLib.
- **Time-Series Statistical Forecast**: Applied Autoregressive integrated moving averages (ARIMA) and Conditional Heteroskedasticity methods (ARCH) to model a change in variance or price of the CBOE volatility index in the stock market. Explored the data with python and used the pandas library to clean, normalize, and split the data.
- **Deep Learning**: Created a convolutional neural network base image classification algorithm using Tensorflow
- **Embedded Firmware Design**: Designed a single-cycle processor and implemented a limited MIPS CPU in verilog and simulated with machine code.

Skills

- **Programming Languages**: C/C++, R, Python, Java, Assembly, Verilog, LaTeX
- **Software**: OrCad/PSPICE, Quartus /Multisim, MatLab/Similink, UNIX/Bash, SSH, git
- **Analog Circuit Design**: Experience in designing analog circuits operating at high frequencies with both passive and active components including OP-AMPS and transmission lines.
- **Embedded Systems Design**: FPGA testbench simulation and embedded systems design experience programming microcontrollors and PIC debuggers.

Experience

- **Garlic Knott** — Denver, CO
  Hospitality — *April 2013 - December 2018*
  - **Line Cook**: Back of the house employee. Prepped food for service and cooked menu items in cooperation with the rest of the kitchen staff.
  - **Customer Service**: Delivery Driver while assisting front of the house with planning, coordination, and organization.
- **The Club at Ravenna** — Littleton, CO
  Golf Course Management — *April 2016 - Oct 2016*
  - **Golf Course Maintenance**: Worked closely with the Assistant and Golf Professional on the outside golf operations to assure a smooth transition for members and their guest around the club.
  - **Valet**: In charge of servicing club members cars.
- **DC Home Builders Inc** — Denver, CO
  Construction — *May 2012 - April 2016*
  - **Electrician**: Worked in residential homes.