NextGen Asset Tracking Device (NAT)

Group 1 – NAT

Brianna Thomason	Computer Engineer
Brittney Fry	Computer Engineer, Project Manager
Lucas Dickinson	Electrical Engineer, Computer Engineer
Ralph Baird	Computer Engineer
Wayne Marshall	Electrical Engineer

Sponsored Project

- Young Engineering Services, LLC
  - Professor Michael Young
- This project is multilayered
  - This SD project is only starting point
  - CS Team(s) will develop further
    - INS Algorithm
    - Other beneficial software features
      - Additional Firmware functionality

Problem and Motivation

- Objects get lost all of the time
  - Both for individuals and companies
- US =~20 to 50 billion dollars in lost or stolen equipment (Incorp, 2017)
- Companies embed software and hardware
  - Find my iPhone (Apple)
  - Find my mobile (Samsung)
  - Car keys tracker dongles
  - OnStar©
- INS Tracking

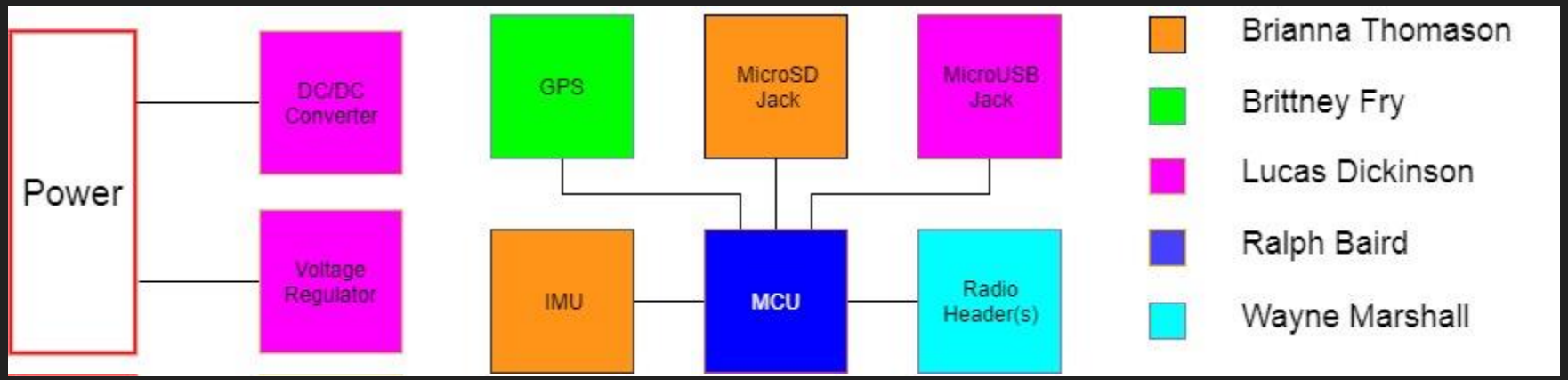
Goals and Objectives

- Main Goal
  - Produce a low-cost IOT module that can be attached to objects and report back its location
- Other Goals
  - Small device
  - Low power consumption

Uniqueness

- The NAT device is unique from other GPS trackers
  - Meant for industrial market, not consumer
    - One company = thousands of NATs
  - Backup INS

Overall Block Diagram



- The main processing power = Microcontroller
- Communication = Radio Modules
- Location = GPS
- Backup Location/Motion Data = IMU
- Main information storage = SD
- Power = Battery
- Everything communications with and through Microcontroller

Responsibilities

Research					
	MCU	Radio	GPS	Power	IMU
Brianna					Primary
Brittney			Primary		
Lucas		Secondary		Primary	
Ralph	Primary				
Wayne		Primary		Secondary	

Responsibilities

Design/Implementation						
	Schematic	Preliminary Testing HW	PCB	Firmware	Configuration GUI	Client GUI
Brianna				Secondary	Secondary	Primary
Brittney				Secondary	Primary	Secondary
Lucas	Primary	Secondary	Primary			
Ralph				Primary	Secondary	Secondary
Wayne	Secondary	Primary	Secondary			

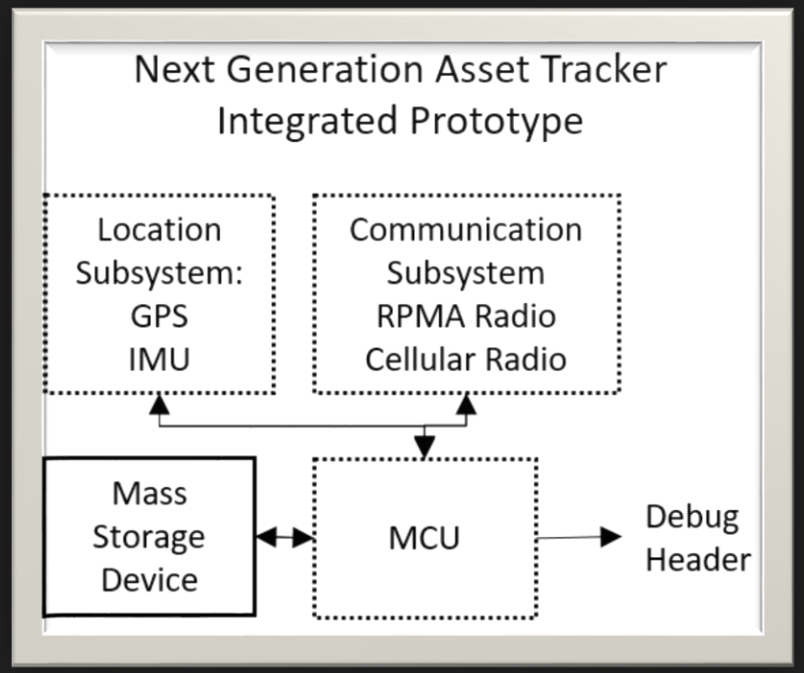
Specifications

General Specifications		
PCB	Size	Approx. size of credit card
Power	Voltage	Operate on 3.7V battery
Location	Accuracy	< 3m
Software	Type	Firmware, Configuration GUI, Client GUI
Motion	Accuracy	< 10degrees

Specifications

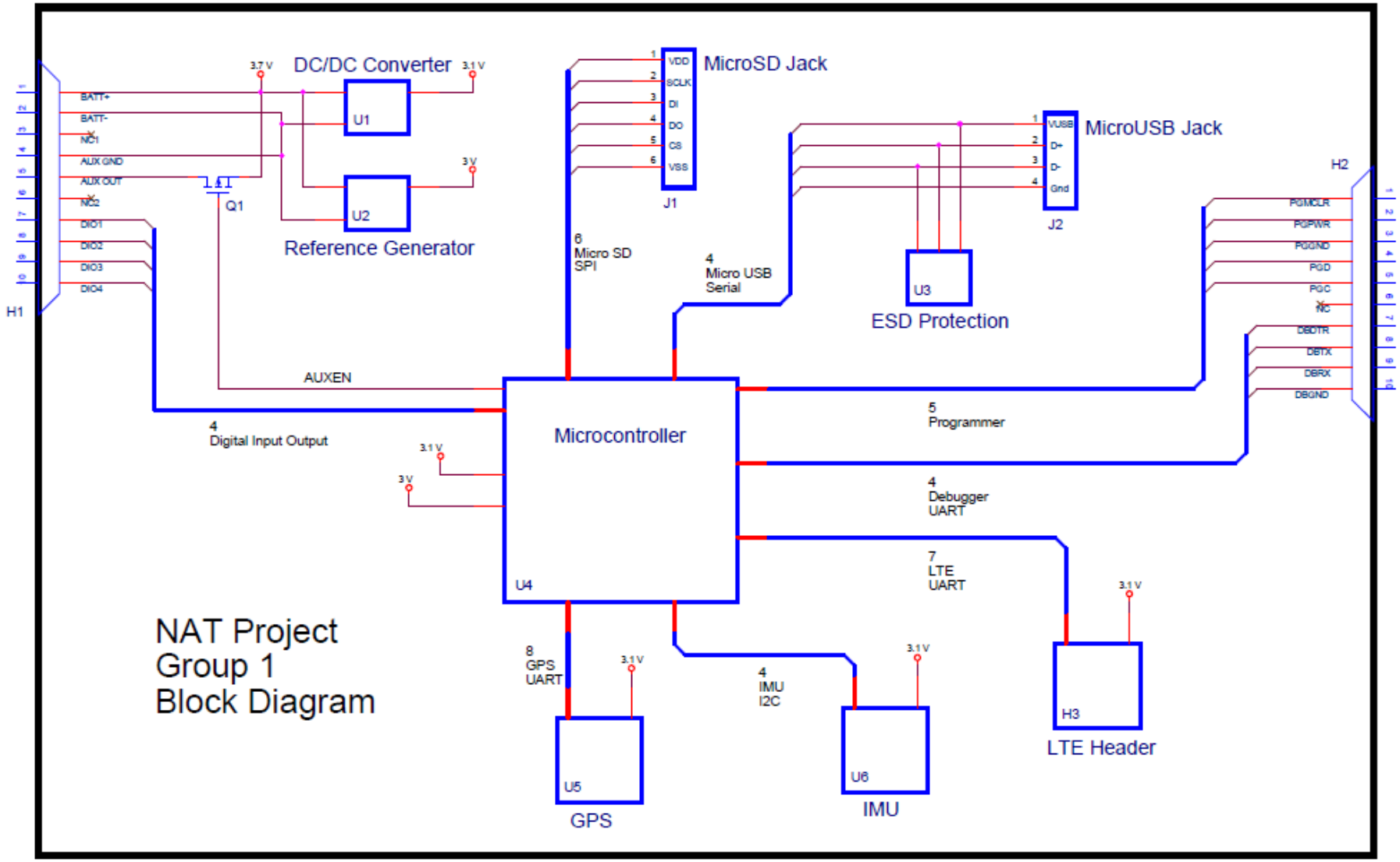
Hardware Specific	Software Specific
Integrate low power 16-bit MCU	Windows based Config GUI
Integrate GPS receiver	Configure Device with MSD/HID
Integrate 9-axis MPU	Communicate with Config GUI over USB
Integrate Radio Module	Web Based Client GUI
Able to record data	Communicate with Client GUI over radio modules
Able to recharge battery	Firmware that interfaces MCU with Radio, MPU, and GPS modules
Able to move between power modes	Firmware that creates data packet(s) to be sent on the network

Hardware Architecture

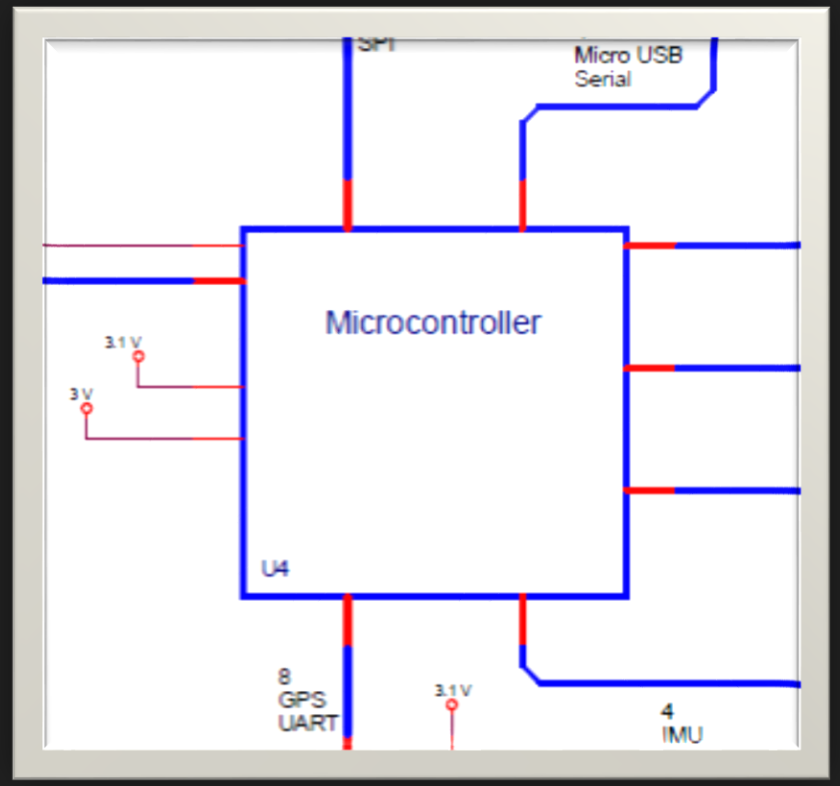


- MCU, IMU, and GPS chips integrated to single board design
- Traces for I^2C and UART from MCU to IMU and GPS respectively
- USB, UART, MSD and programming header on main board
- Off the shelf radio modules attaching to daughterboard interfaces
  - Removable and swappable during development

Electrical Block Diagram



Microcontroller Section



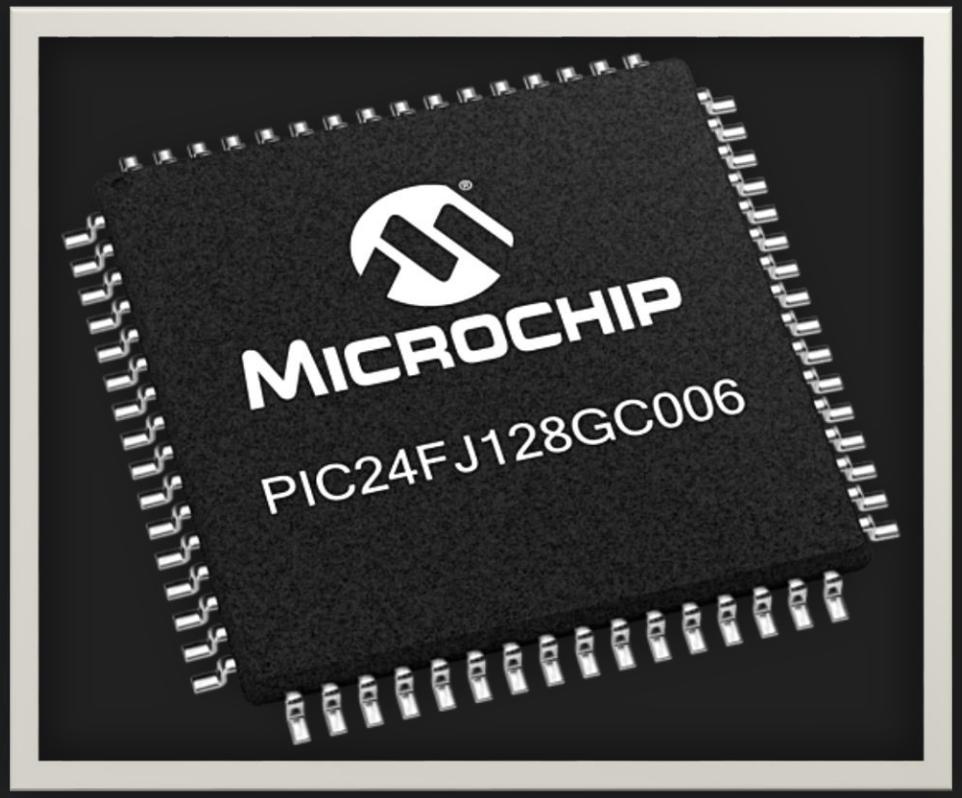
Central digital logic

- Coordinates communication between GPS, IoT communication, IMU, and SD card
- Controls full and low-power states of all of the above

Microcontrollers

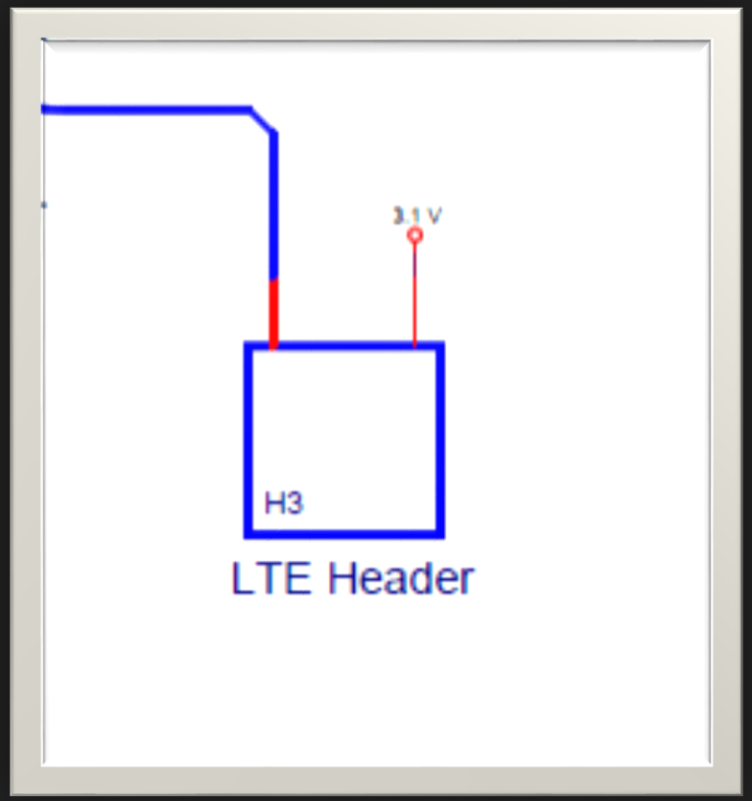
- Most straightforward solution
- Classroom experience in Embedded Systems
- Low power chips meet battery life requirement
- Flash programmability massively simplifies firmware development

PIC24FJ128GC006



- 16-bit architecture optimized for C programming
- Free (Gratis) development toolchain
- Configuration and diagnostics
  - UART communications ports
    - GPS (NMEA standard)
    - LTE (Hayes command set derivative)
    - Debug interface (TTY terminal emulator)
  - I2C interfaces
    - Inertial measurement unit
  - SPI Interfaces
    - MircoSD
  - USB interfaces

Communications Section



- Purpose
  - Communication between NAT device and GUI application.
  - GPS and IMU data to application software
- LTE CAT 1
  - Similar to 4G LTE on cell phones
  - Designed with IoT and M2M in mind
  - 2G and 3G will be phased out
  - Operates on pre-existing networks

LPWAN

- Designed for M2M communication with embedded devices on the IoT
  - Low power communication protocol
  - Effective over a wide are
- Most effective when used with infrequent, low bit-rate communications

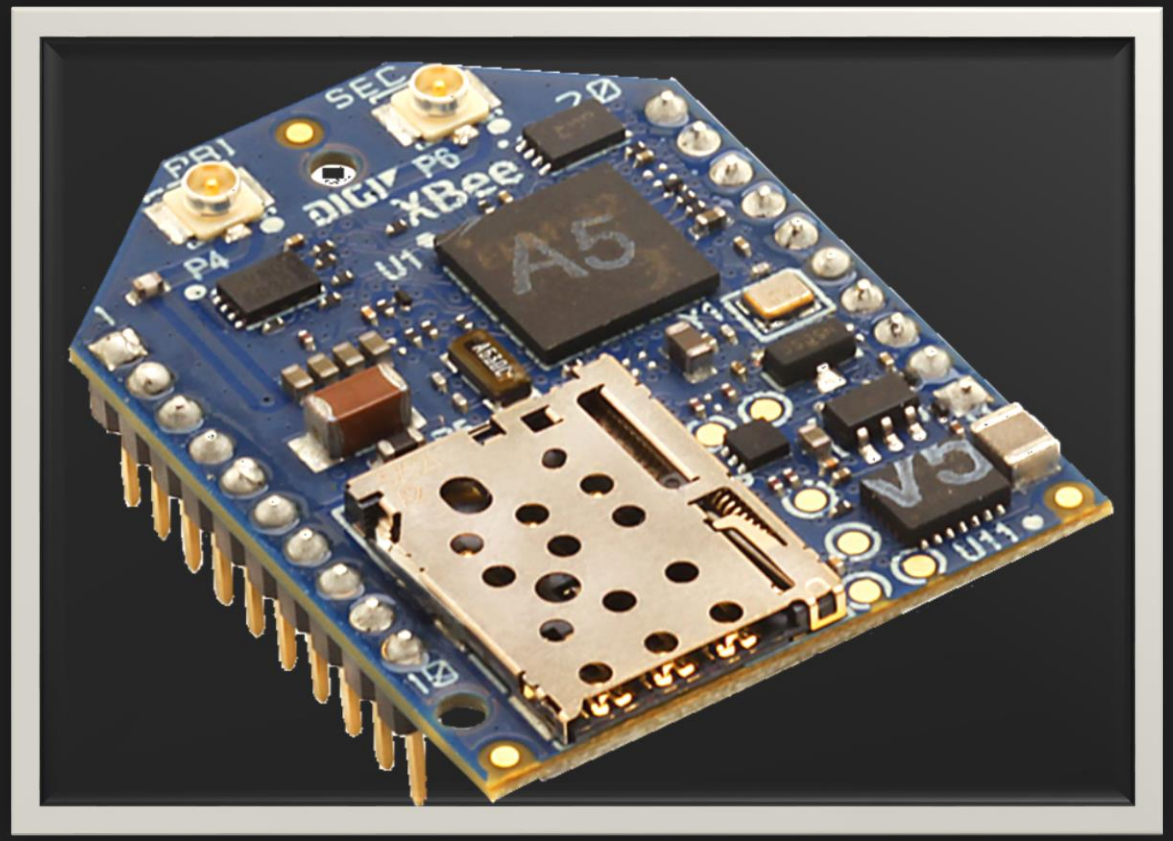
	Sigfox	LoRa	Ingenu	LTE Cat M1
Range	~ 13 km	~ 11 km	~ 15 km	~ 15 km
Data Rate	100 bps	10 kbps	624 kpbs	1 Mbps
Battery Life	> 10 years	> 10 years	> 10 years	> 10 years

LTE CAT1

	CAT 4	CAT 1
Downlink peak rate	150 Mbps	10 Mbps
Uplink peak rate	50 Mbps	5 Mbps
Duplex mode	Full duplex	Full duplex
Maximum Transmit power	23 dBm	23 dBm

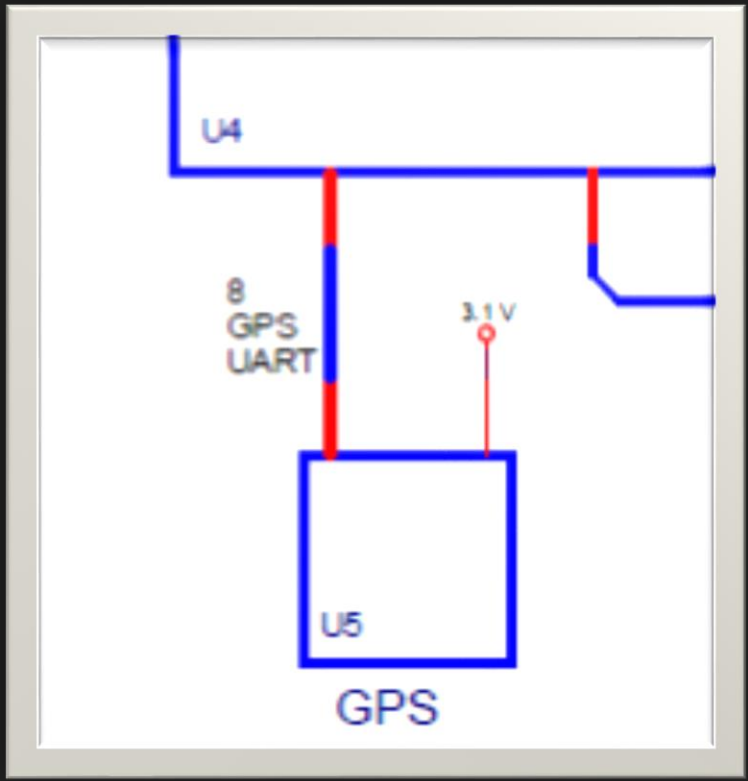
- Low throughput
- Less power hungry than LTE CAT 3 or 4
- Full duplex
- Less complex

Digi XBEE LTE CAT1



- Evaluation board for easy prototyping
- XCTU for easy configuration and testing
- XBee 20-pin form factor
  - Future upgrade
- Free* data for 6 months
- Large online support
  - Forums
  - Customer Support

GPS Section

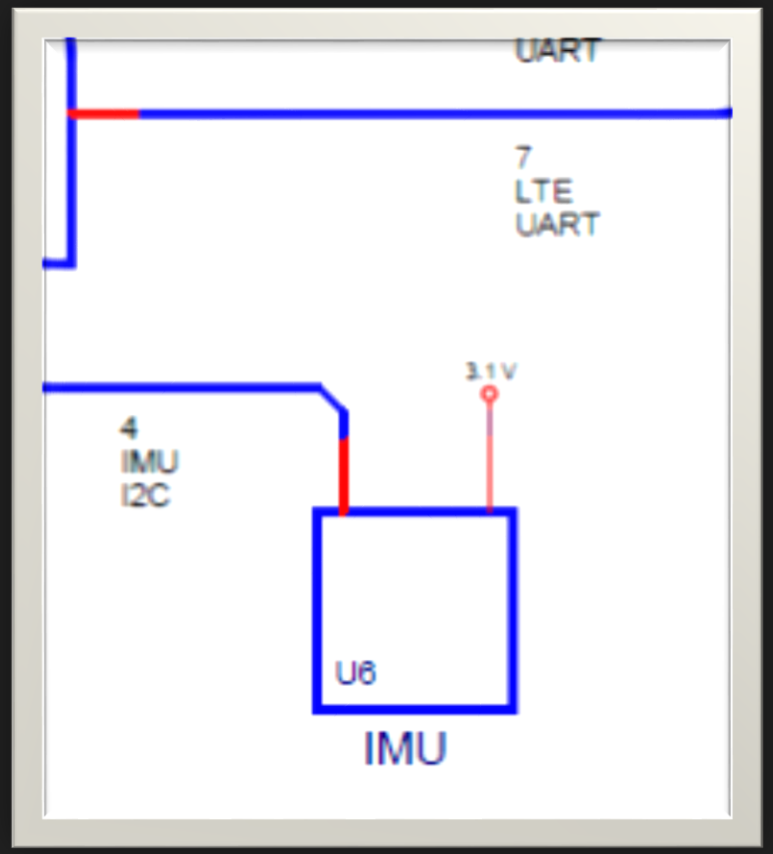


- Tracker device
  - Location hardware necessary
- GPS = Main Location Hardware
- Only communicate with MCU
- Receive the latitude, longitude, and altitude data and report
- Data will be
  - reported directly to users
    - Radio modules and client software
  - Stored on SD card
  - Used in INS software
    - future implementation

OriginGPS NanoHornet

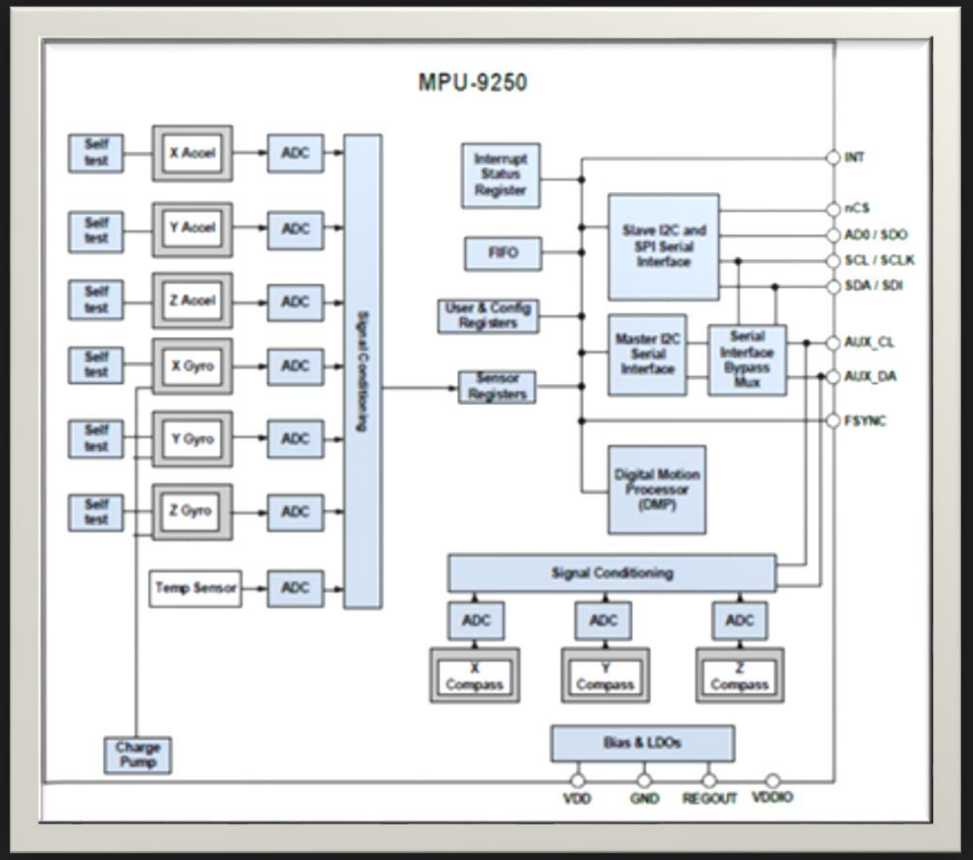
- NanoHornet meets all of the needs of the NAT device
  - Small Size (10mmX10mm)
  - Horizontal accuracy of <2.5m
  - Quick TTFF (<1 second)
  - Supply power within given range
  - Embedded Antenna on the module
    - No extra design necessary
  - Autonomous operation
  - Self Managed Low power modes
  - Selectable interface between UART, SPI, and I^2C
  - Programmable baud rate

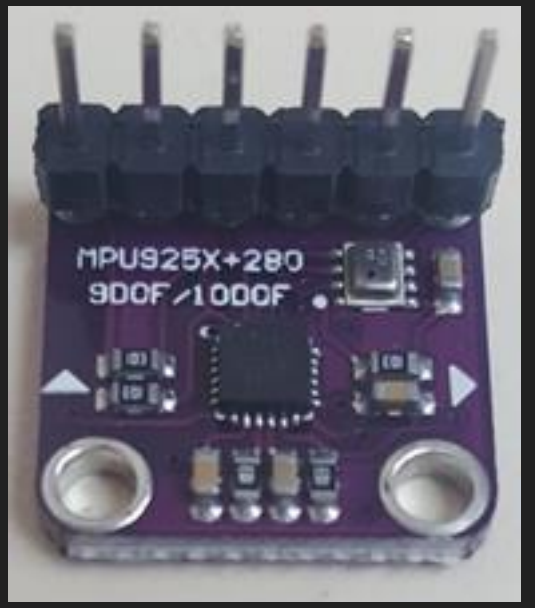
Inertial Measurement Unit (IMU) Section



- IMU and GPS
  - Force, angular rate and magnetic field
  - Sense motion, track position
  - Accelerometers, gyroscopes and magnetometers
  - Inertial Navigation System (INS)

InvenSense MPU 9250





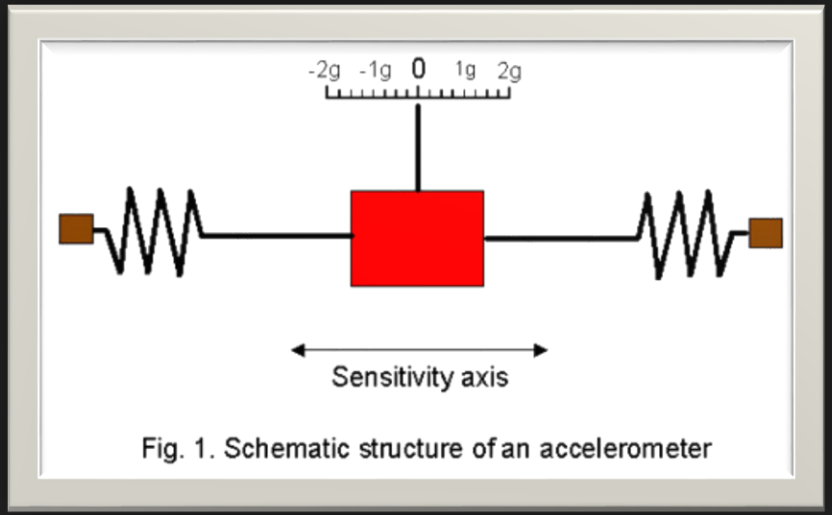
- Small size 3x3x1mm package
- Digital-output x, y, and z-axis angular rate sensors
- Programmed to collect data continuously or when triggered

3-Axis MEMS Gyroscope

- Rotate about x, y and z-axes
  - Maintains a reference direction
  - Vibration sensed
  - Signal amplified, demodulated and filtered
  - Produces voltage proportional to angular rate

3-Axis MEMS Accelerometer

- Rate of change of velocity
- Detects and monitors vibration
- Multi-axes detects
  - Magnitude
  - Direction



Source: Innoventions, INC

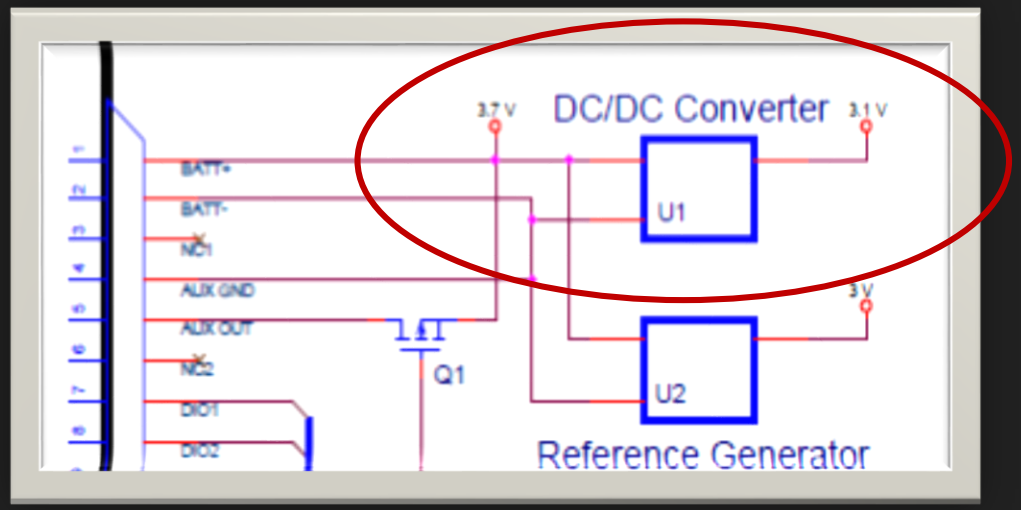
3-Axis MEMS Magnetometer

- Measures magnetic field
  - Relative change of a magnetic field at a particular location
- 3-axis measurements
  - Direction and intensity of the magnetic field around the sensor

USB Interface

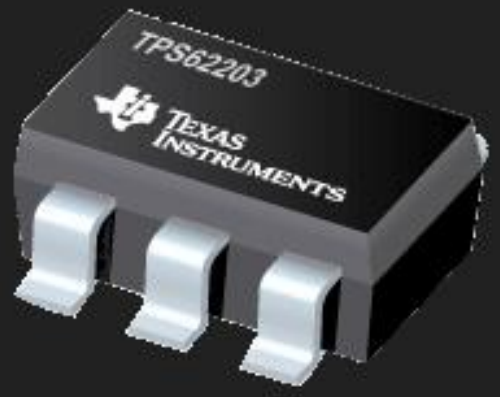
- USB 2.0 standard allows for one USB device to expose multiple interfaces – “composite device”
- HID
  - Streams diagnostic data from each NAT peripheral for display on workstation
- Mass Storage Device (MSD)
  - Exposes SD card for configuration updates and access to the debug and operational logs
- USART
  - Provides UART over USB, adding second option for UART debugging interface

DC/DC Converter Section



- Converts one voltage level to another.
- Step up (boost), step down (buck), inverts.
- Higher efficiency than linear regulator
- Low waste heat

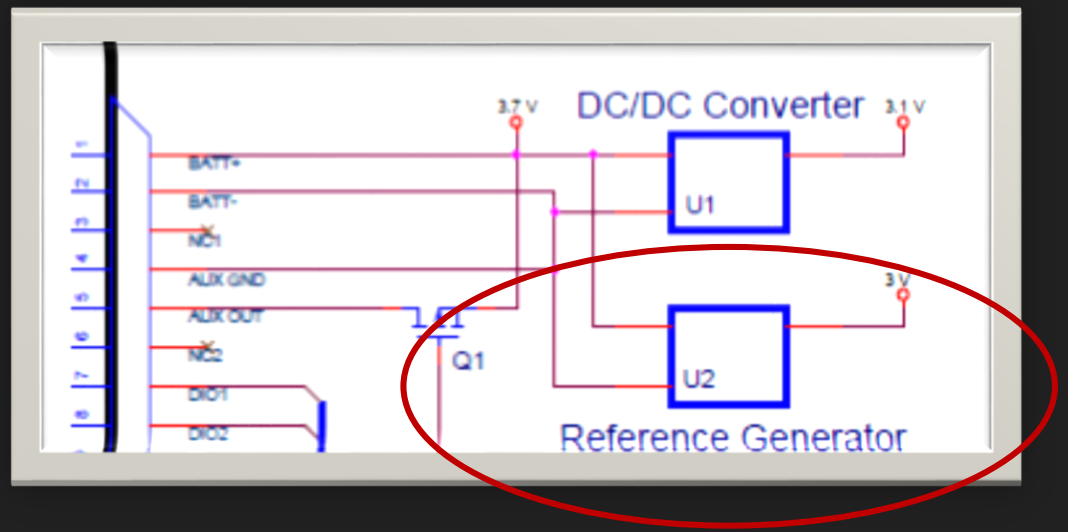
DC/DC Converter Selection



	LDO	Quiescent Current	Low Power	Output Current	Cost [1]
TPS6220	Yes	15 µA – 30 µA	Yes	≤ 300 mA	$0.96
LTC1701	Yes	135 µA	No	≤ 500 mA	$2.12
FAN5307	No	15 µA – 30 µA	Yes	≤ 300 mA	$1.23

- Texas Instruments TPS6220
- high efficiency operation under normal loads
  - 95 % efficiency
- Low Drop Out (LDO) operation
- Low power mode
- Minimal size and part requirements

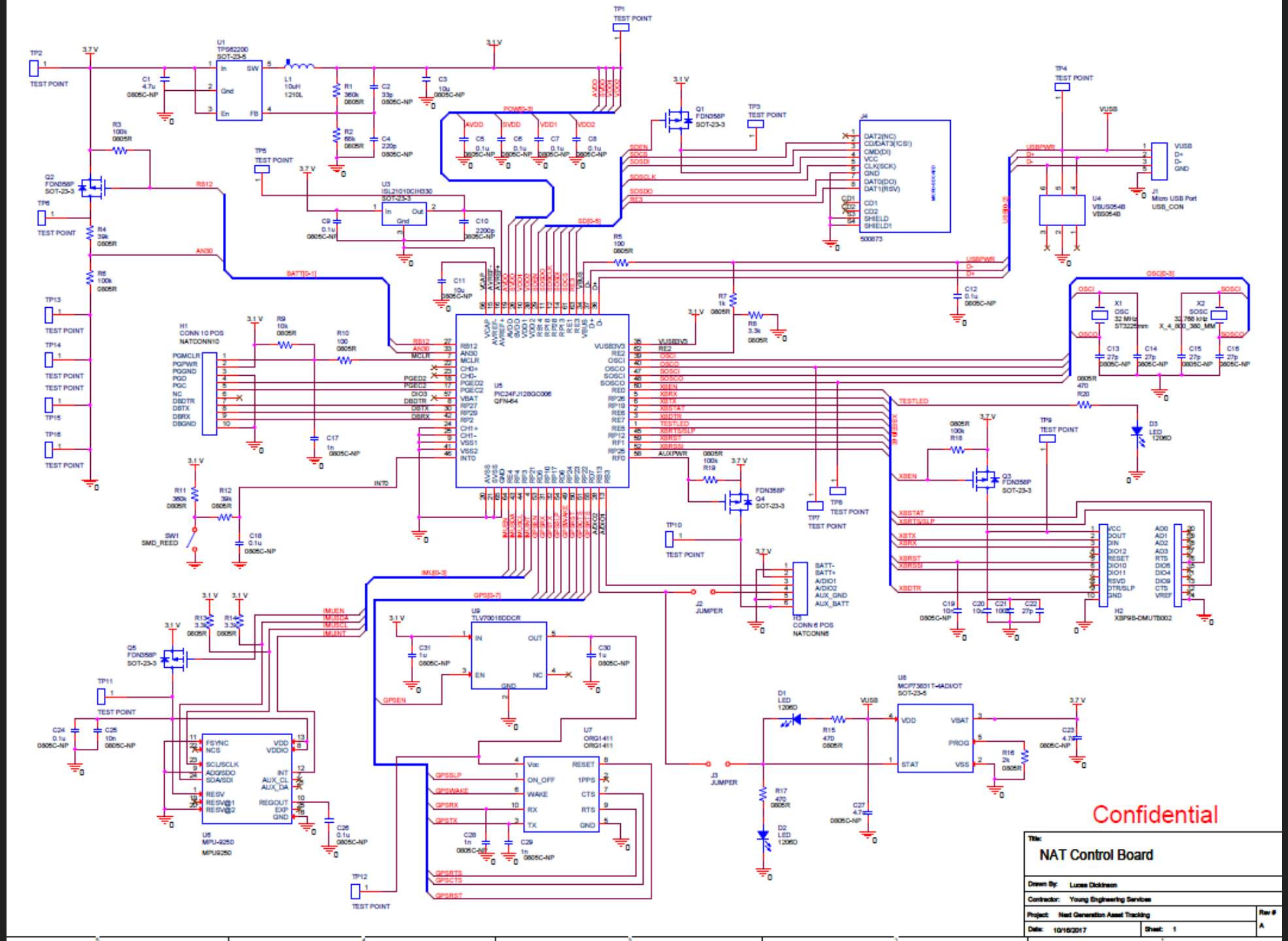
Reference Generator Section

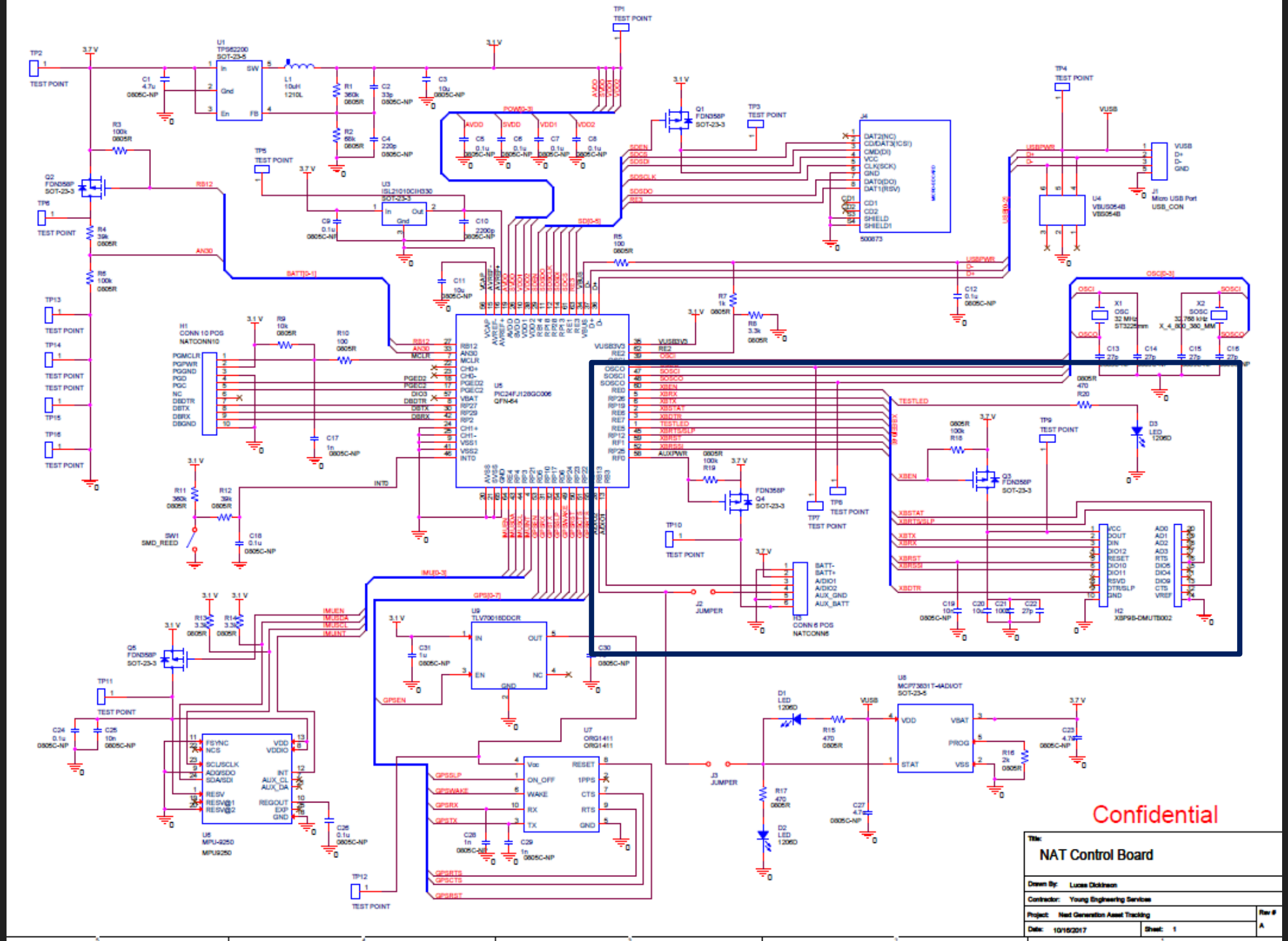


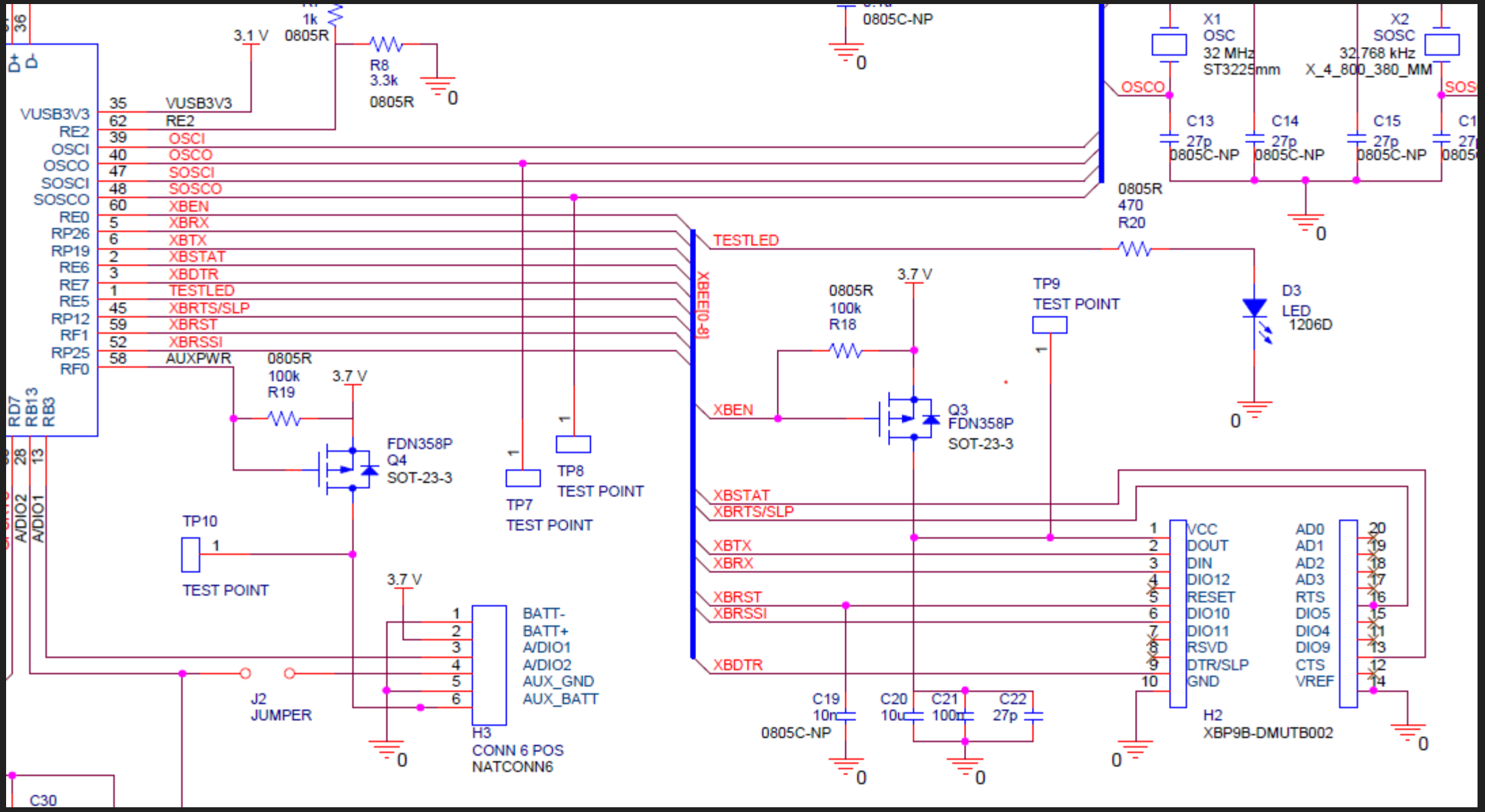
- Similar to voltage regulators
- Tighter output voltage tolerances
- Easy and cheap implementation
  - PN junction diodes
  - Diode connected transistors

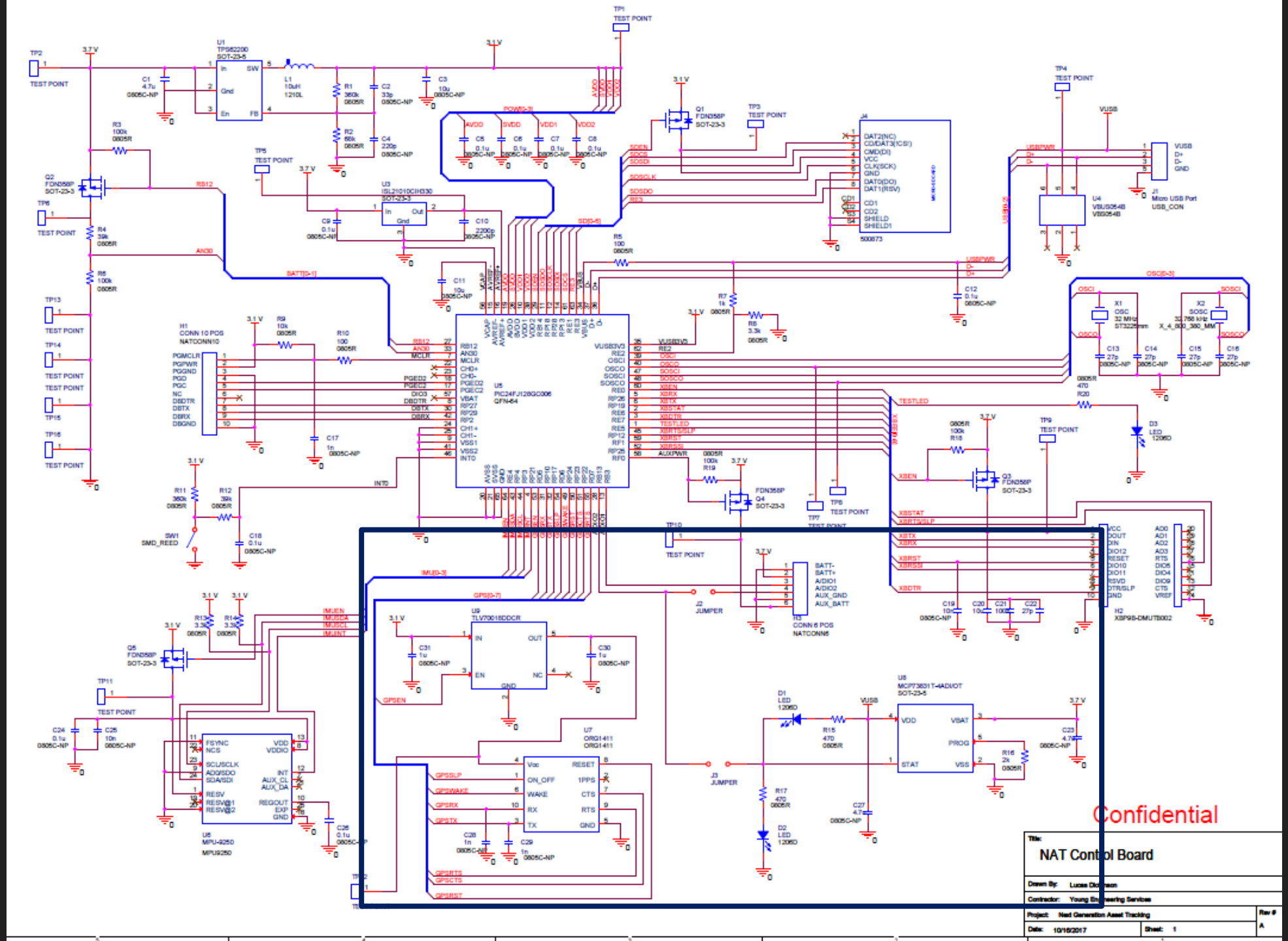
Reference Generator

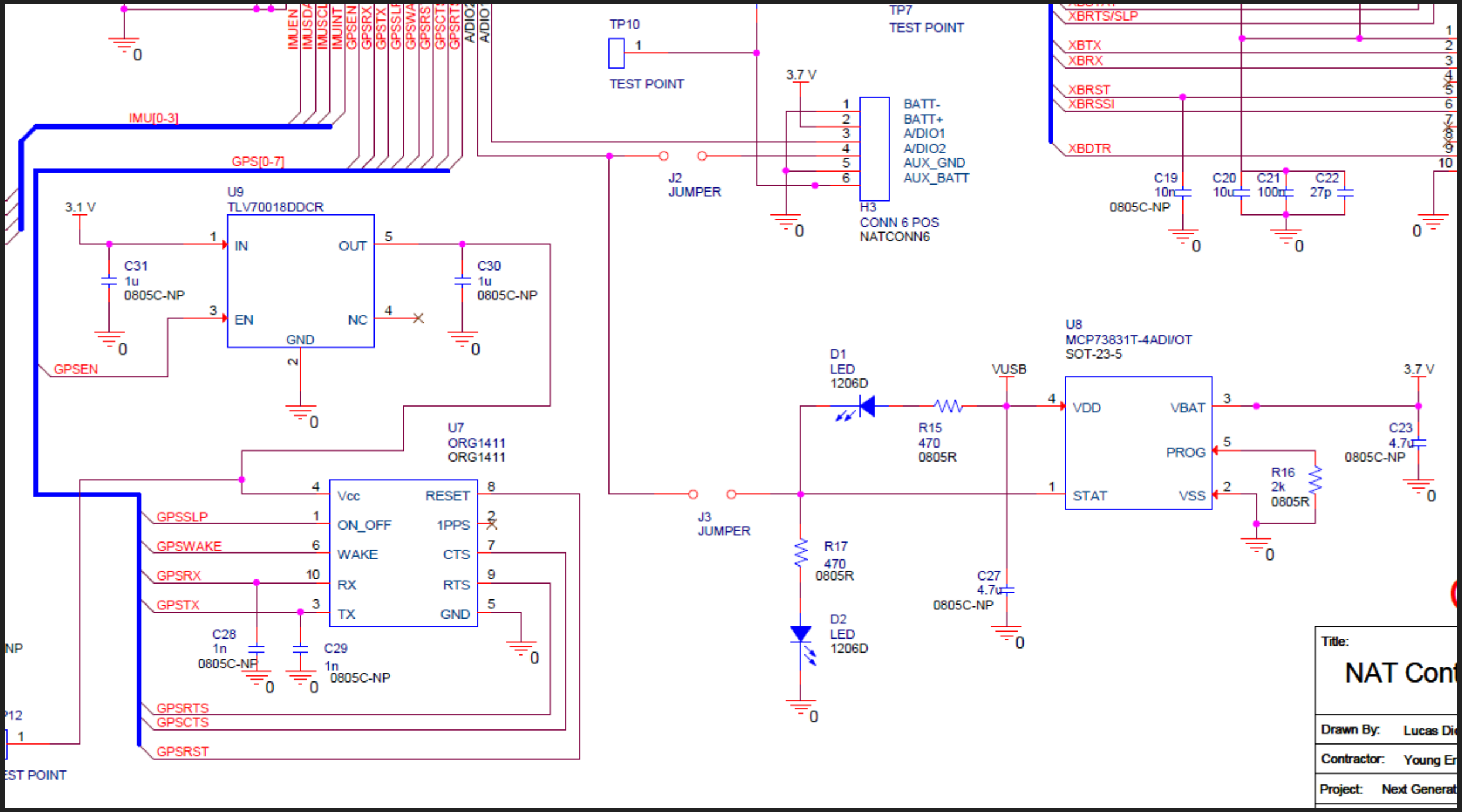
- ISL21080
  - 3.0 volts reference generator
  - Provides Initial accuracy 0.2%
- Used to calibrate 16-bit ADC or DAC
- Maintains high accuracy over long periods

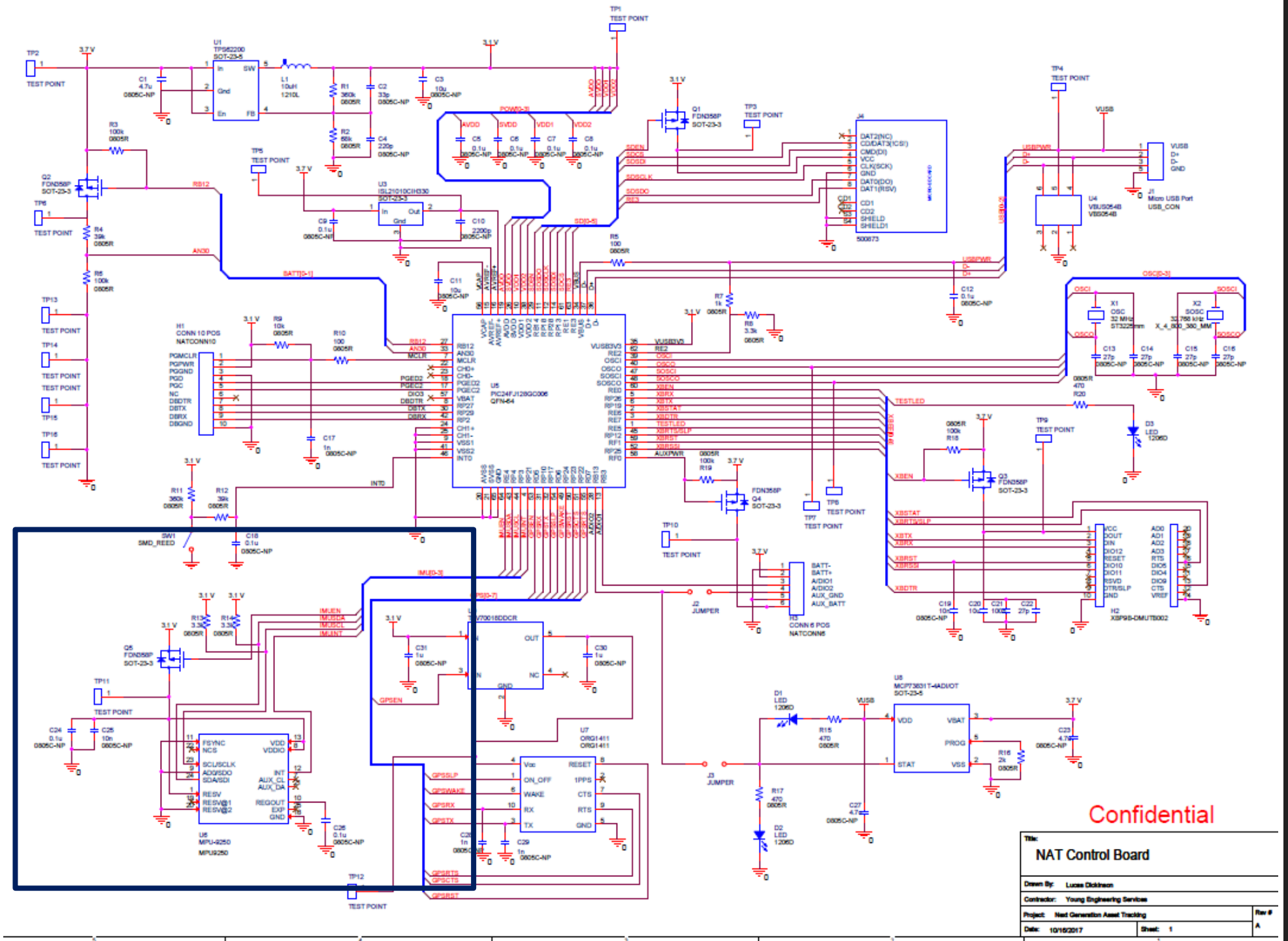

Confidential
NAT Control Board
Drawn By: Lucas Dickinson
Contractor: Young Engineering Services
Project: Next Generation Asset Tracking
Rev # A
Date: 10/15/2017
Sheet: 1
PIC24FJ128GC006
MPU-9250
XBP9B-DMUTB002
Micro USB Port
USB_CON

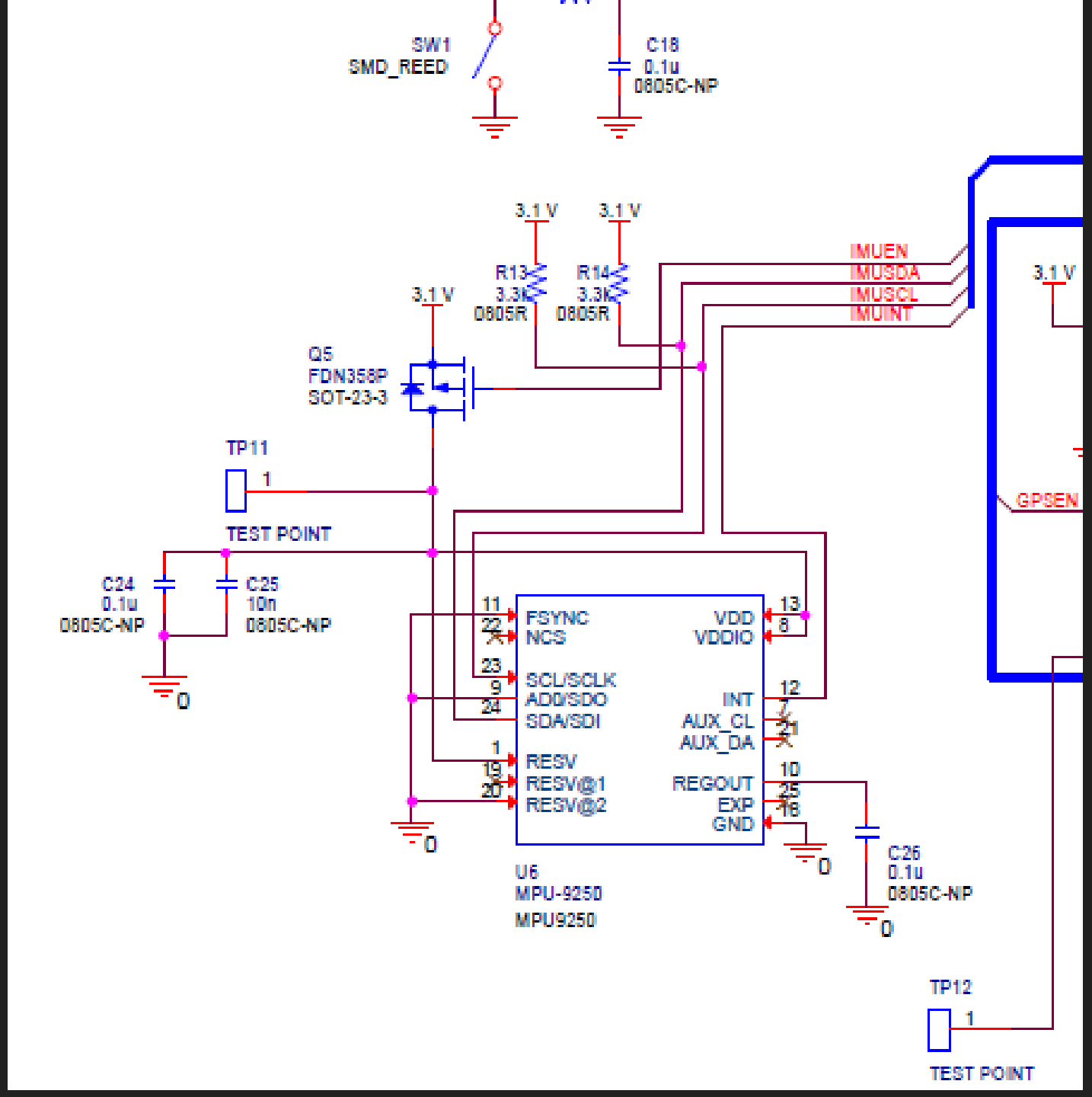

Confidential
NAT Control Board
Drawn By: Lucas Dickinson
Contractor: Young Engineering Services
Project: Next Generation Asset Tracking
Rev # A
Date: 10/15/2017
Sheet: 1

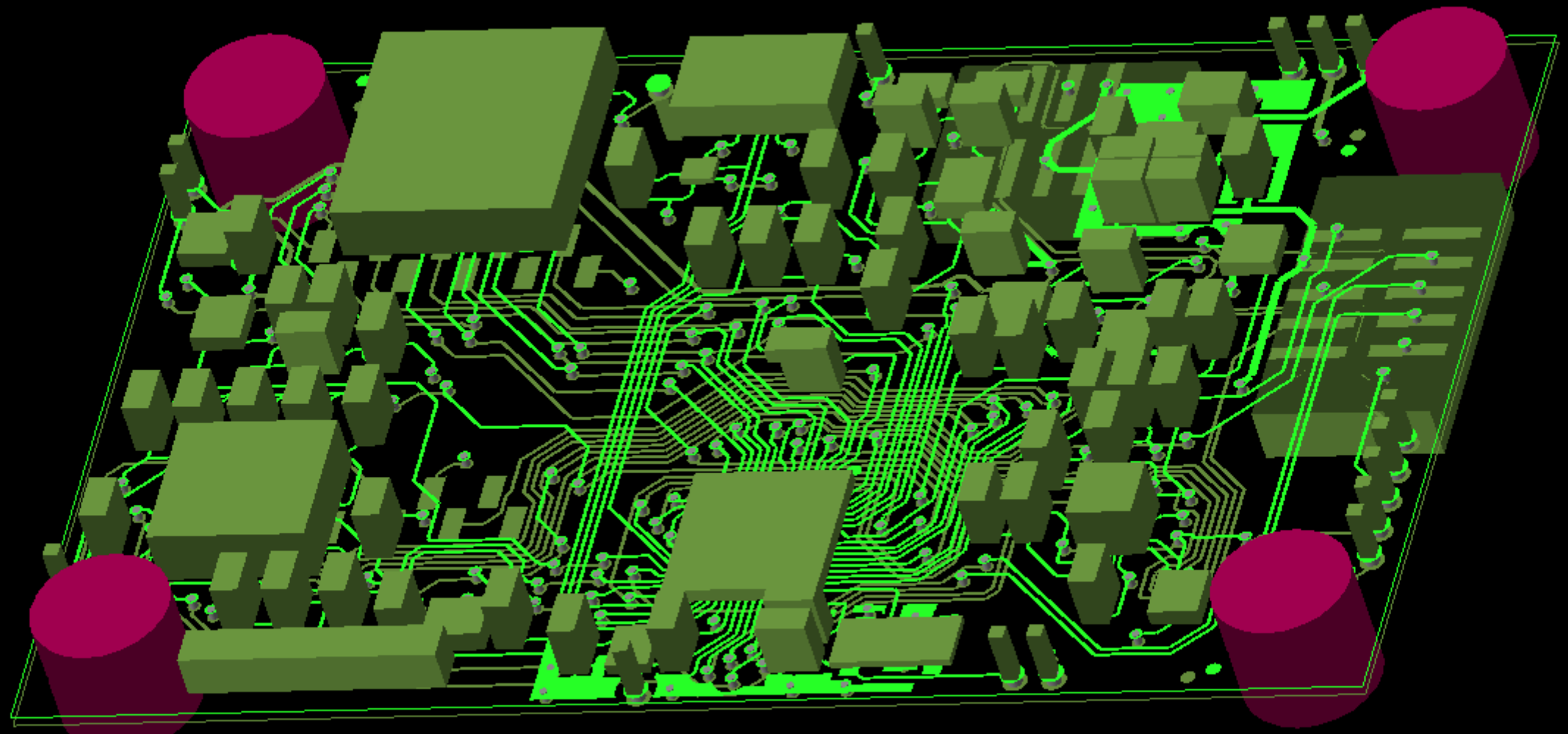

3.1 V
1k
0805R
R8
3.3k
0805R
0
0805C-NP
X1
OSC
32 MHz
ST3225mm
X2
SOSC
32.768 kHz
X_4_800_380_MM
OSCO
SOS
C13
27p
0805C-NP
C14
27p
0805C-NP
C15
27p
0805C-NP
0805R
470
R20
TESTLED
D3
LED
1206D
3.7 V
0805R
100k
R18
TP9
TEST POINT
XBEE[0-8]
VUSB3V3
RE2
OSCI
OSCO
SOSCI
SOSCO
RE0
RP26
RP19
RE6
RE7
RE5
RP12
RF1
RP25
RF0
35 VUSB3V3
62 RE2
39 OSCI
40 OSCO
47 SOSCI
48 SOSCO
60 XBEN
5 XBRX
6 XBTX
2 XBSTAT
3 XBDTR
1 TESTLED
45 XBRTS/SLP
59 XBRST
52 XBRSSI
58 AUXPWR
0805R
100k
R19
3.7 V
FDN358P
Q4
SOT-23-3
TP7
TEST POINT
TP8
TEST POINT
XBEN
Q3
FDN358P
SOT-23-3
XBSTAT
XBRTS/SLP
XBTX
XBRX
XBRST
XBRSSI
XBDTR
TP10
TEST POINT
3.7 V
1 BATT-
2 BATT+
3 A/DIO1
4 A/DIO2
5 AUX_GND
6 AUX_BATT
H3
CONN 6 POS
NATCONN6
J2
JUMPER
C19
10n
0805C-NP
C20
10u
C21
100n
C22
27p
1 VCC
2 DOUT
3 DIN
4 DIO12
5 RESET
6 DIO10
7 DIO11
8 RSVD
9 DTR/SLP
10 GND
AD0
AD1
AD2
AD3
RTS
DIO5
DIO4
DIO9
CTS
VREF
H2
XBP9B-DMUTB002
C30


Confidential
NAT Control Board
Drawn By: Lucas Clarkson
Contractor: Young Engineering Services
Project: Next Generation Asset Tracking
Rev # A
Date: 10/15/2017
Sheet: 1
PIC24FJ128GC006
MPU-9250
TLV70018DDCR
MCP73831T-4ADI/OT
FDN358P
CONN 10 POS NATCONN10
CONN 6 POS NATCONN6
XBP9B-DMUTB002
Micro USB Port USB_CON
JUMPER
TEST POINT


IMUEN
IMUSDA
IMUSCL
IMUINT
GPSEN
GPSRX
GPSTX
GPSSLP
GPSWA
GPSRS
GPSCTS
GPSRTS
A/DIO2
A/DIO1
IMU[0-3]
GPS[0-7]
TP10
TEST POINT
TP7
TEST POINT
3.7 V
J2
JUMPER
BATT-
BATT+
A/DIO1
A/DIO2
AUX_GND
AUX_BATT
H3
CONN 6 POS
NATCONN6
XBRTS/SLP
XBTX
XBRX
XBRST
XBRSSI
XBDTR
C19
10n
0805C-NP
C20
10u
C21
100n
C22
27p
3.1 V
U9
TLV70018DDCR
IN
OUT
EN
NC
GND
C31
1u
0805C-NP
C30
1u
0805C-NP
GPSEN
U7
ORG1411
ORG1411
Vcc
RESET
ON_OFF
1PPS
WAKE
CTS
RX
RTS
TX
GND
GPSSLP
GPSWAKE
GPSRX
GPSTX
C28
1n
0805C-NP
C29
1n
0805C-NP
GPSRTS
GPSCTS
GPSRST
D1
LED
1206D
R15
470
0805R
VUSB
U8
MCP73831T-4ADI/OT
SOT-23-5
VDD
VBAT
PROG
STAT
VSS
R16
2k
0805R
C23
4.7u
0805C-NP
J3
JUMPER
R17
470
0805R
C27
4.7u
0805C-NP
D2
LED
1206D
Title:
NAT Conf
Drawn By:
Lucas Di
Contractor:
Young En
Project:
Next Generat


Confidential
NAT Control Board
Drawn By: Lucas Dickinson
Contractor: Young Engineering Services
Project: Next Generation Asset Tracking
Rev #: A
Date: 10/15/2017
Sheet: 1
PIC24FJ128GC006
MPU-9250
MCP73831T-4ADI/OT
XBP9B-DMUTB002
Micro USB Port
USB_CON
CONN 10 POS
CONN 6 POS
JUMPER
TEST POINT
SMD_REED


SW1
SMD_REED
C18
0.1u
0805C-NP
3.1 V
3.1 V
R13
3.3K
0805R
R14
3.3K
0805R
3.1 V
IMUEN
IMUSDA
IMUSCL
IMUINT
3.1 V
GPSEN
Q5
FDN358P
SOT-23-3
TP11
1
TEST POINT
C24
0.1u
0805C-NP
C25
10n
0805C-NP
0
11
22
23
9
24
1
19
20
FSYNC
NCS
SCL/SCLK
AD0/SDO
SDA/SDI
RESV
RESV@1
RESV@2
13
8
12
7
21
10
25
16
VDD
VDDIO
INT
AUX_CL
AUX_DA
REGOUT
EXP
GND
0
0
C26
0.1u
0805C-NP
U6
MPU-9250
MPU9250
TP12
1
TEST POINT



PCB Layout

Hardware Issues

- Ingenu going through changes
- No RPMA module
  - Had to redesign to implement LTE

Software Components

- 3 Major Pieces of Software
  - Firmware
    - Software inside the device itself
  - Windows Configuration GUI
    - Software the distributer will use to configure the device to the specific settings the user wants
  - Web Client GUI
    - What the client will use to find their device

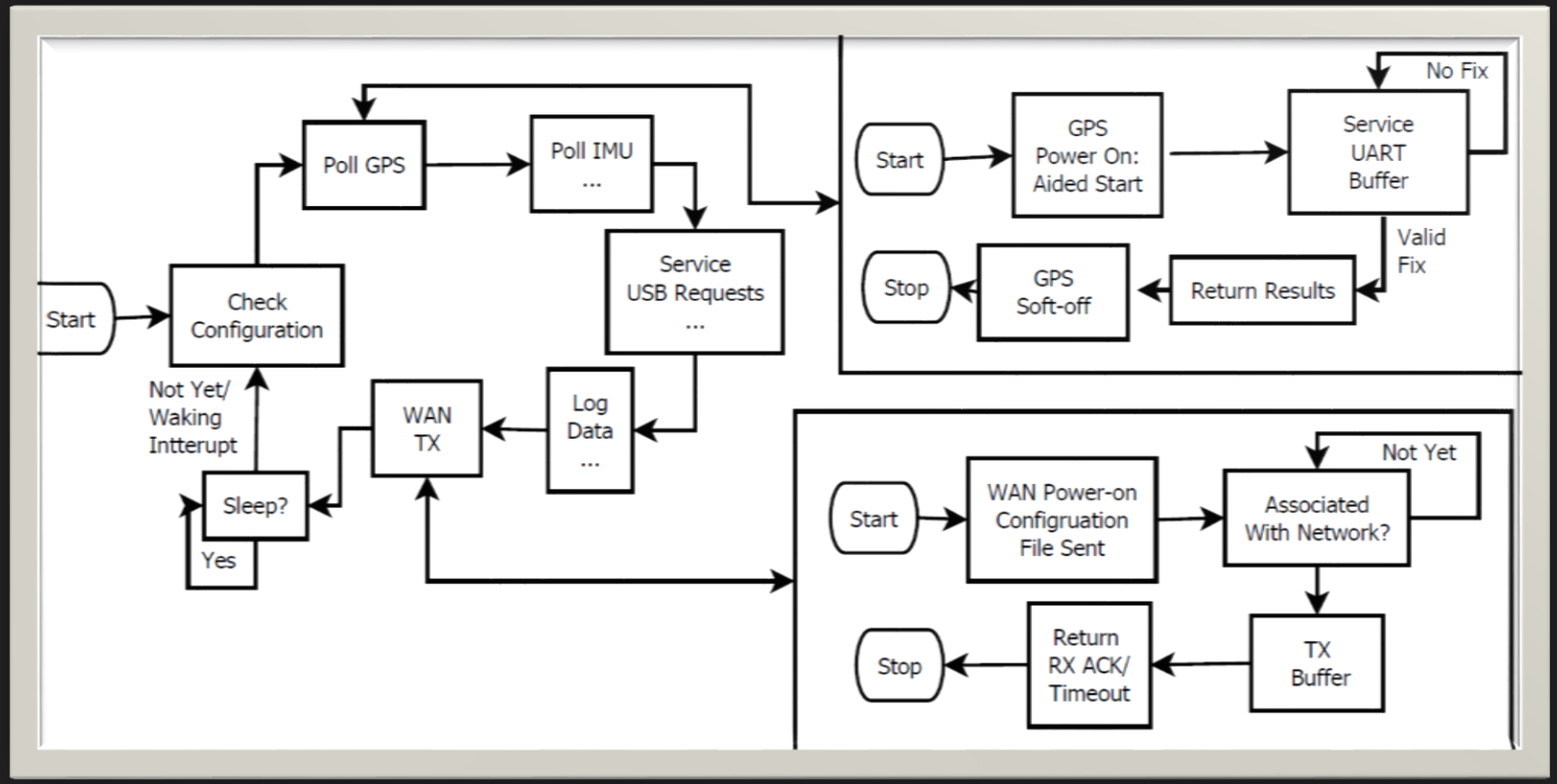
Software Development

- IDE
  - Configuration GUI = Visual Studio
  - Firmware = MPLab X
- Version Control
  - Every software component will use GIT
  - Configuration GUI:
    - GIT through Visual Studio Team Services

Firmware

- PIC24 program executes main loop, polling each peripheral for status and data
  - State machines acting in a cooperative multitasking environment
- After position data is collected
  - Switches to low power mode once IoT transmission buffers are empty or configured timeout interval reached
  - Returns to active processing based on configured timer or inertial measurement interrupts

Firmware Flowcharts



Configuration GUI

- Software utilized by the manufacturer and distributer
  - Will configure to settings client designated
- Developed as a Windows form
- Connected to device over USB
- Not accessible to the client
  - Client has their own software

NAT_Config_GUI

Configuration & Settings | Data Display | Testing Modules

Status

Connection Status: Connected

Device not set to sleep

Sync Device Date/Time

Current PC Time: label32 label27

Set Wakeup Time: label32 label27

GPS — Record GPS

Longitude: 0
Latitude: 0
Altitude: 0
Active Satellites: 0

Connection Status: Unaccessible

Get GPS data every 2 minute(s)

External Sensors

Temperature: 0

Pressure: 0

Record Barometer

*This is where the external sensors' hardare will be tested, set as inputs, as well as where their output data will be shown.

Location Frequency

Report Location on Frequency

Daily
Start Time:
Stop Time:

Weekly
Day of Week:
Start Time:
Stop Time:

Monthly
Day of Month:
Start Time:
Stop Time:

Yearly
Month:
Day of Month:
Start Time:
Stop Time:

SD

View Contents

Save All to Host PC — Save to:

Clear SD Card — as:

0.0004 GB Used of 3.9526 GB Available

INS — Record INS

Longitude: 0
Latitude: 0
Altitude: 0

Connection Status: Unaccessible

Get INS data every 2 minute(s)

IMU — Record IMU

Report on Motion Trigger
Report continuously

IMU (samp/s): 10

IMU data is collected for the above options at the Mission Start time, regardless of the Daily Window.

Motion Trigger — Report Location on Motion Trigger

Magnitude: 20
Duration (ms): 15
Dwell (s): 15

Program Device | Retrieve | Hardware Test

Hardware Status

MCU Status: Active
GPS Status: Unaccessible
IMU Status: Unaccessible
LTE Status: Unaccessible
RPMA Status: Removed from Design
SD Status: Connected as MSD
SD Card Storage — 99.99% Available

SETTINGS IN DEVICE

Date and Time in Device: 11 / 19 / 2017 @ 1357

Location Frequency

D W M Y

Start Time1: 0000
Stop Time1: 0000
Day of Week: -
Month: -

Motion Trigger

Magnitude: 20
Duration (ms): 15
Dwell (s): 15

IMU

Capture on Motion Trigger
Capture continuously

IMU (samp/s): 10

SD

0.0004 GB Used
3.9526 GB Available

NAT_Config_GUI

Configuration & Settings | Data Display | Testing Modules

Status

Connection Status: Connected

Device not set to sleep

Sync Device Date/Time

Current PC Time: label32 label27

Set Wakeup Time: label32 label27

Location Frequency

- [ ] Report Location on Frequency
- [ ] Daily
  - Start Time:
  - Stop Time:
- [ ] Weekly
  - Day of Week:
  - Start Time:
  - Stop Time:
- [ ] Monthly
  - Day of Month:
  - Start Time:
  - Stop Time:
- [ ] Yearly
  - Month:
  - Day of Month:
  - Start Time:
  - Stop Time:

SD

View Contents

Save All to Host PC — Save to:

Clear SD Card — as:

0.0004 GB Used of 3.9526 GB Available

Motion Trigger — [x] Report Location on Motion Trigger

- Magnitude: 20
- Duration (ms): 15
- Dwell (s): 15

Program Device | Retrieve | Hardware Test

GPS — [x] Record GPS

Longitude: 0
Latitude: 0
Altitude: 0
Active Satellites: 0

Connection Status: Unaccessible

Get GPS data every 2 minute(s)

INS — [ ] Record INS

Longitude: 0
Latitude: 0
Altitude: 0

Connection Status: Unaccessible

Get INS data every 2 minute(s)

IMU — [x] Record IMU

(•) Report on Motion Trigger
( ) Report continuously

IMU (samp/s): 10

IMU data is collected for the above options at the Mission Start time, regardless of the Daily Window.

Hardware Status

MCU Status:	Active
GPS Status:	Unaccessible
IMU Status:	Unaccessible
LTE Status:	Unaccessible
RPMA Status:	Removed from Design
SD Status:	Connected as MSD
SD Card Storage	99.99% Available

External Sensors

Temperature: 0

Pressure: 0

[ ] Record Barometer

*This is where the external sensors' hardare will be tested, set as inputs, as well as where their output data will be shown.

SETTINGS IN DEVICE

Date and Time in Device: 11 / 19 / 2017 @ 1357

Location Frequency [ ]

[x] D [ ] W [ ] M [ ] Y

Start Time1: 0000

Stop Time1: 0000

Day of Week: -

Month: -

Motion Trigger [x]

Magnitude: 20
Duration (ms): 15
Dwell (s): 15

IMU

(•) Capture on Motion Trigger
( ) Capture continuously

IMU (samp/s): 10

SD

0.0004 GB Used

3.9526 GB Available

NAT_Config_GUI

Configuration & Settings | Data Display | Testing Modules

Status

Connection Status: Connected

Device not set to sleep

Sync Device Date/Time

Current PC Time: label32 label27

Set Wakeup Time: label32 label27

GPS — Record GPS

Longitude: 0
Latitude: 0
Altitude: 0
Active Satellites: 0

Connection Status: Unaccessible

Get GPS data every 2 minute(s)

External Sensors

Temperature: 0

Pressure: 0

Record Barometer

*This is where the external sensors' hardare will be tested, set as inputs, as well as where their output data will be shown.

Location Frequency

Report Location on Frequency

Daily
Start Time:
Stop Time:

Weekly
Day of Week:
Start Time:
Stop Time:

Monthly
Day of Month:
Start Time:
Stop Time:

Yearly
Month:
Day of Month:
Start Time:
Stop Time:

SD

View Contents

Save All to Host PC — Save to:

Clear SD Card — as:

0.0004 GB Used of 3.9526 GB Available

INS — Record INS

Longitude: 0
Latitude: 0
Altitude: 0

Connection Status: Unaccessible

Get INS data every 2 minute(s)

IMU — Record IMU

Report on Motion Trigger

Report continuously

IMU (samp/s): 10

IMU data is collected for the above options at the Mission Start time, regardless of the Daily Window.

Motion Trigger — Report Location on Motion Trigger

Magnitude: 20
Duration (ms): 15
Dwell (s): 15

Program Device | Retrieve | Hardware Test

Hardware Status

MCU Status: Active
GPS Status: Unaccessible
IMU Status: Unaccessible
LTE Status: Unaccessible
RPMA Status: Removed from Design
SD Status: Connected as MSD
SD Card Storage — 99.99% Available

SETTINGS IN DEVICE

Date and Time in Device: 11 / 19 / 2017 @ 1357

Location Frequency

D W M Y

Start Time1: 0000
Stop Time1: 0000
Day of Week: -
Month: -

Motion Trigger

Magnitude: 20
Duration (ms): 15
Dwell (s): 15

IMU

Capture on Motion Trigger

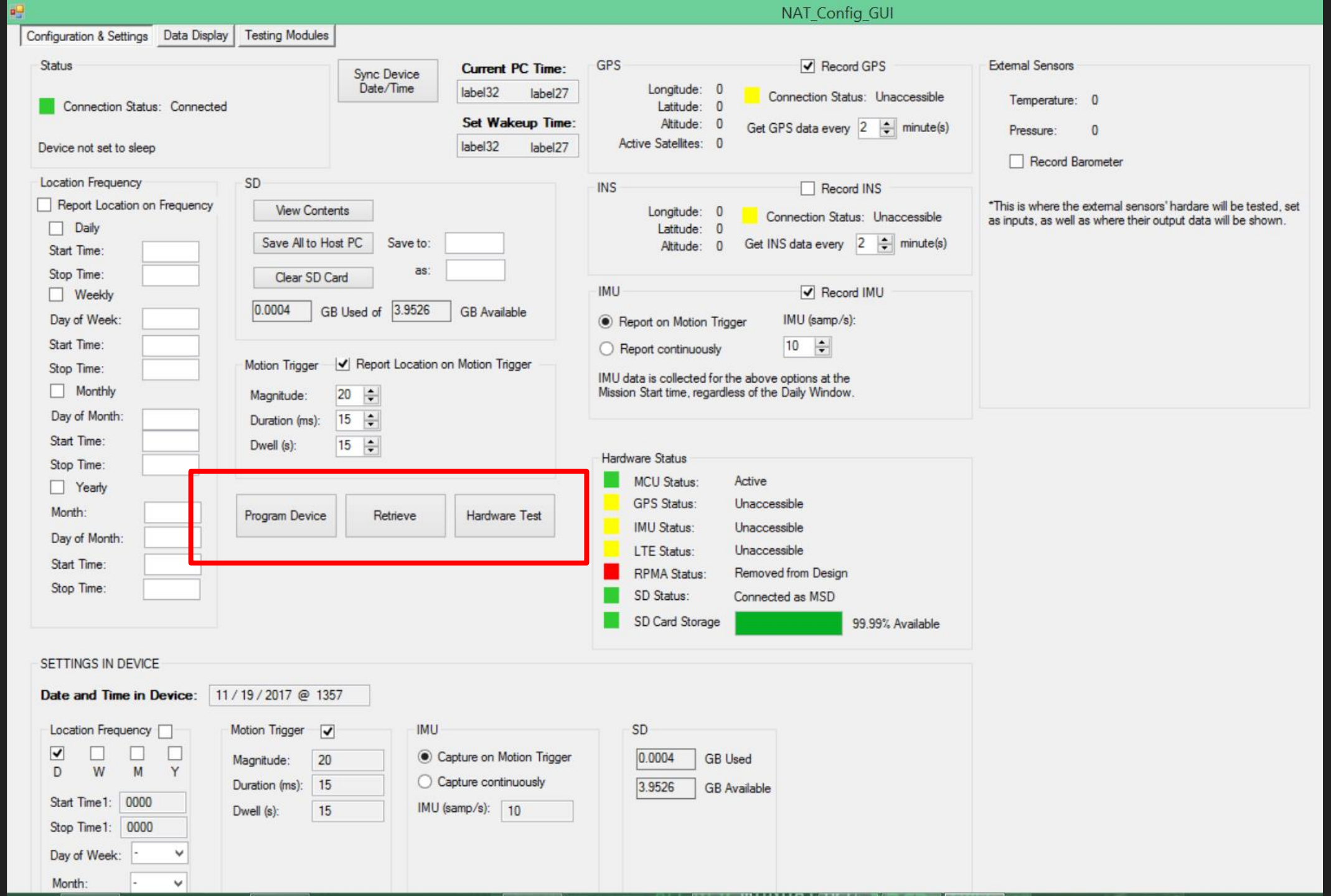
Capture continuously

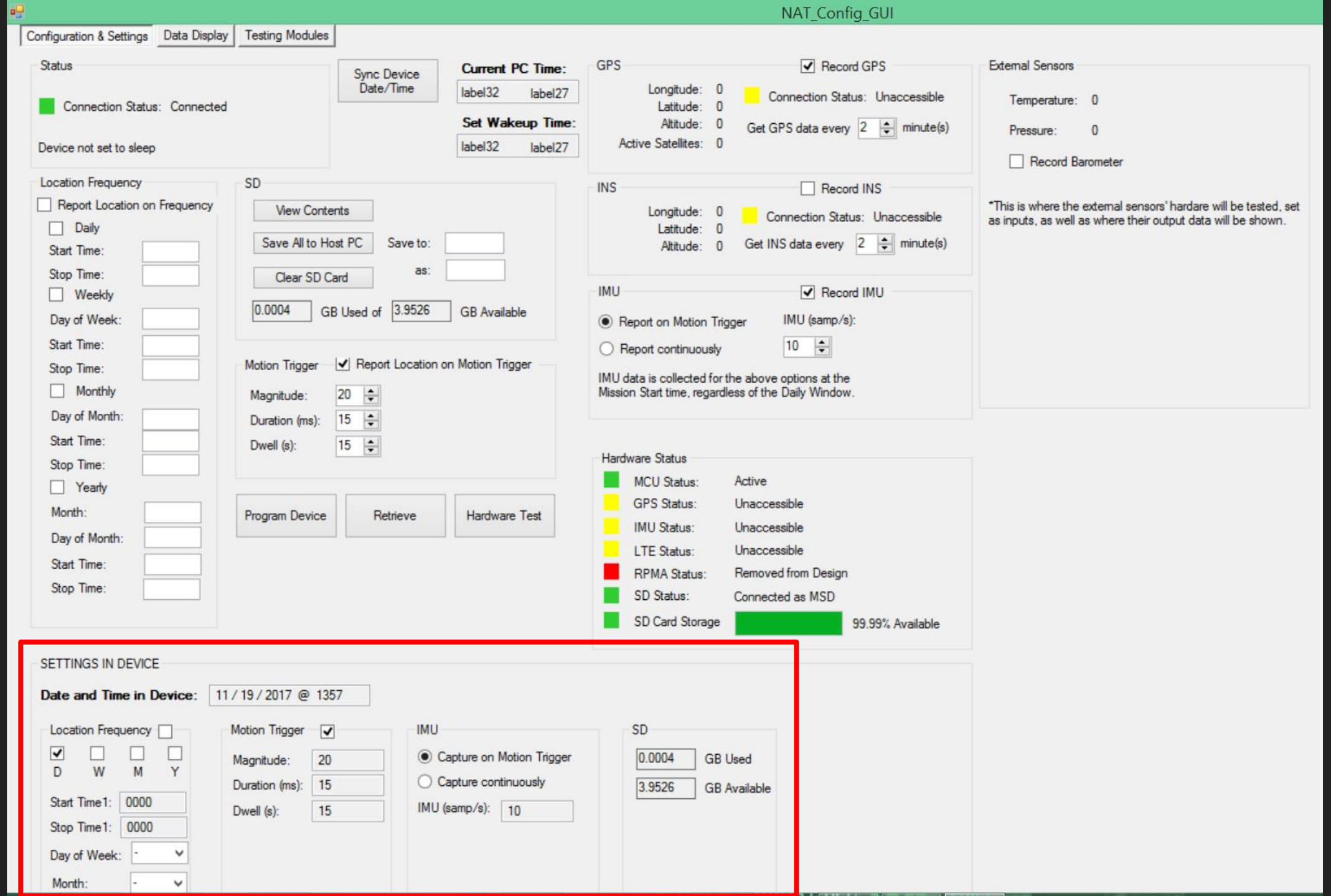
IMU (samp/s): 10

SD

0.0004 GB Used

3.9526 GB Available


NAT_Config_GUI
Configuration & Settings
Data Display
Testing Modules
Status
Connection Status: Connected
Device not set to sleep
Sync Device Date/Time
Current PC Time:
label32 label27
Set Wakeup Time:
label32 label27
GPS
Record GPS
Longitude: 0
Latitude: 0
Altitude: 0
Active Satellites: 0
Connection Status: Unaccessible
Get GPS data every 2 minute(s)
External Sensors
Temperature: 0
Pressure: 0
Record Barometer
*This is where the external sensors' hardare will be tested, set as inputs, as well as where their output data will be shown.
Location Frequency
Report Location on Frequency
Daily
Start Time:
Stop Time:
Weekly
Day of Week:
Start Time:
Stop Time:
Monthly
Day of Month:
Start Time:
Stop Time:
Yearly
Month:
Day of Month:
Start Time:
Stop Time:
SD
View Contents
Save All to Host PC
Save to:
Clear SD Card
as:
0.0004 GB Used of 3.9526 GB Available
INS
Record INS
Longitude: 0
Latitude: 0
Altitude: 0
Connection Status: Unaccessible
Get INS data every 2 minute(s)
IMU
Record IMU
Report on Motion Trigger
Report continuously
IMU (samp/s): 10
IMU data is collected for the above options at the Mission Start time, regardless of the Daily Window.
Motion Trigger
Report Location on Motion Trigger
Magnitude: 20
Duration (ms): 15
Dwell (s): 15
Program Device
Retrieve
Hardware Test
Hardware Status
MCU Status: Active
GPS Status: Unaccessible
IMU Status: Unaccessible
LTE Status: Unaccessible
RPMA Status: Removed from Design
SD Status: Connected as MSD
SD Card Storage
99.99% Available
SETTINGS IN DEVICE
Date and Time in Device: 11 / 19 / 2017 @ 1357
Location Frequency
D W M Y
Start Time1: 0000
Stop Time1: 0000
Day of Week: -
Month: -
Motion Trigger
Magnitude: 20
Duration (ms): 15
Dwell (s): 15
IMU
Capture on Motion Trigger
Capture continuously
IMU (samp/s): 10
SD
0.0004 GB Used
3.9526 GB Available


NAT_Config_GUI
Configuration & Settings
Data Display
Testing Modules
Status
Connection Status: Connected
Device not set to sleep
Sync Device Date/Time
Current PC Time:
label32 label27
Set Wakeup Time:
label32 label27
GPS
Record GPS
Longitude: 0
Latitude: 0
Altitude: 0
Active Satellites: 0
Connection Status: Unaccessible
Get GPS data every 2 minute(s)
External Sensors
Temperature: 0
Pressure: 0
Record Barometer
*This is where the external sensors' hardare will be tested, set as inputs, as well as where their output data will be shown.
Location Frequency
Report Location on Frequency
Daily
Start Time:
Stop Time:
Weekly
Day of Week:
Start Time:
Stop Time:
Monthly
Day of Month:
Start Time:
Stop Time:
Yearly
Month:
Day of Month:
Start Time:
Stop Time:
SD
View Contents
Save All to Host PC
Save to:
Clear SD Card
as:
0.0004 GB Used of 3.9526 GB Available
INS
Record INS
Longitude: 0
Latitude: 0
Altitude: 0
Connection Status: Unaccessible
Get INS data every 2 minute(s)
IMU
Record IMU
Report on Motion Trigger
Report continuously
IMU (samp/s): 10
IMU data is collected for the above options at the Mission Start time, regardless of the Daily Window.
Motion Trigger
Report Location on Motion Trigger
Magnitude: 20
Duration (ms): 15
Dwell (s): 15
Program Device
Retrieve
Hardware Test
Hardware Status
MCU Status: Active
GPS Status: Unaccessible
IMU Status: Unaccessible
LTE Status: Unaccessible
RPMA Status: Removed from Design
SD Status: Connected as MSD
SD Card Storage
99.99% Available
SETTINGS IN DEVICE
Date and Time in Device: 11 / 19 / 2017 @ 1357
Location Frequency
D W M Y
Start Time1: 0000
Stop Time1: 0000
Day of Week: -
Month: -
Motion Trigger
Magnitude: 20
Duration (ms): 15
Dwell (s): 15
IMU
Capture on Motion Trigger
Capture continuously
IMU (samp/s): 10
SD
0.0004 GB Used
3.9526 GB Available

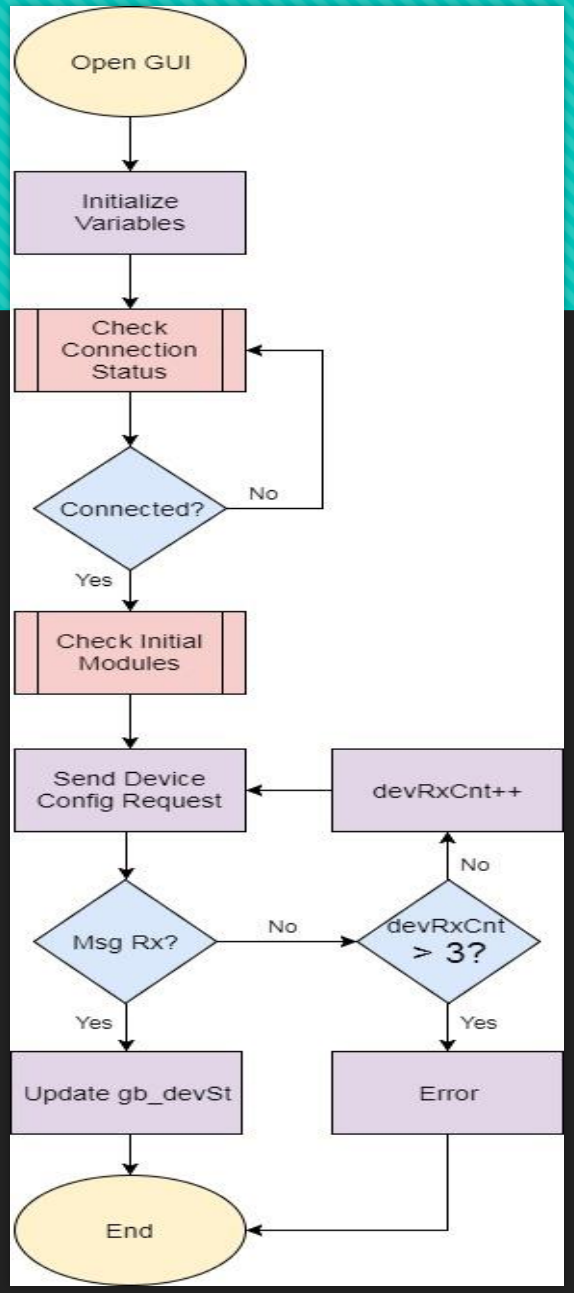
Communication With Firmware

- nat.conf file transmitted between device and GUI
- Will be stored always on the device
  - Storing current communication settings
- Configuration GUI will download the file from the device
  - Update this file directly with any updates from the GUI
  - Send the device the new file
  - The device will update its configuration settings based on changes in the file
  - Overwrite the old file with the new one

```
1  [Date and Time]
2  Day: 11 ;1-31
3  Month: 19 ;1-12
4  Year: 2017 ;2017-3000
5  Time: 1357 ;0000-2400
6  [Interrupt]
7  Wake-Up Interval: False ;true/false
8  Month: 0 ;0-12
9  Day: 0 ;0-28
10 Weekday: UMTWRFS ;UMTWRFS/U/M/T/W/R/F/S/*
11 strt_Time: 0000 ;0000-2400
12 stp_Time: 0000 ;0000-2400
13 [Motion Trigger]
14 Wake on Motion: True ;true/false
15 Magnitude: 20 ;0-9999
16 Duration: 15 ;0-9999 milliseconds
17 Dwell: 15 ;0-9999 seconds
18 [GPS]
19 GPS Record: True ;true/false
20 GPS Poll: 2 ;2-30 minutes
21 [IMU]
22 IMU record: True ;true/false
23 INS record: False ;true/false
24 Record: MotionTrigger ;Continuous/MotionTrigger
25 Sample Rate: 10 ;1-100 samples/second
26 [Server]
27 Location: warthog.eastus.cloudapp.azure.com ;
28 END
```

Configuration GUI Initialization

- When GUI is opened
  - Initialize all variables in the software
  - Check to see if connected
    - If not connected sit in loop until connected
  - Get devices current nat.conf file
    - If the file does not arrive after certain time request again
    - Only request 3 times before failing and exiting loop
  - Update the group of current device settings

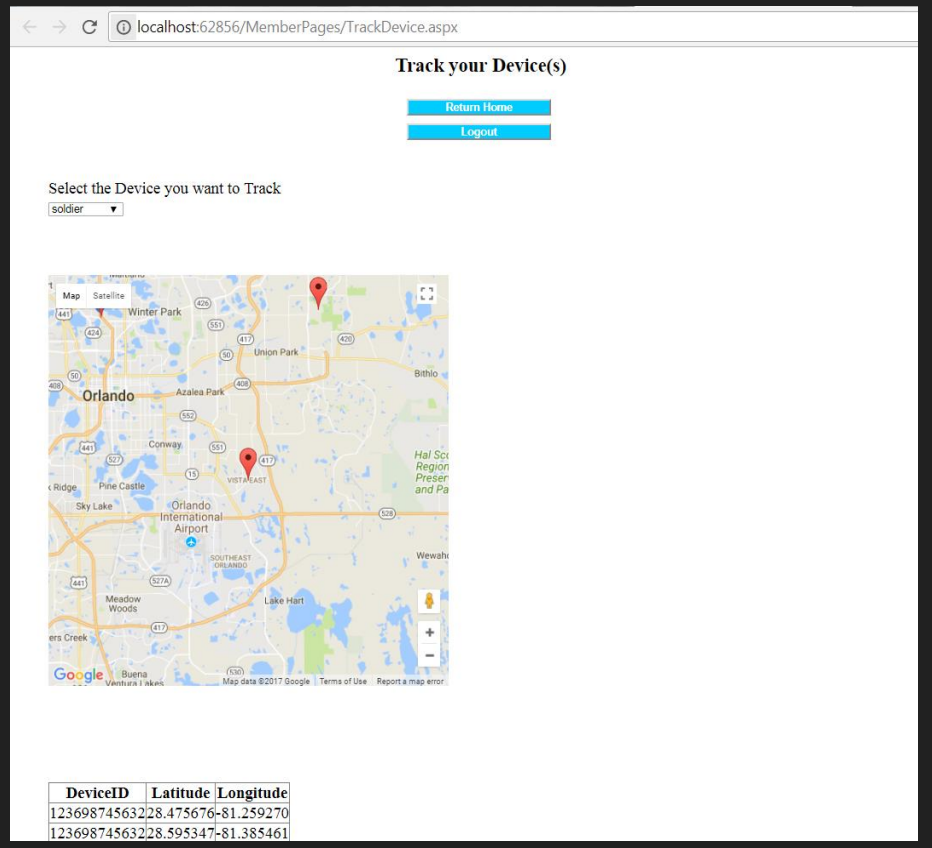


Configuration GUI Operation

- While GUI is running
  - Wait for a button to be pushed
  - Have a Background Worker
    - Constantly check device connection
  - If a button is pushed run that button's specific code flow

Client Web GUI

- Client will create an account
  - View profile page
    - Edit username and password
  - Add device(s) to user's list of current devices
    - Register device through its serial number and 1 time access code
  - Track device(s)
    - View current and history of locations for each current, registered device



Administrative Content - Budget

	Qty/Board * 4	Price/Unit	Total
LTE Module	4	$99.00	$396.00
IMU	4	$8.50	$34.00
MCU	4	$5.00	$20.00
GPS Module	4	$20.50	$82.00
DC-DC Converter	4	$1.50	$6.00
Voltage Reference	4	$1.50	$6.00
SD Socket	4	$10.50	$42.00
USB ESD Protection Unit	4	$1.00	$4.00
TOTAL EST BUDGET		$147.50	**$590.00**

Thank You For Your Time

DEMONSTRATION

- Inside
  - Configuration of device through Configuration GUI
- Outside (HEC Courtyard)
  - Running of the device
  - GPS location on Client Website