Phase 2 Test Report

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| --- | --- | --- |
| Name | Date | Description |
| Richard Bamford | 13/06/2019 | * Set up initial test report directory structure and documents. |
| Richard Bamford, Gary Bamford | 15/06/2019 | * Test day |

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# Document Key

Main Program – MAINPROG

Deployment – DEPLOY

Power Control – POWCONT1

Automatic Interval Control – AUTOINT

Hardware and Pin Interface – HARDINT

Safety & Security – SAFESECT

Communication – COMMS

Persistent Storage - PT

# Description

Using an Arduino Uno with a SX1278 Dragino shield, satellite development kit and both connected to a PC. The Received result will be both serial values and transmitted values to check for differences.

# Main Program

### MAINPROGT1 – Configuration and Global Variable initialization.

#### Steps

1. Compile the software using Arduino version 1.8.9 and confirm the compilation is successful.
2. Power on the satellite.
3. Check the serial monitor for anomalies such as; powering off, freezing, malformed transmission messages.

#### Expected Result

1. Compilation successful.
2. LEDS light up and satellite powers on.
3. Satellite loops through the transmissions cycle with no anomalies in the serial monitor or ground station receiver.

#### Real Result

##### 09/05/2019

1. Compiles successfully.
2. Satellite correctly starts.
3. Anomalies
   1. deployment state is returning 256 instead of 1. (09-05-19 test devlog, software fixes, 3).
   2. board temperature returning -0.06 instead of 0.00 (09-05-19 test devlog, software fixes, 4).
   3. Satellite does not receive PING transmission (09-05-19 test devlog, software fixes, 5).

##### 11/05/2019

1. Compiles successfully.
2. Satellite runs and executed transmission loop.
3. Anomies
   1. -0.06 returned for the board temperature which is not connected.
   2. Each restart results in >1 increment in the restart counter.

##### 15/06/2019

1. Compiles successfully.
2. Satellite runs and executed transmission loop.
3. Anomies
   1. 0 1 1 0 printed, does the power control save correctly?

### MAINPROGT2 – Test Pin configuration is correct.

#### Steps

1. Power the satellite on.
2. Turn on deployment sequence.
3. Run the entire satellite software system.
4. Check that the data received is ok, deployment sequence executed, and hardware being controlled properly.

#### Expected Result

1. Receive a start up transmission.
2. Receive a system information packet and verify its values.
3. Confirm that the deployment hardware is switched correctly.

#### Real Result

##### 11/05/2019

Julian required to test this

### MAINPROGT3 – Test radio error modes.

#### Meaning

If the radio configuration can be configured incorrect but still carry on with normal operation, Is there any point in restarting it? For now we proceed as normal, since restarts can be manually initiated. 08/05/2019

#### Steps

1. Power on the satellite.
2. Wait for 15 transmission loop cycle and receive it with a ground station.
3. Power off the satellite.
4. Power on the satellite.
5. Transmit a PING command to the satellite.
6. Wait for PONG response.
7. Power off the satellite.
8. Power on the satellite.
9. Configure the radio incorrectly. (10-05-19-changes.docx).
10. Wait for 15 transmission loop cycles (normal operation).
11. Power off the satellite.
12. Power on the satellite.
13. Transmit a PING command to the satellite.
14. Wait for PONG response.
15. Configure radio pins incorrectly. (10-05-19-changes.docx).
16. Wait for 15 transmission loop cycles (normal operation).
17. Power off the satellite.
18. Power on the satellite.
19. Transmit a PING.
20. Wait for PONG.
21. Power off the satellite.

#### Expected Result

1. –
2. Receive messages on LoRa amateur band, LoRa ISM band, RTTY amateur band.
3. –
4. –
5. Satellite to receive the PING command.
6. Reception of a PONG command on a ground station.
7. –
8. –
9. Error code will be detected by the Safety & Security system.
10. No transmissions or receives.
11. –
12. –
13. No PING received by the satellite.
14. No PONG received by the ground station.

#### Real Result

##### 10/05/2019

When one LoRa .begin() fails it does NOT cause a complete system failure, therefore we do NOT restart the satellite on settings error.

##### 11/05/2019 Success

(11-05-2019-changes.docx)

### MAINPROGT4 – Confirm Atmega328p has enough memory for the software.

#### Steps

1. Compile the software using Arduino Ide version 1.8.9.
2. Upload the code to the satellite.
3. Run the entire program from 1 week sending it a cycle of commands.
4. Check for memory errors like freezing and crashing.

#### Command Cycle

1. Transmit callsign change for 1 minute.
2. Transmit repeat message for 5 minutes.
3. Transmit PING for 1 minute.
4. Transmit Restart for 5 minutes.

#### Expected Result

1. Compilation successful.
2. Uploaded correctly to the satellite atmega.
3. Satellite runs with no freezing or errors for a week.

#### Real Result

##### 10/05/2019 Success

Satellite runs fine for 1 minute.

### MAINPROGT5 – Check that the satellite is transmitting.

#### Steps

1. Power the satellite on.
2. Receive the startup message on the ground station.
3. Receive the RTTY callsign message on the ground station after 10 cycles have completed.

#### Expected Result

1. Startup transmissions received on a ground station.
2. RTTY callsign message received on a ground station.

#### Real Result

##### 10/05/2019 Success

### MAINPROGT6 – Check that the satellite can receive transmissions.

#### Steps

1. Power the satellite on.
2. Transmit a PING command for 5 minutes.

#### Expected Result

1. PONG command received on ground station.

#### Real Result

##### 10/05/2019

Problem with the String object memory allocation.

1. Heap fragmentation.
2. Heap space runs out.
3. Satellite stops after a few runs.

Temporary solution is to ensure String objects are Free’d.

##### 11/05/2019 Success

Replaced String object with char\*.

### MAINPROGT7 – Check that the radio re-configures successfully.

#### Steps

1. Power the satellite on.
2. Receive a LoRa ISM transmission, LoRa amateur transmission and FSK transmission.

#### Expected Result

1. Receive transmissions on the ground station.
2. No errors in satellite software.

#### Real Result

1. Satellite loops through re-configuration successfully.

##### 12/05/2019 Success

### MAINPROGT8 – Check that the atmega328p can be delayed by up to 10 minutes.

#### Steps

1. Program a 10 minute delay and 10 minute keep-alive delay.
2. Compile and upload the software.
3. Run program.

#### Expected Result

1. Satellite waits for 10 minutes with delay, satellite switches off due to hardware watchdog.
2. Satellite waits for 10 minutes with keep-alive delay, satellite stays powered on for 10 minutes.

#### Real Result

##### 12/05/2019

1. Delaying the program by 10 minutes does not trigger the hardware watchdog.
2. Keep-alive delay does nothing.

Julian required to test this.

### MAINPROGT9 – Check that the atmega328p can run the software system for at least a week.

#### Steps

* MAINPROGT4

#### Expected Result

* MAINPROGT4

#### Real Result

* MAINPROGT4

### MAINPROGT10 – Check that the hardware watchdog is signalled correctly to keep the satellite alive.

#### Steps

* MAINPROGT4

#### Expected Result

* MAINPROGT4

#### Real Result

* MAINPROGT4

### MAINPROGT11 – Check that the hardware watchdog does not switch the satellite off during custom delays.

#### Steps

* MAINPROGT4

#### Expected Result

* MAINPROGT4

#### Real Result

* MAINPROGT4

# Deployment

### DEPLOYT1 – Test deployment sequence in scenarios; debugging, integration and Jettison.

#### Steps

1. Reset satellite EEPROM.
2. Power the satellite on with the ENABLE\_DEPLOYMENT\_SEQUENCE pre-processor definition present.
3. Reset satellite EEPROM.
4. Power the satellite on with the ENABLE\_DEPLOYMENT\_SEQUENCE pre-processor definition removed.

#### Expected Result

1. Deployment sequence skipped and satellite enters the main loop.
2. Deployment sequence ran.

#### Real Result

Julian

##### 15/06/2019 Complete

* Once deployment sequence ran, doesn’t run again.
* Power information packet sent after 3 minutes.

### DEPLOYT2 – Test that the deployment sequence writes to EEPROM.

#### Steps

1. Reset the satellite’s EEPROM.
2. Power the satellite on with deployment enabled.
3. Switch the satellite off.
4. Power the satellite on with deployment enabled.

#### Expected Result

1. Deployment sequence runs.
2. –
3. Deployment sequence does not run.

#### Real Result

##### 13/05/2019 Completed.

##### 15/05/2019 Confirmed.

### DEPLOYT3 – Test that the deployment sequence does not run on power on if EEPROM address is set.

#### Steps

* DEPLOYT2

#### Expected Result

* DEPLOYT2

#### Real Result

##### 12/05/2019

The EEPROM state is set to 1. And on restart the deployment sequence is skipped.

##### 15/05/2019 Confirmed.

### DEPLOYT4 – Test that the deployment sequence mosfet enable time is suitable.

#### Steps

1. Reset the satellite’s EEPROM.
2. Power the satellite with deployment on.

#### Expected Result

1. Check that the deployment hardware successfully deploys with the given MOSFET enable time of 1 second ON and 1 second OFF.

#### Real Result

### DEPLOYT5 – Confirm that a power information packet is sent before the deployment sequence is executed.

#### Steps

1. Reset satellite’s EEPROM.
2. Power the satellite with deployment on.

#### Expected Result

1. Check after >3minutes that a power information packet has been received.

#### Real Result

##### 13/05/2019 Completed.

### DEPLOYT6 – Check that the deployment sequence transmits a success transmission.

#### Steps

1. Power the satellite with deployment on.

#### Expected Result

1. Check that the deployment hardware successfully deploys with the given MOSFET enable time of 1 second ON and 1 second OFF.

#### Real Result

##### 13/05/2019 Completed.

### DEPLOYT7 – Check that the deployment system returns the correct value for its state.

#### Steps

* DEPLOYT2

#### Expected Result

* DEPLOYT2

#### Real Result

##### 13/05/2019 Completed.

# Power Control

### POWCONT1 – Check the battery charging boolean changes between true and false depending on the current battery temperature > 0 and < 0 Celsius.

#### Steps

1. Power the satellite with simulated environments of sub 0 and greater than 0.

#### Expected Result

1. Check that the satellite charging circuit is switched OFF when below 0.

#### Real Result

##### 15/05/2019 Completed

### POWCONT2 – Check the battery charging circuit (MPPT) is switched off and on correctly.

#### Steps

1. Power the satellite on.
2. Wait for a system information packet.

#### Expected Result

1. Power information packet should have correct values for both the battery voltage and battery charging voltage.

#### Real Result

# Automatic Interval Control

### AUTOINTT1 - Test that the intervals returned matches the given table of delay seconds.

#### Steps

1. Power the satellite on with a power supply set to the given table of voltages. OR Power the satellite on with a battery charged to specific amounts.
2. Receive 10 system information transmissions.

#### Expected Result

1. Calculate the average time between each transmission and compare is to the interval table. (remember to account for added time delay of transmissions cycle).

#### Real Result

### AUTOINTT2 – Test that maximum and minimum intervals do not cause errors.

#### Steps

1. Set the keep-alive delay value to minimum value in code.
2. Compile and upload.
3. Startup the satellite.
4. Wait for 5 minutes.
5. Set the keep-alive delay value to the maximum value in code.
6. Compile and upload.
7. Startup the satellite.
8. Wait for 5 minutes.

#### Expected Result

1. Satellite running at the minimum interval value without errors.
2. Satellite running at the maximum interval value without errors.

#### Real Result

### AUTOINTT3 – Low power mode checks.

#### Steps

1. Power the satellite on.
2. Wait for a system information packet.
3. Set the battery to <=3.3V.
4. Check for low power mode cycle.
5. Set the battery back to >3.3.
6. Check that it switches back to normal operating mode.

#### Expected Result

2. Received normal power information packet.
3. Satellite goes quiet, only responds to manual system information command.

#### Real Result

# Hardware/Pin Interface

### HARDINT1 - Test bounds and readings for voltage reading maps

#### Steps

1. Power satellite on.
2. Wait for transmission loops.

#### Expected Result

1. Check system information packet to confirm correct voltage maps
2. Check system information packet to confirm correct current maps.

#### Real Result

### HARDINT2 - Test that the battery voltage is read when disabled MPPT

#### Steps

1. Power satellite on.
2. Wait for transmission loops.

#### Expected Result

1. Check system information packet to confirm correct battery voltage.

#### Real Result

### HARDINT3 - Test that the battery charging voltage is read when enabled MPPT

#### Steps

1. Power satellite on.

#### Expected Result

1. Check system information packet to confirm correct battery charging voltage.

#### Real Result

### HARDINT4 - Test that the satellite restarts when hardware watchdog signal is stopped.

#### Steps

1. Power satellite on.
2. Transmit a restart command.

#### Expected Result

1. Satellite restarts.

#### Real Result

### HARDINT5 - Test that the battery charging voltage reading is correct.

#### Steps

1. Power satellite on.

#### Expected Result

1. Check system information packet to confirm correct battery charging voltage.

#### Real Result

### HARDINT6 - Test that the battery voltage reading is correct.

#### Steps

* HARDINT2

#### Expected Result

* HARDINT2

#### Real Result

* HARDINT2

### HARDINT7 - Test that the Solar cell voltage readings are correct.

#### Steps

1. Power on the satellite.
2. Wait for transmission system information.

#### Expected Result

1. Confirm the voltage readings for the solar cells are correct in the system information packet.

#### Real Result

### HARDINT8 - Test that the battery temperature reading is correct.

#### Steps

1. Power on the satellite.
2. Wait for transmission system information.

#### Expected Result

1. Confirm the battery temperature reading is correct in the system information packet.

#### Real Result

### HARDINT9 - Test that the board temperature reading is correct.

#### Steps

1. Power on the satellite.
2. Wait for transmission system information.

#### Expected Result

1. Confirm the board temperature reading are correct in the system information packet.

#### Real Result

### HARDINT10 -Test that the watchdog heartbeat can be enabled and disabled.

#### Steps

* HARDINT4

#### Expected Result

* HARDINT4

#### Real Result

* HARDINT4

### HARDINT11 - Test that the temperature resolution for the sensors works.

#### Steps

1. Power on the satellite.
2. Wait for transmission system information.

#### Expected Result

1. Confirm the temperature readings are to 2 decimal places.

#### Real Result

# Safety & Security

### SAFESECT1 - Test the satellite correctly handles lora radio codes.

#### Steps

1. Power the satellite on with radio pins correct but antenna disconnected.
2. Run satellite for 5 minutes.
3. Power the satellite on with radio pins correct and antenna connected.
4. Run satellite for 5 minutes.
5. Power the satellite on with radio pins incorrect.
6. Run satellite for 5 minutes.

#### Expected Result

1. Antenna disconnected
   1. Error code be ERR\_NONE for radio startup on.
   2. Error code is ERR\_TX\_TIMEOUT for radio transmissions.
   3. Error code is ERR\_RX\_TIMEOUT for radio receive transmissions.
   4. Error code is N/A for configuration of radio.
2. Antenna connected
   1. Error code be ERR\_NONE for radio startup on.
   2. Error code is ERR\_PACKET\_TOO\_LONG or N/A for radio transmissions.
   3. Error code is ERR\_RX\_TIMOUT, ERR\_CRC\_MISMATCH N/A for radio receive transmissions.
   4. Error code is N/A for configuration of radio.
3. Pins incorrect.
   1. Error code be ERR\_CHIP\_NOT\_FOUND for radio startup on.
      1. Satellite restarts after a minute delay.
   2. Error code is ERR\_TX\_TIMEOUT for radio transmissions.
   3. Error code is ERR\_RX\_TIMEOUT for radio receive transmissions.
   4. Error code is N/A for configuration of radio.

#### Real Result

### SAFESECT2 – Test the string check function returns false for invalid strings.

#### Steps

1. Power the satellite on.
2. Send callsign change command to >64 byte string.

#### Expected Result

1. No callsign change.

#### Real Result

### SAFESECT3 – Test the deployment state eeprom values for errors and error handling.

#### Steps

1. Reset satellite EEPROM.
2. Power the satellite on.
3. Note deployment messages serial println.

#### Expected Result

1. Deployment 0,0 results in an EEPROM wipe.
2. Deployment 0,1 results in nothing.
3. Deployment 1,1 results in nothing.
4. Deployment 1,0, results in EEPROM wipe.

#### Real Result

* SAFESECT1

# Communication

### COMMST1 - Testing the enable and disable transmission state

#### Steps

1. Disable transmissions. “FOSSASAT-17;”
2. Restart Command. “FOSSASAT-114;”
3. Enable transmissions. “FOSSASAT-18;”
4. Disable transmissions. “FOSSASAT-17;”
5. MANUALLY RESTART SATELLITE
6. Restart Command. “FOSSASAT-114;”
7. Enable transmissions. “FOSSASAT-18;”
8. MANUALLY RESTART SATELLITE.
9. Send PING command. “FOSSASAT-15;”

#### Expected result

1. –
2. Satellite restarts via a command.
3. –
4. –
5. Satellite restarts.
6. Satellite ignores restart command.
7. –
8. –
9. Satellite replies with PONG command. “FOSSASAT-16;”

#### Received Result

##### 13/05/2019 - Completed

1. Disabling transmissions works.
2. Re-enabling transmissions results in power information packet being sent again.
   * Satellite transmitting function id 16 without being sent any receiver message.
   * Missing strcmp == 0 comparison.
3. Disabling transmissions works.
4. Transmission state saves to EEPROM correctly.
5. Disabled persists and enabled persists.

##### 15/05/2019 - Confirmed

### COMMST2 – Testing the repeater

#### Steps

1. Enable transmissions. “FOSSASAT-18;”
2. Send repeater message. “FOSSASAT-115;Repeater Message”

#### Expected result

1. Receive repeater message. “FOSSASAT-116;Repeater Message”

The satellite should re-transmit the given message on the next Communications System cycle.

Re-transmitted message will be received by the ground station.

#### Received Result

* TODO

##### 15/05/2019 - Complete

### COMMST3 – Testing the Ping-Pong feature

#### Steps

#### Expected result

1. Receive “FOSSASAT-16;”

Pong to be transmitted on the next Communication System cycle.

#### Received Result

##### 15/05/2019 - Complete

### COMMST4 – Testing the programmable callsign

#### Steps

#### Expected result

The transmitted callsign (sent start of every message) will change to the given string.

#### Received Result

##### 12/05/2019 Success

##### 15/05/2019 Confirmed

### COMMST5 – Testing the transmission password protection

#### Steps

1. Transmit “passcode5;”.

#### Expected result

1. Satellite to reject transmission.

#### Received Result

##### 13/05/219 Completed

##### 15/05/2019 - Complete

### COMMST6 – Testing the notification of satellite power on.

#### Steps

#### Expected result

1. Receive “FOSSASAT-11;”

The satellite to have all LEDs on and executing the program checked via serial communication.

#### Received Result

##### 13/05/2019 Completed

##### 15/05/2019 - Complete

### COMMST7 – Testing the notification of satellite deployment.

#### Steps

#### Expected result

1. Receive “FOSSASAT-14;”

The antenna and solar panels to be deployed.

#### Received Result

##### 13/05/2019 Completed

##### 15/05/2019 Completed

### COMMST8 – Testing the eeprom reset message.

#### Steps

#### Expected result

Reset counter and transmission state wiped but the deployment state persists.

#### Received Result

##### 13/05/2019 Completed

##### 15/05/2019 Completed

### COMMST9 – Testing the restart command

#### Steps

#### Expected result

The satellite should switch off and then back on again.

#### Received Result

##### 12/05/2019

The restart command puts the satellite in a restart loop which only resolves itself after STOPPED\_COUNTER\_MAX iterations. Check that the satellite stops trying to stop the satellite after STOPPED\_COUNTER\_MAX.

1. Counter increments properly.
2. Counter IF check works.
3. STATE\_STOP unsetting works.
4. No more restart attempts once STOPPED\_COUNTER\_MAX is reached.

Requires Julian

### COMMST10 – Testing the frequency band switching

#### Steps

* Send satellite a ping command on the amateur band.
* Listen on amateur band.
* Send satellite a ping command on the amateur band.
* Listen on the ISM band.

#### Expected result

#### Received Result

### COMMST11 – Testing the manual deployment command

#### Steps

#### Expected result

If the antenna and solar panels have not been deployed automatically, they are deployed.

#### Received Result

##### 12/05/2019

The EEPROM deployment state is set to 1, can we still run the deployment command? – The deployment command manually executes the deployment sequence even if the EEPROM state is set to 1.

##### 15/05/2019 Completed

### COMMST12 – Testing the System Information command

#### Steps

1. Set to low power mode
2. Transmit “FOSSASAT-125;”
3. Set to normal mode
4. Transmit “FOSSASAT-125;”

#### Expected result

1. Receive Power information packet
3. Receive power information packet

Receive charging voltage, battery voltage, solar cell a/b/c voltages, reset count, deployment state and board temperature packet.

#### Received Result

##### 13/05/2019 Completed

##### 15/05/2019 Completed

### COMMST13 – Testing the notification of satellite shutting down.

#### Steps

#### Expected result

1. Receive “FOSSASAT-12;”

The satellite to cease executing and to power off and power on again automatically.

#### Received Result

### ~~COMMST14 – Checking transmission times.~~

#### ~~Steps~~

1. ~~For each protocol command, check the transmission is received for;~~
   1. ~~10 second,~~
   2. ~~30 second,~~
   3. ~~1 minute~~
   4. ~~5 minutes~~

#### ~~Expected Result~~

1. ~~The satellite to print to the serial monitor a successful response to each protocol command for each given time.~~

#### ~~Real Result~~

### COMMST15 – Checking SF7 callsign transmission.

#### Steps

1. Send the command “FOSSASAT-117;“ to the satellite.
2. Switch transmitter to receiver.
3. Ensure that the System Information packet is received on SF11 mode.

#### Expected Result

1. The satellite to transmit the message “FOSSASAT-118”;

#### Real Result

##### 15/05/2019 Completed

### COMMST16 – Checking spreading factor switching

#### Steps

1. Send the command “FOSSASAT-119;“ to the satellite.
2. Send the command “FOSSASAT-120;” to the satellite.

#### Expected Result

1. Receive a system information packet on the alternative spreading factor. (SF10)
2. Receive a system information packet on the normal spreading factor (SF11).

#### Real Result

1. When switched to alternative mode, no power information received on SF11. Which is correct.
2. When switched back to normal mode, we can receive system information packet.

##### 15/05/2019 Completed

### COMMST17 – Low power mode disable and enable

#### Steps

1. Put the satellite into low power mode.
2. Disable the low power mode.
3. –
4. Enable low power mode.
5. –
6. Disable low power mode.

Expected Result

1. –
2. –
3. Satellite should move out of low power mode and loop as normal.
4. –
5. Satellite should enter low power mode.
6. –
7. Satellite should leave low power mode.

Real Result

##### 15/05/2019 Completed

### COMMST18 – MPPT keep alive command

#### Steps

1. Start satellite.
2. Check system information packet for correct charging voltage.
3. Send KEEP ALIVE MPPT command.
4. Unplug the battery and ensure satellite charges from MPPT.

Real Result

##### 15/05/2019 Completed

### COMMST19 – MPPT temperature switching enable and disable

#### Steps

1. Start satellite.
2. Check system information packet for correct charging voltage.
3. Send DISABLE MPPT temperature switching command.
4. Check system information that battery voltage is dropping (check that the battery is NOT charging)

Real Result

##### 15/05/2019 Completed

### COMMST20 – Manually transmit system information packet.

#### Steps

1. Start satellite.
2. Check system information packet for correct charging voltage.
3. Put into low power mode
4. Send SEND SYSTEM INFORMATION command.
5. Put into normal power mode
6. Send SEND SYSTEM INFORMATION command.

Real Result