1) Flight

1a) FL-WarmUp

Sequence:

- Activate when Zephyr puts RATS into Flight mode.
- FL-WarmUp is completed when LoRa communication between MainBoard and ECU is established.
- Activate FL-Measure when complete.

Powered components:

- RATS Main Board.
- LoRa.
- Cable/ECU.

Operations:

- Power and configure LoRa radio on Main Board.
- Power cable/ECU.
- Send MainBoard housekeeping.
- Monitor for ECU contact.
- Receive 6 data packets at 10 s intervals.
- If 6 data packets reveived, configure ECU was saved configuration state.
- Receive 6 more ECU data packets and then send to FL-Measure mode.
- If data packets are not received after reconfiguration of ECU, wait ___min, and then reset cable/ECU power. Repeat FL-WarmUp, but do not attempt to reconfigure ECU.

TMs from Ground:

- TM to configure into FL-LowPower mode.

Data to OBC:

- MainBoard housekeeping.
- ECU Data: standard data string.

Send data to OBC in real time.

1b) FL-Measure

Sequence:

- Activated after completion of FL-WarmUp.
- Configure ECU to state saved in ECU memory.
- Update ECU configuration upon receiving TMs.
- Remain in FL-Measure until commanded out, or Zephyr mode change.

Powered components:

- RATS Main Board.
- LoRa.
- Cable/ECU.

Operations:

- Receive/process ECU data on Main Board.
- Execute TMs changing ECU instrument state.
- Send housekeeping data to OBC.
- Send ECU measurment data to OBC.

TMs from Ground:

- TMs configuring ECU measurement state.
- TMs configuring sampling rate.
- TMs configuring data processing on done on MainBoad and data string format.
- RS41 RH regeneration.
- TM saving configuration state.

Data to OBC:

- MainBoard housekeeping.
- ECU data string.

Send data to OBC every xx min.

1c) FL-Reel

Sequence:

- Activate when commanded by TM when instrument is in FL-Measure mode.
- Can enter FL-Reel from FL-WarmUp or FL-Measure.
- Execute TMs stating reel function to complete.
- Activate FL-WarmUp when complete.

Powered components:

- RATS Main Board.
- Motor controllers.
- Motors.

Operations:

- Power down cable/ECU.
- Power motor controllers.
- Check/report motor controller status, motor temps, and MCB data to OBC.
- Execute any incoming MCB commands sent via TM.
- Switch to FL-WarmUp when complete.

TMs from Ground:

- MCB commands for Reel control -- command type, speed, number of revolutions, etc.

Data to OBC:

- MainBoard housekeeping.
- Motor controller T, I, V.
- Motor T.
- MCB data.

Send data to OBC in real time.

1d) FL-LowPower

Sequence:

- Activate when commanded by TM when instrument is in Flight mode.
- Can enter form any other FL-WarmUp or FL-Measure mode.
- Stay in mode until receipt of TM to go into FL-Measure.

Powered components:

- RATS Main Board.
- Cable/ECU

Operations:

- Receive/process ECU data on Main Board.
- Send housekeeping data to OBC.
- Send ECU measurment data to OBC.
- Operates in a predefined ECU configuration that minimizes power consumption.
- ECU sends date once every 60 seconds.

TMs from Ground:

- None

Data to OBC:

- MainBoard housekeeping.
- ECU data string

Send data to OBC every xx min

2) Stand-by

2) Stand-by

Sequence:

- Initiated upon start up, reboot of RATS, or if Zephyr
- Remain in Stand-by until Zephyr mode changes.

Powered components:

- MainBoard

Operations:

- Power RATS MainBoard.
- Gather and send housekeeping data to OBC.
- Send Instrument Mode request (IMR) every 60 s.

TMs from Ground:

- None

Data to OBC:

- Instrument Mode Request (IMR) every 60 seconds.
- MainBoard housekeeping.

3) Low-Power

3) Low-Power

Sequence:

- Activate on command or when gondola voltage drops below a threshold voltage.
- Remain in state until Zephyr changes flight mode.

Powered components:

- MainBoard.

Operations:

- Turn off all components except MainBoard.
- Send housekeeping data to OBC.

TMs from Ground:

- None

Data to OBC:

- MainBoard housekeeping.

4) Safety

4) Deployed Safety

Sequence:

- Activate on command or if communication with Zephyr is lost for more than ___hours.
- Remain in state until Zephyr changes flight mode.

Powered components:

- Main Board.
- Motor controllers.
- Motors.

Operations:

- Power down Cable/ECU.
- Check/report motor controller status, motor temps, and MCB data to OBC.
- Execute Reel in of cable using last known MCB reel position.
- Report status of reel execution.
- Power down motors and controllers.
- Send SAfety message to OBC.

TMs from Ground:

- None

Data to OBC:

- MainBoard housekeeping.
- Motor controller T, I, V.
- Motor T.
- MCB data.
- SAfety status message.

Send data to OBC in real time.

5) End-of-Flight

4) End-of-Flight

Sequence:

1. Power down any active components of RATS.
2. Send final housekeeping data to OCB.
3. Send SAfety status message to OCB.

Powered components:

- MainBoard

TMs from Ground:

- None

Data to OBC:

- MainBoard housekeeping.
- SAfety status message.

Overview of data to include:

Housekeeping for FL-WarmUP, FL-Measure, Stand-by, Low-Power, Safety, End-of-flight modes:

- MainBoard T, Cable V @ MainBoard, other MainBoard voltages and currents.

Housekeeping for FL-Reel, FL-ReelSafe modes:

- MainBoard T, Motor T, Cable V @ MainBoard, Motor controller I V, Reel position, current limit setpoint.

ECU data:

- Science:
  - TSEN T, TSEN P, RS41 T, RS41 P, RS41 RH, GPS lat., GPS lon., GPS alt., GPS time.
- Status:
  - TSEN on/off, RS41 on/off, heater set point.
- Monitoring:
  - V Cable @ ECU, ECU V 12, ECU V 5, LoRa SNR.

TM functionality overview

FL-measure:

- Set sample rate -- 1s or 10s.
- Configure data processing on main board -- none, averaging, report standard deviation, etc., Talk to Joan about specifics.
- TSEN on/off
- RS41 on/off.
- RS41 RH regeneration command.
- Low-data mode -- configure ECU and main board such that only RS41 and GPS data are reported every 60 s. Configure LoRa in mode that provides the most reliable data link. (Note: We may not need this mode).
- Save ECU configuration to memory. ECU will configure itself to the saved state upon powering on.

FL-Reel:

- Reel deploy -- # revs, speed
- Reel retract -- # revs, speed
- Home LevelWind
- Set ignore current, torque limits.
- Reset motor controllers.