University of Washington

HuskySat-2 COM Interface Control Document

ICD-COM-001

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Revision History

Revision	Date	Change	Author	Approved By	Notes
1	9/9/2025	Version 1 created	Catherine Collison	UNP	
2	10/6/2025	Subsystem ICD template	Catherine Collison	Systems Team	
3	7/7/2026	COM ICD created	Lauren Wetzel		

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Acronyms & Symbols List

Acronym	Definition
HSL	Husky Satellite Lab
HS-2	HuskySat-2
CDH	Command and Data Handling
UNP	University Nanosatellite Program
LEO	Low Earth Orbit
LOST	LOST Open-Source Star Tracker
FOUND	Found Open-Source Universal Navigational Determiner
COTS	Commercial Off-The-Shelf
ADCS	Attitude Determination and Control System
CDH	Command and Data Handling System
THR	Thermal control subsystem
STR	Structures subsystem
EPS	Electrical Power Subsystem
BMS	Battery management system
PDS	Power distribution system
COM	Communications Subsystem
PCB	Printed Circuit Board
GPS	Global Positioning System
NDA	Non Disclosure Agreement

Symbol	Definition
**	Number managed by the team, but unable to be provided due to NDA

Purpose and Scope

This Interface Control Document (ICD) defines the **electrical**, **mechanical**, **thermal**, and **data** interfaces required for the **Communications (COM)** subsystem to be successfully integrated into HuskySat-2. The Communications subsystem includes all hardware to support the scientific customer of HuskySat-2. Husky Sat-2 (HS-2) is a 3U CubeSat developed by the Husky Satellite Lab (HSL) at the University of Washington in Seattle. Designed to operate in Low Earth Orbit, HS-2 aims to demonstrate the capabilities of its novel navigation technology: LOST (Lost Open-Source Star Tracker) and FOUND (FOUND Open-Source Universal Navigational Determiner). LOST and FOUND enable GPS-independent navigation for small satellites using a unique star tracker and horizon tracker package developed here at HSL. The Communications subsystem includes all hardware to support the operation of LOST and FOUND.

COM

The COM subsystem has the following hardware components:

Table 1. COM Hardware

Hardware	Description	Datasheet (Public)
S-Band Transceiver	EnduroSat's S-Band Transceiver module is designed for telecommand and telemetry purposes of a LEO uplink communication channel.	Behind NDA
S-Band wideband antenna 1	EnduroSat S-Band Wideband Patch Antenna (SANTV7 Model) used to transmit and receive RF signals.	Behind NDA
S-Band wideband antenna 2	EnduroSat S-Band Wideband Patch Antenna (SANTV7 Model) used to transmit and receive RF signals.	Behind NDA
Splitter	Endurosat S-Band Hybrid Coupler enables a single transceiver to interface with two S-band antennas simultaneously.	Behind NDA

Interface Identification and Definitions

1. Interface Overview

Electrical Interfaces: Defines the power distribution structure, including the 3.3V, 5V, and 12V voltage rails allocated by the power budget. Establishes the physical connectors, pinouts, and signal characteristics managing power and data delivery to the subsystem

Mechanical Interfaces: Captures physical dimensions, mass properties, and mounting requirements of subsystem components, as well as how they interface with each other and the spacecraft structure.

Thermal Interfaces: Specifies the heat generated by each component, establishes operational and survival temperature boundaries, and details the physical conduction paths mounting interfaces that connect the components to the structure.

Software Interfaces: Any exchange of information to, from, or inside the subsystem. Describes the data, data type, connections, and protocols.

1.0 Electrical Interfaces

1.1 - Power

Table 2: COM Power Interfaces

Section	Input Voltage (V)	Meets Input Voltage Req.	TYP Power Draw (W)	Power Draw Max (W)	TYP Current Draw (A)	Peak Current Draw (A)	Description
EPS PDS to S-Band Transceiver (Receive Mode)	12	☑	1.66	-	0.138	-	
EPS PDS to S-Band Transceiver (Transmit Mode)	12	☑	-	10.4		0.86	

1.1.1 EPS PDS to S-Band Transceiver

The S-Band Transceiver nominally receives 1.66 W of power at 12 V from the PDS PCB in receive mode. The peak power draw of the S-Band Transceiver is 10.4 W. The safe mode power draw of the S-Band Transceiver is 1.66 W.

1.2 - Data

Table 3: COM Data Interfaces

Section	Signal	Direction	Protocol	Description
S-Band Transceiver to CDH PCB	GND	PWR	N/A	Common ground
S-Band Transceiver 1 to CDH PCB	*TX*	*Output*	*RS-485*	*Half-Duplex RS-485*

S-Band Transceiver 2 to CDH PCB	*RX*	*Input*	*RS-485*	*Half-Duplex RS-485*
Splitter to S-Band Transceiver	*TX, RX*	*Omnidirectional*	*RS-485*	*MMCX Coaxial Connector, Half-Duplex RS-485*
Splitter to Antennas	*TX, RX*	*Omnidirectional*	*RS-485*	*MMCX Coaxial Connector, Half-Duplex RS-485*

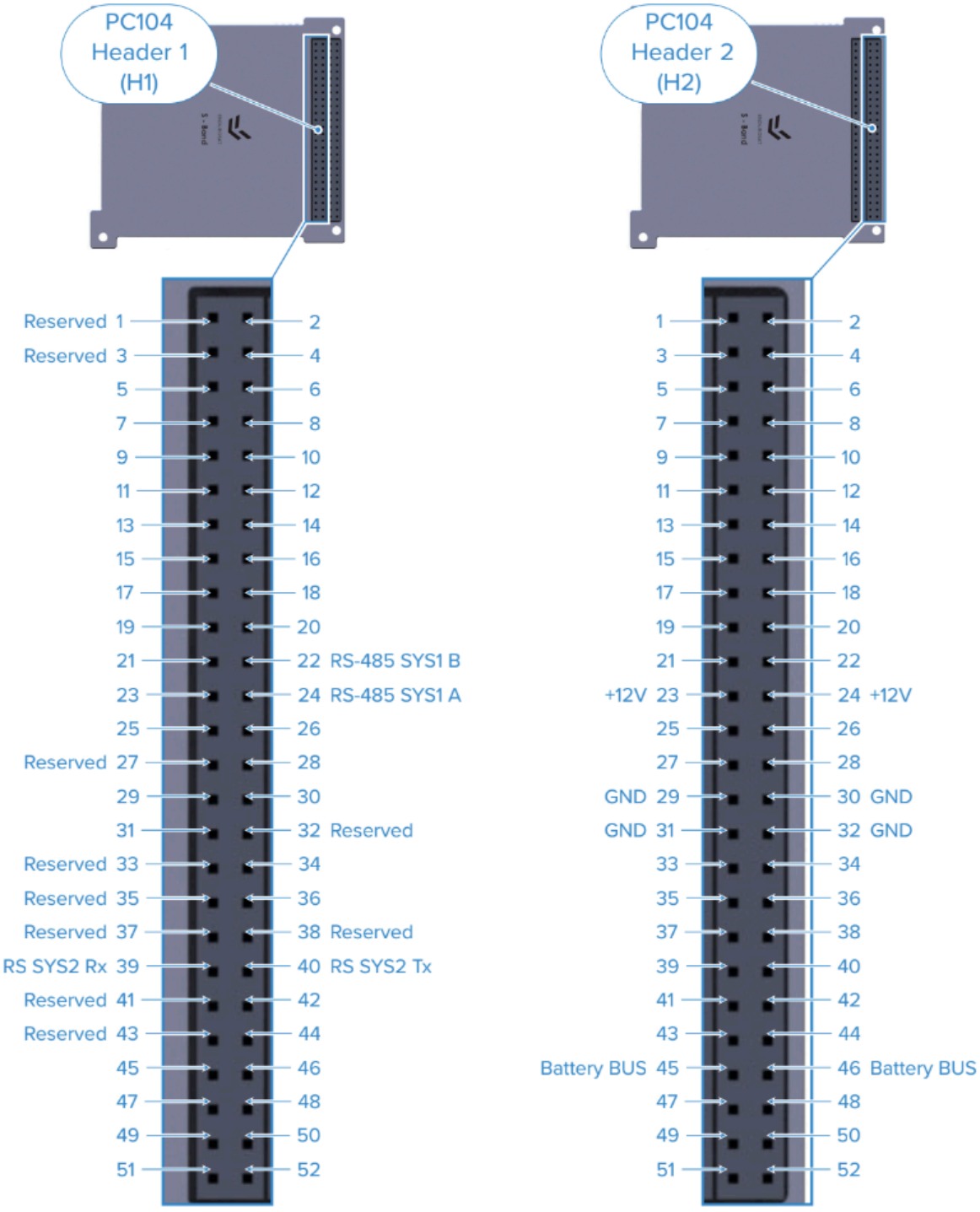
1.3 Pinouts

Table 4: COM Pinouts

Section	Type	Pinout
H1	Reserved	1
H1	Reserved	3
H1	RS-485 SYS1 B	22
H1	RS-485 SYS1 A	24
H1	Reserved	27
H1	Reserved	32
H1	Reserved	33
H1	Reserved	35
H1	Reserved	37
H1	Reserved	38
H1	RS SYS2 Rx	39
H1	RS SYS2 Tx	40
H1	Reserved	41
H1	Reserved	43
H2	+12V	23
H2	+12V	24

H2	GND	29
H2	GND	30
H2	GND	31
H2	GND	32
H2	Battery BUS	45
H2	Battery BUS	46

1.3.1 Pinout Diagram


PC104
Header 1
(H1)
Reserved 1
2
Reserved 3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22 RS-485 SYS1 B
23
24 RS-485 SYS1 A
25
26
Reserved 27
28
29
30
31
32 Reserved
Reserved 33
34
Reserved 35
36
Reserved 37
38 Reserved
RS SYS2 Rx 39
40 RS SYS2 Tx
Reserved 41
42
Reserved 43
44
45
46
47
48
49
50
51
52
PC104
Header 2
(H2)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
+12V 23
24 +12V
25
26
27
28
GND 29
30 GND
GND 31
32 GND
33
34
35
36
37
38
39
40
41
42
43
44
Battery BUS 45
46 Battery BUS
47
48
49
50
51
52

2.0 Mechanical Interfaces

2.0 Mechanical Interfaces

2.1 Interface Overview

Comms' mechanical interfaces to the Structures (STR) subsystem cover three physical elements: the S-Band Transceiver and Splitter, both compressed along the four M3x0.50 structural rods (Grainger 25DM52) within the PCB stack, and two comms patch antennas, externally mounted on the lateral ties. Mounting order and antenna placement are shown in the stack (Figure 1) and antenna-mounting diagram (Figure 2); this section lists fastener specs, torque, and mounting facts only. STR is the authoritative source for fastener sizing, torque, and back-out method; see the Structures ICD (ICD-STR-1) Section 2.6 (PCB stack) and Section 2.7.1 (antennas).

2.2 Transceiver and Splitter: Fasteners and Mounting Facts

- MTA-to-Transceiver standoff: McMaster 95947A512, M3x0.5 hex standoff, 11.24mm, above Tie 2's top-face nut. Structures ICD Index, Table 2.6-2, Fastener ID F-10.
- Transceiver-to-Splitter: 0mm, direct contact; the two components' housings are fully touching, with no standoff, gasket, or other feature in between. This is the only direct contact in the PCB stack. Neither component carries a dedicated retention nut; both are compressed within the Transceiver-Splitter-CDH-Payload PCB zone by the rod preload spanning Tie 2's top-face nut to Tie 1's bottom-face nut.
- Splitter-to-CDH standoff: same standoff part, 7.99mm. Table 2.6-2, Fastener ID F-10.

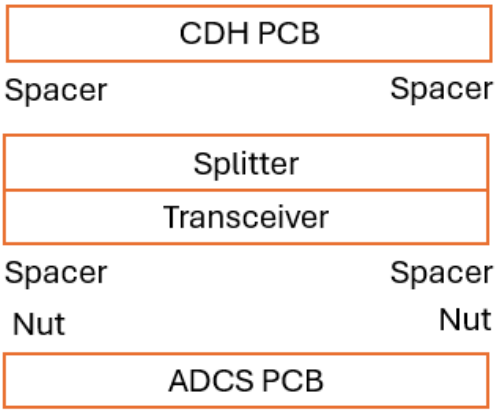


Figure 1: PCB Stack

2.3 Patch Antennas: Fasteners and Mounting Facts

- Both comms patch antennas mount on the lateral ties (STR-owned brackets), not on a dedicated antenna bracket; each tie is square in cross-section with 2 holes on each of 2 opposite faces (4 holes per tie). Each antenna mounts on the matching face across both ties: 2 holes on Tie 1 plus 2 holes on Tie 2, 4 holes per antenna, 8 fastening points total.
- Fastener: McMaster 92095A183, M3x0.5 button head hex-drive, 12mm, ~0.66 N-m, space-grade thread-locking compound (threads directly into the tie, no nut). Structures ICD Index, Table 2.7-1, Fastener ID F-01.
- Face assignment: one antenna mounts on the +Y face (with FOUND); the second mounts on the -Y face (with the GNSS antenna). Structures ICD Section 2.1.

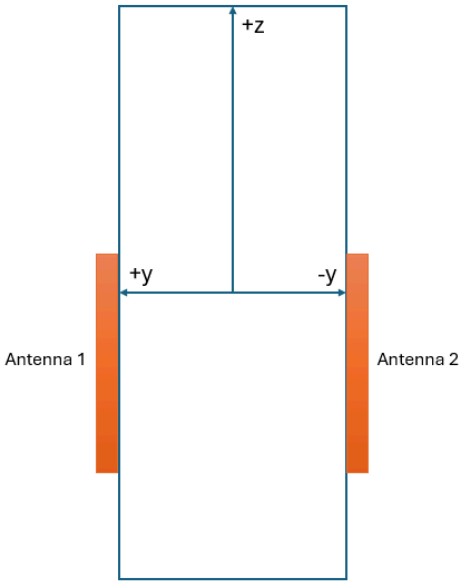


Figure 2: Comms Antenna Location in CubeSat

3.0 Thermal Interfaces

Table 5: COM Thermal Interfaces

Component	Heat Generation (W)	Min Operating Temperature	Max Operating Temperature	Connections
EnduroSat	10.4 peak; 0.34	-40	75	Aluminum

S-band transceiver	avg			housing; rails; conductive path to stack
S-band patch antennas (2)	0 (no DC input)	-40	120	External brackets; coax; primary structure

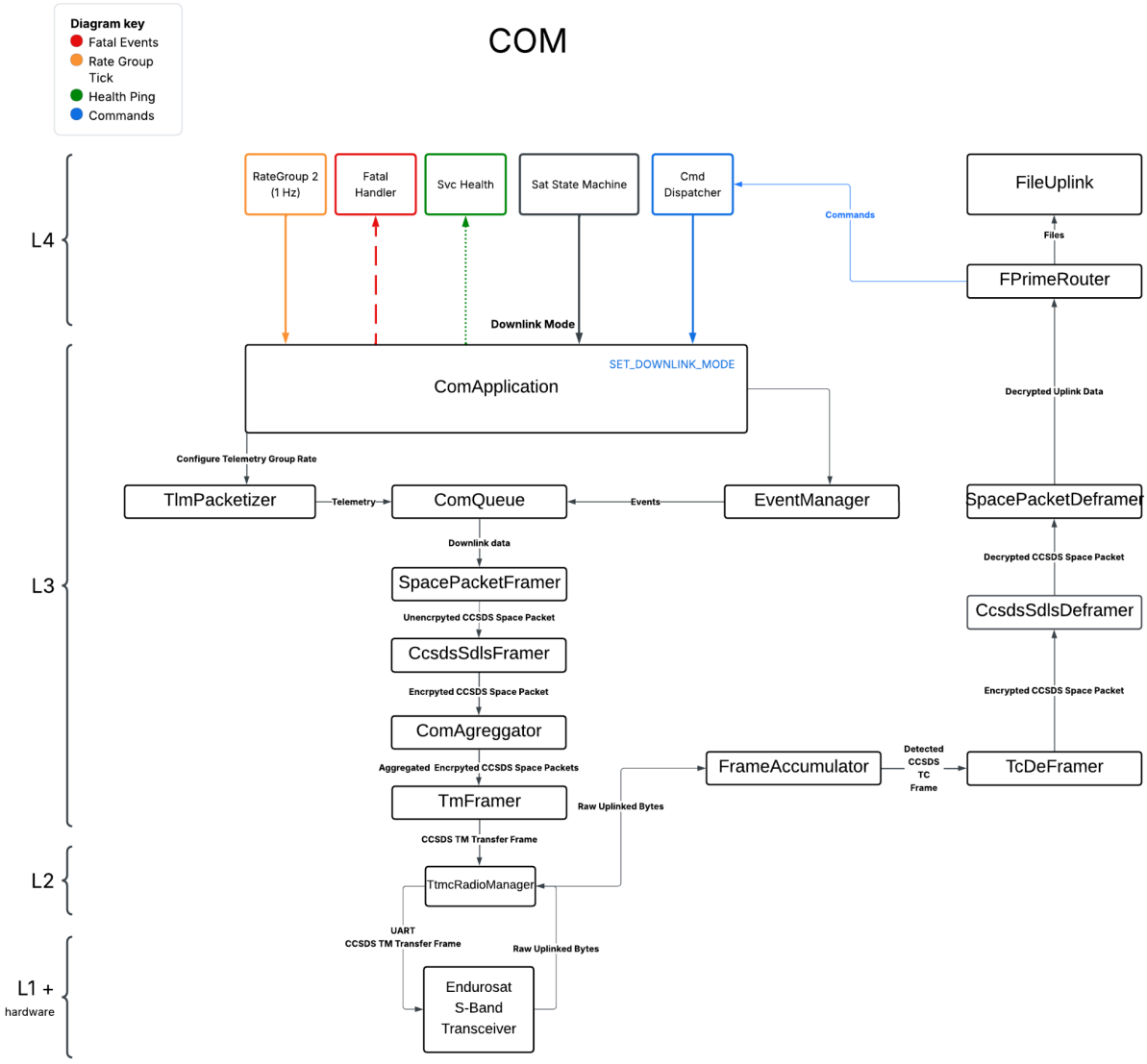
The Communications (COM) subsystem, centered on an EnduroSat S-band transceiver, is the dominant heat source on the spacecraft and is expected to dissipate up to 9.5 W. The transceiver is budgeted for an operating temperature range of −40 to +75 °C, while the externally mounted patch antennas are qualified over −40 to +120 °C. COM has no dedicated heater allocation; thermal control relies on passive conduction. The transceiver is positioned directly beneath the Splitter, a metal-housed RF component, creating a direct housing-to-housing contact interface (ref. ICD-STR-1 Section 2.6) that facilitates efficient lateral heat conduction. Thermal connections are maintained through this Transceiver–Splitter interface and conductive contact through the common M3 rails (F-08, ref. ICD-STR-1 Table 2.6-2), ultimately reaching the external primary structure frame for radiation to space. Thermal interface surfaces and fastener preloads shall be kept free of insulating debris or thermal-isolating materials. One of the externally mounted patch antennas will include a type K thermocouple for active temperature monitoring.

4.0 - Software Interfaces

4.1 - COM Software

Communications software uses the Endurosat S-Band Transceiver to transmit telemetry and receive uplinked commands or files. The transmission and reception of the S-Band RF signals are handled by the Endurosat S-Band Wideband Patch Antennas (as described in the COM block diagrams). The COM software is written in F’ and is structured as two main F’ components. The first is the ComApplication which is responsible for managing the transmission rates of various telemetry packets such as State of Health and PAYLOAD telemetry. Telemetry be transmitted using real-time or stored data with the respective downlink rates parameterized by the mode in which the ComApplication is operating in. The second component for COM software is the TmtcRadioManager which is responsible for passing data to and from the Endurosat S-Band Transceiver over UART.

Alongside the ComApplication and TmtcRadioManager, COM will be making use of the F’-provided components such as FileDownlink, FileUplink, EventManager, Framer(s), Deframer(s), and CmdDispatcher for handling files, deframing/framing CCSDS packets, and routing commands. For encryption/decryption, F’ provides the ComCcsdsSdls subtopology of software components. The aforementioned components and their relationships are described in the following diagram:



4.1.1 - Communication Protocol

For HS-2, the communications protocol used for downlinked packets is the CCSDS TM Space Data Link Protocol (based on the CCSDS TM specification (CCSDS 132.0-B-3)). For uplinked packets, the communication protocol to be used is the CCSDS TC Space Data Link Protocol (based on the CCSDS TC specification (CCSDS 232.0-B-4)). F' provides framing capabilities for downlinking telemetry and deframing capabilities for uplinked packets.

4.1.2 - ComApplication F' Component

The ComApplication makes use of F's "ports" to interface with the various software components within the greater flight software architecture. Input ports allow for processing of data or retrieve data for other components to use. Output ports allow for requesting data or data handoff to other components.

Table 6: COM F' ComApplication port table:

Name	I/O	Type	Description
modeIn	Input	Sat.CommsModePort	Mode command from SatStateMachine
schedIn	Input	Svc.Sched	Rate group tick
pingIn	Input	Svc.Ping	Health monitoring input ping from Svc.Health to component
pingOut	Output	Svc.Ping	Health monitoring ping response from component to Svc.Health
logOut	Output	Fw.Log	Event logging
configureGroupRate	Output	Svc.ConfigureGroupRate	Configure rate at which certain telemetry sections are transmitted as per the Svc.TlmPacketizer component
tlmOut	Output	Fw.Tlm	Telemetry (current mode) that will be used in SOH packets
prmGet	Output	Fw.PrmGet	Port to return the value of a parameter
prmSet	Output	Fw.PrmSet	Port to set the value of a parameter

Table 7: COM F' ComApplication command table:

Name	Opcode	Description	Parameters	Response
SET_COMMS_MODE	0x01	Sets transmission mode of CommsManager	*comms_mode*: U8 BEACON = 0x00 STANDARD_DOWNLINK = 0x01 STORED_PLAYBACK= 0x02 NO_DOWNLINK = 0x03	COMM_MODE will be set to *comms_mode*. When in **BEACON** mode: Only SOH telemetry shall be transmitted at 1 Hz When in **STANDARD_DOWNLINK**

				mode: All telemetry will be downlinked at 1 Hz When in **STORED_PLAYBACK** mode: Real-time SOH telemetry will be downlinked at a rate of 1 Hz. When in **NO_DOWNLINK** mode: During this mode, nothing will be transmitted from the satellite. Refer to requirement UNP12-91 within the RVM.

Table 8: COM F' ComApplication event table:

Name	Description
DownlinkModeUpdateCmd	Emitted when ComApplication processes a command from the ground to update downlink mode
pingReceived	Emitted when SatStateMachine updates the link mode through the modeIn input port

Table 9: COM F' ComApplication telemetry table:

Name	Port Type	Data Type	Description
downlink_mode	Comms.Mode	U8	Downlink mode that will be set by SatStateMachine.

4.1.3 - TmtcRadioManager F' Component

The TmtcRadioManager makes use of F's "ports" to interface with the various software components within the greater flight software architecture. Input ports allow for processing of data or retrieve data for other components to use. Output ports allow for requesting data or data handoff to other components.

Table 10: COM F' TmtcRadioManager port table:

Name:	I/O:	Type:	Description:
prmGet	Output	Fw.PrmGet	Port to return the value of a parameter
prmSet	Output	Fw.PrmSet	Port to set the value of a parameter
drvConnected	Input	Drv.ByteStreamReady	Ready signal when driver is connected
drvReceiveIn	Input	Drv.ByteStreamData	Receive (read) data from driver. This gets forwarded to dataOut
drvReceiveReturnOut	Output	Fw.BufferSend	Returning ownership of buffer that came in on drvReceiveIn
drvSendOut	Output	Drv.ByteStreamSend	Send (write) data to the driver. This gets invoked on dataIn invocation
drvAsyncSendOut	Output	Fw.BufferSend	Send (write) data to driver asynchronously
drvAsyncSendReturnIn	Input	Drv.ByteStreamData	Callback from drvAsyncSendOut (retrieving status and ownership of sent buffer)

Table Xa: COM F' TmtcRadioManager command table:
The TmtcRadioManager F' component will not take in any commands and will simply be a pipeline to forward uplink and downlink data between the FSW and the Endurosat S-Band Transceiver.

Table Xb: COM F' TmtcRadioManager telemetry table:
The TmtcRadioManager will not hold any telemetry due to its simple purpose of passing data between FSW and the Endurosat S-Band Transceiver.

4.1.4 - FileDownlink Component

FileDownlink is an active F´-provided component that manages spacecraft file downlink. Both operators and components on the spacecraft can add files to the file queue, which FileDownlink will downlink from. F' provides the software design document here.

4.1.5 - ComQueue Component

ComQueue is an F'-provided component that receives data from multiple sources (telemetry, F' events, or file packets) and transmits them for transmission based on priority. ComQueue sends data selected for transmission to the SpacePacketFramer to wrap the data in a CCSDS SpacePacketFramer. F' provides the software design document here.

4.1.6 - SpacePacketFramer Component

SpacePacketFramer is an F'-provided component that encapsulates user data into a CCSDS Space Packet, adding the necessary header fields to be passed into a CCSDS TM Transfer Frame for downlink. F' provides the software design document here.

4.1.7 - CcsdsSdlsFramer Component

CcsdsSdlsFramer is an F'-provided component that generates CCSDS SDLS frames from incoming data. Data that is sent to this component is encrypted and forwarded to the TmFramer component for downlink. F' provides the software design document here.

4.1.8 - TmFramer Component

TmFramer is an F'-provided component that is coupled with the SpacePacketFramer to wrap CCSDS Space Packets into TM frames. F' provides the software design document here.

4.1.9 - FileUplink Component

FileUplink is an F'-provided component that manages uplink of files to the software deployment. F' provides the software design document here.

4.1.10 - FrameAccumulator Component

FrameAccumulator is an F'-provided component that is responsible for accumulating a stream of data from the TmtcRadioManager to extract complete frames for uplinked data. F' provides the software design document here.

4.1.11 - TcDeframer Component

TcDeframer is an F'-provided component that is coupled with the SpacePacketDeframer component to unwrap CCSDS Space Packets from TC frames sent over UART by the S-Band Transceiver. F' provides the software design document here.

4.1.12 - CcsdsSdlsDeframer Component

CcsdsSdlsDeframer is an F'-provided component that defames data that contains CCSDS SDLS frames. Data sent to this component is deframed and decrypted to be forwarded to the SpacePacketDeframer. F' provides the software design document here.

4.1.13 - SpacePacketDeframer Component

SpacePacketDeframer is an F'-provided component that removes transfer frame headers and validates the Space Packet header and extracts the payload. F' provides the software design document here.

4.1.14 - FprimeRouter Component

FprimeRouter is an F'-provided component that is responsible for routing uplinked data packets (containing command or file data) to other components.The FprimeRouter forwards command packets to the CmdDispatcher component and file packets to the FileUplink component. F' provides the software design document here.

4.1.15 - CmdDispatcher Component

CmdDispatcher is an F'-provided component that is responsible for dispatching incoming commands to the components that implement those commands. F' provides the software design document here.

4.1.16 - SdlsRouter Component

SdlsRouter is an F'-provided component that routes encryption/decryption requests to an encryptor/decryptor. This component sits in between the TcDeframer and SpacePacketDeframer components to decrypt data and sits between SpacePacketFramer and TmFramer to encrypt data. F' provides the software design document here.

4.2 - Endurosat S-Band Transceiver

The Endurosat S-Band Transceiver contains RS-485 SYS1 A and RS-485 SYS1 B pins to allow for communication over an RS485 link. COM will use the CDH Hardware to communicate to these pins for transmission and reception of data. Specifically, COM software will transmit UART data converted into RS-485 signals for downlinking telemetry and convert incoming RS-485 signals into UART signals for uplinked commands/files.

4.3 - COM Data Interface Details

4.3.1 - CDH to COM Endurosat S-Band Transceiver

Description: Connection between CDH computer and S-band Transceiver.

Wired/Wireless	Wired
Communications Protocol	Half-duplex RS-485
Signal Type	Digital

Data Format	N/A
Protocol (if defined)	UART
Type of Data	N/A
Software	CDH RS-485 Driver
Commands/Inputs	- Configure baud-rate - Initialize driver - Read N bytes from S-Band Transceiver - Write N bytes to S-Band Transceiver - Close
Data rate	8 data bit, 1 stop bit

4.3.2 - COM Endurosat S-Band Transceiver to CDH

Description: Connection between CDH computer and S-band Transceiver.

Wired/Wireless	Wired
Communications Protocol	Half-duplex RS-485
Signal Type	Digital
Data Format	N/A
Protocol (if defined)	UART
Type of Data	N/A
Software	CDH RS-485 Driver
Commands/Inputs	- Configure baud-rate - Initialize driver - Read N bytes from S-Band Transceiver - Write N bytes to S-Band Transceiver - Close
Data rate	8 data bit, 1 stop bit

5.0 References

The EnduroSat documentation (ICDs and datasheets) for their equipment is behind NDAs, and thus, we are unable to provide concrete references here.