The Frontier-X by Rocket Lab is a high-speed, X-band, software-defined telemetry, tracking, and control (TT&C) X-band radio designed for both near Earth and deep space missions. The Frontier-X by Rocket Lab, based on the Johns Hopkins University (JHU) Applied Physics Lab (APL) Frontier Radio, packs Deep Space Network (DSN) and other typical waveforms (SN, KSAT, SSC) into a compact package with up-screened commercial components for high reliability applications. Frontier-X by Rocket Lab includes extended functionality not typically available in a low-cost radio including a coherent transponder to enable radiometric navigation methods, precision timekeeping functions, FEC encoding and decoding, and a hardware based critical command decoder (CCD).

**KEY FEATURES**

- GEO/deep space radiation tolerance – high tolerance to total dose, no destructive latchup, and robust to single event upsets
- High Reliability variant available with enhanced radiation tolerance and upgraded parts program
- Hardware critical command decoder (CCD) enables hardware-based functionality like fire-codes for spacecraft reset or precision time keeping
- DSN, SN, NEN, AFSCN Unified S-band (USB), and commercial (SSC, KSAT) waveform compatible
- CCSDS compliant turbo and convolutional encoding
- Two-way Doppler and two-way ranging for navigation beyond low Earth orbit
- Non-regenerative (coherent turn-around) or regenerative PN ranging
- Very low data rates and beacon tones enable long range communications and signaling
**Product Line Name**

**Configuration Options:**
- XXX = LEO (Low Earth)
- XXX = DSN (Deep Space)

**Model:**
- ZZ = EM (Engineering Model)
- ZZ = FM (Flight Model)

**Variant Options:**
- YY = ST (Standard)
- YY = HR (High Reliability)

---

**Configuration Options:**
- XXX = LEO (Low Earth)
- XXX = DSN (Deep Space)

**Model:**
- ZZ = EM (Engineering Model)
- ZZ = FM (Flight Model)

---

**General Specifications**

- **Enclosure Dimensions:** 184 mm x 128 mm x 50 mm
- **Mass:** 920 g, based on standard enclosure
- **Bus Voltage:** 22–35 V, 30 V Nominal
- **Power:** ≤ 1.5 W Standby, ≤ 7 W Rx only, ≤ 12 W Rx + Tx
- **Host Interface:** SpaceWire – ECSS-E-ST-50-12C single port

**Receiver**

- **Frequency:** 7145 to 7235 MHz (96 kHz nominal sub-carrier frequency)
- **Noise Figure:** ≤ 0.2 dB
- **Implementation Loss:** ≤ 0 dB at < 100 bps, ≤ 0.5 dB at > 100 bps
- **Turnaround Bandwidth:** 300 kHz to 1.7 MHz
- **Carrier Sensitivity:** ≤ 54 dBm

**Transmitter**

- **TX Power:** +14 dBm ± 1 dB
- **Frequency:** 8400 to 8500 MHz (25 kHz nominal sub-carrier frequency)
- **Phase Noise:** ≤ 0.5 RMS
- **Frequency Stability:** < 32 ppm/°C, < 1 ppm/year

**RF Waveforms**

- **Compatibility:** DSN, SSC, SN, KSAT
- **Modulations:** PM, BPSK, QPSK, OQPSK
- **Coding Options:** CCSDS 131.0-B-3 compliant turbo (1/3 to 1/2) and convolutional (1/2 to 7/8) downlink encoding

**Data/Symbol Rates**

<table>
<thead>
<tr>
<th>Symbol Rate</th>
<th>Data Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Downlink</td>
<td>10 Bd - 13.5 Mb/s</td>
</tr>
<tr>
<td>Uplink</td>
<td>10 Bd - 1 Mb/s</td>
</tr>
</tbody>
</table>

*Specific data rate will depend on encoding (turbo, convolutional, or un-encoded). **Assumes BCH encoding

**Environmental**

- **Random Vibration:** GSFC-STD-7000
- **Shock:** GSFC-STD-7000
- **Temp:** -25 to +55 °C op, -35 to +70 °C non-op
- **EM/EMC:** MIL-STD-461C/F
- **TID:** > 20 kRad, component level, enclosure not included (ST).
  - Sensitive components are spot shielded.
  - Custom killed – with enhanced bulk and spot shield (HR)
- **SEL LET:** > 43 MeV·cm²/mg
- **SEU & SEFIET:** < 1 Event/year @ GEO. Self-detecting and correcting through several methods including scrubbing, ECC, TMR and WDT

**Connectors**

- **RF Connectors:**
  - **Host:** VSR4F-04-10-50-03-N
  - **Variant Options:**
    - YY = ST (Standard)
    - YY = HR (High Reliability)
  - **Model:**
    - ZZ = EM (Engineering Model)
    - ZZ = FM (Flight Model)

**Deep Space Features (DSN Configuration Only)**

- **Compatibility:** DSN, SSC, SN, KSAT
- **Modulations:** PM, BPSK, QPSK, OQPSK
- **Coding Options:** CCSDS 131.0-B-3 compliant turbo (1/6 to 1/2) and convolutional (1/2 to 7/8) downlink encoding
- **Data/Symbol Rates:**
  - Symbol Rate:
    - 10 Bd - 13.5 Mb/s
  - Data Rate:
    - 1.7 bps - 13.3 Mbps*

**Environment**

- **Random Vibration:** GSFC-STD-7000
- **Shock:** GSFC-STD-7000
- **Temp:** -25 to +55 °C op, -35 to +70 °C non-op
- **EM/EMC:** MIL-STD-461C/F
- **TID:** > 20 kRad, component level, enclosure not included (ST).
  - Sensitive components are spot shielded.
  - Custom killed – with enhanced bulk and spot shield (HR)
- **SEL LET:** > 43 MeV·cm²/mg
- **SEU & SEFIET:** < 1 Event/year @ GEO. Self-detecting and correcting through several methods including scrubbing, ECC, TMR and WDT

**Connectors**

- **RF Connector:**
  - **Host:** VSR4F-04-10-50-03-N
  - **Variant Options:**
    - YY = ST (Standard)
    - YY = HR (High Reliability)
  - **Model:**
    - ZZ = EM (Engineering Model)
    - ZZ = FM (Flight Model)

**Deep Space Features (DSN Configuration Only)**

- **Carrier Sensitivity:** -154 dBm
- **Transmit Power:** +14 dBm ± 1 dB
- **Frequency:** 8400 to 8500 MHz (25 kHz nominal sub-carrier frequency)
- **Phase Noise:** ≤ 0.5 RMS
- **Frequency Stability:** < 32 ppm/°C, < 1 ppm/year

**Additional Features**

- **Multi-spacecraft per aperture (MSPA), delta-DOR

**Part Number**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>FM Price (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontier-X-LEO-ST</td>
<td>LEO Configuration, Standard</td>
<td>$175,000</td>
</tr>
<tr>
<td>Frontier-X-LEO-HR</td>
<td>LEO Configuration, High Reliability</td>
<td>Enquire</td>
</tr>
<tr>
<td>Frontier-X-DSN-ST</td>
<td>Deep Space Configuration, Standard</td>
<td>$225,000</td>
</tr>
<tr>
<td>Frontier-X-DSN-HR</td>
<td>Deep Space Configuration, High Reliability</td>
<td>Enquire</td>
</tr>
<tr>
<td>AirBorn verSI mating connector with flying leads</td>
<td>$500</td>
<td></td>
</tr>
</tbody>
</table>