



Exhibit 1

Supplemental Information Regarding Earth Stations

Applicant: **Space Exploration Technologies Corp. (SpaceX)**

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Telemetry and Command Stations

The characteristics of the Ku band telemetry and command stations proposed for this experimental authorization are summarized in the table below. SpaceX is working with partners to realize the Ku and Ka band telemetry and control system with ground stations around the world, including Brewster (WA) USA, Cordoba Argentina, Tromsø Norway, and Awarua New Zealand. The telemetry and control link can be active for up to 2.5 hours per day (12 minutes per orbit), though a more typical value will be 60 minutes per day.

| Station Name | BR1 | CD1 | TR1 | AW1 |
|----------------------------------|--------|--------|--------|--------|
| Organization | SpaceX | SpaceX | SpaceX | SpaceX |
| Latitude (deg) | 48.1 | -31.5 | 69.7 | -46.5 |
| Longitude (deg) | -119.7 | -64.5 | 18.9 | 168.4 |
| Diameter (m) | 5 | 5 | 5 | 5 |
| Ka Rx Antenna Gain (dBi) | 57 | 57 | 57 | 57 |
| Ku Rx Antenna Gain (dBi) | 52 | 52 | 52 | 52 |
| Ku Tx Antenna Gain (dBi) | 56 | 56 | 56 | 56 |
| Ku Tx Half Power Beamwidth (deg) | 0.22 | 0.22 | 0.22 | 0.22 |
| TX Power (W) | 40 | 40 | 40 | 40 |
| TX ERP (KW) | 9706 | 9706 | 9706 | 9706 |
| TX EIRP (dBW) | 72 | 72 | 72 | 72 |
| RX Figure of Merit (dB/K) | 31 | 31 | 31 | 31 |

Table 1. Ku/Ka Telemetry and Command Stations



The X and S band system will have the option to use the entire KSAT ground network consisting of stations all over the world, including Tromso Norway, Svalbard Norway, Antarctica, Singapore, South Africa, Dubai, and Mauritius. This global network has been used extensively for SpaceX missions in support of the Falcon 9 launch vehicle and Dragon spacecraft. This allows SpaceX to use existing infrastructure to support this demonstration. While the entire network of stations will be available at any given time, the SpaceX Washington ground station (“RED1”) will be used for the majority of ground passes and only use KSAT stations to supplement for additional operational needs. The S- or X-band link can be active for up to 2.5 hours per day (10 minutes per orbit), though a more typical value will be 60 minutes per day.

| Station Name | RED1 | SG25 | SG42 | TG2 | TG6 | TR3 | TR4 | MA1 | DU1 | HA1 | SI1 |
|-------------------------------------|--------|------|------|------|------|------|------|------|------|------|-------|
| Organization | SpaceX | KSAT | KSAT | KSAT | KSAT | KSAT | KSAT | KSAT | KSAT | KSAT | KSAT |
| Diameter (m) | 3.7 | 13 | 3.7 | 10 | 5.4 | 7.3 | 3.7 | 7.3 | 7.3 | 7.3 | 9.1 |
| Latitude (deg) | 47.7 | 78.2 | 78.2 | 69.7 | 69.7 | -70 | -70 | - | 20.5 | 25.2 | -25.9 |
| Longitude (deg) | -122.1 | 15.4 | 15.4 | 18.9 | 18.9 | 2.5 | 2.5 | 57.5 | 55.5 | 27.7 | 103.8 |
| Transmit (S-Band) | | | | | | | | | | | |
| Antenna Gain (dBi) | 35 | 46 | 35 | 44 | 38 | 41 | 35 | 41 | 41 | 41 | 43 |
| Antenna Full Beamwidth (deg) | 2.7 | 0.8 | 2.7 | 1.0 | 1.9 | 1.4 | 2.7 | 1.4 | 1.4 | 1.4 | 1.1 |
| TX Power (W) | 63 | 5 | 63 | 8 | 32 | 16 | 63 | 16 | 16 | 16 | 16 |
| TX ERP (KW) | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 | 122 |
| TX EIRP (dBW) | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 | 53 |
| Receive (X-Band) | | | | | | | | | | | |
| Antenna Gain (dBi) | 47 | 58 | 47 | 56 | 50 | 53 | 47 | 53 | 53 | 53 | 55 |
| Antenna Full Beamwidth (deg) | 0.7 | 0.2 | 0.7 | 0.3 | 0.5 | 0.3 | 0.7 | 0.3 | 0.3 | 0.3 | 0.3 |
| RX Figure of Merit (dB/K) | 25 | 36 | 25 | 32 | 31 | 33 | 25 | 32 | 33 | 33 | 34 |

Table 2. X/S Band Telemetry and Command Stations

For the earth stations with command (uplink) capability, the ERP levels are derived as follows:

- For each ground station, the maximum transmit power will be selected based on the antenna gain to maintain a fixed EIRP of 53 dBW, or ERP of 122 kW
- The amount of EIRP SpaceX will authorize for radiation for commanding purposes is listed in the EIRP row in dBW
- The calculation for ERP is derived from the instructions stated here: <https://apps.fcc.gov/eas/comments/GetPublishedDocument.html?id=204&tn=255011> Basically ERP is $10^{((EIRP - 2.15)/10)}$ Watts

The ‘TX ERP (KW)’ is what should be authorized for licensing since this is the planned operating ERP required. The actual transmit power listed in the earth station data and the gain of the reflector combined would give the maximum capability of the earth station, but the requirements for mission operation are much less than the capabilities of the earth station.



Broadband Test Stations

For the broadband downlink, SpaceX is utilizing ground terminal locations exclusively in the continental United States. The ground stations include six fixed locations, and three transportable ground stations:

1. SpaceX Headquarters: Hawthorne, California
2. Tesla Motors Headquarters: Fremont, California
3. SpaceX Test Center: McGregor, Texas
4. SpaceX Brownsville: Brownsville, Texas
5. SpaceX Redmond: Redmond, Washington
6. SpaceX Brewster: Brewster, Washington
7. SpaceX Broadband Test Van 1: Transportable
8. SpaceX Broadband Test Van 2: Transportable
9. SpaceX Broadband Test Van 3: Transportable

The satellites will transmit exclusively when over these ground stations (elevations between 40° and 90°), which results in transmission times of approximately 10 minutes each day. Each ground station is equipped with up-to four phased array and/or parabolic antennas with the characteristics outlined below. Additionally, the Ku-band Telemetry and Control antennas can be used for broadband tests.

| Antenna | ES-A | ES-B | ES-C | ES-D | ES-E |
|------------------------------|------|------|------|-------|------|
| Diameter (m) * | N/A | N/A | 1.2 | 1.6 | 5.0 |
| Transmit | | | | | |
| Antenna Gain (dBi) | 33 | 37 | 36 | 46 | 56 |
| Antenna Full Beamwidth (deg) | 3.5 | 2 | 2.4 | 0.9 | 0.22 |
| TX Power (W) | 2.8 | 2.8 | 2.8 | 10 | 40 |
| TX ERP (kW) | 3.4 | 8.6 | 6.8 | 242.7 | 9706 |
| TX EIRP (dBW) | 37.5 | 41.5 | 40.5 | 56 | 72 |
| Receive | | | | | |
| Antenna Gain (dBi) | 33 | 37 | 36 | 44 | 52 |
| Antenna Full Beamwidth (deg) | 3.5 | 2 | 2.4 | 1.1 | 0.3 |
| RX Figure of Merit (dB/K) | 8.4 | 12.4 | 11.4 | 19.4 | 31 |

Table 3. Broadband Ground Antenna Parameters



**Data Requirements for Operational Earth Station Certification
(SpaceX Stations)**

Antenna Characteristics

| <i>Item</i> | <i>Model "SpaceX Telem Ku/Ka"</i> | <i>Model "SpaceX Telem X"</i> | <i>Model "ES-A"</i> | <i>Model "ES-B"</i> | <i>Model "ES-C"</i> | <i>Model "ES-D"</i> | <i>Model "ES-E"</i> |
|---|--|--|--|--|--|--|---|
| The antenna nomenclature/name model number and manufacturer | CGC Technology T450 | Orbital Systems 3.7 Meter | SpaceX | SpaceX | SpaceX | SpaceX | CGC Technology T450 |
| The antenna type (e.g. parabolic reflector, horn, slot, cassegrain parabolic, etc) | Cassegrain parabolic | Prime focus parabolic | Phased Array | Phased Array | TBD | Parabolic | Cassegrain parabolic |
| The range of frequencies for which it is designed | All operating frequencies per frequency plan | 2.0 – 2.1 GHz Uplink 7.2 – 8.4 GHz Downlink | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan |
| The polarization | RHCP/LHCP | RHCP/LHCP | RHCP | RHCP | RHCP | RHCP | RHCP/LHCP |
| The maximum gain and 3 dB beamwidth | Uplink (Ku): 56 dBi 0.22 deg Downlink (Ku): 52 dBi 0.3 deg Downlink (Ka): 57 dBi 0.2 deg | Uplink: 38.9 dBi, 1.7 deg Downlink: 46.8 dBi, 0.8 deg | 33 dBi @ 3.5 deg full beam | 37 dBi @ 2 deg full beam | 36 dBi at 2.4 deg full beam | 46 dBi at 0.9 deg full beam | Uplink: 56 dBi 0.22 deg Downlink: 52 dBi 0.3 deg |
| The maximum gain of the first side lobe and the angular displacement from the main beam | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| The front to back gain ratio of the antenna | TBD | TBD | TBD | TBD | TBD | TBD | TBD |
| The diameter of the antenna if a parabolic reflector is being used | 5m | 3.7m | N/A | N/A | 1.2m | 1.6m | 5m |



| | | | | | | | |
|--|--------------------------|--------------------------|--------------|--------------|--------------|--------------|--------------------------|
| The range of azimuth angles the antenna is capable of scanning horizontally | 360 deg | 360 deg | 360 deg | 360 deg | 360 deg | 360 deg | 360 deg |
| The range of elevation angles the antenna is capable of scanning vertically | 0 to 90 deg | 0 – 90 deg | 40 to 90 deg | 40 to 90 deg | 40 to 90 deg | 40 to 90 deg | 40 to 90 deg |
| The scanning method employed by the antenna (e.g. raster, spiral, tracking, etc) | None - through telemetry | None - through telemetry | N/A | N/A | N/A | N/A | None - through telemetry |

Transmission

| <i>Item</i> | <i>Model "SpaceX Command"</i> | <i>Model "ES-A"</i> | <i>Model "ES-B"</i> | <i>Model "ES-C"</i> | <i>Model "ES-D"</i> | <i>Model "ES-E"</i> |
|---|--|---|---|---|---|--|
| The transmitter nomenclature/name model number and manufacturer | USRP X310 | TBD (SpaceX) | TBD (SpaceX) | TBD (SpaceX) | TBD (SpaceX) | TBD (SpaceX) |
| The frequency stability | +/- 2e-8; optional external 10 MHz and GPS input | 10ppm | 10ppm | 10ppm | 10ppm | 10ppm |
| The spurious emission level | -60 dBc | -60dBc over the tunable range of the transmitter | -60dBc over the tunable range of the transmitter | -60dBc over the tunable range of the transmitter | -60dBc over the tunable range of the transmitter | -60dBc over the tunable range of the transmitter |
| The harmonic emission levels (2 nd , 3 rd , and others) | -25 dBc | -60dB suppression | -60dB suppression | -60dB suppression | -60dB suppression | -60dB suppression |
| The transmitter power delivered to the antenna terminals | 46 dBm | 2.8 W / 15.625MHz 2.8 W / 31.25MHz 2.8/ 62.5MHz | 2.8 W / 15.625MHz 2.8 W / 31.25MHz 2.8W / 62.5MHz | 2.8 W / 15.625MHz 2.8W / 31.25MHz 2.8 W / 62.5MHz | 10 W / 15.625MHz 10 W / 31.25MHz 10 W / 62.5MHz | 46 dBm |



| | | | | | | |
|--|--|--|--|--|--|--|
| | | 2.8 W / 125 MHz | 2.8 W / 125 MHz | 2.8 W / 125 MHz | 10 W / 125 MHz | |
| | | 5.6 W / 250MHz | 5.6 W / 250MHz | 5.6 W / 250MHz | 20 W / 250MHz | |
| The frequency range through which the transmitter is capable of being tuned | 5.85 – 14.5 GHz | 13.0-13.25 GHz and 14.0-14.5 GHz continuously adjustable via synthesizer | 13.0-13.25 GHz and 14.0-14.5 GHz continuously adjustable via synthesizer | 13.0-13.25 GHz and 14.0-14.5 GHz continuously adjustable via synthesizer | 13.0-13.25 GHz and 14.0-14.5 GHz continuously adjustable via synthesizer | 13.0-13.25 GHz and 14.0-14.5 GHz continuously adjustable via synthesizer |
| The emission designators for the types of emission capable of being used by the transmitter | 41M4D7W 13M5D7W 2M7D7W | 240M8D7W 120M8D7W 62M5D7W 31M3D7W 15M6D7W | 240M8D7W 120M8D7W 62M5D7W 31M3D7W 15M6D7W | 240M8D7W 120M8D7W 62M5D7W 31M3D7W 15M6D7W | 240M8D7W 120M8D7W 62M5D7W 31M3D7W 15M6D7W | 240M8D7W 120M8D7W 62M5D7W 31M3D7W 15M6D7W |
| The modulation format and data rate for each emission capable of being used by the transmitter, including detailed information concerning the deviation ratio, max modulation frequency, and digital pulse format as appropriate | Uplink: BPSK 1 – 15.36 Mbps Downlink: SS-OQPSK 0.050 – 15.36 Mbps | BPSK to 64QAM | BPSK to 64QAM | BPSK to 64QAM | BPSK to 64QAM | BPSK to 64QAM |
| | | | | | | |
| | | 240 120 60 30 15 Msym/sec | 240 120 60 30 15 Msym/sec | 240 120 60 30 15 Msym/sec | 240 120 60 30 15 Msym/sec | 240 120 60 30 15 Msym/sec |
| | | 240 MHz 120 MHz 60 MHz 30 MHz 15 MHz necessary bandwidth | 240 MHz 120 MHz 60 MHz 30 MHz 15 MHz necessary bandwidth | 240 MHz 120 MHz 60 MHz 30 MHz 15 MHz necessary bandwidth | 240 MHz 120 MHz 60 MHz 30 MHz 15 MHz necessary bandwidth | 240 MHz 120 MHz 60 MHz 30 MHz 15 MHz necessary bandwidth |
| For each emission designator the emission bandwidth at the -3, -20, -40, -60 dB levels for each emission capable of being used by the transmitter | <= 2.6 MHz | TBD | TBD | TBD | TBD | TBD |



Reception

| <i>Item</i> | <i>Model "SpaceX Telem"</i> | <i>Model "ES-A"</i> | <i>Model "ES-B"</i> | <i>Model "ES-C"</i> | <i>Model "ES-D"</i> | <i>Model "ES-E"</i> |
|---|--|--|--|--|--|--|
| The receiver nomenclature/name model number and manufacturer | USRP X310 | SpaceX Broadband Modem | SpaceX Broadband Modem | SpaceX Broadband Modem | SpaceX Broadband Modem | SpaceX Broadband Modem |
| The frequency stability | +/- 2e-8; optional external 10 MHz and GPS input | 10ppm | 10ppm | 10ppm | 10ppm | 10ppm |
| The spurious rejection level | 60dB | 60dB | 60dB | 60dB | 60dB | 60dB |
| The image rejection level | 80 dB | TBD | TBD | TBD | TBD | TBD |
| The adjacent channel selectivity | Set by digital filter which is adjusted to accommodate bitrate and modulation type | TBD | TBD | TBD | TBD | TBD |
| Indicate whether the local oscillator is tuned above, below, or either above or below the associated mixer input signal | LO tuned below | TBD | TBD | TBD | TBD | TBD |
| The method of tuning (e.g. PLL Synthesizer, Voltage Controlled Oscillator, etc) | PLL synthesizer, derived from 10 MHz internal/external reference | PLL Synthesizer | PLL Synthesizer | PLL Synthesizer | PLL Synthesizer | PLL Synthesizer |
| The frequency range through which the receiver is capable of being tuned | 10.7 – 12.75 GHz | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan | All operating frequencies per frequency plan |
| The emission designators identifying the types of emission for which this receiver is designed | 41M4D7W | 240M8D1W | 240M8D1W | 240M8D1W | 240M8D1W | 240M8D1W |



| | | | | | | |
|---|---|-----|-----|-----|-----|-----|
| For each frequency band the RF selectivity bandwidths at the -3, -20, -60 dB levels | Set by external filter selected during build. | TBD | TBD | TBD | TBD | TBD |
| For each emission designator the IF selectivity bandwidths at the -3, -20, -60 dB levels for the narrowest IF amplifier | This is a direct conversion receiver, with a 0Hz IF and a complex baseband filter. (estimated) -3 dBc = 40 MHz - 20 dBc = 46 MHz - 60 dBc = 52 MHz | TBD | TBD | TBD | TBD | TBD |