

APPLICATION FOR BLANKET LICENSED EARTH STATIONS IN MOTION

I. OVERVIEW

In this application, SpaceX Services, Inc. (“SpaceX Services”) seeks authorization to deploy a new generation of end-user earth-station equipment for deployment as Vehicle-Mounted Earth Stations (“VMESs”), Earth Stations on Vessels (“ESVs”), and Earth Stations Aboard Aircraft (“ESAAs”) (collectively, “Earth Stations in Motion” or “ESIMs”) with the ability to communicate with both the SpaceX Gen1 and Gen2 systems.¹ SpaceX Services seeks authority to deploy and operate these earth stations (1) as VMESs throughout the United States and its territories, (2) as ESVs in the territorial waters of the United States and throughout international waters worldwide, and (3) as ESAAs on U.S.-registered aircraft operating worldwide and non-U.S.-registered aircraft operating in U.S. airspace. Consistent with SpaceX’s space-station authorization, these ESIMs will transmit in the 14.0-14.5 GHz band and receive in the 10.7-12.7 GHz band.

The Commission has authorized SpaceX Services’ sister company, Space Exploration Holdings, LLC (“SpaceX”), to launch and operate two constellations of NGSO satellites—SpaceX’s “Gen1”² and “Gen2”³ systems. In doing so, the Commission recognized that the SpaceX NGSO systems “will bring next generation satellite broadband to Americans nationwide, including those living and working in areas traditionally unserved or underserved by terrestrial systems.”⁴ SpaceX has launched more than 3,800 satellites into its Gen1 and Gen2 constellations.

¹ See 47 C.F.R. § 25.103 (defining VMES, ESV, ESAA, and ESIM).

² See *Space Exploration Holdings, LLC*, 36 FCC Rcd. 7995 (2021) (“*Gen1 Order*”).

³ *Space Exploration Holdings, LLC*, Order and Authorization, FCC 22-91 (rel. Dec. 1, 2022) (“*Gen2 Order*”).

⁴ *Id.* ¶ 1.

The Commission has granted SpaceX Services several blanket licenses to operate end-user earth stations that communicate with SpaceX’s Gen1 NGSO constellation, and SpaceX has received temporary authority permitting these terminals to communicate with SpaceX’s Gen2 constellation.⁵ These include authorizations for SpaceX’s next-generation and high-performance (“HP”) ESIM user terminals.⁶

Since securing those authorizations, SpaceX has continued to develop and refine its user terminal models to provide continually improved and cost-effective broadband service to consumers and businesses in the United States and around the world. Like its predecessors, these new units employ advanced phased-array beam-forming and digital processing technologies to make very efficient use of Ku-band spectrum resources, supporting highly directive antenna beams that point and track the systems’ low-Earth orbit satellites.

The Commission has already found that granting SpaceX authority to operate ESIM user terminals serves the public interest.⁷ Moreover, the Commission has found it in the public interest to authorize SpaceX to operate ESIMs across its entire requested Ku-band range, including in parts of the Ku-band downlink for which SpaceX has received authority to deploy fixed end-user terminals.⁸ Below, SpaceX Services discusses the enhanced service that these new ESIMs will provide, as well as certain spectrum sharing issues relevant to their operation. Each of the considerations that previously led the Commission to authorize SpaceX Services’ ESIM operations

⁵ See Radio Station Authorization, Call Sign E210127 (issued Nov. 10, 2021); Radio Station Authorization, Call Sign E190066 (issued Mar. 13, 2020); Radio Station Authorization, Call Sign E220009 (issued May 16, 2022). SpaceX has sought authority to add its Gen2 system as a point of communication for its existing user terminal licenses, and the Commission has granted special temporary authority for its user terminals to communicate with both its Gen1 and Gen2 systems while those underlying modifications pend.

⁶ *SpaceX Services, Inc.*, Order and Authorization, DA 22-695 (IB, rel. Jun. 30, 2022) (“*SpaceX First ESIM Authorization*”).

⁷ *Id.*

⁸ *Id.*

in these bands apply equally here. In fact, this new generation of ESIMs will provide even more benefits that only strengthen the public interest in granting SpaceX's request. Lastly, SpaceX Services provides technical information to supplement the information provided in Schedule B to Form 312 filed with this narrative application.⁹ To support its ambitious timetable for offering ever more diverse and innovative satellite broadband services to consumers throughout the United States and around the world, SpaceX Services requests that the Commission grant the requested blanket license as expeditiously as possible.

II. THESE ESIMs WILL EXPAND SPACEX'S INNOVATIVE BROADBAND SATELLITE SERVICE TO USERS IN MOVING VEHICLES, VESSELS AND AIRCRAFT

SpaceX Services' ESIMs will communicate with those SpaceX satellites that are visible on the horizon above the minimum elevation angle specified in the applicable space station authorization. The proposed phased array ESIM will track SpaceX's NGSO satellites passing within its field of view. These ESIMs will be electrically identical to SpaceX Services' new generation of fixed user terminals from a radiofrequency perspective,¹⁰ though they will have some additional features appropriate for a mobile operating environment (e.g., sensors to improve performance in motion and mountings that provide secure installation on trucks/RVs, boats, and aircraft).

As part of this application, SpaceX aims to introduce two versions of its new ESIM.

Version 1: Version 1 of SpaceX Services' new ESIM terminals will offer a high-performance solution for consumers that improves upon SpaceX Services' previously authorized

⁹ To the extent relevant, SpaceX Services hereby incorporates the technical information submitted with SpaceX's space station applications. See IBFS File Nos. SAT-LOA-20200526-00055, SAT-AMD-20210818-00105, SAT-LOA-20161115-00118, SAT-LOA-20170726-00110, SAT-MOD-20181108-00083, and SAT-MOD-20200417-00037.

¹⁰ SpaceX Services is filing an application seeking blanket authority for these new fixed user terminals concurrently with this application.

ESIMs. At the phased array’s equivalent of an “antenna flange”, the highest transmit power is 3.69 W while the highest EIRP for all carriers is 42.1 dBW. The antenna gain is highest at boresight (35.0 dBi and 36.4 dBi for the receive and transmit antennas, respectively) and lowest at maximum slant (32.6 dBi and 34.0 dBi for the receive and transmit antennas, respectively).¹¹

Table 1 summarizes the technical specifications of the Version 1 ESIMs.

Link Type	Frequency	Modulation	Emission Designator	Max EIRP
Broadband Downlink (Space-to-Earth)	10.7-12.7 GHz	Up to 64 QAM	240MD7W	--
Broadband Uplink (Earth-to-space)	14.0-14.5 GHz	Up to 64 QAM	62M5D7W	42.1 dBW

Table 1. ESIM Specifications (Version 1)

Version 2: Version 2 of SpaceX Services’ new ESIM will leverage a smaller form factor than Version 1 to allow consumers to enjoy the benefits of high-speed, low-latency broadband wherever they live or work, including in rural and remote areas where applications in motion are necessary. For Version 2, at the phased array’s equivalent of an “antenna flange”, the highest transmit power is 1.37 W while the highest EIRP for all carriers is 33.2 dBW. The antenna gain is highest at boresight (30.4 dBi and 31.8 dBi for the receive and transmit antennas, respectively) and lowest at maximum slant (28.0 dBi and 29.4 dBi for the receive and transmit antennas, respectively).

Table 2 summarizes the technical specifications of the Version 2 ESIMs.¹²

¹¹ For purposes of Form 312 accompanying this application, SpaceX Services has supplied the highest transmit power and EIRP figures to present worst-case conditions for both user-terminal versions.

¹² The Commission's rules do not require applicants to submit a maximum number of user terminals to be deployed in the Ku band because, as the Commission concluded, the number of terminals “will not significantly affect any necessary coordination.” *Comprehensive Review of Licensing and Operating Rules for Satellite Services*, 30 FCC Rcd. 14713, ¶ 291 (2015). However, Form 312 Schedule B requires a number of antennas to be entered. To

Link Type	Frequency	Modulation	Emission Designator	Max EIRP
Broadband Downlink (Space-to-Earth)	10.7-12.7 GHz	Up to 64 QAM	240MD7W	--
Broadband Uplink (Earth-to-space)	14.0-14.5 GHz	Up to 64 QAM	62M5D7W	33.2 dBW

Table 2. ESIM Specifications (Version 2)

The EIRP masks for these ESIMs, for co-polarized and cross-polarized signals, are set forth in Exhibit A hereto. In addition, SpaceX Services has submitted with this application a radiation hazard analysis to demonstrate that these earth stations are compliant with and will not result in exposure levels exceeding the applicable radiation hazard limits established by the Commission.¹³

III. SPECTRUM SHARING ISSUES

From a spectrum-sharing perspective, SpaceX Services' latest-generation ESIMs are no different from SpaceX Services ESIMs that the Commission has already authorized. The Commission has allocated the Ku-band spectrum that SpaceX Services proposes to use for uplink communications (14.0-14.5 GHz) from these blanket-licensed earth stations on a primary basis only to the fixed-satellite service ("FSS"). Nonetheless, SpaceX Services recognizes that its earth station operations will be subject to certain sharing conditions.¹⁴ With respect to the requirements in Section 25.228(j), SpaceX Services will coordinate the operations of its ESIMs in the 14.0-14.2

satisfy this technical form-validation requirement, SpaceX Services has entered a value of "0" on the accompanying Form 312 Schedule B. However, this is strictly to satisfy the form-validation requirements and is not intended to establish a maximum number of units that SpaceX Services may deploy.

¹³ The methodology used in the attached analysis, which is consistent with that required under draft FCC guidance, does not take into account important features of the electronically steerable phased-array antennas used in SpaceX's user terminals, which significantly reduce the power density received at any given location. As a result, the attached radiation-hazard analysis, and the duty-cycle limit that it includes, is excessively conservative for these devices.

¹⁴ See, e.g., 47 C.F.R. §§ 25.115(f)(2), 25.208(o), 101.1409, 2.106 nn.5.487A & US342. In addition, pursuant to Section 25.115(i), SpaceX Services hereby certifies that it is planning to use a contention protocol (TDMA/FDMA), and such protocol usage will be reasonable.

GHz band within 125 km of NASA TDRSS facilities at three specified locations (for ESVs and VMESs) or within radio line of sight (for ESAAs); until such coordination has been completed, these ESIMs will not exceed an EIRP spectral density towards the horizon of 12.5 dBW/MHz and will not exceed an EIRP towards the horizon of 16.3 dBW when operating within that 125 km zone (for ESVs and VMESs) or within radio line of sight (for ESAAs).¹⁵ In addition, SpaceX Services will not operate these earth stations in the 14.47-14.5 GHz band in the vicinity of radio astronomy observatories at sixteen locations, without first completing coordination.¹⁶ SpaceX Services will use Global Positioning Satellite-related or other similar geolocation location technology to ensure compliance with this commitment.¹⁷

Prior to operating its ESAAs on U.S.-registered aircraft within a foreign nation's airspace, SpaceX Services will ascertain whether the relevant administration has operations that could be affected by ESAA terminals and determine whether that administration has adopted specific requirements concerning ESAA operations. When the ESAA-equipped aircraft enters foreign airspace, the ESAA terminal will operate under the Commission's rules, or those of the foreign administration, whichever is more constraining.¹⁸ To the extent that all relevant administrations have identified geographic areas from which ESAA operations would not affect their radio operations, SpaceX Services will operate within those identified areas without further action. To the extent that the foreign administration has not adopted requirements regarding ESAA operations, SpaceX Services will coordinate its operations with any potentially affected operations.

¹⁵ See 47 C.F.R. §§ 25.228(j)(1), (2).

¹⁶ See *id.* § 25.228(j)(3).

¹⁷ See *id.* § 25.228(j)(5).

¹⁸ See *id.* § 25.228(g)(3).

SpaceX Services ESAA transmissions in the 14.0-14.5 GHz band from international airspace within line-of-sight of the territory of a foreign administration, where fixed service networks have primary allocation in this band, will be limited to a maximum power flux density (“PFD”) produced at the surface of the Earth by emissions from a single aircraft to not exceed the values provided in Section 25.228(i) of the Commission’s rules, unless the foreign administration has imposed other conditions for protecting its fixed service stations.

Certain portions of the 10.7-12.7 GHz downlink band are shared with other commercial and government services. Notably, the proposed SpaceX Services ESIMs would not transmit in those bands and thus could not cause any interference to other operators using those bands. Moreover, SpaceX has engineered the design of its NGSO systems to achieve a high degree of flexibility to facilitate spectrum sharing with other currently authorized satellite and terrestrial systems. In addition, its systems are capable of immediately ceasing operations in the unlikely event it is notified that harmful interference has occurred. SpaceX Services understands that its operations in the 10.7-11.7 GHz band would be authorized on an unprotected basis with respect to current and future systems operating in the fixed service.¹⁹ In addition, as the Commission found to be in the public interest in its previous authorization of SpaceX Services ESIMs, SpaceX Services seeks authorization for its ESIMs to receive in the 12.2-12.7 GHz band pursuant to Section 25.202(b) of the Commission’s rules.²⁰

SpaceX is aware of its obligations under its authorization to protect terrestrial and space systems in these shared bands, and has certified that it will comply with the applicable equivalent power flux density (“EPFD”) limits set forth in Article 22 and Resolution 76 of the ITU Radio

¹⁹ See *id.* § 25.115(f)(2).

²⁰ *SpaceX First ESIM Authorization* ¶10.

Regulations.²¹ SpaceX has also demonstrated that it will comply with the applicable PFD limits in the Ku-band set forth in the Commission’s rules and Article 21 of the ITU Radio Regulations.²² The Commission has found that compliance with these EPFD and PFD limits is sufficient to protect GSO systems and terrestrial systems, respectively, against unacceptable interference.²³

As required under the Commission’s rules, each ESIM will be self-monitoring and, should a condition occur that would cause the ESIM to exceed any emission limits included in the conditions of its license, the ESIM will automatically cease transmissions within 100 milliseconds and not resume transmissions until the condition that caused the ESIM to exceed those limits is corrected.²⁴ In addition, each ESIM will be monitored and controlled by a network control and monitoring center (“NCMC”) or equivalent facility located in the United States.²⁵ Each ESIM will be designed to comply with a “disable transmission” command from the NCMC within 100 milliseconds of receiving the command. In addition, the NCMC will monitor the operation of each ESIM in its network and transmit a “disable transmission” command to any ESIM that operates in such a way as to exceed any emission limits included in the conditions of its license. The NCMC

²¹ See Application for Modification of Authorization for the SpaceX NGSO Satellite System, IBFS File No. SAT-MOD-20200417-00037, Technical Attachment at 15 (Apr. 17, 2020) (“Gen1 Application”); Amendment, IBFS File No. SAT-AMD-20210818-00105 (Aug. 18, 2021) (“Gen2 Application”); 47 C.F.R. § 25.115(f)(1) (incorporating certification requirement in 47 C.F.R. § 25.146(a)(2)).

²² See Gen1 Application, Technical Attachment at 10-12; Gen2 Application, Technical Attachment at 10-12, 14.

²³ See, e.g., *Updates to Parts 2 and 25 Concerning Non-Geostationary, Fixed-Satellite Service Systems and Related Matters*, 32 FCC Rcd. 7809, ¶ 32 (2017) (“Any NGSO FSS system operating in compliance with these [EPFD] limits is considered as having fulfilled its obligation under Article 22 of the ITU Radio Regulations not to cause unacceptable interference to any GSO network.”) (citation omitted); 47 C.F.R. § 25.289 (same); *Amendment of Parts 2 and 25 of the Commission’s Rules to Permit Operation of NGSO FSS Systems Co-Frequency with GSO and Terrestrial Systems in the Ku-Band Frequency Range*, 16 FCC Rcd. 4096, ¶ 42 (2000) (observing PFD limits should protect terrestrial systems in the band).

²⁴ See 47 C.F.R. § 25.228(b).

²⁵ See *id.* §§ 25.228(e)(2), (f). In addition, to the extent SpaceX Services uses the NCMC to communicate with ESVs on vessels of foreign registry, it will maintain detailed information on each such vessel’s country of registry and a point of contact for the relevant administration responsible for licensing those ESVs. *Id.* § 25.228(e)(3).

will not allow the ESIM(s) under its control to resume transmissions until the condition that caused the ESIM(s) to exceed the authorized emission limits is corrected.²⁶

The highly advanced and flexible capabilities of its NGSO systems, including those of the new ESIM models proposed in this application, will allow SpaceX Services to comply with the limitations discussed above. Nonetheless, in the extremely unlikely event that harmful interference should occur due to transmissions to or from its ESIMs, SpaceX Services can be reached at its Starlink network operations center via phone at (360) 780-3103 or email at satellite-operators-pager@spacex.com, which links to the pagers of appropriate technical personnel with authority and ability to cease all transmissions from these ESIMs on a 24/7 basis.

IV. AUTHORIZING OPERATIONS IN THE 12 GHZ BAND WOULD PROVIDE REQUIRED OPERATIONAL FLEXIBILITY WITHOUT AFFECTING OTHER AUTHORIZED USERS OF THE BAND

As discussed above, although the Commission's rules provide for blanket licensing of NGSO earth stations operating in the 12.2-12.7 GHz band (the "12 GHz band"), this spectrum is not specifically listed among the bands available for ESIM operations. However, the Commission has explained that "inclusion of a list of frequencies for ESIMs communicating with NGSO FSS space stations in paragraph (a) of section 25.202 does not limit [its] ability to authorize these operations in other frequency bands."²⁷ The Commission may authorize operations in additional frequency bands on a case-by-case basis without the need for a waiver, so long as such operations would be consistent with the U.S. Table of Allocations.²⁸ The Commission has already granted SpaceX authority to operate its existing ESIMs in the 12.2-12.7 GHz band pursuant to Section 25.202(b). Here, as in that previous authorization, the public interest strongly supports

²⁶ See *id.* §§ 25.228(c), (e)(1).

²⁷ *SpaceX First ESIM Authorization* ¶10.

²⁸ *Id.*

authorization of the 12.2-12.7 GHz band for ESIM downlink. Like the previous SpaceX ESIM generation, the ESIMs described in this application would not transmit in the 12.2-12.7 GHz band and space-to-earth transmissions would take place on a non-protected basis. In addition, because SpaceX will operate its satellites in compliance with the EPFD and PFD limits that the Commission has found sufficient to protect GSO and terrestrial systems, these downlinks present no risk of interference to other authorized spectrum users.

V. GRANT OF THIS APPLICATION WOULD SERVE THE PUBLIC INTEREST AND PROVIDE SERVICE TO VEHICLES, VESSELS, AND AIRCRAFT OPERATING IN AREAS OTHERWISE UNSERVED OR UNDERSERVED BY HIGH-THROUGHPUT, LOW-LATENCY BROADBAND

Since 2019, SpaceX has deployed more than 3,800 satellites, sufficient to support introduction of its high-capacity, low-latency broadband services across the United States—including the most remote corners and polar regions of the country that too often get left behind. The demand for more broadband is surging and the need for connectivity has never been more important. Granting this application would serve the public interest by authorizing a new class of ground-based components for SpaceX’s satellite system that will expand the range of broadband capabilities available to moving vehicles throughout the United States and to moving vessels and aircraft worldwide. U.S. and worldwide demand for broadband services and Internet connectivity continues to increase with escalating requirements for speed, capacity, and reliability and ongoing adaptations for usage. Users now require high-speed, low-latency connectivity while on the move, whether driving an RV across the country, moving a freighter from Europe to a U.S. port, or while on a domestic or international flight. Unfortunately, in many cases, these users lack any true high-throughput, low-latency options. To close this gap, SpaceX is deploying two innovative, cost-effective, and spectrum-efficient satellite systems capable of delivering robust broadband service to customers around the world. SpaceX has already secured U.S. authority for the space station components of its first- and second-generation NGSO systems. This application takes the next

step by seeking authority for a new generation of ESIM user-terminal hardware to enhance service on moving vehicles, vessels, and aircraft. Accordingly, an expeditious grant of this application would serve the public interest.

Respectfully submitted,

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Exhibit A

