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APPLICATION FOR BLANKET LICENSE AUTHORIZING THE OPERATION OF EARTH STATIONS ON VESSELS

I. OVERVIEW

Kepler Communications Inc. ("Kepler") is developing next-generation satellite communication technologies with the vision of providing global data connectivity using a wide array of satellite services. In November 2018, the Commission granted a space station authorization for Kepler's non-geostationary orbit ("NGSO") satellite network to deliver Ku-band Fixed Satellite Service ("FSS") to the U.S.[1] Kepler was also granted a Ku-band earth station blanket license in August 2020, authorizing communications with fixed terminals situated throughout the United States.[2] Kepler has proceeded in the deployment of its 140-satellite constellation, with 15 satellites currently launched and operating. To optimize the use of this continued capacity growth, Kepler is building upon its current operations and extending its service to a broader array of end users in the United States. Kepler hereby seeks an earth station blanket license authorizing the operation of Earth Stations in Motion ("ESIMs"), specifically Ku-band Earth Stations on Vessels ("ESVs") in the territorial waters of the United States.[3] Kepler has refined its ability to communicate with vessels in motion by conducting two proof-of-concept demonstrations in U.S. waters, operations which were authorized by the Commission with

[1] *See* Kepler Communications Inc., Petition for Declaratory Ruling to Grant Access to the U.S. Market for Kepler's NGSO FSS System, Order and Declaratory Ruling, FCC 18-162 (Nov. 19, 2018) ("Kepler Grant" or "Market Access Grant").

[2] *See* Kepler Communications Inc., Radio Station Authorization, IBFS File No. SES-LIC-20190627-00861 (granted Aug. 17, 2020) ("Fixed Blanket License").

[3] As defined in 47 C.F.R. § 25.103.

Experimental Special Temporary Authorizations.[4] Having brought its network to sufficient maturity, Kepler is now able to provide this service commercially to support mobile vessels throughout the entire duration of their mission. In support of this crucial expansion of Kepler's services in the U.S., Kepler requests that the Commission expeditiously grant the requested license. Such an authorization would not materially impact the interference environment, yet would greatly serve public interest.

II. ESV TERMINALS

Consistent with its Market Access Grant, Kepler seeks to provide FSS in the 14.0-14.5 GHz (Earth-to-space) and 10.7-12.7 GHz (space-to-Earth) bands for various terminals aboard vessels.[5] As granted in its Fixed Blanket License, Kepler seeks to authorize both the Permitted Space Station List and Kepler's satellites as points of communication with the mobile terminals. Several of the user terminals authorized under Kepler's Fixed Blanket License are also suited to maritime operations; for the purposes of the current application, Kepler seeks authority to operate the following terminals which were included in the Fixed Blanket License:[6]

- Intellian v65
- Intellian v85NX

[4] *See* Kepler Communications Inc., Experimental Special Temporary Authorization, OET File No. 0438-EX-ST-2021 (Apr. 16, 2021); Kepler Communications Inc., Experimental Special Temporary Authorization, OET File No. 0721-EX-ST-2021 (May 24, 2021).

[5] Kepler certifies that it will comply with the applicable terms and conditions of its Market Access Grant. To the extent relevant, Kepler hereby incorporates the technical information related to its space station authorization.

[6] *See* Fixed Blanket License p. 2-3.

- Intellian v240MT
- Cobham Sailor 900

In addition to those listed above, Kepler also seeks authority to operate the following terminals aboard vessels:

- Cobham Sailor 600
- Cobham Sailor XTR
- Cobham Sea Tel 3011
- Cobham Sea Tel 9711
- Kymeta u7
- Kymeta u8

As a supplement to the information supplied in Schedule B and Form 312 of this application, technical details pertaining to all the requested terminals are provided in the appended Technical Annex. Kepler seeks permission to operate these terminals aboard vessels situated throughout the territorial waters of the United States, as well as aboard U.S.-registered vessels in international waters.

III. SPECTRUM SHARING

Kepler intends to operate ESIMs in the same bands authorized in its Market Access Grant: 10.7-12.7 GHz downlink and 14.0-14.5 uplink. The Commission explicitly contemplates blanket licensing for ESIMs that operate in these frequency bands.[7] These bands are allocated to FSS on a

[7] 47 C.F.R 25.115 (f)(2); Kepler duly notes that blanket licenses emitted in the 10.7-11.7 GHz band is on an unprotected basis with respect to current and future systems operating in the fixed service.

primary basis, with other services sharing co-primary status in certain subsets of the downlink band. Kepler recognizes its obligations to adhere to sharing rules set out by the Commission within these bands, as well as those stipulated in Kepler's previous authorizations.[8]

Kepler certifies that its transmissions will conform to the applicable power flux density ("PFD") and equivalent power flux density ("EPFD") levels specified by Article 21, Article 22, and Resolution 76 of the ITU Radio Regulations.[9] The Commission has determined that an NGSO system operating under these respective limits will sufficiently protect terrestrial and geostationary orbit ("GSO") systems against harmful interference.[10]

Per the Commission's rules, Kepler will coordinate operation of its ESIMs in the 14.0-14.2 GHz band within 125 km of the specified NASA TDRSS facilities.[11] Operations in the 14.0-14.2 GHz band within 125 km of the specified locations shall not exceed an EIRP spectral density towards the horizon of 12 dBW/Mz, and shall not exceed an EIRP towards the horizon of 16.3 dBW.[12] Furthermore, Kepler will carry out any necessary coordination with the National Science Foundation ("NSF") in the 14.47-14.5 GHz band for ESVs operating in the vicinity of radio

[8] See Market Access Grant; Fixed Blanket License.

[9] In accordance with 47 C.F.R. § 25.146 (a)(2).

[10] *See* 47 C.F.R. § 25.289; *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, paras 42, 77 (2000).

[11] In accordance with 47 C.F.R. § 25.228 (j)(1).

[12] *Id.* § 25.228 (j)(2).

astronomy service stations.[13] In order to ensure compliance with the coordination requirements above, Kepler's ESIMs will utilize Global Positioning Satellite functionality, or other similar position location technology.[14] Spectrum sharing will be accommodated in accordance with the rules set forth in the appropriate FCC and ITU regulations.

IV. ESIM OPERATIONAL CONSIDERATIONS

All ESIMs will be self-monitoring. If circumstances arise in which the ESIMs exceed the emission limits specified in the conditions of Kepler's license, the ESIM will automatically cease transmissions within 100 milliseconds, resuming transmissions only when the circumstances causing the ESIM to exceed emission limits are rectified.[15] All ESIMs will also be controlled by a Network Control and Monitoring Center ("NCMC"), or an equivalent facility located in the United States, or will maintain a point of contact within the United States that "will have the capability and authority" to cause an ESV to stop transmitting if required.[16] All ESIMs will comply with a "disable transmission" command from the NCMC within 100 milliseconds of receiving the command.[17] If a situation arises in which an ESIM exceeds the emission limits included in the conditions of its license, the NCMC will transmit a disable transmission command, and will only

[13] *Id.* § 25.228 (j)(3).

[14] *Id.* § 25.228 (j)(5).

[15] In accordance with 47 C.F.R. § 25.228 (b).

[16] In accordance with 47 C.F.R. § 25.228 (c), (e)(2).

[17] *See* 47 C.F.R. § 25.228 (c).

allow the resumption of transmissions when the conditions that caused the ESIM to exceed emission limits are corrected. If an ESV on a U.S.-registered vessel operates under the control of an NCMC location outside of the United States, Kepler will ensure that the ESV operator maintains a point of contact within the United States that has both the authority and capability to cease ESV transmissions when necessary.[18] Kepler has established a rotating team on call with authority and ability to cease all emissions from Kepler's earth stations should any interference concerns arise. Kepler's satellite operations team is available 24 hours per day, seven days per week at: satops@kepler.space. The lead contact within Kepler's satellite operations team is Jake Urbanek who can be contacted at jurbanek@kepler.space or +1 (437) 637-0022.

V. RADIATION HAZARD CONSIDERATIONS

Kepler will ensure installation of ESIM terminals on vessels by qualified installers who have an understanding of the antenna's radiation environment, taking measures that are best suited to maximize protection of the general public and persons operating the vessel and equipment.[19] Kepler will further ensure that in any circumstances where ESIM terminals may exhibit radiation exposure levels exceeding 1.0 mW/cm in accessible areas, they will have a label attached to the surface of the terminal warning about the radiation hazard.[20] This label will include a diagram depicting the regions around the terminal where the radiation levels could exceed the maximum

[18] In accordance with 47 C.F.R. § 25.228 (c); see also 47 C.F.R. § 25.228 (e)(1).

[19] In accordance with 47 C.F.R. § 25.228 (d).

[20] In accordance with 47 C.F.R. § 25.228 (d).

radiation exposure limits.[21] Moreover, Kepler has attached to this application a radiation hazard analysis, which demonstrates that operation of these earth stations will be in compliance with the radiation exposure safety standards set forth by the Commission.

VI. PUBLIC INTEREST BENEFITS

The authorization of Kepler's blanket ESIM license would serve public interest by expanding the breadth of Kepler's services, supporting communications with a wider variety of earth station types. Critically, this authorization will allow Kepler to provide connectivity for remote assets in underserved maritime regions, thus further bridging the digital divide. Other operators currently providing satellite data services in high-latitude regions are often bandwidth restricted, rendering them incapable of meeting the data-heavy demands of customers operating in these regions. To help meet this demand, Kepler's Ku-band service provides a cost-effective option in a field that otherwise lacks any affordable means to offload large quantities of data from remote assets. Grant of the requested blanket license will promote competition and further innovation in the FSS market, resulting in higher quality services for the American public. As demonstrated by Kepler's existing operations with fixed terminals, Kepler's FSS service offers a uniquely effective option for operations throughout the U.S., particularly in the Arctic region and territorial waters around Alaska and Hawaii. A blanket authorization for the operation of ESVs therefore provides a necessary expansion of Kepler's existing low-cost, high-value services. Consequently, as

[21] *See* 47 C.F.R § 1.1310 Table 1.

Kepler's blanket license would greatly serve public interest, the Commission is requested to grant this authorization expeditiously.

Respectfully submitted,

/s/ Nickolas G. Spina

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TECHNICAL ANNEX

The information provided in this annex is intended to supplement that supplied in the associated Schedule B and Form 312 of this application.

I. TECHNICAL CHARACTERISTICS OF ESIM USER TERMINALS

In order to provide the greatest flexibility in terminal choice for its customers, Kepler's network has been designed to be compatible with several commercially available models of maritime Ku-band antennas. The antenna manufacturers of the terminals requested in this application are required by default to meet all applicable technical standards for related radiofrequency devices specified under Federal regulations. For the purposes of the current ESIM blanket license application, Kepler requests to incorporate certain terminals from Kepler's Fixed Blanket License, the technical parameters of which were provided in the Fixed Blanket License application. For convenience, the characteristics of those terminals are repeated in Table 1 below. Additionally, Kepler also seeks authority to operate the terminals listed in Table 2 aboard vessels.

Table 1 - Terminal Characteristics 1 (terminals authorized in the Fixed Blanket License)

Manufacturer	Model	Antenna Diameter [m]	Tx Peak Gain [dBi]	Rx Peak Gain [dBi]	Max Input Power [W][22]	Max EIRP [dBW]	Max EIRP Density [dBW/Hz][23]
Intellian	v65	0.65	37.7 @ *14.125 GHz*	36.3 @ *11.725 GHz*	8	46.7	-13.3
Intellian	v85NX	0.85	40.7 @ *14.25 GHz*	38.9 @ *11.7 GHz*	8	49.7	-10.3
Intellian	v240MT	2.40	47.4 @ *14.25 GHz*	46.5 @ *11.8 GHz*	125	68.4	8.4
Cobham	Sailor 900	1.03	41.6 @ *14.25 GHz*	40.6 @ *11.7 GHz*	8	50.6	-9.4

Table 2 – Terminal Characteristics 2 (additional terminals)

Manufacturer	Model	Antenna Diameter [m][24]	Tx Peak Gain [dBi]	Rx Peak Gain [dBi]	Max Input Power [W]	Max EIRP [dBW]	Max EIRP Density [dBW/Hz]
Cobham	Sailor 600	0.65	37.7 @ *14.0 GHz*	36.0 @ *11.7 GHz*	6	45.5	-14.5
Cobham	XTR	1.03	41.6 @ *14.25 GHz*	40.6 @ *11.7 GHz*	16	53.1	-6.9
Cobham	Sea Tel 3011	0.75	39.1 @ *14.25 GHz*	37.0 @ *11.85 GHz*	8	48.1	-11.9
Cobham	Sea Tel 9711	2.40	48.5 @ *14.25 GHz*	47.8 @ *11.85 GHz*	125	69.4	9.5
Kymeta	u7	0.82	33.5 @ *14.25 GHz*	32.5 @ *12.3 GHz*	16	44.5	-15.5
Kymeta	u8	0.90	34.6 @ *14.2 GHz*	35.5 @ *12.2 GHz*	20	45.5	-14.5

Frequency parameters common across all user terminal systems are provided in Table 3 below. Each user terminal modem will be equipped with a Kepler software-defined radio ("SDR"), granting the capability to take advantage of dynamic beam patterns, channel bandwidth, and output power (and thus, dynamic EIRP). Due to the technical flexibility of the SDR, rapid and efficient adjustment of center frequency and channel bandwidth is a trivial procedure.

Table 3 - Frequency Parameters Common Across User Terminals for ESIM Communications

	Tx	**Rx**
Frequencies	14.0 – 14.5 GHz	10.7 – 12.7 GHz
Emission Designators	1M00G7W – 400MG7W	1M00G7W – 400MG7W
Modulation	up to 32APSK 9/10 (DVB-S2)	up to 32APSK 9/10 (DVB-S2)
Polarization	LHCP	RHCP

Identical to that indicated for Kepler's Fixed Blanket License, all user terminal types will employ a 10° horizon elevation mask to protect terrestrial fixed services. When communicating to NGSO, terminals will apply a variable avoidance mask to GSO to ensure that $EPFD_{up}$ limits are met.[25]

[22] Excludes losses and/or back-off. In practice, Kepler operates its earth stations with at least 2 dB input power back off. Kepler will not operate its earth stations at an excessive power level in violation of the conditions of its licenses, national regulations, or applicable provisions of the ITU Radio Regulations.
[23] The Max EIRP Densities provided in Table 1 are worst case numbers provided for the maximum corresponding input power and a minimum channel bandwidth of 1 MHz.
[24] Note that the Kymeta u7 and u8 antennas are not circular; the dish width is provided here.
[25] Depending on both the EIRP of a given user terminal and the number of antennas transmitting from a single location, exclusion angles to the GSO arc will vary between 5° and 20°.

Antenna Performance Standards

§ 25.209 of the Commission's rules detail the requirements pertaining to antenna performance standards, but the existing items are applicable only to GSO networks and NGSO gateway stations – the Commission's rules do not enforce particular performance standards for *user terminals* communicating with NGSO networks.[26]

Although no standards apply to NGSO FSS user terminals, Kepler has also requested that the Permitted Space Station List be authorized as a point of communication for the requested stations. In accordance with FCC regulations regarding FSS terminals transmitting to GSO, Kepler hereby certifies that the requested antennas conform to the appropriate gain performance standards

[26] *See* 47 C.F.R. §25.132(a)(1) on the requirement to test FSS earth stations and ensure that the results "demonstrate that the equipment meets relevant off-axis gain standards in §25.209". Since no standards apply to from §25.209 to NGSO FSS user terminals, this section and the associated testing requirement is therefore generally inapplicable to NGSO user terminals. The Commission chose not to adopt such standards after undertaking its own investigations, concluding in 2000 that it "[did] not see the need at this time to specify an NGSO FSS customer premise earth station reference antenna pattern", and then deferring the issue to later proceedings. After further considerations the Commission chose to maintain this position. *See* 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, ¶ 240 (2000). *See also* Establishment of Policies and Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band, 16 FCC Rcd. 9680, ¶ 48 (2001) (On the relative ineffectiveness of limitations on NGSOs user terminals towards overall sharing, and the concern that limitations would also introduce unnecessary regulatory burdens to NGSO operators). *See also* Establishment of Policies and Rules for the Non-Geostationary Satellite Orbit, Fixed Satellite Service in the Ku-Band, 17 FCC Rcd. 7841, ¶ 60 (2002) (Decision not to adopt an antenna reference pattern for NGSO FSS user terminals). *See also* Comprehensive Review of Licensing and Operating Rules for Satellite Services, 30 FCC Rcd. 14713, ¶ 213 (2015) (The Commission reiterates that it "has not yet determined what off-axis gain envelopes might be appropriate for earth stations operating with NGSO FSS space stations, either to facilitate NGSO-to-NGSO or NGSO-to-GSO interference protection).

of § 25.209 and EIRP density standards of § 25.132 and therefore qualify for routine processing.[27] Further, input power density supplied to the antennas will not exceed the limit specified by § 25.212 when communicating with space stations in GSO. Therefore, in accordance with § 25.115(g)(2) Kepler has not included these test results with this application.

Communications to NGSO

Although no antenna performance standards specifically apply to NGSO FSS user terminals, it is possible to use the performance limit for NGSO FSS gateways given by § 25.209(h) to obtain a reasonable estimate for expected power densities measured at the horizon.

Table 4 - Antenna performance standards for NGSO FSS gateways.

Formula	Unit	Range
$29\text{-}25\log_{10}(\theta)$	dBi	for $1° \leq \theta \leq 36°$.
-10	dBi	for $36° \leq \theta \leq 180°$.

Since Kepler employs a minimum horizon elevation mask of 10°, the estimated gain at the horizon from a given antenna will be:

$$29 - 25\log_{10}(10) = 4\ dBi$$

[27] *See* 47 C.F.R. § 25.115(c)(1), § 25.115(g), and § 25.212(c)(2). To quality for routine processing, FSS earth stations transmitting to GSO in the conventional Ku-band must not exceed an input power of -14 dBW/4 kHz and must certify pursuant to § 25.132(a)(1) that the antenna meets the gain performance requirements of § 25.209(a) and (b).

Using the worst-case transmission configuration (a bandwidth of 1 MHz and a power of 125 W), the total received power at the horizon will be 24.97 dBW in this scenario, with a corresponding power density of -35.03 dBW/Hz.

Communications to GSO

When communicating to GSO, Kepler will use appropriate transmission characteristics on all antennas to ensure compliance with the input power density limitation of -14 dBW/4 kHz specified by 47 C.F.R. § 25.212(c)(2). As indicated previously and in the associated Schedule B, the minimum bandwidth employed will be 1.0 MHz, which limits the maximum permissible input power to approximately 9.95 W. Most of the requested antennas are already limited in this regard by the specifications of their block up-converter hardware.[28] However, in all cases, Kepler expects a typical transmission to GSO to use about 6 W input power and 1.5 MHz bandwidth – yielding a corresponding power density of -17.96 dBW/4 kHz. Kepler notes that regardless of the limitations under 47 C.F.R. § 25, this power density often can not be substantially increased beyond this point due to saturation flux density limitations of the GSO satellite receivers.

[28] Most of the antenna models use block up converters that can only supply a maximum of 8 W of power to the antenna input.