1. Please demonstrate that your proposed operations in the 14.0-14.5 GHz frequency band via Kepler's NGSO satellites will be in compliance with the equivalent power Flux-density limit (-160 dBW/m2/40 kHz) in Article 22.5D of the ITU Radio Regulations.

Because Viasat's operations with Kepler's NGSO network will only use a single antenna at any given time, the equivalent power flux density (EPFD) produced by the full system is just the power flux density (PFD) produced by a single antenna. As shown below, the PFD analysis for a single antenna more than adequately meets the $EPFD_{up}$ limits when operated with a 5-degree exclusion angle from the GSO arc. Indeed, the employment of such exclusion angles is a practice that Kepler maintains for all of its ground stations, as discussed further in its request for U.S. market access.[1]

2. Please provide the detail calculation, data/number/value and formula that you used to calculate the EPFD for 14.0-14.5 GHz frequency band, emissions (34M0G7D and 36M0G7D) and its associated powers (30kW (ERP) and 6MW (ERP)).

In summary,

Table 1: Summary of Viasat compliance with Article 22 $EPFD_{up}$ limits.

ID	EIRP	Designator	Spectral Flux Density	Unit
Article 22 EPFD	-	-	-160	$dBW/m^2/40kHz$
Viasat Config 1	30 kW	34M0G7D--	-173.81	$dBW/m^2/40kHz$
Viasat Config 2	6 MW	36M0G7D--	-163.09	$dBW/m^2/40kHz$

For calculations, see Tables 2 and 3 below.

[1] *See Kepler Communications Inc., Petition for a Declaratory Ruling*, IBFS File No. SAT-PDR-20161115-00114 (filed Nov. 15, 2016). Kepler has designed its system to operate with GSO exclusion angles as high as 20 degrees to comply with EPFD limits when servicing hundreds to thousands of user terminals. However, Kepler currently has two prototype satellites in orbit, neither of which have multi-access capability. Therefore, they can support no more two links at a time, one for each satellite. The stringent exclusion angles considered by Kepler's market access grant are therefore not necessary to meet the limits of Article 22 for the scope of this license, and as the calculations show, a 5-degree exclusion angle meets the limit with ample margin.

Table 2: PFD/EPFD for Viasat terminal operating at 4 W input power (boresight EIRP of 30 kW) with designator 34M0G7D--

PFD/EPFD Limits

Parameter	Value	Units	Symbol
Article 22 EPFD	-160	dBW/m^2/40kHz	P_{lim}

Constants

Parameter	Value	Units	Symbol
Radius of Earth	6371	km	R
Speed of Light	299792458	m/s	c

Inputs

Input Parameter	Value	Units	Value (log)	Units	Symbol
Carrier Frequency	1.43E+10	Hz	-		f
Bandwidth	3.40E+07	Hz	-		B
Reference Bandwidth	4.00E+04	Hz	-		B_{ref}
Angle from GSO arc	5	degrees	-		θ
Antenna Input Power	4	W	6.02	dBW	P
Orbit Altitude	35,789	km			r
Ground Elevation Angle	90	deg.			ϕ
Atmospheric Loss	-	-	0	dB	L_{atm}
Antenna Loss	-	-	0	dB	L_{ant}

Results

Calculated Parameters	Value	Units	Value (log)	Units	Symbol	Formula
Gain (at θ deg. off-axis)[2]	-	-	11.53	dBi	G	$29 - 25*\log_{10}(\theta)$
EIRP (E)	-	-	17.55	dBW	E	$G + P - L_{ant}$
Slant distance	35789.00	km	-	-	D	$\sqrt{[R\cos(90-\phi)^2 + (R + r)^2 - R^2]} - R\cos(90-\phi)$
Spreading Loss	-	-	162.07	dB	L_{sp}	$1/4\pi R^2$
Power Flux Density			-144.52	dBW/m^2	F_P	$E - L_{sp} - L_{atm}$
Spectral Flux Density			-173.81	dBW/m^2/40kHz	F_S	$F_P + (10*\log_{10}(B_{ref}/B))$

[2] Using the maximum earth station antenna performance standard given by 47 C.F.R. § 25.209(h) for communication between transmitting gateway stations and NGSO satellites in the FSS. Even when using a user terminal, the standards for gateway transmissions serve as a good approximation of performance. From 25.209(h), the permitted max off-axis gain = $29 - 25\log_{10}(\theta)$, where θ is the angle from the antenna boresight to the GSO arc.

Table 3: PFD/EPFD for Viasat terminal operating at 50 W input power (boresight EIRP of 6 MW) with designator 36M0G7D--

PFD/EPFD Limits

Parameter	Value	Units	Symbol
Article 22 EPFD	-160	dBW/m^2/40kHz	P_{lim}

Constants

Parameter	Value	Units	Symbol
Radius of Earth	6371	km	R
Speed of Light	299792458	m/s	c

Inputs

Input Parameter	Value	Units	Value (log)	Units	Symbol
Carrier Frequency	1.43E+10	Hz	-		f
Bandwidth	3.60E+07	Hz	-		B
Reference Bandwidth	4.00E+04	Hz	-		B_{ref}
Angle from GSO arc	5	degrees	-		θ
Antenna Input Power	50	W	16.99	dBW	P
Orbit Altitude	35,789	km			r
Ground Elevation Angle	90	deg.			ϕ
Atmospheric Loss	-	-	0	dB	L_{atm}
Antenna Loss	-	-	0	dB	L_{ant}

Results

Calculated Parameters	Value	Units	Value (log)	Units	Symbol	Formula
Gain (at θ deg. off-axis)[3]	-	-	11.53	dBi	G	$29 - 25*\log_{10}(\theta)$
EIRP (E)	-	-	28.52	dBW	E	$G + P - L_{ant}$
Slant distance	35789.00	km	-	-	D	$\sqrt{[R\cos(90-\phi)^2 + (R + r)^2 - R^2]} - R\cos(90-\phi)$
Spreading Loss	-	-	162.07	dB	L_{sp}	$1/4\pi R^2$
Power Flux Density			-133.55	dBW/m^2	F_P	$E - L_{sp} - L_{atm}$
Spectral Flux Density			-163.09	dBW/m^2/40kHz	F_S	$F_P + (10*\log_{10}(B_{ref}/B))$

[3] *See Id.*

3. Please certify that your proposed operations and communication between earth stations (user terminals) and satellites are in compliance with all existing and future coordination agreements between Canada and other administrations, GSO and NGSO satellite operators.

All of Kepler's proposed operations both now and in the future, are and will be conducted in accordance with the coordination agreements to which it is party to, including those with the administrations of Canada, the United States, and all other administrations, as well as the operators of the concerned NGSO and GSO networks filed with these administrations.