UWB and Radio Astronomy

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UWB Definition

- **Ultra-wideband (UWB) transmitter**. An intentional radiator that, at any point in time, has a fractional bandwidth equal to or greater than 0.20 or has a UWB bandwidth equal to or greater than 500 MHz, regardless of the fractional bandwidth (15.503d)
  - **UWB Bandwidth**. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M (15.503a)
- UWB devices by design and by rule are limited to radiated power spectral densities that are very low – typically comparable to or much less than the level of *unwanted* emissions allowed by other RF services
- Due to their low PSDs, UWB devices are categorized as Part 15 (unlicensed) devices, however…
  - They must adhere to PSD limits that are different from general Part 15 devices (generally lower)
  - Although unlicensed, some categories of UWB devices are limited to use by licensees under other rule parts, or by personnel licensed in other (non-radio) professions

UWB in the Marketplace

- Ground Penetrating Radars
  - Lawn-mower type objects able to probe into ground and floors to image buried objects such as utility infrastructure or forensic evidence
- Wall Imaging Devices
  - Used to image objects inside nominally optically-thick walls
- Through-Wall Imaging Devices
  - Able to detect and image objects on the other side of a wall
- Surveillance Systems
  - Systems that are able to detect with great sensitivity intrusions into a protected area
- Medical Systems
  - Imaging the insides of people or animals
- Vehicular Radar
  - For adaptive cruise control, blind spot monitoring, etc.
- Communications and Measurement
  - Wide bandwidth data networks. Also storage tank measurement devices

FCC-Defined Classes of UWB Devices and their Operating Restrictions

Class	Sub-Class	General Purpose	Frequency Limits	Dead Man Switch	Coordination	Authorized Users & Other Restrictions
Imaging Systems	Ground Penetrating Radar Systems	Operate in contact with or close proximity to the ground to detect or obtain images of buried objects	UWB BW < 10.6 GHz	Required	Required	Law enforcement (1) Fire & rescue organizations (1) Scientific research institutions Commercial mining companies Construction companies
	Wall Imaging Systems	Detect the location of objects contained within a wall	UWB BW < 10.6 GHz	Required	Required	Law enforcement (1) Fire & rescue organizations (1) Scientific research institutions Commercial mining companies Construction companies
	Through-Wall Imaging Systems, below 960 MHz	Detect the location or movement of persons or objects that are located on the other side of a structure such as a wall	UWB BW < 960 MHz	Required	Required	Law enforcement (1) Fire & rescue organizations (1)
	Through-Wall Imaging Systems, 1990 MHz - 10.6 GHz	Detect the location or movement of persons or objects that are located on the other side of a structure such as a wall	Center frequency and frequency of maximum PSD must be between 1990 MHz and 10.6 GHz	Required	Required	Law enforcement (1) Fire & rescue organizations (1)
	Surveillance Systems	"Security fences" that establish a stationary RF perimeter field and detect the intrusion of persons or objects in that field	UWB BW between 1990 MHz and 10.6 GHz	Required		Law enforcement (1) Fire & rescue organizations (1) Public utilities (2) Industrial entities (2)
	Medical Systems	Health applications to "see" inside the body of a person or animal	UWB BW between 3.1 GHz and 10.6 GHz	Required	Required	At the direction of, or under the supervision of, a licensed health care practitioner
Vehicular Radar Systems		Detect the location and movement of objects near a vehicle	UWB BW between 22 - 29 GHz (center freq and freq of highest PSD must be >24.075 GHz)			Terrestrial transportation vehicles only; attenuation of emissions at 23.6 - 24 GHz required above the horizontal plane to protect passive space borne sensors in the 23.6 - 24.0 GHz band (3)
Communications & Measurement Systems	Indoor	Wide variety: home & business networks; storage tank measurement; etc	UWB BW between 3.1 and 10.6 GHz			Indoor only; no outdoor infrastructure
	Handheld	PDAs, etc.	UWB BW between 3.1 and 10.6 GHz			Only on when sending data; no antennas mounted on outdoor structures

Source: FCC 03-33, Memorandum Opinion & Order and Further Notice of Proposed Rule Making, Revision of Part 15 of the Commission's Rules Regarding Ultrawideband Transmission Systems (ET Docket 98-153), Released 2003 March 12

(1) Law enforcement and fire & rescue organizations are those eligible for licenses under 47 CFR 90.20(a)(1)

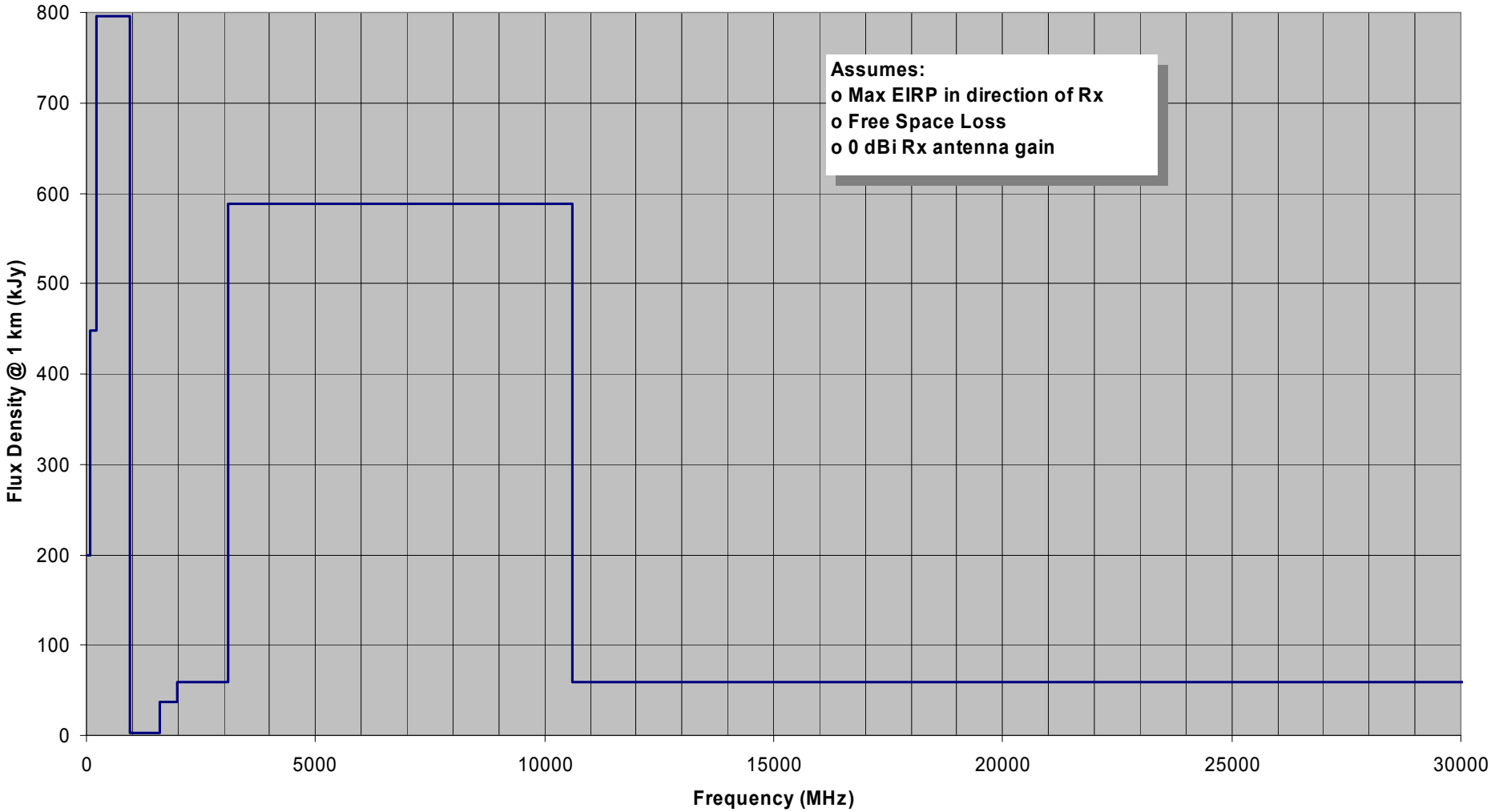
(2) Public utilities and industrial entitities refers to the manufacturers licensees, petroleum licensees, and power licensees defined in 47 CFR 90.7

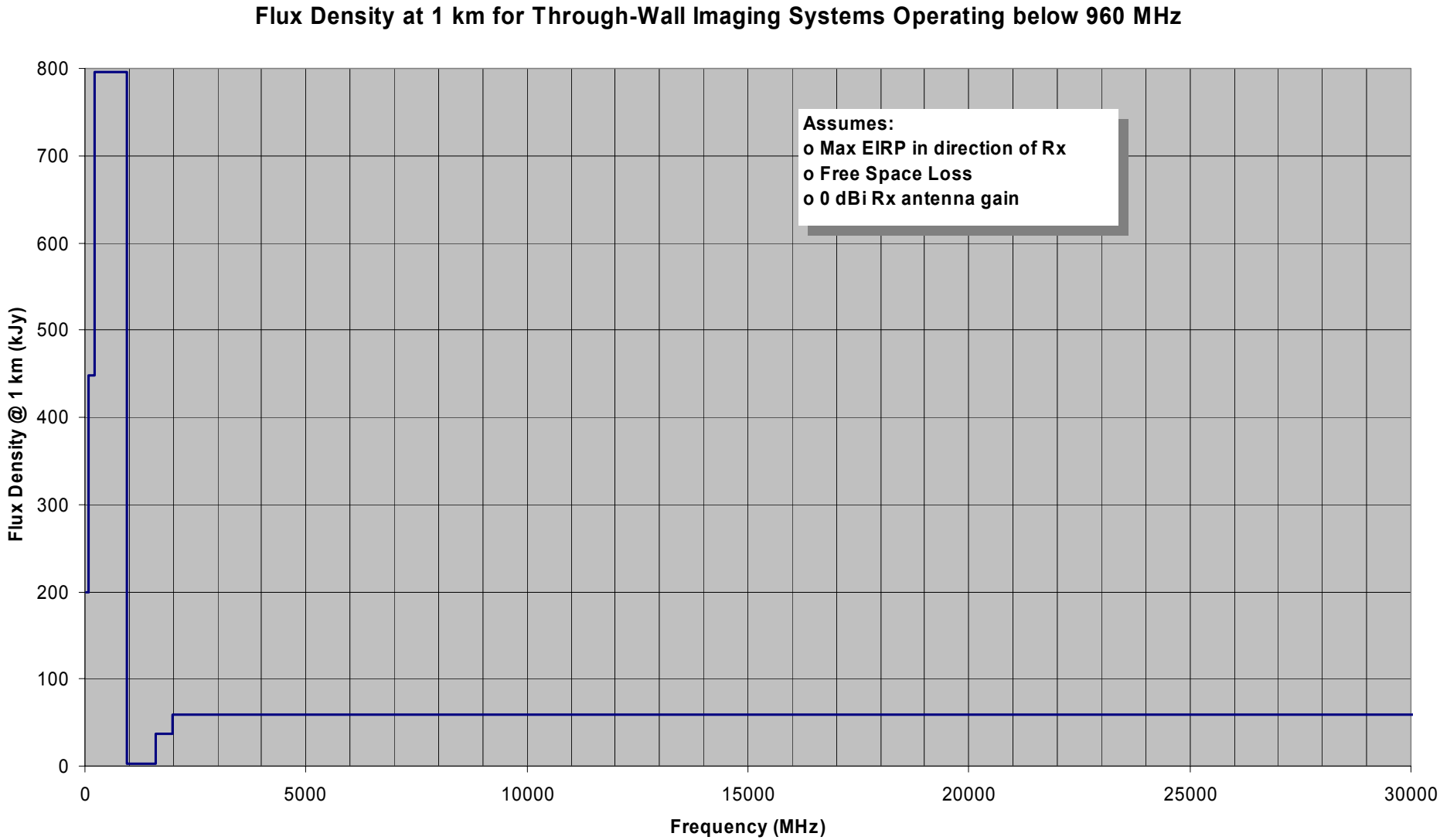
(3) Specific attenuation requirements are in 47 CFR 15.515(c)

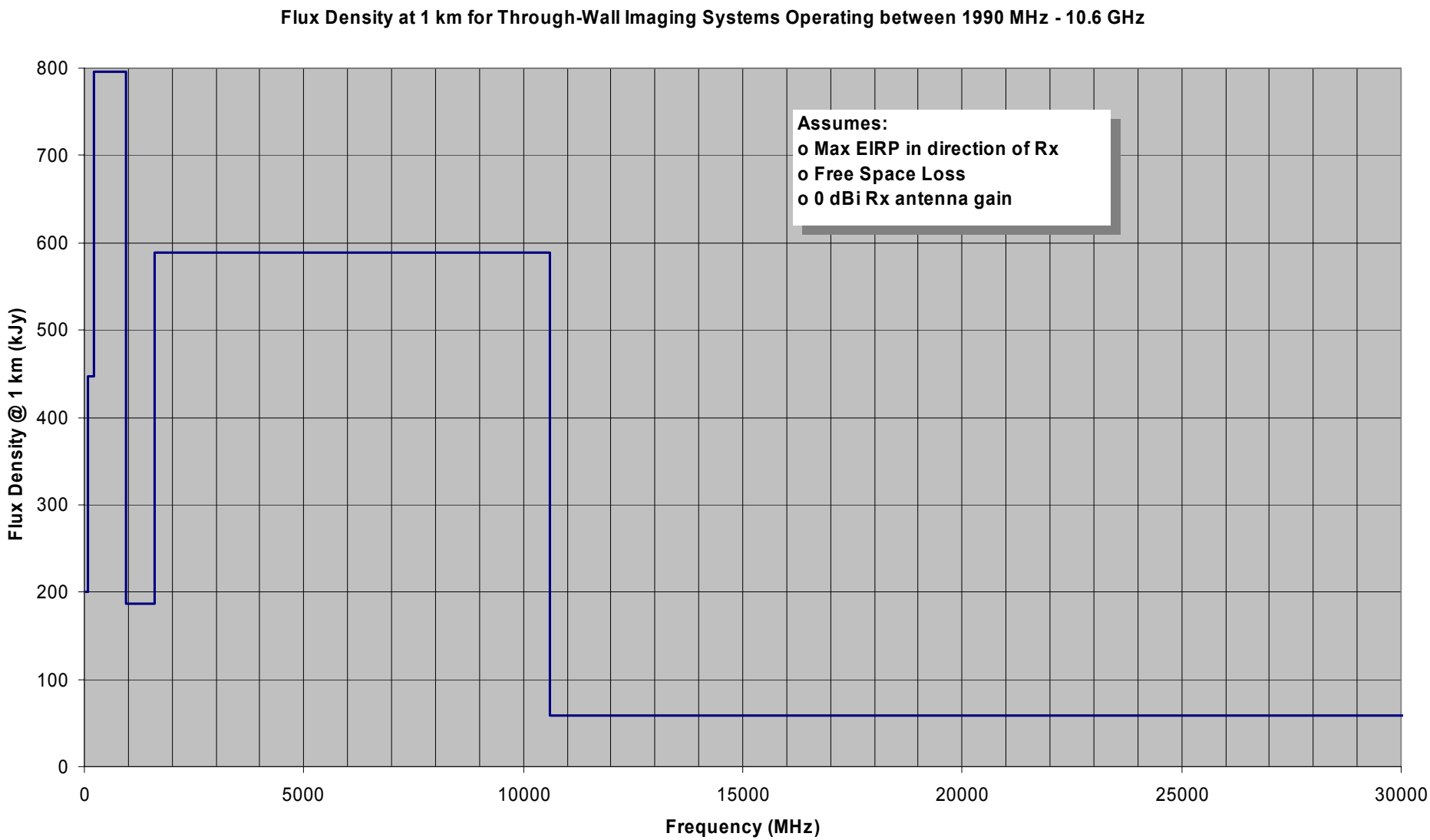
UWB Regulatory Summary

- Feb 14, 2002 – First Report & Order
  - Promised one-year review of rules impact
- Feb 13, 2003 – MOO & Further NPRM
  - FCC 03-33 (ET Docket 98-153)
  - Minor modifications to first R&O
  - Addressed numerous petitions for recon
  - FNPRM requests comments on
    - Elimination of UWB definition
    - Low PRF devices vis-à-vis peak emissions limits
    - Frequency hopping systems under UWB
    - Modifications to Part 15 measurement procedures for peak emissions from wideband (not necessarily UWB) devices
    - Comments due third week of July

Flux Density at 1 km for GPR and Wall Imaging UWB Systems




Flux Density at 1 km for Through-Wall Imaging Systems Operating below 960 MHz
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
25000
30000
Frequency (MHz)


Flux Density at 1 km for Through-Wall Imaging Systems Operating between 1990 MHz - 10.6 GHz
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
600
500
400
300
200
100
0
0
5000
10000
15000
20000
25000
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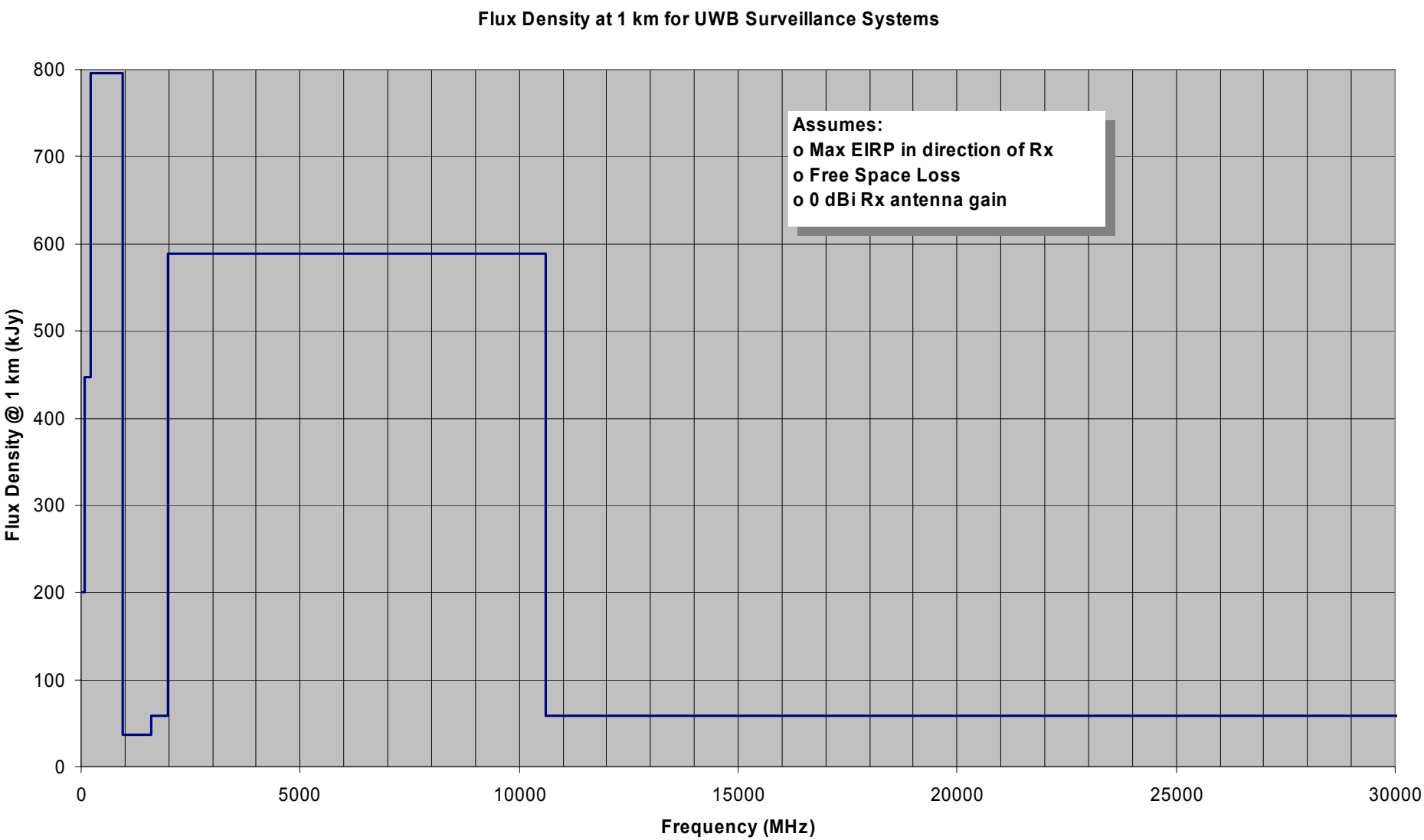
Frequency (MHz)


Flux Density at 1 km for UWB Surveillance Systems
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
600
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300
200
100
0
0
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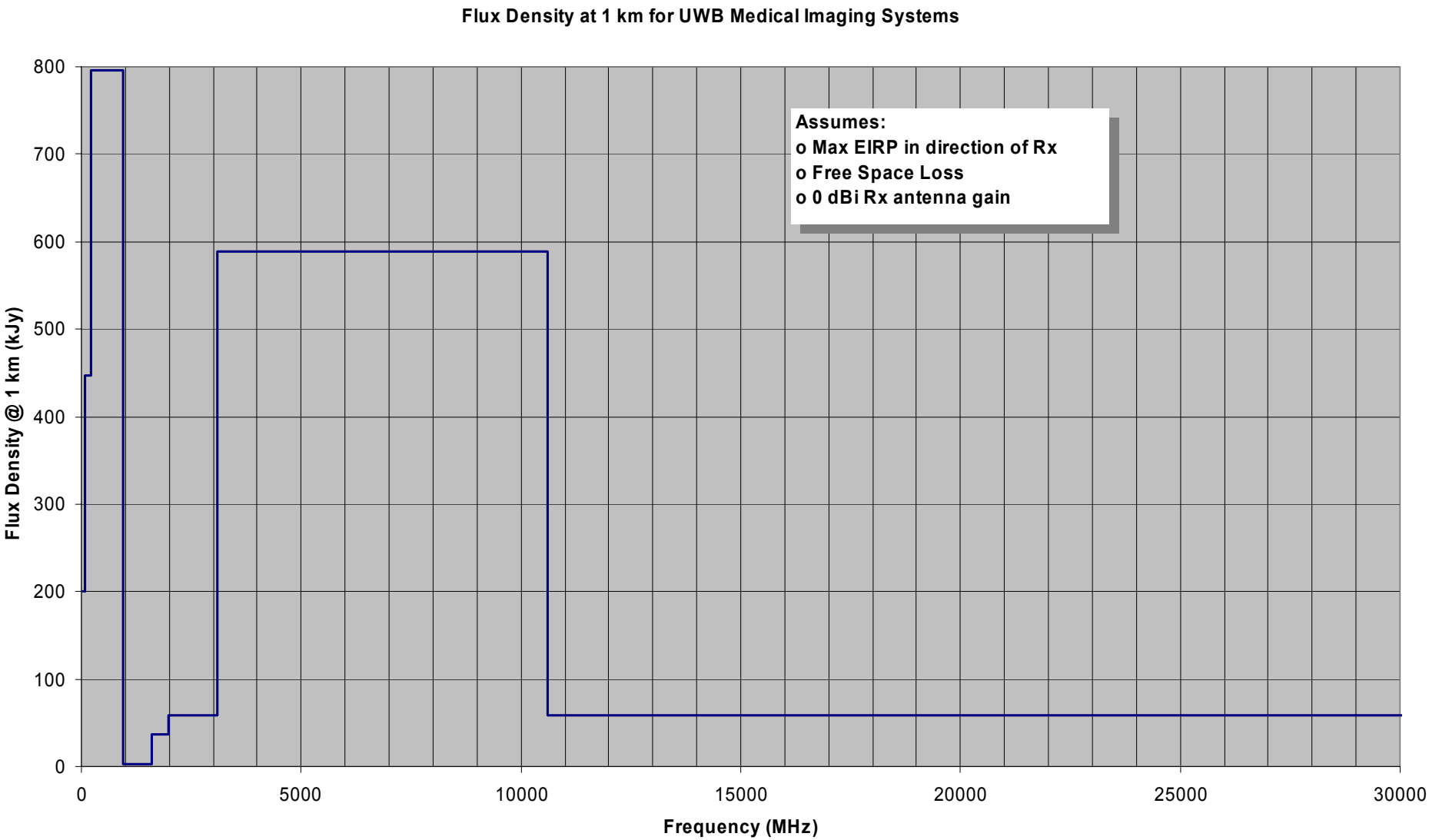
10000
15000
20000
25000
30000
Frequency (MHz)


Flux Density at 1 km for UWB Medical Imaging Systems
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
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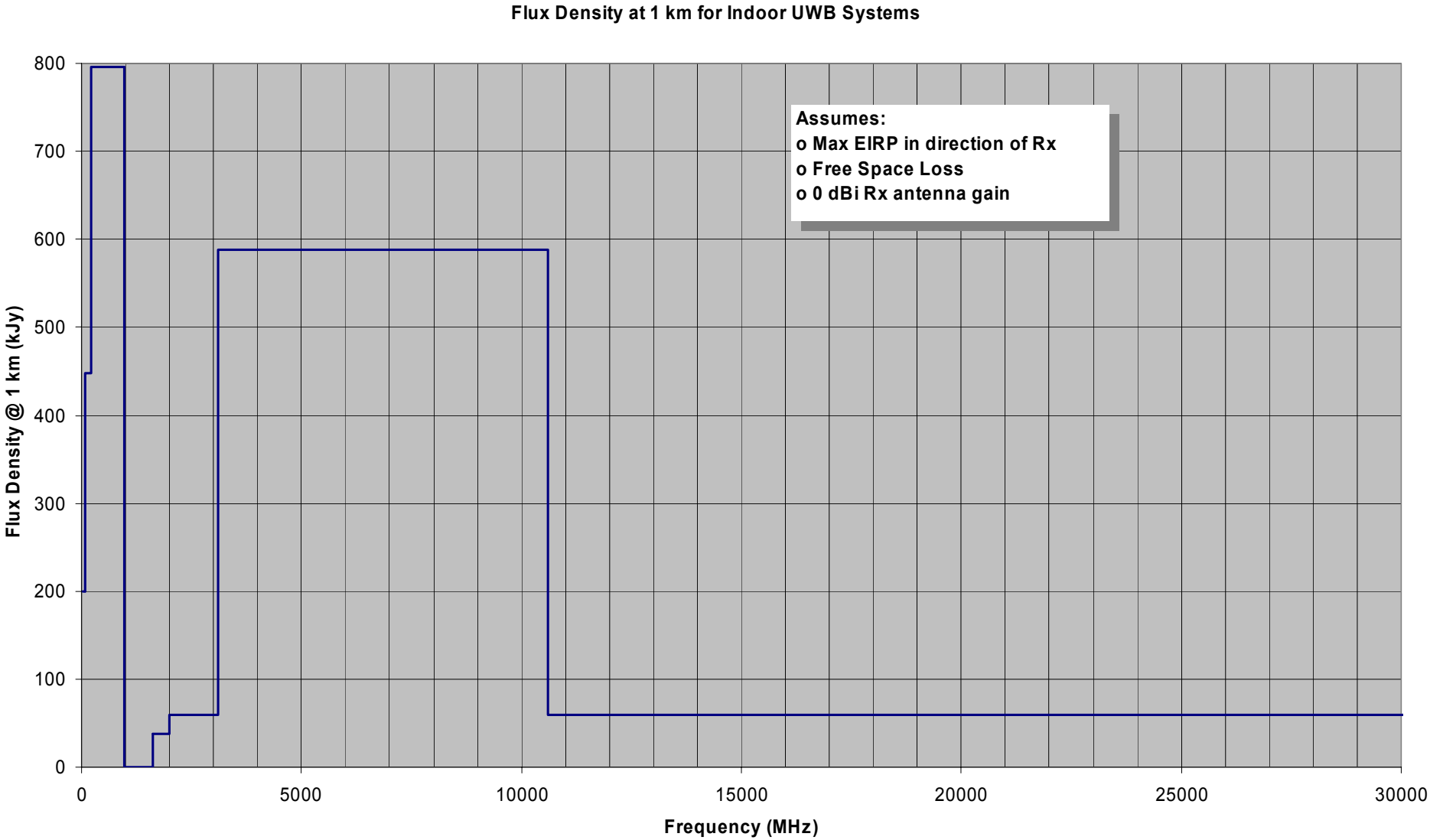
25000
30000
Frequency (MHz)


Flux Density at 1 km for Indoor UWB Systems
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
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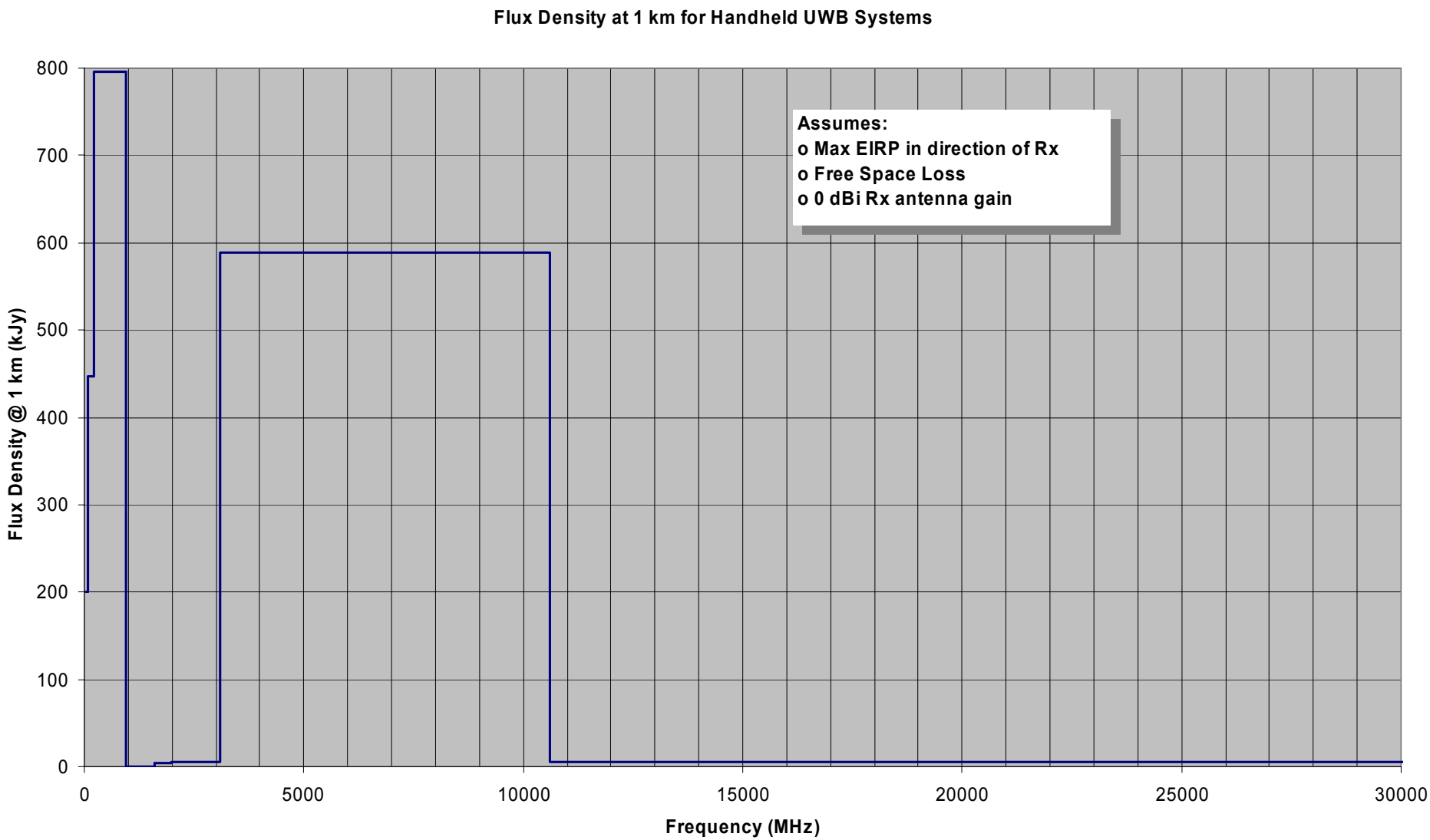
20000
25000
30000
Frequency (MHz)


Flux Density at 1 km for Handheld UWB Systems
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
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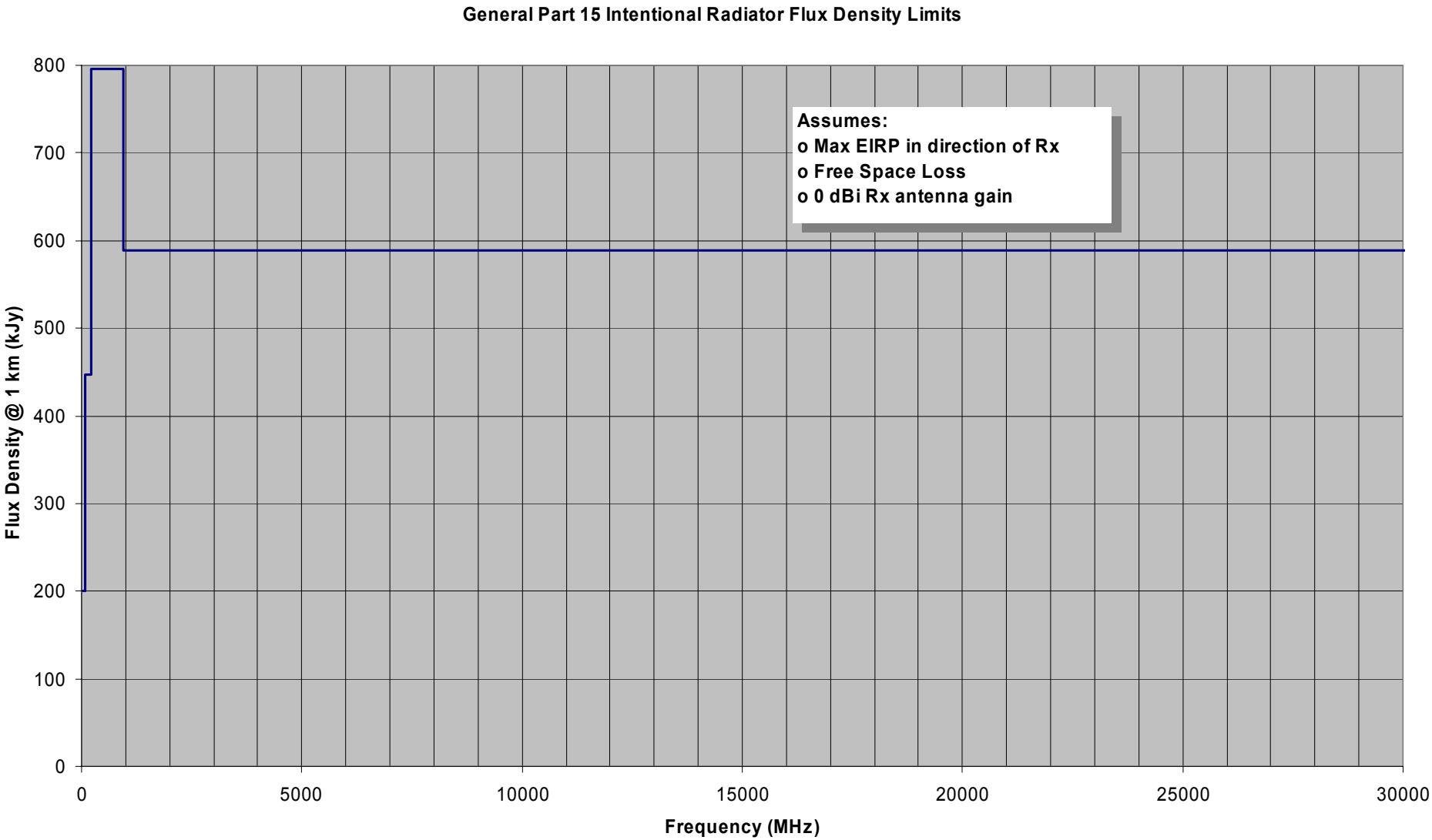
20000
25000
30000
Frequency (MHz)


General Part 15 Intentional Radiator Flux Density Limits
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
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500
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100
0
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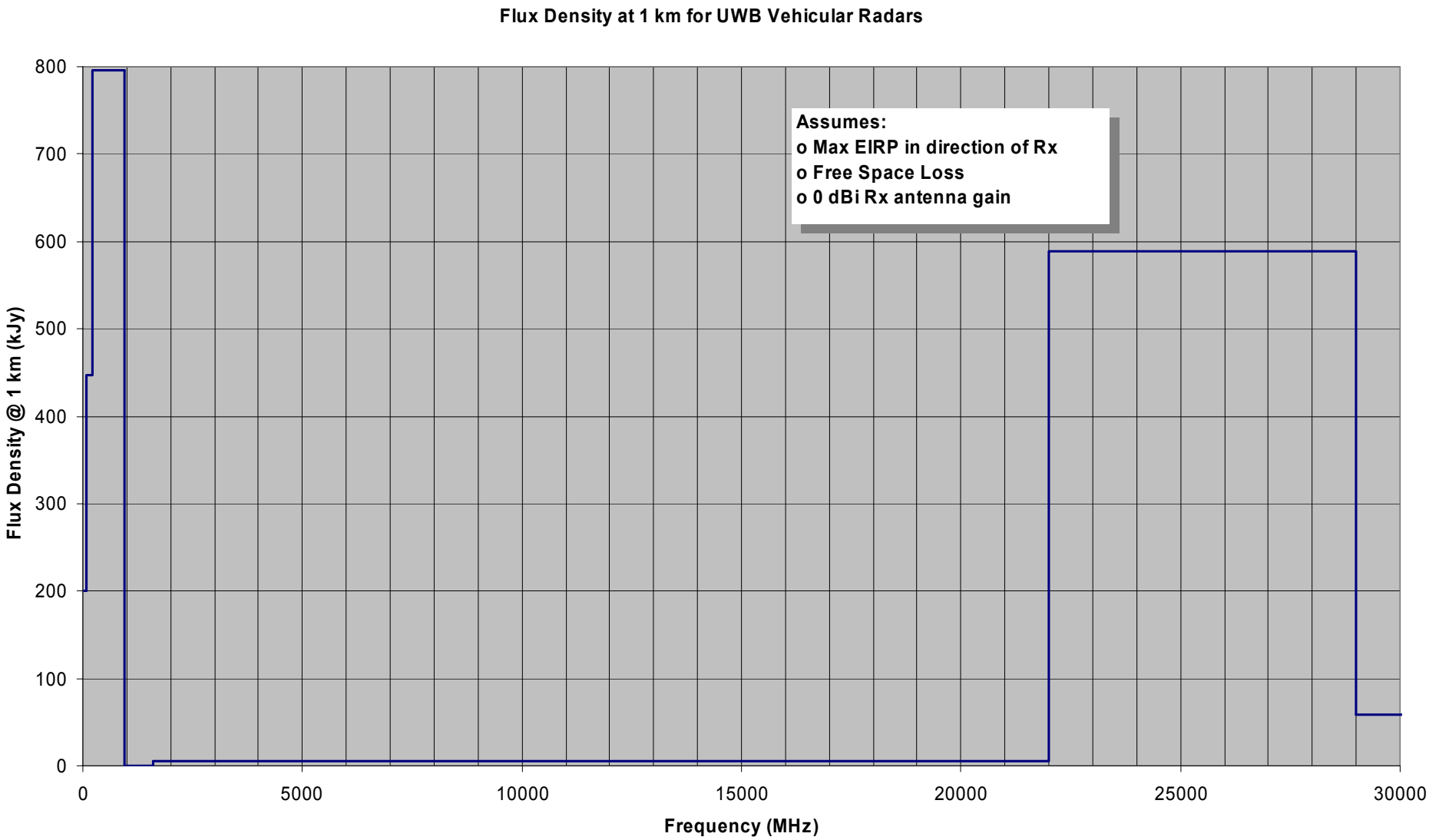
10000
15000
20000
25000
30000
Frequency (MHz)


Flux Density at 1 km for UWB Vehicular Radars
Assumes:
o Max EIRP in direction of Rx
o Free Space Loss
o 0 dBi Rx antenna gain
Flux Density @ 1 km (kJy)
800
700
600
500
400
300
200
100
0
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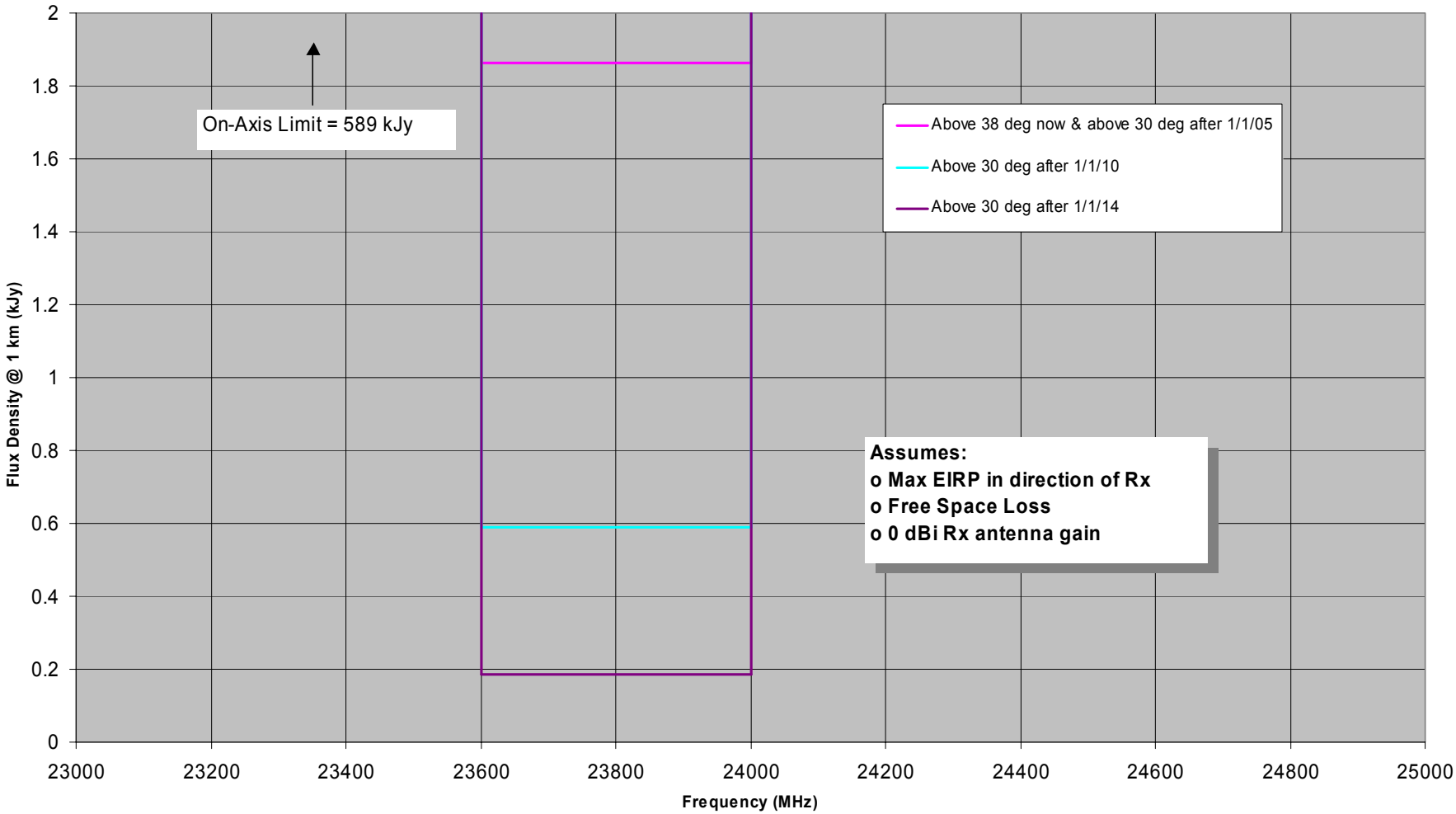
5000
10000
15000
20000
25000
30000
Frequency (MHz)

Flux Density at 1 km from UWB Vehicular Radar Systems Showing Time Evolution of Off-Axis Emissions Limits



UWB Threat Assessment

- Possibility of interference between UWB devices and radio astronomy facilities depends upon the type of UWB device.
  - Vehicular radar and handheld UWB devices are the most likely to end up in close proximity to a radio telescope
  - Indoor UWB devices could be deployed in buildings or residences in the general vicinity of an observatory, but would be relatively easy to track down
  - Absent nearby construction or industrial operations, other UWB devices are unlikely to be deployed in the vicinity of an observatory, unless deployed by the observatory itself
- Threat from vehicular radars at 23 GHz is similar to threat from spark plugs and other RF emissions from vehicles. Control of vehicular access will be required, as is practiced now at many observatories. Interference from vehicles driving past an observatory could produce occasional interference.
- Handheld UWB devices operated in the vicinity of a telescope could produce isolated incidents of extreme interference, although presumable the user would be associated with the observatory and would be aware of the interference threat.
  - Existing limits on unintentional radiations from Part 15 devices such as computers and PDAs is significantly greater than the emission limits on UWB devices. Screened control rooms, etc., are used to control such interference, and will be effective against UWB devices.
- Overall threat assessment: low to moderate.