

Appendix A

This appendix summarizes the receiver standards in Chapter 5 of the NTIA Manual.

NTIA Manual Section	Frequency band	Service	Parameter	Requirement
3.9.10 Annex I	162-174 MHz	VHF for Mexico International Boundary and Water Commission	Selectivity	90 dB
			Intermodulation Rejection	80 dB
			Spurious & Image Rejection	100 dB
5.3.1.2	HF 2 – 29.7 MHz	Fixed & Mobile	Selectivity	The pass band shall be no greater than the authorized bandwidth of emission and the slope of the selectivity outside the pass band shall be 100 dB/kHz
5.3.3.2	406.1 - 420 MHz, 932-935/941-944 MHz, 1.71 - 15.35 GHz	Fixed	Spurious Rejection	The receiver unwanted signals shall be attenuated at least 60 dB relative to the receiver sensitivity at the center of the pass band
			Selectivity	The –3 dB receiver bandwidth should be commensurate with the authorized emission bandwidth plus twice the frequency tolerance of the transmitter specified in Section 5.2.1. The -60 dB receiver bandwidth shall not exceed five times the -3 dB receiver bandwidth
			Noise Figure	The receiver noise figure including preamplifier should be 9 dB or less for frequencies below 4400 MHz, 12 dB or less for frequencies between 4400 MHz, and 10 GHz, and 14 dB or less for higher frequencies (up to 15.35 GHz).
5.3.6.2	29.7-50 MHz, 162-174 MHz, 406.1-420 MHz	Fixed & Mobile (Wide Band)	Spurious Rejection	Land, Fixed, Mobile: 85 dB Portable: 60 dB (29.7-50, 162-174 MHz); 50 dB (406.1-420 MHz)
			Adjacent Channel Rejection (Analog)	Land, Fixed, Mobile: 80 dB; Portable: 50 dB (29.7-50 MHz), 70 dB (162-174 MHz), 60 dB (406.1-420 MHz).
			Adjacent Channel rejection (Digital)	Land, Fixed, Mobile: 50 dB (29.7-50 MHz), 55 dB (162-174, 406.1-420 MHz);

				Portable: 50 dB.
			Intermodulation Rejection	Land, Fixed, Mobile: 60 dB (29.7-50 MHz), 70 dB (162-174, 406.1-420 MHz); Portable: 50 dB.
5.3.7.3	138-150.8 MHz, 162-174 MHz, 406.1-420 MHz	Fixed & Mobile (Narrow Band)	Spurious Rejection	Land, Fixed: 90 dB (digital), 75 dB (analog); Mobile: 80 dB (digital), 75 dB (analog); Portable: 70 dB (digital, analog).
			Adjacent Channel Rejection	60 dB (digital), 45 dB (analog).
			Intermodulation Rejection	Land, Fixed: 80 dB (digital), 75 dB (analog); Mobile: 75 dB (digital and analog); Portable: 70 dB (digital and analog).
5.3.11	162-174 MHz and 406.1-420 MHz Band	Fixed and Mobile Digital 6.25 kHz Channel Equipment	Spurious Response	Land, Fixed: 90 dB Mobile: 80 dB Portable: 70 dB
			Adjacent Channel Selectivity	Land, Fixed: 60 dB Mobile: 60 dB Portable: 60 dB
			Intermodulation Rejection	Land, Fixed: 80 dB Mobile: 75 dB Portable: 70 dB
5.5.7.1	Non-pulsed radars of 40 watts or less rated average power; or Pulsed radars of 1 kW or less rated peak power; or Radars with an operating frequency above 40 GHz; or Man-portable radars; or Man-transportable	Radars (Criteria A)	RF Selectivity	For fixed-tuned and tunable RSEC Criteria A systems, the radar receiver's 3 dB RF bandwidth should not exceed 30 times the value of the 3 dB IF bandwidth for non-hopping systems and 145 times for hopping systems. For systems with multiple IF stages, the RF bandwidth standard will be based on the multiple of the final IF bandwidth stage before the I and Q detector or digitizer. For systems with multiple IF filters, the standard will be applied to each filter that matches its' emission designator. For systems with digital IF filters, the equivalent analog bandwidth shall be used. For systems with multiple IF pathways, the RF standard pass or fail check will be calculated for each path. This standard comes into effect on January 1, 2025.
			IF Selectivity	The 3 dB IF bandwidth of the radar receiver shall be equal to or less than 13 times the 3 dB bandwidth of the emissions, for all

	radars; or as described above; or Expendable, non-recoverable radars on missiles.			modulation types. For multi-stage IF radar receivers, the standard would apply to the final IF stage, prior to the detector or I and Q digitizer. This standard only applies to radars with superhetrodyne receivers. Stage 4 systems will be grandfathered, but they will have to meet the standard if the receiver is altered or redesigned. This standard came into effect on January 1, 2022.
			Spurious Rejection, excluding image	50 dB, except where broadband front ends are required
			Stability	Frequency stability of receivers shall be commensurate with, or better than that of the associated transmitter
5.5.7.2	Radars having a rated peak power of more than 1 kW but not more than 100 kW and operating between 2900 MHz and 40 GHz	Radars (Criteria B)	RF Selectivity	For fixed-tuned and tunable RSEC Criteria B systems, the radar receiver's 3 dB RF bandwidth should not exceed 30 times the value of the 3 dB IF bandwidth for non-hopping systems and 145 times for hopping systems. For systems with multiple IF stages, the RF bandwidth standard will be based on the multiple of the final IF bandwidth stage before the I and Q detector or digitizer. For systems with multiple IF filters, the standard will be applied to each filter that matches its' emission designator. For systems with digital IF filters, the equivalent analog 3 dB bandwidth shall be used. For systems with multiple IF pathways, the RF standard pass or fail check will be calculated for each path. This standard comes into effect on January 1, 2025.
			IF Selectivity	The 3 dB IF bandwidth of the radar receiver shall be equal to or less than 20 times the 3 dB bandwidth of the emissions, for all modulation types. For multi-stage IF radar receivers, the standard would apply to the final IF stage, prior to the detector or I and Q digitizer. This standard only applies to radars with superhetrodyne receivers. Stage 4 systems will be grandfathered, but they will have to meet the standard if the receiver is altered or redesigned. This standard came into effect on January 1, 2022.
			Spurious Rejection, excluding image	50 dB, except where broadband front ends are required

			Stability	Frequency stability of receivers shall be commensurate with, or better than that of the associated transmitter
5.5.7.3	All radars not included in Group A, B, D, or E	Radars (Criteria C)	RF Selectivity	For fixed-tuned and tunable RSEC Criteria C systems, the radar receiver's 3 dB RF bandwidth should not exceed 130 times the value of the 3 dB IF bandwidth for non-hopping systems and for hopping systems. For systems with multiple IF stages, the RF bandwidth standard will be based on the multiple of the final IF bandwidth stage before the I and Q detector or digitizer. For systems with multiple IF filters, the standard will be applied to each filter that matches its' emission designator. For systems with digital IF filters, the equivalent analog 3 dB bandwidth shall be used. For systems with multiple IF pathways, the RF standard pass or fail check will be calculated for each path. This standard comes into effect on January 1, 2025.
			IF Selectivity	The 3 dB IF bandwidth of the radar receiver shall be equal to or less than 20 times the 3 dB bandwidth of the emissions, for all modulation types. For multi-stage IF radar receivers, the standard would apply to the final IF stage, prior to the detector or I and Q digitizer. This standard only applies to radars with superhetrodyne receivers. This standard came into effect on January 1, 2022.
			Spurious Rejection, excluding image	60 dB
			Image rejection	50 dB
			Stability	Frequency stability of receivers shall be commensurate with, or better than that of the associated transmitter
5.5.7.4	All fixed radars in the 2700-2900 MHz band.	Radars (Criteria D)	RF Selectivity	For fixed-tuned and tunable RSEC Criteria D systems, the radar receiver's 3 dB RF bandwidth should not exceed 200 times the value of the 3 dB IF bandwidth for non-hopping systems and for hopping systems. For systems with multiple IF stages, the RF bandwidth standard will be based on the multiple of the final IF bandwidth stage before the I and Q detector or digitizer. For systems with multiple IF filters, the standard will be applied to each filter that matches its' emission designator. For systems with digital IF filters, the equivalent analog 3 dB bandwidth shall be

			IF Selectivity	<p>used. For systems with multiple IF pathways, the RF standard pass or fail check will be calculated for each path. This standard comes into effect on January 1, 2025.</p> <p>The 3 dB IF bandwidth of the radar receiver shall be equal to or less than 1.75 times the 3 dB bandwidth of the emissions, for all modulation types. For multi-stage IF radar receivers, the standard would apply to the final IF stage, prior to the detector or I and Q digitizer. This standard only applies to radars with superheterodyne receivers. This standard came into effect on January 1, 2022.</p>
			Spurious Rejection, excluding image	60 dB
			Image Rejection	50 dB
			Stability	Frequency stability of receivers shall be commensurate with, or better than that of the associated transmitter
			Receiver Interference Suppression Circuitry	<p>Radar systems should have provisions incorporated into the system to suppress pulsed interference. The following information is intended for use as an aid in the design and development of receiver signal processing circuitry or software to suppress asynchronous pulsed interference. A description of the parametric range of the expected environmental signal characteristics at the receiver IF output is:</p> <p>Peak I/N ratio:<50 dB Pulse width: 0.5 to 4.0 μs PRF: 100 to 2000 pps</p>
5.5.7.5	Wind Profiler Radar (WPR) operating on 449 MHz	Criteria E, Wind Profiler Radars)	Selectivity	<p>The 3 dB receiver bandwidth should be commensurate with the authorized emission bandwidth plus twice the transmitter frequency tolerance of 10 parts per million (ppm). The 60 dB receiver bandwidth shall be commensurate with the 60 dB emission bandwidth.</p> <p>Receivers shall be capable of switching bandwidth limits to appropriate values whenever the transmitter bandwidth is switched</p>
			Spurious rejection, excluding image	60 dB

			Image Rejection	50 dB
			EMC Provision	Radars shall have the capability to tolerate incoherent pulsed interference of duty cycles less than 1.5 percent such that peak interfering signal levels 30 dB greater than the receiver noise level at the IF output will not degrade performance

The definitions of terms used to specify receiver standards vary among standardization bodies, especially for technical definitions that describe the means for measuring compliance. Thus, the source documents and associated publications, as well as the *IEEE Standard Dictionary of Electrical and Electronics Terms*, ITU Recommendation SM.332-4, *Selectivity of Receivers*, and Federal Standard 1037C, *Telecommunications: Glossary of Telecommunications Terms*, should be consulted for proper interpretation and application of the standards. Following are generalized definitions for receiver parameters and other technical terms used in this document:

- Adjacent Channel – A channel with bandwidth equal to, and abutting the desired signal channel.
- Adjacent Channel Rejection (attenuation) – The ability of a receiver to reject signals in the adjacent channel.
- Adjacent Channel Selectivity – The ability of a receiver to discriminate between a desired signal and an undesired signal in an adjacent channel.
- Blocking – Saturation of the front end amplifier stage of a receiver by an undesired signal on a frequency different from that of the desired signal, thereby causing severe distortion and other non-linear effects that prevent proper operation of the receiver. This is also called the receiver saturation or blanking.
- Cross Modulation – The appearance of modulation from an unwanted signal on the desired signal.
- Image Frequency (of a heterodyne receiver) – The frequency removed from the local oscillator frequency, in the direction opposite to the direction of the desired signal frequency, by an amount equal to the intermediate frequency (i.e., difference between the desired channel frequency and the local oscillator frequency).
- Image Frequency Rejection – The ability of a receiver to reject signals at the image frequency.
- Intermodulation Rejection – The ability of a receiver to reject intermodulation products produced by the mixing of two or more signals at the input to the receiver.
- Necessary Bandwidth – For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.
- Non-Cochannel Signal – Any signal or portion of a signal falling outside the authorized bandwidth of the desired signal.
- Occupied Bandwidth – The width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to a specified percentage $\beta/2$ of the total mean power of a given emission. Unless otherwise specified, the value of $\beta/2$ should be taken as 0.5%. β equals the percentage of power outside the occupied bandwidth frequency limits.

- Out-of-Band Emission – Emission on a frequency or frequencies immediately outside the necessary bandwidth that result from the modulation process, but excluding spurious emissions.
- Selectivity – Rejection (attenuation) of an undesired signal at frequencies close to the desired signal frequency. It is often specified as the amount of frequency difference between desired and undesired signals needed to produce a specified attenuation of the undesired signal.
- Sensitivity Depression or Desensitization – The level of a non-cochannel signal that increases a receiver signal power threshold or decreases receiver gain by a defined amount.
- Spurious Emission – Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.
- Spurious Response – Undesired receiver response resulting from mixing of the local oscillator and undesired signals. This includes the response to undesired signals at the image frequency.
- Unwanted Emissions – Both spurious emissions and out-of-band emissions.