NATO STANDARD

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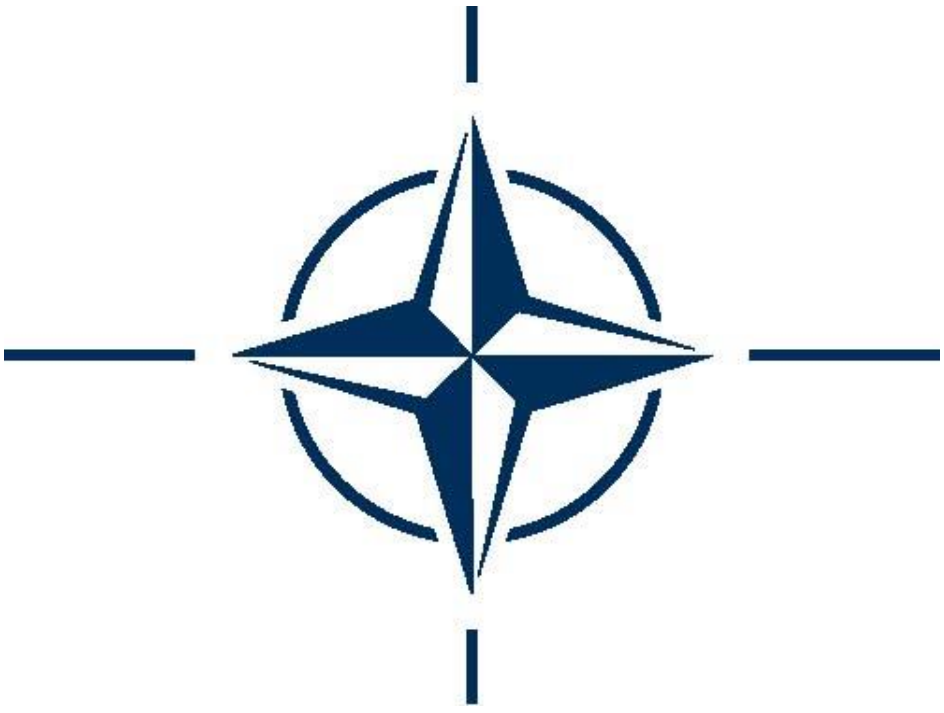
TECHNICAL STANDARDS FOR SINGLE CHANNEL AND MULTICHANNEL HF RADIO EQUIPMENT

Edition A Version 1

JUNE 2022



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NATO LETTER OF PROMULGATION

21 June 2022

1. The enclosed Allied Communications Publication AComP-4203, Edition A, Version 1, TECHNICAL STANDARDS FOR SINGLE CHANNEL AND MULTICHANNEL HF RADIO EQUIPMENT, which has been approved by the nations in the C3 Board, is promulgated herewith. The agreement of nations to use this publication is recorded in STANAG 4203.

2. AComP-4203, Edition A, Version 1, is effective upon receipt.

3. This NATO standardization document is issued by NATO. In case of reproduction, NATO is to be acknowledged. NATO does not charge any fee for its standardization documents at any stage, which are not intended to be sold. They can be retrieved from the NATO Standardization Document Database (https://nso.nato.int/nso/) or through your national standardization authorities.

4. This publication shall be handled in accordance with C-M(2002)60.

Dimitrios SIGOULAKIS
Major General, GRC (A)
Director, NATO Standardization Office

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RECORD OF RESERVATIONS

CHAPTER	RECORD OF RESERVATION BY NATIONS

Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.

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RECORD OF SPECIFIC RESERVATIONS

[nation]	[detail of reservation]
ALB	Albanian Armed Forces currently do not have single channel HF radio equipment in service complies with the STANAG 4203 Ed 4 requirements.
Note: The reservations listed on this page include only those that were recorded at time of promulgation and may not be complete. Refer to the NATO Standardization Document Database for the complete list of existing reservations.	

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TECHNICAL STANDARDS FOR SINGLE CHANNEL AND MULTICHANNEL HF RADIO EQUIPMENT

Annexes:

- **A.** Terms and Definitions
- **B.** Technical Standards to Ensure Interoperability of Single Channel HF Radio Equipment
- **C.** Independent Sideband (ISB) Operations
- **D.** Interoperability Standards for Wideband HF Systems
- **E.** Interoperability Standards for Multichannel HF Systems
- **F.** References to More Stringent HF Radio Requirements in other STANAGs

Related Documents:

STANAG 4202 -	Transmission envelope characteristics for high reliability data exchange between land tactical data processing equipment over single channel radio links
STANAG 4197 -	Modulation and coding characteristics that must be common to assure interoperability of 2400 bps linear predictive encoded digital speech transmitted over HF radio facilities
STANAG 4285 -	Characteristics of 1200/2400/3600 bits per second single tone modulators/demodulators for HF radio links
STANAG 4529 -	Characteristics of single tone modulators/demodulators for maritime HF radio links with 1240 Hz bandwidth
STANAG 4415 -	Characteristics of a robust, non-hopping, serial tone modulator/demodulator for severely degraded HF radio links
STANAG 4481 -	Minimum technical equipment standards for naval HF shore to ship broadcast systems
STANAG 4538 -	Technical standards for an Automatic Radio Control System (ARCS) for HF communication links
STANAG 4539 -	Technical standards for non-hopping HF communication Waveforms
STANAG 4591 -	The 1K2 and 2K4 NATO interoperable narrow band voice coder
STANAG 5514 -	Tactical data broadcasting - Link 14
ACP-167 (J) -	Glossary of Communication Electronics Terms

AIM

1. The aim of this agreement is to define the technical standards required to ensure interoperability of land, air and maritime COMMON single channel HF radio equipment. For technical standards of SPECIFIC single channel radio equipment reference should be made to the appropriate STANAGs (e.g. STANAGs 4444 and 5511, see Annex D).

AGREEMENT

2. Participating nations agree to use the standards defined in this STANAG for the traffic mode or modes in which interoperability is required.

GENERAL

3. STANAG 4203 contains the minimum interoperability standards for single channel HF radio equipment. It does not contain performance specifications. For performance specifications reference should be made to other standards such as MIL-STD-188-141.

The terms and definitions are detailed in Annex A. The technical standards are in Annexes B, D and E. Annexes C and F contain references to the more stringent HF radio requirements in the various SPECIFIC STANAGs. An implementation matrix is added in Annex F.

IMPLEMENTATION OF THE AGREEMENT

4. This STANAG is implemented by a nation when it is national policy that all new single channel and multichannel HF equipment placed in service in that nation’s forces comply with the standards described in this STANAG. It is not intended that existing equipment and systems be immediately converted to comply with the provisions of this standard but that compliance be enforced as those systems undergo major modification or rehabilitation.

ANNEX A TERMS AND DEFINITIONS

ASSIGNED FREQUENCY
The centre of the assigned frequency band, or the centre frequency of the bandwidth of an emission.

ASSIGNED FREQUENCY BAND
The frequency band within which the emission of a station is authorized; the width of the band equals the necessary bandwidth plus twice the absolute value of the frequency tolerance.

BANDWIDTH, NECESSARY
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.

BANDWIDTH, OCCUPIED (See also ACP-167 (J))
The width of a frequency band such that the mean power emitted within the frequency band is at least equal to a specified percentage of the total mean power of a given emission. Unless otherwise specified, the percentage shall be 99.0%.

BANDWIDTH, WORKING
The total width of the frequency band used for narrowband and wideband HF communications. Generally, for Wideband and Multichannel implementations this is further defined as follows:

(a) Wideband systems – An integer number of adjacent 3 kHz bandwidths; i.e., N*3 kHz where N is in the range 1 thru 16, together comprising the communications channel.

(b) Multichannel systems – The width of the frequency interval (maximum 200 kHz) containing all of the non-contiguous 3 kHz bandwidths together comprising the communications channel.

CARRIER (See also ACP-167 (J))
An electromagnetic wave that is suitable for modulation by an information-bearing signal to be transmitted over a communication system. The frequency of this wave is referenced as f_0 within the definitions of this standard.

FREQUENCY, CHARACTERISTIC
A frequency which can easily be identified and measured in a given emission. A carrier frequency may, for example, be designated as the characteristic frequency.

FREQUENCY, REFERENCE
A frequency having a fixed and specified position with respect to the assigned frequency. The displacement of this frequency with respect to the assigned frequency has the same absolute value and sign that the displacement of the characteristic frequency has with respect to the centre of the frequency band occupied by the emission.

FREQUENCY, DISPLAY
The frequency indicated on the dial settings of RF equipment.

FREQUENCY TOLERANCE (See also ACP-167 (J))
The maximum permissible departure by the centre frequency of the frequency band occupied by an emission from the assigned frequency, or by the characteristic frequency of an emission from the reference frequency. (For SSB modulation, the characteristic and reference frequencies are typically specified as carrier frequencies.)

FREQUENCY ACCURACY/STABILITY
The accuracy of the characteristic frequency (e.g., the carrier frequency for SSB modulation) of radio emissions, including tolerance and long-term stability, but not any variation due to Doppler shift.

LINEARITY
The extent to which the output signal of a system or device is a linear function of the input signal: i.e., the operation of the system or device is accomplished ideally without nonlinear distortion of the desired signal. Intermodulation distortion is one form of nonlinear distortion.

MODULATION (See also ACP-167 (J))
The process of varying some characteristics of the carrier wave in accordance with the instantaneous value of samples of the intelligence to be transmitted. See CARRIER.

MODULATION, AMPLITUDE (AM) (See also ACP-167 (J))
The form of modulation in which the amplitude of the carrier varies in accordance with the instantaneous value of the modulation signal.

MODULATION, PHASE (PSK)
The form of modulation in which the phase of the carrier varies in accordance with the instantaneous value of the modulation signal.

MODULATION, QUADRATURE AMPLITUDE (QAM)
The form of modulation in which both the phase and the amplitude of the carrier vary in accordance with the instantaneous value of the modulation signal.

PHASE NOISE
The short term phase variations of the radio carrier frequency due to noise sources within the frequency synthesizer and external influences, e.g. thermal effects and power supply variations.

RATT (See also ACP-167 (J))
The system of communication by teletypewriter over radio circuits.

RECEIVER ATTACK-TIME
The time interval from the application of a step increase in the RF signal (as stated in Annex B, Gain Control, Note 1) to the receiver input until the receiver audio output amplitude reaches and stays within 3 dB of its steady-state value.

RECEIVER RELEASE-TIME
The time interval from the application of a step decrease in the RF signal (as stated in Annex B, Gain Control, Note 1) applied to the receiver input until the receiver audio output reaches and stays within 3 dB of its steady state value.

SIDEBAND (See also ACP-167 (J))
The band of frequencies produced on either side of a carrier frequency when the carrier frequency is (amplitude or phase) modulated by a baseband signal. For amplitude modulation these are components whose frequencies are, respectively, the sum or difference of the carrier frequency and the modulating frequencies. The sum frequencies form the “upper sideband” and the difference frequencies form the “lower sideband”.

SINGLE-SIDEBAND (SSB) TRANSMISSION
Sideband transmission in which only one sideband is transmitted. NOTE: Usually, the carrier is suppressed.

TOTAL SPECTRUM OCCUPANCY
The Total Spectrum Occupancy (TSO) is a transmitter power spectral density measure represented in a diagram in which each data point yields, on the horizontal axis, the total (i.e. double-sided) maximum allowable bandwidth over which the total transmission signal results in an emissions power spectral density greater than or equal to the level as indicated on the vertical axis.

TRANSMITTER ATTACK-TIME
The time interval from keying-on a transmitter until the transmitted RF signal amplitude has increased to 90% of its steady-state value. The attack-time delay excludes any necessary time for automatic antenna tuning.

TRANSMITTER RELEASE-TIME
The time interval from keying-off a transmitter until the transmitted RF signal amplitude has decreased to 10% of its key-on steady-state value.

TYPE A RADIO SYSTEM

Type A radio systems applies to fixed installations on land based sites, maritime and aircrafts (both fixed wing and rotary). The transmit power is typically greater than 150 W PEP although some platforms may impose restrictions (e.g. rotary wing aircrafts).

Requirements for unwanted emissions in this standard are defined to achieve reasonable non-interference conditions between receivers and distant transmitters. In cosite deployments more stringent requirements should be considered.

TYPE B RADIO SYSTEM

Type B radio systems applies mainly to vehicle mounted installations and dismounted use, but partially also to aircrafts, where relaxations in some performance requirements due to antenna limitations etc. can be accepted. The transmit power is typically up to 150 W PEP.

Requirements for unwanted emissions in this standard are defined to achieve reasonable non-interference conditions between receivers and distant transmitters. In cosite deployments more stringent requirements should be considered.

ANNEX B TECHNICAL STANDARDS TO ENSURE INTEROPERABILITY OF SINGLE CHANNEL HF RADIO EQUIPMENT

The requirements contained within this Annex are applicable to all HF Communications using single 3 kHz bandwidth channels and unless otherwise stated will apply at all rated transmit power levels including maximum rated power.

FREQUENCY RANGE

The frequency range for both transmission and reception shall be:

(a) 2.0 to 29.99990 MHz for Type B radio systems.

(b) 1.6 to 29.99990 MHz for Type A radio systems.

TUNING

(a) Type B radio equipment shall tune to integral multiples of 100 Hz, starting at 2.0 MHz. Type A radio equipment shall tune to integral multiples of 100 Hz starting at 1.6 MHz. For maritime use it is desirable that the receiver is able to tune to integral multiples of 10 Hz.

(b) The frequency of the suppressed carrier shall be the reference frequency. In fixed-frequency operation, this shall be the dial setting of the RF equipment.

FREQUENCY ACCURACY/STABILITY

The radio frequency accuracy shall be within ±30 Hz for Type B radio equipment and within ±10 Hz for Type A radio equipment. For Type B radio systems the frequency stability of the transmitter carrier frequency shall be 1×10^{-8} per day or better (± 10Hz in 30 days). For Type A radio systems, the accuracy of the radio carrier frequency shall be within ±1.0 Hz when the frequency accuracy of the internal standard is ±1 part in 10^{-9} or better.

FREQUENCY RESPONSE/GROUP DELAY (Upper Sideband (USB))

(a) The amplitude versus frequency response of the transmitter or the receiver over the frequency range (f_0 + 300 Hz) to (f_0 + 3050 Hz) shall be within 3 dB for all types of equipment. The attenuation shall be at least 20 dB from f_0 to (f_0 - 415 Hz), at least 40 dB from (f_0 – 415 Hz) to (f_0 - 1000 Hz), and at least 60 dB below (f_0 – 1000 Hz). Attenuation shall be at least 30 dB from (f_0 + 4000 Hz) to (f_0 + 5000 Hz) and at least 60 dB above (f_0 + 5000 Hz).

(b) The group delay shall not vary by more than 0.5 ms over the passband of (f_0 + 575 Hz) to (f_0 + 2775 Hz). The group delay variation (in time) shall be within 0.15 ms per 100 Hz increment.

(c) The maximum time delay measured between the input and the output of either the transmitter or receiver shall be less than 5 ms (desirable objective 2.5 ms) over the passband of (f_0 + 300 Hz) to (f_0 + 3050 Hz).

NOTE: For radio systems having embedded waveform (e.g., data modem and/or protocol) implementations, these requirements shall be superseded by any applicable waveform requirements.

BROADBAND EMISSIONS

When the transmitter is driven to rated PEP with a single tone in the centre of the necessary bandwidth, the power spectral density of the transmitter broadband emission shall not exceed the level specified in the following table. Discrete spurs shall be excluded from the measurement, and the measurement bandwidth shall be 1 Hz. In cases where the necessary bandwidth causes a conflict with limits based on percentage offset from f_c, the less stringent limit shall apply.

Measurement Frequency (Hz)	Spectral Power Density Limit (dBc/Hz)	
	Type B Transmitters	Type A Transmitters
f_c -1.0 B $\leq f_m \leq$ f_c -0.5 B -500 Hz f_c +0.5 B +500 Hz $\leq f_m \leq$ f_c +1.0 B	–65	–75
f_c -2.5 B $\leq f_m <$ f_c -1.0 B f_c +1.0 B $< f_m \leq$ f_c +2.5 B	–70	–80
f_c -4.0 B $\leq f_m <$ f_c -2.5 B f_c +2.5 B $< f_m \leq$ f_c +4.0 B	–85	–95
MIN{0.95 f_c, f_c - 0.25 MHz} $< f_m <$ (f_c - 4.0 B) (f_c + 4.0 B) $< f_m <$ MAX{1.05 f_c, f_c + 0.25 MHz}	–95	–105
$f_m <$ MIN{0.95 f_c, f_c - 0.25 MHz} $f_m >$ MAX{1.05 f_c, f_c + 0.25 MHz}	–125	–125 (DO –140)
Where f_m = frequency of measurement (Hz) f_c = centre frequency of bandwidth (Hz) B = necessary bandwidth (Hz) DO = Desirable objective		

LINEARITY FOR 3 kHz SSB SYSTEMS

For Type B radio systems the IMD products shall be at least 24 dB (desirable objective: 30 dB) below either tone.

For Type A system the IMD products shall be at least 30 dB (desirable objective: 40 dB) below either tone.

The frequencies of the two equal-level audio test signals shall not be harmonically related and shall have a minimum separation of 300 Hz within the 3 dB bandwidth of the transmitter.

The IMD products shall be measured when the transmitter is operating at rated PEP.

SPECTRAL CONTAINMENT OF TRANSMITTED SIGNAL

(a) 99% of the total mean radiated power shall be contained within a bandwidth of 3000 Hz;

(b) For Type B radio systems, the power of any spurious emission shall be at least 40 dB below the peak envelope power within ±12 kHz of the carrier frequency and at least 50 dB below the peak envelope power at any other frequency.
For Type A radio systems, the power of any spurious emission shall be at least 40 dB below the peak envelope power within ±12 kHz of the carrier frequency, at least 60 dB below the peak envelope power between ±12 kHz and ±5% removed from the carrier frequency, and at least 80 dB below the peak envelope power at any other frequency.

(c) For Type B radio systems: Intermodulation products in the adjacent channel shall be at least 24 dB (desirable objective 30 dB) below the level of either of two equal tones modulating the transmitter at peak envelope power
For Type A radio systems: Intermodulation products in the adjacent channel shall be at least 30 dB (desirable objective 36 dB) below the level of either of two equal tones modulating the transmitter at peak envelope power.

MODULATION

(a) For analogue voice, digital voice and in-band RATT/data, the carrier shall be single side-band suppressed-carrier modulated, with the carrier and lower side band suppressed to at least 40 dB below the peak envelope power.

(b) Single-channel RATT shall be sent by two-tone FSK with a mark (or 1) frequency of 1575 Hz ±5 Hz and a space (or 0) frequency of 2425 Hz ±5 Hz (2000 Hz sub-carrier with 425 Hz shift) or two-tone FSK with a mark (or 1) frequency of 1572.5 Hz ±1 Hz and a space (or 0) frequency of 1657.5 Hz ±1 Hz (1615 Hz sub-carrier with a 42.5 Hz shift).

(c) Multi-channel RATT shall be sent by two-tone FSK of sub-carriers centred on 425 Hz, 595 Hz, 765 Hz, 935 Hz, 1105 Hz, 1275 Hz, 1445 Hz and 1615 Hz, with a sub-carrier shift of ±42.5 Hz ±1 Hz. In multi-channel fleet broadcast operation it shall be normally arranged that the channel centred on 765 Hz can be received as a single channel*).

(d) Morse telegraphy shall be sent by on-off keying of a 1000 Hz ±5 Hz tone at rates up to 30 wpm (manual) and up to 300 wpm (burst).

(e) Digital voice at 2400 bps when using the vocoder specified in STANAG 4198, shall be sent by means of a modem having the characteristics specified in STANAG 4197.

(f) For narrow band direct printing telegraphy in the maritime mobile service, the ITU has outlined parameters in the Radio Regulations. These provide for F1B emissions of 170 Hz frequency shift at a maximum rate of 100 baud. The frequency tolerance is cited as ±40 Hz for ship equipment and ±15 Hz for coast stations.

(g) Single-channel data transmissions using COMMON single channel radio equipment and sent by means of modems (internal/external) at data-rates of 75 bps and above shall be sent by the (serial-tone) waveforms as described in the referenced STANAG's 4285, 4415, 4529, 4538 and 4539. Note: ISB (6 kHz operation) may be required in order to support future enhanced data rate modes standardized in MIL-STD-188-110C Appendix F.

*) US reservation: "is not compatible with the narrow band FSK centre frequency agreed in other documents such as MIL-STD-188C where the 1232.5 Hz for a mark (or 1) and 1317.5 Hz for a space (or 0) is prescribed. Under this condition the assignment of a channel with a centre frequency of 1275 Hz is appropriate for single channel operation."

MODE OF OPERATION

Equipment shall be capable of operating in the single frequency simplex/half duplex mode; split frequency half duplex mode is highly desirable.

TRANSMIT/RECEIVE SWITCHING TIME

The change-over time between transmit and receive modes shall meet the following requirements:

(a) Transmit to receive changeover time shall not be greater than 15 ms from the keying-off of the transmitter until the receiver achieves 90% of full specified sensitivity.

(b) Receive to transmit changeover time shall not be greater than 25 ms (10 ms highly desirable) from keying-on for the transmitter to achieve 90% of full specified output power.

For radio systems having embedded waveform (e.g., data modem and/or protocol) implementations, these requirements shall be superseded by any applicable waveform requirements.

GAIN CONTROL

Transmit Automatic Level Control (ALC)

Transmitter ALC action shall be implemented in such a way as to not degrade waveform performance, i.e. switched-off and/or set very slow in data mode. Note: this is known to be a concern particularly for high order modulation schemes such as QAM (e.g. as used in STANAG 4539).

Receive Automatic Gain Control

These requirements apply to receivers that employ AGC. Any change in input level above the receiver AGC threshold shall produce an output change of less than ±3 dB.

The AGC time constants during non-data operating modes shall be as follows:

(a) Attack: <30 ms

(b) Decay: between 500 ms and 1.5 s.

The AGC time constants during single channel (not Link 11) data communications shall be as follows:

(a) Attack: <10 ms

(b) Decay: <25 ms (recommended for modes not employing amplitude modulation or PSK)

(c) Decay: between 500 ms and 1 s. (modes employing PSK or amplitude modulation, e.g. QAM).

NOTE:

1. Attack and decay times to be measured between an upper RF input level of -10 dBm and a lower RF input level of -93 dBm.
2. Attack time measured between the time at which the RF input is increased to the time when the audio output is within 3 dB of its steady-state value
3. Decay (release) time measured from the time at which the RF input is deceased to the audio output is within 3 dB of its steady-state output.

For radio systems having embedded waveform (e.g., data modem) implementations, these requirements shall be superseded by any applicable waveform requirements.

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ANNEX C INDEPENDENT SIDE-BAND (ISB) OPERATIONS

Some systems may require independent side band (ISB 6 kHz) operation in order to support enhanced data rate modes such as those standardized in MIL-STD-188-110C Appendix F.

Link 11 data link operations, where employed, shall be as per STANAG 5511 and utilize USB, LSB or ISB modes.

Lower sideband (LSB) - For LSB operation or the lower sideband during ISB operation the amplitude versus frequency response between (f_0 - 300 Hz) and (f_0 – 3050 Hz) shall be within 3 dB where f_0 is the carrier frequency. The attenuation shall be at least 20 dB from f_0 to (f_0 + 415 Hz), at least 40 dB from (f_0 + 415 Hz) to (f_0 + 1000 Hz),and at least 60 dB above (f_0 + 1000 Hz). Attenuation shall be at least 30 dB from (f_0 - 4000 Hz) to (f_0 – 5000 Hz) and at least 60 dB below (f_0 - 5000 Hz).

Upper sideband (USB) as defined under FREQUENCY RESPONSE/GROUP DELAY (Upper Sideband (USB))

AGC SSB/ISB Operation - During ISB operation the AGC shall be developed independently for the two side bands as specified in STANAG 5511. The implementation shall be such that the side band of greater magnitude controls the gain of the receiver RF stages. When in SSB mode, the receiver shall prevent any AGC voltage developed by the unused side band from controlling the RF gain.

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ANNEX D INTEROPERABILITY STANDARDS FOR WIDEBAND HF SYSTEMS

For wideband radio equipment operating with contiguous bandwidths up to 48 kHz, the following standards shall be applied in place of or in conjunction with those of Annex B, as appropriate. Unless otherwise stated, requirements apply at all rated transmit power levels including maximum rated power.

TUNING

For fixed-frequency radios operating without ALE, the frequency of the suppressed carrier shall be the reference frequency and it is mandatory that this frequency be also the display frequency (dial setting) of the RF equipment (if available).

FREQUENCY RESPONSE/GROUP DELAY

(a) The base-band amplitude versus frequency response of the transmitter and of the receiver over the range (f_0 + 300 Hz) to (f_0 + B + 50 Hz) shall be within 3 dB where B is the working bandwidth, B = N*3 kHz and f_0 is the carrier frequency. The attenuation shall be at least 20 dB from f_0 to (f_0 - 415 Hz), at least 40 dB from (f_0 – 415 Hz) to (f_0 - 1000 Hz), and at least 60 dB below (f_0 - 1000 Hz). Attenuation shall be at least 30 dB from (f_0 + B + 1000 Hz) to (f_0 + B + 2000 Hz) and at least 60 dB above (f_0 + B + 2000 Hz).

(b) The group delay shall not vary by more than 0.5 ms over the range (f_0 + 575 Hz) to (f_0 + B – 225 Hz) where f_0 is the carrier frequency and B is the working bandwidth. The group delay variation (in time) shall be within 0.15 ms per 100 Hz frequency increment.

(c) The maximum time delay measured between the input and the output of either the transmitter or receiver shall be less than 5 ms (desirable objective 2.5 ms) over this passband.

NOTE: For radio systems having embedded waveform (e.g., data modem and/or protocol) implementations, these requirements shall be superseded by any applicable waveform requirements.

MODULATION

Single-channel data transmissions using COMMON single channel radio equipment and sent by means of modems (internal/external) using a contiguous working bandwidth of an integer multiple of 3 kHz up to a maximum of 48 kHz, shall be sent by the (serial-tone) waveforms as described in the referenced MIL-STD-188-110C, Appendix D.

LINEARITY

The IMD products of HF transmitters generated by any two equal-level tones within the passband f_0 + 300 Hz to f_0 + B + 50 Hz shall be at least 24 dB (desirable objective 30 dB) below either tone for Type B radio systems, and 30 dB (desirable objective 40 dB) below either tone for Type A radio systems when the transmitter is operating at rated PEP. The frequencies of the two audio test signals shall not be harmonically or sub-harmonically related and shall have a minimum separation of 300 Hz.

PHASE NOISE

For a wideband transmission using a contiguous working bandwidth B, of an integer multiple of 3 kHz up to a maximum of 48 kHz, the requirements for phase noise are superseded by the requirements for Spectral Containment detailed below in the sense that the impact of transmit phase noise is included in the values shown in the TSO mask table, provided under Broadband Emissions.

SPECTRAL CONTAINMENT OF TRANSMITTED SIGNAL

(a) 99% of the total mean radiated power shall be contained within the necessary bandwidth, B kHz.

(b) For Type B radio systems, the power of any discrete frequency (non-harmonic) spurious emission shall be at least 40 dB below the peak envelope power within ±4B (where B = bandwidth) of the carrier frequency and at least 50 dB below the peak envelope power at any other frequency. For Type A radio systems, the power of any such spurious emission shall be at least 40 dB below the peak envelope power within ±4B of the carrier frequency, at least 60 dB below the peak envelope power between ±4B and ±5% removed from the carrier frequency, and at least 80 dB below the peak envelope power at any other frequency. These shall be measured when the HF transmitter is driven with a single tone to produce an RF output of 25 percent rated PEP.

BROADBAND EMISSIONS

When the transmitter is driven to rated PEP with any of the wideband HF waveforms specified by MIL-STD-188-110C Appendix D, the Total Spectrum Occupancy (TSO) of the transmitter broadband emission shall not exceed the levels indicated in the following table. Discrete spurs shall be excluded from the measurement, and the measurement bandwidth shall be 1 Hz. TSO is specified in dBc/Hz, with 0 dBc representing the rated peak power of a single-tone transmission.
The TSO bandwidths, in a logarithmic frequency horizontal scale, are linearly interpolated between the following points:

Total Spectrum Occupancy Limit (dBc/Hz)	**Maximum frequency band B_m around the assigned frequency F_c (Hz)**
-20 - 10*log10(B)	1.16*B
-40 - 10*log10(B)	2.56*B
-60 - 10*log10(B)	7.44*B + 20 kHz
-90 - 10*log10(B)	400 kHz
Where - B = necessary bandwidth (Hz) - F_c = assigned frequency (centre frequency) (Hz) - B_m = (double-sided) measurement frequency band (Hz)	

The spectrum mask defined above shall be fulfilled during the whole transmission period. If, for example, a training phase is needed to achieve spectral purity, this phase may need to be conducted with a reduced transmitter output power.

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ANNEX E INTEROPERABILITY STANDARDS FOR MULTICHANNEL HF SYSTEMS

For multichannel radio equipment operating with non-contiguous 3 kHz bandwidths within the Working Bandwidth, the following standards shall be applied in place of or in conjunction with those of Annex B, as appropriate. Unless otherwise stated, requirements apply at all rated transmit power levels including maximum rated power.

WORKING BANDWIDTH

Multichannel HF Communication using non-contiguous frequency channels shall comprise the use of up to sixteen 3 kHz bandwidth channels contained within a Working Bandwidth of up to a maximum of 200 kHz.

TUNING

The display frequency shall be the centre (mean) frequency of the lowest and highest 3 kHz channel frequencies used by the waveform transmission.

MODULATION

The multiple carrier modulation shall be as defined in STANAG 4539, Appendix H.

SPECTRAL CONTAINMENT OF TRANSMITTED SIGNAL

When the transmitter is driven to rated PEP with any of the wideband HF waveforms specified by the STANAG 4539 Appendix H, the power spectral density of the transmitter broadband emission shall not exceed the levels given in the following spectrum mask table.

Spectral density is specified in dBc/Hz, with the reference representing the rated peak power (PEP) of the transmission of the total waveform (including all individual 3 kHz channels).

Measurement frequency	Spectral power density limit [dBc/Hz]	
	Type B transmitters	Type A transmitters
2000 Hz ≤ f_d ≤ 3000 Hz	-65	-75
3000 Hz < f_d ≤ 4500 Hz	-70	-80
4500 Hz < f_d ≤ 12 kHz	-85	-95
12 kHz < f_d < Max{250 kHz, 5% f_c kHz}	-95	-105
Max {250 kHz, 5% f_c kHz} < f_d	-125	-125 (DO -140)
Where f_d = frequency difference to the closest carrier centre frequency f_c = centre frequency of bandwidth		

The spectrum mask defined above shall be fulfilled during the whole transmission period. If, for example, a training phase is needed to achieve spectral purity, this phase may need to be conducted with a reduced transmitter output power.

For Type B radio systems, the power of any discrete frequency (non-harmonic) spurious emission shall be at least 40 dB below the peak envelope power within ±12 kHz of each individual 3 kHz carrier frequency and at least 50 dB below the peak envelope power at any other frequency.

For Type A radio systems, the power of any such spurious emission shall be at least 40 dB below the peak envelope power within ±12 kHz of each individual carrier frequency, at least 60 dB below the peak envelope power between ±12 kHz and ±5% removed from each individual carrier frequency, and at least 80 dB below the peak envelope power at any other frequency. These shall be measured when the HF transmitter is transmitting modulated 3 kHz channels multicarrier signals at full rated PEP power.

ANNEX F REFERENCES TO MORE STRINGENT HF RADIO REQUIREMENTS IN OTHER STANAGS

1. STANAG 4444 Technical Standards for a Slow Hop HF EPM Communications System (Edition 1)

Annex B Functional Characteristics and Technical overview of a HF EPM Communications system

Chapter 4 Physical layer characteristics

Paragraph 4.3 Equipment characteristics

Table 4.3-1

2. STANAG 5511 Tactical data Exchange – Link 11/Link 11B (Edition 4)

Annex B Technical description

Chapter 3 Special functions

Chapter 4 Link 11 type of transmissions

Paragraph 4.a For ranges beyond line of sight

Chapter 5 Link 11 Frequency setting accuracy and stability

Paragraph a, b and c

Chapter 7 Equipment Technical characteristics

Paragraph 7.1 HF Transmitter

Paragraph 7.2 HF Receiver

ANNEX F TO
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IMPLEMENTATION MATRIX

The table below denotes which STANAG may apply for the implementation of each system or technology given in the columns. This matrix is inevitably subject to change due to developments in NATO standardization and therefore has to be regarded as indicative.

STANAG (Mil-Std)	Link11 HF	Link22 HF	HF EPM	ARCS 3G ALE	BRASS BCT	BRASS S/S	HF email	WBHF
4203	X	X	X	X	X	X	X	X
4285					X	X	X	
4415								
4444			X					
4481					X			
4529					X	X		
4538				X				
4539							X	X
5066						X	X	
5511	X							
5522		X						
MIL-STD-188-110C								X

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