

DEFENSE INFORMATION SYSTEMS AGENCY

**JOINT INTEROPERABILITY TEST COMMAND
FORT HUACHUCA, ARIZONA**



**STANAG 4529
CONFORMANCE
TEST PROCEDURES**

APRIL 2004

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CONFORMANCE
TEST PROCEDURES**

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INTRODUCTION

The North Atlantic Treaty Organization Standardization Agreement (STANAG) 4529 establishes mandatory standards and design objectives that are necessary to ensure conformance for single-tone data modulators-demodulators (modems) for Maritime High Frequency (HF) radios, which establish links using 1240-Hertz (Hz) bandwidth signals.

This document contains the test procedures that will be used to determine the level of compliance of single-tone data modems to the requirements of STANAG 4529. This test plan is intended to be generic and can be used to test any equipment that requires conformance to the STANAG 4529.

If test item performance does not meet a requirement, the failure and its potential operational impact will be discussed in the follow-on test report and/or certification letter. Any requirement capabilities that are not implemented will also be discussed.

The Joint Interoperability Test Command will conduct testing at Fort Huachuca, Arizona.

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TEST PROCEDURES

MODULATION RATES, DATA RATES, TIMING, AND SYNCHRONIZATION

1.1 Objective. To determine the extent of compliance to the requirements of Standardization Agreement (STANAG) 4529, reference numbers 1-17.

1.2 Criteria

a. This document describes the modulation, call establishment process, and data correction required to ensure interoperability between modems transmitting data over High Frequency (HF) radio links where the data rate at the digital interface may be 75, 150, 300, 600, or 1200 bits per second (bps). The rate at which data (user data bits plus bits for error correction coding) is transmitted (i.e., the channel data rate) may be a 600 bps (when the user data rate is 75, 150, or 300 bps), 1200 bps (when the user data rate is 600 bps), or 1800 bps (when the user data rate is 1200 bps). The equipment may also be used for uncoded data transmission in which data input to a modulator's digital interface is transmitted without the addition of the error correction coding and interleaving described in paragraph 10. The uncoded modes provide data rates of 600, 1200, and 1800 bps. (appendix B, reference numbers 1 and 2)

b. The modulation technique consists of phase shifting of a subcarrier frequency that is selectable in 100-hertz (Hz) steps from 800 to 2400 Hz inclusive. Modulation speed is 1200 bauds with a minimum accuracy of 1 part in 10^5 . The accuracy of the clock linked with the generation of the subcarrier frequency is 1 part in 10^5 . The phase shift of the modulated signal relative to the unmodulated reference subcarrier may take one of the specified values in table 1.1 and figure 1.1. (appendix B, reference numbers 3-5)

Table 1.1. Symbol Number and Phase Conversion

Symbol Number (n)	Phase
0	0
1	$\pi/4$
2	$\pi/2$
3	$3\pi/4$
4	π
5	$5\pi/4$
6	$3\pi/2$
7	$7\pi/4$

Note: The complex number $\exp[jn\pi/2]$ is linked with the symbol number n, where j is the imaginary number $\sqrt{-1}$.

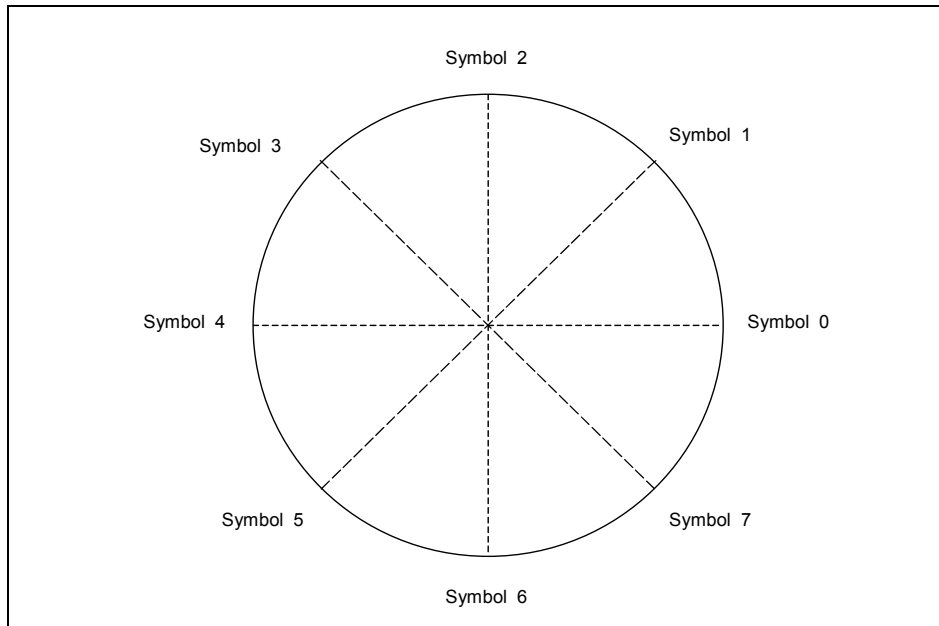


Figure 1.1. Phase State Encoding

c. For the 600 bps channel data rate (75, 150, and 300 bps user data rates), transcoding is achieved by linking one symbol to one bit according to table 1.2. For the 1200 bps channels data rate (600 bps user data rate), transcoding is achieved by linking one symbol to a set of two consecutive bits (dibit) according to table 1.3. For the 1800 bps channel data rate (1200 bps user data rate), transcoding is achieved by linking one symbol to a set of three consecutive bits (tribit) according to table 1.4. (appendix B, reference numbers 6-8)

Table 1.2. Bit Value and Symbol Linking for 600 bps Channel Rate

Bit	Symbol
0	0
1	4

Table 1.3. Bit Value and Symbol Linking for 1200 bps Channel Rate

Dibit	Symbol
00	0
01	2
11	4
10	6
↑ Most recent bit	

Table 1.4. Bit Value and Symbol Linking for 1800 bps Channel Rate

Tribit	Symbol
000	1
001	0
010	2
011	3
100	6
101	7
110	5
111	4
↑ Most recent bit	

d. The power spectral density of the modulated signal shall be centered on a frequency that is selectable in 100 Hz to 2400 Hz inclusive, with a default value of 1700 Hz. Filtering shall be applied as necessary so that 99 percent (%) of the output power is within 1240 Hz. (appendix B, reference numbers 9-10)

e. The symbols to be transmitted are structured in recurrent frames 213.3 milliseconds (ms) in length as shown in figure 1.2. A frame consists of 256 symbols. A frame can be broken down into: 80 symbols for synchronization, 48 reference symbols, and 128 data symbols. The 176 reference and data symbols are scrambled by a scrambling sequence with eight-phase-states of length 176. The reference and data symbols are formed into 4 blocks: the first 3 consist of 32 data symbols followed by 16 reference symbols; the last block consists of 32 symbols. The reference symbols are all symbol number 0. (appendix B, reference number 11)

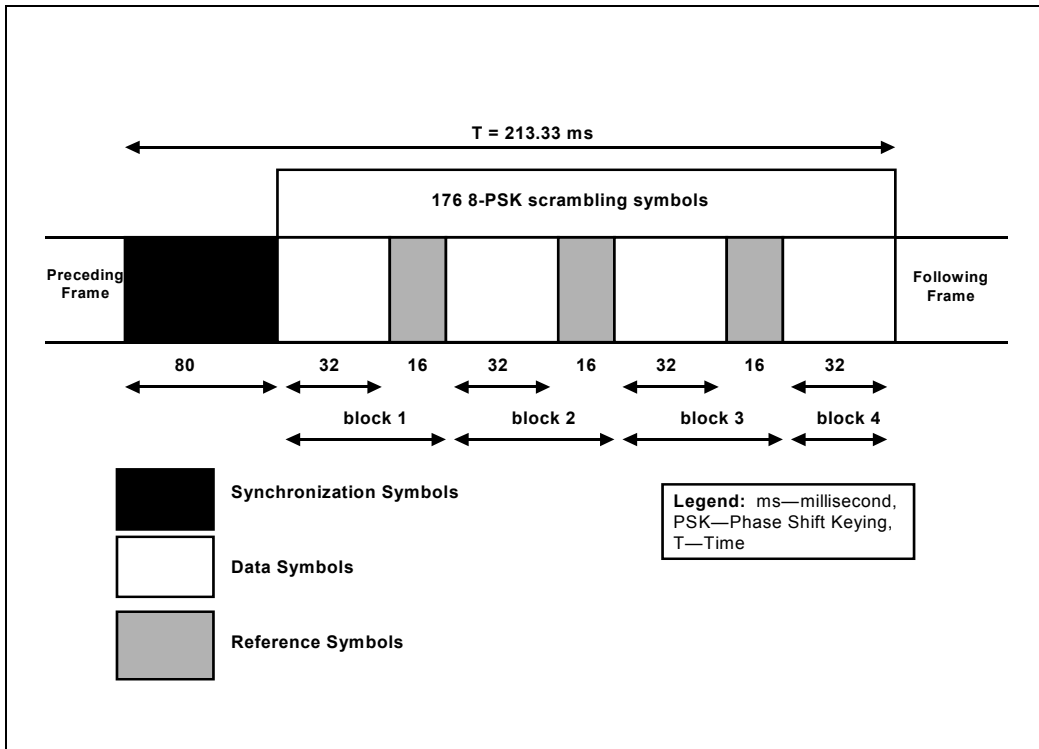


Figure 1.2. Frame Structure

f. The synchronization consists of 80 symbols and is transmitted recurrently every 213.3 ms. This sequence uses 2-bit phase shift keying (2-PSK) modulation and the modulation rate is equal to 1200 bauds. The sequence is identical to a pseudo-random sequence of length 31, which is repeated periodically within the 80-symbol window, i.e., the synchronization sequence consists of 2 periods of length 31 plus the first 18 symbols of another period. A generator for the synchronization sequence is described in figure 1.3. The generator polynomial is: $x^5 + x^2 + 1$. At the beginning of every frame the generator is initially set to the following value: 11010. The first symbol of the synchronization sequence is identical to the least significant bit of this initial value. The remaining 79 symbols are obtained by applying the clock 79 times. (appendix B, reference number 12)

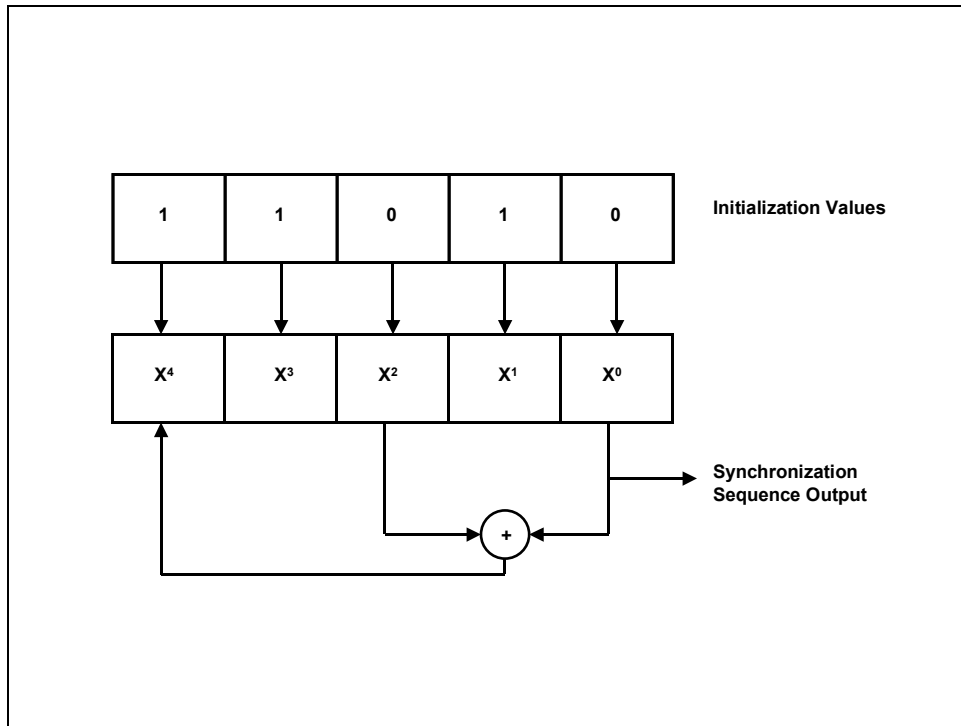


Figure 1.3. Synchronization Sequence Generator

g. The scrambling sequence is composed of 176 symbols and is repeated every 213.3 ms. This sequence is transmitted in eight-phase-state modulation at the rate of 1200 bauds. Data scrambling by an eight-phase-state sequence is done to maintain commonality with STANAG 4285 implementations. The scrambling symbol generator is shown in figure 1.4. The symbols are formed by means of a pseudo-random code of length 511, the generator polynomial of which is: $x^9 + x^4 + 1$. The generator is initialized to 1 at the start of each frame. A symbol is derived from the triplet consisting of the last three bits in the Pseudo-random Numerical (PN) register, i.e., $x_0 x_1 x_2$ by the following relationship:

$$\text{Scrambling symbol } B_k = \exp[jn\pi/4]$$

Where:

$$n = 4x_2 + 2x_1 + x_0$$

$$x_0 = 0 \text{ or } 1$$

$$x_1 = 0 \text{ or } 1$$

$$x_2 = 0 \text{ or } 1$$

Generation from one symbol to the next is by successive shifting of the PN register by three positions. (appendix B, reference number 13)

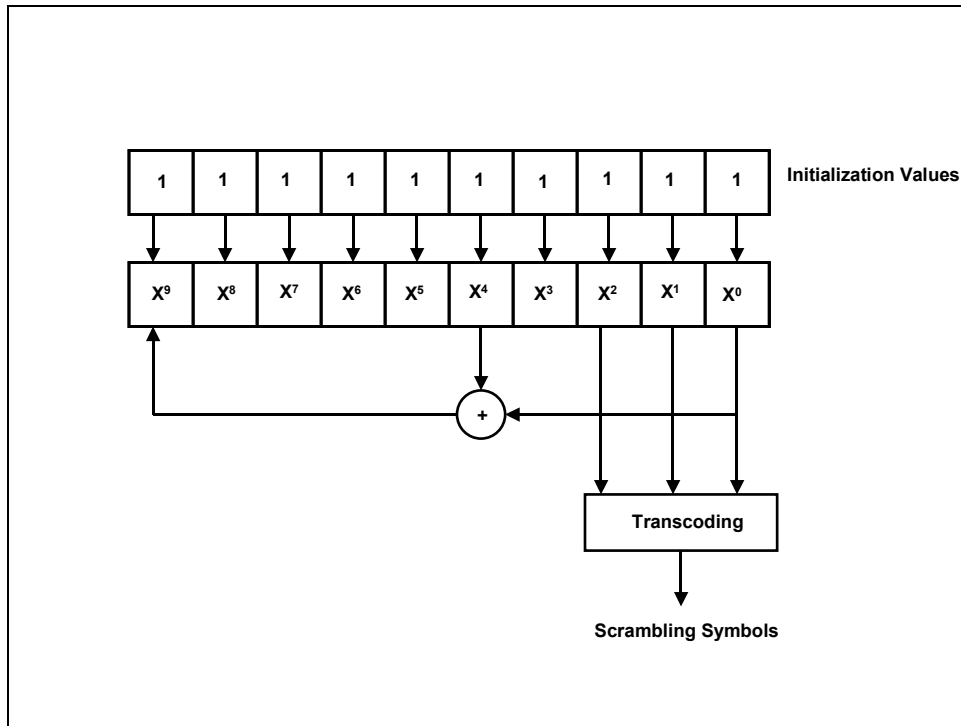


Figure 1.4. Generation of Scrambling Sequence

h. The scrambling operation is carried out on reference and data symbols only, not on the synchronization sequence. This operation consists of module 8 addition of the data symbol number to the scrambling symbol number; this amounts to complex multiplication of the data symbol by the scrambling symbol. (appendix B, reference number 14)

i. The modem must be capable of tolerating a frequency error of ± 37.5 Hz between the transmission and reception of HF carriers (transmitter/receiver frequency error and Doppler shift included) and rate of frequency change of up to 3.5 Hz/second (sec). (appendix B, reference number 15)

j. For the error correction modes defined in this STANAG, the error correction coding used shall be the rate $\frac{1}{2}$, constraint length 7 convolutional coding as described STANAG 4285, annex E. For each user data rate described in this STANAG (i.e., 75, 150, 300, 600, and 1200 bps) the coding, interleaving, and flush bits shall be as described for the higher data rate in STANAG 4285, annex E. The changes necessary to allow 1240-Hz operation are explicitly shown, in table 1.5. The error correction coding used shall be as in STANAG 4285, annex E, section 2 with the following changes as shown in table 1.5.

Table 1.5. Error Correction Coding

Coded data area	Waveform	Effective code rate	Coding method
1200 bps	8 phase (1800 bps)	2/3	Rate 1/2 punctured to rate 2/3
600 bps	4 phase (1200 bps)	1/2	Rate 1/2 code
300 bps	2 phase (600 bps)	1/2	Rate 1/2 code
150 bps	2 phase (600 bps)	1/4	Rate 1/2 code repeated 2x
75 bps	2 phase (600 bps)	1/8	Rate 1/2 code repeated 4x

Legend: bps—bits per second

The interleaving shall be as described in STANAG 4285, annex E, section 3 with the following different parameters:

Number of rows: $I = 32$ for all data rates

Delay increment “j” for each successive row:

Total Interleaving Delay:

Data rates	20.48 sec	1.706 sec
1200 bps	48	4
600 bps	24	2
300, 150 and 75 bps	12	1

Interleaver synchronization shall be as described in STANAG 4285, annex E, part 4 with no changes. The initialization and message protocol for use with coding and interleaving shall be as described in STANAG 4285, annex E, part 5 with the following difference:

The number of flush zeros for each of the data rates and the two interleaver lengths are as follows: (appendix B, reference number 16)

Interleaver Delay

Data rate	20.48 sec	1.706 sec
1200 bps	24678	2150
600 bps	12390	1126
300 bps	6246	614
150 bps	3174	358
75 bps	1638	230

k. Modems shall provide uncoded data transmission modes, in which the coding, interleaving, and associated initialization and message protocols (described in section 10 of STANAG 4529) are not applied to the data transmitted. Uncoded data modes shall retain all other characteristics described in STANAG 4529, annex A, paragraph 11. Uncoded data rates of 600, 1200, and 1800 bps shall be provided. (appendix B, reference number 17)

1.3 Test Procedures

a. Test Equipment Required

- (1) Bit Error Rate Tester (BERT) (2 each)
- (2) Vector Signal Analyzer
- (3) Personal Computer
- (4) Spectrum Analyzer
- (5) Unit Under Test (UUT)
- (6) High Frequency (HF) Simulator
- (7) Modem (similar to UUT)

b. Test Configuration. Figures 1.5, 1.6, 1.7, and 1.8 shows the equipment setup for this test.

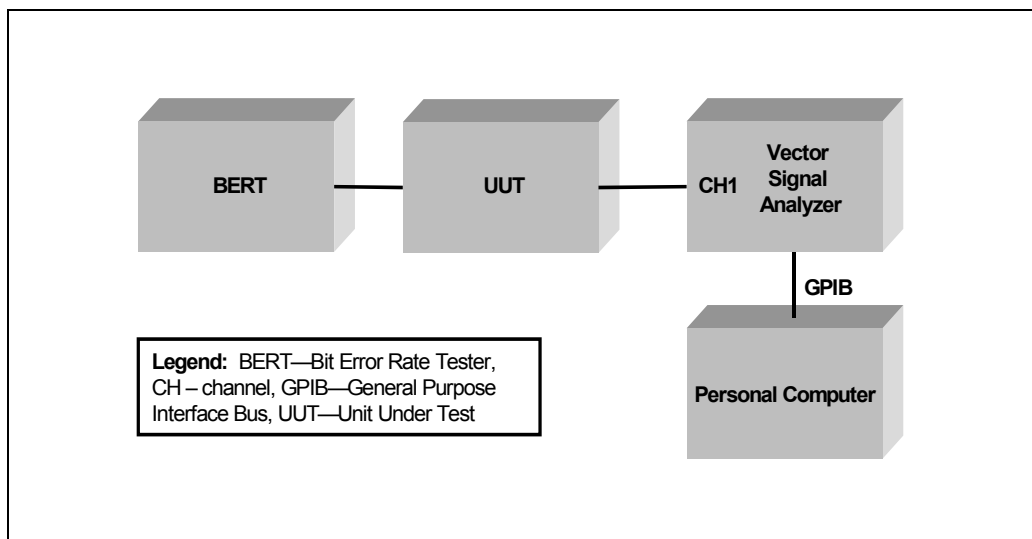


Figure 1.5. Equipment Configuration for Data Analysis

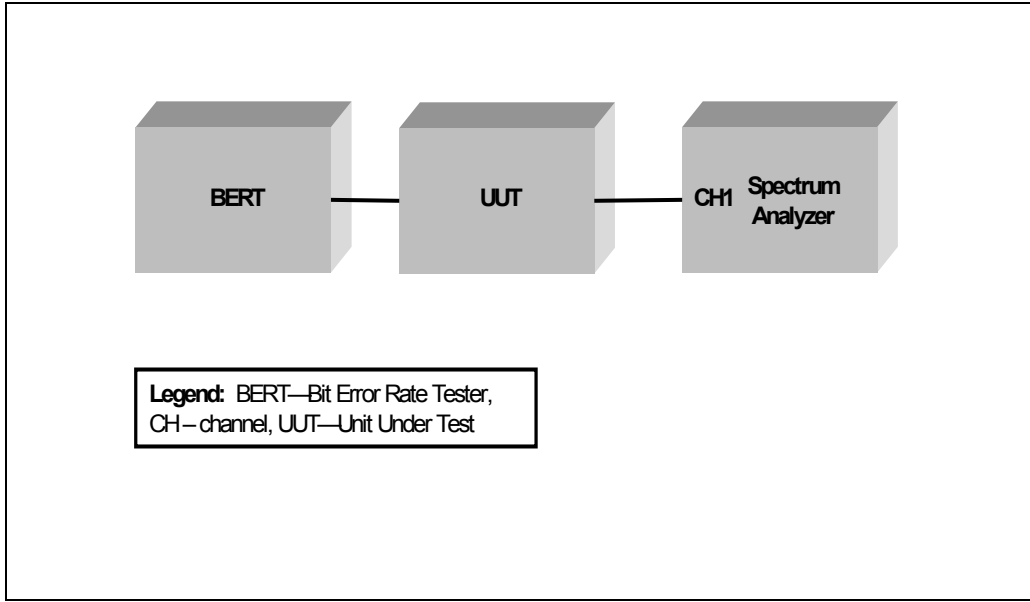


Figure 1.6. Equipment Configuration for Output Power Measurements

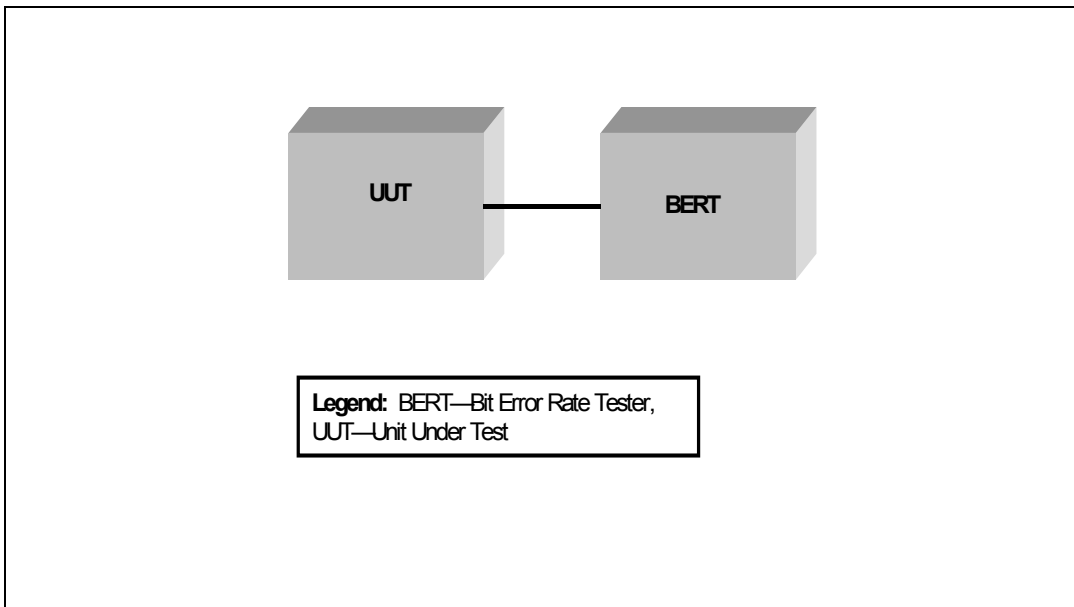


Figure 1.7. Equipment Configuration for Clock Accuracy

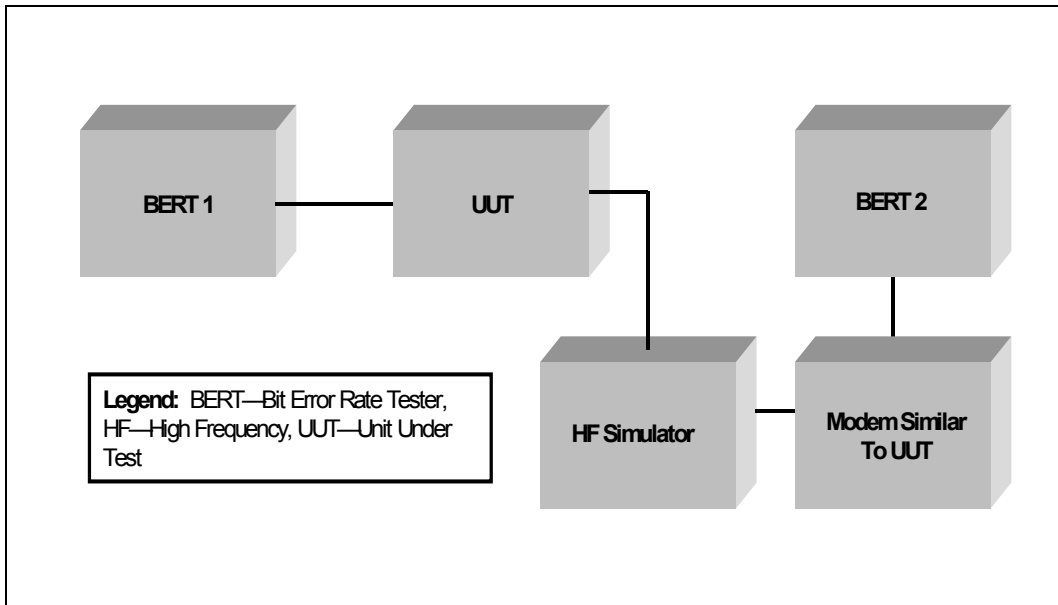


Figure 1.8. Equipment Configuration for Frequency Error

- c.** Test Conduct. The procedures for this test are listed in table 1.6.

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures

Step	Action	Settings/Action	Result
The following procedures are for reference numbers 1, 2, and 12.			
1	Set up equipment.	Set up equipment as shown in figure 1.5. Configure the vector analyzer so its phase state diagram is as specified in figure 1.1 and tables 1.2, 1.3, and 1.4.	
2	Configure vector signal analyzer.	Frequency Center: 2 kHz Span: 1.24 kHz Time Result Length: 2000 symbols Search Length: 853.33 ms Sync Setup Pattern: 01011001111100011011 Offset: 0 symbols Instrument Mode Digital Demodulation Demodulation Setup Demodulation Format: BPSK Symbol Rate: 1.2 kHz Result Length: 1000 symbols Reference Filter: Raised Cos Meas Filter: Root Raised Cos Alpha: 0.16 Sweep: Single Trigger Trigger Type: IF CH1 Configure state constellation diagram as given in figure 1.1.	
3	Configure UUT.	Configure the UUT to transmit using a STANAG 4529 coded, 75 bps, short interleaving waveform. Configure the subcarrier frequency to 2000 Hz.	
4	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
5	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
6	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
7	Re-configure UUT.	Re-configure the UUT to transmit with coded, 75 bps, long interleaving.	
8	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
9	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
10	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
11	Re-configure UUT.	Re-configure the UUT to transmit with coded, 150 bps, short interleaving.	
12	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
13	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
14	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
15	Re-configure UUT.	Re-configure the UUT to transmit with coded, 150 bps, long interleaving.	
16	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
17	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
18	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
19	Re-configure UUT.	Re-configure the UUT to transmit with coded, 300 bps, short interleaving.	
20	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
21	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
22	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
23	Re-configure UUT.	Re-configure the UUT to transmit with coded, 300 bps, long interleaving.	
24	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
25	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
26	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
27	Re-configure UUT.	Re-configure the UUT to transmit with coded, 600 bps, short interleaving.	
28	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
29	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
30	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
31	Re-configure UUT.	Re-configure the UUT to transmit with coded, 600 bps, long interleaving.	
32	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
33	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
34	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
35	Re-configure UUT.	Re-configure the UUT to transmit with coded, 1200 bps, short interleaving.	
36	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
37	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
38	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
39	Re-configure UUT.	Re-configure the UUT to transmit with coded, 1200 bps, long interleaving.	
40	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
41	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
42	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
43	Re-configure vector signal analyzer.	Re-configure the vector signal analyzer's demodulation format to BPSK and to sync on the following sequence: 01011001111100011011.	
44	Re-configure UUT.	Re-configure the UUT to transmit with uncoded, 600 bps (if available).	
45	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
46	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
47	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
48	Re-configure UUT.	Re-configure the UUT to transmit with uncoded, 1200 bps (if available).	
49	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
50	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
51	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
52	Re-configure UUT.	Re-configure the UUT to transmit with uncoded, 1800 bps (if available).	
53	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
54	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
55	Verify vector signal analyzer was able to synchronize.	On the vector signal analyzer screen, compare the following BPSK synchronization sequence pattern to the pattern that the vector signal analyzer synchronized on: 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0 1 1 1 0 1 0 1 0 0 0 0 1 0 0 1 0 1 1 0 0 1 1 1 1 1 0 0 0 1 1 0	
The following procedures are for reference numbers 5-8, 11, 13-14, and 16.			
56	The following procedures use automated software to decode STANAG 4529 data transmitted from the UUT. The test operator must program the UUT to transmit the following test pattern: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII. The automated software is available for download from the JITC website: http://jitc.fhu.disa.mil/it/hf.htm	Successful decode of the STANAG 4529 data validates that the following requirements have been met: FEC encoder, interleaver, frame synchronization symbols, scrambler, reference symbols, frame structure, and transcoding.	
57	Copy and paste STANAG4529.vi file onto hard disk of personal computer containing LabVIEW software.	Copy and paste 4529.STA file onto a 3.5-inch floppy disk. Insert floppy disk into drive a: of vector signal analyzer.	
58	Connect the UUT to channel 1 of the vector signal analyzer.	Connect the vector signal analyzer to personal computer via the GPIB interface.	
59	Load LabVIEW software.	Open STANAG4529.vi.	
60	Program the UUT to send STANAG 4529 data at coded 75 bps, using the short interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
61	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
62	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
63	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
64	Program the UUT to send STANAG 4529 data at coded 75 bps, using the long interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
65	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
66	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
67	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
68	Program the UUT to send STANAG 4529 data at coded 150 bps, using the short interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
69	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
70	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
71	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
72	Program the UUT to send STANAG 4529 data at coded 150 bps, using the long interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
73	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
74	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
75	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
76	Program the UUT to send STANAG 4529 data at coded 300 bps, using the short interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
77	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
78	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
79	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
80	Program the UUT to send STANAG 4529 data at coded 300 bps, using the long interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
81	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
82	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
83	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
84	Program the UUT to send STANAG 4529 data at coded 600 bps, using the short interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
85	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.	Re-configure the vector signal analyzer Demodulation Setup: Demodulation Format to 4-PSK.	
86	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
87	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
88	Program the UUT to send STANAG 4529 data at coded 600 bps, using the long interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
89	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
90	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
91	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
92	Program the UUT to send STANAG 4529 data at coded 1200 bps, using the short interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
93	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.	Re-configure the vector signal analyzer Demodulation Setup: Demodulation Format to 8-PSK.	
94	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
95	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
96	Program the UUT to send STANAG 4529 data at coded 1200 bps, using the long interleaver and a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
97	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.		
98	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
99	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
The following procedures are for reference number 17.			
100	Program the UUT to send STANAG 4529 data at uncoded 600 bps, using a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
101	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.	Re-configure the vector signal analyzer Demodulation Setup: Demodulation Format to BPSK.	
102	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
103	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
104	Program the UUT to send STANAG 4529 data at uncoded 1200 bps, using a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
105	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.	Re-configure the vector signal analyzer Demodulation Setup: Demodulation Format to 4-PSK.	
106	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	
107	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
108	Program the UUT to send STANAG 4529 data at uncoded 1800 bps, using a subcarrier frequency of 2000 Hz.	Ensure that the UUT is in the idle state (not sending).	
109	Use the automated software's Test Information box to select data rate, interleaver, and uncoded/coded type.	Re-configure the vector signal analyzer Demodulation Setup: Demodulation Format to 8-PSK.	
110	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern stated in step 56.	

Step	Action	Settings/Action	Result
111	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
The following procedures are for reference number 3.			
112	Configure vector signal analyzer.	Frequency Center: 800 Hz Span: 1.24 kHz Time Result Length: 2000 symbols Search Length: 853.33 ms Sync Setup Pattern: 01011001111100011011 Offset: 0 symbols Instrument Mode Digital Demodulation Demodulation Setup Demodulation format: BPSK Symbol Rate: 1.2 kHz Result Length: 1000 symbols Reference Filter: Root Raised Cos Meas Filter: Root Raised Cos Alpha: 0.16 Sweep: Single Trigger Trigger Type: IF CH1 Configure state constellation diagram as given in figure 1.1	
113	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 800 Hz.	
114	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
115	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
116	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
117	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
118	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 900 Hz.	
119	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 900 Hz.	
120	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
121	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
122	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
123	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
124	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1000 Hz.	
125	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1000 Hz.	
126	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
127	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
128	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
129	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
130	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1100 Hz.	
131	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1100 Hz.	
132	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
133	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
134	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
135	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
136	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1200 Hz.	
137	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1200 Hz.	
138	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
139	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
140	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
141	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
142	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1300 Hz.	
143	Configure UUT.	Configure the UUT to transmit with coded, 600 bps, short interleaving. Configure the subcarrier frequency to 1300 Hz.	
144	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
145	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
146	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
147	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
148	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1400 Hz.	
149	Configure UUT.	Configure the UUT to transmit with coded, 600 bps, short interleaving. Configure the subcarrier frequency to 1400 Hz.	
150	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
151	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
152	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
153	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
154	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1500 Hz.	
155	Configure UUT.	Configure the UUT to transmit with coded, 600 bps, short interleaving. Configure the subcarrier frequency to 1500 Hz.	
156	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
157	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
158	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
159	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
160	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1600 Hz.	
161	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1600 Hz.	
162	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
163	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
164	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
165	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
166	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1700 Hz.	
167	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1700 Hz.	
168	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
169	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
170	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
171	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
172	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1800 Hz.	
173	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1800 Hz.	
174	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
175	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
176	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
177	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
178	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 1900 Hz.	
179	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 1900 Hz.	
180	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
181	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
182	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
183	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
184	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 2000 Hz.	
185	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 2000 Hz.	
186	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
187	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
188	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
189	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
190	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 2100 Hz.	
191	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 2100 Hz.	
192	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
193	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
194	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
195	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
196	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 2200 Hz.	
197	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 2200 Hz.	
198	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
199	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
200	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
201	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
202	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 2300 Hz.	
203	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 2300 Hz.	
204	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
205	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
206	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	
207	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
208	Re-configure center frequency on vector signal analyzer.	Re-configure the vector signal analyzer's center frequency setting to 2400 Hz.	
209	Configure UUT.	Configure the UUT to transmit with coded, 300 bps, short interleaving. Configure the subcarrier frequency to 2400 Hz.	
210	Configure BERT.	Configure the BERT to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
211	Transmit data.	Allow for the BERT to transmit its data through the UUT. Save the data captured on the vector signal analyzer to a file.	
212	Run STANAG4529.vi file.	Observe vector signal analyzer. When analyzer displays "Waiting for Trigger," key the modem and begin sending test pattern in step 114.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
213	Automated software will run for several minutes.	Record results of software decode. (Note that the operator may choose to view the raw data captured on the vector signal analyzer). Save encoded data to file.	
The following procedures are for reference numbers 9 and 10.			
214	Set up equipment.	Set up the equipment as shown in figure 1.6.	
215	Configure spectrum analyzer.	Frequency Channel Center Frequency: 1.7 kHz Span Span: 3 kHz Input/Output RF Coupling: DC Measure Occupied Bandwidth Measure Setup Occupied Bandwidth: 99%	
216	Configure BERT.	Configure the BERT to transmit the MARK pattern.	
217	Configure UUT.	Configure the UUT to transmit with a subcarrier frequency of 1.7 kHz with coded 600 bps and short interleaving.	
218	Verify occupied bandwidth.	Record the 99% occupied bandwidth frequency.	
The following procedures are for reference number 4.			
219	Set up equipment.	Set up the equipment as shown in figure 1.7.	
220	Configure BERT.	Analysis Results Signal: Received Frequency	
221	Verify frequency.	The frequency the BERT is receiving from the UUT will be displayed under "Received Frequency." Record the Received Frequency.	
The following procedures are for reference number 15.			
222	Set up equipment.	Set up the equipment as shown in figure 1.8.	
223	Configure BERT1.	Configure the BERT1 to transmit: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG 0123456789" using 7-bit ASCII.	
224	Configure BERT2.	Analysis Results Error: Bit Errors	
225	Configure HF Simulator.	Frequency Offset: 37.5 Hz Sweep Rate: 3.5 Hz/sec	
226	Configure UUT.	Configure the UUT to transmit with coded, 600 bps, short interleaving. Configure the subcarrier frequency to 1700 Hz.	

Table 1.6. Modulation Rates, Data Rates, Timing, and Synchronization Procedures (continued)

Step	Action	Settings/Action	Result
227	Run test.	Program BERT1 to transmit its message through the UUT for 5 minutes.	
228	Determine bit errors.	Record the number of bit errors received by BERT2.	
<p>Legend: ASCII—American Standard Code for Information Interchange; BERT—Bit Error Rate Tester; bps—bits per second; BPSK—Binary Phase Shift Keying; CH1—Channel 1; Cos—Cosine; DC—Direct Current; FEC—Forward Error Correction; GPIB—General Purpose Interface Bus; HF—High Frequency; Hz—Hertz; IF—Intermediate Frequency; JITC—Joint Interoperability Test Command; kHz—Kilohertz; Meas—Measured; ms—millisecond; PSK—Phase Shift Keying; RF—Radio Frequency; sec—second; STANAG—Standardization Agreement; Sync—Synchronization; UUT—Unit Under Test</p>			

1.4. Presentation of Results. The results will be shown in table 1.7 indicating the requirement and measured value or indications of capability.

Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
1	1a	This document describes the modulation; call establishment process, and data correction required to ensure interoperability between modems transmitting data over HF radio links where the data rate at the digital interface may be 75, 150, 300, 600, or 1200 bps. The rate at which data (user data bits plus bits for error correction coding) is transmitted (i.e., the channel data rate) may be a 600 bps (when the user data rate is 75, 150, or 300 bps), 1200 bps (when the user data rate is 600 bps), or 1800 bps (when the user data rate is 1200 bps).	Modem provides coded data rates of 75, 150, 300, 600, and 1200 bps.			
2	1b	The equipment may also be used for uncoded data transmission in which data input to a modulator's digital interface is transmitted without the addition of the error correction coding and interleaving described in paragraph 10. The uncoded modes provide data rates of 600, 1200, and 1800 bps.	(optional) Modem provides uncoded data rates of 600, 1200, and 1800 bps.			
3	2a	The modulation technique consists of phase shifting of a subcarrier frequency that is selectable in 100-Hz steps from 800 to 2400 Hz inclusive.	Subcarrier frequency selectable in 100 Hz increments with a range of 800 to 2400 Hz.			
4	2b	Modulation speed is 1200 bauds with a minimum accuracy of 1 part in 10^5 . The accuracy of the clock linked with the generation of the subcarrier frequency is 1 part in 10^5 .	Received frequency on BERT is 1200.00 Hz.			

**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding																			
			Required Value	Measured Value	Met	Not Met																		
5	2c	<p>The phase shift of the modulated signal relative to the unmodulated reference subcarrier may take one of the following values. (see figure A-1).</p> <table border="0"> <tr> <td align="center">Symbol Number</td> <td align="center">Phase</td> </tr> <tr> <td align="center">0</td> <td align="center">0</td> </tr> <tr> <td align="center">1</td> <td align="center">$\pi/4$</td> </tr> <tr> <td align="center">2</td> <td align="center">$\pi/2$</td> </tr> <tr> <td align="center">3</td> <td align="center">$3\pi/4$</td> </tr> <tr> <td align="center">4</td> <td align="center">π</td> </tr> <tr> <td align="center">5</td> <td align="center">$5\pi/4$</td> </tr> <tr> <td align="center">6</td> <td align="center">$3\pi/2$</td> </tr> <tr> <td align="center">7</td> <td align="center">$7\pi/4$</td> </tr> </table> <p>The complex number $\exp[jn\pi/2]$ is linked with the symbol number n.</p>	Symbol Number	Phase	0	0	1	$\pi/4$	2	$\pi/2$	3	$3\pi/4$	4	π	5	$5\pi/4$	6	$3\pi/2$	7	$7\pi/4$	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			
Symbol Number	Phase																							
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5	$5\pi/4$																							
6	$3\pi/2$																							
7	$7\pi/4$																							
6	3a	<p>For the 600 bps channel data rate (75, 150, and 300 bps user data rates), transcoding is achieved by linking one symbol to one bit according to the following rule:</p> <table border="0"> <tr> <td align="center">Bit</td> <td align="center">Symbol</td> </tr> <tr> <td align="center">0</td> <td align="center">0</td> </tr> <tr> <td align="center">1</td> <td align="center">4</td> </tr> </table>	Bit	Symbol	0	0	1	4	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.															
Bit	Symbol																							
0	0																							
1	4																							
7	3b	<p>For the 1200 bps channels data rate (600 bps user data rate), transcoding is achieved by linking one symbol to a set of two consecutive bits (dibit) according to the following rule:</p> <table border="0"> <tr> <td align="center">Dibit</td> <td align="center">Symbol</td> </tr> <tr> <td align="center">00</td> <td align="center">0</td> </tr> <tr> <td align="center">01</td> <td align="center">2</td> </tr> <tr> <td align="center">11</td> <td align="center">4</td> </tr> <tr> <td align="center">10</td> <td align="center">6</td> </tr> <tr> <td align="center">↑</td> <td></td> </tr> <tr> <td align="center" colspan="2">Most recent bit</td> </tr> </table>	Dibit	Symbol	00	0	01	2	11	4	10	6	↑		Most recent bit		STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.							
Dibit	Symbol																							
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**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding																							
			Required Value	Measured Value	Met	Not Met																						
8	3c	<p>For the 1800 bps channel data rate (1200 bps user data rate), transcoding is achieved by linking one symbol to a set of three consecutive bits (tribit) according to the following rule:</p> <table border="0" style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding-right: 20px;">Tribit</td> <td>Symbol</td> </tr> <tr> <td>000</td> <td>1</td> </tr> <tr> <td>001</td> <td>0</td> </tr> <tr> <td>010</td> <td>2</td> </tr> <tr> <td>011</td> <td>3</td> </tr> <tr> <td>100</td> <td>6</td> </tr> <tr> <td>101</td> <td>7</td> </tr> <tr> <td>110</td> <td>5</td> </tr> <tr> <td>111</td> <td>4</td> </tr> <tr> <td align="center">↑</td> <td></td> </tr> <tr> <td align="center" colspan="2">Most recent bit</td> </tr> </table>	Tribit	Symbol	000	1	001	0	010	2	011	3	100	6	101	7	110	5	111	4	↑		Most recent bit		STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			
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9	4	The power spectral density of the modulated signal shall be centered on a frequency that is selectable in 100-Hz steps from 800 Hz to 2400 Hz inclusive, with a default value of 1700 Hz.	Power spectral density centered at 1700 Hz.																									
10	4	Filtering shall be applied as necessary so that 99% of the output power is within 1240 Hz.	99% output power contained within 1240 Hz.																									
11	5	The symbols to be transmitted are structured in recurrent frames 213.3 ms is length. A frame consists of 256 symbols. A frame can be broken down into: 80 symbols for synchronization, 48 reference symbols and 128 data symbols. The 176 reference and data symbols are scrambled by a scrambling sequence with eight-phase-states of length 176. The reference and data symbols are formed into 4 blocks: the first 3 consist of 32 data symbols followed by 16 reference symbols: the last block consists of 32 symbols. The reference symbols area all symbol number 0.	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.																									

**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
12	6	<p>The synchronization consists of 80 symbols and is transmitted recurrently every 213.3 ms. This sequence uses 2PSK modulation and the modulation rate is equal to 1200 bauds.</p> <p>The sequence is identical to a pseudo random sequence of length 31, which is repeated periodically within the 80 symbol window, i.e., the synchronization sequence consists of 2 periods of length 31 plus the first 18 symbols of another period. A generator for the synchronization sequence is described in figure A-4. The generator polynomial is: $x^5 + x^2 + 1$.</p> <p>At the beginning of every frame the generator is initially set to the following value: 11010.</p> <p>The first symbol of the synchronization sequence is identical to the least significant bit of this initial value. The remaining 79 symbols are obtained by applying the clock 79 times.</p>	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			

**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
13	7	<p>The scrambling sequence is composed of 176 symbols and is repeated every 213.3 ms. This sequence is transmitted in eight-phase-state modulation at the rate of 1200 bauds. Data scrambling by an eight-phase-state sequence is done to maintain commonality with STANAG 4285 implementations. The scrambling signal generator is shown in figure A-5. The symbols are formed by means of a pseudo-random code of length 511, the generator polynomial of which is: $x^9 + x^4 + 1$. The generator is initialized to 1 at the start of each frame. A symbol is derived from the triplet consisting of the last three bits in the PN register, i.e., $x_0 x_1 x_2$ by the following relationship: Scrambling symbol $B_k = \exp[jn\pi/4]$ Where: $n = 4x_2 + 2x_1 + x_0$</p> <p>$x_0 = 0$ or 1 $x_1 = 0$ or 1 $x_2 = 0$ or 1 Generation from one symbol to the next is by successive shifting of the PN register by three positions.</p>	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			
14	8	<p>The scrambling operation is carried out on reference and data symbols only, not on the synchronization sequence. This operation consists of modulo 8 addition of the data symbol number to the scrambling symbol number; this amounts to complex multiplication of the data symbol by the scrambling symbol.</p>	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			

**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
15	9	The modem must be capable of tolerating a frequency error of +/-37.5 Hz between the transmission and reception of HF carriers (transmitter/receiver frequency error and Doppler shift included) and rate of frequency change of up to 3.5 Hz/sec.	0 Bit Errors.			

**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding																																					
			Required Value	Measured Value	Met	Not Met																																				
16	10	<p>For the error correction modes defined in this STANAG, the error correction coding used shall be the rate $\frac{1}{2}$, constraint length 7 convolutional coding as described STANAG 4285, annex E. For each user data rate described in this STANAG (i.e., 75, 150, 300, 600, and 1200 bps) the coding, interleaving, and flush bits shall be as described for the higher data rate in STANAG 4285, annex E. The changes necessary to allow 1240-Hz operation are explicitly shown below:</p> <p>The error correction coding used shall be as in STANAG 4285, annex E, section 2 with the following changes: See figure A-6.</p> <p>The interleaving shall be as described in STANAG 4285, annex E, section 3 with the following different parameters:</p> <p>Number of rows: $l = 32$ for all data rates Delay increment "j" for each successive row:</p> <table border="0"> <tr> <td></td> <td align="center" colspan="2">Total Interleaving Delay:</td> </tr> <tr> <td>Data rates</td> <td align="center">20.48 sec</td> <td align="center">1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td align="center">48</td> <td align="center">4</td> </tr> <tr> <td>600 bps</td> <td align="center">24</td> <td align="center">2</td> </tr> <tr> <td>300, 150, and 75 bps</td> <td align="center">12</td> <td align="center">1</td> </tr> </table> <p>Interleaver synchronization shall be as described in STANAG 4285, annex E, part 4 with no changes. The initialization and message protocol for use with coding and interleaving shall be as described in STANAG 4285, annex E, part 5 with the following difference: The number of flush zeros for each of the data rates and the two interleaver lengths are as follows:</p> <table border="0"> <tr> <td></td> <td align="center" colspan="2">Interleaver Delay</td> </tr> <tr> <td>Data rate</td> <td align="center">20.48 sec</td> <td align="center">1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td align="center">24678</td> <td align="center">2150</td> </tr> <tr> <td>600 bps</td> <td align="center">12390</td> <td align="center">1126</td> </tr> <tr> <td>300 bps</td> <td align="center">6246</td> <td align="center">614</td> </tr> <tr> <td>150 bps</td> <td align="center">3174</td> <td align="center">358</td> </tr> <tr> <td>75 bps</td> <td align="center">1638</td> <td align="center">230</td> </tr> </table>		Total Interleaving Delay:		Data rates	20.48 sec	1.706 sec	1200 bps	48	4	600 bps	24	2	300, 150, and 75 bps	12	1		Interleaver Delay		Data rate	20.48 sec	1.706 sec	1200 bps	24678	2150	600 bps	12390	1126	300 bps	6246	614	150 bps	3174	358	75 bps	1638	230	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			
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**Table 1.7. Modulation Rates, Data Rates, Timing, and Synchronization Results
(continued)**

Reference Number	STANAG 4203 Paragraph	Requirement	Result		Finding	
			Required Value	Measured Value	Met	Not Met
17	11	Modems shall provide uncoded data transmission modes, in which the coding, interleaving, and associated initialization and message protocols (described in section 10) are not applied to the data transmitted. Uncoded data modes shall retain all other characteristics described in this STANAG. Uncoded data rates of 600, 1200, and 1800 bps shall be provided.	STANAG 4529 decode software developed by JITC capable of decoding data transmitted from UUT.			
Legend: BERT—Bit Error Rate Tester; bps—bits per second; HF—High Frequency; Hz—hertz; JITC—Joint Interoperability Test Command; ms—millisecond; PN—Pseudo-random Numerical; PSK—Phase Shift Keying; sec—second; STANAG—Standardization Agreement; UUT—Unit Under Test						

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APPENDIX A
ACRONYMS

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APPENDIX A

ACRONYMS

BERT	Bit Error Rate Tester
bps	bits per second
dibit	Two Consecutive Bits
HF	High Frequency
Hz	Hertz
ms	milliseconds
PN	Pseudo-random Numerical
PSK	Phase Shift Keying
Sec	Seconds
STANAG	Standardization Agreement
tribit	Three Consecutive Bits
UUT	Unit Under Test

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APPENDIX B
STANAG 4529 REQUIREMENTS MATRIX

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Table B-1. STANAG 4529 Requirements Matrix

Reference Number	STANAG Paragraph	Requirements																		
1	1a	This document describes the modulation, call establishment processes, and data correction required to insure interoperability between modems transmitting data over HF radio links where the data rate at the digital interface may be 75,150, 300, 600, or 1200 bps. The rate at which data (user data bits plus bits for error correction coding) are transmitted (i.e., the channel data rate) may be a 600 bps (when the user data rate is 75, 150, or 300 bps), 1200 bps (when the user data rate is 600 bps), or 1800 bps (when the user data rate is 1200 bps).																		
2	1b	The equipment may also be used for uncoded data transmission in which data input to a modulator's digital interface is transmitted without the addition of the error correction coding and interleaving described in paragraph 10. The uncoded modes provide data rates of 600, 1200, and 1800 bps.																		
3	2a	The modulation technique consists of phase shifting of a subcarrier frequency that is selectable in 100-Hz steps from 800 to 2400 Hz inclusive.																		
4	2b	Modulation speed is 1200 bauds with a minimum accuracy of 1 part in 10^5 . The accuracy of the clock linked with the generation of the subcarrier frequency is 1 part in 10^5 .																		
5	2c	<p>The phase shift of the modulated signal relative to the unmodulated reference subcarrier may take one of the following values. (see figure A-1).</p> <table border="0"> <thead> <tr> <th>Symbol Number</th> <th>Phase</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>$\pi/4$</td> </tr> <tr> <td>2</td> <td>$\pi/2$</td> </tr> <tr> <td>3</td> <td>$3\pi/4$</td> </tr> <tr> <td>4</td> <td>π</td> </tr> <tr> <td>5</td> <td>$5\pi/4$</td> </tr> <tr> <td>6</td> <td>$3\pi/2$</td> </tr> <tr> <td>7</td> <td>$7\pi/4$</td> </tr> </tbody> </table> <p>The complex number $\exp[jn\pi/2]$ is linked with the symbol number n.</p>	Symbol Number	Phase	0	0	1	$\pi/4$	2	$\pi/2$	3	$3\pi/4$	4	π	5	$5\pi/4$	6	$3\pi/2$	7	$7\pi/4$
Symbol Number	Phase																			
0	0																			
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4	π																			
5	$5\pi/4$																			
6	$3\pi/2$																			
7	$7\pi/4$																			
6	3a	<p>For the 600 bps channel data rate (75, 150, and 300 bps user data rates), transcoding is achieved by linking one symbol to one bit according to the following rule:</p> <table border="0"> <thead> <tr> <th>Bit</th> <th>Symbol</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>0</td> </tr> <tr> <td>1</td> <td>4</td> </tr> </tbody> </table>	Bit	Symbol	0	0	1	4												
Bit	Symbol																			
0	0																			
1	4																			
7	3b	<p>For the 1200 bps channels data rate (600 bps user data rate), transcoding is achieved by linking one symbol to a set of two consecutive bits (dibit) according to the following rule:</p> <table border="0"> <thead> <tr> <th>Dibit</th> <th>Symbol</th> </tr> </thead> <tbody> <tr> <td>00</td> <td>0</td> </tr> <tr> <td>01</td> <td>2</td> </tr> <tr> <td>11</td> <td>4</td> </tr> <tr> <td>10</td> <td>6</td> </tr> <tr> <td>↑</td> <td></td> </tr> <tr> <td>Most recent bit</td> <td></td> </tr> </tbody> </table>	Dibit	Symbol	00	0	01	2	11	4	10	6	↑		Most recent bit					
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10	6																			
↑																				
Most recent bit																				

Table B-1. STANAG 4529 Requirements Matrix (continued)

Reference Number	STANAG Paragraph	Requirements	Subtest Number																						
8	3c	<p>For the 1800 bps channel data rate (1200 bps user data rate), transcoding is achieved by linking one symbol to a set of three consecutive bits (tribit) according to the following rule:</p> <table style="margin-left: auto; margin-right: auto;"> <tr> <td style="padding-right: 20px;">Tribit</td> <td>Symbol</td> </tr> <tr> <td>000</td> <td>1</td> </tr> <tr> <td>001</td> <td>0</td> </tr> <tr> <td>010</td> <td>2</td> </tr> <tr> <td>011</td> <td>3</td> </tr> <tr> <td>100</td> <td>6</td> </tr> <tr> <td>101</td> <td>7</td> </tr> <tr> <td>110</td> <td>5</td> </tr> <tr> <td>111</td> <td>4</td> </tr> <tr> <td style="text-align: center;">↑</td> <td></td> </tr> <tr> <td colspan="2" style="text-align: center;">Most recent bit</td> </tr> </table>	Tribit	Symbol	000	1	001	0	010	2	011	3	100	6	101	7	110	5	111	4	↑		Most recent bit		
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9	4	The power spectral density of the modulated signal shall be centered on a frequency that is selectable in 100 Hz to 2400 Hz inclusive, with a default value of 1700 Hz.																							
10	4	Filtering shall be applied as necessary so that 99% of the output power is within 1240 Hz.																							
11	5	The symbols to be transmitted are structured in recurrent frames 213.3 ms length. A frame consists of 256 symbols. A frame can be broken down into: 80 symbols for synchronization, 48 reference symbols, and 128 data symbols. The 176 reference and data symbols are scrambled by a scrambling sequence with eight-phase-states of length 176. The reference and data symbols are formed into 4 blocks: the first 3 consist of 32 data symbols followed by 16 reference symbols: the last block consists of 32 symbols. The reference symbols area all symbol number 0.																							
12	6	<p>The synchronization consists of 80 symbols and is transmitted recurrently every 213.3 ms. This sequence uses 2-PSK modulation and the modulation rate is equal to 1200 bauds. The sequence is identical to a pseudo random sequence of length 31, which is repeated periodically within the 80 symbol window, i.e., the synchronization sequence consists of 2 periods of length 31 plus the first 18 symbols of another period. A generator for the synchronization sequence is described in figure A-4. The generator polynomial is: $x^5 + x^2 + 1$.</p> <p>At the beginning of every frame the generator is initially set to the following value: 11010. The first symbol of the synchronization sequence is identical to the least significant bit of this initial value. The remaining 79 symbols are obtained by applying the clock 79 times.</p>																							

Table B-1. STANAG 4529 Requirements Matrix (continued)

Reference Number	STANAG Paragraph	Requirements	Subtest Number
13	7	<p>The scrambling sequence is composed of 176 symbols and is repeated every 213.3 ms. This sequence is transmitted in eight-phase-state modulation at the rate of 1200 bauds. Data scrambling by an eight-phase-state sequence is done to maintain commonality with STANAG 4285 implementations.</p> <p>The scrambling signal generator is shown in figure A-5. The symbols are formed by means of a pseudo-random code of length 511, the generator polynomial of which is: $x^9 + x^4 + 1$. The generator is initialized to 1 at the start of each frame. A symbol is derived from the triplet consisting of the last three bits in the PN register, i.e., $x_0 x_1 x_2$ by the following relationship: Scrambling symbol $B_k = \exp[jn\pi/4]$ Where: $n = 4x_2 + 2x_1 + x_0$</p> <p>$x_0 = 0$ or 1 $x_1 = 0$ or 1 $x_2 = 0$ or 1</p> <p>Generation from one symbol to the next is by successive shifting of the PN register by three positions.</p>	
14	8	<p>The scrambling operation is carried out on reference and data symbols only, not on the synchronization sequence. This operation consists of module 8 addition of the data symbol number to the scrambling symbol number; this amounts to complex multiplication of the data symbol by the scrambling symbol.</p>	
15	9	<p>The modem must be capable of tolerating a frequency error of ± 37.5 Hz between the transmission and reception of HF carriers (transmitter/receiver frequency error and Doppler shift included) and rate of frequency change of up to 3.5 Hz/sec.</p>	

Table B-1. STANAG 4529 Requirements Matrix (continued)

Reference Number	STANAG Paragraph	Requirements																																				
16	10	<p>For the error correction modes defined in this STANAG, the error correction coding used shall be the rate $\frac{1}{2}$, constraint length 7 convolutional coding as described STANAG 4285, annex E. For each user data rate described in this STANAG (i.e., 75, 150, 300, 600, and 1200 bps) the coding, interleaving, and flush bits shall be as described for the higher data rate in STANAG 4285, annex E. The changes necessary to allow 1240 Hz operation are explicitly shown below:</p> <p>The error correction coding used shall be as in STANAG 4285, annex E, section 2 with the following changes:</p> <p>The interleaving shall be as described in STANAG 4285, annex E, section 3 with the following different parameters:</p> <p>Number of rows: $I = 32$ for all data rates</p> <p>Delay increment "j" for each successive row:</p> <table data-bbox="537 877 1149 1056"> <thead> <tr> <th></th> <th colspan="2">Total Interleaving Delay</th> </tr> </thead> <tbody> <tr> <td>Data rates</td> <td>20.48 sec</td> <td>1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td>48</td> <td>4</td> </tr> <tr> <td>600 bps</td> <td>24</td> <td>2</td> </tr> <tr> <td>300, 150, and 75 bps</td> <td>12</td> <td>1</td> </tr> </tbody> </table> <p>Interleaver synchronization shall be as described in STANAG 4285, annex E, part 4 with no changes. The initialization and message protocol for use with coding and interleaving shall be as described in STANAG 4285, annex E, part 5 with the following difference:</p> <p>The number of flush zeros for each of the data rates and the two interleaver lengths are as follows:</p> <table data-bbox="537 1272 1089 1509"> <thead> <tr> <th></th> <th colspan="2">Interleaver Delay</th> </tr> </thead> <tbody> <tr> <td>Data rate</td> <td>20.48 sec</td> <td>1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td>24678</td> <td>2150</td> </tr> <tr> <td>600 bps</td> <td>12390</td> <td>1126</td> </tr> <tr> <td>300 bps</td> <td>6246</td> <td>614</td> </tr> <tr> <td>150 bps</td> <td>3174</td> <td>358</td> </tr> <tr> <td>75 bps</td> <td>1638</td> <td>230</td> </tr> </tbody> </table>		Total Interleaving Delay		Data rates	20.48 sec	1.706 sec	1200 bps	48	4	600 bps	24	2	300, 150, and 75 bps	12	1		Interleaver Delay		Data rate	20.48 sec	1.706 sec	1200 bps	24678	2150	600 bps	12390	1126	300 bps	6246	614	150 bps	3174	358	75 bps	1638	230
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1200 bps	24678	2150																																				
600 bps	12390	1126																																				
300 bps	6246	614																																				
150 bps	3174	358																																				
75 bps	1638	230																																				

Table B-1. STANAG 4529 Requirements Matrix (continued)

Reference Number	STANAG Paragraph	Requirements
17	11	<p>Modems shall provide uncoded data transmission modes, in which the coding, interleaving, and associated initialization and message protocols (described in section 10) are not applied to the data transmitted.</p> <p>Uncoded data modes shall retain all other characteristics described In this STANAG. Uncoded data rates of 600, 1200, and 1800 bps shall be provided.</p>
<p>Legend: bps – bits per second; HF – High Frequency; Hz – hertz; ms—millisecond; sec—second; PN—Pseudo-random Numerical; PSK—Phase Shift Keying; STANAG – Standardization Agreement</p>		

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APPENDIX C
DATA COLLECTION FORMS

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**STANAG 4529
CONFORMANCE TEST
Equipment Configuration Diagram Form**

CONTROL NUMBER:

DATE:
(DD/MM/YY)

DATA ENTRY TECHNICIAN:

TEST DIRECTOR:

SIGNATURE:

SIGNATURE:

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**STANAG 4529
Waveform Conformance
Test Plan Form**

CONTROL NUMBER:

DATE:
(DD/MM/YY)

Equipment:

Serial Number:

Description:

Remarks

TEST TECHNICIAN:

DATA ENTRY TECHNICIAN:

TEST DIRECTOR:

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APPENDIX D
STANAG 4529 CONFORMANCE TEST PROCEDURES
RESULTS MATRIX

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Table D-1. STANAG 4529 Conformance Test Procedures Results Matrix

STANAG Paragraph	Requirements	Findings																			
		Met	Not Met																		
1a	This document describes the modulation, call establishment process, and data correction required to ensure interoperability between modems transmitting data over HF radio links where the data rate at the digital interface may be 75, 150, 300, 600, or 1200 bps. The rate at which data (user data bits plus bits for error correction coding) is transmitted (i.e., the channel data rate) may be a 600 bps (when the user data rate is 75, 150, or 300 bps), 1200 bps (when the user data rate is 600 bps), or 1800 bps (when the user data rate is 1200 bps).																				
1b	The equipment may also be used for uncoded data transmission in which data input to a modulator's digital interface is transmitted without the addition of the error correction coding and interleaving described in paragraph 10. The uncoded modes provide data rates of 600, 1200, and 1800 bps.																				
2a	The modulation technique consists of phase shifting of a subcarrier frequency that is selectable in 100-Hz steps from 800 to 2400 Hz inclusive.																				
2b	Modulation speed is 1200 bauds with a minimum accuracy of 1 part in 10^5 . The accuracy of the clock linked with the generation of the subcarrier frequency is 1 part in 10^5 .																				
2c	<p>The phase shift of the modulated signal relative to the unmodulated reference subcarrier may take one of the following values. (see figure A-1).</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Symbol Number</th> <th>Phase</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>$\pi/4$</td></tr> <tr><td>2</td><td>$\pi/2$</td></tr> <tr><td>3</td><td>$3\pi/4$</td></tr> <tr><td>4</td><td>π</td></tr> <tr><td>5</td><td>$5\pi/4$</td></tr> <tr><td>6</td><td>$3\pi/2$</td></tr> <tr><td>7</td><td>$7\pi/4$</td></tr> </tbody> </table> <p>The complex number $\exp[jn\pi/2]$ is linked with the symbol number n.</p>	Symbol Number	Phase	0	0	1	$\pi/4$	2	$\pi/2$	3	$3\pi/4$	4	π	5	$5\pi/4$	6	$3\pi/2$	7	$7\pi/4$		
Symbol Number	Phase																				
0	0																				
1	$\pi/4$																				
2	$\pi/2$																				
3	$3\pi/4$																				
4	π																				
5	$5\pi/4$																				
6	$3\pi/2$																				
7	$7\pi/4$																				
3a	<p>For the 600 bps channel data rate (75, 150, and 300 bps user data rates), transcoding is achieved by linking one symbol to one bit according to the following rule:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Bit</th> <th>Symbol</th> </tr> </thead> <tbody> <tr><td>0</td><td>0</td></tr> <tr><td>1</td><td>4</td></tr> </tbody> </table>	Bit	Symbol	0	0	1	4														
Bit	Symbol																				
0	0																				
1	4																				
3b	<p>For the 1200 bps channels data rate (600 bps user data rate), transcoding is achieved by linking one symbol to a set of two consecutive bits (dibit) according to the following rule:</p> <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th>Dibit</th> <th>Symbol</th> </tr> </thead> <tbody> <tr><td>00</td><td>0</td></tr> <tr><td>01</td><td>2</td></tr> <tr><td>11</td><td>4</td></tr> <tr><td>10</td><td>6</td></tr> <tr><td>↑</td><td></td></tr> <tr><td>Most recent bit</td><td></td></tr> </tbody> </table>	Dibit	Symbol	00	0	01	2	11	4	10	6	↑		Most recent bit							
Dibit	Symbol																				
00	0																				
01	2																				
11	4																				
10	6																				
↑																					
Most recent bit																					

**Table D-1. STANAG 4529 Conformance Test Procedures Results Matrix
(continued)**

STANAG Paragraph	Requirements	Findings																							
		Met	Not Met																						
3c	<p>For the 1800 bps channel data rate (1200 bps user data rate), transcoding is achieved by linking one symbol to a set of three consecutive bits (tribit) according to the following rule:</p> <table border="0"> <tr> <td style="padding-right: 40px;">Tribit</td> <td>Symbol</td> </tr> <tr> <td>000</td> <td>1</td> </tr> <tr> <td>001</td> <td>0</td> </tr> <tr> <td>010</td> <td>2</td> </tr> <tr> <td>011</td> <td>3</td> </tr> <tr> <td>100</td> <td>6</td> </tr> <tr> <td>101</td> <td>7</td> </tr> <tr> <td>110</td> <td>5</td> </tr> <tr> <td>111</td> <td>4</td> </tr> <tr> <td>↑</td> <td></td> </tr> <tr> <td align="center" colspan="2">Most recent bit</td> </tr> </table>	Tribit	Symbol	000	1	001	0	010	2	011	3	100	6	101	7	110	5	111	4	↑		Most recent bit			
Tribit	Symbol																								
000	1																								
001	0																								
010	2																								
011	3																								
100	6																								
101	7																								
110	5																								
111	4																								
↑																									
Most recent bit																									
4	- The power spectral density of the modulated signal shall be centered on a frequency that is selectable in 100 Hz to 2400 Hz inclusive, with a default value of 1700 Hz.																								
4	- Filtering shall be applied as necessary so that 99% of the output power is within 1240 Hz.																								
5a	The symbols to be transmitted are structured in recurrent frames 213.3 ms is length.																								
5b	A frame consists of 256 symbols. A frame can be broken down into: 80 symbols for synchronization, 48 reference symbols, and 128 data symbols.																								
5c	The 176 reference and data symbols are scrambled by a scrambling sequence with eight-phase-states of length 176.																								
5e	The reference and data symbols are formed into 4 blocks: the first 3 consist of 32 data symbols followed by 16 reference symbols: the last block consists of 32 symbols. The reference symbols area all symbol number 0.																								
6a	The synchronization consists of 80 symbols and is transmitted recurrently every 213.3 ms. This sequence uses 2-PSK modulation and the modulation rate is equal to 1200 bauds.																								
6b	The sequence is identical to a pseudo random sequence of length 31, which is repeated periodically within the 80 symbol window, i.e., the synchronization sequence consists of 2 periods of length 31 plus the first 18 symbols of another period.																								
6c	A generator for the synchronization sequence is described in figure A-4. The generator polynomial is: $x^5 + x^2 + 1$.																								
6d	At the beginning of every frame the generator is initially set to the following value: 11010.																								
6e	The first symbol of the synchronization sequence is identical to the least significant bit of this initial value. The remaining 79 symbols are obtained by applying the clock 79 times.																								

**Table D-1. STANAG 4529 Conformance Test Procedures Results Matrix
(continued)**

STANAG Paragraph	Requirements	Findings	
		Met	Not Met
7a	The scrambling sequence is composed of 176 symbols and is repeated every 213.3 ms. This sequence is transmitted in eight-phase-state modulation at the rate of 1200 bauds.		
7b	Data scrambling by an eight-phase-state sequence is done to maintain commonality with STANAG 4285 implementations.		
7c	The scrambling signal generator is shown in figure A-5. The symbols are formed by means of a pseudo-random code of length 511, the generator polynomial of which is: $x^9 + x^4 + 1$.		
7d	The generator is initialized to 1 at the start of each frame.		
7e	A symbol is derived from the triplet consisting of the last three bits in the PN register, i.e., $x_0 x_1 x_2$ by the following relationship: Scrambling symbol $B_k = \exp[jn\pi/4]$ Where: $n = 4x_2 + 2x_1 + x_0$ $x_0 = 0$ or 1 $x_1 = 0$ or 1 $x_2 = 0$ or 1		
7f	Generation from one symbol to the next is by successive shifting of the PN register by three positions.		
8	The scrambling operation is carried out on reference and data symbols only, not on the synchronization sequence. This operation consists of module 8 addition of the data symbol number to the scrambling symbol number; this amounts to complex multiplication of the data symbol by the scrambling symbol.		
9	The modem must be capable of tolerating a frequency error of ± 37.5 Hz between the transmission and reception of HF carriers (transmitter/receiver frequency error and Doppler shift included) and rate of frequency change of up to 3.5 Hz/sec.		
10	For the error correction modes defined in this STANAG, the error correction coding used shall be the rate $1/2$, constraint length 7 convolutional coding as described STANAG 4285, annex E.		
10	For each user data rate described in this STANAG (i.e., 75, 150, 300, 600, and 1200 bps) the coding, interleaving, and flush bits shall be as described for the higher data rate in STANAG 4285, annex E. The changes necessary to allow 1240 Hz operation are explicitly shown below:		
10a	The error correction coding used shall be as in STANAG 4285, annex E, section 2 with the following changes:		

**Table D-1. STANAG 4529 Conformance Test Procedures Results Matrix
(continued)**

STANAG Paragraph	Requirements	Findings																			
		Met	Not Met																		
10b	<p>The interleaving shall be as described in STANAG 4285, annex E, section 3 with the following different parameters:</p> <p>Number of rows: I = 32 for all data rates</p> <p>Delay increment “j” for each successive row:</p> <p align="center">Total Interleaving Delay:</p> <table border="0"> <tr> <td>Data rates</td> <td>20.48 sec</td> <td>1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td>48</td> <td>4</td> </tr> <tr> <td>600 bps</td> <td>24</td> <td>2</td> </tr> <tr> <td>300, 150 and 75 bps</td> <td>12</td> <td>1</td> </tr> </table>	Data rates	20.48 sec	1.706 sec	1200 bps	48	4	600 bps	24	2	300, 150 and 75 bps	12	1								
Data rates	20.48 sec	1.706 sec																			
1200 bps	48	4																			
600 bps	24	2																			
300, 150 and 75 bps	12	1																			
10c	Interleaver synchronization shall be as described in STANAG 4285, annex E, part 4 with no changes.																				
10d	<p>The initialization and message protocol for use with coding and interleaving shall be as described in STANAG 4285, annex E, part 5 with the following difference: The number of flush zeros for each of the data rates and the two interleaver lengths are as follows:</p> <p align="center">Interleaver Delay</p> <table border="0"> <tr> <td>Data rate</td> <td>20.48 sec</td> <td>1.706 sec</td> </tr> <tr> <td>1200 bps</td> <td>24678</td> <td>2150</td> </tr> <tr> <td>600 bps</td> <td>12390</td> <td>1126</td> </tr> <tr> <td>300 bps</td> <td>6246</td> <td>614</td> </tr> <tr> <td>150 bps</td> <td>3174</td> <td>358</td> </tr> <tr> <td>75 bps</td> <td>1638</td> <td>230</td> </tr> </table>	Data rate	20.48 sec	1.706 sec	1200 bps	24678	2150	600 bps	12390	1126	300 bps	6246	614	150 bps	3174	358	75 bps	1638	230		
Data rate	20.48 sec	1.706 sec																			
1200 bps	24678	2150																			
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11	- Uncoded data modes shall retain all other characteristics described in this STANAG.																				
11	- Uncoded data rates of 600, 1200, and 1800 bps shall be provided.																				
<p>Legend: bps – bits per second; HF – High Frequency; Hz – hertz; ms—millisecond; PSK—Phase Shift Keying; PN—Pseudo-random Numerical; sec—second; STANAG – Standardization Agreement</p>																					

APPENDIX E
REFERENCES

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APPENDIX E

REFERENCES

- E-1** STANAG 4285, Characteristics of 1200/2400/3600 Bits per Second Single Tone Modulators/Demodulators for HF Radio Links, 16 February 1989
- E-2** STANAG 4203, Technical Standards for Single Channel HF Radio Equipment, 31 May 1988
- E-3** STANAG 4481, Minimum Technical Equipment Standards for Naval HF Shore-to-Ship Broadcast Systems, 18 March 1993