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TEST SIGNALS FOR ELECTRONIC TACTICAL AIR NAVIGATION EQUIPMENT (TACAN)

OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
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Supply and Logistics

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1. This standard has been approved by the Department of Defense and is mandatory for use by the Departments of the Army, the Navy, and the Air Force, effective immediately.

2. In accordance with established procedure, the Standardization Divison has designated the Signal Corps, the Bureau of Aeronautics, and the Air Force, respectively, as Army-Navy-Air Force custodians of this standard.

3. Recommended corrections, additions, or deletions should be addressed to the Standardization Division, Office of the Asistant Secretary of Defense (Supply and Logistics), Washington 25, D. C.

MILITARY STANDARD

TEST SIGNALS FOR ELECTRONIC TACTICAL AIR NAVIGATION EQUIPMENT (TACAN)

1. INTRODUCTION

1.1 Purpose. The purpose of this document is to define a signal to be emitted by test equipment for Electronic Tactical Air Navigation Equipment (TACAN).

It is recognized that test equipment of lesser performance may be adequate for many applications.

1.2 Scope. This standard covers the frequencies and characteristics of signals necessary to properly test TACAN equipment.

2. REQUIREMENTS

2.1 Tacan test set channels. The test signal for airborne equipment shall be generated at the following frequencies listed under the column "Reply Freq."; the associated signal frequencies from the airborne equipment are listed under the column "Interrogating Freq.".

CHANNEL	INTERROGATING FREQ. (Mc)	REPLY FREQ. (Mc)
1	1025	962
2	1026	963
3	1027	964
4	1028	965
5	1029	966
6	1030	967
7	1031	968
8	1032	969
9	1033	970
10	1034	971
11	1035	972
12	1036	973
13	1037	974
14	1038	975
15	1039	976
16	1040	977
17	1041	978
18	1042	979
19	1043	980
20	1044	981
21	1045	982
22	1046	983
23	1047	984
24	1048	985
25	1049	986
26	1050	987
27	1051	988
28	1052	989
29	1053	990
30	1054	991
31	1055	992
32	1056	993
33	1057	994

CHANNEL	INTERROGATING FREQ. (Mc)	REPLY FREQ. (Mc)
34	1058	995
35	1059	996
36	1060	997
37	1061	998
38	1062	999
39	1063	1000
40	1064	1001
41	1065	1002
42	1066	1003
43	1067	1004
44	1068	1005
45	1069	1006
46	1070	1007
47	1071	1008
48	1072	1009
49	1073	1010
50	1074	1011
51	1075	1012
52	1076	1013
53	1077	1014
54	1078	1015
55	1079	1016
56	1080	1017
57	1081	1018
58	1082	1019
59	1083	1020
60	1084	1021
61	1085	1022
62	1086	1023
63	1087	1024
64	1088	1151
65	1089	1152
66	1090	1153

INTERROGATING CHANNEL	INTERROGATING FREQ. (Mc)	REPLY FREQ. (Mc)	INTERROGATING CHANNEL	INTERROGATING FREQ. (Mc)	REPLY FREQ. (Mc)
67	1091	1154	97	1121	1184
68	1092	1155	98	1122	1185
69	1093	1156	99	1123	1186
70	1094	1157	100	1124	1187
71	1095	1158	101	1125	1188
72	1096	1159	102	1126	1189
73	1097	1160	103	1127	1190
74	1098	1161	104	1128	1191
75	1099	1162	105	1129	1192
76	1100	1163	106	1130	1193
77	1101	1164	107	1131	1194
78	1102	1165	108	1132	1195
79	1103	1166	109	1133	1196
80	1104	1167	110	1134	1197
81	1105	1168	111	1135	1198
82	1106	1169	112	1136	1199
83	1107	1170	113	1137	1200
84	1108	1171	114	1138	1201
85	1109	1172	115	1139	1202
86	1110	1173	116	1140	1203
87	1111	1174	117	1141	1204
88	1112	1175	118	1142	1205
89	1113	1176	119	1143	1206
90	1114	1177	120	1144	1207
91	1115	1178	121	1145	1208
92	1116	1179	122	1146	1209
93	1117	1180	123	1147	1210
94	1118	1181	124	1148	1211
95	1119	1182	125	1149	1212
96	1120	1183	126	1150	1213

2.1.1 *Number of channels.* There shall be 126 channels provided, numbered 1 through 126. Each channel shall have:

(a) An interrogating frequency.

(b) A reply frequency.

2.1.1.1 *Interrogating frequency.* The interrogating frequency shall begin with channel 1 at 1025 mc and increase in 1 mc increments until channel 126 at 1150 mc is reached.

2.1.1.2 *Reply frequency.* The reply frequency shall begin with channel 1 at 962 mc (which is 63 mc *lower than* the interrogating frequency) and increase in 1 mc increments until channel 63 is reached at 1024 mc. Continuing with channel 64 at a reply frequency of 1151 mc (which is 63 mc *higher than* the interrogating frequency) and increase in 1 mc increments until channel 126 is reached at 1213 mc.

3. CHARACTERISTICS OF THE TACAN TEST SIGNAL FOR AIRBORNE EQUIPMENT

The Airborne Tacan equipment shall be tested with a signal having the following characteristics.

3.1 **Radio frequency.** The frequency of the signal generator oscillator shall be maintained within ± 0.005% of its specified frequency.

3.2 **R-F pulse spectrum.** The energy level contained in a 0.5 mc band centered on a frequency ± 0.8 mc from the channel frequency, shall be at least 25 db below the energy level contained in a 0.5 mc band centered on the channel frequency. The energy level contained in a 0.5 mc band centered on a frequency ± 2.0 mc from the channel frequency shall be at least 40 db below the energy level contained in a 0.5 mc band centered on the channel frequency. Each lobe of the spectrum shall be of less amplitude than the adjacent lobe nearer the center frequency.

3.2.1 *CW output.* CW output between pulses shall be at least 50 db below the peak level of the pulses.

3.2.2 *Requirements for adjacent channel interference measurements.* The following specifications apply when adjacent channel interference measurements are made:

(a) The oscillator output frequency shall be within 0.002% of the specified frequency.

(b) The r-f pulse spectrum, as defined in paragraph 3.2 shall require 60 db in lieu of 25 db and 65 db in lieu of 40 db.

(c) CW output, as specified in paragraph 3.2.1, shall be at least 70 db below the peak level of the pulses.

3.3 Pulse shape. The pulse envelope as detected by a linear detector shall have a rounded shape falling within the following limits:

3.3.1 *Pulse top.* The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95% of maximum amplitude and the point of the trailing edge which is 95% of the maximum amplitude, fall below a line which is 95% of the maximum voltage amplitude of the pulse and is parallel to the base line.

3.3.2 *Pulse rise time.* The time required for the leading edge of the pulse to rise from 10 to 90% of its maximum voltage amplitude shall be 2.5 ± 0.5 microseconds.

3.3.3 *Pulse fall time.* The time required for the trailing edge of the pulse to fall from 90 to 10% of its maximum voltage amplitude shall be 2.5 ± 0.5 microseconds.

3.3.4 *Pulse duration.* The pulse duration, which is measured between the points on the leading and trailing edges of the pulse which are 50% of the maximum voltage amplitude of the pulse, shall be 3.5 ± 0.3 microseconds.

3.4 Pulse droop. Without amplitude modulation of the composite r-f pulse train, any pulse in a pair, or in the Main Reference Group, shall not deviate from the average peak amplitude by more than ± 2.0% and any pulse in an Auxiliary Reference Group shall not deviate by more than ± 1.0%. In addition, the recovery time following this droop shall be such that the 135 cycle component of amplitude modulation, due to droop, shall not introduce an error greater than 0.08° for modulation depths (Of 135 cps) of 5% and greater. (Attention is drawn to the fact that if the longest recovery time is used, the droop must be on the order of 0.2%).

3.5 Pulse coding. The pulses shall be coded in pairs with a spacing which shall be 12 ± 0.25 microseconds as measured at the 50% maximum voltage amplitude points from the leading edge of the first pulse to the leading edge of the second pulse.

3.6 Main reference pulse group. The 15 cycle reference bearing signal, called the Main Reference Group, shall consist of a group of 12 pairs of pulses. The spacing between pairs shall be 30 ± 0.3 microseconds. The repetition rate of the group shall be 15 cycles per second ± 0.2%.

3.7 Auxiliary reference pulse group. The 135 cycle reference bearing signal, called Auxiliary Reference Group, shall consist of a group of six pairs of pulses. The spacing between pairs shall be 24 ± 0.25 microseconds. The repetition rate shall be 135 cycles per second and shall be precisely synchronized with the Main Reference Group; however, the Auxiliary Group which would otherwise coincide in time with the Main Reference Group, shall be removed so that only the Main Reference Group appears in this position in the final output signal.

3.7.1 *Precedence.* The Main and Auxiliary Reference Groups shall have precedence over random, identity and distance reply fuses; therefore, these pulses shall not appear during a Main or Auxiliary Reference Group.

3.8 Identification test signal. The identification signal shall consist of a series of paired pulses transmitted at a repetition rate of 1350 pulse pairs per second, phase-locked within ± 50 microseconds of the tenth harmonic of the 135 cycle reference bearing signal. The first pulse of an identity pair shall occur 740 ± 50 microseconds after the first pulse of each Auxiliary Reference Group. Distance replies shall be removed during generation of the identity signal.

3.8.1 *Equalizing pulse pair.* To preserve a constant duty cycle and to eliminate bearing error during identity signals, an equalizing pair of pulses shall be transmitted 100 microseconds after each identity pair.

3.8.2 *Identity cycle.* When an automatic keyer is used to provide identity tone, the random and distance reply pulses shall be replaced by the identity pulses at a recurrency rate of once every 37.5 ± 10% seconds. During identity, the code shall be transmitted as dots and dashes (Morse code) of identity pulses; the spaces between dots and dashes being occupied by random pulses. The dots shall be 0.125 ± 10% seconds long; dashes shall be 0.375 ± 10% seconds long. Key-down time per identity cycle shall not be less than 4 seconds out of 7.5 seconds, repeated every identity cycle.

3.9 Pulse repetition rate. In addition to the reference pulse groups, the signal shall have a randomly distributed pulse repetition rate which shall be maintained at 2700 ± 90 pairs per second before the reference groups are added to the signal; the random rate may include distance replies. The minimum spacing between any two consecutive random pulse pairs shall be 60 ± 10 microseconds. The distribution of the random pulse spacing, for no interrogation load, shall fall within the limits shown in the graph, figure 1.

3.10 Composite 15 and 135 cycle variable bearing test signal. The 15 and 135 cycle bearing signal shall be generated by the composite amplitude modulation of the radio-frequency pulse signals at 15 and 135 cycles per second. The combined amplitude modulation percentage shall be as given in the formula following. The amplitude modulation shall be synchronized with the 15 cycle Main Reference Group so that, for a bearing of zero degrees, receiver south of the beacon, the 10th pulse of the Main Reference Group will coincide with the positive slope point of inflection of the 15 cycle component of the bearing signal to within ± 1.0°. The 12th pulse of each Auxiliary Reference Group shall coincide with a positive slope point of inflection of the 135 cycle component of the bearing signal to within ± 0.3° at 135 cycles. In the absence of harmonics, the envelope of the detected r-f signal shall follow this formula.

$$y = 1.0 + A \sin (2\pi f t \pm \theta - \gamma) + B \sin (18\pi f t \pm \phi - 9 \gamma)$$

Where

y = normalized composite 15-135 cycle signal amplitude
A = represents modulation of 15 cycle component
A = variable from 0 to 0.30
B = represents modulation of 135 cycle component
B = variable from 0 to 0.30

The sum of A and B shall not exceed 0.55

- Θ = 1° Maximum (of 15 cycles)
- ϕ = 0.3° Maximum (of 135 cycles)
- γ = bearing to the ground or shipboard station from the point of observation
- f = 15.0 cps ± 0.2%
- t = time in seconds from the corrected position of the 10th pulse of the Main Reference Group. This is computed from the average position of the 12th pulse of each Auxiliary Reference Group.

3.10.1 *Harmonic content.* The harmonic content of the 15 and 135 cps components of the radiated signal (other than the ninth harmonic of 15 and the tenth harmonic of 135) shall not exceed 10% for each component.

3.10.2 *Variable bearing rate.* Provision shall be made to change the bearing at a uniform rate up to 10° per second.

3.11 Distance reply signal. The distance reply signal shall consist of a pair of pulses transmitted in response to a pair of interrogating pulses. The time delay measured from the leading edge of the second interrogating pulse at the input to the test set to the leading edge of the second reply pulse at the output from the test set shall be 50 ± 0.25 microseconds when the test set is adjusted for zero mile range. For other range settings of the test equipment, the time delay in microseconds between the input interrogations and output replies shall be:

50 ± 0.5 + 12.359 times the distance in International Nautical Miles

3.11.1 *Reply efficiency.* Reply efficiency is defined by:

$$\frac{\text{(number of replies per second)}}{\text{(number of interrogations per second)}}$$

Provision shall be made for varying reply effciency from the maximum down to 40%.

3.11.2 *Variable range rate.* Provision shall be made for changing the range at a uniform rate to simulate aircraft speeds up to 3000 knots.

4. CHARACTERISTICS OF TACAN INTERROGATING SIGNAL

The interrogating signal, radiated by the airborne equipment, shall have the following characteristics:

4.1 Radio frequency. The frequency of the transmitter oscillator shall be maintained to within ± 0.007% of its specified frequency.

4.2 R-F pulse spectrum. The energy level contained in a 0.5 mc band centered on a frequency ± 0.8 mc from the channel frequency, shall be at least 23 db below the energy level contained in a 0.5 mc band centered on the channel frequency. The energy level contained in a 0.5 mc band centered on a frequency ± 2.0 mc from the channel frequency, shall be at least 38 db below the energy level contained in a 0.5 mc band centered on the channel frequency. Each lobe of the spectrum shall be of less amplitude than the adjacent lobe nearer the multiplied oscillator frequency.

4.2.1 *CW output.* CW output between pulses shall be at least 80 db below the peak pulse level. In addition, the CW output shall not exceed 0.02 microwatt in the frequency range of 1015 to 1045 mc.

4.3 Pulse shape. The pulse envelope as detected by a linear detector shall have a rounded shape falling within the following limits:

4.3.1 *Pulse top.* The instantaneous amplitude of the pulse shall not, at any instant between the point of the leading edge which is 95% of maximum amplitude and the point of the trailing edge which is 95% of the maximum amplitude of the pulse and is parallel to the base line.

4.3.2 *Pulse rise time.* The time required for the leading edge of the pulse to rise from 10 to 90% of its maximum voltage amplitude shall be 2.5 ± 0.5 microseconds.

4.3.3 *Pulse fall time.* The time required for the trailing edge of the pulse to fall from 90 to 10% of its maximum voltage amplitude shall be 2.5 ± 1.0 microseconds.

4.3.4 *Pulse duration.* The pulse duration, which is measured between the points on the leading and trailing edges of the pulse which are 50% of the maximum voltage amplitude of the pulse, shall be 3.5 ± 0.5 microseconds.

4.4 **Pulse coding.** The pulses shall be coded in pair with a spacing which shall be 12 ± 0.5 microseconds as measured at the 50% maximum voltage amplitude points from the leading edge of the first pulse to the leading edge of the second pulse.

4.5 **Pulse repetition rate.** In the search condition, the interrogating signal from one aircraft shall not exceed 150 pulse pairs per second, however, an interrogation rate in the region of 135 pairs per second shall be avoided. In the track condition, this number shall not exceed 30 pulse pairs per second.

4.5.1 *Pulse repetition rate variation.* The spacing between successive interrogations shall be sufficiently nonuniform as to preclude one aircraft from locking-on to range replies intended for any other equipment interrogating the same beacon.

Preparing activity:
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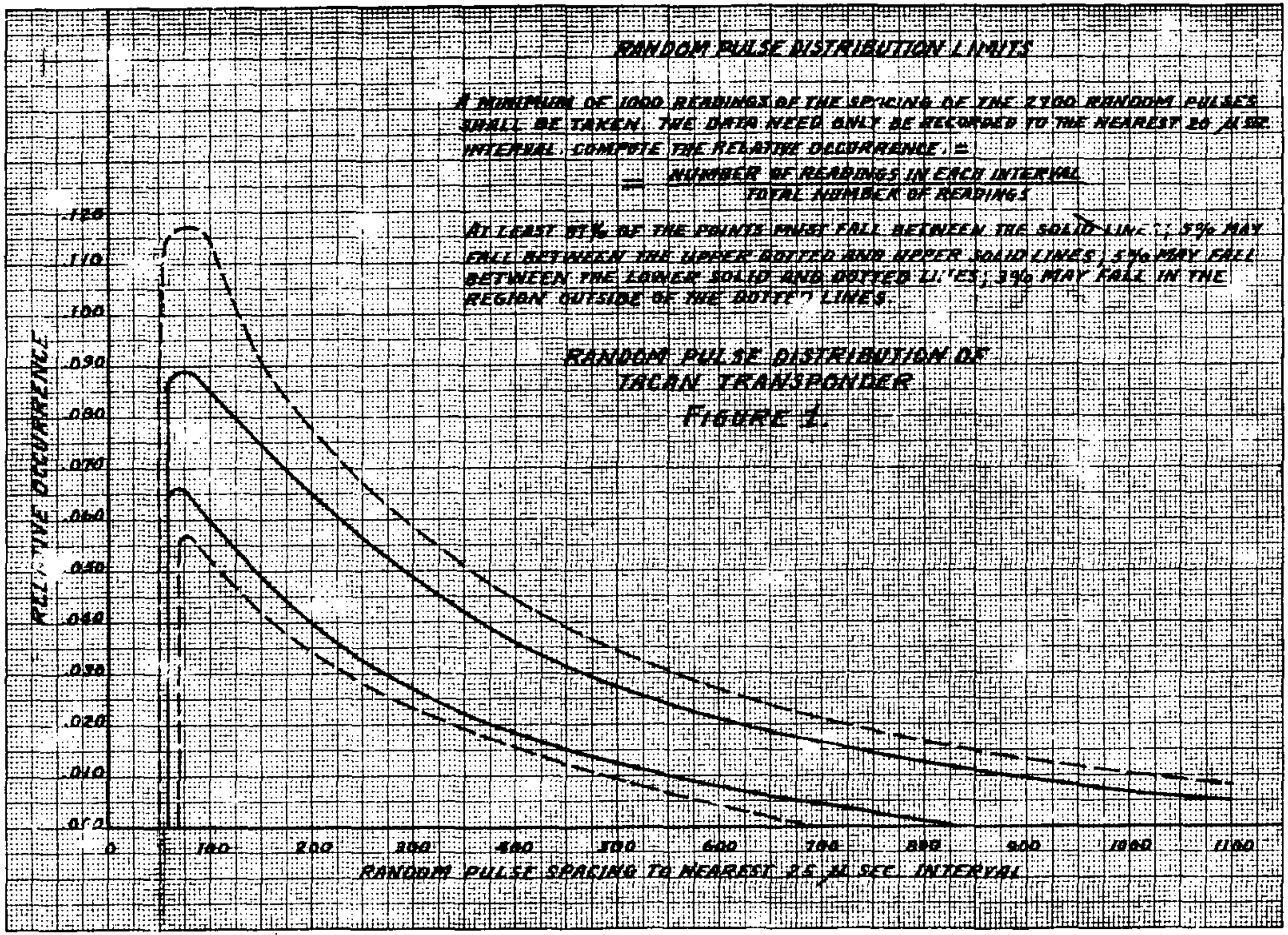

RANDOM PULSE DISTRIBUTION OF
TACAN TRANSPONDER
FIGURE 1.

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