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PROGRAMMABLE DATA TERMINAL SET (PDTS) UHF TEST WITH AN/WSC-3 RA--ETC(U)
AUG 77 G P FRANCIS, W O SMITH
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Technical Report 142

PROGRAMMABLE DATA TERMINAL SET (PDTS) UHF TEST WITH AN/WSC-3 RADIO

Operational capability of PDTS is demonstrated

GP Francis and WO Smith

17 August 1977

Prepared for
NAVAL ELECTRONIC SYSTEMS COMMAND

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

FM Link 11 radio circuits in the range from 225 to 300 MHz were used to demonstrate the practicality of the PDTS. High frequencies were used as "order-wire" circuits. The PDTS was shown to be compatible with the AN/WSC-3 uhf-FM radio (as modified for Link 11 usage) and the AN/WSC-3 performed well in the uhf-FM mode.

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OBJECTIVE

Demonstrate the practicality of a Programmable Data Terminal Set at uhf when used with a modified AN/WSC-3 radio.

RESULTS

1. Test 28 was successfully completed using CGN 9, DLGN 35, and the S-3A and E-2C aircraft.

2. The PDTS is compatible with the AN/WSC-3 uhf-FM radio (as modified for Link 11).

3. The AN/WSC-3 AGC action and the sync time for the PDTS are compatible while the PDTS is NCS or picket after modifications described in this report are made.

4. From the tests which were performed, it is apparent that the AN/WSC-3 radio (modified as described in this report) performs well in the uhf-FM Link 11 mode.

RECOMMENDATIONS

Establish a Fleet-wide procedure for setting transmit deviation when operating Link 11 in the uhf-FM mode. Further, modify the AN/WSC-3 radio to disable automatically the AM sidetone when in the Link 11 mode. Use revised PDTS software in any future testing of the PDTS and links.

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ILLUSTRATIONS

TABLES

TEST OBJECTIVES

The tests were designed to evaluate and demonstrate the feasibility and compatibility of the Programmable Data Terminal Set (PDTS) transmitting Link 11 over a uhf line-of-sight radio circuit with current uhf Link 11 equipment aboard ships and aircraft. An AN/WSC-3 uhf radio (modified for Link 11 operations) was used with the PDTS while operating in a Link 11 on-the-air network.

TEST METHOD

Test frequencies were selected in the range of 225 to 400 MHz for the FM Link 11 circuits. HF frequencies were selected for use as an operational control order-wire circuit. Figure 1 is a block diagram of the NOSC test setup. Note the extensive signal monitoring capability. Prior to actual net operation, the audio signal levels into and out of the AN/WSC-3 radio were set to 0 dBm using the Net Test signal from the PDTS and the NOSC Amplifier. The deviation of the FM signal from the AN/WSC-3 radio was accurately set using a method developed by NOSC personnel (Code 8142) to ±25 kHz. This method will be described in a forthcoming NOSC Technical Report. The net was then initialized and a 2-party multistation POFA (Performance Operational Functional Analysis) was exchanged until both parties were satisfied with the quality and condition of the net.

The major portion of the test consisted of what is termed Test 28, Live-Link Testing, which is described in detail for the hf test phase in reference 1. The test was slightly modified to accommodate the uhf tests and is outlined in tables 1, 2, and 3 of this report. Pretest inputs are listed in table 2. Configurations are shown for the PDTS and a DTS (shown as DTS 1). Other data-terminal sets in the net would be configured as shown in the column for DTS "N". PU addresses were assigned by test letter; the DLRP and two pickets were established at the following positions:

	Latitude	Longitude
DLRP	32° 00′ N	118° 00′ W
PU 1 (PDTS)	32° 40′ N	117° 15′ W
PU 2 (DTS)	Actual ship position	

Test inputs consisted of operator entries made at the display console (AN/UYA-4). These inputs were converted by the PUSIM (Models III or IV) software program into data (tracks, ID, location, etc) to be passed over the link. Table 1 provides a list of tests performed with pretest input configurations taken from Table 2 and operator script inputs taken from Table 3. Data passed over the link regarding target positions were required to have accuracies to within ±2.5 degrees (bearing) and ±1 nautical mile (range).

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1. NELC TM 124, Program Test Plan/Specification for Link 11 Programmable Data Terminal Set (PDTS), 8 June 1976

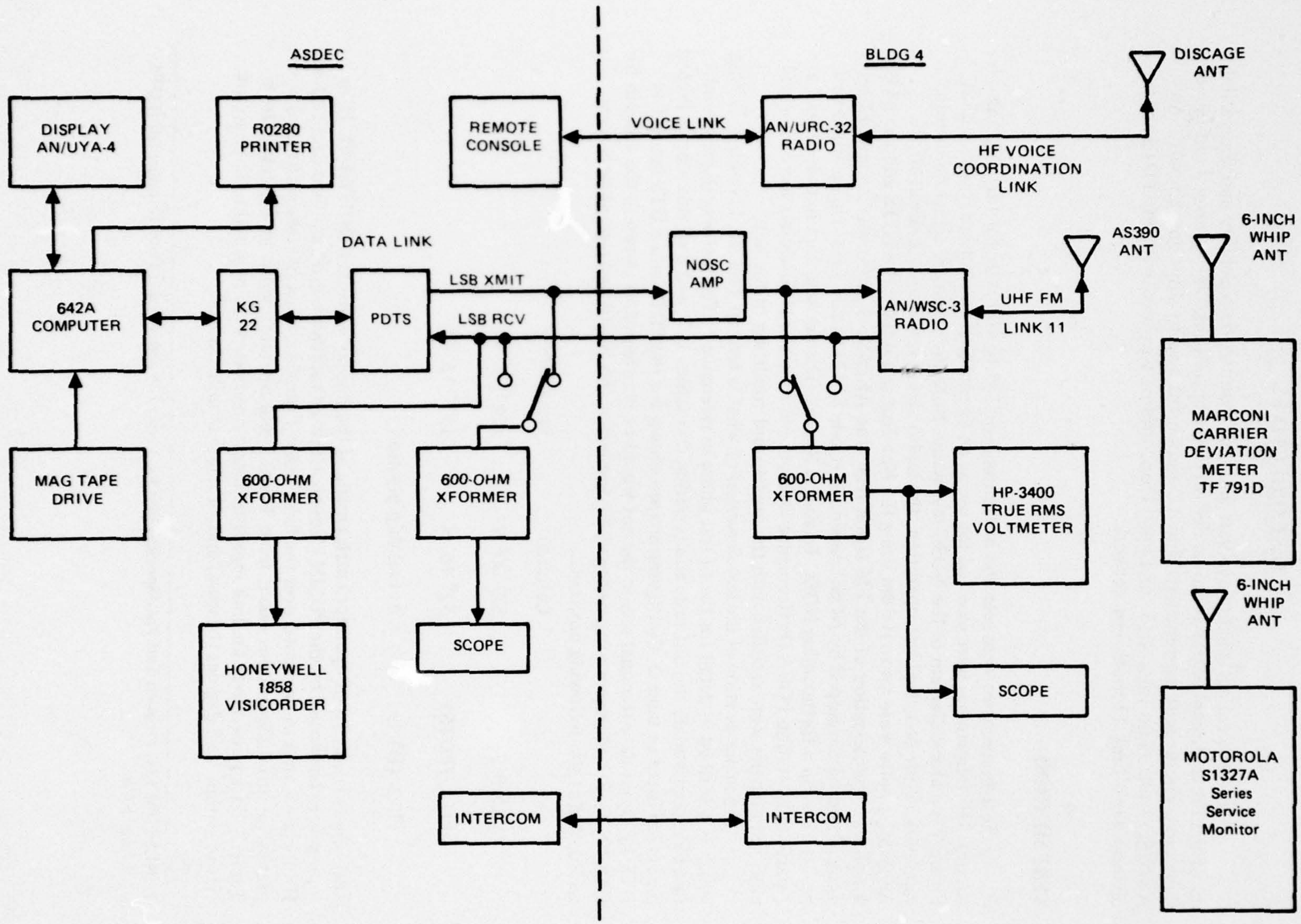

Figure 1. On-the-air test setup.

TABLE 1. LIVE LINK TESTING AT UHF

TEST NUMBER	PRETEST CONFIGURATION (SEE TABLE 2)	ENTRY SCRIPT (SEE TABLE 3)	INTENT
28a	28a	none	Establish Net Sync
28b	28b	none	Establish Net Sync
28c	28c	none	Run Net Test
28d	28d	none	Run Net Test
28e	28e	28a	PDTS transmits data to NCS
28f	28f	28b	PDTS receives data from PKT
28g	28g	28c	PDTS exchanges data with PKT
28h	28h	28d	PDTS exchanges data with PKT
28i	28i	28e	PDTS exchanges data with PKT
28j	28j	28f	PDTS exchanges data with NCS
28k	28k	28g	PDTS exchanges data with PKT
28l	28l	28j	PDTS receives only
28m	28m	28h	PDTS transmits Broadcast
28n	28n	28h	PDTS transmits Short Broadcast
28o	28o	28j	PDTS receives Broadcast
28p	28f	28k	PDTS exchanges data with PKT
28q	28f	28i	PDTS exchanges data with PKT
28r	28p	28j	PDTS receives Short Broadcast

TABLE 2. PRETEST CONFIGURATIONS.

CONFIGURATION 28A
PDTS TRANSMITS NET SYNC

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	NS	NS	NS	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28A
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28B
PDTS RECEIVES NET SYNC

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	NS	NS	NS	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28B
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED).

CONFIGURATION 28C
PDTS TRANSMITS NET TEST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	NT	NT	NT	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28C
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28D
PDTS RECEIVES NET TEST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	NT	NT	NT	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28D
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED).

CONFIGURATION 28E
PDTS OPERATES AS A PKT IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28E
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28F
PDTS OPERATES AS AN NCS IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TESTS 28F, P & Q
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED).

CONFIGURATION 28G
PDTS OPERATES AS AN NCS IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28G
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28H
PDTS OPERATES AS AN NCS IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28H
NET CONT	NCS	PKT	PKT	
SYNC	F	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED)

CONFIGURATION 28I
PDTS OPERATES AS AN NCS IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28I
NET CONT	NCS	PKT	PKT	
SYNC	F	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28J
PDTS OPERATES AS A PKT IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28J
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED).

CONFIGURATION 28K
PDTS OPERATES AS AN NCS IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28K
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	S	S	S	
RANGE	000	000	000	

CONFIGURATION 28L
PDTS OPERATES AS A PKT IN ROLL CALL

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	RCV ONLY	XMT/RCV	XMT/RCV	
NET MODE	RC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28L
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	750	000	000	

TABLE 2. (CONTINUED).

CONFIGURATION 28M
PDTS TRANSMITS BROADCAST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	BC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28M
NET CONT	NCS	PKT	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28N
PDTS TRANSMITS IN SHORT BROADCAST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	SBC	RC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28N
NET CONT	NCS	PKT	PKT	
SYNC	F	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 2. (CONTINUED)

CONFIGURATION 28O
PDTS RECEIVES BROADCAST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	BC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	C	C	C	TEST 28O
NET CONT	PKT	NCS	PKT	
SYNC	F/C	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

CONFIGURATION 28P
PDTS RECEIVES SHORT BROADCAST

CONFIGURATION PARAMETER	PDTS CONFIGURATION	DTS #1 CONFIGURATION	DTS #N CONFIGURATION	
OP	XMT/RCV	XMT/RCV	XMT/RCV	
NET MODE	RC	SBC	RC	
SB SEL	LSB	LSB	LSB	
TIMING	COR	COR	COR	
ERR COR	L	C	C	TEST 28R
NET CONT	PKT	NCS	PKT	
SYNC	F	F/C	F/C	
DOP COR	ON	ON	ON	
DATA RATE	F	F	F	
RANGE	000	000	000	

TABLE 3. OPERATOR ENTRY SCRIPT.

SCRIPT	TYPE	RANGE	BEARING	
28A	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	100	000	
	Air Friend	100	045	
	Air Friend	100	090	
	Air Friend	100	135	TEST 28E
	Air Friend	100	180	
	Air Friend	100	225	
	Air Friend	100	270	
	Air Friend	100	315	
28B	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			
	Air Friend	100	000	
	Air Friend	100	045	
	Air Friend	100	090	
	Air Friend	100	135	TEST 28F
	Air Friend	100	180	
	Air Friend	100	225	
	Air Friend	100	270	
	Air Friend	100	315	
28C	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	100	000	
	Air Friend	100	090	
	Air Friend	100	180	
	Air Friend	100	270	
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			
	Air Hostile	100	045	
	Air Hostile	100	135	TEST 28G
	Air Hostile	100	225	
	Air Hostile	100	270	

TABLE 3. (CONTINUED).

SCRIPT	TYPE	RANGE	BEARING	
28D.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	50	000	
	Air Friend	100	000	
	Surf Friend	50	020	
	Surf Friend	100	020	
	Subsurf Friend	50	040	
	Subsurf Friend	100	040	
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			TEST 28H
	Air Hostile	50	180	
	Air Hostile	100	180	
	Surf Hostile	50	200	
	Surf Hostile	100	200	
	Subsurf Hostile	50	220	
	Subsurf Hostile	100	220	
28E.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	110	025	
	Air Hostile	110	028	
	Surf Friend	140	025	
	Surf Hostile	140	028	
	Subsurf Friend	170	025	
	Subsurf Hostile	170	028	
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			TEST 28I
	Air Friend	120	025	
	Air Hostile	120	028	
	Surf Friend	150	025	
	Surf Hostile	150	028	
	Subsurf Friend	180	025	
	Subsurf Friend	180	028	

TABLE 3. (CONTINUED).

SCRIPT	TYPE	RANGE	BEARING	
28F.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Unk	100	045	
	Surf Unk	120	045	
	Subsurf Unk	140	045	
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			TEST 28J
	Air Unk	100	270	
	Surf Unk	120	270	
	Subsurf Unk	140	270	
28G.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	125	012	
	Air Unk	150	024	
	Surf Friend	150	035	
	Surf Unk	160	045	
	Subsurf Hostile	200	060	
	Subsurf Unk	220	080	
	Subsurf Friend	180	090	
	Surf Hostile	120	090	
	Air Hostile	80	070	
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			TEST 28K
	Air Friend	125	192	
	Air Unk	150	204	
	Surf Friend	150	215	
	Surf Unk	160	225	
	Subsurf Hostile	200	240	
	Subsurf Unk	220	260	
	Subsurf Friend	180	270	
	Surf Hostile	120	270	
	Air Hostile	80	250	

TABLE 3. (CONTINUED).

SCRIPT	TYPE	RANGE	BEARING	
28H.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Friend	100	180	
	Air Unk	120	200	
	Air Hostile	140	220	
	Surf Friend	100	240	
	Surf Unk	120	260	
	Surf Hostile	140	280	
	Subsurf Friend	100	300	
	Subsurf Unk	120	320	
	Subsurf Hostile	140	340	TESTS 28M AND N
	At the AN/UYA-4 associated with the PDTS drop tracks as follows:			
	Air Unk	120	200	
	Surf Unk	120	260	
	Subsurf Unk	120	320	
	Air Hostile	140	220	
	Surf Hostile	140	280	
	Subsurf Hostile	140	340	
28I.	At the AN/UYA-4 associated with the PDTS enter tracks as follows:			
	Air Unk	110	110	
	Air Unk	110	140	
	Air Unk	110	160	
	Air Unk	110	200	
	Air Unk	110	220	TEST 28Q
	Surf Unk	140	110	
	Surf Unk	140	140	
	Surf Unk	140	200	
	Surf Unk	140	220	
	Subsurf Unk	200	110	

TABLE 3. (CONTINUED).

SCRIPT	TYPE	RANGE	BEARING	
28I. (Cont)	At the AN/UYA-4 associated with the PDTS alter the previously entered track IDs as follows:			
	Air Friend	110	110	
	Air Hostile	110	140	
	Air Friend	110	160	
	Air Hostile	110	200	
	Air Friend	110	220	
	Surf Friend	140	110	TEST 28Q (cont)
	Surf Hostile	140	140	
	Surf Hostile	140	200	
	Surf Friend	140	220	
	Subsurf Hostile	200	110	
28J.	At the AN/UYA-4 associated with DTS#1, enter tracks as follows:			
	Surf Friend	300	020	
	Surf Hostile	300	040	
	Surf Unk	300	060	
	Air Friend	320	080	
	Air Hostile	320	100	
	Air Unk	320	120	
	Subsurf Friend	340	140	
	Subsurf Hostile	340	160	
	Subsurf Unk	340	180	TESTS 28L, O, AND R
	At the AN/UYA-4 associated with DTS#1 drop tracks as follows:			
	Surf Unk	300	060	
	Air Unk	320	120	
	Subsurf Unk	340	180	
	Surf Hostile	300	040	
	Air Hostile	320	100	
	Subsurf Hostile	340	160	

TABLE 3. (CONTINUED).

SCRIPT	TYPE	RANGE	BEARING	
28K.	At the AN/UYA-4 associated with the PDTS enter multiple tracks as follows:			
	Air Friend	100/120/140	010	
	Air Friend	100/120/140	030	
	Air Friend	100/120/140	050	
	Air Friend	100/120/140	070	
	Air Friend	100/120/140	090	
	Air Unk	200/220/240	110	
	Air Unk	200/220/240	130	
	Air Unk	200/220/240	150	
	Air Unk	200/220/240	170	
	Air Unk	200/220/240	190	TEST 28P
	At the AN/UYA-4 associated with DTS#1 enter tracks as follows:			
	Surf Hostile	300/330/360	210	
	Surf Hostile	300/330/360	230	
	Surf Hostile	300/330/360	250	
	Surf Hostile	300/330/360	270	
	Subsurf Unk	400/420/440	290	
	Subsurf Unk	400/420/440	310	
	Subsurf Unk	400/420/440	330	
	Subsurf Unk	400/420/440	350	

EQUIPMENT MODIFICATIONS

Prior to shipment of the AN/WSC-3 radio to NOSC, ECI personnel modified the receiver AGC to speed up the turn-around time between transmit and receive conditions and to prevent sync frame loss when operating in a network composed of nearby "strong-signal" stations and distant stations having relatively low received signal strength. The modification required the AGC hang time be reduced to 10 milliseconds or less to achieve frame synchronization. This problem with the AN/WSC-3 radio was found and diagnosed by NOSC Code 8142 personnel in late 1976.

The radio supplied to NOSC for this test by ECI was its "LOS Voice And Data Radio" version of the AN/WSC-3. An additional problem was encountered with this radio by NOSC personnel and was corrected by ECI; it was necessary that the AM sidetone be disabled while in the Link 11 mode to ensure a zero-volt dc offset of the received audio to the PDTS. Figure 2 is a before and after "fix" comparison of the received audio at the PDTS as taken on the Honeywell visicorder.

We were assured by ECI that intermodulation distortion and audio frequency response characteristics were essentially unaffected by these modifications. No attempt was made by NOSC to confirm this fact.

TEST RESULTS

IN-HOUSE TESTS

Before conducting Test 28, several in-house tests were conducted utilizing the PDTS–AN/WSC-3 combination.

Multistation POFAs were conducted with the AN/WSC-3/PDTS linked antenna-to-antenna with the NOSC AN/USQ-36 modem and the ECI IR&D radio (the frequency synthesis scheme of the IR&D radio is entirely different from that of the AN/WSC-3). The uhf antennas employed by these radios were separated by approximately 6 feet. Multistation POFAs were conducted in the same test configuration with the NOSC AN/USQ-59 modem in place of the PDTS. POFA printouts gathered in these exchanges were helpful in defining quantitatively the PDTS uhf Link 11 performance and for comparing this performance with that of the AN/USQ-59. In addition, various portions of Test 28 were simulated using this in-house configuration with the AN/WSC-3/PDTS simulating the shore site and the AN/USQ-36/IR&D simulating the ship site.

Another in-house test consisted of "ping-pong" (no computer data exchanged, just passing back and forth of preamble, control codes, and address codes) exchange between the AN/WSC-3/PDTS and the AN/USQ-36/IR&D while monitoring the received audio with the Honeywell visicorder (see figure 1). The visicorder plot was then inspected to ensure the proper timing and AGC action of the AN/WSC-3/PDTS combination. The visicorder plot also provided information on the deviation of the received rf signal (the amplitude of the received audio is a direct indication of the deviation of the received rf-FM signal).

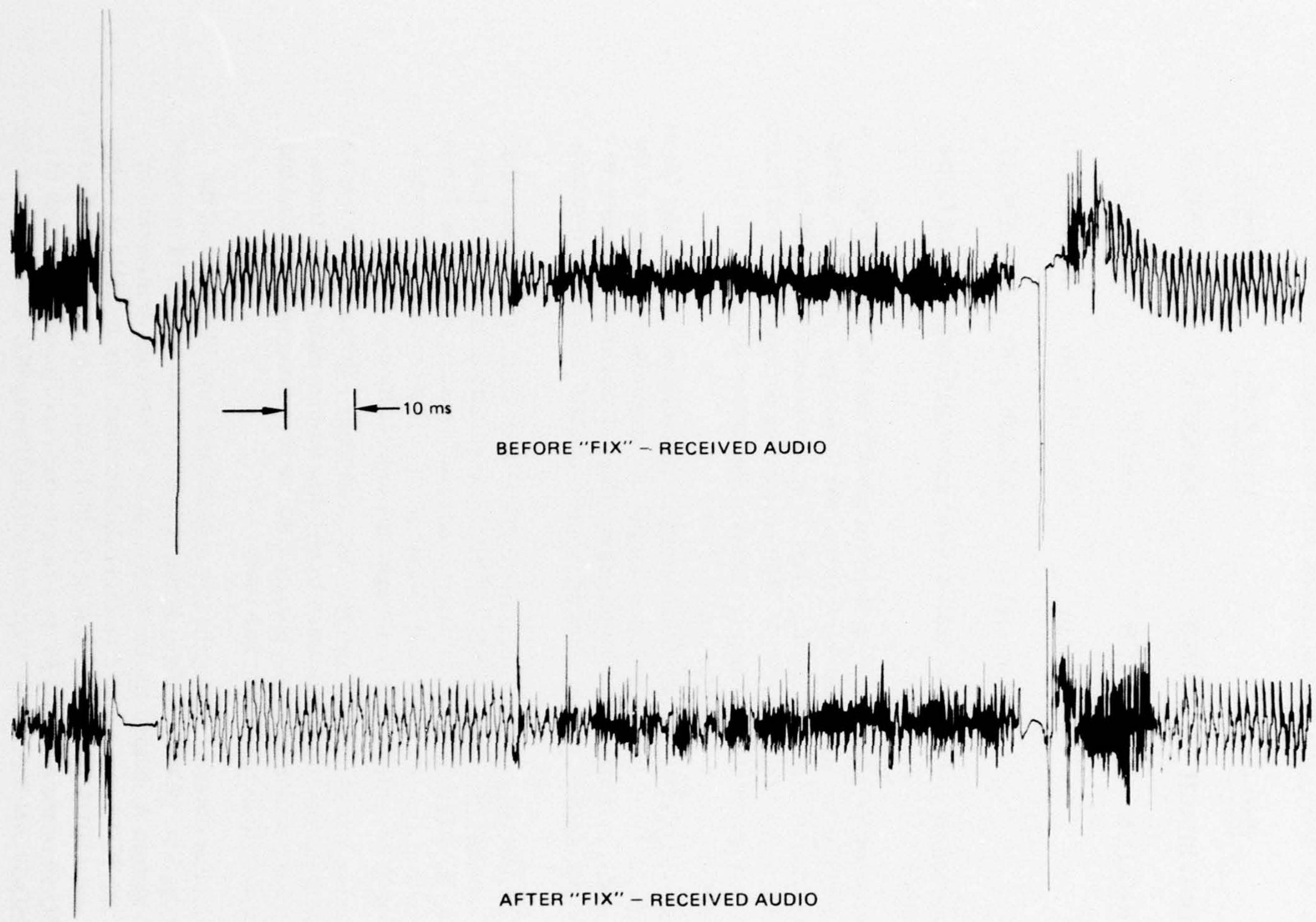

Figure 2. Comparison of before and after "fix" on the AN/WSC-3 radio (10 ms per division).

ON-THE-AIR TESTS

The on-the-air tests consisted of live links (ping-pong, POFA, and Test 28) with NOSC using the AN/WSC-3/PDTS combination with the following platforms:

Platform		UHF Radio	Modem
USS LONG BEACH	CGN 9	AN/SRC-31	AN/USQ-36
USS TRUXTUN	DLGN 35	AN/SRC-31	AN/SSQ-29
S-3A	Aircraft	AN/ARC-156	AN/CV-2830
E-2C	Aircraft	AN/ARC-158	AN/ARQ-35

Test 28 was successfully completed with all 4 of the above platforms with the following modifications:

The AN/CV-2830 modem on the S-3A aircraft and the AN/USQ-36 modem on USS LONG BEACH could not perform the "broadcast" and "short broadcast" functions. Therefore steps O and R of Test 28 were omitted for these platforms. (It has since been learned that the AN/CV-2830 modem can perform the "short broadcast" function, but the airborne modem operators at the time of the link were not aware of this fact nor how to perform the function.)

(b) USS TRUXTUN and NOSC had problems receiving successfully the "short broadcast" function (Test 28 steps N and R) on the first transmission. Because of the high missed message rate (sometimes approaching 90%), it was often necessary to retransmit the same message several times on "short broadcast" before it was successfully received.

(c) The AN/ARQ-35 modem on the E-2C Aircraft could not perform the "broadcast" function; therefore, step O of Test 28 was omitted. Because of time limitations, step R of Test 28 (E-2C in "short broadcast") was not performed. It was necessary to compensate for a consistent +3 nmi offset of E-2C entered tracks and a −3 nmi offset of NOSC entered tracks (thought due to inaccurate gridlock).

(d) Accuracy of the track positions was occasionally a problem. This was not due to equipment malfunctions, but rather to operator haste in entering the tracks. Once the error was pointed out to the operator, the track position could be changed and brought easily within the required accuracy.

One problem observed during the in-house test and Test 28 concerned the *Received Message Rate (RMR is defined as the ratio of the total number of messages* received from station A divided by the total number of messages transmitted by station A) of the PDTS as compared to other data-terminal sets available at NOSC (AN/USQ-36 and AN/USQ-59). The RMR of the PDTS was, in general, lower than that of the AN/USQ-59 or the AN/USQ-36. In a back-to-back configuration through the radios (AN/USQ-59/AN/WSC-3 and AN/USQ-36/IR&D) using POFA exchange, a consistent RMR of 1.00 on both ends of the link was obtained with interrupt and buffer status satisfactory. When the PDTS replaced the AN/USQ-59 in this configuration, the

RMR was generally less than unity on both ends of the link with PDTS in NCS and on the PDTS end in PICKET. Interrupt and buffer errors were reported. Table 4 summarizes the results of one such comparison. On live-link operations (Test 28), it was observed that the RMR at the PDTS was lower than that at the AN/USQ-36 (even more so than in the back-to-back observations) but no quantitative measurement was made. This same problem had been observed by Data/Ware Development, Inc engineers while performing the acceptance level tests on the PDTS and was pointed out in their report.[2]

In live-link operations, the track quality gives a poor indication of RMR in that track quality is held constant if 1 message is received every 20 seconds. In the worst case for Test 28, each party (in a 2-party net) transmits approximately 13 messages every 20 seconds. If 1 out of 13 messages is received (RMR = 0.077), the track quality will be held constant.

This problem was demonstrated to the PDTS software programmers and their investigation pointed to problems with the PDTS doppler-correction algorithm or its implementation. The PDTS signal-presence and doppler-correction algorithms were modified to correct this problem. These modified algorithms were tested in the back-to-back configuration through the radios. In 136 minutes, the PDTS missed one message out of 1006 (RMR = 0.999) with one Interrupt and Buffer-Status error (a considerable improvement). Table 5 lists the results after the software fix. The AN/USQ-59 was used in place of the AN/USQ-36 because this modem was unavailable at the time of the "software fix" test. It is felt that identical results would be obtained with the AN/USQ-36. The revised program with the modified algorithms was used for the E-2C aircraft link with no apparent problems in the RMR at the PDTS or at the aircraft as had been seen in other links using the unmodified software.

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2. Data/Ware Development, Inc Report, Acceptance Level Test Report for Link 11 Programmable Data Terminal Set (PDTS), 13 January 1977

TABLE 4. RMR, INTERRUPT, AND BUFFER STATUS COMPARISON.

AN/USQ-36/IR&D AN/USQ-59/WSC-3					AN/USQ-36/IR&D AN/WSC-3/PDTS				
Modem	AN/USQ-59 NCS		AN/USQ-36 NCS		Modem	PDTS NCS		AN/USQ-36 NCS	
	RMR	Interrupt & Buffer Status	RMR	Interrupt & Buffer Status		RMR	Interrupt & Buffer Status	RMR	Interrupt & Buffer Status
36	1.00	Satisfactory	1.00	Satisfactory	36	0.96	3 Errors	0.96	3 Errors
59	1.00	Satisfactory	1.00	Satisfactory	PDTS	0.98	3 Errors	0.94	3 Errors
36	1.00	Satisfactory	1.00	Satisfactory	36	1.00	Satisfactory	1.00	Satisfactory
59	1.00	Satisfactory	1.00	Satisfactory	PDTS	1.00	Satisfactory	0.96	2 Errors
36	1.00	Satisfactory	1.00	Satisfactory	36	0.94	3 Errors		
59	1.00	Satisfactory	1.00	Satisfactory	PDTS	0.90	5 Errors		

Note: Each test lasted approximately 5 minutes with 50 messages exchanged.

TABLE 5. RMR, INTERRUPT, AND BUFFER STATUS COMPARISON AFTER "SOFTWARE FIX."

AN/USQ-59/IR&D
PDTS/WSC-3

Modem	PDTS NCS		AN/USQ-59 NCS	
	RMR	Interrupt & Buffer Status	RMR	Interrupt & Buffer Status
59	1.00	Satisfactory	1.00	Satisfactory
PDTS	1.00	Satisfactory	1.00	Satisfactory
59	1.00	Satisfactory	1.00	Satisfactory
PDTS	1.00	Satisfactory	0.99	1 Error
59	1.00	Satisfactory	1.00	Satisfactory
PDTS	1.00	Satisfactory	1.00	Satisfactory

Note: Each test lasted approximately 17 minutes with 145 messages exchanged. The third run with the AN/USQ-59 as NCS lasted 33 minutes with 280 messages exchanged.

CONCLUSIONS AND RECOMMENDATIONS

It is concluded that the PDTS is compatible with the AN/WSC-3 uhf-FM radio (as modified for Link 11) and that the AN/WSC-3 AGC action and the sync time for the PDTS are compatible while the PDTS is NCS or PICKET after modifications are made (described in paragraph "Equipment Modifications"). From the tests which were performed, it is apparent that the AN/WSC-3 radio (modified as described in this report) performs well in the uhf-FM Link 11 mode.

It is recommended that a standard Fleet-wide procedure be established and followed for setting transmit deviation when operating Link 11 in the uhf-FM mode. Further, it is recommended that the AN/WSC-3 "LOS Voice and Data Radio" be modified to disable automatically the AM sidetone when in the Link 11 mode and that the revised PDTS software be used exclusively for future PDTS testing and links.