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United States Coast Guard

DOT/TSC LORSTA MALONE TEST REPORT

Project Memorandum
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Center for Navigation

Approved for Distribution:

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PREFACE

A field test team from the U.S. Department of Transportation, Transportation Systems Center (TSC), made a series of measurements on the signals being radiated by U.S. Coast Guard LORAN-C Station (LORSTA) Malone, Florida on 14 to 16 April 1984. The measurements were made with a suite of semi-automatic test equipment, which was designed and integrated specifically to measure LORAN-C signal parameters.

These signal measures determined the following:

A. Frequency Domain Measurements

1. Spectrum of the transmitter contained 99.14 percent of the radiated energy in the 90 to 110 kHz band.
2. Radiated harmonics were over 100 dB below peak signal levels at 200 kHz, over 55 dB below at 300 kHz, over 80 dB below at 500 kHz, and over 100 dB below at all other harmonic frequencies.
3. No spurious emissions were observed.

B. Time Domain Measurements

1. The signals being radiated by LORSTA Malone met or exceeded Coast Guard specifications with the exception of the half-cycle zero crossings at 10 and 15μsec and several pulses exceeding the pulse-to-pulse time specifications.

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1. INTRODUCTION

A series of detailed signal measurements were taken at USCG LORAN-C Station (LORSTA) Malone, Florida by an engineering field test team from the U.S. Department of Transportation, Transportation Systems Center (TSC). These measurements were made with an instrumentation van designed for measuring LORAN-C signals. All data were collected from 14 to 16 April 1984.

Signal measurements included both frequency and time domain signatures at several field sites near the transmitting station as well as data from the station's internal signal sensors.

This report documents the data obtained and presents a discussion of the results.

2. STATION DESCRIPTION

U.S. Coast Guard LORAN-C Station (LORSTA) Malone, Florida is a dual-rated master/secondary station operating on group repetition intervals (GRI) of 7980 and 8970. The station is equipped with an AN/FPN-64 solid state transmitter, and with a 700-foot top-loaded monople antenna. The station transmitter has two separate antenna couplers for redundancy.

The combination of the FPN-64 transmitter and 700-foot antenna is rated to deliver a peak output power of 800 kw.

During the period of this data collection, operation of the station was reported to be normal.

3. OBSERVATION SITES

Measurements were made and data were recorded in the LORAN-C station Operations Building and at five field sites shown in Figure 3-1. Selection of satisfactory remote measurement sites presented some difficulty at Malone. No suitable site could be located to the east of the station. The three remote sites chosen were to the west, north, and southeast of the station and represented acceptable choices for obtaining an accurate data set. Sites ranged from 0.1 miles to approximately 2.5 miles from the transmitting antenna and none were near power lines.

For data reporting purposes, the site designations (indicated in Figure 3-1) were:

Site 1 -- 0.1 MILE

2 -- 0.5 MILE

3 -- SOUTHEAST SITE

4 -- WEST SITE

5 -- NORTH SITE

Frequency spectrum measurements were taken at 4 sites while time domain pulse waveforms were recorded at the station and at Sites 1 and 2. The sensor for measurements made on the station was the "operate" Pearson current transformer located on the antenna ground return.

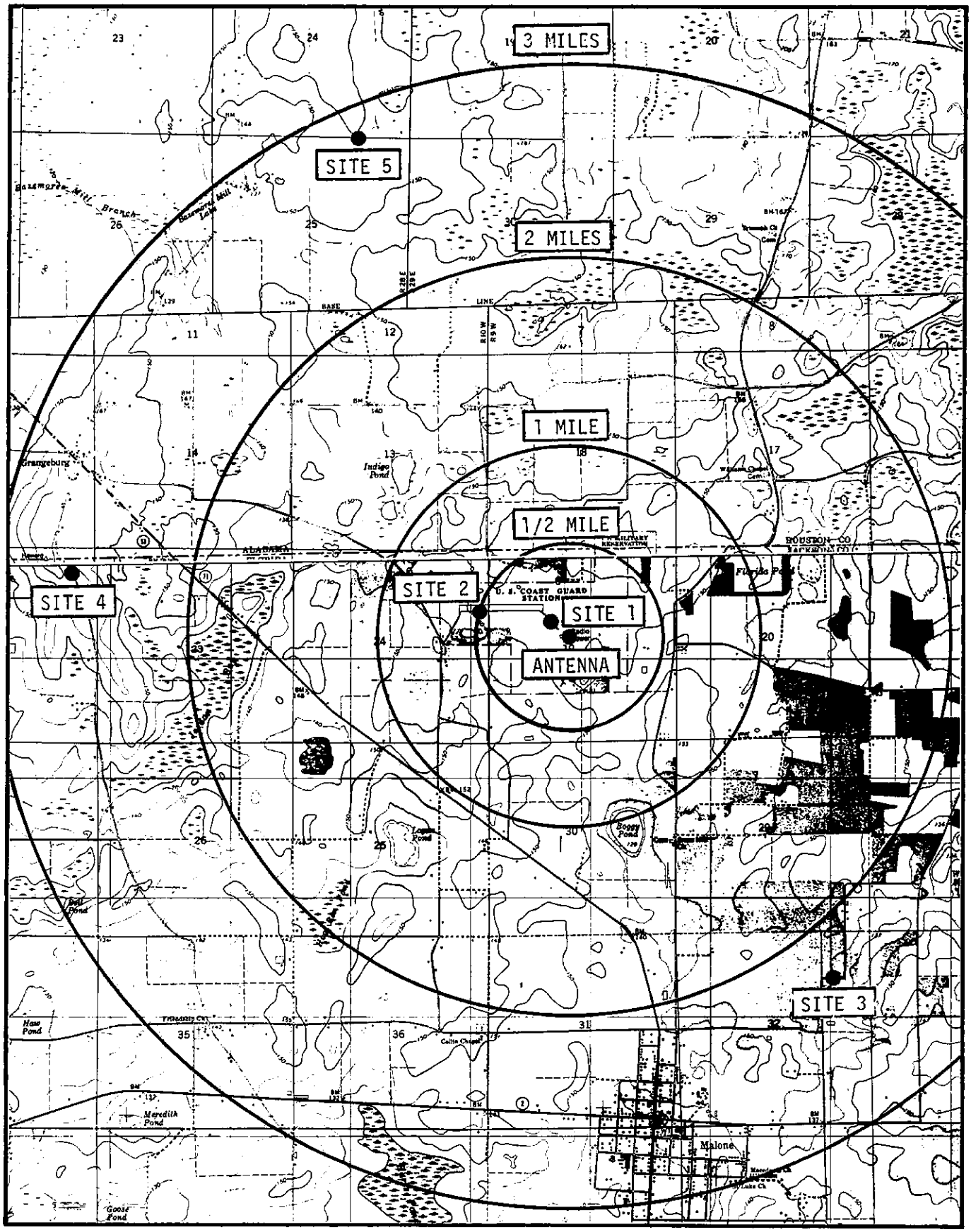


FIGURE 3-1. TEST SITE LOCATIONS

4. FREQUENCY DOMAIN MEASUREMENTS

4.1 MEASUREMENT TECHNIQUES

All frequency domain measurements were made with a van mounted instrumentation package designed for collecting this type of data. The major components of this system are shown in Figure 4-1.

Signals were sampled at 1 kHz increments in the range from 70 kHz to 130 kHz by a Hewlett Packard (HP) 3585A spectrum analyzer. The spectrum analyzer was controlled by a Tektronix 4052 graphics computer. The computer calculated in-band and out-of-band radiated power percentages after a spectrum sampling sequence.

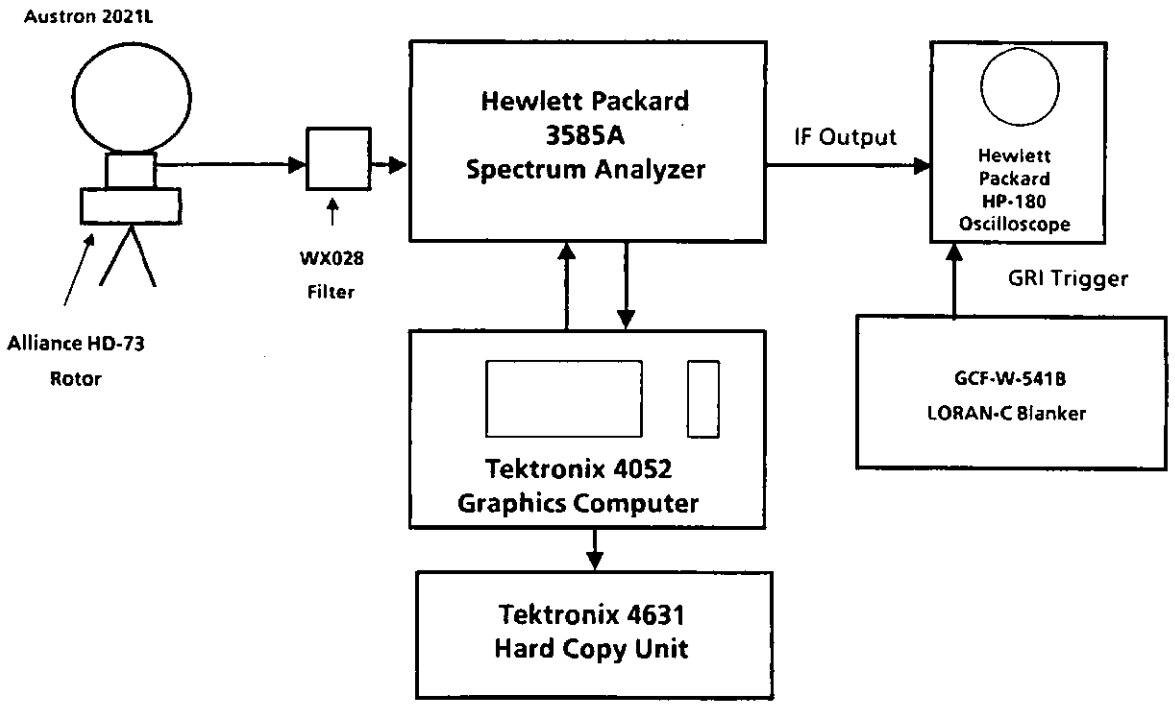


FIGURE 4-1. EQUIPMENT CONFIGURATION FOR MEASUREMENT OF FREQUENCY DOMAIN DATA

Harmonic radiation measurements werre made by placing the spectrum analyzer in the manual mode and examing the intermediate frequency (IF) output for evidence of radiated LORAN-C energy at all hormonic frequencies. The IF output was analyzed by observing the energy present at each harmonic frequency on an oscilloscope triggered with the group repetition interval (GRI) of the station. Harmonic energy could be seen as characteristic LORAN-C pulse group patterns. A 100 kHz notch filter was inserted in the signal line from the antenna during harmonic measurements to prevent dynamic range signal overloads in the spectrum analyzer circuitry from affecting the obtained data. Measurements of any extant near-band signals were also made and documented. The procedure for making these measurements is detailed in the DOT/TSC LORSTA Seneca Test Report (DOT-TSC-CG337-PM-83-29).

4.2 LORAN-C SPECTRUM EVALUATION

The radiated spectrum from LORSTA Malone was well within the requirement for 99 percent of radiated energy to be contained in the 90 to 110 kHz band. Table 4-1 shows that the average in-band energy for both couplers was 99.14 percent at the Operations Building and at 4 field test sites. The radiated energy above 110 kHz and below 90 kHz was less than the allowed 0.5 percent. Examination of the data and spectrum photographs in Figures 4-2 through 4-7 shows good correlation between the data from all field sites. Comparison of the spectrums exhibited by Coupler 2 and Coupler 1 shows no significant difference. Frequency domain data for all sites are contained in Appendix A.

RF Spectrum measurements were recorded by the Tektronix 4052 graphics computer in the Operations Building and at Sites 2, 3, 4, and 5. These data are presented in Figures 4-8 through 4-10. The tabular data are contained in Tables 4-2 through 4-4.

4.3 RADIATED HARMONIC SIGNALS

Radiated harmonic frequency levels were measured at Sites 1 and 2. The results are tabulated in Table 4-5. The tabulated results indicate that the harmonics were, in general, more than 80 dB below the signal level at 100 kHz.

4.4 BROADBAND SPECTRUM EVALUATION

The frequency band from 200 kHz to 1200 kHz was examined at the Operations Building and several field sites to determine if spurious LORAN-C transmissions were present. LORAN-C spurious signals are identified by using rapid scan rates of 5-to-10

TABLE 4-1. MALONE SPECTRUM MEASUREMENTS, SIGNAL POWER DISTRIBUTION IN RANGE FROM 76 kHz TO 124 kHZ

Measurement Site	Date	COUPLER 1 (S/N 8) % of total power				COUPLER 2 (S/N 1008) % of total power			
		Time	IN-BAND	Below 90 kHz	Above 110 kHz	Time	IN-BAND	Below 90 kHz	Above 110 kHz
Operations Building	04/16/84					11:47	99.08	0.37	0.54
0.5 Mile Site	04/14/84					13.28	99.17	0.37	0.46
0.5 Mile Site	04/15/84	11:20	99.13	0.38	0.49				
Map Site 2	04/14/84					14:56	99.15	0.37	0.49
Map Site 3	04/14/84					16:30	99.12	0.39	0.49
Map Site 4	04/15/84	09:30	99.14	0.36	0.50				
Average			99.14	0.37	0.50		99.13	0.375	0.495

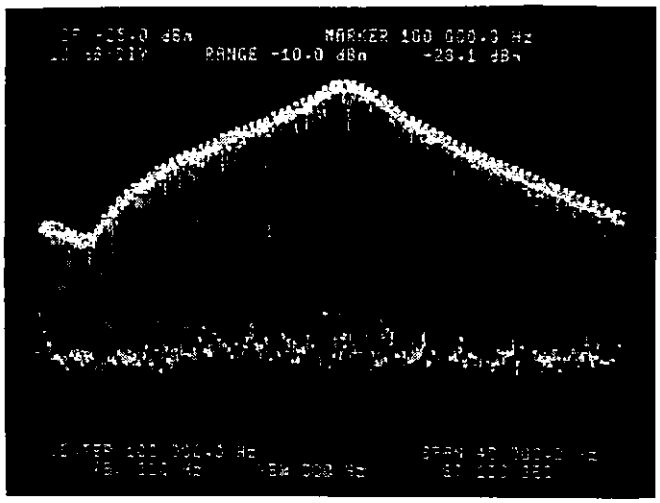


FIGURE 4-2. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 2 (0.5 MILE),HORIZONTAL SCALE - 4 kHz/DIV

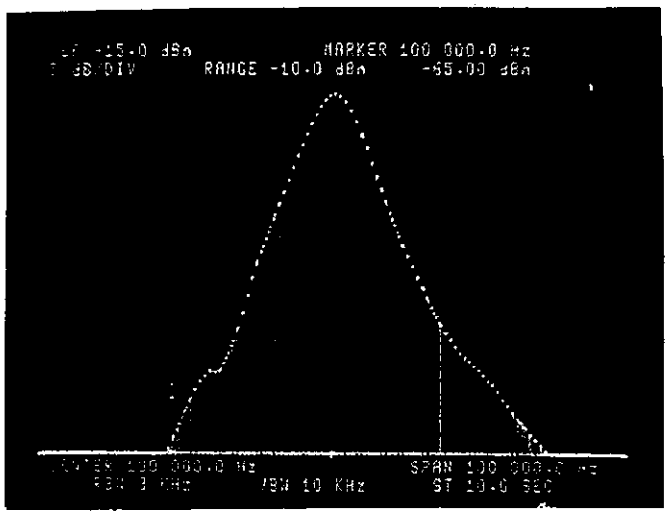


FIGURE 4-3. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 2 (0.5 MILE), HORIZONTAL SCALE - 10 kHz/DIV

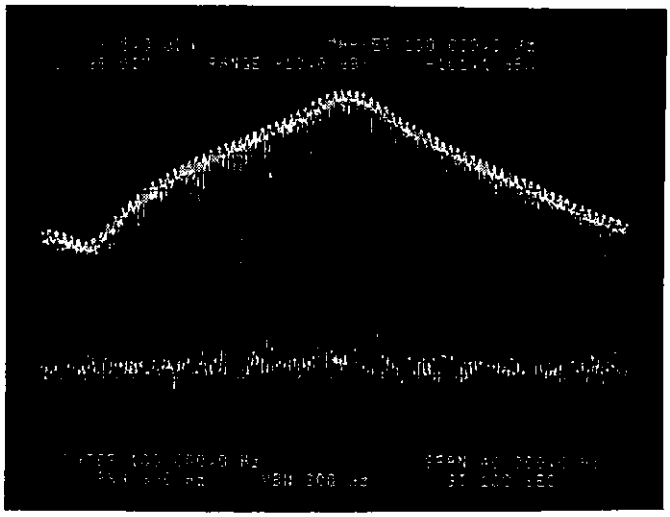


FIGURE 4-4. RF SPECTRUM FROM LORSTA MALONE COUPLER 1 AT SITE 2 (0.5 MILE), HORIZONTAL SCALE - 4 kHz/DIV

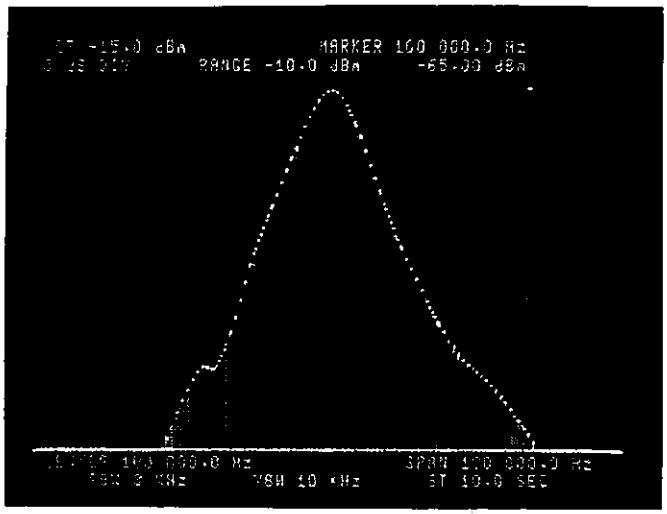


FIGURE 4-5. RF SPECTRUM FROM LORSTA MALONE COUPLER 1 AT SITE 2 (0.5 MILE), HORIZONTAL SCALE - 10 kHz/DIV

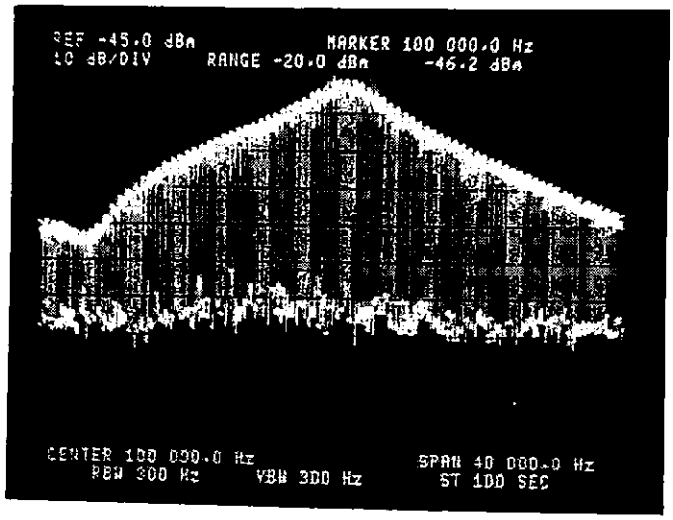


FIGURE 4-6. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 3 (SOUTHEAST SITE), HORIZONTAL SCALE - 4 kHz/DIV

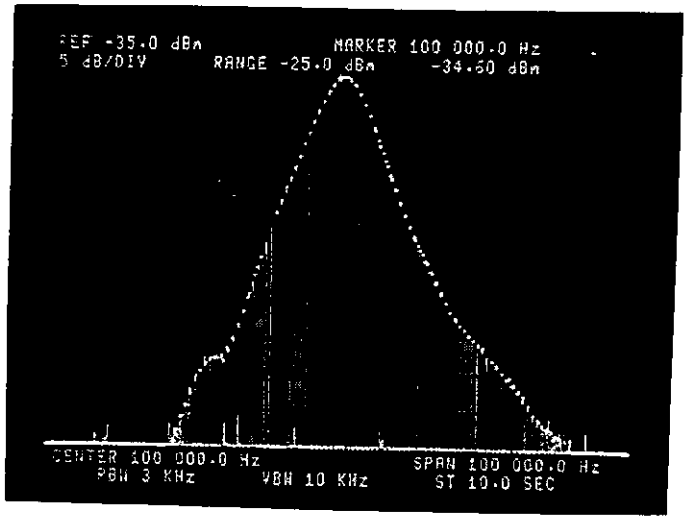


FIGURE 4-7. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 3 (SOUTHEAST SITE), HORIZONTAL SCALE - 10 kHz/DIV

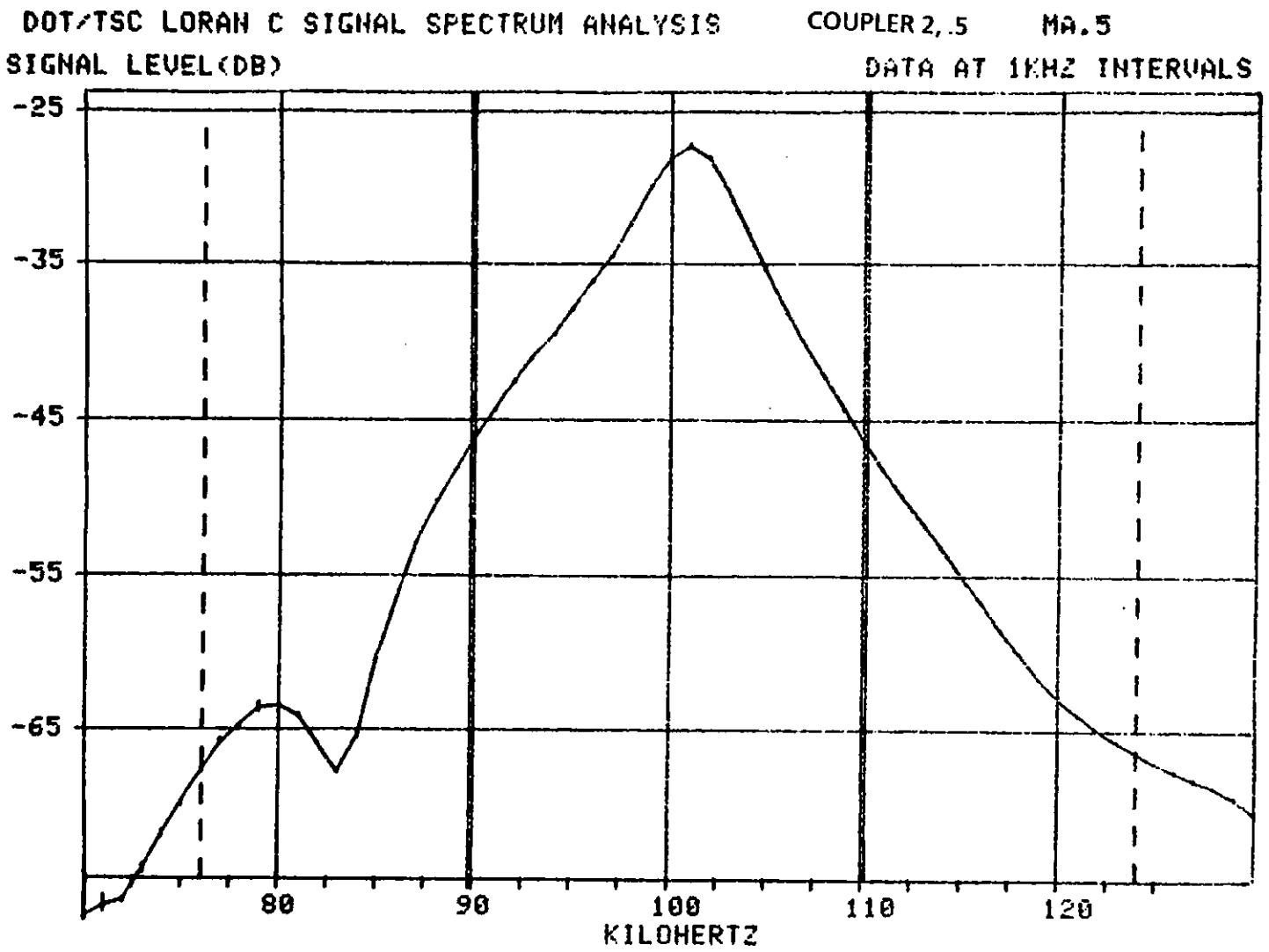


FIGURE 4-8. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 2 (0.5 MILE), RECORDED BY TEKTRONIX 4052 GRAPHICS COMPUTER

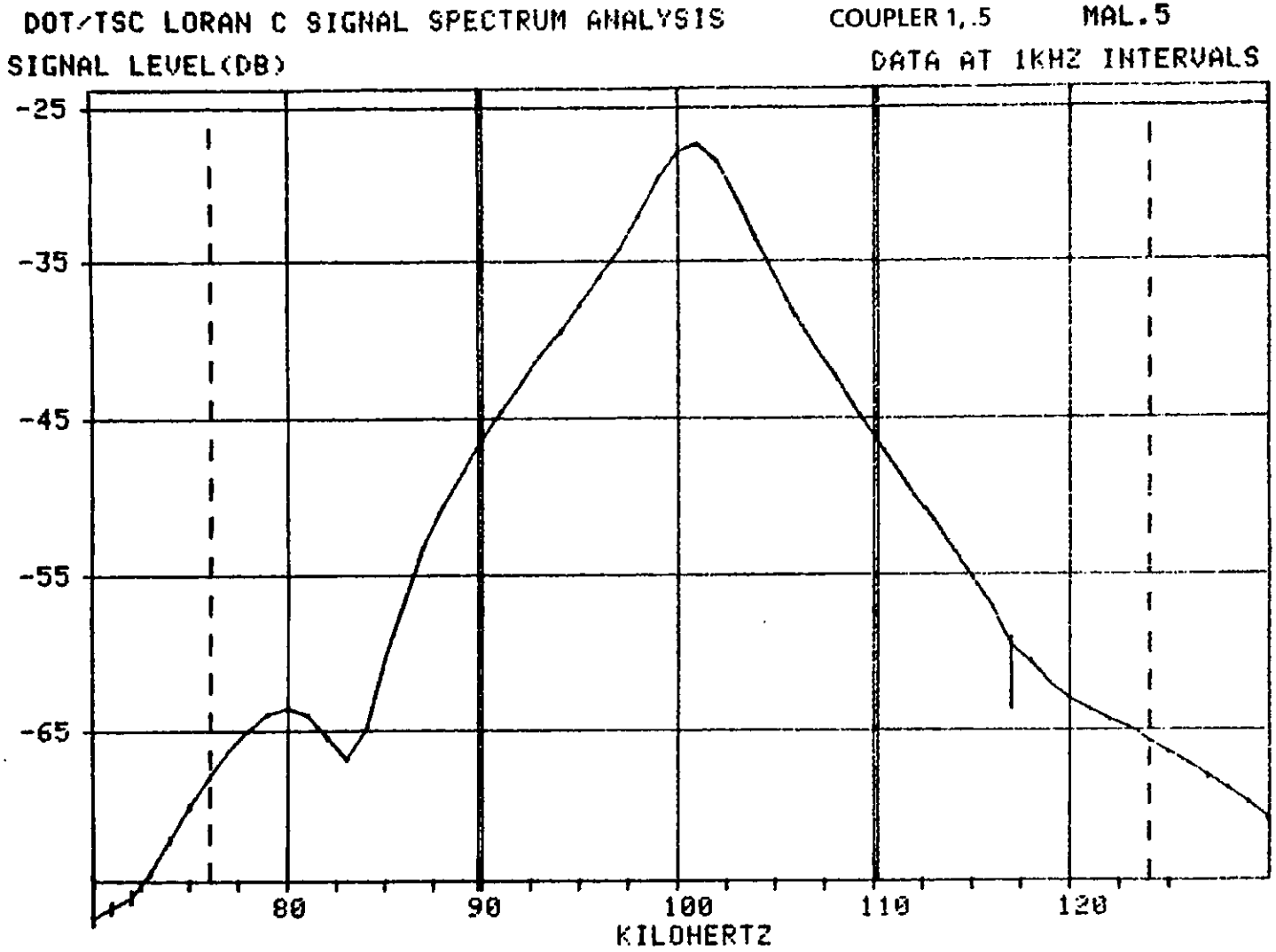


FIGURE 4-9. RF SPECTRUM FROM LORSTA MALONE COUPLER 1 AT SITE 2 (0.5 MILE), RECORDED BY TEKTRONIX 4052 GRAPHICS COMPUTER

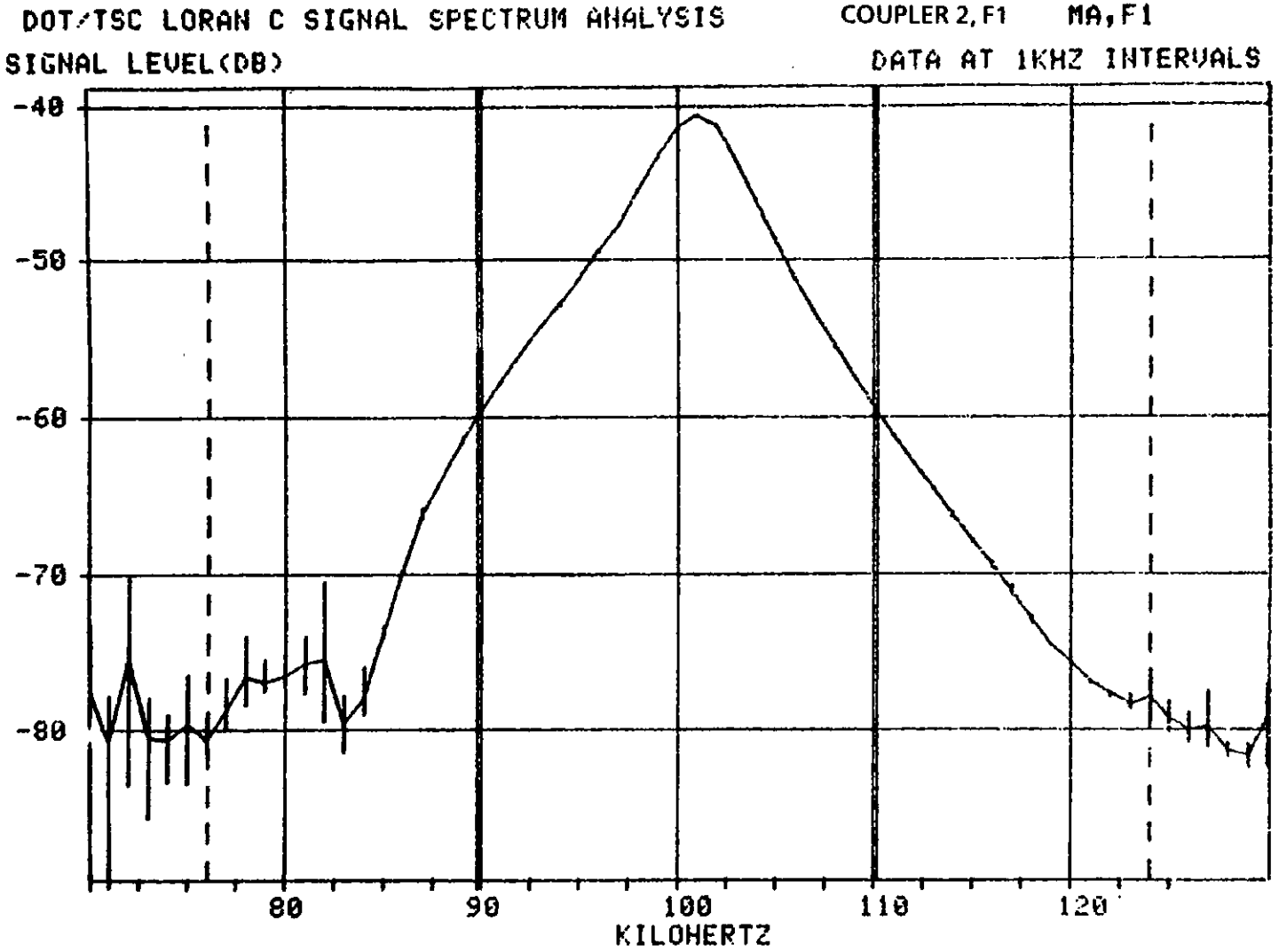


FIGURE 4-10. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 3 (SOUTHEAST SITE), RECORDED BY TEKTRONIX 4052 GRAPHICS COMPUTER

TABLE 4-2. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 2 (0.5 MILE)

MA.5 14-APR-84 13:29:37 AVE. OF 5 SAMPLES

FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL
100	-28.05	101	-27.27	99	-29.94
		102	-29.07	98	-32.32
		103	-30.26	97	-34.41
		104	-33.01	96	-36.05
		105	-35.69	95	-37.91
		106	-38.06	94	-39.44
		107	-40.26	93	-40.81
		108	-42.31	92	-42.46
		109	-44.30	91	-44.28
		110	-46.30	90	-46.08
		111	-48.06	89	-48.11
		112	-49.83	88	-50.22
		113	-51.53	87	-52.84
		114	-53.18	86	-56.24
		115	-54.94	85	-60.30
		116	-56.63	84	-65.27
		117	-58.38	83	-67.80
		118	-60.04	82	-65.82
		119	-61.55	81	-64.05
		120	-62.92	80	-63.42
		121	-63.96	79	-63.54
		122	-64.87	78	-64.59
		123	-65.69	77	-65.85
		124	-66.41	76	-67.68
		125	-67.10	75	-69.88
		126	-67.68	74	-72.02
		127	-68.23	73	-74.33
		128	-68.74	72	-76.42
		129	-69.43	71	-76.90
100	-28.11	130	-70.42	70	-77.54

MA.5 14-APR-84 13:38:57

TABLE 4-3. RF SPECTRUM FROM LORSTA MALONE COUPLER 1 AT SITE 2 (0.5 MILE)

MAL.5 01-JAN-50 03:13:46 AVE. OF 5 SAMPLES

FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL
100	-27.85	101	-27.41	99	-29.64
		102	-28.53	98	-32.00
		103	-30.82	97	-34.21
		104	-33.61	96	-35.93
		105	-36.09	95	-37.79
		106	-38.40	94	-39.44
		107	-40.51	93	-40.91
		108	-42.35	92	-42.64
		109	-44.32	91	-44.42
		110	-46.20	90	-46.26
		111	-47.94	89	-48.35
		112	-49.83	88	-50.52
		113	-51.49	87	-53.14
		114	-53.30	86	-56.50
		115	-55.18	85	-60.36
		116	-57.05	84	-64.83
		117	-59.54	83	-66.79
		118	-60.56	82	-65.42
		119	-61.93	81	-63.93
		120	-62.94	80	-63.48
		121	-63.64	79	-63.87
		122	-64.29	78	-64.91
		123	-64.96	77	-66.25
		124	-65.71	76	-68.00
		125	-66.40	75	-70.00
		126	-67.19	74	-72.29
		127	-68.03	73	-74.45
		128	-68.90	72	-76.13
		129	-69.79	71	-76.83
100	-27.85	130	-70.82	70	-77.45

MAL.5 01-JAN-50 03:22:55

TABLE 4-4. RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 3 (SOUTHEAST SITE)

MA,F1 14-APR-84 14:56:20 AVE. OF 5 SAMPLES

FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL	FREQUENCY	SIGNAL LEVEL
100	-41.33	101	-40.55	99	-43.27
		102	-41.27	98	-45.60
		103	-43.47	97	-47.70
		104	-46.20	96	-49.33
		105	-48.79	95	-51.19
		106	-51.17	94	-52.74
		107	-53.40	93	-54.20
		108	-55.40	92	-55.80
		109	-57.39	91	-57.65
		110	-59.33	90	-59.47
		111	-61.10	89	-61.46
		112	-62.84	88	-63.72
		113	-64.51	87	-66.15
		114	-66.13	86	-69.69
		115	-67.88	85	-73.70
		116	-69.40	84	-77.91
		117	-71.11	83	-79.48
		118	-72.87	82	-75.43
		119	-74.44	81	-75.63
		120	-75.59	80	-76.49
		121	-76.89	79	-76.87
		122	-77.62	78	-76.57
		123	-78.30	77	-78.79
		124	-77.79	76	-80.62
		125	-79.19	75	-79.55
		126	-79.97	74	-80.60
		127	-79.78	73	-80.44
		128	-81.36	72	-75.44
		129	-81.63	71	-80.82
100	-41.37	130	-79.17	70	-77.45

MA,F1 14-APR-84 15:05:31

TABLE 4-5. LORSTA MALONE RADIATED HARMONIC SIGNAL LEVELS

HARMONIC FREQUENCY (kHz)	0.1 MILE SITE COUPLER 2 S/N 1008 (dB)	0.5 MILE SITE COUPLER 2 S/N 1008 (dB)	0.5 MILE SITE COUPLER 1 S/N 8 (dB)
200	101	91	112
300	86	87	107
400	109	95	116
500	81	91	115
600	113	91	111
700	103	91	113
800	117	95	115
900	113	95	115
1000	117	95	113

Harmonic signal levels are referenced to the fundamental at 100 kHz

seconds. At these scan rates, LORAN-C energy appears as a "comb" signal rather than as a single envelope as AM radio stations do. No spurious LORAN-C signals were observed. The RF Spectrum is presented in Figure 4-11.

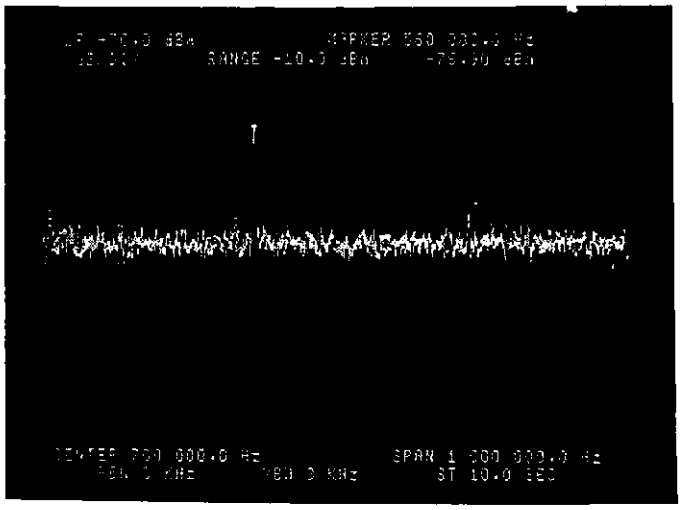


FIGURE 4-11. BROADBAND RF SPECTRUM FROM LORSTA MALONE COUPLER 2 AT SITE 2 (0.5 MILE)

4.5 INTERFERENCE

In the 70 kHz to 130 kHz band RF interference in or near the LORAN-C band is detected by using fast scan rates between 5 and 10 seconds on the spectrum analyzer. No interfering frequencies were detected.

5. TIME DOMAIN MEASUREMENTS

5.1 MEASUREMENT TECHNIQUES

5.1.1 Equipment Description

The equipment configuration used to measure the time domain parameters of the radiated LORAN-C pulses is illustrated in Figure 5-1. The HP5180A waveform recorder is the primary equipment in this setup and is used to sample, digitize, and store data on input analog signals. The sample window of the HP5180A is 10 nsec wide and the minimum sample spacing is 50 nsec. At LORSTA Malone, a sample interval of 200 nsec was used. This sample rate provides 25 samples per half-cycle and provides an accurate reconstruction of the LORAN-C pulse for analysis. A stable sampling trigger is generated by two Coast Guard-provided cross rate blankers (LORAN-C rate generators). This trigger can be adjusted in time to allow sampling to begin on any pulse for either phase code interval. The trigger circuit allows selection of the desired

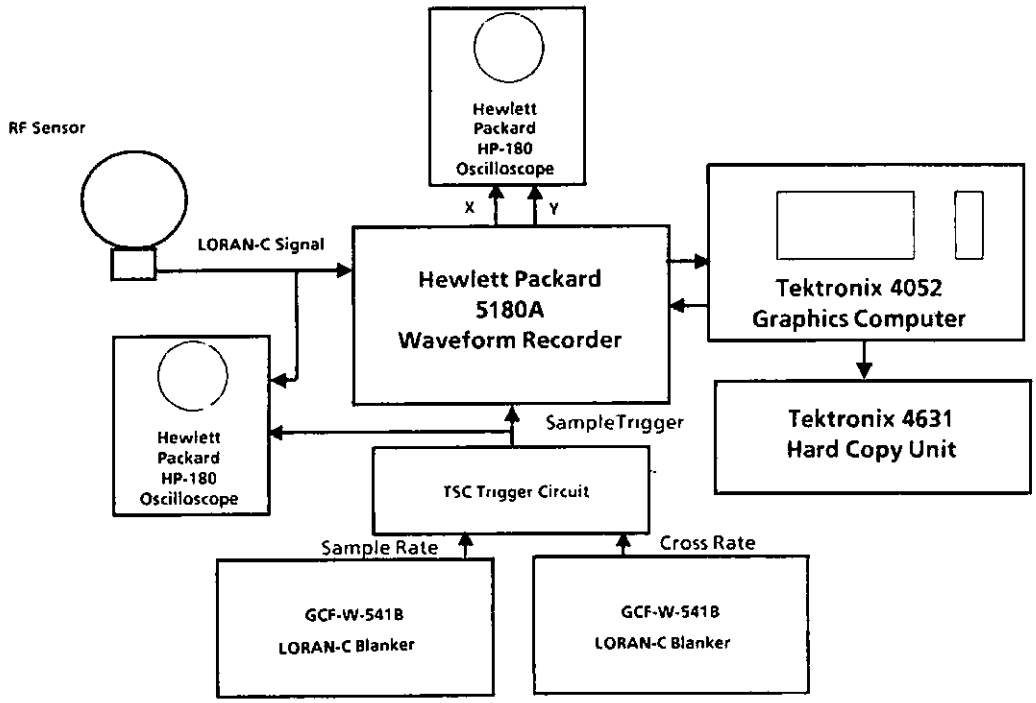


FIGURE 5-1. EQUIPMENT CONFIGURATION FOR MEASUREMENT OF TIME DOMAIN DATA

GRI. At LORSTA Malone, sampling was done in the first GRI after crossover of the two rates. This procedure ensures that only pulses from the appropriate rate are sampled. Data are then transferred to tape storage by the Tektronix 4052 graphics computer.

5.1.2 Data Collected

Pulse waveform data collected at LORSTA Malone are listed in Table 5-1. Data were collected from the antenna current transformers in the Operations Building and with a loop antenna at Sites 1 and 2. Since U.S. Coast Guard Commandant's Instruction "Specification of the Transmitted LORAN-C Signal" (COMDTINST M16562.4) states that station performance is measured by using the antenna current waveform, all anlaysis was done using those signals. The Site 1 and 2 measurements were done to ensure that no substantial errors were made in the antenna current observations.

5.1.3 Data Analysis and Display

The pulse samples were analyzed by a special processing program written for the Tektronix 4052 graphics computer. After data has been collected on a pulse, the program first estimates a zero signal level, adjusts all values to this reference, converts stored digital values to volts, and provides a plot similar to that shown in Figure 5-2. The program then identifies the cycle zero crossing at 30 μsec, locates 5 half-cycle zero crossings before this point and 6 half-cycle zero crossings after it, establishes the exact relative time of each zero crossing, and displays the results in tabular form similar to those shown in Figure 5-3. The zero crossing data are then reformatted into graphical form in a curve similar to Figure 5-4. The zero crossing tolerances established by the Coast Guard for LORSTA Malone are superimposed on the graphs.

The analysis program then computes an effective Envelope-to-Cycle Difference (ECD) using a standard Coast Guard algorithm published in Coast Guard Electronic Engineering Center (EECEN) Project WO8990-A4 -- Interim Report 1. The ECD value is used to compute the expected peak half-cycle value and the rms ensemble error is obtained through comparison of the measured individual half-cycle peak values with the calculated half-cycle peak values. All of this data, as well as effective pulse carrier frequency and pulse-to-pulse offset values, are summarized in tables similar to Table 5-2, which shows results for Coupler 1 on rate 7980.

TABLE 5-1. PULSE WAVEFORM RECORDS COLLECTED AT LORSTA MALONE FOR TIME DOMAIN ANALYSIS

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL	PULSE #
ON STATION	PEARSON CURRENT TRANSFORMER	Coupler 2 (s/n 1008)	8970	A	1 2 3 4 5 6 7 8
			8970	B	1 2 3 4 5 6 7 8
			7980	A	1 2 3 4 5 6 7 8
			7980	B	1 2 3 4 5 6 7 8
			7980		16 GRI,Pulse 2
			8970		16 GRI,Pulse 1
0.5 MILE	AUSTRON 2041 LOOP ANTENNA	Coupler 1 (s/n 8)	7980	A	1 2 3 4 5 6 7 8
			7980	B	1 2 3 4 5 6 7 8
			7980		16 GRI,Pulse 8
			8970		16 GRI,Pulse 1
0.5 MILE	AUSTRON 2041 LOOP ANTENNA	Coupler 2 (s/n1008)	7980	A	1 2 3 4 5 6 7 8
			7980	B	1 2 3 4 5 6 7 8
			7980		16 GRI,Pulse 2
			8970	A	1 2 3 4 5 6 7 8
			8970	B	1 2 3 4 5 6 7 8
			8970		16 GRI,Pulse 1
0.1 MILE	AUSTRON 2041 LOOP ANTENNA	Coupler 2 (s/n 1008)	7980	A	1 2 3 4 5 6 7 8
			7980	B	1 2 3 4 5 6 7 8

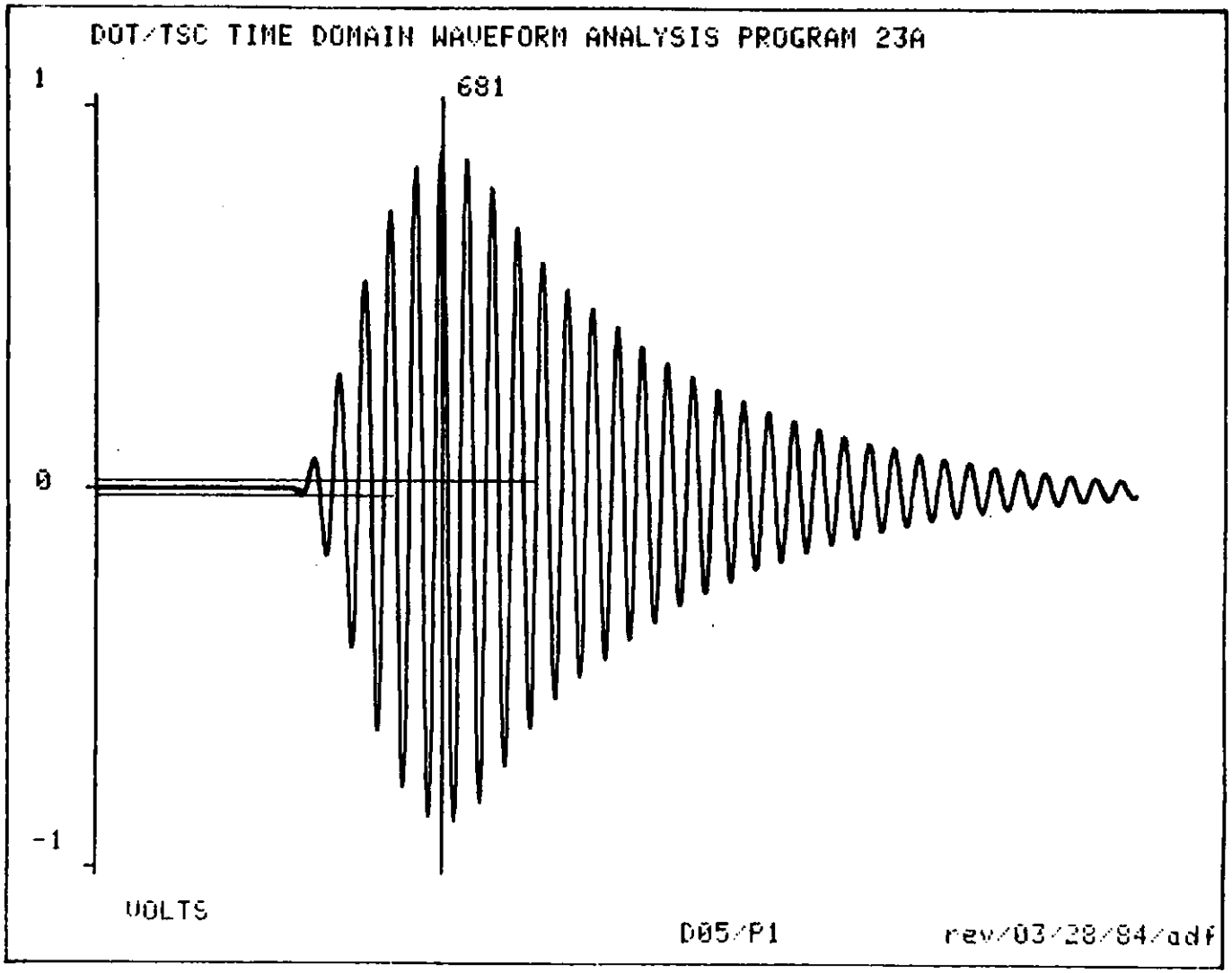


FIGURE 5-2. COMPUTER GENERATED PLOT OF DIGITIZED LORAN-C PULSE

DOT/TSC TIME DOMAIN WAVEFORM ANALYSIS PROGRAM 23A

ZERO CROSSINGS

REGISTER INDEX	TIME(MICRO SEC) (#6 SET TO 30 MICROSEC) LOCATION	DIFFERENCES
416.8750	4.7125	0.2875
442.4653	9.8306	0.1694
467.9401	14.9255	0.0745
493.1659	19.9707	0.0293
518.2583	24.9892	0.0108
543.3125	30.0000	0.0000
568.3164	35.0008	-0.0008
593.3330	40.0041	-0.0041
618.3119	44.9999	0.0001
643.3437	50.0062	-0.0062
668.3208	55.0017	-0.0017
693.3478	60.0071	-0.0071
718.3521	65.0079	-0.0079
743.3762	70.0127	-0.0127
768.3958	75.0167	-0.0167
793.3847	80.0144	-0.0144
818.2691	84.9913	0.0087

SCAN AT 200 NSEC INTERVALS

D05/P1 rev/03/28/84/adf

FIGURE 5-3. TABULATED HALF-CYCLE ZERO CROSSING TIMES

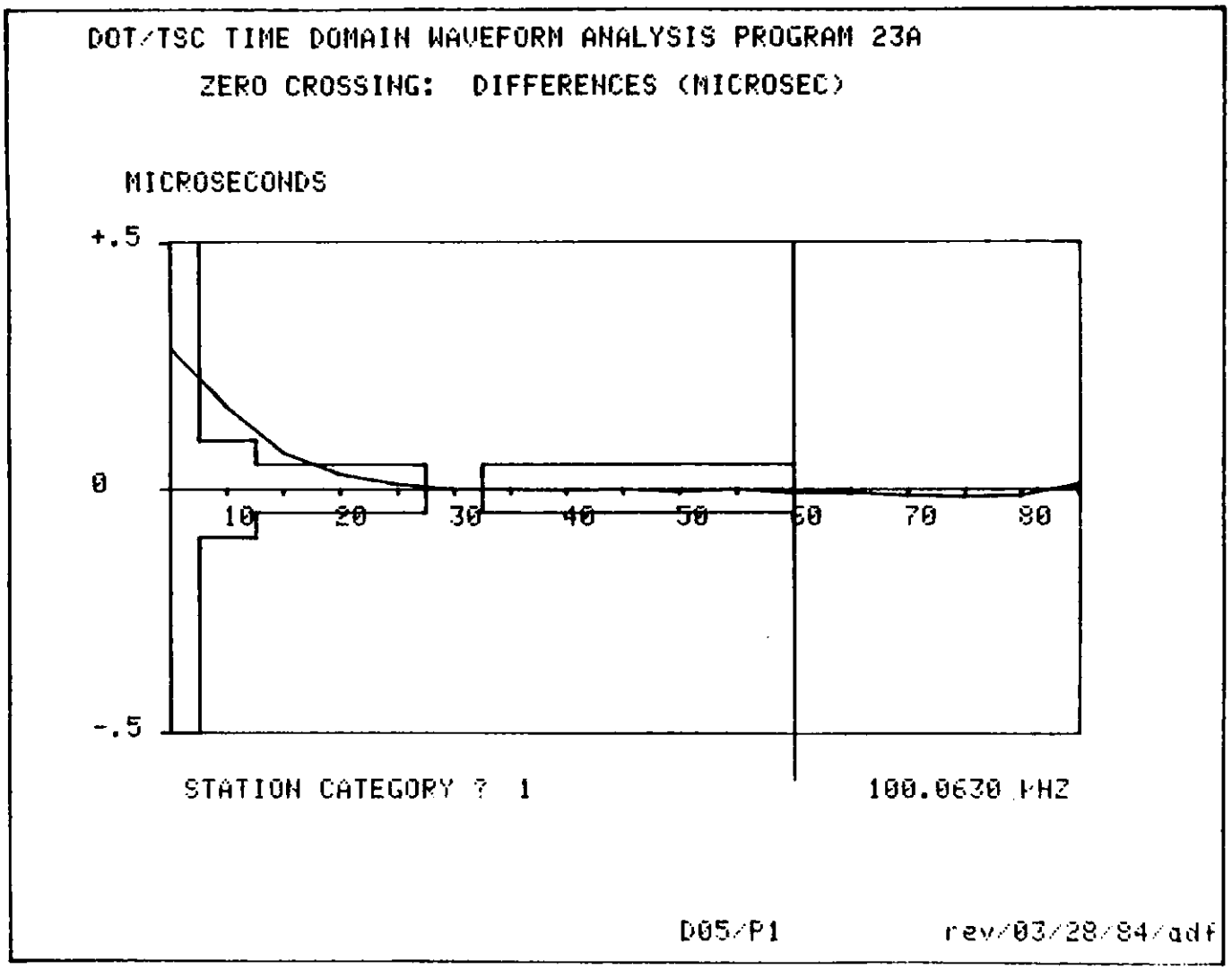


FIGURE 5-4. LORAN-C PULSE ZERO CROSSING ERRORS PLOTTED BY THE GRAPHIC COMPUTER FROM THE SAMPLED RF SIGNAL

TABLE 5-2. REPRESENTATIVE PULSE WAVEFORM RESULTS FOR LORSTA MALONE COUPLER 1, RATE 7980, RATE A

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 1 (s/n 8)	7980	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.371	0.0901	0.0901	1.044	2.1≤	1.4≤	100.0297		50
2	+	1.328	0.0915	0.0920	0.931	1.9≤	1.6≤	100.0262	-118.98	50
3	-	1.372	0.0921	0.0925	0.993	2.1≤	1.6≤	100.0159	-107.06	50
4	-	1.395	0.0923	0.0928	0.996	2.0≤	1.5≤	99.9948	-103.68	50
5	+	1.344	0.0924	0.093	0.947	2.1≤	1.3≤	100.0728		40
6	-	1.39	0.0929	0.093	0.970	2.0≤	1.7≤	100.0357	34.23	40
7	+	1.386	0.0927	0.093	0.904	1.9≤	1.1≤	100.0637	-4.16	40
8	-	1.359	0.0929	0.093	0.926	1.8≤	1.8≤	100.0492	38.08	40
	Overall Avg:	1.368	0.0921		0.964			100.036		
	+ Code	1.357						100.048	-30.79	
	- Code	1.379	Droop = 3.014%					100.024	-34.61	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

5.1.4 Radiated Signal Standards

All data collected at LORSTA Malone were compared to the standards established by the U.S. Coast Guard for that station. These standards are contained in COMDTINST M16562.4.

5.2 MEASUREMENT RESULTS

5.2.1 General

The time domain data measured at LORSTA Malone are presented in the order in which the data standards are published in COMDTINST M16562.4. Significant variations from specified values are noted. Individual tables for each data set are contained in Appendix B.

5.2.2 Half-Cycle Peak Amplitudes

5.2.2.1 Ensemble Tolerance - (Standard requires rms ensemble errors of the radiated pulse to be $\leq$1 percent.)

All pulses measured were well within the specified tolerance. Some pulses measured at the field sites exceeded the standard by a small amount. This was attributed to the fact that the data were taken in the near field of the transmitter.

5.2.2.2 Individual Half-Cycle Tolerance - (Standard requires half-cycles 1 through 8 of the radiated pulse to be$\leq$3 percent and half-cycles 9 through 13 to be $\leq$10 percent.)

The transmitter was well within the 3 percent specification on the first 8 half-cycles and the 10 percent specification on half-cycles 9 through 13.

5.2.2.3 Pulse Trailing Edge - (Standard requires pulse trailing edge to be $\leq$.0014A for all pulse times greater than 500μsec, where A is the peak pulse value.)

Examination of the trailing edge of the pulse showed that the transmitter met the specification at 485μsec. The transmitter was well within the 500 μsec requirement.

5.2.2.4 Zero Crossing Times and Tolerances within a Pulse - (Specification requires different error values for each half-cycle before 30μsec; then $\pm$ 50 nsec for half-cycles from 30μsec to 60 μsec. Beyond 60μsec, the zero crossings are required to conform to 100 kHz $\pm$ 1 kHz.)

The half-cycle zero crossings at 10 and 15 μsec were out of tolerance for every pulse measured by a small amount. These half-cycles are too wide. After 15 μsec, all half-cycle zero crossings and the pulse tails were within specification.

5.2.3 Uniformity of Pulses within a Group

5.2.3.1 Pulse-to-Pulse Amplitude Tolerance - (The specification calls for the amplitude of the smallest pulse to be within 10 percent of the amplitude of the largest pusIse within a group.)

The transmitter was well within the specified 10 percent with the largest difference being less than 3 percent in any one group.

5.2.3.2 Pulse-to-Pulse ECD Tolerance - (The specification calls for the ECD tolerance for each pulse within a group to be within 0.7 μsec of all the pulses in Group A and Group B.)

All pulses measured were well within the limits of the specification. The average ECD for the 32 pulses measured was -0.156 μsec. No pulse differed from this value by more than 0.116 μsec. The ECD balance between postively and negatively phase coded pulses was excellent.

5.2.3.3 Pulse-to-Pulse Timing Tolerance - (The specification states that the pulses 2 through 8 must satisfy the relationship (N-1) 1000 μsec $\pm$ 50 nsec + C; where N is the pulse number, C=0 for positively coded pulses and is $\leq$150 nsec for negatively coded pulses.)

Two of the measured positively coded pulses on rate 7980 exceeded the pulse-to-pulse timing tolerance. The mean offset between positively coded pulses and negatively coded pulses was 39.3 nsec.

5.2.4 Uniformity of Pulses in Different GRI

Measurements were made of 6 different 16 pulse sequences to observe what variations were exhibited by the couplers in successive GRI. The results for pulse 2, GRI 7980, of Coupler 2 as observed at the Operations Building are shown in Table 5-3.

TABLE 5-3. PULSE WAVEFORM RESULTS FOR 16 CONSECUTIVE PULSE 2 OBSERVATIONS, LORSTA MALONE, COUPLER 2

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	7980	2

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1	-	-0.199	0.8999	0.944	0.526	1.2≤	3.6≤	100.043	
2	+	-0.164	0.8984	0.948	0.383	0.7≤	4.5≤	100.073	
3	-	-0.082	0.8997	0.947	0.453	0.7≤	4.1≤	100.061	
4	+	-0.203	0.9000	0.948	0.425	0.7≤	4.1≤	100.064	
5	-	-0.262	0.8960	0.939	0.425	0.9≤	3.5≤	100.040	
6	+	-0.113	0.8942	0.945	0.416	0.7≤	4.4≤	100.029	
7	-	-0.227	0.8977	0.942	0.475	1.0≤	3.8≤	100.020	
8	+	-0.191	0.8981	0.946	0.387	0.7≤	4.1≤	100.067	
9	-	-0.107	0.9000	0.948	0.495	1.1≤	4.2≤	100.042	
10	+	-0.216	0.8982	0.946	0.359	0.5≤	3.9≤	100.057	
11	-	-0.108	0.8978	0.946	0.415	0.7≤	4.0≤	100.050	
12	+	-0.073	0.8962	0.950	0.409	0.6≤	4.5≤	100.081	
13	-	-0.092	0.8998	0.949	0.488	0.9≤	4.1≤	100.064	
14	+	-0.105	0.8958	0.948	0.325	0.7≤	4.5≤	100.061	
15	-	-0.218	0.8938	0.940	0.528	1.2≤	4.0≤	100.025	
16	+	-0.111	0.8983	0.947	0.409	0.8≤	4.4≤	100.053	
	Overall Avg:	-0.154	0.8977					100.052	
	+ Code								
			Droop = 0.693%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Over the 16 GRI sample, ECD varied within a range of 0.189 μsec, with an average of -0.154 μsec. Droop was 0.693 percent for the same sample. Variations of all pulse parameters were within established tolerance of COMDTINST M16562.4. Similar results were obtained for Coupler 1.

6. DISCUSSION OF OBSERVATIONS AND SUMMARY OF RESULTS

6.1 FREQUENCY DOMAIN MEASUREMENTS

6.1.1 General

Data of excellent quality were obtained at the Operations Building and at the five field sites, where the data recorded were generally well correlated. All of the equipment functioned normally and the results obtained represent a good picture of the signal being radiated by LORSTA Malone. The frequency domain data are contained in Appendix B.

6.1.2 Radiated Spectrum

The radiated spectrum at LORSTA Malone met the requirement for maintaining 99 percent of radiated energy in the 90 to 110 kHz band. Computations of in-band radiated power from the measured signals produced a 5-site average of 99.14 percent in-band for both couplers. Out-of-band components for both couplers were fairly evenly distributed and within requirements. The radiated spectrum peaked at 100 kHz.

6.1.3 Harmonics

The harmonic content of the radiated signal was considered to be very low. Harmonics from both transmitters were similar, with the second harmonic being over 50 dB below the peak and the third harmonic being over 60 dB below the peak. All other harmonics were below the background and instrumentation noise.

6.1.4 Spurious Emissions

The broadband spectrum measurements from 200 kHz to 1200 kHz showed no spurious emissions from this station.

6.2 TIME DOMAIN MEASUREMENTS

6.2.1 General

Measurement of all eight pulses, for both GRI and for both phase codes, at LORSTA Malone presented a sampling challenge. The complete set required sampling

32 pulses. Observation of 16 consecutive pulses provided insight into transmitter operations, both before and after rate crossover. While the sample is incomplete, taking 16 consecutive GRI samples of the same pulse permitted the field team to verify that the instantaneous samples taken by the spectrum analyzer agreed with the averaged data given by the envelope pulse analyzer in the Operations Building.

The time domain measurements at LORSTA Malone did not produce any major surprises. With the exception of some cycle zero crossings, all measured pulse data were well within the required specification.

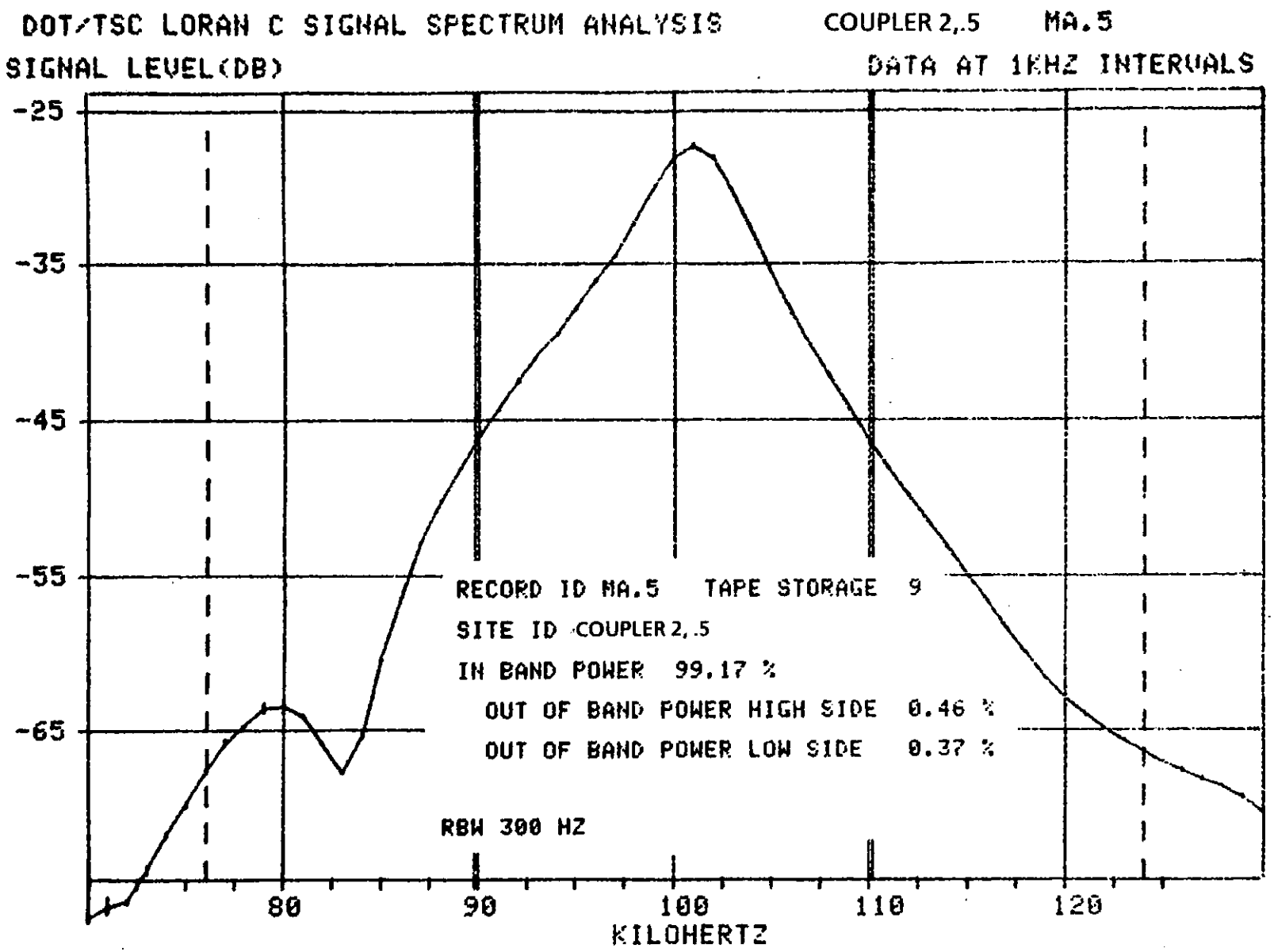
6.2.2 Pulse Waveform Evaluation

6.2.2.1 Half-Cycles Within a Pulse - The data show the transmitter to be very close to specification in terms of half-cycle timing tolerances within a pulse for all half-cycles, except for those at 10 and 15 sec. Examination of the data shows a negative slope for all plots of half-cycle zero crossings versus pulse timing before 30 sec, which is indicative of an effective pulse frequency below 100 kHz. It appears that the output network is taking longer than expected to reach a steady state (100 kHz) condition. The pulse trailing edges were well within specifications for both transmitters.

6.2.2.2 Pulses Within a Group - All measured pulses were well within the specified tolerances for pulse-to-pulse amplitude, ECD, and timing.

APPENDIX A

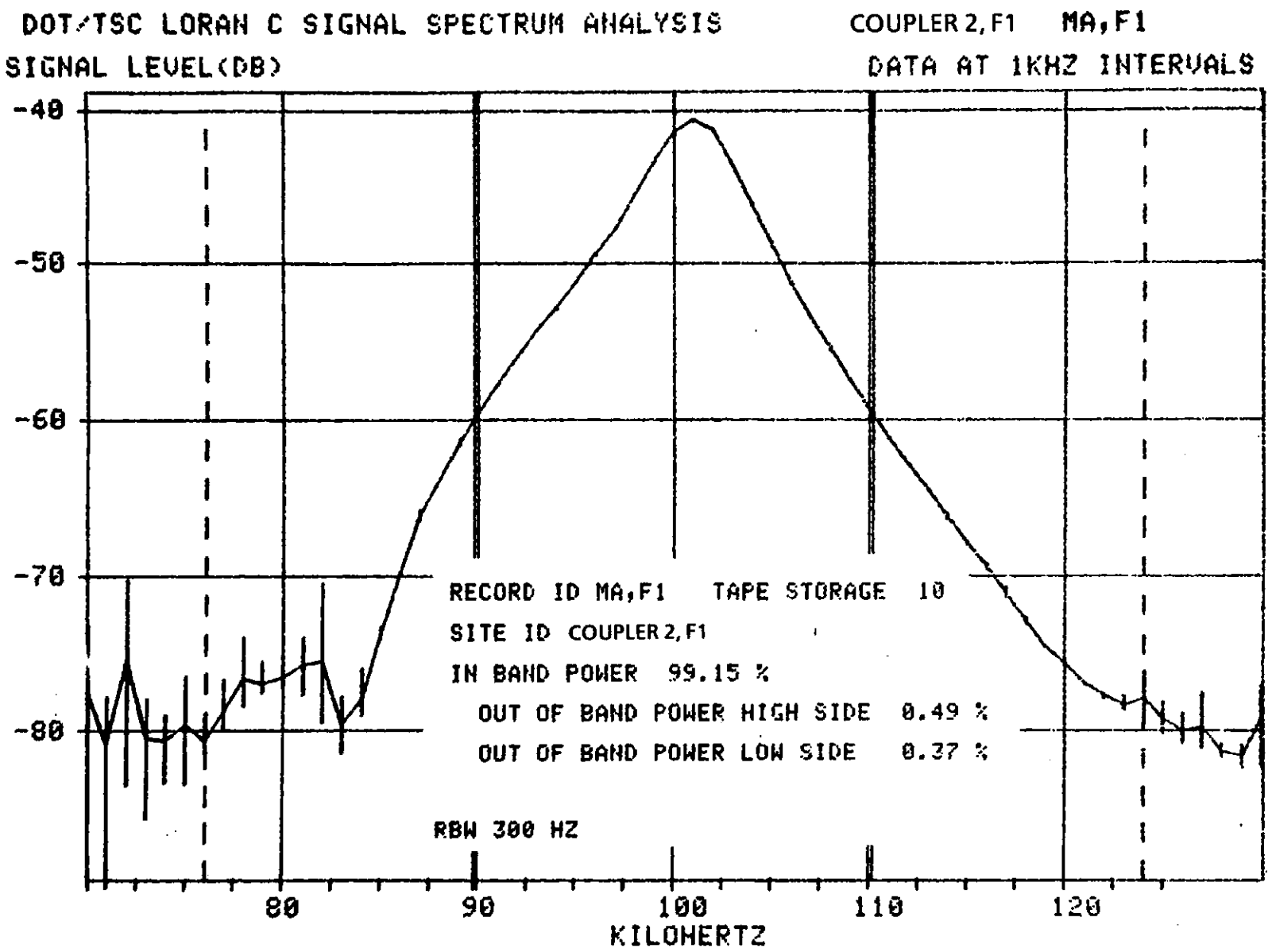
FREQUENCY DOMAIN DATA COLLECTED AT LORSTA MALONE, FLORIDA FROM 14 to 16 APRIL 1984


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 2,.5 MA.5
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-25
-35
-45
-55
-65
RECORD ID MA.5 TAPE STORAGE 9
SITE ID COUPLER 2,.5
IN BAND POWER 99.17 %
OUT OF BAND POWER HIGH SIDE 0.46 %
OUT OF BAND POWER LOW SIDE 0.37 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MA.5 14-APR-84 13:28:37 AVE. OF 5 SAMPLES

100	-28.05	101	-27.27	99	-29.94
		102	-29.07	98	-32.32
		103	-30.26	97	-34.41
		104	-33.01	96	-36.05
		105	-35.69	95	-37.81
		106	-38.06	94	-39.44
		107	-40.26	93	-40.81
		108	-42.31	92	-42.46
		109	-44.30	91	-44.20
		110	-46.30	90	-46.08
		111	-48.06	89	-48.11
		112	-49.83	88	-50.22
		113	-51.53	87	-52.84
		114	-53.18	86	-56.24
		115	-54.94	85	-60.30
		116	-56.63	84	-65.27
		117	-58.38	83	-67.90
		118	-60.04	82	-65.82
		119	-61.55	81	-64.05
		120	-62.92	80	-63.42
		121	-63.96	79	-63.54
		122	-64.87	78	-64.59
		123	-65.68	77	-65.85
		124	-66.41	76	-67.68
		125	-67.10	75	-69.80
		126	-67.69	74	-72.02
		127	-68.23	73	-74.33
		128	-68.74	72	-76.42
		129	-69.43	71	-76.80
100	-28.11	130	-70.42	70	-77.54

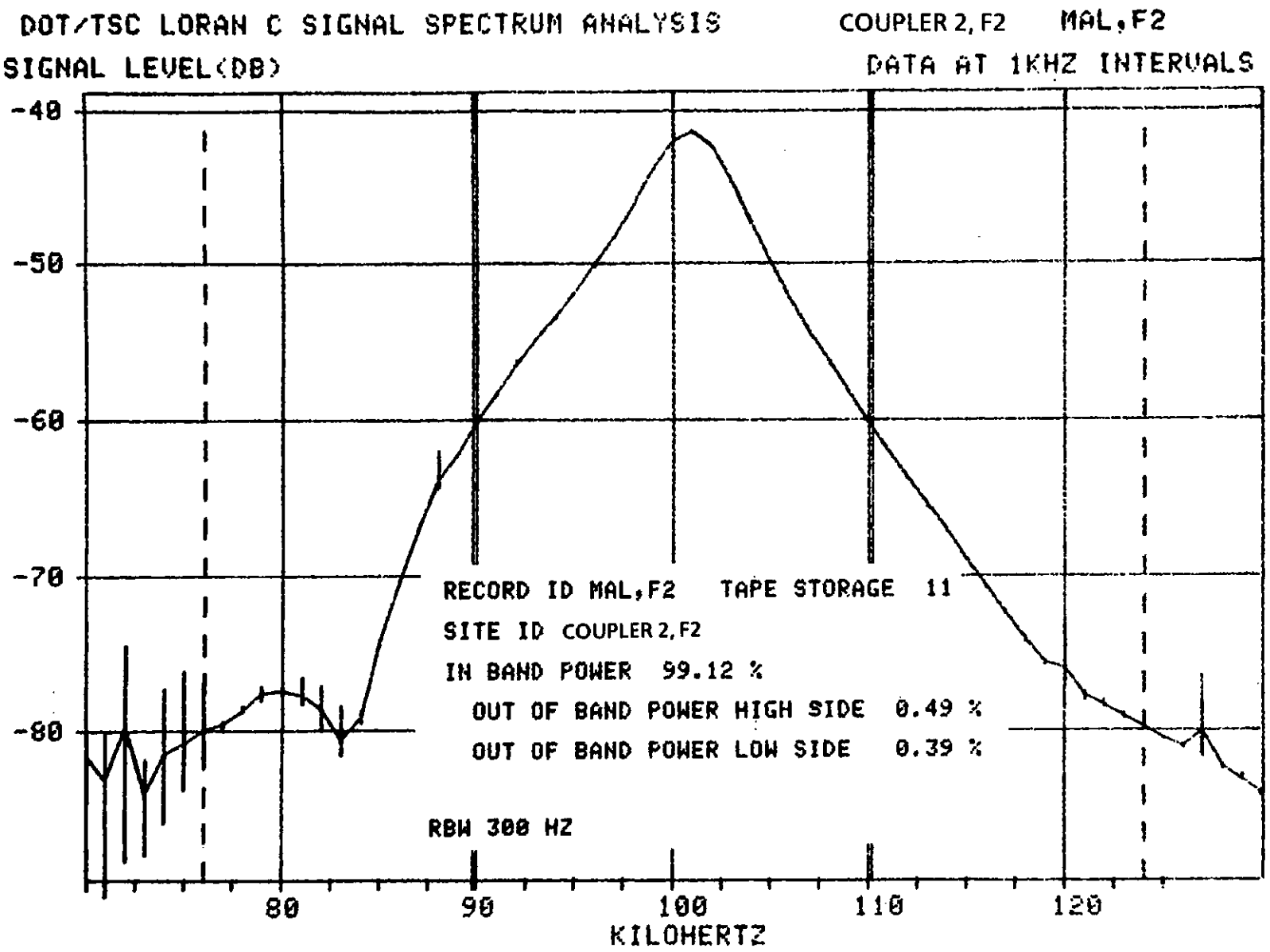
MA.5 14-APR-84 13:38:57


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 2, F1 MA, F1
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-40
-50
-60
-70
-80
RECORD ID MA,F1 TAPE STORAGE 10
SITE ID COUPLER 2, F1
IN BAND POWER 99.15 %
OUT OF BAND POWER HIGH SIDE 0.49 %
OUT OF BAND POWER LOW SIDE 0.37 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MA,F1 14-APR-84 14:56:20 AVE. OF 5 SAMPLES

100	-41.33	101	-40.55	99	-43.27
		102	-41.27	98	-45.60
		103	-43.47	97	-47.70
		104	-46.20	96	-49.33
		105	-48.79	95	-51.19
		106	-51.17	94	-52.74
		107	-53.40	93	-54.20
		108	-55.40	92	-55.80
		109	-57.39	91	-57.65
		110	-59.33	90	-59.47
		111	-61.10	89	-61.46
		112	-62.84	88	-63.72
		113	-64.51	87	-66.15
		114	-66.13	86	-69.69
		115	-67.88	85	-73.70
		116	-69.40	84	-77.91
		117	-71.11	83	-79.48
		118	-72.87	82	-75.43
		119	-74.44	81	-75.63
		120	-75.59	80	-76.49
		121	-76.89	79	-76.87
		122	-77.62	78	-76.57
		123	-78.30	77	-78.70
		124	-77.79	76	-80.62
		125	-79.19	75	-79.55
		126	-79.97	74	-80.60
		127	-79.78	73	-80.44
		128	-81.36	72	-75.44
		129	-81.63	71	-80.82
100	-41.37	130	-79.17	70	-77.45

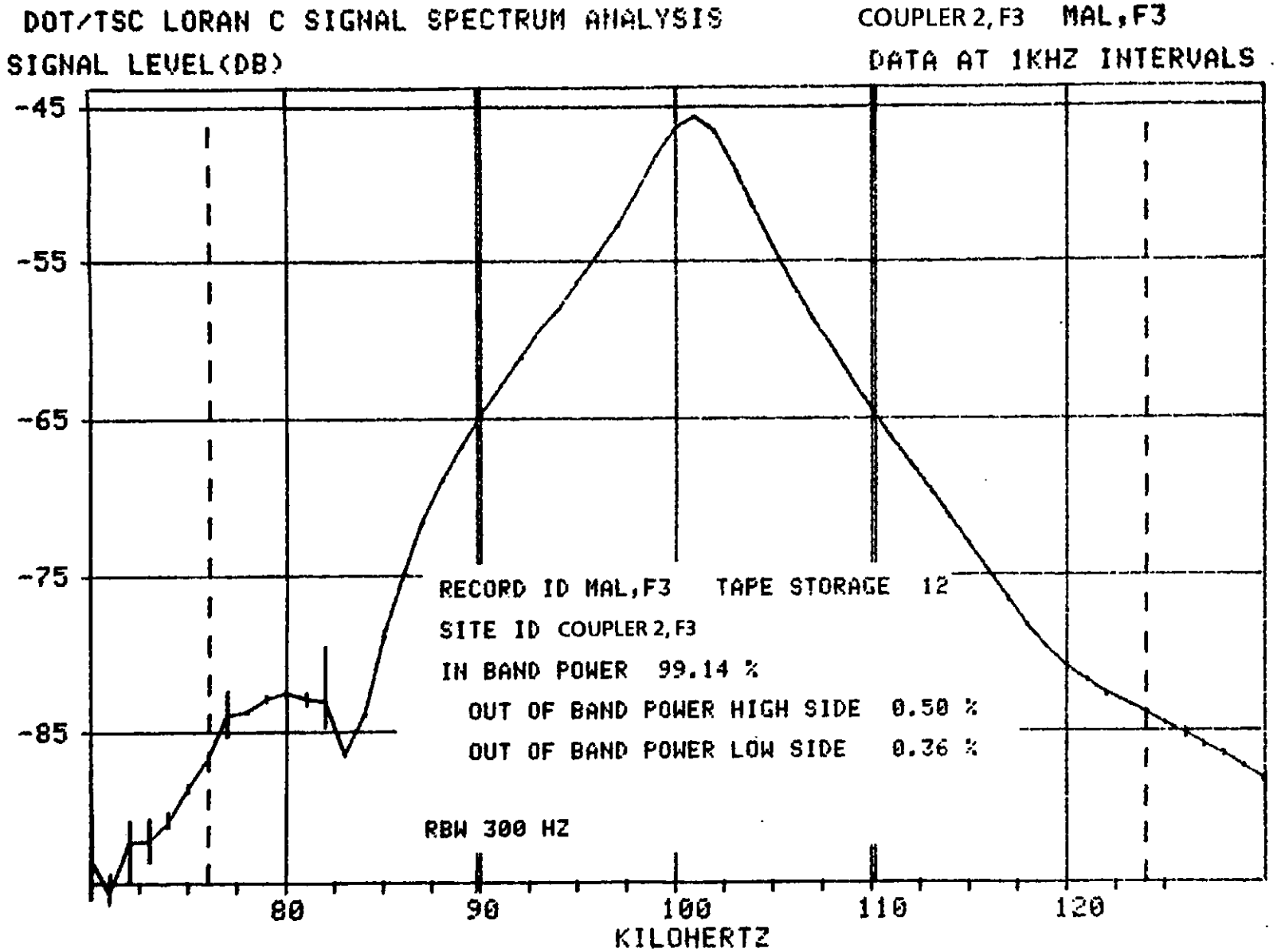
MA,F1 14-APR-84 15:05:31


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 2, F2 MAL, F2
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-40
-50
-60
-70
-80
RECORD ID MAL, F2 TAPE STORAGE 11
SITE ID COUPLER 2, F2
IN BAND POWER 99.12 %
OUT OF BAND POWER HIGH SIDE 0.49 %
OUT OF BAND POWER LOW SIDE 0.39 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MAL,F2 14-APR-84 16:31:21 AVE. OF 5 SAMPLES

100	-41.95	101	-41.33	99	-43.77
		102	-42.31	98	-46.18
		103	-44.56	97	-48.25
		104	-47.36	96	-50.01
		105	-49.93	95	-51.78
		106	-52.24	94	-53.38
		107	-54.38	93	-54.82
		108	-56.33	92	-56.40
		109	-58.25	91	-59.27
		110	-60.20	90	-60.88
		111	-61.96	89	-62.16
		112	-63.77	88	-63.78
		113	-65.43	87	-66.93
		114	-67.05	86	-70.33
		115	-68.92	85	-74.23
		116	-70.68	84	-79.10
		117	-72.42	83	-80.55
		118	-74.05	82	-78.56
		119	-75.51	81	-77.65
		120	-75.88	80	-77.35
		121	-77.63	79	-77.51
		122	-78.26	78	-78.62
		123	-78.99	77	-79.59
		124	-79.73	76	-79.87
		125	-80.50	75	-80.80
		126	-81.05	74	-81.50
		127	-79.98	73	-84.17
		128	-82.39	72	-79.77
		129	-83.24	71	-83.20
100	-41.95	130	-84.18	70	-81.69

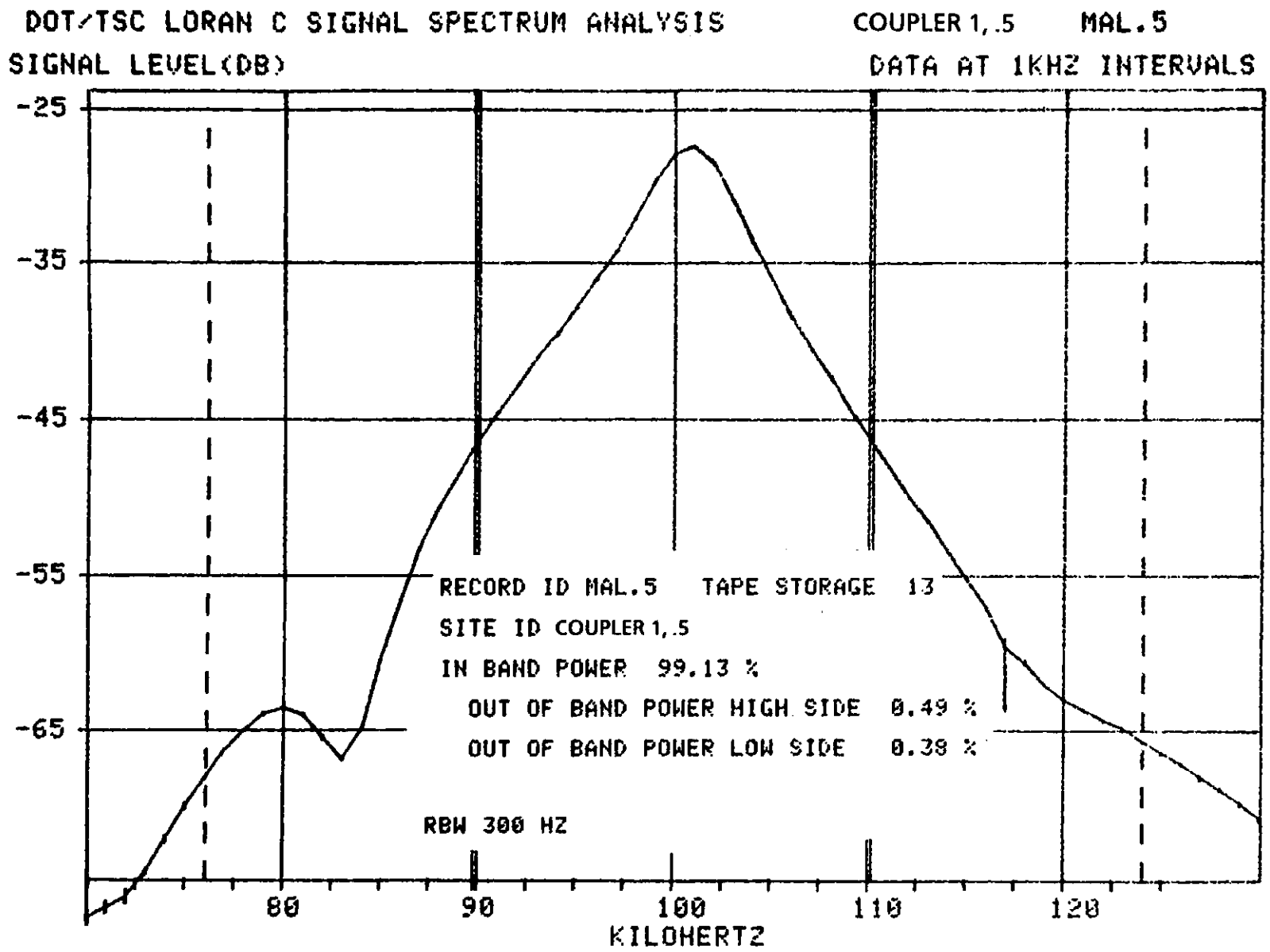
MAL,F2 14-APR-84 16:40:13


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 2,F3 MAL,F3
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-45
-55
-65
-75
-85
RECORD ID MAL,F3 TAPE STORAGE 12
SITE ID COUPLER 2,F3
IN BAND POWER 99.14 %
OUT OF BAND POWER HIGH SIDE 0.50 %
OUT OF BAND POWER LOW SIDE 0.36 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MAL,F3 01-JAN-50 01:22:58 AVE. OF 5 SAMPLES

100	-46.30	101	-45.66	99	-48.15
		102	-46.58	98	-50.57
		103	-48.83	97	-52.70
		104	-51.61	96	-54.50
		105	-54.18	95	-56.26
		106	-56.53	94	-57.95
		107	-58.65	93	-59.35
		108	-60.58	92	-61.09
		109	-62.54	91	-62.86
		110	-64.43	90	-64.73
		111	-66.17	89	-66.63
		112	-67.90	88	-68.83
		113	-69.56	87	-71.47
		114	-71.25	86	-74.82
		115	-73.03	85	-78.76
		116	-74.81	84	-83.76
		117	-76.51	83	-86.40
		118	-78.24	82	-82.99
		119	-79.66	81	-82.83
		120	-80.83	80	-82.40
		121	-81.68	79	-82.83
		122	-82.53	78	-83.66
		123	-83.11	77	-93.90
		124	-83.78	76	-86.68
		125	-84.49	75	-88.66
		126	-85.11	74	-90.96
		127	-85.83	73	-92.18
		128	-86.48	72	-92.22
		129	-87.36	71	-95.60
100	-46.40	130	-88.09	70	-93.42

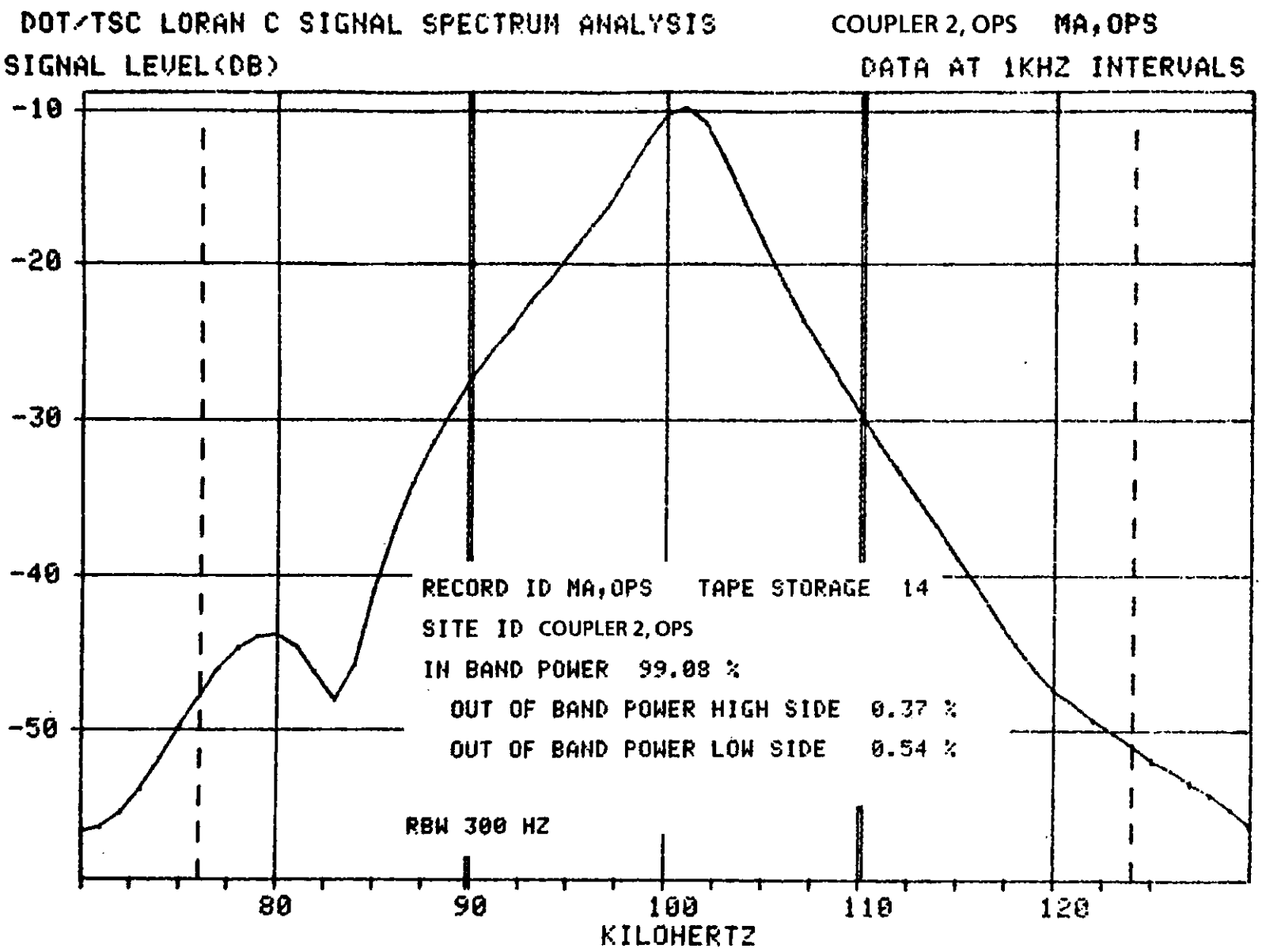
MAL,F3 01-JAN-50 01:31:22


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 1,.5 MAL.5
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-25
-35
-45
-55
-65
RECORD ID MAL.5 TAPE STORAGE 13
SITE ID COUPLER 1,.5
IN BAND POWER 99.13 %
OUT OF BAND POWER HIGH SIDE 0.49 %
OUT OF BAND POWER LOW SIDE 0.38 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MAL.5 01-JAN-50 03:13:46 AVE. OF 5 SAMPLES

100	-27.85	101	-27.41	99	-29.64
		102	-28.53	98	-32.00
		103	-30.82	97	-34.21
		104	-33.61	96	-35.93
		105	-36.09	95	-37.79
		106	-38.40	94	-39.44
		107	-40.51	93	-40.91
		108	-42.35	92	-42.64
		109	-44.32	91	-44.42
		110	-46.20	90	-46.26
		111	-47.94	89	-48.35
		112	-49.83	88	-50.52
		113	-51.49	87	-53.14
		114	-53.30	86	-56.50
		115	-55.18	85	-60.36
		116	-57.05	84	-64.83
		117	-59.54	83	-66.79
		118	-60.56	82	-65.42
		119	-61.93	81	-63.93
		120	-62.94	80	-63.48
		121	-63.64	79	-63.87
		122	-64.29	78	-64.91
		123	-64.96	77	-66.25
		124	-65.71	76	-68.00
		125	-66.40	75	-70.00
		126	-67.19	74	-72.28
		127	-68.03	73	-74.45
		128	-68.90	72	-76.13
		129	-69.79	71	-76.83
100	-27.85	130	-70.82	70	-77.45

MAL.5 01-JAN-50 03:22:55


DOT/TSC LORAN C SIGNAL SPECTRUM ANALYSIS
COUPLER 2, OPS MA, OPS
SIGNAL LEVEL(DB)
DATA AT 1KHZ INTERVALS
-10
-20
-30
-40
-50
RECORD ID MA, OPS TAPE STORAGE 14
SITE ID COUPLER 2, OPS
IN BAND POWER 99.08 %
OUT OF BAND POWER HIGH SIDE 0.37 %
OUT OF BAND POWER LOW SIDE 0.54 %
RBW 300 HZ
80
90
100
110
120
KILOHERTZ

MA,OPS 16-APR-84 11:48:26 AVE. OF 5 SAMPLES

100	-10.23	101	-9.73	99	-11.95
		102	-10.81	98	-14.10
		103	-13.21	97	-16.10
		104	-16.02	96	-17.75
		105	-18.67	95	-19.39
		106	-21.16	94	-20.95
		107	-23.48	93	-22.42
		108	-25.55	92	-23.98
		109	-27.57	91	-25.55
		110	-29.58	90	-27.23
		111	-31.48	89	-29.22
		112	-33.35	88	-31.34
		113	-35.17	87	-33.89
		114	-36.90	86	-36.92
		115	-38.82	85	-40.91
		116	-40.71	84	-45.66
		117	-42.59	83	-47.98
		118	-44.44	82	-46.24
		119	-46.00	81	-44.52
		120	-47.40	80	-43.77
		121	-48.31	79	-43.87
		122	-49.27	78	-44.64
		123	-50.15	77	-45.94
		124	-51.05	76	-47.76
		125	-51.97	75	-49.67
		126	-52.66	74	-51.89
		127	-53.50	73	-53.82
		128	-54.22	72	-55.46
		129	-55.20	71	-56.49
100	-10.31	130	-56.33	70	-56.77

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APPENDIX B

TIME DOMAIN DATA COLLECTED AT LORSTA MALONE, FLORIDA FROM 14 TO 16 APRIL 1984

Date: 4/16/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	8970	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+									
2	+	-0.086	0.9001	0.948	0.31	0.4≤	4.3≤	100.0436		
3	+	-0.051	0.8999	0.952	0.333	0.5≤	4.4≤	100.0361		
4	+	-0.037	0.9001	0.953	0.358	0.5≤	4.7≤	100.0375		
5	+									
6	-	-0.085	0.8984	0.952	0.462	0.8≤	4.4≤	100.0419		
7	-	-0.178	0.8984	0.948	0.460	1.0≤	4.3≤	100.0353		
8	+									
	Overall Avg:	-0.087	0.899		0.385			100.039		
	+ Code	-0.058						100.039		
	- Code	-0.132	Droop = 0.189%					100.039		

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/16/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	8970	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	-0.270	0.9015	0.948	0.433	0.8≤	4.0≤	100.0351		
2	-	-0.225	0.9043	0.954	0.398	0.7≤	4.0≤	100.0510	-1.62	
3	+	-0.248	0.9056	0.953	0.451	0.9≤	4.1≤	100.0415	-26.68	
4	-	-0.224	0.9044	0.954	0.394	0.7≤	4.0≤	100.0544	-1.92	
5	+	-0.183	0.9054	0.952	0.492	1.0≤	4.2≤	100.0283		
6	+	-0.183	0.9054	0.953	0.416	0.6≤	4.5≤	100.0194	2.48	
7	-	-0.228	0.9044	0.953	0.464	0.7≤	3.9≤	100.0377	-4.12	
8	-	-0.137	0.9026	0.955	0.511	0.9≤	4.3≤	100.0343	-1.48	
	Overall Avg:	-0.212	0.904		0.445			100.038		
	+ Code	-0.221						100.031	-6.05	
	- Code	-0.204	Droop = 0.453%					100.044	-2.29	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/16/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	7980	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	-0.124	0.8785	0.928	0.398	0.6≤	4.6≤	100.0630		
2	+	-0.156	0.8943	0.942	0.378	0.6≤	4.3≤	100.0350	-125.00	
3	-	-0.239	0.8953	0.941	0.444	0.8≤	3.7≤	100.0460	-119.10	
4	-	-0.253	0.8987	0.943	0.410	0.8≤	3.5≤	100.0267	-126.44	
5	+	-0.103	0.9008	0.953	0.376	0.8≤	4.6≤	100.0323		
6	-	-0.113	0.9032	0.951	0.489	1.1≤	4.1≤	100.0310	10.56	
7	+	-0.107	0.9005	0.953	0.364	0.6≤	4.4≤	100.0361	-8.24	
8	-	-0.11	0.9005	0.952	0.521	1.1≤	4.2≤	100.0337	14.06	
	Overall Avg:	-0.151	0.896		0.423			100.0380		
	+ Code	-0.123						100.0416	-33.31	
	- Code	-0.179	Droop = 2.735%					100.0344	-67.54	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/16/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	7980	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed.	Ens	1-8	9-13			
1	+	-0.106	0.8806	0.93	0.304	0.5≤	4.6≤	100.0354		
2	-	-0.272	0.8949	0.94	0.437	0.8≤	3.8≤	100.0121	-112.46	
3	-	-0.212	0.8973	0.944	0.474	1.0≤	3.8≤	100.0206	-113.14	
4	+	-0.194	0.8965	0.946	0.338	0.5≤	4.0≤	100.0393	-135.36	
5	+	-0.128	0.8984	0.948	0.386	0.6≤	4.3≤	100.0209		
6	+	-0.157	0.8948	0.947	0.406	0.6≤	4.4≤	100.0193	-3.96	
7	+	-0.164	0.8987	0.949	0.401	0.7≤	4.4≤	100.0349	-5.84	
8	+	-0.143	0.9007	0.949	0.424	0.7≤	4.4≤	100.0419	-7.28	
	Overall Avg:	-0.172	0.895		0.396			100.029		
	+ Code	-0.149						100.034	-25.41	
	- Code	-0.242	Droop = 2.232%					100.0164	-112.80	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/16/84

16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	7980	2

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1	-	-0.199	0.8999	0.944	0.526	1.2≤	3.6≤	100.043	
2	+	-0.164	0.8984	0.948	0.383	0.7≤	4.5≤	100.073	
3	-	-0.082	0.8997	0.947	0.453	0.7≤	4.1≤	100.061	
4	+	-0.203	0.9000	0.948	0.425	0.7≤	4.1≤	100.064	
5	-	-0.262	0.8960	0.939	0.425	0.9≤	3.5≤	100.040	
6	+	-0.113	0.8942	0.945	0.416	0.7≤	4.4≤	100.029	
7	-	-0.227	0.8977	0.942	0.475	1.0≤	3.8≤	100.020	
8	+	-0.191	0.8981	0.946	0.387	0.7≤	4.1≤	100.067	
9	-	-0.107	0.9000	0.948	0.495	1.1≤	4.2≤	100.042	
10	+	-0.216	0.8982	0.946	0.359	0.5≤	3.9≤	100.057	
11	-	-0.108	0.8978	0.946	0.415	0.7≤	4.0≤	100.050	
12	+	-0.073	0.8962	0.950	0.409	0.6≤	4.5≤	100.081	
13	-	-0.092	0.8998	0.949	0.488	0.9≤	4.1≤	100.064	
14	+	-0.105	0.8958	0.948	0.325	0.7≤	4.5≤	100.061	
15	-	-0.218	0.8938	0.940	0.528	1.2≤	4.0≤	100.025	
16	+	-0.111	0.8983	0.947	0.409	0.8≤	4.4≤	100.053	
	Overall Avg:	-0.154	0.8977					100.052	
	+ Code								
			Droop = 0.693%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/16/84

16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
ON STATION	Pearson Current Transformer	Coupler 2 (s/n 1008)	8970	1

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1		-0.002	0.8777	0.930	0.331	0.5≤	4.7≤	100.030	
2		-0.191	0.8976	0.943	0.336	0.6≤	3.9≤	100.020	
3		-0.124	0.8941	0.941	0.319	0.6≤	4.2≤	100.027	
4		-0.160	0.8917	0.938	0.378	0.7≤	3.8≤	334.657	
5		-0.150	0.8918	0.936	0.335	0.6≤	3.9≤	335.456	
6		-0.135	0.8898	0.937	0.398	0.7≤	4.2≤	335.225	
7		-0.069	0.8858	0.935	0.360	0.5≤	4.4≤	335.057	
8		-0.083	0.8797	0.930	0.346	0.5≤	4.3≤	335.812	
9		-0.058	0.8759	0.925	0.327	0.5≤	4.3≤	335.657	
10		-0.116	0.8960	0.944	0.335	0.6≤	4.1≤	334.636	
11		-0.120	0.8935	0.941	0.387	0.7≤	4.1≤	334.426	
12		-0.097	0.8921	0.941	0.368	0.6≤	4.2≤	335.252	
13		-0.068	0.8918	0.941	0.349	0.7≤	4.6≤	335.006	
14		-0.077	0.8880	0.937	0.371	0.7≤	4.1≤	334.828	
15		-0.145	0.8858	0.931	0.372	0.7≤	3.8≤	335.587	
16		-0.133	0.8781	0.927	0.315	0.5≤	4.1≤	335.408	
	Overall Avg:	-0.108	0.8881					291.068	
	+ Code								
			Droop = 2.42%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/15/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 1 (s/n 8)	7980	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.371	0.0901	0.0901	1.044	2.1≤	1.4≤	100.0297		50
2	+	1.328	0.0915	0.0920	0.931	1.9≤	1.6≤	100.0262	-118.98	50
3	-	1.372	0.0921	0.0925	0.993	2.1≤	1.6≤	100.0159	-107.06	50
4	-	1.395	0.0923	0.0928	0.996	2.0≤	1.5≤	99.9948	-103.68	50
5	+	1.344	0.0924	0.093	0.947	2.1≤	1.3≤	100.0728		40
6	-	1.39	0.0929	0.093	0.970	2.0≤	1.7≤	100.0357	34.23	40
7	+	1.386	0.0927	0.093	0.904	1.9≤	1.1≤	100.0637	-4.16	40
8	-	1.359	0.0929	0.093	0.926	1.8≤	1.8≤	100.0492	38.08	40
	Overall Avg:	1.368	0.0921		0.964			100.036		
	+ Code	1.357						100.048	-30.79	
	- Code	1.379	Droop = 3.014%					100.024	-34.61	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/15/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 1 (s/n 8)	7980	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.322	0.0901	0.09	1.021	2.2≤	1.7≤	100.0328		45
2	-	1.372	0.0922	0.092	0.982	2.0≤	1.2≤	100.0154	-118.28	50
3	-	1.273	0.0923	0.092	1.012	1.8≤	2.3≤	100.0203	-124.44	50
4	+	1.245	0.0919	0.092	0.993	1.8≤	1.6≤	100.0317	-130.30	45
5	+	1.283	0.0925	0.092	0.981	2.0≤	2. 1≤	100.0407		40
6	+	1.298	0.0926	0.093	0.958	1.7≤	1.5≤	100.0515	-3.76	40
7	+	1.396	0.0925	0.093	0.975	1.8≤	1.5≤	100.0578	-3.6	40
8	+	1.412	0.925	0.093	0.96	1.9≤	1.5≤	100.0668	-0.58	35
	Overall Avg:	1.325	0.0921		0.985			100.040		
	+ Code	1.326						100.047	-23.04	
	- Code	1.323	Droop = 2.699%					100.018	-121.36	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/15/84

16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	PULSE #
0.5 MILES	Austron Loop Antenna	Coupler 1 (s/n 8)	7980	8

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1	-	1.376	0.0928	0.092	0.909	1.8≤	2.3≤	100.068	40
2	+	1.199	0.0921	0.092	0.946	2.0≤	2.4≤	100.072	35
3	-	1.401	0.0927	0.092	0.953	1.8≤	1.9≤	100.069	35
4	+	1.320	0.0925	0.092	1.028	2.1≤	1.8≤	100.069	40
5	-	1.456	0.0929	0.093	0.834	1.7≤	1.4≤	100.050	40
6	+	1.337	0.0928	0.092	0.980	1.9≤	1.6≤	100.036	45
7	-	1.382	0.0932	0.093	0.903	1.6≤	1.8≤	100.049	40
8	+	1.336	0.0926	0.092	1.030	2.3≤	1.6≤	100.051	40
9	-	1.351	0.0929	0.093	0.962	1.8≤	2.1≤	100.060	40
10	+	1.302	0.0923	0.092	0.958	2.1≤	2.0≤	100.071	40
11	-	1.499	0.0926	0.093	0.914	1.9≤	1.4≤	100.078	40
12	+	1.341	0.0918	0.092	0.905	1.9≤	1.6≤	100.072	40
13	-	1.322	0.0930	0.092	0.957	2.0≤	2.3≤	100.063	40
14	+	1.409	0.0925	0.093	0.935	1.9≤	1.4≤	100.056	40
15	-	1.334	0.0931	0.093	0.932	1.8≤	2.2≤	100.048	40
16	+	1.326	0.0926	0.092	0.955	1.9≤	1.7≤	100.065	35
	Overall Avg:	1.356	0.0927					100.061	
	+ Code								
			Droop = 1.553%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/15/84

16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
0.5 MILES	Austron Loop Antenna	Coupler 1 (s/n 8)	8970	1

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1		1.463	0.0905	0.091	1.045	1.9≤	1.3≤	100.039	50
2		1.362	0.0927	0.092	0.965	1.8≤	2.0<	100.006	45
3		1.371	0.0924	0.092	0.939	1.9≤	1.8≤	100.027	40
4		1.268	0.0921	0.092	0.897	1.8≤	1.9≤	100.040	45
5		1.270	0.0919	0.091	1.044	2.0≤	2.0≤	100.045	45
6		1.303	0.0917	0.092	0.923	1.8≤	2.3≤	100.030	40
7		1.380	0.0915	0.091	0.964	1.9≤	1.8≤	100.027	40
8		1.364	0.0910	0.091	0.972	1.9≤	1.9≤	100.054	45
9		1.306	0.0907	0.090	0.977	1.8≤	1.8≤	100.046	50
10		1.328	0.0926	0.092	0.895	1.9≤	1.8≤	100.049	55
11		1.325	0.0923	0.092	0.966	1.9≤	1.9≤	100.010	45
12		1.226	0.0925	0.091	1.003	2.0≤	2.2≤	100.032	45
13		1.245	0.0919	0.091	0.992	1.8≤	2.2≤	100.039	45
14		1.308	0.0921	0.092	0.960	1.8≤	1.7≤	100.036	45
15		1.452	0.0913	0.092	1.127	2.4≤	1.2≤	100.028	45
16		1.371	0.0909	0.091	0.971	1.9≤	1.6≤	100.043	45
	Overall Avg:	1.334	0.0917					100.034	
	+ Code								
			Droop = 2.325%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	7980	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.363	0.0910	0.092	1.033	2.0≤	1.4≤	100.0782		45
2	+	1.343	0.0922	0.094	1.042	2.1≤	1.3≤	100.078	-121.36	45
3	-	1.394	0.0928	0.948	0.886	1.7≤	1.2≤	100.1105	-129.82	40
4	-	1.398	0.0930	0.094	0.942	1.7≤	1.6≤	100.1187	-133.70	40
5	+	1.358	0.0931	0.094	1.004	1.8≤	1.3≤	100.0893		45
6	-	1.364	0.0934	0.094	0.964	1.7≤	1.3≤	100.1256	-18.20	40
7	+	1.497	0.0930	0.095	1.076	1.9≤	0.7≤	100.0997	-2.04	45
8	-	1.323	0.0932	0.094	1.037	2.1≤	1.6≤	100.1346	-13.08	35
	Overall Avg:	1.380	0.0927		0.998			100.216		
	+ Code	1.390						100.311	-30.85	
	- Code	1.370	Droop = 2.570%					100.122	-73.70	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	7980	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.387	0.0902	0.092	0.978	1.9≤	1.6≤	100.0781		50
2	-	1.322	0.0924	0.093	0.997	1.7≤	1.3≤	100.0939	-127.00	40
3	-	1.369	0.0925	0.094	0.992	2.0≤	1.3≤	100.1057	-135.62	40
4	+	1.331	0.0924	0.094	1.017	2.2≤	1.5≤	100.0992	-120.24	45
5	+	1.352	0.0930	0.094	0.974	1.9≤	1.4≤	100.1210		40
6	+	1.311	0.0932	0.094	0.936	1.9≤	1.2≤	100.1301	-0.68	40
7	+	1.284	0.0932	0.094	0.94	1.9≤	1.8≤	100.1247	-1.26	40
8	+	1.37	0.0934	0.094	0.984	1.9≤	1.7≤	100.1377	9.90	35
	Overall Avg:	1.340	0.0925		0.977			100.113		
	+ Code	1.339						100.115	-18.71	
	- Code	1.346	Droop = 3.426%					100.100	-131.31	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	7980	2

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1	+	1.311	0.0943	0.094	0.940	1.9≤	1.5≤	100.131	40
2	-	1.363	0.0938	0.094	0.907	1.8≤	1.3≤	100.133	40
3	+	1.266	0.0938	0.094	0.997	1.9≤	1.5≤	100.129	40
4	-	1.363	0.0940	0.095	1.021	1.9≤	1.3≤	100.130	40
5	+	1.281	0.0932	0.094	0.903	1.9≤	1.2≤	100.083	45
6	-	1.302	0.0927	0.094	0.834	1.6≤	1.4≤	100.078	50
7	+	1.400	0.0934	0.094	0.926	1.7≤	1.2≤	100.081	45
8	-	1.417	0.0938	0.095	0.889	1.7≤	1.1≤	100.115	40
9	+	1.413	0.0938	0.094	1.019	1.9≤	1.4≤	100.134	45
10	-	1.354	0.0938	0.094	0.997	2.1≤	1.4≤	100.118	45
11	+	1.391	0.0939	0.095	1.025	2.0≤	1.5≤	100.105	40
12	-	1.319	0.0936	0.094	0.966	1.8≤	1.6≤	100.116	35
13	+	1.382	0.0938	0.095	1.077	2.0≤	1.3≤	100.141	35
14	-	1.262	0.0934	0.094	0.941	1.9≤	1.7≤	100.124	40
15	+	1.240	0.0930	0.093	1.045	2.1≤	1.5≤	100.072	50
16	-	1.279	0.0935	0.094	0.986	2.0≤	1.9≤	100.128	40
	Overall Avg:	1.334	0.0936					100.114	
	+ Code								
			Droop = 1.611%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	8970	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+									
2	+	1.289	0.0936	0.094	1.052	2.1≤	1.2≤	100.1287		40
3	+	1.315	0.0938	0.094	0.994	2.1≤	1.2≤	100.1323		40
4	+	1.284	0.0938	0.094	0.965	1.8≤	1.5≤	100.1328		40
5	+	1.278	0.0935	0.094	1.077	2.2≤	1.4≤	100.1387		40
6	-	1.392	0.0939	0.095	0.971	2.0≤	1.1≤	100.1196	4.56	40
7	-	1.441	0.0937	0.095	0.937	2.0≤	1.2≤	100.1441	-1.14	40
8	+	1.277	0.0936	0.094	1.031	2.0≤	1.6≤	100.1413	13.66	35
	Overall Avg:	1.325	0.0937		1.004			100.134		
	+ Code	1.289						100.135		
	- Code	1.417	Droop = 0.426%					100.132		

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	8970	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.177	0.0934	0.093	1.019	2.0≤	1.8≤	100.1187		40
2	-	1.238	0.0935	0.094	0.93	1.8≤	1.7≤	100.1141	-14.72	40
3	+	1.219	0.0938	0.094	0.987	2.0≤	1.5≤	100.100	-23.10	40
4	-	1.237	0.0938	0.094	0.932	1.8≤	1.6≤	100.1253	-15.30	40
5	+	1.239	0.0937	0.094	0.977	2.0≤	1.5≤	100.1190		40
6	+	1.385	0.0935	0.094	1.003	2.0≤	1.5≤	100.1105	1.90	40
7	-	1.275	0.0935	0.094	0.888	1.8≤	1.7≤	100.1394	18.30	40
8	-	1.279	0.0935	0.094	0.964	1.9≤	1.5≤	100.1449	23.96	40
	Overall Avg:	1.256	0.0936		0.963			100.121		
	+ Code	1.255						100.112	-5.30	
	- Code	1.257	Droop = 0.426%					100.131	3.06	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

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16 PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	Pulse #
0.5 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	8970	1

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Peak Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	N*
			Measured	Computed	Ens	1-8	9-13		
1		1.439	0.0920	0.093	1.019	1.9≤	1.0≤	100.125	
2		1.533	0.0918	0.093	0.958	2.0≤	0.9≤	100.121	
3		1.331	0.0918	0.092	0.984	1.9≤	1.3≤	100.121	
4		1.351	0.0914	0.091	0.942	1.9≤	1.6≤	100.131	
5		1.222	0.0906	0.090	1.078	2.2≤	2.2≤	100.151	
6		1.296	0.0930	0.093	1.163	2.3≤	1.6≤	100.149	
7		1.193	0.0920	0.092	1.025	2.3≤	2.1≤	100.141	
8		1.234	0.0920	0.092	1.066	2.3≤	2.1≤	100.129	
9		1.370	0.0918	0.092	1.052	2.2≤	2.1≤	100.101	
10		1.436	0.0916	0.092	0.998	1.8≤	1.6≤	100.113	
11		1.454	0.0916	0.092	0.970	2.0≤	1.2≤	100.105	
12		1.432	0.0910	0.092	1.015	2.0≤	1.1≤	100.110	
13		1.362	0.0908	0.091	1.023	2.0≤	1.2≤	100.111	
14		1.438	0.0906	0.091	1.071	2.1≤	1.6≤	100.095	
15		1.467	0.0922	0.093	1.088	2.2≤	1.3≤	100.072	
16		1.382	0.0922	0.093	0.978	1.9≤	1.1≤	100.090	
	Overall Avg:	1.371	0.0916					100.117	
	+ Code								
			Droop = 2.559%						

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

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PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.1 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	7980	A

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.218	0.9069	0.953	1.302	2.5≤	3.2≤	100.4490		45
2	+	1.201	0.9229	0.968	1.373	2.7≤	3.3≤	100.4313	-134.256	50
3	-	1.175	0.9247	0.97	1.336	2.7≤	3.2≤	100.4554	-144.92	45
4	-	1.228	0.9244	0.973	1.341	2.7≤	3.3≤	100.47	-143.02	45
5	+	1.245	0.9112	0.977	1.364	2.7≤	3.5≤	100.4759		45
6	-	1.216	0.9293	0.974	1.293	2.6≤	2.8≤	100.4679	-8.96	45
7	+	1.28	0.9133	0.979	1.322	2.7≤	3.5≤	100.4650	2.52	45
8	-	1.217	0.9313	0.974	1.342	2.6≤	2.9≤	100.4669	-7.18	45
	Overall Avg:	1.223	0.921		1.334			100.460		
	+ Code	1.236						100.455	-32.93	
	- Code	1.209	Droop = 2.62%					100.465	-76.02	

N* is defined as the nominal zero crossing interval (in microseconds) after which pulse zero crossings exceed the 100 nanosecond limit.

Date: 4/14/84

PULSE WAVEFORM RESULTS FOR LORSTA MALONE

SITE	SIGNAL SOURCE	TRANSMITTER	GRI	INTERVAL
0.1 MILES	Austron Loop Antenna	Coupler 2 (s/n 1008)	7980	B

PULSE #	PHASE CODE	ECD microseconds	PULSE PEAK		Half Cycle Errors in %			EFFECTIVE CARRIER FREQUENCY kHz	PULSE to PULSE OFFSET nanoseconds	N*
			Measured	Computed	Ens	1-8	9-13			
1	+	1.211	0.8976	0.945	1.334	2.7≤	3.5≤	100.4278		50
2	-	1.23	0.9186	0.967	1.263	2.5≤	3.5≤	100.4238	-162.240	45
3	-	1.213	0.9202	0.968	1.362	2.8≤	3.4≤	100.4478	-166.260	50
4	+	1.203	0.9218	0.968	1.285	2.6≤	3.4≤	100.4427	-139.680	50
5	+	1.212	0.9229	0.971	1.312	2.5≤	3.2≤	100.4528		50
6	+	1.264	0.9267	0.975	1.395	2.7≤	3.5≤	100.4735	-0.560	50
7	+	1.239	0.9109	0.974	1.317	2.7≤	3.4≤	100.4645	0.560	45
8	+	1.202	0.9273	0.975	1.275	2.4≤	3.3≤	100.4637	-0.480	45
	Overall Avg:	1.222	0.918		1.318			100.450		
	+ Code	1.222						100.454	-23.55	
	- Code	1.222	Droop = 3.203%					100.436	-164.25	

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