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RADAR RANGE CALIBRATOR SYSTEM EVALUATION REPORT.(U)
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RADAR RANGE CALIBRATOR

SYSTEM EVALUATION REPORT

Federal Electric Corporation
Vandenberg AFB, Calif. 93437

2 December 1976

UNLIMITED DISTRIBUTION

Prepared for

SPACE AND MISSILE TEST CENTER
Vandenberg AFB, Calif. 93437

This final report was submitted by Federal Electric Corporation, Vandenberg AFB, CA 93437 under Contract FO 4701-72-C-0203 with the Space and Missile Test Center, Vandenberg AFB, CA 93437. Operations Research Analyst, Mr. R. Lane, XREA, was the Division Scientist-in-Charge.

This report has been reviewed by the Information Office (OI) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

This technical report has been reviewed and is approved for publication.

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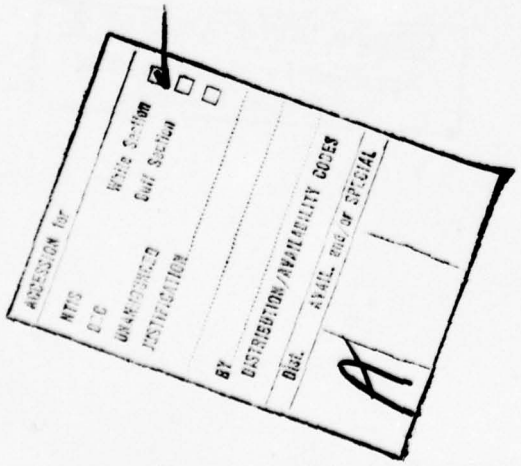

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Radar Calibration
Target Generation

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

The Radar Range Calibrator System was installed at the Pillar Point AN/FPQ-6 radar during September 1976. The system is capable of generating a target at a known range using digital techniques. An evaluation of this system is presented in this report.

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4.0 SYSTEM LEVEL TESTS

Radar data from GEOS III tracking missions were used to evaluate the RRCS from the system level, i.e., does the RRCS accurately calibrate the range measurements of the radar? Table I provides the results of this testing.

Table I
System Level Test Results
AN/FPQ-6

Date	GEOS III Rev No	Range Bias (Ft)
24 Aug 76	7114	-5
25 Aug 76	7128	Bad site tape
27 Aug 76	7157	9
1 Sep 76	7228	16
3 Sep 76	7242	-4
10 Sep 76	7356	16
11 Sep 76	7441	Bad site tape
20 Sep 76	7498	-3
30 Sep 76	7626	1
14 Oct 76	7825	-9
	Mean (Ft)	2.6
	Std. Dev. (Ft)	10

These biases are defined as the radar measurement minus the NSWC reference orbit and are indicative of excellent range zero set capability. The accuracy of the NSWC ephemerides used for the reference standard are not known other than NSWC quotes of 5 meters or better. A test to test variability in the reference data of up to 10 feet at the one sigma level is not unreasonable.

5.0 DETAIL LEVEL TESTS

The following tests were performed on site by Performance Analysis during October for purposes of establishing the RRCS baseline capabilities:

a. Stability of range calibration lock-on as a function of signal level.

FPQ-6 Radar Range Calibrator System

1.0 INTRODUCTION

In August of 1976 the Radar Range Calibrator System (RRCS) was installed at the FPQ-6 under Engineering Task CET-ER-606. The evaluation of the RRCS was conducted in two phases: testing and evaluation conducted by the Instrumentation Systems Engineering Department (IC400) and testing and evaluation conducted by the Performance Analysis Department (PA300). This report documents the evaluation conducted by the Performance Analysis Department and is intended to define, both the baseline accuracy of the RRCS and its operational usage.

Results of the evaluation show that except for minor discrepancies, the calibrator is accurate and it is recommended that it be used during operational support.

2.0 RANGE CALIBRATION MODIFICATION

The range calibration modification at the FPQ-6 was installed to provide the radar system with a calibration method which would minimize the errors which occur in the range measurements due to pulse width mismatch conditions and due to pulse shape distortion caused by clutter and multipaths using an external range target. Basically the pulse width mismatch error occurs when the radar pulse width and corresponding return from the range target is not equal to the pulse width of the signal return from the C band transponders carried aboard ballistic missiles launched from Vandenberg Air Force Base. The form of the error and the model for correction are reported in Range Bias Corrections, report number PA100-75-40, 3 August 1976 and will not be covered in this report.

3.0 EVALUATION APPROACH

Two levels of testing and evaluation were conducted by the Performance Analysis Department. The first consisted of system level tests conducted in association with GEOS III tracking missions and the second a series of tests conducted on site specifically designed to detect potential error sources and define the capabilities of the modification.

b. Linearity of the range calibrator.

c. Width, stability and rise-fall time of output pulse.

d. Ability to lock-on radar beacons at a known range after calibrating on the RRCS.

5.1 OUTPUT PULSE EVALUATION

The RRCS output pulse was evaluated with the use of a Hewlett-Packard 7844 (7824/7B80/7B85 plug-ins) oscilloscope. The 30 MHz output (J-4) was displayed as shown in Photo #1 (Figure 1). In this photograph the pulse is displayed on three traces. The sweep speed on the top trace is 200 nanoseconds per centimeter. The entire pulse appears again on the second and third traces at a sweep rate of 50 nanoseconds per centimeter. The trigger time on the second and third traces have been adjusted so that the leading edge of the pulse on the second trace just coincides with the trailing edge of pulse on the third trace. The difference in trigger time is presented digitally as Δ 0.136 μsec at the bottom on the oscilloscope. This feature permits a high degree of resolution for measurement of pulse widths.

5.1.1 RISE TIME

The rise and decay time of the output pulse was observed to be very fast. Something less than five nanoseconds may be observed in the photograph.

5.1.2 WIDTH STABILITY

Pulse width stability appears good. Instability was not observed at a measurable level.

5.1.3 PULSE WIDTH BIAS

The width of output pulse shown in photo #2 is the minimum width available and was measured as 126 nanoseconds. Initially the bias was believed to be 136 nanoseconds as shown in photo #1. It was later determined that the 12 nanosecond switch operates in reverse if the "Range" switch is in the "up" position (as it was during the test). Photo #1 was taken with the 12 nanosecond switch in the "off" position while the range switch is "up". Photo

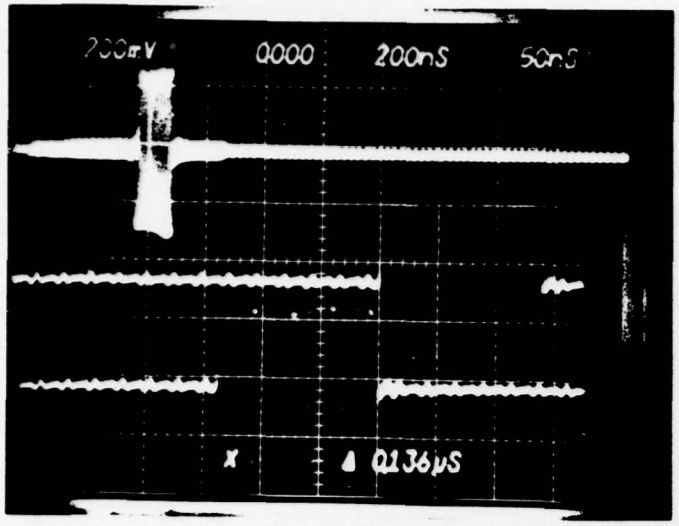
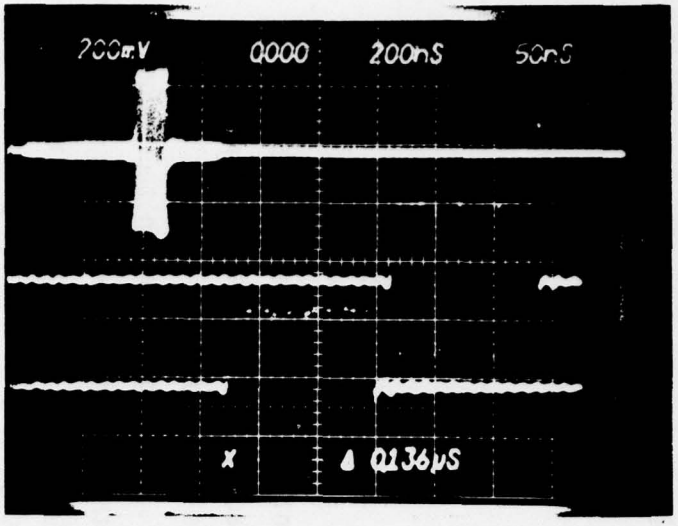


PHOTO 1



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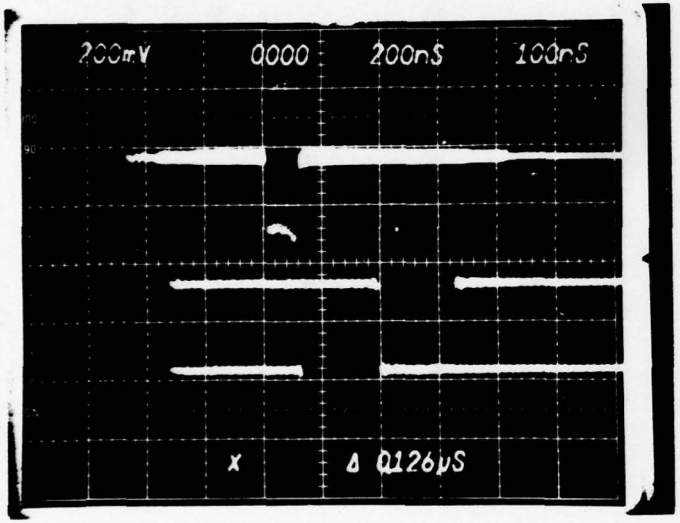


PHOTO 2

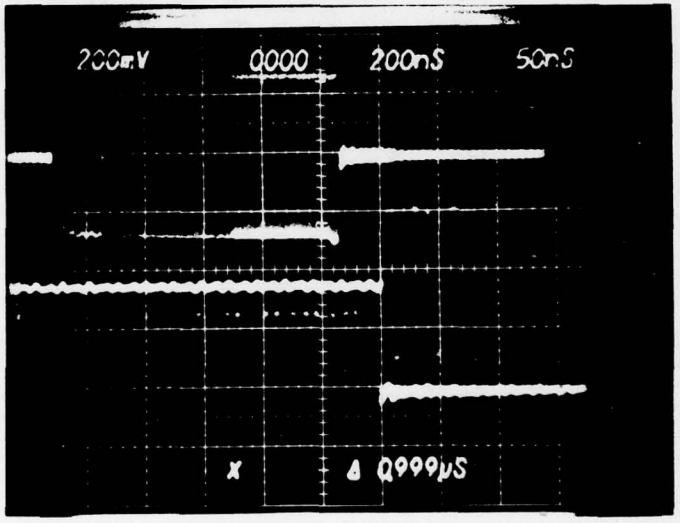


PHOTO 4

FIGURE 1

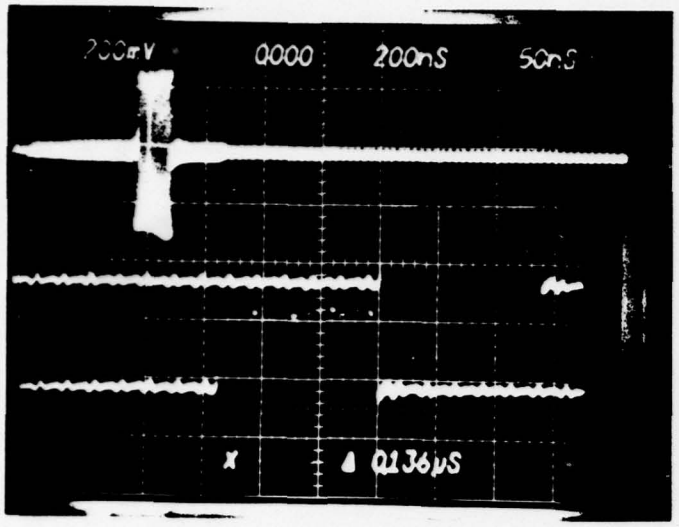


PHOTO 1

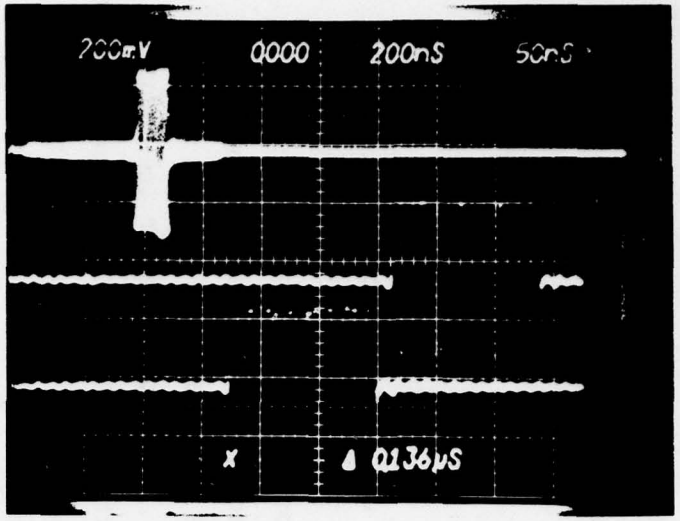


PHOTO 3

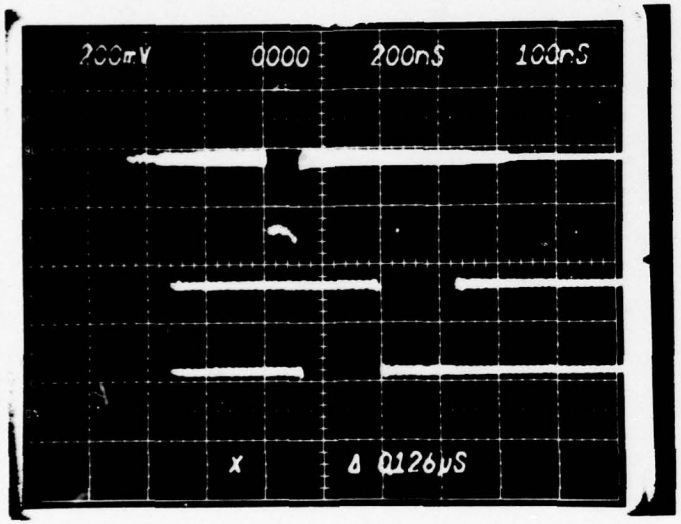


PHOTO 2

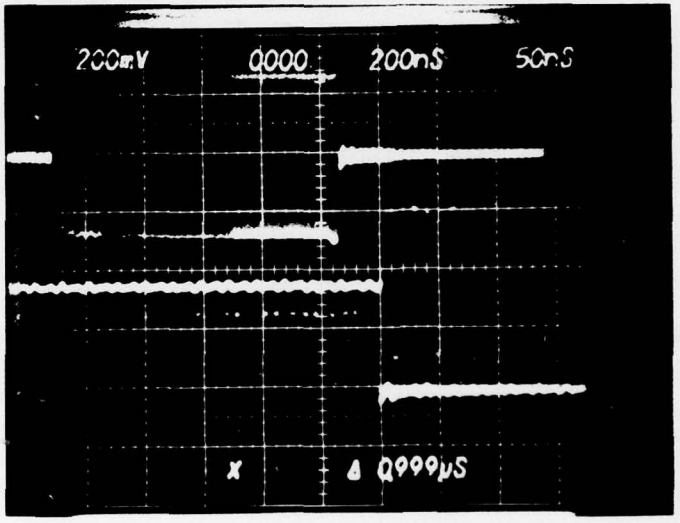


PHOTO 4

FIGURE 1

#3 shows the result of moving the range switch down while the 12 nanosecond switch is unchanged. The leading edge of the pulse has shifted 12 nanoseconds in photo #3, as it should, but the width has also changed. When the range switch is in the "down" position the operation of the 12 nanosecond switch is proper.

The initial calibration of the RRCS was accomplished with the range switch in the "up" position. Therefore, the 12 nanosecond switch was labelled "reversed" on the front panel to correct the problem. This will present no problems in the operation of the unit until such time that a permanent correction can be made.

5.1.4 PULSE WIDTH ACCURACY

All pulse width switches were operated independently and the width of each pulse was measured and recorded on the data sheet (Appendix A). After subtracting the bias of 126 nanoseconds from the measured widths the mean of the differences (measured change minus expected change) is zero indicating that the 126 nanosecond bias is valid. The standard deviation is 3.2 nanoseconds. A 3 nanosecond error in pulse width calibration represents an error of 0.75 ft in range which is insignificant.

Switches were used in combinations to generate pulse widths of .25, .5, .75 and 1.0 μseconds. The 1 μsec pulse is shown in photo 4.

5.2 LINEARITY OF PULSE POSITIONS

The RRCS pulse (range) position switches were set to the 100 k yd position. The pulse was gated at the radar and placed in auto track mode. The radar console display indicated 100,000 yds with occasional indications of 99,999 yds (1 yd low). The RCM was switched to provide a pulse at range of 200 k, 300 k, ... 1,000 k yds. The radar always read the correct range when locked on the target. Lock-ons were also made at 25 k and 50 k with the same result. Linearity was excellent as expected (see data sheet Appendix A).

5.3 STABILITY OF RANGE LOCK-ON AS A FUNCTION OF SIGNAL LEVEL

An RF attenuator was placed between the Watkins/Johnson mixer and the 40 db directional coupler (10 A6A24) located in the RF head. The radar was locked

on the RRCS output at a range of 100 k yds. The console display indicated 100,001 yds, occasionally reading 100,003 yds with no attenuation. Attenuation was inserted in steps of 5 db.

AGC voltage and console range display readings were recorded on the data sheet (Appendix A). The radar range was observed not to change over a 50 db attenuation range. The AGC voltage which should have continued to change until the noise level was reached did not decrease beyond the 30 db level (well above the noise floor). Since the attenuation did not effect the signal beyond 30 db, leakage was suspected. It was determined that the signal was present at the receiver even when the input to the attenuator was disconnected.

The RF leakage problem did not appear to produce adverse effects when the range calibration system is being used. The Instrumentation Systems Engineering Department is aware of this problem and has provided new cabling.

5.4 RADAR BEACON TESTING

The USAF Geodetic Survey Squadron was asked to determine the range between the radar pedestal and a selected position on Montara Peak. Two C band beacons were operated at the surveyed position while the radar tracked and recorded range data. The radar was calibrated using the RCCS and the pre operation parameters for each beacon as shown in Table II.

Lock-on values for both beacons are tabulated below.

	Radar Lock-on (yds)	Corrected Lock-on (yds)	Beacon Survey (yds)	Corrected Lock-on minus Survey (yds)
174C	8040.8	8045.5	8043.3	+2.2
302C	8045.4	8054.4	8043.3	+11.1

Corrections were made (see Appendix A) for beacon delay errors, cable delay between beacon and antenna, and pulse width errors. Pulse width set at the radar was based on preoperation beacon tests. Corrections were based on the mean of pre and postoperational beacon test data.

Table II

AN/FPQ-6

Pre Operation Measurements

Beacon Parameters

(SAMTEC Form 89 were completed (pre-and post test)
and are included in Appendix A)

	Motorola 174C (coho)	Vega 302C
Ser #	103	3150
Delay (-20 dbm)	2.501 μsec	2.49 μsec
PW	.927 μsec	.535 μsec
Real Time	.077 μsec	.011 μsec
Fall Time	.041 μsec	.025 μsec
Date	3 Aug 76	29 Sep 76

Post Operation Measurements

Delay (-20 dbm)	2.507 μsec	2.47
PW	.983 μsec	.535
Rise	.013 μsec	.013
Fall	.020 μsec	.051
Date	8 Nov 76	3 Nov 76

Actual beacon delay used at the radar was 2.573 μsec (422 yds) on the 174C beacon and 2.561 μsec (420 yds) on the 302C beacon.

6.0 GENERAL OBSERVATIONS

Site personnel stated that the RRCS caused interference, which is noticable on the range scope at the operators console, even though power to the RRCS is turned off. It can be eliminated by disconnecting the 30 MHz input to the RRCS. Interference of this nature was not observed during the evaluation period. Engineering (IC400) is aware of the problem and intends to investigate. It is recommended that the power be removed from the RRCS and the 30 MHz input be disconnected at the source when the system is not in use to preclude interference of this type.

7.0 OPERATIONAL TESTING

Data was recorded during support from Operations 8080, 6995 and 1160 for purposes of obtaining range data recordings at pulse widths used during Minuteman support. The radar range was zero set and the beacon delay adjusted using the range target and the radar transmitter. Data recordings were then made of the skin gate and beacon gate measurements while tracking the RRCS signal. Table III is a summary of the results obtained during those operations. As may be seen from the Table the data obtained from the RRCS agreed very well with theoretical values. All lock-on values for Operation 6995 were short by 14 yards with respect to the RRCS. Data for GEOS III operations previous and subsequent to Operation 6995 have been examined but no errors were detected. The cause for all RRCS values being short by 14 yards could not be isolated.

TABLE III

FPQ-6 RADAR RANGE CALIBRATOR SYSTEM

OPERATIONAL EVALUATION

OP NUMBER	TX PW µsec	BEACON PW µsec	BEACON DELAY FROM RANGE TGT (Ft)	BEACON DELAY FROM RRCS (Ft)	B-A MEAS (Ft)	B-A THEOR (Ft)
8080	1.0	0.89	1215	1239	24	27
6995	1.0	0.90	1230	1260	30	25
1160	1.0	0.86	1220	1255	35	34

NOTE: Skin gate data from RRCS obtained at TX PW at 10 k yds.
Beacon gate data from RRCS obtained at beacon PW at 10 k yds.

APPENDIX A

MOTOROLA	SST174C	103	☐ STD	KFML	
VEHICLE TYPE	FACILITY	WAFER S/N	☐ BACK-UP ☐ PRIME	TEST DOCUMENT	CODE NAME / R/U
—	B1801	—		RF6.1.1	—

TEST SET P/N	TEST SET S/N	BEACON	BEACON	TOTAL TIME	MAG. BURN-IN-DATE LAST PERFORMED
TSS	001	ON	OFF	4.75	☐ N/A ☐ COMP. DATE

ANTENNA P/N	ANT. 1 S/N	ANT. 2 S/N	ANT. 3 S/N	COUPLER P/N	COUPLER S/N	BATT. P/N	BATT. S/N	DATED
—	—	—	—	—	—	—	—	—

TRANSMITTER

1. Time to See – Pwr Delay Timer		<30	Sec
2. Time to Stabilize		90	Sec
3. Transmitter Frequency	(+3 min) Start	5763.5	MHz
	(+10 min) Finish	5763.5	MHz
4. Frequency Drift Rate (MHz/min)	Start	0.233	MHz
	Finish	0.0	MHz
5. Pulse Frequency Jitter		N/A	MHz
6. Pulse Width	@ 0.5	.927	μsec
	@ .75	.928	μsec
	@ 1.0	.927	μsec
7. Pulse Width Jitter		.019	μsec
8. Pulse Amplitude Variation		<1.0	dB
9. Pulse Amplitude Jitter		<0.5	dB
10. Pulse Rise Time		.077	μsec
11. Pulse Fall Time		.041	μsec
12. Pulse RF Spectrum @ 6 dB BW		1.6	MHz
13. Reply Delay @ -55 dBm		2.498	μsec
14. Delay Variation vs Signal (dBm)	Absolute	0.026	μsec
15. Delay Jitter vs Signal (dBm)	Absolute	0.052	μsec

0	-10	-20	-30	-40	-50
2.495	2.493	2.501	2.525	2.568	2.57
Jit .003	.005	.005	.0048	.006	.016

-57	-60	-62	-65	-67	-70
2.572	2.577	2.589	2.603	2.617	2565
Jit .018	.021	.025	.034	.038	.055

16. Delay Variation vs Freq. (MHz)	Absolute	.004	μsec
17. Delay Jitter vs Freq. (MHz)	Absolute	.007	μsec

-1.5	-1	-.5	+.5	+1	+1.5
2.498	2.499	2.502	2.50	2.498	2.5
Jit .017	.018	.013	.015	.020	.019

18. Delay Variation vs PRF (pps)	Absolute	.016	μsec
19. Delay Jitter vs PRF (pps)	Absolute	.009	μsec

100	160	320	640	1000	1500
2.521	2.591	2.589	2.52	2.52	2.505
Jit .015	.016	.022	.024	.021	.013

20. Delay Variation vs Opr. Voltage	Absolute	.003	μsec
21. Delay Jitter vs Opr. Voltage	Absolute	.009	μsec

24	26	28	30	32
2.513	2.511	2.51	2.51	2.511
Jit .010	.012	.017	.017	.019

22. Peak Power Output	Xponder	170 Watts

ANT. NO 1	ANT. NO 2	ANT. NO. 3
— Watts	— Watts	— Watts

RECEIVER

23. Receiver Bandwidth @ 3 dB	Low	5760.0 MHz	Total 8.7 MHz
	Center	5764.35 MHz	
	Max Sens	5765.2 MHz	Hi 5768.7 MHz
24. Receiver Bandwidth @ 60 dB	Low — MHz	Center — MHz	Total — MHz
			Hi — MHz
25. Threshold Sensitivity			-71 dBm
26. Dynamic Range			Low -65 dBm Hi 0 dBm
27. Image Rejection			-34 dB
28. Pulse Width Acceptence			Low <.2 μsec Hi >3 μsec
29. Decoder Accept Limits @ -55 dBm	Low 8.76 μsec		Center 8.98 μsec Hi 9.2 μsec
30. Decoder Reject Limits @ -55 dBm			Low 8.673 μsec Hi 9.24 μsec
31. Decoder Immunity @ 0 dBm			Pulse OK CW N/A

TRANSPONDER

32. Random Triggering	NONE pps
33. Recovery Time @ 0 dBm	38 μsec
34. Over-Interrogation	3705 pps
35. Maximum Duty Cycle	Product .0034

36. Operating Current vs Voltage				Quiet
24 .68 A	26 .68 A	28 .68 A	30 .68 A	32 .68 A
Vdc .71 A	Vdc .71 A	Vdc .71 A	Vdc .71 A	Vdc .71 Interg. A

37. Pressurization Test	☒ N/A	☐ Go	☐ No Go

COHERENCY

38. Carrier Phase Coherency		Std Dev. Hz	Vel Accry ft/sec
39. Carrier Line Width @ 3 dB			Hz
40. Spectral Skew @ ± 350 KHz			dB
41. Interline Noise (relative)			dB
42. Dynamic Pulse Spectrum		Carrier Δ Hz	Interline Δ dB
43. Frequency Tracking		Low -6 MHz	Hi +5 MHz

TEST PERFORMED BY	DATE	TEST ACCEPTAN	QA	DATE	SAMTEC ACCEPTANCE	DATE
SMITH J F.	3AUGX7					

SAMTEC [illegible] 89 PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED

	FACILITY B1801	WAFER S/N —	BACK-UP / PRIME	TEST EQUIPMENT RF 6.1.1	CODE NAME —	R/U —	
TEST SET P/N TTS	TEST SET S/N 0001	BEACON ON 1100	BEACON OFF 1530	TOTAL TIME 3 Hours	MAG. BURN-IN-DATE LAST PERFORMED: N/A / COMP.	DATE	
ANTENNA P/N	ANT. S/N	ANT. 2 S/N —	ANT. 3 S/N —	COUPLER P/N —	COUPLER S/N —	BATT. P/N —	BATT. S/N —	DATED —

TRANSMITTER

1. Time to See Pwr Delay Timer		< 30	Sec
2. Time to Stabilize		180	Sec
3. Transmitter Frequency (+3 min) / (+10 min)	Start	5728.2	MHz
	Finish	5728.6	MHz
4. Frequency Drift Rate (MHz/min)	Start	.266	MHz
	Finish	.133	MHz
5. Pulse Frequency Jitter		—	MHz
6. Pulse Width ✓	@ 0.5	0.982	µsec
	@ .75	0.231	µsec
	@ 1.0	0.983	µsec
7. Pulse Width Jitter ✓		.0033	µsec
8. Pulse Amplitude Variation		< 1.0	dB
9. Pulse Amplitude Jitter		< 0.5	dB
10. Pulse Rise Time		.013	✓ µsec
11. Pulse Fall Time		.020	✓ µsec
12. Pulse RF Spectrum @ 6 dB BW		2.2	MHz
13. Delay @ -55 dBm		2.508	µsec

14. Delay Variation vs Signal (dBm)					Absolute	0.042	µsec
15. Delay Jitter vs Signal (dBm)					Absolute	0.042	µsec
0	2.513	-10 2.509	-20 2.507	-30 2.501	-40 2.536	-50 2.51	
Jit	.007	.007	.010	.012	025	.025	
-57	2.506	-60 2.514	-62 2.524	-65 2.533	-67 2.542	-70 —	
Jit	.021	.030	.029	.030	.049	—	
16. Delay Variation vs Freq. (MHz)					Absolute	0.003	µsec
17. Delay Jitter vs Freq. (MHz)					Absolute	0.008	µsec
-1.5	2.50	-1 2.502	-.5 2.502	+.5 2.505	+1 2.5	+1.5 2.503	
Jit	.019	.020	.020	.012	.012	.015	
18. Delay Variation vs PRF (pps)					Absolute	0.014	µsec
19. Delay Jitter vs PRF (pps)					Absolute	0.011	µsec
100	2.516	160 2.515	320 2.514	640 2.513	1000 2.5	1500 2.502	
Jit	.018	.019	.022	.026	.014	.014	
20. Delay Variation vs Opr. Voltage					Absolute	0.004	µsec
21. Delay Jitter vs Opr. Voltage					Absolute	0.004	µsec
24	2.504	26 2.507	28 2.502	30 2.503	32 2.503		
Jit	.015	.016	.014	.012	012		
22. Peak Power Output				Xponder 105			Watts

ANT. NO 1	ANT. NO 2	ANT. NO. 3
— Watts	— Watts	— Watts

RECEIVER

23. Receiver Bandwidth @ 3 dB	Low 5759.5 MHz	Center 5765.35 MHz / Max Sens. 5765.2 MHz	Hi 5771.2 MHz / Total 11.7 MHz
24. Receiver Bandwidth @ 60 dB	Low — MHz	Center — MHz	Hi — MHz / Total — MHz
25. Threshold Sensitivity			< -69 dBm
26. Dynamic Range	Low < -64 dBm		Hi 0 dBm
27. Image Rejection			— dB
28. Pulse Width Acceptance	Low < .15 µsec		Hi > 3.0 µsec
29. Decoder Accept Limits @ -55 dBm	Low 8.78 µsec	Center µsec	Hi 9.2 µsec
30. Decoder Reject Limits @ -55 dBm	Low 8.7 µsec		Hi 9.25 µsec
31. Decoder Immunity @ 0 dBm	Pulse OK		CW N/A

TRANSPONDER

32. Random Triggering			NONE pps
33. Recovery Time @ 0 dBm			38 µsec
34. Over-Interrogation			3285 pps
35. Maximum Duty Cycle			Product

36. Operating Current vs Voltage	24 .68 A	26 .68 A	28 .68 A	30 .68 A	Quiet 32 .68 A
	Vdc .71 A	Vdc .71 A	Vdc .71 A	Vdc .71 A	Vdc .71 Interg. A

37. Pressurization Test	☑ N/A	☐ Go	☐ No Go

COHERENCY

38. Carrier Phase Coherency		Std Dev. Hz	Vel Accry ft/sec
39. Carrier Line Width @ 3 dB			Hz
40. Spectral Skew @ ± 350 KHz			dB
41. Interline Noise (relative)			dB
42. Dynamic Pulse Spectrum		Carrier Δ Hz	Interline Δ dB
43. Frequency Tracking		Low - MHz	Hi + MHz

TEST PERFORMED BY	DATE	TEST ACCEPTAN	QA	DATE	SAMTEC ACCEPTANCE	DATE
[illegible] F.	8 Nov 76					

302-C 3150							
FACILITY	WAFER S/N	☐ BACK-UP ☐ PRIME	TEST DOCUMENT	CODE NAME	R/U		
31801	—		RF 6.1.1	—	—		
TEST SET P/N	TEST SET S/N	BEACON ON	BEACON OFF	TOTAL TIME	MAG. BURN-IN-DATE LAST PERFORMED ☐ N/A ☐ COMP. DATE		
TTS	0001			5 HOURS			
ANTENNAS P/N	ANT. 1 S/N	ANT. 2 S/N	ANT. 3 S/N	COUPLER P/N	COUPLER S/N	BATT. P/N	BATT. S/N	DATED
—	—	—	—	—	—	—	—	

TRANSMITTER			RECEIVER		
1. Time to See – Pwr Delay Timer	< 30 Sec		23. Receiver Bandwidth @ 3 dB	Total 11.1 MHz	
2. Time to Stabilize	180 Sec			Low 5483.1 MHz	Cntr 5488.5 MHz / 5489.1 MHz; Hi 5494.2 MHz
3. Transmitter Frequency (+3 min) (+10 min)	Start 5698.2 MHz	Finish 5698.2 MHz	24. Receiver Bandwidth @ 60 dB	Total — MHz	
4. Frequency Drift Rate (MHz/min)	Start 0.333 MHz	Finish 0 MHz		Low — MHz	Center — MHz; Hi — MHz
5. Pulse Frequency Jitter	N/A MHz		25. Threshold Sensitivity	−68 dBm	
6. Pulse Width	@ 0.5 0.534 µsec; @ .75 0.535 µsec; @ 1.0 0.535 µsec		26. Dynamic Range	Low −63 dBm	Hi 0 dBm
7. Pulse Width Jitter	.004 µsec		27. Image Rejection	— dB	
8. Pulse Amplitude Variation	< 1.0 dB		28. Pulse Width Acceptance	Low < .2 µsec	Hi > 3 µsec
9. Pulse Amplitude Jitter	< 0.5 dB		29. Decoder Accept Limits @ −55 dBm	Low 4.76 µsec	Center 4.98 µsec; Hi 5.2 µsec
10. Pulse Rise Time	.011 µsec		30. Decoder Reject Limits @ −55 dBm	Low 4.7 µsec	Hi 5.21 µsec
11. Pulse Fall Time	.025 µsec		31. Decoder Immunity @ 0 dBm	Pulse OK	CW N/A
12. Pulse RF Spectrum @ 6 dB BW	2.2 MHz		TRANSPONDER		
13. Reply Delay @ −55 dBm	2.48 µsec		32. Random Triggering	NONE pps	
14. Delay Variation vs Signal (dBm)	Absolute 0.19 µsec		33. Recovery Time @ 0 dBm	45 µsec	
15. Delay Jitter vs Signal (dBm)	Absolute 0.135 µsec		34. Over-Interrogation	2920 pps	
0 2.49 / Jit .005	−10 2.49 / .005	−20 2.49 / .005	−30 2.50 / .004	−40 2.49 / .038	−50 2.48 / .007
−57 2.48 / Jit .010	−60 2.50 / .012	−62 2.52 / .027	−65 2.57 / .045	−67 2.67 / .139	−70 — / —
16. Delay Variation vs Freq. (MHz)	Absolute 0.01 µsec		35. Maximum Duty Cycle	Product .0015	
17. Delay Jitter vs Freq. (MHz)	Absolute 0.006 µsec		36. Operating Current vs Voltage	24 .7 A; 26 .7 A; 28 .7 A; 30 .7 A; Quiet 32 .7 A	
−1.5 2.47 / Jit .008	−1 2.47 / .008	−.5 2.47 / .006	+.5 2.48 / .007	+1 2.48 / .008	+1.5 2.47 / .012
18. Delay Variation vs PRF (pps)	Absolute 0.03 µsec			Vdc .85 A; Vdc .85 A; Vdc .85 A; Vdc .85 A; Vdc .85 A Inter.	
19. Delay Jitter vs PRF (pps)	Absolute 0.00 µsec		37. Pressurization Test	☑ N/A	☐ Go ☐ No Go
100 2.47 / Jit .008	160 2.47 / .008	320 2.47 / .008	640 2.47 / .008	1000 2.48 / .008	1500 2.50 / .009
20. Delay Variation vs Opr. Voltage	Absolute 0.0 µsec		COHERENCY	Std Dev. Hz	Vel Accry ft/sec
21. Delay Jitter vs Opr. Voltage	Absolute 0.001 µsec		38. Carrier Phase Coherency		
24 2.48 / Jit .007	26 2.48 / .008	28 2.48 / .008	30 2.48 / .008	32 2.48 / .008	
22. Peak Power Output	Xponder 530 Watts		39. Carrier Line Width @ 3 dB	Hz	
ANT. NO 1 — Watts	ANT. NO 2 — Watts	ANT. NO. 3 — Watts	40. Spectral Skew @ ±360 KHz	dB	
			41. Interline Noise (relative)	dB	
			42. Dynamic Pulse Spectrum	Carrier Δ Hz	Interline Δ dB
			43. Frequency Tracking	Low − MHz	Hi + MHz

TEST PERFORMED BY	DATE	TEST ACCEPTAN	QA	DATE	SAMTEC ACCEPTANCE	DATE
SAMTEC JF	40CT76					

SAMTEC JUL 73 89 PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED

VEHICLE TYPE	FACILITY	WAFER S/N		TEST DOCUMENT	CODE NAME	R/U
VEGA	B1801	—	☐ BACK-UP ☐ PRIME	RF 6.1.1	—	—

TEST SET P/N	TEST SET S/N	BEACON	BEACON	TOTAL TIME	MAG. BURN-IN-DATE LAST PERFORMED
TTS	0001	ON	OFF	16. Hours	☐ N/A ☐ COMP. DATE

ANTENNAS P/N	ANT. 1 S/N	ANT. 2 S/N	ANT. 3 S/N	COUPLER P/N	COUPLER S/N	BATT. P/N	BATT. S/N	DATED
—	—	—	—	—	—	—	—	—

TRANSMITTER

1. Time to See – Pwr Delay Timer		< 30	Sec
2. Time to Stabilize		180	Sec
3. Transmitter Frequency (+3 min) (+10 min)	Start	5765.5	MHz
	Finish	5765.5	MHz
4. Frequency Drift Rate (MHz/min)	Start	0.114	MHz
	Finish	0.0	MHz
5. Pulse Frequency Jitter		—	MHz
6. Pulse Width	@ 0.5	0.535	μsec
	@ .75	0.535	μsec
	@ 1.0	0.535	μsec
7. Pulse Width Jitter		0.0015	μsec
8. Pulse Amplitude Variation		< 1.0	dB
9. Pulse Amplitude Jitter		< 0.5	dB
10. Pulse Rise Time		0.013	μsec
11. Pulse Fall Time		0.051	μsec
12. Pulse RF Spectrum @ 6 dB BW		2.4	MHz
13. Reply Delay @ -55 dBm		2.44	μsec
14. Delay Variation vs Signal (dBm)	Absolute	0.048	μsec
15. Delay Jitter vs Signal (dBm)	Absolute	0.024	μsec

0	-10	-20	-30	-40	-50
2.471	2.423	2.477	2.477	2.472	2.455
Jit .003	.004	.004	.003	.003	.006
-57	**-60**	**-62**	**-65**	**-67**	**-70**
2.44	2.446	2.457	2.474	2.488	—
Jit .005	.010	.012	.017	.027	—

16. Delay Variation vs Freq. (MHz)	Absolute	0.007	μsec
17. Delay Jitter vs Freq. (MHz)	Absolute	0.000	μsec

-1.5	-1	-.5	+.5	+1	+1.5
2.435	2.433	2.435	2.439	2.439	2.444
Jit .006	.006	.006	.007	.006	.006

18. Delay Variation vs PRF (pps)	Absolute	0.034	μsec
19. Delay Jitter vs PRF (pps)	Absolute	0.001	μsec

100	160	320	640	1000	1500
2.432	2.432	2.437	2.411	2.411	2.445
Jit .005	.007	.007	.006	.006	.006

20. Delay Variation vs Opr. Voltage	Absolute	0.000	μsec
21. Delay Jitter vs Opr. Voltage	Absolute	0.000	μsec

24	26	28	30	32
2.445	2.445	2.445	2.445	2.445
Jit .007	.007	.007	.007	

22. Peak Power Output	Xponder	508 Watts

ANT. NO 1	ANT. NO 2	ANT. NO. 3
— Watts	— Watts	— Watts

RECEIVER

23. Receiver Bandwidth @ 3 dB	Low 5686.68 MHz	Center 5693.14 MHz / Mean Freq 5692.0 MHz	Hi 5699.6 MHz
			Total 12.92 MHz
24. Receiver Bandwidth @ 60 dB	Low — MHz	Center — MHz	Hi — MHz
			Total — MHz
25. Threshold Sensitivity			-69 dBm
26. Dynamic Range	Low -64 dBm		Hi 0 dBm
27. Image Rejection			— dB
28. Pulse Width Acceptance	Low < .159 μsec		Hi > 3 μsec
29. Decoder Accept Limits @ -55 dBm	Low N/A μsec	Center N/A μsec	Hi N/A μsec
30. Decoder Reject Limits @ -55 dBm	Low N/A μsec		Hi N/A μsec
31. Decoder Immunity @ 0 dBm	Pulse N/A		CW N/A

TRANSPONDER

32. Random Triggering	NONE pps
33. Recovery Time @ 0 dBm	42 μsec
34. Over-Interrogation	3155 pps
35. Maximum Duty Cycle	Product 0.0015

36. Operating Current vs Voltage				Quiet
24	26	28	30	32
0.65 A	0.65 A	0.65 A	0.65 A	0.65 A
Vdc	Vdc	Vdc	Vdc	Vdc
0.85 A	0.85 A	0.85 A	0.85 A	0.85 A Interg.

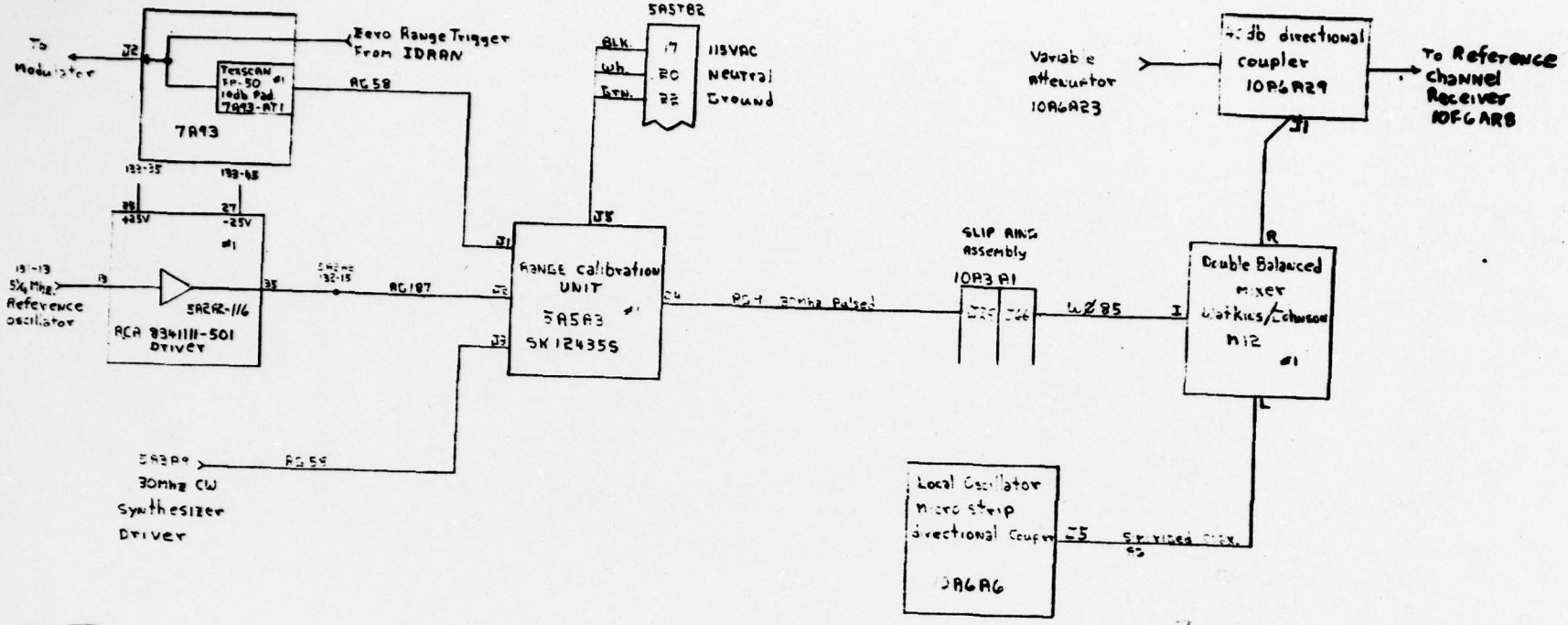
37. Pressurization Test	☑ N/A	☐ Go	☐ No Go

COHERENCY

38. Carrier Phase Coherency	Std Dev. Hz	Vel Accry ft/sec
39. Carrier Line Width @ 3 dB		Hz
40. Spectral Skew @ ± 350 KHz		dB
41. Interline Noise (relative)		dB
42. Dynamic Pulse Spectrum	Carrier Δ Hz	Interline Δ dB
43. Frequency Tracking	Low - MHz	Hi + MHz

TEST PERFORMED BY	DATE	TEST ACCEPTAN	QA	DATE	SAMTEC ACCEPTANCE	DATE
James F Smith	4-Nov 76					

SAMTEC JUL 73 89 PREVIOUS EDITION MAY BE USED UNTIL EXHAUSTED



NOTE:

1. Added to existing System

Radar Range Calibration System
AN/FPS-16 Series
Block Diagram

5

D

Delay in lead edge of pulse with respect to sweep start (if any)

_____nano sec

Switch selected (one only)	Measured Width	Nominal Width (nano sec)	Δ
5-3	165	1525	-1
5-4	892	763	+3
5-5	511	381	+4
5-6	319	191	+2
5-7	222	95	+1
5-8	173	48	-1
5-9	144	24	-6
5-10	136	12	-2
None	126		0 ±3.2

Switch Combinations	Measured Width	Nominal Width μsec
~~4,6,8~~ 4,7,10	.999	1.0
~~5 through 10~~ 5,6,8	.749	.75
~~5,7,9~~ 6,7,8,9,10	.497	.5
~~6,8,10~~ 7,9	.247	.25

C

RCM Range Position (yds)	Console Range (yds)
100K	100,000 -1
200K	200,000 -1
300K	300,000 -1
400K	400,000 -1
500K	500,000 -1
600K	600,000 -1
700K	700,000 -1
800K	800,000 -1
1000K	1,000,000 -1
50K	50,000 -1
25K	25,000 -1

A

B12 and B14 switch positions after initial calibration

B12 Position 2 3 4 4 On 1 5 6 7 8 Off

B14 Position

B

Attenuation (db)	Console Range (yds)	Nominal(yds)	AGC Volts
0	100,001	100K	6
5	100,001 -3	100K	5.7
10	100,003 -1	100K	5.3
15	100,001 -3	100K	4.95
20	100,001 -3	100K	4.6
25	100,001	100K	4.4
30	100,001	100K	4.2
35	100 09	100K	4.2
40	100,001	100K	4.2
45	100,001	100K	4.2
50	100,001	100K	41

Corrections Applied to Radar Beacon Lock On Data

Corrections for 174 beacon

+11 yds for beacon delay error (used 2.573 instead of 2.503)
-2.3 yds for pulse width calibrated for .927 instead of .955
-4 yds for cable delay (between beacon and antenna)
+4.7 yds Correction (Total)
+8040.8 yds Measured with radar
8045.5 yds Corrected

Correction for 302 beacon

+13 yds for beacon delay error (used 2.56 instead of 2.48)
0 yds for pulse width
-4 yds for cable delay
+9 yds Correction (Total)
8045.4 Measured with radar
8054.4 yds Corrected