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BELL ENGINEERING

P.O. BOX 568
FORT WALTON BEACH, FL 32549
850-244-5777 (Voice)
850-244-4435 (FAX)
email: bell@bsc.net

Randy Bell

EXPERIENCE

Bell Engineering, Fort Walton Beach, FL (1985 - Present) - Designed military and commercial RF/Microwave products for various clients. These include:

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PCOM - Designed 5.7 - 5.9 GHz transceiver for use in unlicensed ISM band. Transmitter had output power of 1 watt and receiver had noise figure < 1 dB.

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Wiltron Model 6409 Scalar Network Analyzer
EIP Model 545 Microwave Frequency Counter
Farnell Model AMM2000 Automatic Modulation Meter
Hewlett-Packard Model 8660C Synthesized Signal Generator
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Wandel and Goltermann Model TSA-1 Spectrum/Network Analyzer
Weinschel Engineering Model 4310A/KN Multiband Sweep Oscillator
Stanford Research Systems Synthesized Function Generator Model DS345

CAD/CAE SOFTWARE

Tesla - System Simulator
Word Pro - Word Processing
Vellum - Mechanical Design
Coda - Crystal Oscillator Design
CiAO - Matching Network Design
WaveCon - Microwave Filter Design
TxRx Designer - RF System Analysis
Spectra Plus - Audio Spectrum Analysis
Protel - Schematic and Printed Circuit Board Design
Acolade - Communications Link Analysis and Design
Touchstone - Linear RF/microwave Circuit Analysis and Optimization

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FEDERAL COMMUNICATIONS COMMISSION
GENERAL RADIOTELEPHONE
OPERATOR LICENSE
(General Radiotelephone Certificate)

Endorsement

[X] Ship Radar

[ ] None

[ ] Other
(See attachment)

INVALID IF MORE THAN ONE BLOCK MARKED
(SEE OVER)

Name: RANDALL A BELL

Date of Birth: Ø4/Ø6/53

Issuance Date: Ø2/19/87

License Number: PG-8-15516

Signature: Randall A Bell

INVALID UNLESS SIGNED

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[ ] None

[ ] Other
(See attachment)

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Date of Birth 04/06/53	Issuance Date 02/19/87
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Signature INVALID UNLESS SIGNED

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S F D - 3 4 9

CEM COAXIAL MAGNETRON

TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 1 Of 24

Effective ________ Revision ________

ELECTRON TUBE, SFD-349 SRD COAXIAL MAGNETRON PULSED

REVISIONS

Page 3 - deleted MIL-T-5422 reference. 4308 changed "to" to "and".
Page 4 - 4308 changed "to" to "and". Page 6 - 1031 deleted "part II"
Page 9 - Note 14 changed from 15 to 65 Hz to 5 to 20; 20.
Page 10 - Note 15. Changed 4 ± 1 to 3 turns min, Note 18, 20 changed "min of 150" to 150 + 10, -0. Page 12, Note 33 "seconds (Min)" to "+10, -0 sec."
Note 34 Deleted "The test shall be performed using a.c. ... on the heater..."
Page 13, Note 46 changed 15 Hz to 5 Hz, "fifteen" min. to "7 1/2" min...
Page 14, changed note from "The tube shall then be vibrated at the indicated resonant conditions for a period of 10 minutes. If more than one resonant frequency is encountered, the test period may be accomplished at the most severe resonance, or the period may be divided among the resonant frequencies, whichever is most likely to produce failure." to "The tube shall then be vibrated at the two most severe resonant conditions for a period of 10 minutes each."

The above per agreement with customer 12-66. — [signature] 7/21/67 — [signature] 7-18-67

B - Page 6 - Backlash, add "Note 37", change "2" MHz to "3" MHz max.
Page - 10 - Note 15 change turns from "160 ± 1" to "160 ± 2"
Page 12 - Note 37 change "...dial...setting...setting". to "...shaft...angular position. ...position....."

Per WRL letter 17 April 1967 — PB 8/8/67 — [signature] 8-8-67

C - Page 3 - Pushing: change "MHz/a to "KHz/a", page 15, change note "25" to note "27";
Page 19; add note "25", Page 21, Note 15 change plane "B" to "C". — [signature] 10-6-67 — [signature] 10-6-67

D - Page 2 - Tuner Torque change 96 to 48
Page 3 - Pushing change 0.1 to 100
Page 5 - Spectrum measurements; add Mil Ref 4308
Page 8 - Note 3, change 96 to 48
Page 9 - Note 14 change "fifteen" to "thirty"
Page 13 - Note 41 change 13.5 to 13.75
Note 46, change 7 1/2 to 15; "change 15 to 500-15" to "15-500-15"
Page 15 - Change (N) 3.046 to 3.406; add letters (AT), (J), (N), (K), (P); add Fig 1a
Page 16 - Add BN .515 ± .010; add letters (C), (C) max, (A) and Fig 1b note 28
Page 17, 18, 19, 20, add Fig's 1c, 1d, 1e, 1f respectively
Page 19, added UNC-2B to thread callout
Page 22 added Note 28
Page 23, 24, add (AT), (BL), (BN), add mm
to agree with customer drawing D and reflect tube capability — [signature] 12/20/67 — [signature] 12-20-67

E - Figure 1a 3.390 was 3.406, sheet 24, Nominal Dimension Letter N was 3.406 In., 86.50 MM. — [signature] — [signature] 15 APR 69

SEE PAGE 1A

3

ELECTRICAL:	MECHANICAL:	APPLICATIONS:
[signature]	[signature]	[signature] 7-7-67

Varian/Beverly

Type No SFD-349 Page 1A Of 24

TEST SPECIFICATION APPROVAL SHEET

TITLE ELECTRON TUBE, SFD-349 CEM® COAXIAL MAGNETRON PULSED

ELECTRICAL	MECHANICAL	APPLICATIONS
P BAHR	G. GLENFIELD	W. A. GERARL

REV	LOCATION	DESCRIPTION	DATE	APPROVAL
F	Page 1 Page 15 Page 16 Page 17 Page 18 Page 20 Page 22 Page 23A	Add new first page 1A. Added (L) to (AU) .010 tolerance was .003 on (AU) (26) was (17) (19) was (20) Added (26) to (AM) (23) was (24) Width of tuner slot was .040 ± .002 (BF) Note 17. Read "The dimension applies to the axis of the tuner input shaft, which nominally lies on reference plane "B". The dimensional limits are plus and minus this nominal location". Note 23. Read "This--------length "E". Note 24. Read "This surface shall be parallel with the axis of tuner drive shaft within .005 T.I.R. and shall also be parallel with Ref. plane "C" within .015 T.I.R." Note 26.- "Z" was 23. "AU" was - 1.247 - 1.253 - 31.67 - 31.83.	7/23/70	EO 593 [signature]
G	Pages 15-17, 23-24, 19,20	As per SCN #74-0989	6/2/[illegible]	[signature]
H	Page 8	Changed values for Pi and Ef in Note 5. per ECO 76-2238	11/23/76	[signature]
J		Update MIL Methods and update outline drawing, Figure 1 per ECO #77-2403.	3/16/77	[signature]
K		Changes per ECO 79-3435.	2/8/79	[signature]
L	pages 15 16, 17	Add directional arrows, ECO 79-3547	4/24/79	

2

TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 2 Of 24

Effective ______ Revision E

ELECTRON TUBE, SFD-349 CEM® COAXIAL MAGNETRON PULSED

The provisions of the latest issue of MIL-E-1 apply to this specification

DESCRIPTION 8,500 to 9600 MHz, tunable frequency, integral magnet, air cooled, 220 kw nominal peak power output. Unipotential cathode.

ABSOLUTE MAXIMUM AND MINIMUM RATINGS: Note 1

INDEPENDENT

PARAMETER	If Surge	tk	VSWR	Tuner Torque	Body Temp	Input Bushing Temp	Pressurization Input	Pressurization Output		
UNITS	a	sec		in-oz	°C	°C	psia	psia		
MAXIMUM	12	---	1.5:1	48	125	165	45	45		
MINIMUM	--	150	----	--	-55	-55	15	15		
NOTES				3	2	2	4			

DEPENDENT

PARAMETER	Ef	If	ib	Pi	pi	Du	tpc	prr	rrv
UNITS	V	A	a	W	kw	—	µsec	pps	kv/µsec
MAXIMUM	15	3.6	30	680	680	0.0011	2.8	5500	160
MINIMUM	--	---	15	---	---	---	0.2	---	90
NOTES	5						6		7

MECHANICAL

MOUNTING POSITION — Any

SUPPORT — Mounting flange

COOLING — Forced air (note 10)

OUTLINE — Figure 1

MAGNET — Note 8

COUPLING — WR112 Figure 1

NET WEIGHT — 13.5 pounds nominal

TEST SPECIFICATION

Varian/Beverly

Type No. SFD-349 Page 3 Of 24

Effective ____ Revision L

MIL-E-1 MIL-STD 1311	TEST	CONDITIONS	SYMBOL	LIMITS MIN	LIMITS MAX	UNITS
4.1.1(b)	Qualification Approval Tests					
4.2	Qualification	Required for JAN. marking (see note 9)				
1143	Air cooling	Osc. (2) notes 2, 10 11	ΔT	---	90	°C
4027	Temperature coefficient	Osc. (2) T = 70°C to 115°C; F = F2, notes 2, 12, 23	ΔF/ΔT	---	0.25	MHz/°C
4223	Tuner torque	-55° approx. non-operating, 150°C max operating Osc. (2)	Dynamic static	--- ---	8 10	in-oz in-oz
1042	Shock	30 G; 11 ± 1 msec duration; no voltages note 13	---	---	---	---
	Variable frequency vibration (operating)	Osc. (2) F = F3, notes 14 and 36	---	---	---	---
	Frequency mod.	See note 34	ΔF	---	1.0	MHz
4315	Stability	See note 16	MP	---	0.5	%
4266	Input capacitance	Cathode terminal to mounting plate	C	9	14	pF
4223	Tuner life	No voltages, note 17		5×10^4	---	cycles
4311	Pushing factor	Osc. (2) ib = 15 to 27 a, notes 23 and 44, F1, F2, F3	$\Delta F/\Delta i_b$	---	100	KHz/a
4310	Pulling factor	Osc. (2) notes 23 and 45, F1, F2, F3	ΔF	---	5	MHz
4308	Spectrum measurements	Osc. (1) ib = 15 and 27.5 a, notes 23, 24, F1, F2, F3				
	RF bandwidth		BW	---	2.0/tpc	MHz

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TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 4 Of 24

Effective ________ Revision L

MIL-E-1 MIL-STD-1311	TEST	CONDITIONS	SYMBOL	LIMITS MIN.	LIMITS MAX.	UNITS
	Minor lobes		S L	-10	---	db
4250	Power output	Osc. (2) note 32	Po	200	---	watts
4308	Spectrum measurements	Osc. (2) ib = 15 and27.5 a notes 23 & 24 F1, F2, F3				
	RF bandwidth		BW	---	2.0/tpc	MHz
	Minor lobes		S L	-8	---	db
----	Low temperature operation	Osc. (2) F = F2 see notes 15 and 19	MP	---	0.5	%
4302	Thermal drift	Osc. (2) F = F3 t = 20 minutes see note 20	ΔF	---	18	MHz
1006	Salt spray	See notes 21 and 22	Static torque	---	12	in-oz
1011	Humidity	See note 22	Static torque	---	12	in-oz
4.1.1(c)	Quality Conformance Inspection Part 1	Notes 30 and 31				
30(b)	Dimensions	Per figure 1	---	---	---	---
4.8.5	Holding period	t = 168 hours				
4003	Pressurization	45 psia minimum input and output assemblies see notes 25 and 26				
4289	Heater current	Ef = 13.75 V tk = 150 sec. min. see note 27	If	2.9	3.3	A
	Oscillation (1)					
----	Coupling	VSWR = 1.1 max. except as noted see notes 28 and 29				

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Varian/Beverly

TEST SPECIFICATION

Type No SFD-349 Page 5 Of 24

Effective ______ Revision L

MIL-E-1 MIL-STD-1311	TEST	CONDITIONS	SYMBOL	LIMITS		UNITS
				MIN.	MAX.	
4303	Heater-cathode warm-up time	Ef - 13.75 V tk = 150 sec. min. see note 5				
4304	Pulse characteristics	tpc= 0.25 ± 0.05 μs Du = 0.001 rrv = 160 kv/μs min. see notes 6 and 7				
---	Average anode current	Ib = 27.5 mAdc				
4308	Spectrum measurements	See notes 23 and 24 F1, F2, F3				
	RF bandwidth		BW	---	2.0/tpc	MHz
	Minor lobes		S L	-10	---	db
4315	Stability	See notes 19 and 23 F1, F2, F3	MP	---	0.25	%
4223	Tunable frequency	Upper limit	F	9600	---	MHz
		Lower limit see note 15	F	---	8500	MHz
	Oscillation (2)					
----	Coupling	VSWR 1.1 max. except as noted see notes 28 and 29				
4303	Heater-cathode warm-up time	Ef = 13.75 V tk = 150 sec. min. see note 5				
4304	Pulse characteristics	tpc= 2.35 ± 0.25 μs Du = 0.001 rrv = 160 kv/μs min. see notes 6 and 7				
---	Average anode current	Ib = 27.5 mAdc				
4306	Pulse voltage	See note 23; F1, F2, F3	epy	20.0	23.0	kv
4308	Spectrum measurements	See notes 23 and 24 F1, F2, F3				7
	RF bandwidth		BW		2.0/tpc	MHz

TEST SPECIFICATION

Varian/Beverly

Type No. SFD-349 Page 6 Of 24
Effective ________ Revision 4

MIL-E-1 MIL-STD 1311	TEST	CONDITIONS	SYMBOL	LIMITS MIN	LIMITS MAX	UNITS
	Minor lobes		SL	-8	---	db
4315	Stability	See notes 19, and 23 F1, F2, F3	MP	---	0.25	%
4315	Starting stability	F = F2 see notes 19 and 33	MP	---	0.25	%
4250	Power output	See note 23 F1, F2, F3	Po	200	270	watts
----	Frequency modulation	F = F1, F2, F3 see note 34	FM	---	0.1	MHz
4.1.1(d)	<u>Quality Conformance Inspection Part 2</u>	Note 30				
3.6	Marking	See figure 1 see note 35				
---	High frequency vibration (operating)	Osc. (2) F = F3 per MIL-T-5422E (ASG) curve IV see notes 36 and 46				
	Frequency modulation	See note 34 F1, F2, F3	FM		5	MHz
	Stability	See note 16 F1, F2, F3	MP		2	%
4223	Resetability	Osc. (2) Note 37 F1 + 50 ± 5 MHz F2 ± 5 MHz F3 - 50 ± 5 MHz	ΔF	---	3	MHz
4223	Tuner drive torque	Room temp. (25°C) see note 38	Dynamic torque	---	8	in-oz

TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 7 Of 24

Effective ______ Revision ✓

MIL-E-1 MIL-STD 1311	TEST	CONDITIONS	SYMBOL	LIMITS MIN.	LIMITS MAX.	UNITS
	Special Testing					
4.6	Life Testing					
4551	Life tests	Group D; VSWR 1.5 min cycled through λg every 15 min. approx. see note 41		1500 1250	--- ---	cycles hours
4.6.2	Life test end points	See note 42				
4250	Power output	Osc. (2) note 23 F1, F2, F3	Po	160	---	watts
4223	Tunable frequency	Osc. (2) upper limit Osc. (2) lower limit	F F	9600 ---	--- 8500	MHz MHz
4308	Spectrum measurements	Osc. (1) and Osc. (2) notes 23 and 24 F1, F2, F3				
	RF bandwidth		BW	---	2.5/tpc	MHz
	Minor lobes		S L	-6	---	db
4315	Stability	Osc. (1) see notes 19 and 23; F1, F2, F3	MP	---	0.5	%
4315	Stability	Osc. (2) see notes 19 and 23; F1, F2, F3	MP	---	0.5	%
	Tuning characteristics	See note 43	F	---	3	MHz

NOTES:

1. The requirements of paragraph 6.5 of MIL-E-1E shall apply. For the assistance of designers of electronic equipment, the ratings have been divided into two groups as follows:

   a. Independent (ratings which may be obtained simultaneously).

   b. Dependent (ratings which are interrelated and may not necessarily be obtained simultaneously).

2. The temperature is to be measured at the point indicated on figure 1.

3. The tuning mechanism shall be capable of withstanding a static torque of 48 in-oz at the ends of its travel.

4. The magnetron shall be capable of normal operation without electrical breakdown with the input bushing in air at normal atmospheric conditions.

5. Prior to the application of high voltage, the cathode shall be heated to the required initial operating temperature. This shall be done by applying 13.75 volts ± 5 percent for 150 seconds minimum. On the application of anode voltage, the heater voltage shall be reduced according to the following:

	Du	Ib(mAdc)	Ef(V) ± 5%
Standby	----	----	13.75
Operate	0.001	27.5	0

For Pi equal to or greater than 600 watts Ef = 0

For Pi between 375 w and 600 w: $E_f = 19.0\ (1 - \frac{Pi}{600})\ {}^{+1.4}_{-0.7}$ volts

For Pi less than 375 watts $E_f = 13.75\ (1 - \frac{Pi}{800})$ volts ${}^{+1.4}_{-0.7}$ volts

6. The characteristics of the applied pulse must be those which result in proper starting and oscillation. The rate of rise of the voltage pulse, the percentage of pulse voltage ripple, and the rate of pulse voltage fall are among the more important considerations. The cognizant service electron tube group should be consulted regarding pulse characteristics as related to the specific application.

7. The rate of rise of voltage (rrv) shall be expressed in kilovolts per microsecond (kv/μs) defined by the steepest tangent to the leading edge of the voltage pulse above the 70 percent amplitude point. Any capacitance used in the viewing (measuring) circuit shall not exceed 6 picofarads (pf).

8. In handling and mounting the magnetron, care must be exercised to prevent demagnetization. See figure 1. The use of magnetic inspection tools is prohibited.

9. The activity responsible for the qualified products list is the Naval Ship Engineering Center, Department of the Navy, Washington, D.C., 20360, and information pertaining to qualification of products may be obtained from that activity. Application for Qualification tests shall be made in accordance

NOTES: (Cont'd)

with "Provisions Governing Qualification". (Copies of "Provisions Governing Qualification" may be obtained upon application to Commanding Officer, Naval Supply Depot, 5801 Tabor Avenue, Philadelphia, Pennsylvania, 19120.

10. With a total airflow of approximately 40 c.f.m. at approximately 760 mm. Hg., 25°C, divided equally and directed through the cooling fins toward the body of the tube from two 3/4 inch ducts placed 1/2 to 3/4 inch from the cooling fins, the specified rise above ambient temperature shall not be exceeded.

11. The frequency shall be the frequency of minimum power output between F1 and F3.

12. Temperature measurements shall be made only after thermal equilibrium has been reached. The frequency shall be measured at the extremes of any 30°C temperature range.

13. The tube shall be subjected to five shocks of the specified peak amplitude and duration in each of three mutually perpendicular directions. Following impact tests, the tube shall show no mechanical failure and shall meet all power output and voltage requirements of oscillation (2).

14. The magnetron shall be mounted in a resonance free jig and vibrated with sinusoidal excitation in each of three mutually perpendicular planes through the following amplitudes:

5 Hz to 20 Hz	0.1 inch D.A.
20 Hz to 500 Hz	2 G

Cycling test: The frequency shall vary from 5-500-5 Hz with approximately logarithmic progression, and shall require approximately thirty minutes to traverse the range. This constitutes one cycle. The magnetron shall be vibrated for two such cycles in each of the three planes.

Resonance test: Mechanical resonant frequencies of the magnetron shall be determined during the cycling test. The tube shall then be vibrated at the indicated resonant conditions for a period of 30 minutes. If more than one resonant frequency is encountered, the test period may be accomplished at the most sever resonance, or the period may be divided among the resonant frequencies whichever is most likely to produce a failure.

Vibration Test Schedule (Times shown refer to one axis)

Type	Rm. Temp. Time
Resonance	30 minutes
Cycling	30 minutes

Interpulse frequency stability (FM) and RF stability (MP) shall not exceed the limits specified.

//

NOTES:

15. The frequency range F1 to F3 shall be traversed by a tuning shaft rotation of 160 ± 2 turns. A mechanical over-run of 3 turns min shall be provided at each end of the tuning range before contacting the mechanical stops.

16. A missing pulse is defined as one whose energy within ± 1 percent frequency range of the normal operating frequency is 70 percent or less than that of a normal pulse. The tube shall be considered stable if the specified missing pulse limit is not exceeded during the vibration time and acceleration levels as specified in the operating vibration test.

17. The tuning shaft shall be continuously driven at a speed of 1400 ± 50 rpm. At the completion of the test the tube shall meet oscillation (1) requirements. The backlash shall not exceed 3 MHz. During the test, the tuning shaft <u>may</u> <u>not</u> <u>be</u> <u>lubricated</u>. A cycle consists of two complete excursions each in opposite directions through the tuning range of the magnetron.

18. The ambient temperature of the chamber shall be -55°C. The cooling air supplied to the magnetron shall be at -55°C at 40 cubic feet maximum per minute. The Temperature of the magnetron shall be allowed to stabilize at this ambient temperature for a minimum of four hours.

At the conclusion of this exposure period and while at this temperature, heater voltage of 13.75 V shall be applied for a 150 + 10, - 0 seconds before application of anode voltage. This stability test shall be 3 minute duration to begin after 30 seconds of anode operation.

19. Stability shall be measured in terms of the average number of output pulses missing, expressed as a percentage of the number of input pulses applied during the period of observation. The missing pulses (MP) due to any causes, are considered to be missing if the RF energy is less than 70 percent of the normal energy level. The stability shall be measured when a VSWR of 1.5 minimum is introduced in the load at a distance of 1 ± 0.05 meters from the magnetron flange and the phase is adjusted at the start of each measurement interval to produce maximum instability. The missing pulse count shall be performed over a 3 minute test interval.

20. Cooling air shall be applied so that under the conditions of OSC (2) the temperature (TA) as measured at the indicated area per figure 1, shall fall between 30 and 100°C. After thermal equilibrium has been reached, measure and record the actual frequency. The tube shall then be allowed to cool with no voltages applied for at least 15 minutes before the following test. Anode voltage, as specified for OSC (2), shall be applied after a 150 +10, -0 seconds heater warm-up time. The frequency shall then be measured at approximately 3 minute intervals until 20 minutes has elapsed. A graph of frequency versus time shall be constructed using the data. The maximum frequency deviation from the previously recorded thermal equilibrium frequency shall not exceed the limit specified.

NOTES:

21. The salt solution concentration shall be 20 percent. The length of the salt spray test shall be 50 hours. Upon completion of test, salt deposits resulting from the exposure conditions may be removed by rinsing with tap water. The tuning mechanism may be completely cycled (cw and ccw) once prior to measuring static torque. There shall be no degradation outside of measurement accuracy of electrical characteristics.

22. The waveguide output flange and the high voltage input bushing shall be enclosed for the Humidity and Salt Spray tests.

23. Though the requirement exists continually from F1 to F2, tests shall be performed at the following frequencies:

F1 = 8500 ± 5 MHz
F2 = 9000 ± 5 MHz
F3 = 9600 ± 5 MHz

24. The radio frequency bandwidth and side lobes shall be within the limits specified when a VSWR of 1.5 minimum is introduced in the load at a distance of 1 ± 0.05 meters from the magnetron flange and the phase is adjusted at the start of each measurement to produce maximum degradation. A satisfactory spectrum is one whose slope does not change sign more than once for power levels greater than the specified db below its peak.

25. The seal formed by clamping the magnetron mounting plate against a suitable magnetron test fixture shall be hermetically tight for one minute minimum with the specified air pressure applied so as to surround the entire input bushing below the mounting plate.

26. The seal formed by clamping the magnetron output flange against a suitable magnetron test fixture shall be hermetically tight for one minute minimum with the specified air pressure applied internally to the test fixture.

27. The magnetron shall be capable of withstanding a heater surge current of 3.5 times the rated heater current.

28. The minimum air pressure to assure prevention of electrical breakdown in the output coupling shall be 15 psia for voltage standing wave ratios up to 1.5 with phase shift variable over 360 electrical degrees. The magnetron shall be coupled directly to UG-52 B/U choke flange modified so that mounting holes provide clearance for No. 8 bolts.

29. The modulator shall be such that energy per pulse delivered to the tube, if arcing occurs, shall not greatly exceed the normal energy per pulse. The tube heater shall be protected against arcing by use of a connector that places a minimum of 4000 pf across the heater directly at the input terminals.

TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 12 Of 24

Effective ________ Revision L

NOTES:

30. The AQL for the combined defectives for attributes in Quality Conformance Inspection Part 1, excluding inoperatives and mechanical shall be 1 percent. A tube having one or more defects shall be counted as one defective. Standard MIL-STD-105, Inspection Level II shall apply. For Part 2 the AQL percent defects shall be 6.5 percent, Inspection Level S3 shall apply.

Rejection and resubmittals shall be in accordance with MIL-STD-105, section 12.

31. Unless otherwise specified, all tests required by this specification shall be made under the following atmospheric conditions:

Temperature 25 $\pm$ 10°C
Relative Humidity 90% or less
Barometric Pressure - Local Standard

32. The power output shall be continuous over the range from F1 to F3. At no frequency in this range shall the power output be less than the specified values.

33. After the non-operational holding period of 168 hours minimum, the anode voltage shall be applied 150 + 10, - 0 sec. after the application of the standby heater voltage (Ef). The missing pulse count test interval of 3 minutes shall start immediately after the application of anode voltage.

34. For frequency modulation measurements during vibration, the maximum peak to peak frequency deviation shall not exceed the specifications. The test shall be run excluding thermal drift and pushing effects. The test equipment shall have a bandpass of 10 MegaHertz minimum at the 3 db points. Frequency modulation is defined as inter-pulse frequency changes, commonly called clatter.

35. In addition to regular markings the tuner dial settins for the following frequencies shall be marked on the tube. The accuracy of these settings shall be $\pm$ 5 MHz at the start of life under conditions of oscillation (2) with the anode temperature approximately 80°C as measured at the point specified on figure 1 when tuning is performed in the order of increasing the frequency.

Frequency MHz	Dial Setting	Frequency MHz	Dial Setting
8500	----	9150	----
8650	----	9300	----
8800	----	9450	----
9000	----	9600	----

36. At the completion of this test, the tube shall meet the power output and voltage requirements of oscillation (2) of the Quality Conformance Inspection, Part 1, and the tuner drive torque and backlash requirements of Part II.

37. The frequency obtained by turning the tuning shaft to a given angular position in one direction shall be reproducible within the specified limits when returning to that same position from the opposite direction after thermal equilibrium.

NOTES:

38. The tube shall meet the limit specified herein after it has been subjected to the shock and vibration tests.

39. DELETED.

40. DELETED.

41. Starting at F1 increasing to F3, then decreasing to F1, the frequency of the magnetron will be changed in 150 MHz increments after each 50 hours (approximately) of high voltage operation. The duration of the switching interval between Osc. (1) and Osc. (2) shall not exceed 5 seconds. The following cycle shall apply:

Condition	ib (a)	Ef (V)	Duration
Standby	0	13.75	2.5 min
Osc. (1)	27.5	0	25.0
Osc. (2)	27.5	0	25.0
Off	0	0	7.5

42. If during life test, the tube does not meet the specific limits, it shall be recycled for an additional five cycles. At such time, the tests shall be repeated. The tube will be considered satisfactory if it passes the second test.

43. At each of the dial settings and under the operating conditions specified in note 35, the measured frequency shall not differ from the stated frequency by more than the amount specified when tuning is performed in the order of increasing the frequency.

44. The pushing factor shall be measured in three steps, 4 amperes each (15a to 19a, 19a to 23a, 23a to 27a) and no value shall exceed the limits specified herein. The peak current through the magnetron shall alternately be the limits as specified under this test condition. These tests shall be run to exclude the effects of thermal drift and frequency instability not due to pushing.

45. The frequency deviation (maximum frequency minus minimum frequency) shall not exceed the stated limits when a VSWR of 1.5 minimum, introduced into the load at a distance 1 ± 0.05 meters from the magnetron flange, is varied throughout all phases.

46. The magnetron shall be mounted in a resonance free jig and vibrated with sinusoidal excitation in each of three mutually perpendicular planes through the following amplitudes for both resonance and cycling tests.

5 Hz to 20 Hz	0.1 inch D.A.
20 Hz to 35 Hz	2 G
35 Hz to 75 Hz	0.036 inch D.A.
75 Hz to 500 Hz	10 G

Cycling test: The frequency shall increase from 15-500-15 Hz with approximately logarithmic progression, and shall require approximately 15 minutes to

NOTES: (Cont'd)

traverse the range. This constitutes one cycle. The magnetron shall be vibrated for two such cycles in each of the three planes.

Resonance test: Mechanical resonant frequencies of the magnetron shall be determined during the cycling test. The cube shall then be vibrated at the two most severe resonant conditions for a period of 10 minutes each.

TEST SPECIFICATION

Varian/Beverly

Type No SFD-349 Page 15 of 24

Effective ______ Revision 6

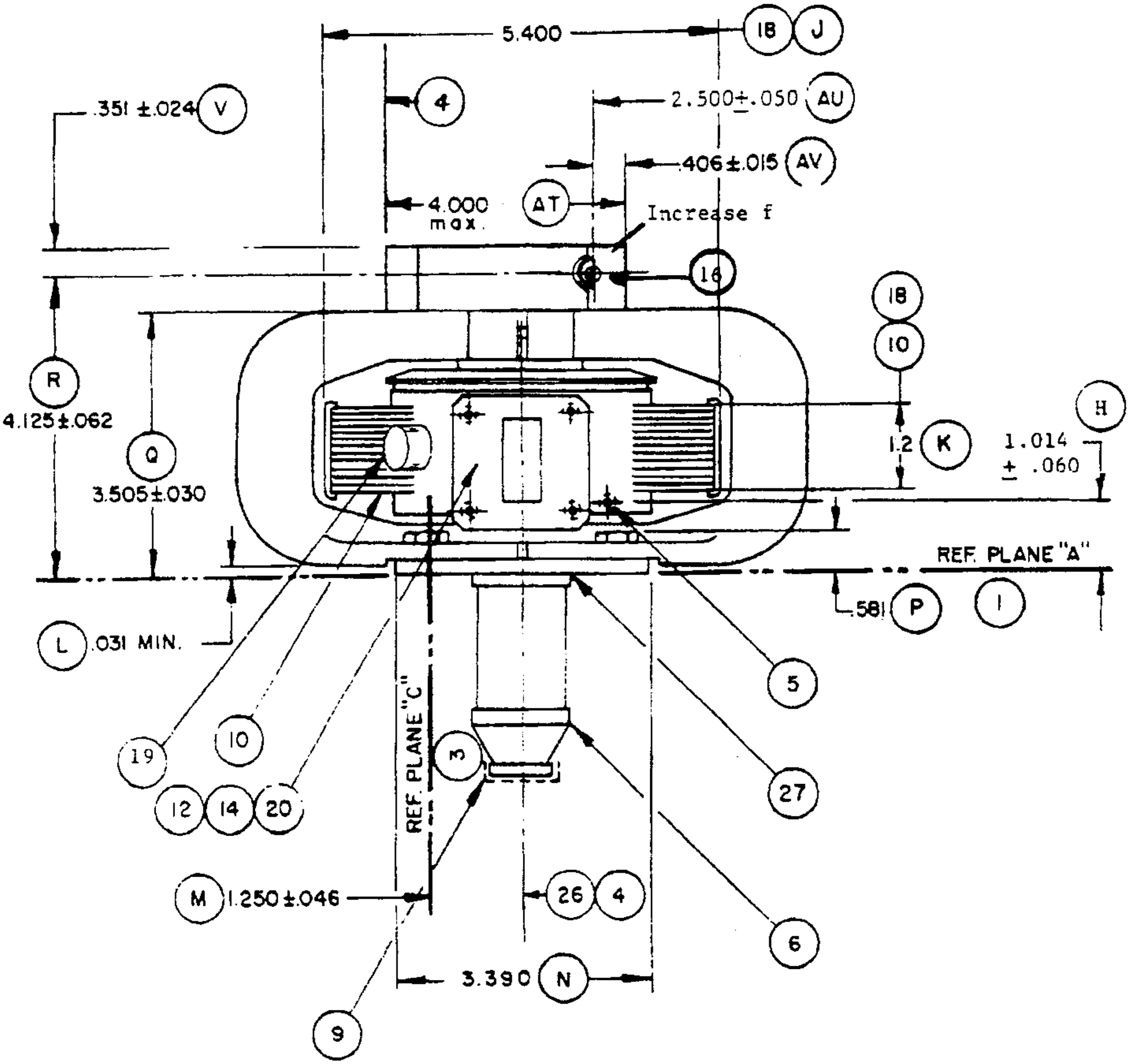

FIGURE 1a

JAYCOR
HPM OPERATION

OPERATIONAL MANUAL

SOLID STATE MODULATOR FOR THE BARON SYSTEMS RADAR

WARNING
INTERNAL VOLTAGES MAY CAUSE SEVERE SHOCK OR DEATH; USE CAUTION AND AVOID CONTACT WITH ENERGIZED COMPONENTS.

2186 EASTMAN AVE - SUITE 107, VENTURA, CALIFORNIA -93003
PHONE: 805 6508074 FAX: 805 6509275

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SECTION 1
GENERAL DESCRIPTION

1-1. INTRODUCTION
This manual contains information and procedures for operation of the Solid State Modulator for use in the Baron Transmitter using the Varian SFD-349 Magnetron.

The manual is organized into three sections as follows:

1-2. GENERAL DESCRIPTION
A Solid State Modulator, figure 1-1, The Solid State Modulator in essence is a Hard Tube Modulator which uses low voltage IGBT switches and pulse transformers to drive SFD-349 Magnetron at the proper operating voltage of 25 kV. The SFD-349 coaxial magnetron will generate high-power microwave RF pulse energy in the frequency range of 8.5 to 9.6 GHZ with a peak power output of a minimum of 250 kilowatt. It is driven by a JAYCOR Solid State Modulator which will drive the magnetron with proper pulse widths and at a repetition frequency as directed by the external pulse groups. The duty cycle for the transmitter is limited 0.0011 as dictated by the magnetron specification. Protective circuitry will protect the magnetron by not allowing R.F. pulses to be generated at a combination of pulse width and rep rate not to exceed the .0011 duty. The magnetrons output frequency is adjusted manually.

Primary power is 220VAC, 60 Hz, 1 phase and is connected to the Transmitter through connector TB3 . The remote control signals from the host system is on connector J 2 and J3. J4 , BNC, is a pulse representing the magnetron peak current . Cooling for the emitter is provided by internal fans. The fans circulates cooling air over plenums and heatsinks.

1.3 REQUIREMENTS

TRANSMITTER SPECIFICATION:

Magnetron: SFD-349 or equivalent—8.5 to 9.6 GHZ
Magnetron Input: 25 kV, 26 amps (Nominal)
Peak RF Power: 250kw

Pulse Widths (measured at -3 dB power points):

a. 0.5
b. 1.00
c. 2.00

Rise Time: equal to or less than 100 NSEC (measured between the 10 and 90% power points):

Fall Time: Less than 200 NSEC (measured between the 90 and 10% power points):

<u>Output Requirements</u>:

Stability: 0. 1 dB, Pulse to Pulse

Spectrum: Side lobes greater than 12 dB down

<u>NOTE: -</u> **The modulator will be capable of delivering the correct pulse stability and power to permit the necessary RF source performance. Maximum duty cycle will be limited by modulator circuitry.**

Output Pulse Variation: Less than 1% at any combination PRF, Pulse Width and Pulse Code

Jitter: Less than 3 NSEC, RMS (Referenced to Input Trigger)

Delay Stability: Less than .1 usec after warm-up (One-half hour)

Duty Cycle: <u>MAGNETRON IS .0011</u>

<u>NOTE:</u> **The modulators will employ magnetron "over duty" protection. <u>JAYCOR will drop pulses when the duty cycle Is exceeded, thus maintaining the maximum duty cycle</u>. A fault light will alert the operator of the over duty.**

Modulator Output: Output to the magnetron will approximate 250 kilowatts. Output Pulse Amplitude (Negative Pulse) shall be adjustable to a preset value between 22 to 26KV. A softstart build up of the operating voltage to the magnetron is preset and this shall occur during the first ten seconds after transmitter HV turn-on. Typical operating conditions require a pulse of 25

	KV at 26 amperes.
Filaments:	Standby: 13.75 volts, 3.6amps: Operate: Down to "0" volts at full duty
Input Trigger:	10 to 15 volts level signal with a pulse width of .5 usec to 2 usec via BNC connector. 50 ohm load
Output Connections:	The Magnetron shall be connected directly to the Pulse Transformer using the 6 inch long leads provided with the magnetron..
HVPS Regulation:	The output voltage regulation over the Modulator duty cycle range to .0011 shall be better than 1.0 percent. Output ripple shall be less than 0.1 percent, and recovery from a 50 percent transient spike on the load shall not be greater than 3 milliseconds.

OTHER CONSIDERATIONS:

Altitude:

Operating .... To 10,000 Feet

Ambient temperature: .... - 40C to +55 degrees C

Humidity................................ 95 %, non-condensing

Cooling................................ Internal, forced air

Dimensions:

Height........ 19.25....... inches

Width......... 16.00...... inches

Depth....... 27.25....... inches

Transmitter Weight: .... 50 pounds with Magnetron

TABLE 1.1

CONTROL INPUT/OUTPUT LINES/CONNECTOR TYPE

INPUT CONNECTOR FOR SINGLE PHASE 208VAC - MS3112E16-8P (J1)
PIN A - PHASE A
PIN H - NEUTRAL
PIN G - GROUND

CONNECTOR UG291B (BNC) (J3) - COMMAND PULSE
0-10V LOGIC PULSE INPUT FOR MODULATION

CONNECTOR UG291B (BNC) (J4) - MAGNETRON CURRENT
VOLTAGE PULSE REPRESENTING MAGNETRON PEAK CURRENT

INTERFACE CONNECTOR M24308/3-2F (J2)

PIN 1 - RESET COMMAND
ACTIVE HIGH, 10-28V INPUT, OPTO-ISOLATED

PIN 2 - SUMMARY FAULT
ACTIVE HIGH, 10-15V TOTEMPOLE OUTPUT (VCC), OPTO-ISOLATED

PIN 3 - BUSS VCC
10-15VDC TO POWER THE OPTO-COUPLERS

PIN 4 - FILAMENT VOLTMETER (15Volts, Full Scale)
0-1MA CURRENT OUTPUT FOR METER MOVEMENT, INDICATING FILAMENT VOLTAGE

PIN 5 - HV POWER SUPPLY CURRENT METER (1.0 Amps, Full Scale)
0-1MA CURRENT OUTPUT FOR METER MOVEMENT, INDICATING MODULATOR CURRENT

PIN 6 - HV POWER SUPPLY VOLTAGE METER (2000 VOLTS, Full Scale)
0-1MA CURRENT OUTPUT FOR METER MOVEMENT, INDICATING OUTPUT VOLTAGE

PIN 7 - MAGNETRON CURRENT METER (50 ma , Full Scale)
0-1MA CURRENT OUTPUT FOR METER MOVEMENT, INDICATING AVERAGE MAGNETRON CURRENT

PIN 8 - GROUND
RETURN FOR METER CIRCUITS, TRANSMITTER GROUND

PIN 9 - HV ON/RADIATE COMMAND

ACTIVE HIGH, 10-28V INPUT, OPTO-ISOLATED
PIN 10 - FILAMENT READY
ACTIVE HIGH, 10-15V TOTEMPOLE OUTPUT (VCC), OPTO-ISOLATED, INDICATING FILAMENT WARM-UP DELAY IS COMPLETED

PIN 11 - MAGNETRON AIR FLOW
SWITCH CONTACT TO GROUND INDICATING MAGNETRON COOLING AIR FLOW

PIN 12 - N/C

PIN 13 - BUS RETURN/BUS COMMON
RETURN VOR VCC IN, COMMON FOR COMMANDS

PIN 14 - AC ON
ACTIVE HIGH, 10-28V INPUT, OPTO-ISOLATED

PIN 15 - N/C

NOTE: THE COMMAND AND STATUS SIGNALS ARE ISOLATED FROM THE TRANSMITTER GROUND BY OPTO-COUPLERS. THE STATUS SIGNAL (SUMMARY FAULT AND FILAMENT READY) OPTO-COUPLERS ARE POWERED BY THE EXTERNAL BUSS VCC VOLTAGE, WHICH SHOULD BE +10-15VDC (20V MAX). THE POWER RETURN IS BUS RETURN/BUS COMMON, WHICH IS ISOLATED FROM THE TRANSMITTER GROUND.

The Front Panel has the following meters:

FILAMENT VOLTMETER – 15 volts Full Scale

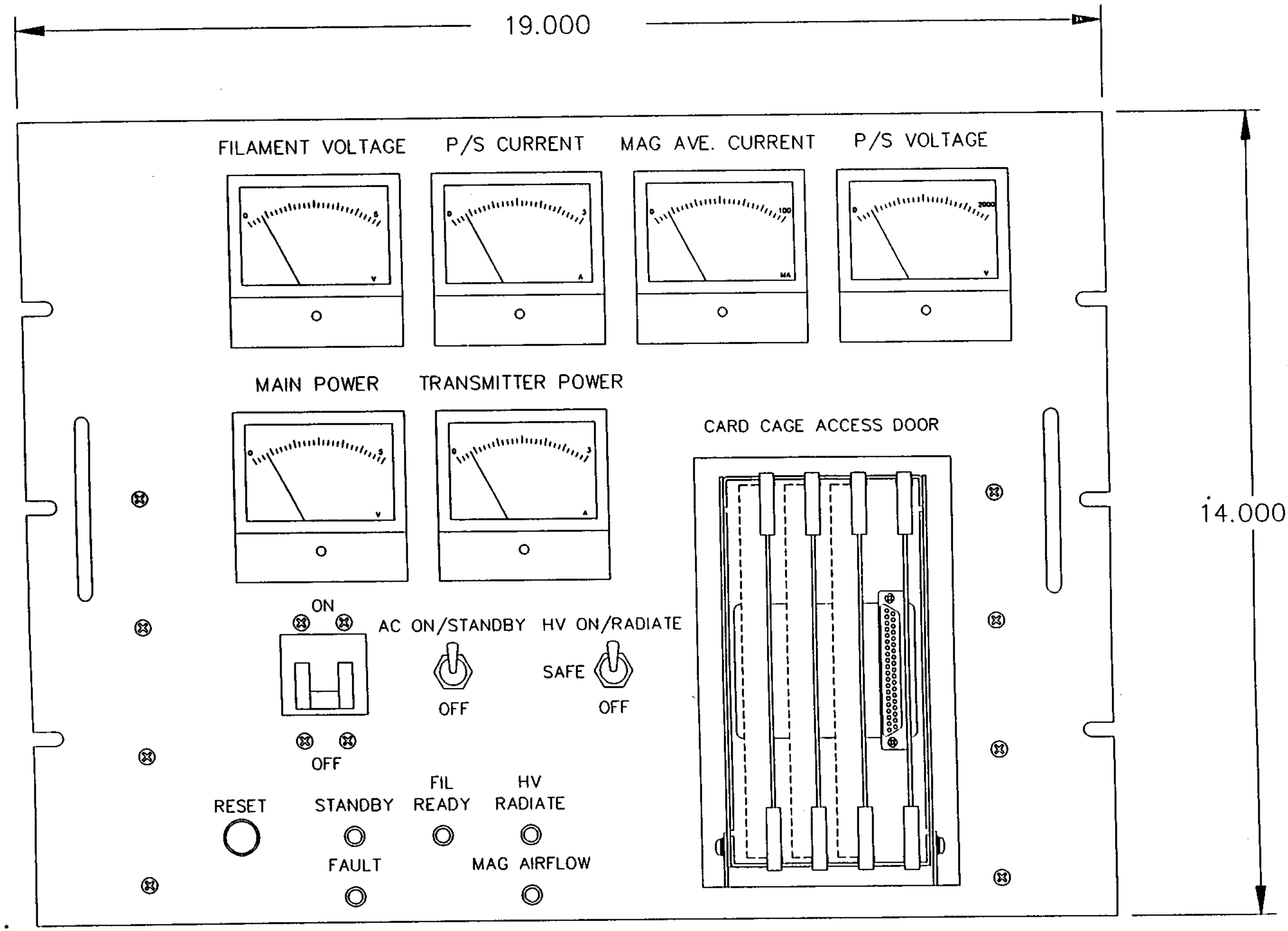
HV POWER SUPPLY CURRENT METER – 1.0 Amps Full Scale

HV POWER SUPPLY VOLTAGE METER – 2000 volts Full Scale

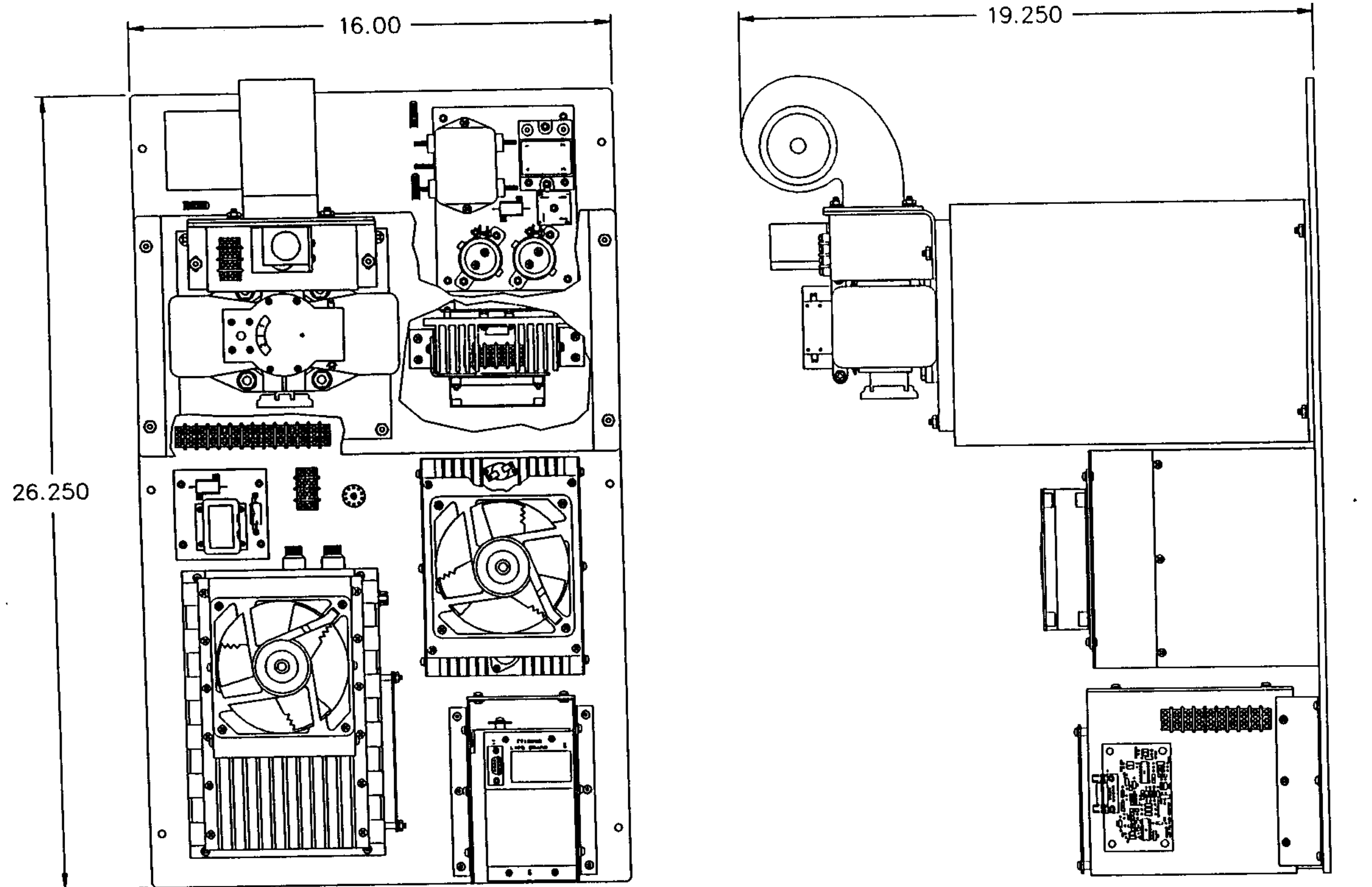
MAGNETRON CURRENT METER – 50 ma Full Scale

AC INPUT VOLTS – 220VAC – SYSTEM POWER

AC INPUT VOLTS – 220VAC – TRANSMITTER POWER


19.000
14.000
FILAMENT VOLTAGE
P/S CURRENT
MAG AVE. CURRENT
P/S VOLTAGE
MAIN POWER
TRANSMITTER POWER
CARD CAGE ACCESS DOOR
ON
OFF
AC ON/STANDBY
OFF
HV ON/RADIATE
SAFE
OFF
RESET
STANDBY
FIL
READY
HV
RADIATE
FAULT
MAG AIRFLOW

ZONE	REV	DESCRIPTION	DATE	APPROVED
	-	INITIAL RELEASE	12/22/97	



JAYCOR, HPM DIVISION

XBAND XMTR OUTLINE

DRAWN	K KOENIG 12/22/97
SIZE	C
DWG NO	BA9000
REV	–
SCALE	NONE
SHEET	1 OF 1

DO NOT SCALE DRAWING

NEXT ASSY	USED ON
APPLICATION	

SECTION - 2
PREPARATION FOR USE

2-1. INTRODUCTION

This section contains unpacking, inspection and installation instructions for a Solid State Modulator/Transmitter for use with Baron Services Radar.

2-2. UNPACKING AND INSPECTION

The ASSEMBLY is shipped in one container; carefully open the container and remove the Modulator assembly. Visually inspect Modulator for damage that may have occurred during shipment. Check for evidence of water damage, bent or warped chassis, loose screws or nuts, or extraneous packing material in connectors or air vents. Inspect all connectors for bent connector pins. Inspect all connectors on the card cage to be sure that the PCB's are properly seated and securely connected. After inspection, the SFD - 349 Magnetron is ready for **MOUNTING TO MODULATOR , Transmitter should be tested with dummy load prior to Radiating from the Antenna.**

CAUTION

Exercise care in handling equipment during inspection to prevent damage due to rough or careless handling.

2-3. INSTALLATION

The Transmitter assembly is designed for mounting on a flat stationary surface. Cooling for the Transmitter is provided by internal fans. Be sure when mounting into enclosure that enough cooling air is allowed from the intakes and also provisions are made for exhausting hot air.

TO INSTALL THE TRANSMITTER, PROCEED AS FOLLOWS:

- Install Transmitter and secure with (6) - 6/32 mounting bolts where indicated by the configuration drawing.

NOTE

Be sure that the Transmitter is mounted close enough to the host equipment to prevent stress on the interconnecting cables.

- Refer to figure 2-1 for location of Transmitter connectors and connect to power lines and host console with interconnecting cables.

- **After the magnetron and dummy load is installed**, Refer to paragraph 2.4, run minimum performance tests to ensure that the Transmitter meets performance standards.

2.4 Installation Performance Check Out:

1. Insure Dummy Load is connected to transmitter RF Output Port
2. Place unit into standby operation, External trigger Pulse Train should be set for 1 usec PW at 500 Hz PRF. Modulator is awaiting 5 minute time out.
3. Verify Filament Voltmeter indicates approximately 13.75V.
4. After time out switch unit into radiate. Verify power supply meter ramps up to approximately 1200V and power supply current meter and magi average current meter have an indication.
5. While monitoring detected RF on oscilloscope change external settings PW to 2.0 usec and PRF to 250 PPS. Verify waveform is to specification and **flat across the top**. If not adjust CCA A4A5 R2 for a flat response.
6. If all tests have passed, shut down transmitter and remove dummy load. Connect transmitter RF output port to the antenna waveguide system.

SECTION 3
PRINCIPLES OF OPERATION

3.1 INTRODUCTION

This section contains a functional description of the Solid State Transmitter. A glossary of interface signals is provided in Table 1-1, page 1-4.

Other sections give functional descriptions of the assemblies that make up the Transmitter Group. The schematics for each of the assemblies can be found in the back of the manual.

3.2 SYSTEM FUNCTIONAL DESCRIPTION

The Transmitter employs a SFD-349 pulsed magnetron. The tunable magnetron operates in the frequency band of 8.6 to 9.2 Ghz. The magnetron RF output frequency is set by manual control. The magnetron will generate peak RF power of 250 Kilowatts Peak. Besides the magnetron, the Transmitter has the following Sub – Assemblies.

1. Rectifier Filter (A1) BA15000
2. 28vdc & Bias P.S. (A2) RC2003
3. Filament P.S. (A3) RC4000
4. Card Cage Assy (A4) RC7000

   4.1 CCA Control Conditioner (A4-A4) TT 21000
   4.2 CCA Interface & Control (A4-A5) RC 2004
   4.3 CCA Master Regulator (A4-A6) FPQ 1104
   4.4 Low Voltage Monitor (A4-A1) RC 2002
   4.5 Low Voltage P.S. (A4-A2) TT 10600
   4.6 Extender Board (A4-A3) TT 20200

5. DC-DC P.S. (A5) RC3000
6. Modulator Assy (A6) BA-16000

   6.1 IGBT Assy (A6-A3) RC5500
   6.2 IGBT Driver (A6-A1) TT10210
   6.3 Oil Can Assy (A6-A2) BA16500

7. Reset Circuit (A7) BA 17000

The RF output pulse width and PRF are controlled by an external pulse train supplied by the host system. The Transmitter is designed to operate at a pulse or pulse code repetition frequency (PRF) of 250 to 1200 Hz , Pulse Widths of .5, 1.0, 2.0 usec. and limited to a maximum duty cycle of .001 and 1200 PPS.

Cooling for the Transmitter is provided by internal fans .

3.3 SYSTEM OPERATION

When the Power circuit breaker is On and Standby is selected, filament voltage is applied to the magnetron by an AC (3.8 kHz nominal) square wave, isolated from the high voltage pulse by a specially designed transformer. After a warm-up period of 5 minutes, the Transmitter will indicate Filament Ready and will switch to the HV/Radiate mode if it has been selected. The magnetron will operate at the PRF and pulse width as received by external trigger.

When the magnetron starts pulsed operation, the peak current is sensed and converted to an average current for scheduling the filament voltages for proper magnetron operation. As the duty cycle is increased, the filament voltage is reduced. This type of scheduling allows the transmitter to be operated at different duty cycles without concern for damage to the magnetron. The average operating current of the magnetron is monitored by the Interface & Control Card (A4A5).

The primary 220 VAC is rectified and filtered to an unregulated voltage of 270V DC. The unregulated 270 VDC is boosted and regulated to a nominal voltage of 1240 volts by the DC-DC Converter (A5). The HVPS remains off until warm-up is complete and the HV/Radiate mode is manually selected, by the operator, in concert with the selected repetition rate and pulse width. The high voltage is then ramped to the proper preset operating point in a period of 10 seconds. Master regulator circuit card assembly A4A6 maintain the DC voltage at a prescribed level by pulse width modulating the DC/DC converters drive pulses. It is advantageous to ramp the DC voltage, which in turn slowly increases the peak current to the magnetron. This enhances the magnetron reliability and also helps burn out any gases that may have built up if the magnetron has not been used for a period of time. Ramping the voltage allows the magnetron to be turned on at its minimum operating current and slowly increased to the peak operating current.

The external generated pulse is processed and amplified by the control/conditioner CCA (A4A4) then fed to the IGBT Driver/Modulator assembly (A6). The Control/Conditioner monitors the input pulse train. to keep the magnetron duty cycle from exceeding its limit of 0.001. When the duty cycle is exceeded, the circuitry on (A4-A5) drops out pulses to maintain the duty cycle at 0.001.

When the IGBTs are driven on they apply a nominal 1220 volt pulse to the primary of the pulse transformer. The secondary of the pulse transformer applies a nominal operating voltage of 25,000 volts to the magnetron at the specified rate of rise of voltage to assure its proper operation.

3.4 <u>28 VDC AND BIAS POWER SUPPLY CCA (A2)</u>
This chassis mounted assembly contains two DC-DC converters that are powered by the unregulated 270 VDC. The 28 VDC converter is used to drive the programmed filament power supply A6 and LVPS A5. The 3.3 VDC Bias converter supplies reset current via A7 and L1 to the pulse transformers in the Oil Can Assembly A6-A2.

3.5 <u>FILAMENT POWER SUPPLY ASSEMBLY (A3)</u>
The power supply pass and switching transistors are mounted through a heat sink to the CCA. The assembly has a small fan to ;help dissipate the 50 watts of loss. The power supply comprising a linear regulator and push-pull transformer driver is controlled by the Interface and Control and Monitor CCA A4A5. The Filament transformer is located in the Oil Can Assembly A6A2. The transformer driver operates at 3.8 KHz and is current limited. The filament transformer output is 13.75 VAC rms.

3.6 CARD CAGE (A4)

The Card Cage houses the following " plug-in " circuit card assemblies (CCA):

- Master Regulator CCA (A4A6)
- Control Conditioner CCA (A4A4)
- Interface and Control CCA (A4A5)
- Extender Board (A4A3)

The LVPS CCA (A4A2) is mounted onto the left side of the Card Cage and the Standby P/S, LV Monitor And Relay CCA (A4A1) is mounted onto the back of the Card Cage.

3.7 MASTER REGULATOR CONTROL CCA (A4A6)

The DC-DC Converter is configured as a current mode buck regulator with a push-pull inverter output. A pair of Pulse Width Modulator (PWM) ICs generate the regulator and inverter FET gate drive pulses. Circuitry monitors the output current for a fault condition and produces outputs for the panel meter.

3.8 CONTROL CONDITIONER CCA (A4A4)

The command pulse is monitored by the duty cycle limiter circuit. The circuit is an integrating limiter. When the voltage on the capacitor is charged to the comparator limit, the pulses are inhibited for approximately 1.8 ms which can limit pulse widths as well as drop whole pulses. The duty cycle limit is set to .0011 to guarantee operation at .0010. Because there is a finite rise time and magnetron turn-on delay, the generated pulse must be stretched to obtain the proper RF pulse width. The compensation circuit adds approximately 300 ns to the pulse width.

The output buffer amplifiers drive the shielded lines that go to the IGBT Driver CCA (A6A1) The Mod Pulse turns on the main IGBTs and the End Pulse, that is generated by the trailing edge of the Mod Pulse, helps turn off the main IGBT.

The CCA has a Test switch that can be used to disable the IGBT gate drive pulses while the high voltage is on or enable the pulses without the high voltage being on. A LED on the CCA indicates if the switch is not in the Normal position.

3.9 INTERFACE AND CONTROL CCA (A4A5)

The Interface and Control CCA performs eight functions:

1. Isolation of the external control and status signals from the Transmitter to ground.
    - This is accomplished by using optocouplers.
2. Generation of the 10 second ramp that controls the High Voltage Power Supply. (HVPS)
3. Monitoring of the actual HVPS output to insure that the output is lass than 1925volts and at least 90% of the programmed voltage.
4. Monitoring of the peak magnetron current
    - If the peak magnetron current exceeds the normal operating current by 25%, the pulse is terminated. If there are two successive over current pulses, a magnetron current fault is generated and the radiate command is terminated.
5. Automatically resetting the magnetron current fault.
    - The circuitry will reset the fault three times, after that the fault has to be manually reset.
6. Automatic programming of the filament voltage based on the magnetron average current.

7. Filament warm-up time delay when the AC voltage is first applied.
8. Fault logic used to protect the transmitter.

The Interface and Control CCA has three adjustments which are as follows:

- High Voltage
- Maximum Magnetron Current (Fault Threshold)
- Filament Program Slope

The CCA also has a three position test switch which allows:

1. "TEST" —The modulator IGBT gate drive to be enabled without having to wait for the filaments to time-out. This is an aid in troubleshooting.
2. CENTER – "OFF" —Will disable the gate drives with the HVPS "On".
3. "ON" – Allows normal operation.

<u>CAUTION:</u> <u>ONLY in the "Normal Operation Mode" can the transmitter emit R.F.</u>

The Interface and Control CCA has 10 LED indicators which are as follows:

- DS2. H.V. Over Voltage Fault
- DS3. H.V. Under Voltage Fault
- DS4. Modulator (HVPS) Average Current Fault
- DS5. Magnetron Peak Current Fault
- DS6. In Test Fault. (Test switch not in "normal operate" position)
- DS7. HV On/Radiate (Green)
- DS8. Filament (under) Current Fault
- DS9. Filament Ready (Green) , Time out Complete.
- DS10. Low Voltage Fault
- DS11. Temperature Fault

All LED indicators are "RED" unless otherwise noted.

3.10 LOW VOLTAGE POWER SUPPLY CCA (A4A2)

The chassis mounted Low Voltage Power Supply contains two DC-DC converters which provide three independent output voltages of +/-15 V DC and +5 V DC.

3.11 LOW VOLTAGE MONITOR (A4A1)

The (LVMB) samples the following voltages:

- +5 vdc
- +15 vdc
- -15 vdc
- +28 vdc
- +3.3 vdc

If any of these voltage are out of tolerance, a Low Voltage fault signal is sent to (A4-A5) CCA

3.12 DC TO DC CONVERTER(A5)

The DC to DC Converter is the line/load regulator and receives the unregulated 270 VDC output from the rectifier/filter.

CAUTION: The 270 VDC is not referenced to ground.

The DC to DC Converter contains a Buck regulator and a push-pull inverter that provides the step-up in output voltage and the necessary isolation between the primary AC input lines and the rest of the system. The DC to DC Converter has three current sense transformers, which are as follows:

- **REGULATOR**
- **INVERTER**
- **OUTPUT**

The sensed regulator current is used by the regulator IC to control the voltage feedback loop. The Inverter current is monitored to limit the transformer primary current. The output current is filtered and buffered to drive the panel meter and monitored for high average current.

3.13 MODULATOR ASSEMBLY (A6)

The modulator Assembly has five major components or assemblies which are as follows:

- **CAPACITOR BANK**
- **IGBT DRIVER CCA**
- **IGBTS**
- **SNUBBER ASSEMBLY**

The Capacitor Bank supplies the peak current drawn by the IGBTs when they are driving the primary of the HV pulse transformer. The IGBT Driver CCA is the interface between the PRF and Pulse Width Conditioner on CCA (A4-A4) and the IGBTs. The IGBT Driver CCA output uses a low leakage inductance pulse transformer to isolate and drive the gates of the IGBTs. The Mod Pulse turns on the IGBTs and the End Pulse helps turn off the IGBTs. The Snubber Assembly absorbs the inductive energy left in the primary of the HV pulse transformer at the end of the pulse.

3.14 OIL CAN ASSEMBLY (A6-A2)

The Oil Can Assembly contains the HV pulse transformer, filament transformer and the pulse shaping network. Also, there is a current sense transformer to monitor the magnetron current. The HV pulse transformer has a reset winding that when biased with a direct current allow a larger flux swing (volt microsecond product).

3. 15 RESET CIRCUIT (A7)

The Reset Circuit is comprised of resistor (R2) and inductors (L1) that provides a constant reset bias current for the pulse transformer. The 3.3V converter on the A2 CCA supplies the power and the current is set by the resistor.

3.16 OVER-TEMPERATURE PROTECTION

The Transmitter contains two thermostats; one mounted on the DC/DC Heatsink and one mounted on the Modulator Assembly Heatsink. The thermostat contacts are normally closed, and open when the transmitter internal operating temperature exceeds 95 degrees C. When an over-temperature occurs, one or more of the thermostats will open and generate a fault signal on the Fault Interface CCA A4-A5. When an over temperature fault occurs, the logic disables the HV/Radiate command. When the open thermostat is sufficiently cooled, it will reset (close) and the transmitter will automatically initiate HV ramp-up and radiate.

3.17 MAGNETRON ASSEMBLY (V1)

The magnetron generates a pulsed RF output of 250kw. The magnetron is manual tunable from 8.5 to 9.6 Ghz.

SECTION - 4
OPERATING INSTRUCTIONS

4.1 INTRODUCTION

This section contains operating instructions for the Solid State Modulator using a "X" Band, SFD-349, 250kw Magnetron for the Baron Systems Radar. The Transmitter has a control panel for local operation and an I/O interface for remote control by a host system.

4-2. CONTROLS AND INDICATORS

The location and function of all controls and indicators on the modulator assembly are shown in figure 4-1 and are described in table 4-1.

TABLE 4-1.

TRANSMITTER CONTROLS AND INDICATORS

Name	Function
	OPERATING MODE CONTROLS/INDICATORS
AC POWER: (CB1)	Load protection for primary 220VAC power source. Circuit Breaker (CB1)Opens if transmitter exceeds normal load. Turn "OFF" then back "ON" to reset.
OFF/STANDBY: (Switch. S1)	In OFF position, AC voltage to the transmitter is off. In STANDBY position, AC voltage is applied to transmitter Power supplies and power is applied to all control circuits and magnetron filaments. In "Standby" , with the filaments warming -up the triggers are inhibited. (Local mode only)
MAIN POWER (Meter. M1)	Used to indicate the AC input voltage The nominal indication is 230 VAC.
P/S VOLTAGE (Meter. M6)	Allows the operator to check the voltage from the power supply. Will be in the range of 1200 to 1400 VDC.
P/S CURRENT (Meter. M4)	Gives the operator a indication of the proper operation of the Transmitter. The maximum high voltage power supply current is .8 Amps.

FILAMENT VOLTAGE (Meter. M3) Let s the operator know what the voltage on the filaments are at standby and when in "RADIATE" to see if the filaments are being programmed properly. The standby voltage is 13.75 volts.

TRANSMITTER POWER (METER M2) Indicates the transmitter AC voltage is "ON" and the transmitter is in Standby awaiting time-out. The nominal indication is 230VAC.

FAULT (Indicator.DS3) Indicates one or more faults exist. The fault(s)will be indicated on the Control/Conditioner CCA (A4A4) and Interface Control CCA (A4A5) by edge mounted LED's

STANDBY (Indicator. DS2) Green LED: When lit, indicates that power is applied to the transmitter control circuits and filaments.

MAGNETRON AIRFLOW (INDICATOR, DS4) Indicates magnetron cooling air is restricted or the Blower has failed

MAGNETRON AVERAGE CURRENT: (Indicator, M5) The Meter is a indication of average R.F. power and the meter is calibrated for 50 milliamps full scale.

FILAMENT READY (Indicator, DS2) GREEN LED , When lit, indicates that the transmitter has completed the warm-up cycle.

HV RADIATE - (Indicator DS5) When RADIATE is selected, the green HV / Radiate LED will be illuminated and the average current meter will indicate that R.F. is being emitted.

PULSE WIDTH AND REP RATE IS SUPPLIED EXTERNALLY THROUGH THE BNC CONNECTOR. THE TRANSMITTER IS SET FOR .5 USEC TO 2 USEC PULSE WIDTH AND A REP RATE FROM 250 TO 1200 PPS.

RESET (Switch S2) **Depressing the push button will clear the latched faults.**

FAULT INDICATORS:

TEMPERATURE - Indicator (DS11) RED LED Indicates modulator/power supply heatsinks over temperature.

FILAMENT CURRENT - Indicator (DS8) RED LED Filaments not connected or filament supply not operating correctly.

DUTY CYCLE - Indicator (DS3) — YELLOW LED Duty cycle exceeded, (pulse width x rep rate) and pulses are being dropped. (Warning Only)

POWER SUPPLY OVER CURRENT - Indicator (DS4) — RED LED Indicates the DC to DC converters has exceeded it rated output current.
(THIS FAULT IS LATCHED)

LOW VOLTAGE POWER SUPPLY – Indicator (DS10) — RED LED indicate one or more of the voltages are under voltage.

MAGNETRON PEAK CURRENT - Indicator (DS5) — RED LED Indicates the peak current has exceeded 33 amps for two pulses in a row.
(THIS FAULT IS LATCHED)

CONNECTORS

TB3 MAIN POWER — Screw Terminal Block. Receives 230 VAC and out put Load.

J2 INTERFACE CONNECTOR

J3 COMMAND PULSE

J4 MAGNETRON CURRENT SAMPLE

WAVEGUIDE — WR- 112 Waveguide flange. Will have a gasket and FLANGE protective cover for shipping and storage.

4-3. OPERATING PROCEDURES

To operate the emitter, proceed as follows;

1. Air flow is important for proper cooling, make sure that the intake and exhaust outlets have no obstructions.

2. Check to be sure that RF power output Waveguide is properly connected . Check to be sure that all transmitter power and I/O cables are properly connected to the host system.

3. Refer to fig 4.1 On the transmitter control panel, turn " ON " the power with CB1 and be sure (OFF/SAFE/HV RADIATE) to (SAFE) position.

4. Set OFF/STANDBY switch to STANDBY position. The STANDBY indicator on the transmitter control panel should be lit and the internal cooling fans should operate.

5. Set the RF frequency adjustment on the magnetron for the desired output frequency .

NOTE:

THE TRANSMITTER WARM-UP CYCLE TAKES APPROXIMATELY 5 MINUTES. WHEN THE WARM-UP CYCLE IS COMPLETE, THE FILAMENT/ READY INDICATOR WILL BE LIT.

6. Set OFF/SAFE/RADIATE switch to HV/RADIATE position and observe the magnetron average current. The Average current meter will indicate the average R.F. Power.

SECTION 5

MAINTENANCE

5-1. INTRODUCTION

This section contains periodic maintenance, test and trouble analysis procedures for the Solid State Transmitter located in the Baron Radar System. It also contains a description of test equipment required to perform the identified tasks.

5-2. PERIODIC MAINTENANCE

Periodic maintenance requirements and the intervals at which the tasks should be performed. are listed in Table 5-1

CAUTION
WEAR PROPER EYE PROTECTION TO AVOID EYE INJURY WHEN USING COMPRESSED AIR

TABLE 5-1. PERIODIC MAINTENANCE

TASK	INTERVAL	ACTION
Clean magnetron cooling fins, Cathode Stem	6 Months	
Power and Pulse Width Check	As required	Check power and pulse width per paragraph 5-4.

WARNING

INTERNAL VOLTAGES MAY CAUSE SEVERE SHOCK OR DEATH. USE CAUTION AND AVOID CONTACT WITH ENERGIZED COMPONENTS.

CAUTION

INTERNAL VOLTAGES MAY ALSO CAUSE ARCING AND BURNS. REMOVE ALL JEWELRY WHICH MAY CAUSE SHOCK OR HAZARDS.

5-3. INSPECTION AND CLEANING

Inspection and cleaning should be performed every six (6) months. If the transmitter is operated in a severe dust environment, perform inspection and cleaning more often.

MAKE SURE THE CIRCUIT BREAKER IS OFF AND THE OFF/SAFE/HV RADIATE SWITCH IS IN THE SAFE POSISTION

Remove covers as necessary so cooling fans and interior of transmitter can be inspected for dirt and dust. Inspect and if necessary, clean the fan blades. If dust and dirt are allowed to accumulate, the cooling efficiency may be diminished.

Using either compressed air or a brush with soft bristles, loosen and remove accumulated dust and dirt from the air vents (if added) and fan blades.

After completion of inspection and cleaning, return the "Off/Safe/HV Radiate" and "Off/Standby switches to the "OFF" posistion.

5-4. POWER AND PULSE WIDTH OUTPUT CHECK

To check the transmitter RF power output and/or pulse width, the following equipment and procedures are recommended:

1. Connect appropriate test equipment to external RF MONITOR connector. Use any combination of the following test equipment available to monitor the RF output.
    a. Spectrum analyzer
    b. RF Crystal detector and Oscilloscope.
    c. Peak Power Meter.

2. Generate required PRF and pulse width
3. Activate Transmitter and select LOCAL/RADIATE modes of operation.
4. Check power and if necessary adjust the H.V. is set for the flattest response on the Detected .RF. at the 2.0 usec setting.

5.5 REMOVAL OF MODULES

Procedure #1 - Standby Power Supply Low Voltage Monitor (Removal)

1. Remove 4 mounting screws on A2.
2. Loosen 2 captive screws on A2J1.

Procedure #2 - DC-DC Converter A5 (Removal)

1. Loosen 2 captive screws on assembly's J1.
2. Remove 4 mounting screws from underside of drawer.
3. Disconnect black and white output cables from TB2.

Procedure # 3 - Modulator Assembly A6 Removal)

1. Remove 4 mounting screws underneath shelf.
2. Disconnect black and white high voltage cables.
3. Disconnect J1 and P1 from module.
4. Remove 6 screws on upper and lower interconnecting bars to oil can.

Procedure #4 - Filament P/S A3 (Removal)

1. Loosen 2 captive screws on A6 J1.
2. Remove 4 mounting screws on power supply brackets.

Procedure #5- Low Voltage Power Supply A4A2 (Removal)

1. Remove card cage cover panel.
2. Loosen 2 captive screws on A5J1.
3. Remove 4 screws on A5 module.

Procedure #6- 28Volts and Bias Power Supply A2 (Removal)

1. Loosen 2 captive screws on A4J1.
2. Remove 12 screws on both power supply modules.
3. Wipe terminal compound off yourself.

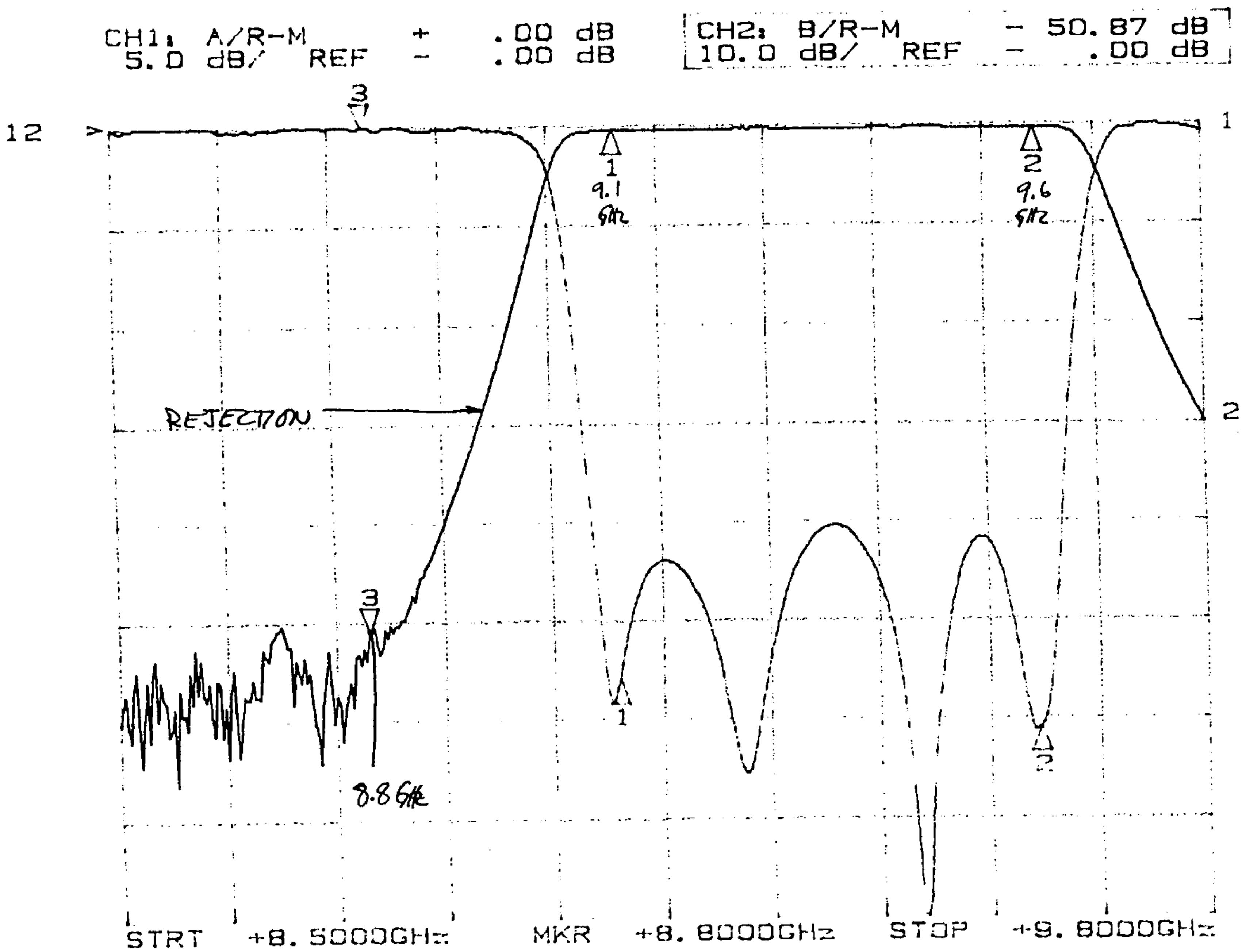
Procedure #7- Magnetron (Removal)

1. Remove 2 screws on magnetron return cable strap.
2. Remove J1 and J2 from the oil can. (Fig. 1, Ref. 2)
3. Remove 8 screws on the magnetron output flange.

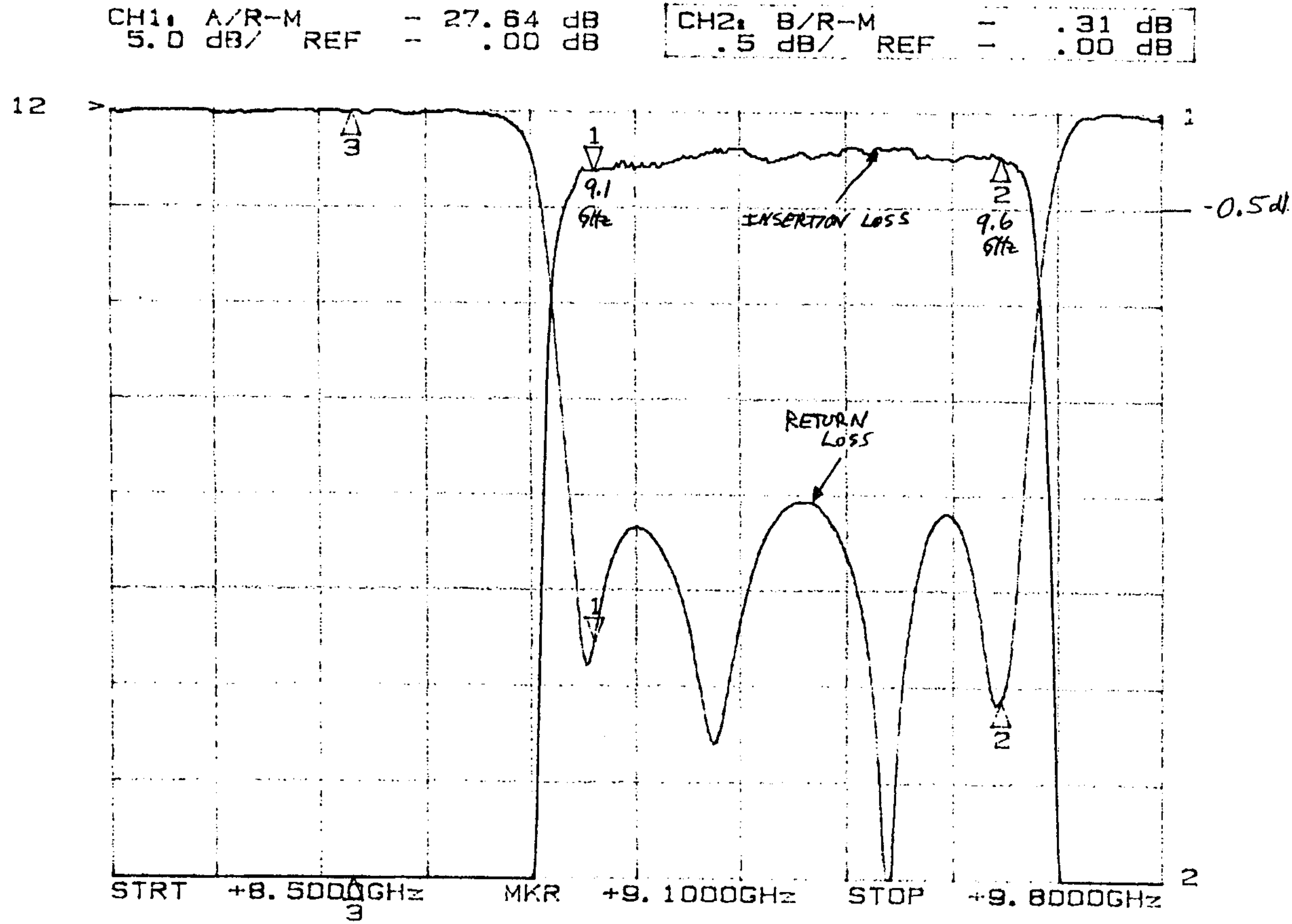
CAUTION: Be sure the high voltage lead labeled "Filament" is on the magnetron filament lead!

CAUTION: Be sure to tighten the magnetron plate screws or the contact resistance to ground for the magnetron can cause problems

1. Connect the magnetron return braid with 2 screws
2. Connect P1 and P2 to the oil can.

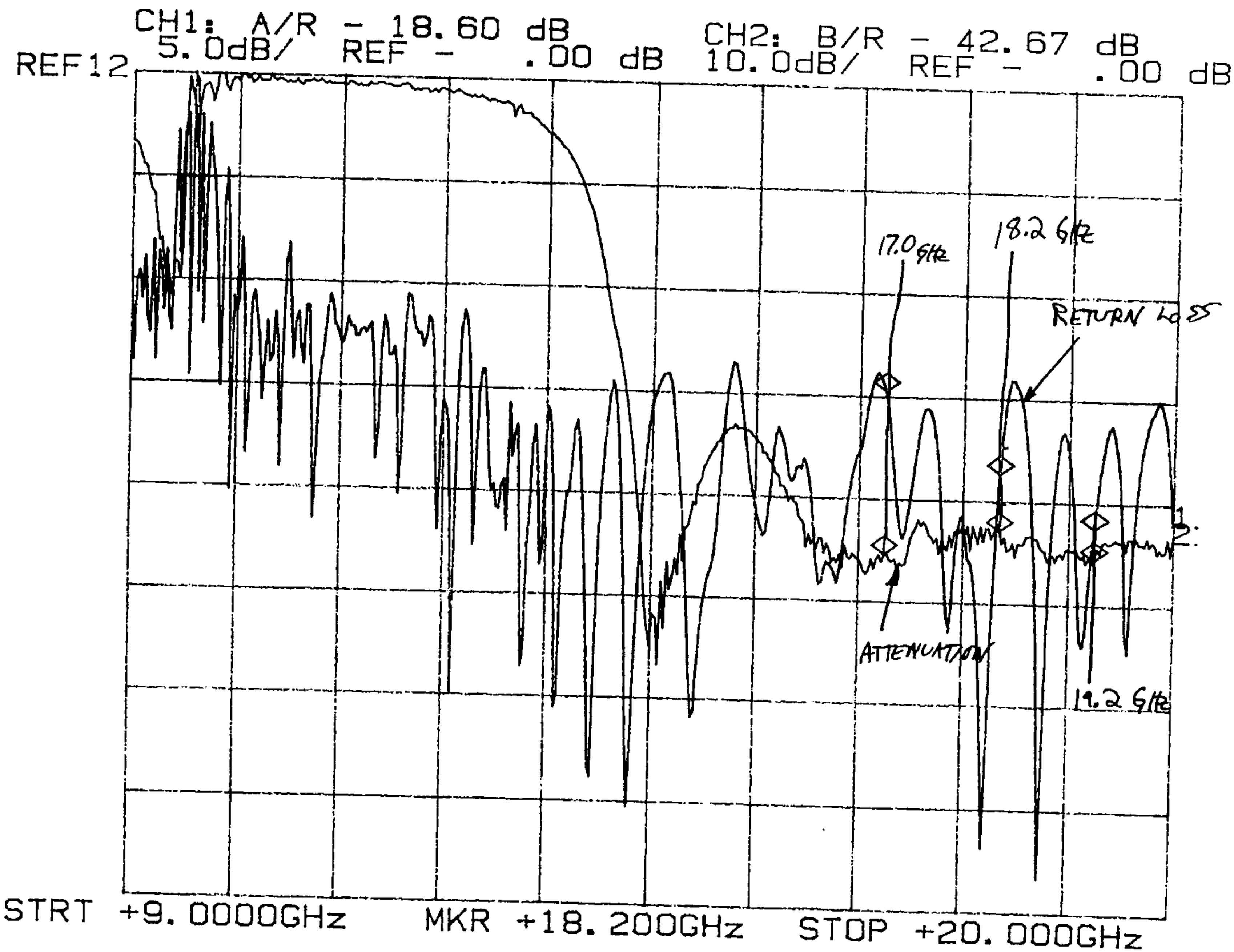


CH1: A/R−M + .00 dB
5.0 dB/ REF − .00 dB
CH2: B/R−M − 50.87 dB
10.0 dB/ REF − .00 dB
12
1
2
3
9.1 GHz
9.6 GHz
8.8 GHz
REJECTION
STRT +8.5000GHz
MKR +8.8000GHz
STOP +9.8000GHz

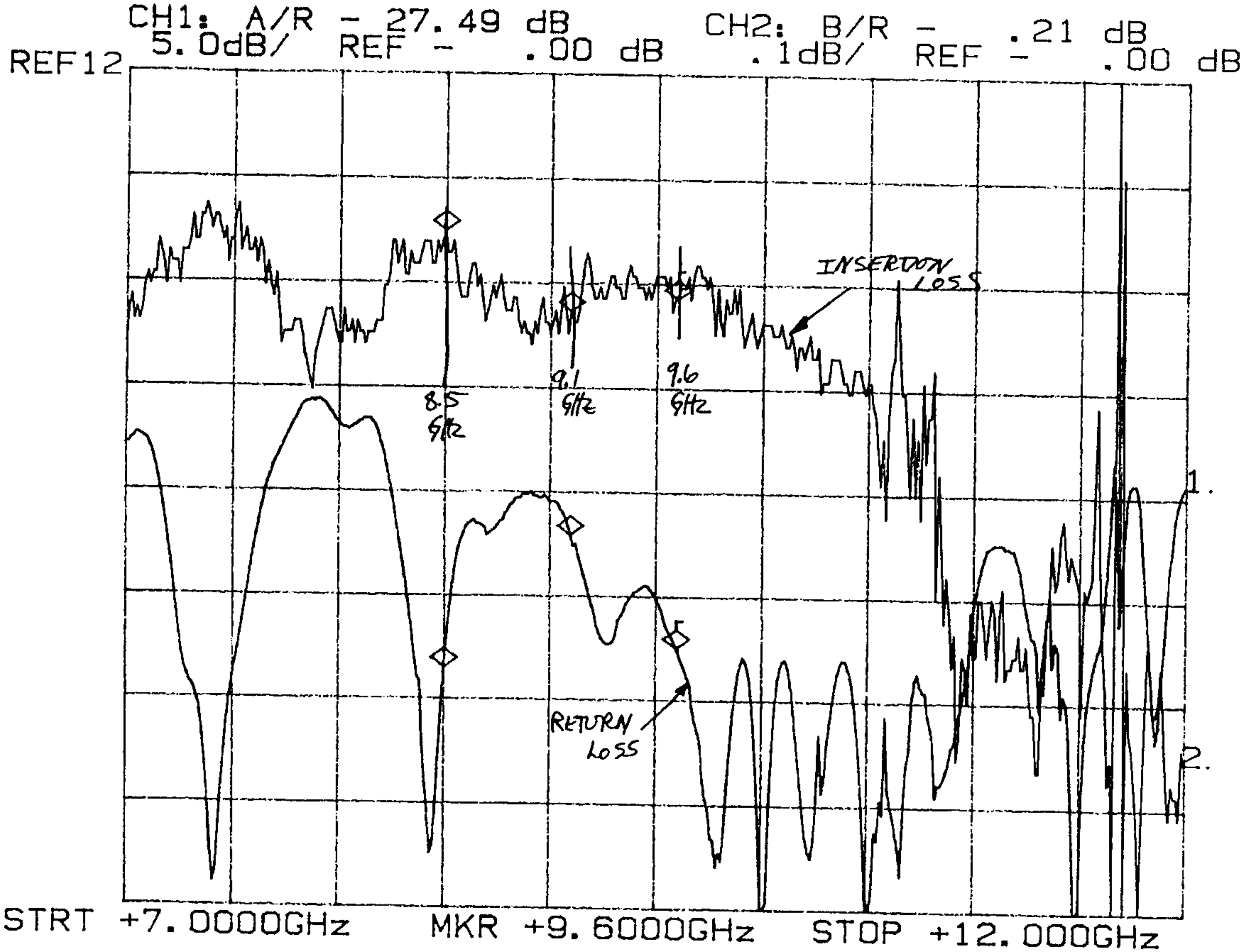

CH1: A/R−M − 27.64 dB
5.0 dB/ REF − .00 dB
CH2: B/R−M − .31 dB
.5 dB/ REF − .00 dB
12
1
2
3
9.1 GHz
9.6 GHz
-0.5 dB
INSERTION LOSS
RETURN LOSS
STRT +8.5000GHz
MKR +9.1000GHz
STOP +9.8000GHz

'N 46376

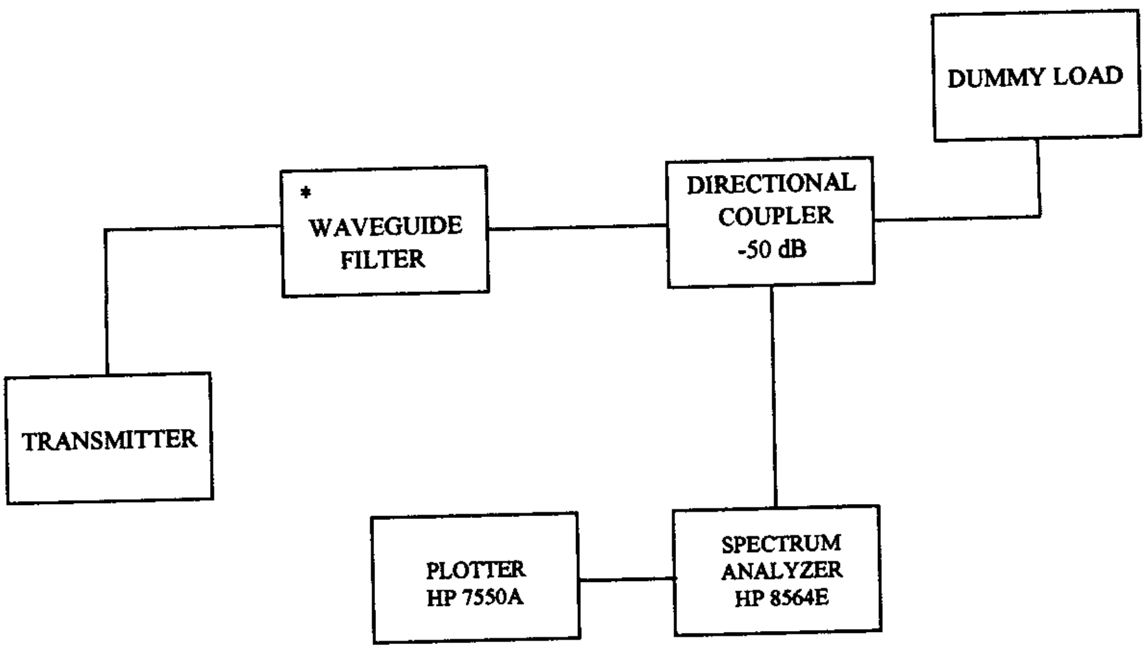
ATTENUATION



S/N 46316


CH1: A/R - 27.49 dB
5.0dB/ REF - .00 dB
CH2: B/R - .21 dB
.1dB/ REF - .00 dB
REF12
INSERTION LOSS
RETURN LOSS
8.5 GHz
9.1 GHz
9.6 GHz
1.
2.
STRT +7.0000GHz
MKR +9.6000GHz
STOP +12.000GHz

TEST SETUP FOR
SPECTRUM AND EMISSION MEASUREMENTS
DATA MEASURED AT 9375 MHz



Spurious measurements data taken from transmitter directional coupler.

Required emissions below carrier = 43 + 10 log (Pm) =
43+ 10log(295)=
43 + 24 = 67.7 dB below carrier.

Note that from 0 Hz to 40 Ghz no spurious signals shown are greater than approximately -70 dBc.

* WAVGUIDE FILTER INCLUDED IN TEST SETUP IS NORMALLY LOCATED IN THE WAVEGUIDE ASSEMBLY AT THE EQUIPMENT RACK. CENTER FREQUENCY IS 9375 MHz.

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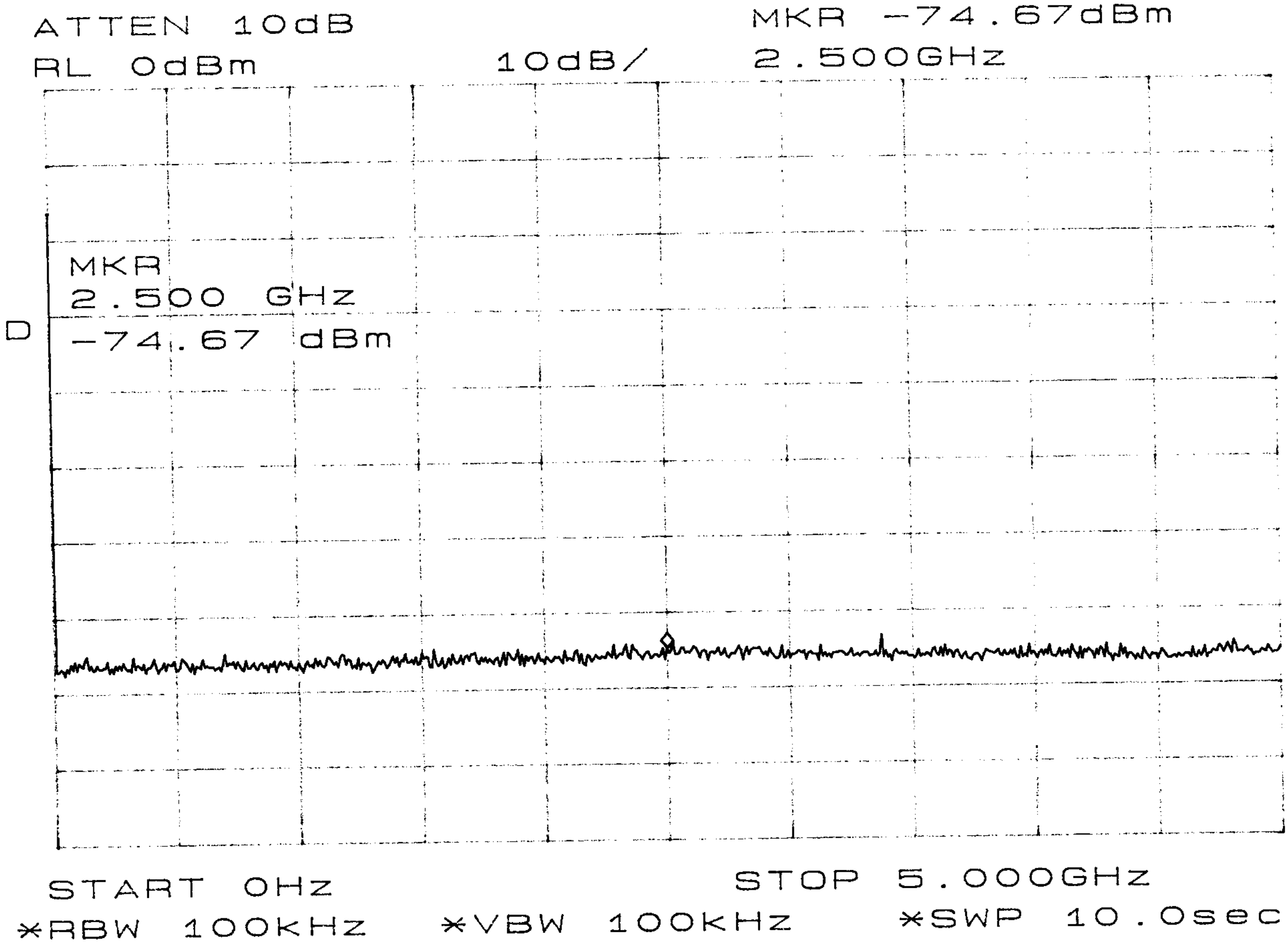
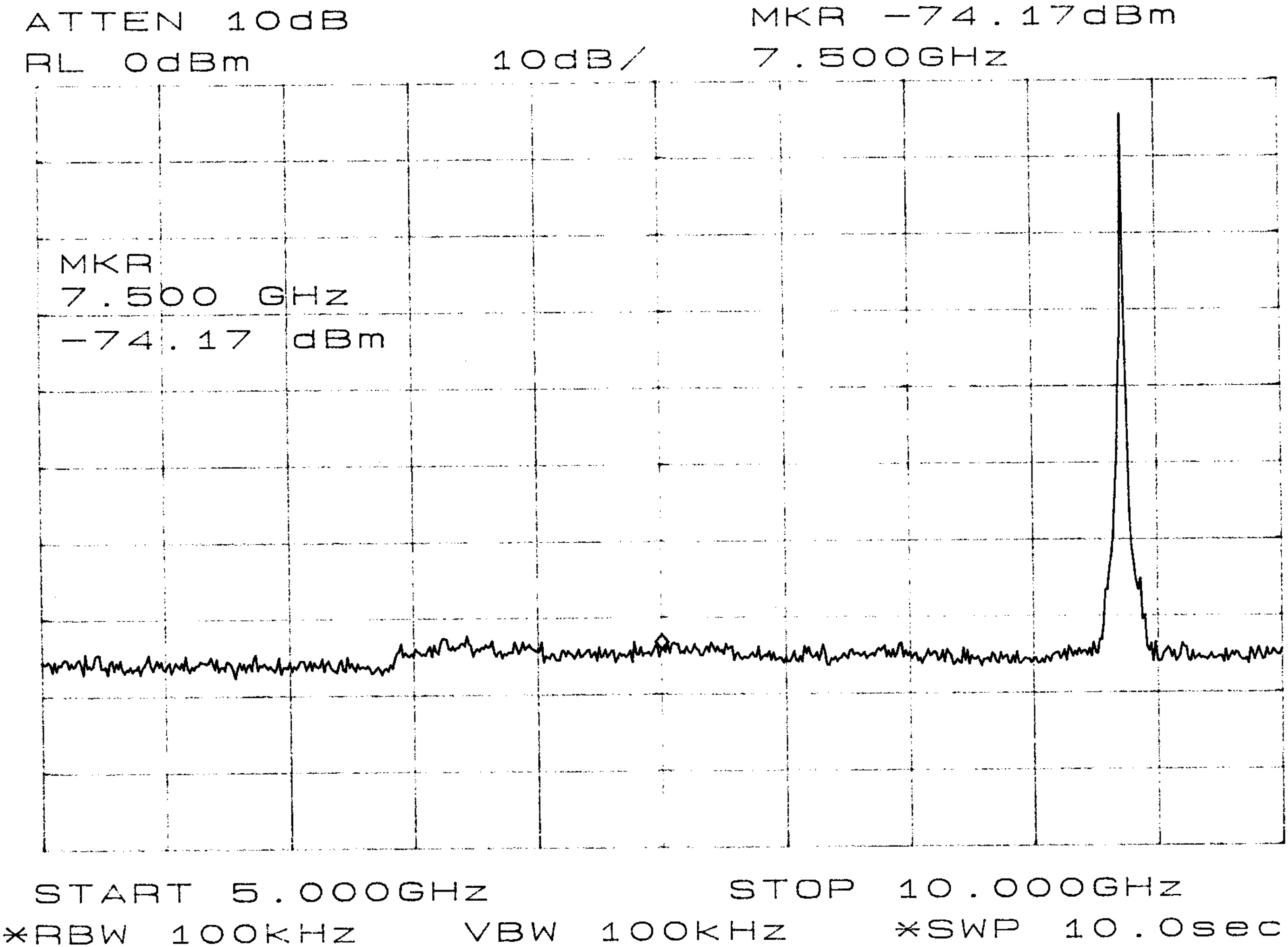
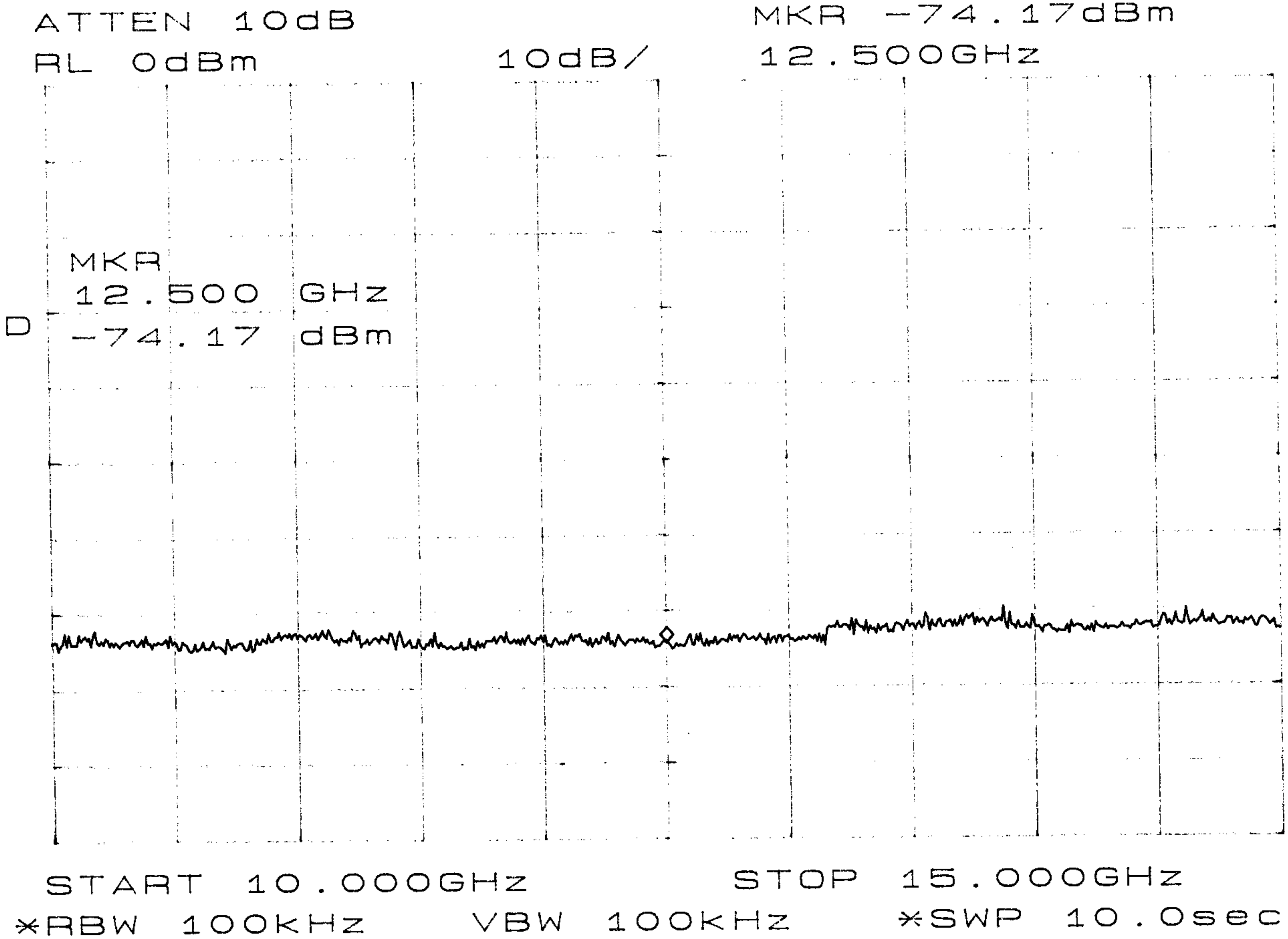
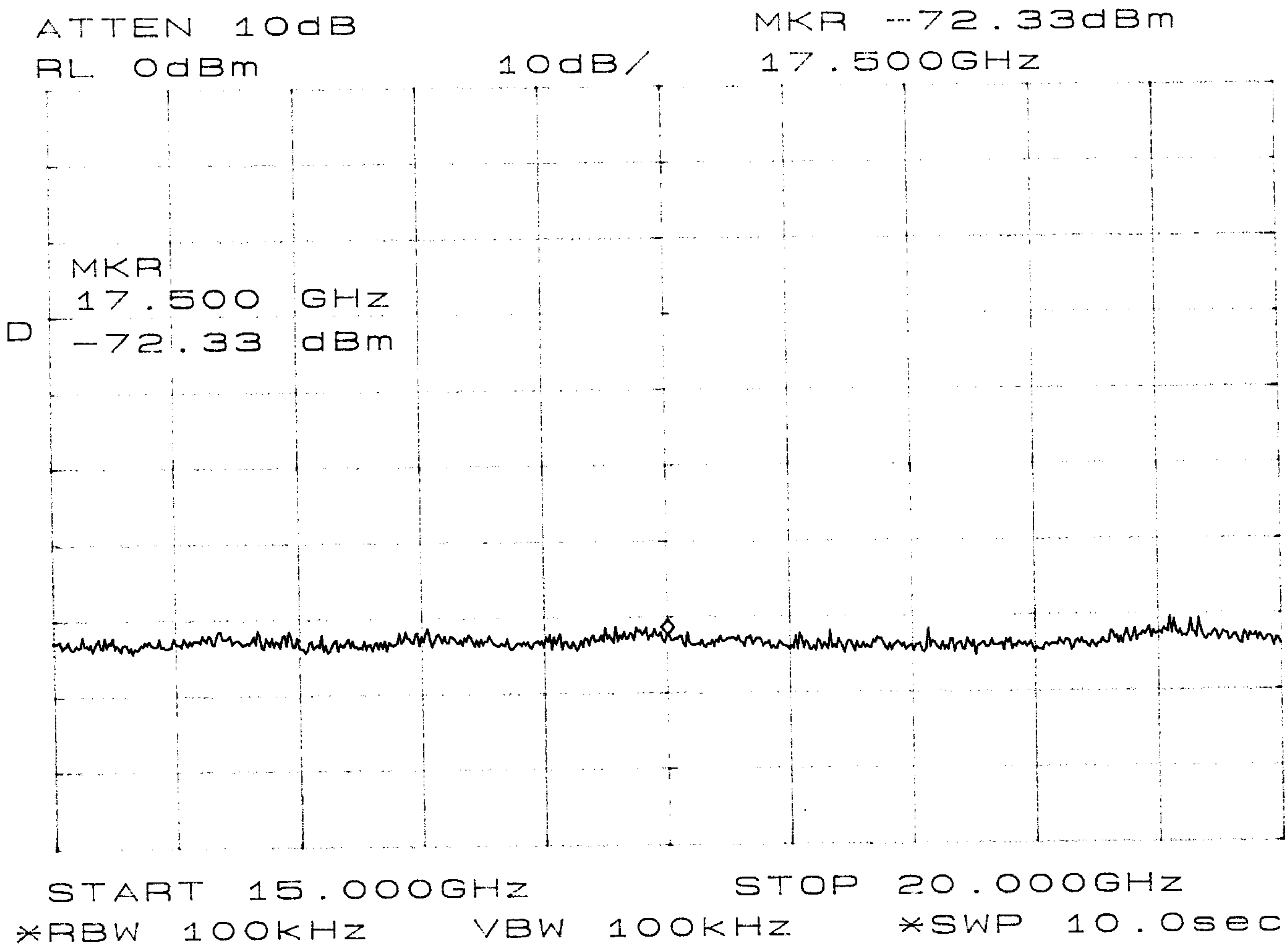
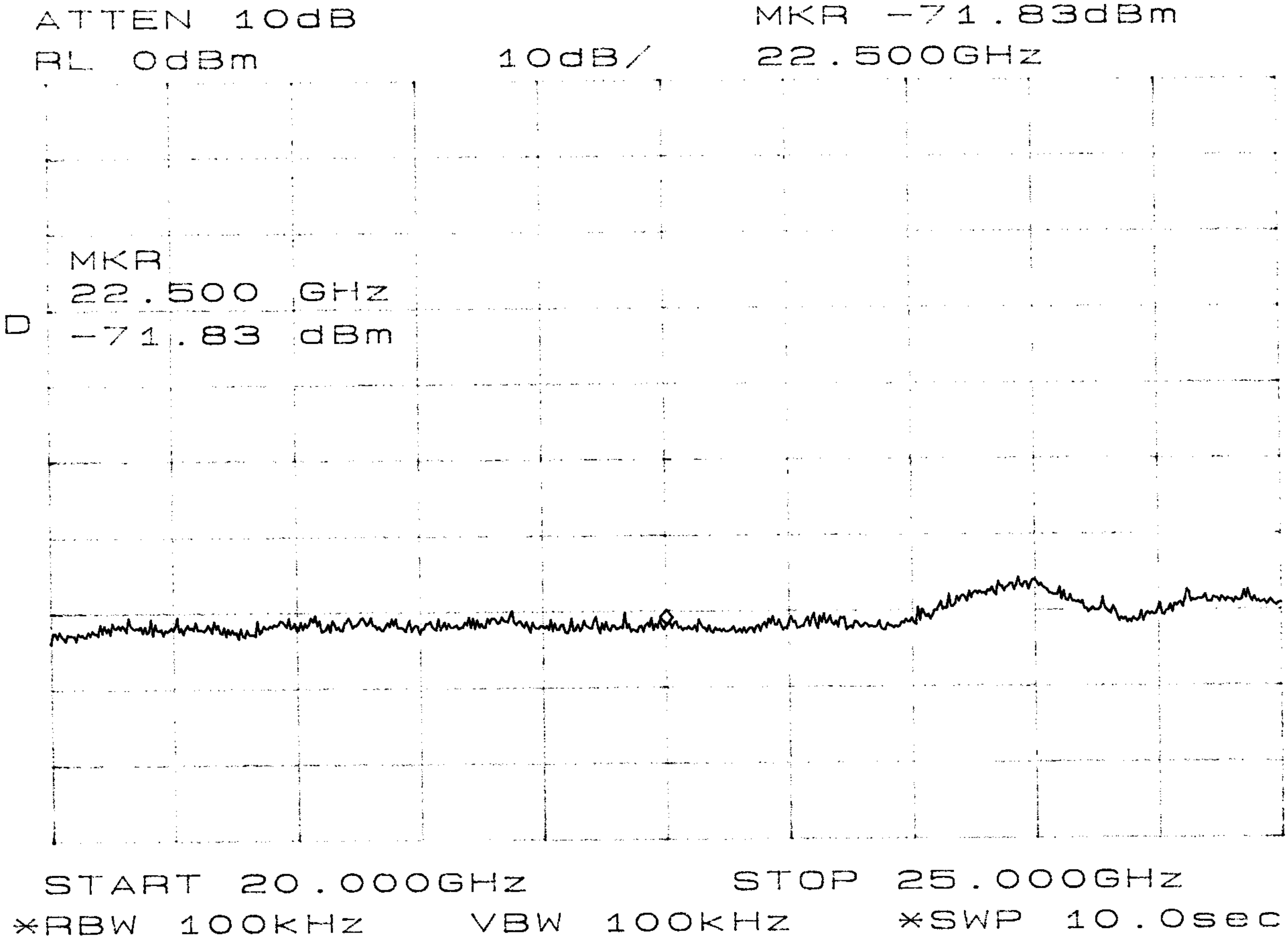
APPR./DATE	SCALE	52005	SHEET 1 OF 1

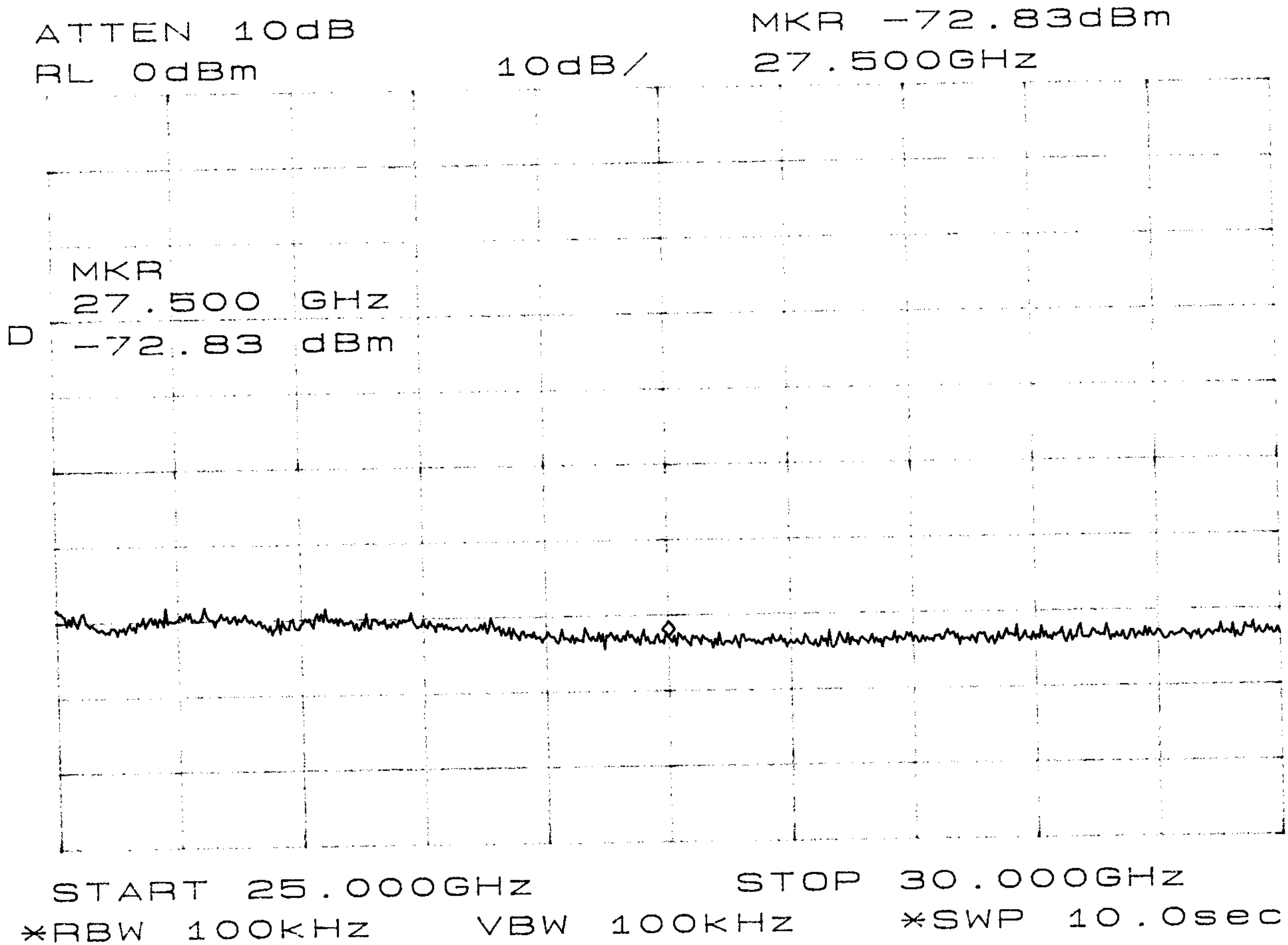

ATTEN 10dB
RL 0dBm
10dB/
MKR -74.67dBm
2.500GHz
MKR
2.500 GHz
-74.67 dBm
D
START 0Hz
STOP 5.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec

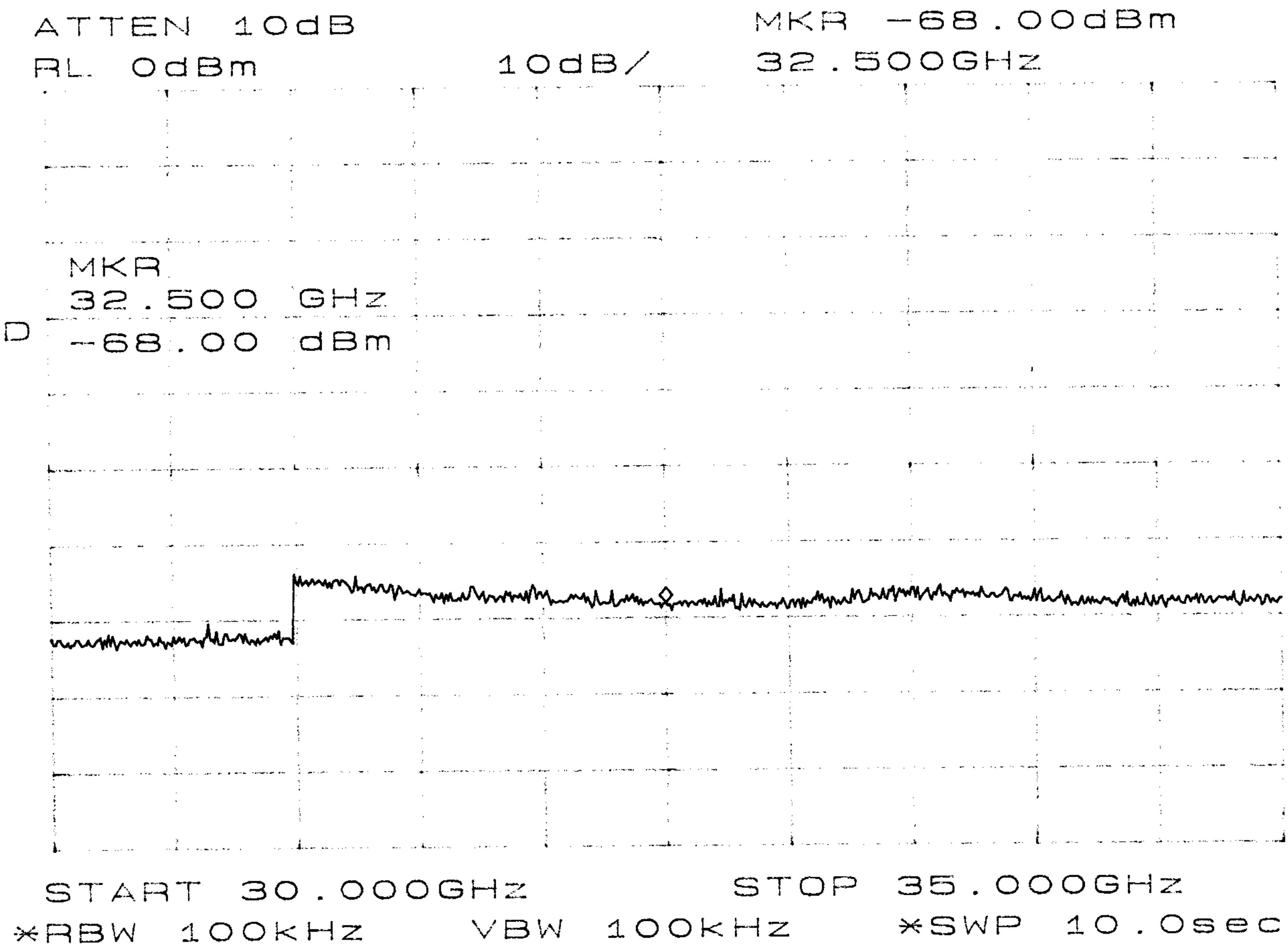

ATTEN 10dB
RL 0dBm
10dB/
MKR -74.17dBm
7.500GHz
MKR
7.500 GHz
-74.17 dBm
START 5.000GHz
STOP 10.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec

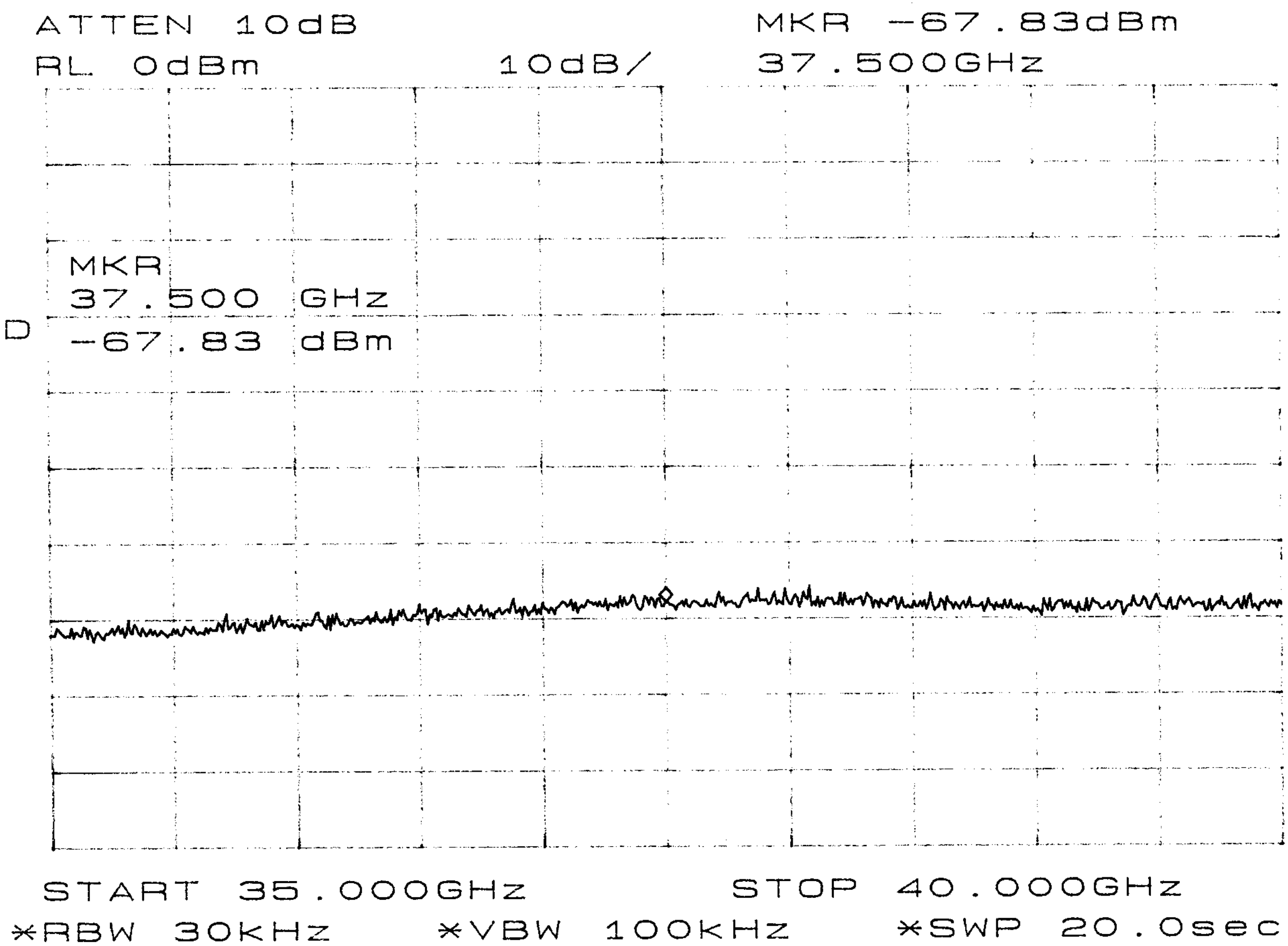

ATTEN 10dB
RL 0dBm
10dB/
MKR -74.17dBm
12.500GHz
MKR
12.500 GHz
-74.17 dBm
D
START 10.000GHz
STOP 15.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -72.33dBm
17.500GHz
MKR
17.500 GHz
-72.33 dBm
D
START 15.000GHz
STOP 20.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec

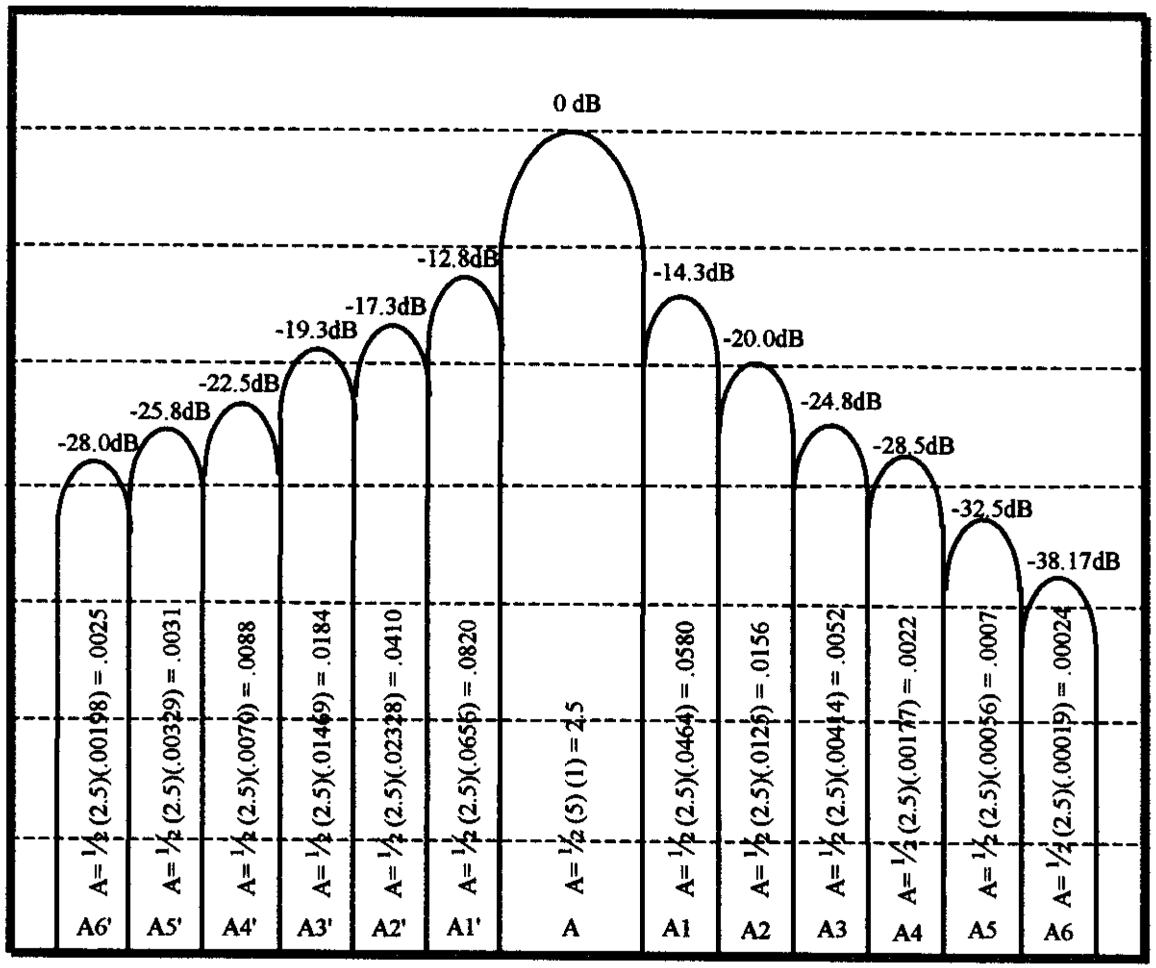

ATTEN 10dB
RL 0dBm
10dB/
MKR −71.83dBm
22.500GHz
MKR
22.500 GHz
−71.83 dBm
D
START 20.000GHz
STOP 25.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -72.83dBm
27.500GHz
MKR
27.500 GHz
D -72.83 dBm
START 25.000GHz
STOP 30.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -68.00dBm
32.500GHz
MKR
32.500 GHz
-68.00 dBm
D
START 30.000GHz
STOP 35.000GHz
*RBW 100kHz
VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -67.83dBm
37.500GHz
MKR
37.500 GHz
-67.83 dBm
D
START 35.000GHz
STOP 40.000GHz
*RBW 30KHz
*VBW 100KHz
*SWP 20.0sec

XDD-300X SPECTRUM



FEDERAL REGULATION 2.989,
OCCUPIED BANDWIDTH FOR
XDD-300X METEOROLOGICAL
RADAR

PULSE WIDTH =0.4 µsec
PRF=1180
FREQUENCY=9375 MHz

MAJOR LOBE WIDTH=5.0 MHz
MINOR LOBE WIDTH=2.5 MHz

LOSE AREA = ½ LOBE WIDTH $\left(\frac{1}{LOG^{-1}\frac{dB}{10}}\right)$

A6 THROUGH A6' = 2.6814

MEAN RADIATED POWER =2.6814 *.99 = 2.6545

A3 THROUGH A3' = 2.6477

OCCUPIED BANDWIDTH = 17.5 MHz (worst case)

EMISSION DESIGNATOR, 11M25PON

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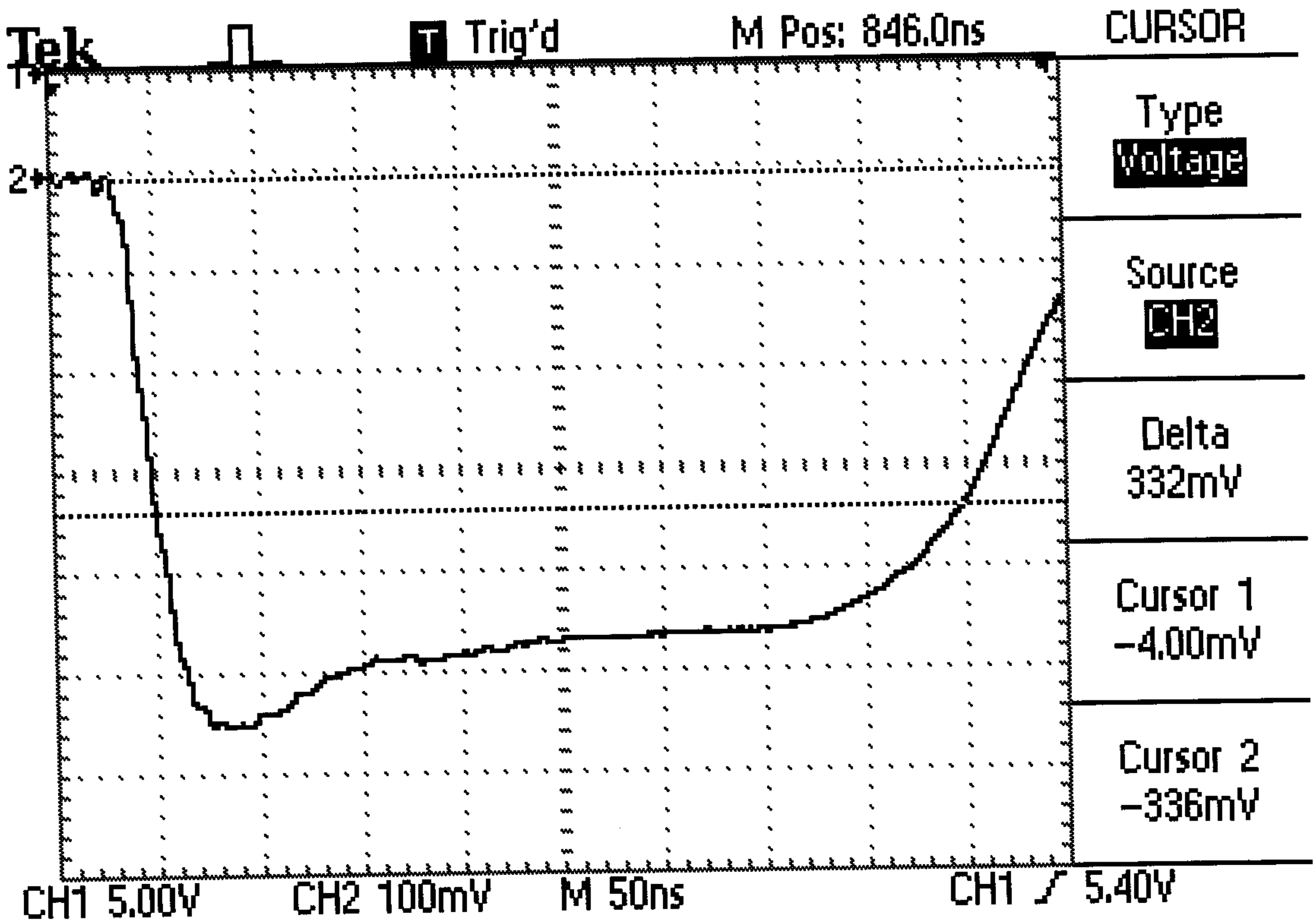
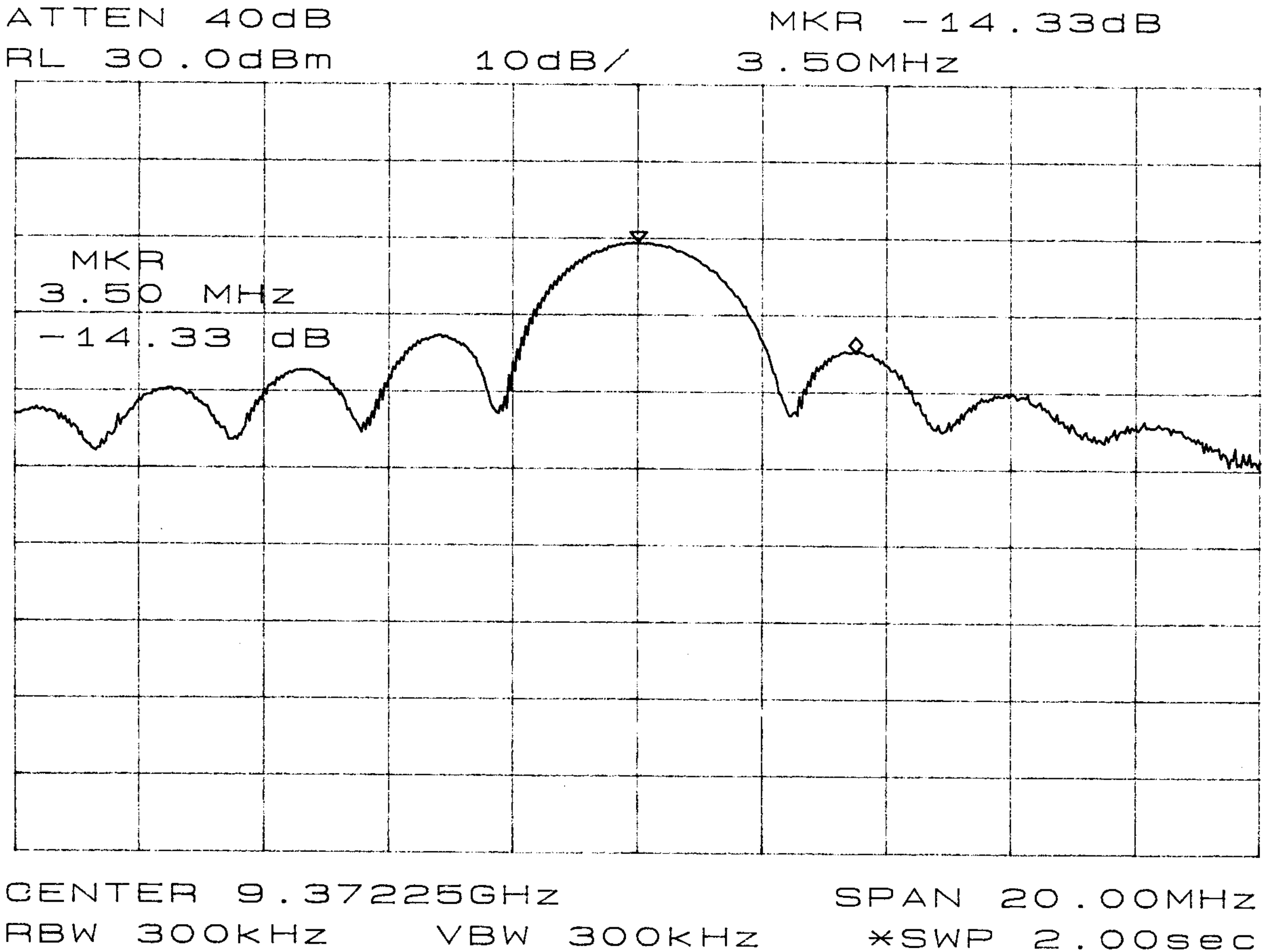
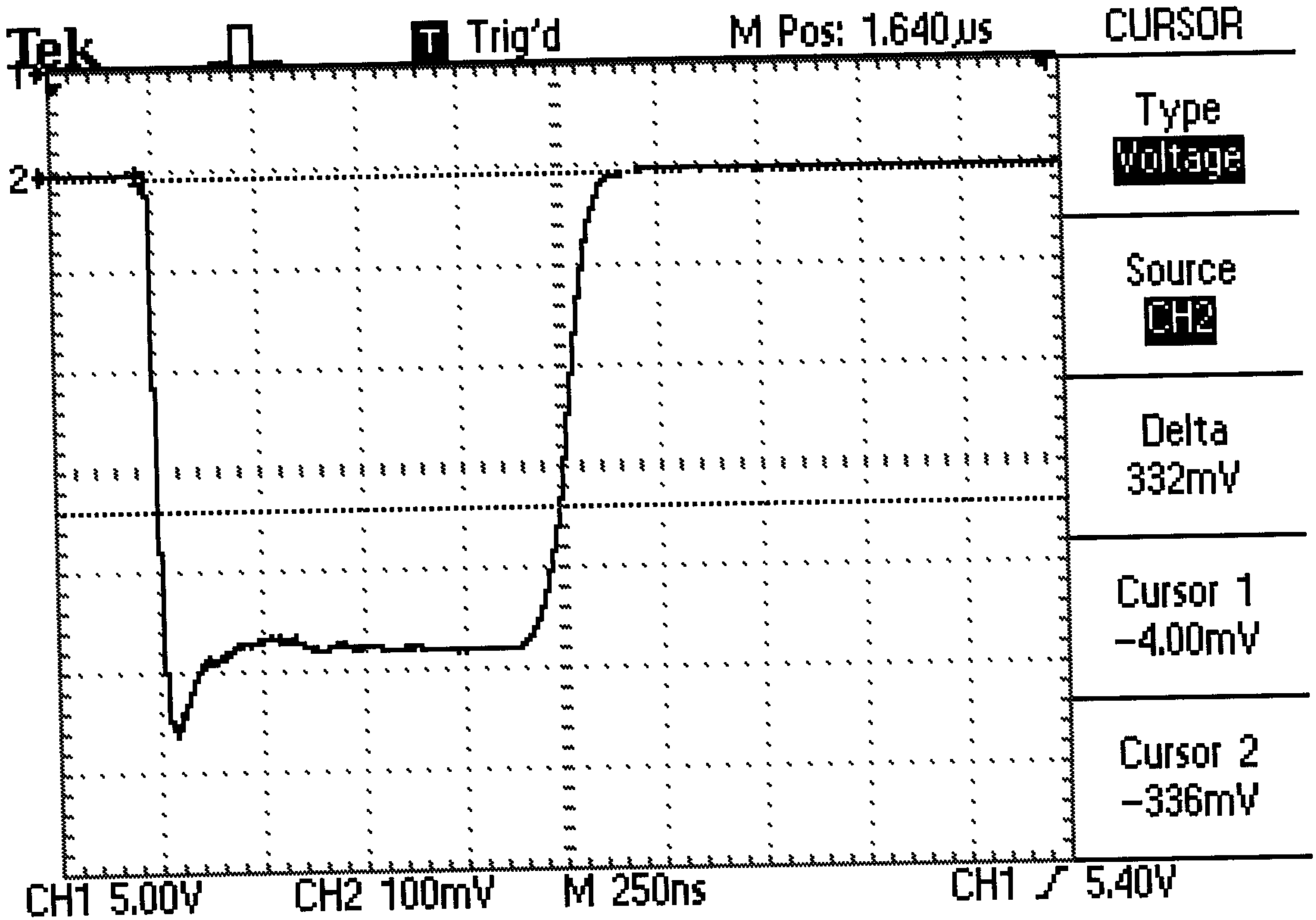
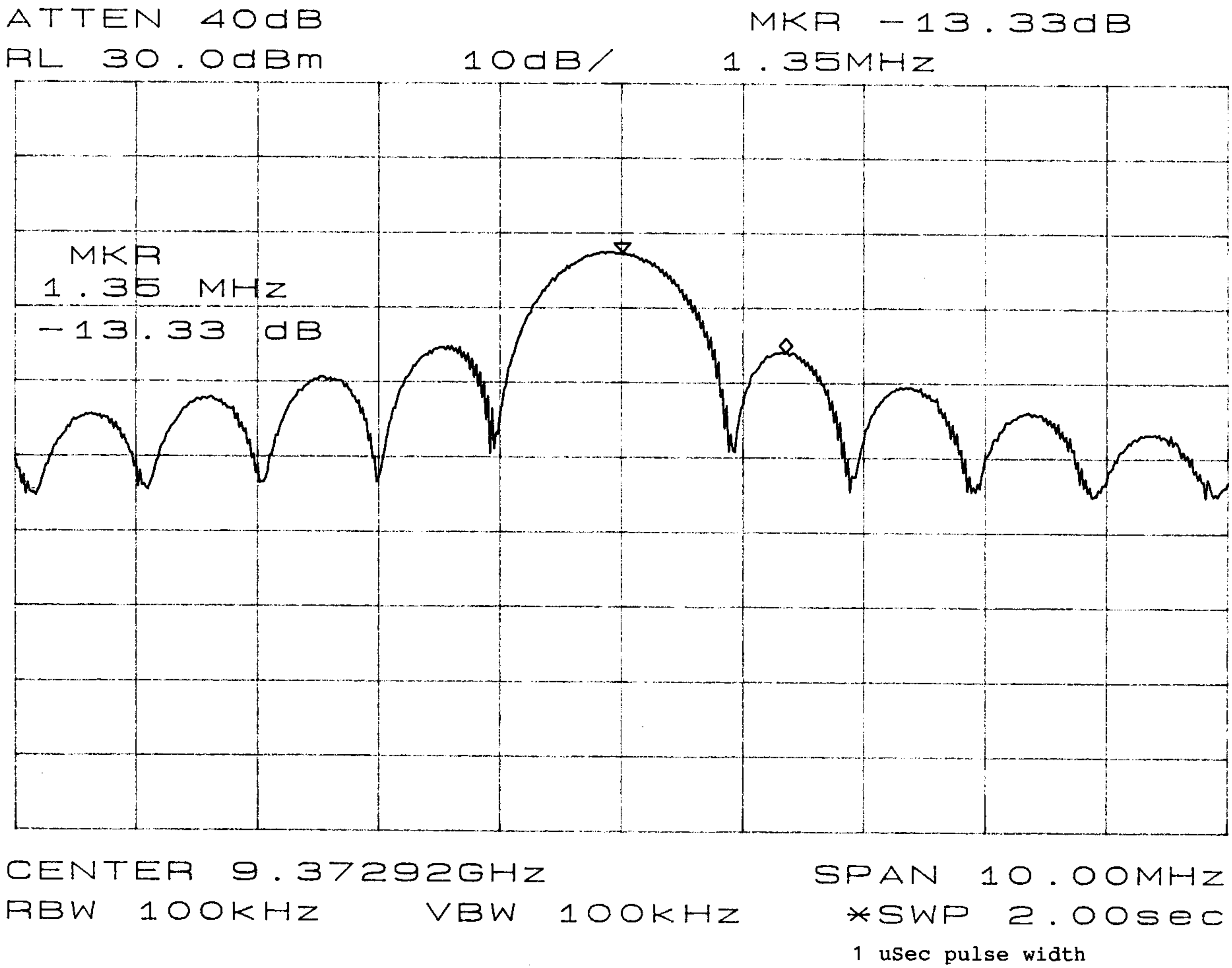
	SCALE	52005	SHEET 1 OF 1

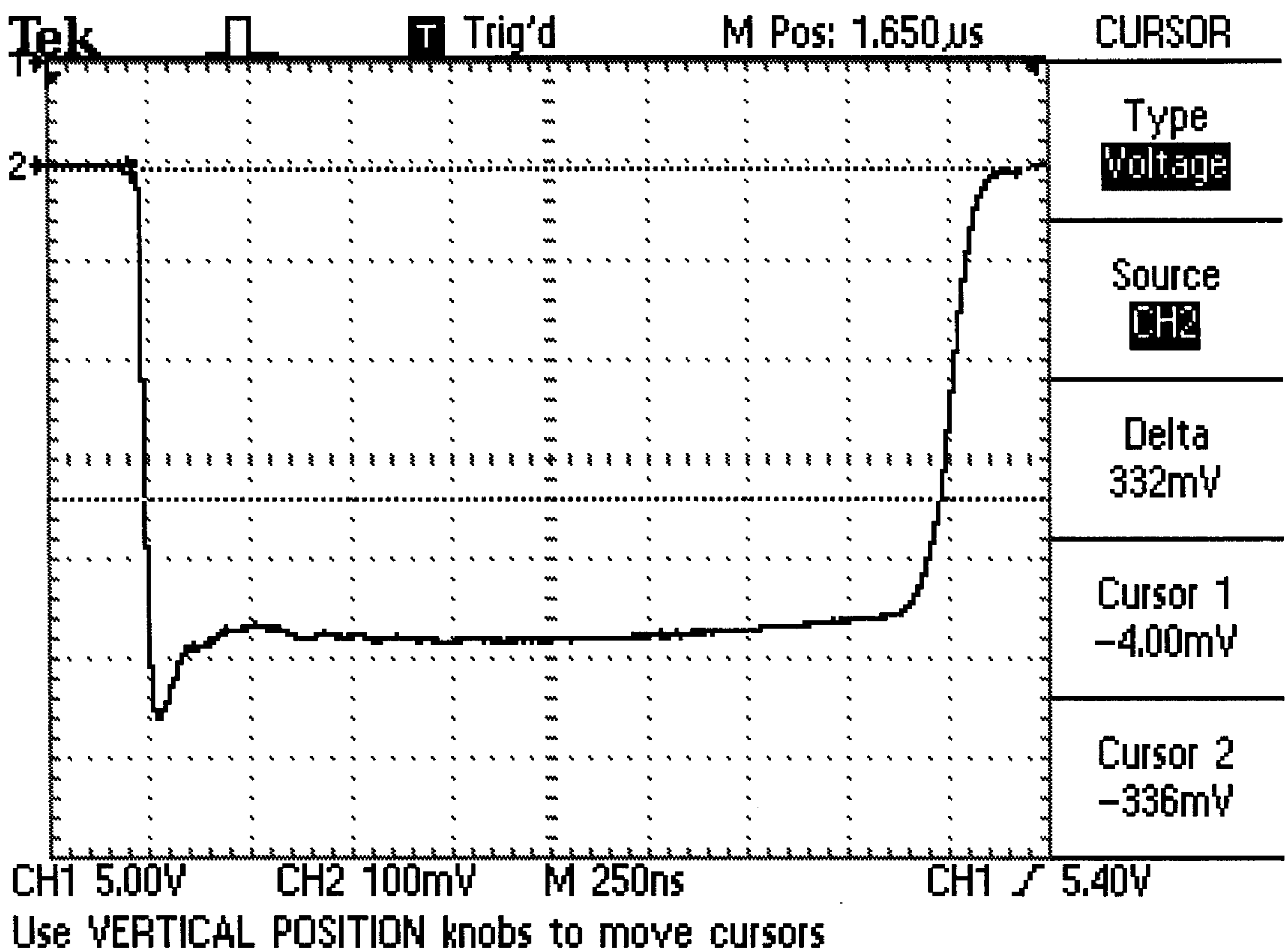

Tek
Trig'd
M Pos: 846.0ns
CURSOR
Type
Voltage
Source
CH2
Delta
332mV
Cursor 1
-4.00mV
Cursor 2
-336mV
CH1 5.00V
CH2 100mV
M 50ns
CH1 5.40V

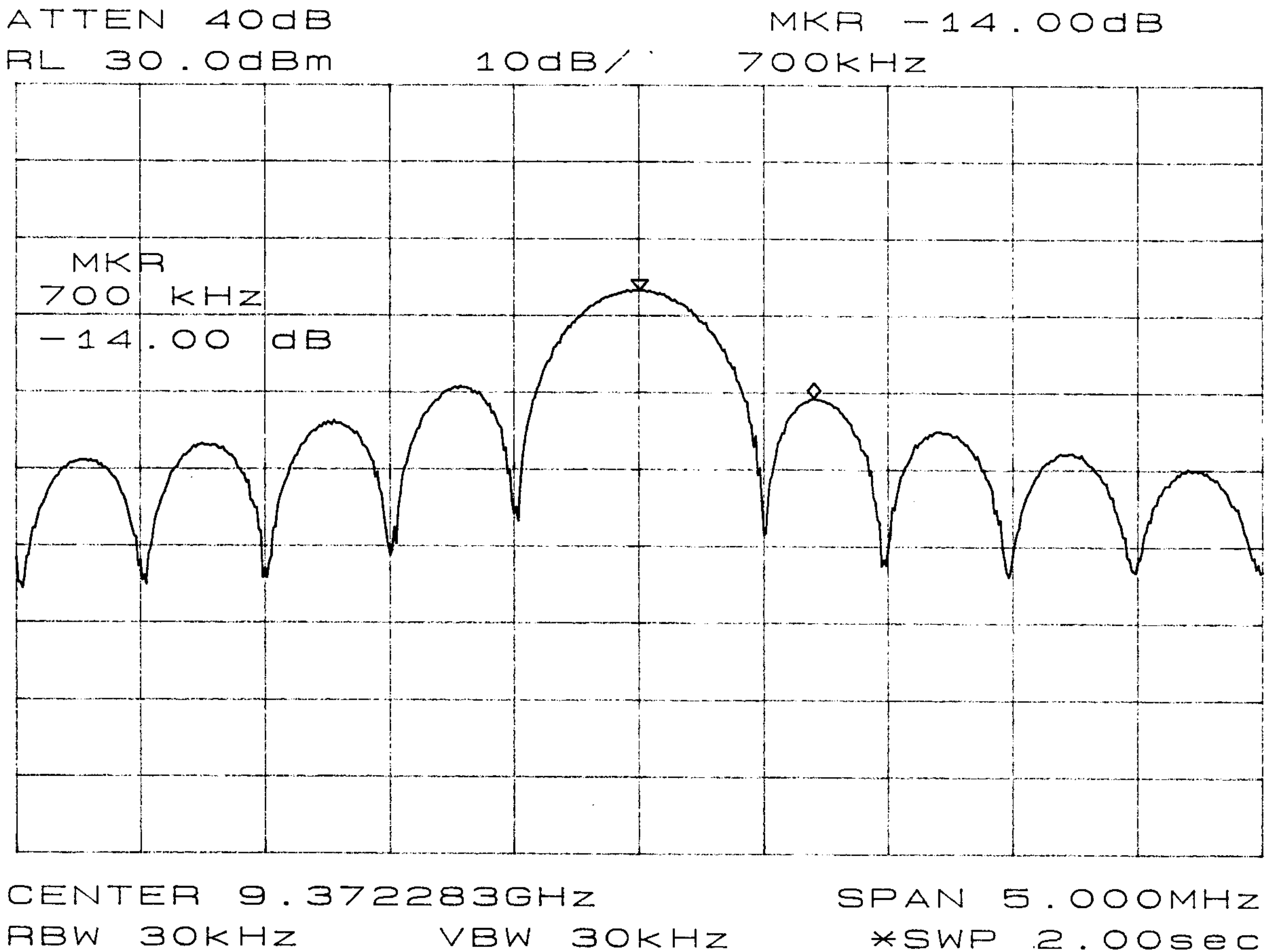


400 ns pulse width


Tek
Trig'd
M Pos: 1.640 µs
CURSOR
Type
Voltage
Source
CH2
Delta
332mV
Cursor 1
−4.00mV
Cursor 2
−336mV
CH1 5.00V
CH2 100mV
M 250ns
CH1 ∫ 5.40V

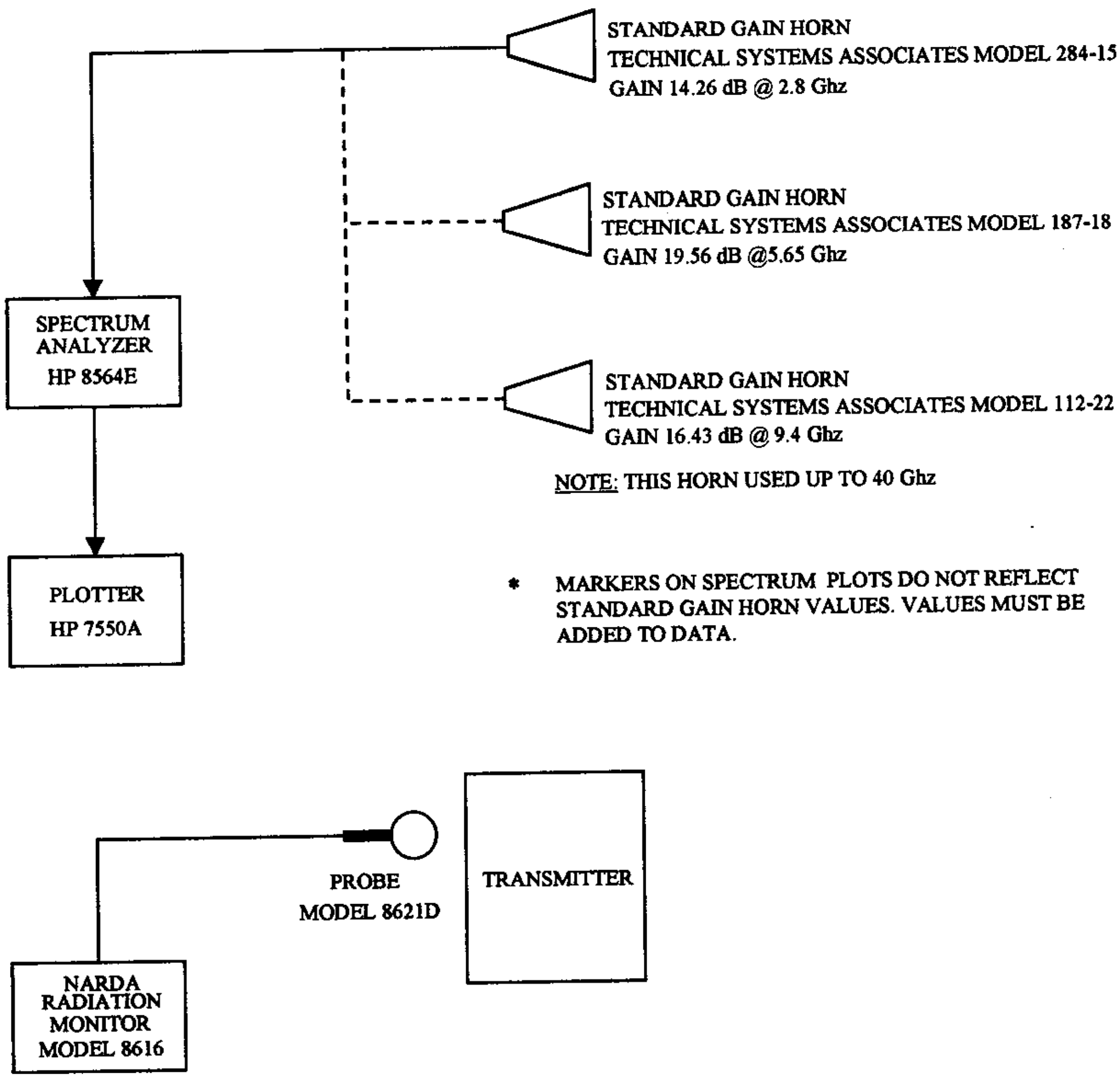

ATTEN 40dB
RL 30.0dBm
10dB/
MKR -13.33dB
1.35MHz
MKR
1.35 MHz
-13.33 dB
CENTER 9.37292GHz
RBW 100kHz
VBW 100kHz
SPAN 10.00MHz
*SWP 2.00sec
1 uSec pulse width


Tek
T Trig'd
M Pos: 1.650 µs
CURSOR
Type
Voltage
Source
CH2
Delta
332mV
Cursor 1
−4.00mV
Cursor 2
−336mV
CH1 5.00V
CH2 100mV
M 250ns
CH1 ⟋ 5.40V
Use VERTICAL POSITION knobs to move cursors



2 uSec pulse width

TEST SETUP FOR SPURIOUS RADIATION FIELD STRENGH

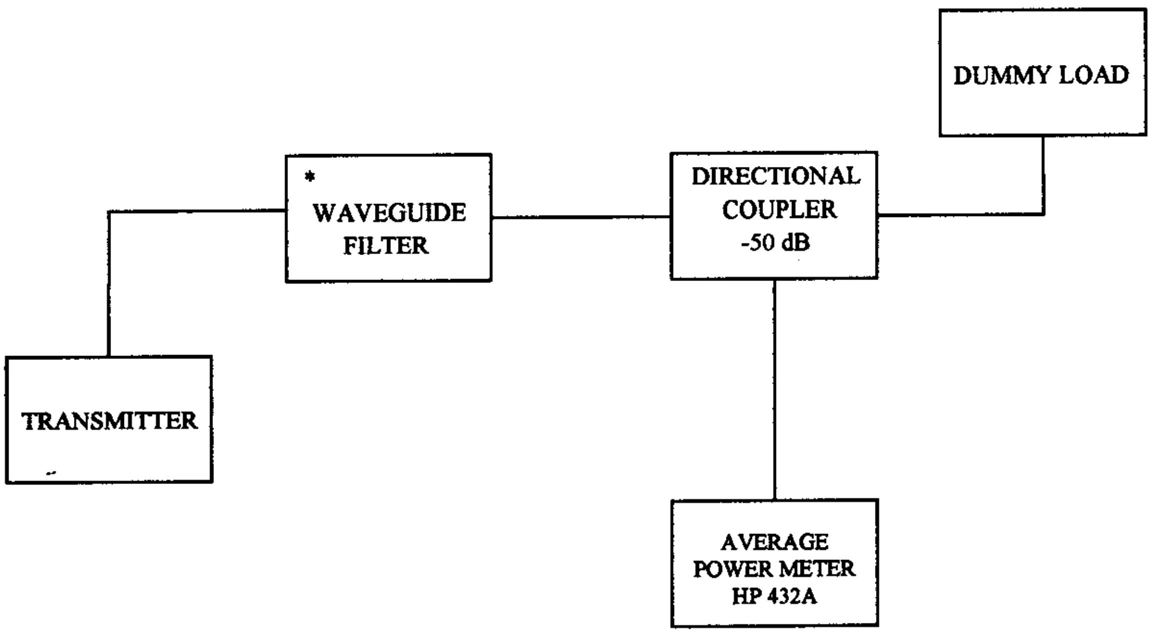


Measurements were made using each standard gain horn,as shown in the analyzer plot,probing around doors,panels and cables. Highest readings were obtained in front of the air filter. Measurements were taken with the transmitter at full power (295 kW peak) with the horn located 3 feet away in front of the air filter.

In addition a Narda Electromagnetic Radiation Monitor, Model 8616 and isotropic probe, Model 8621D were used to probe around the transmitter,cabinet doors,panels,etc. No readings were observed greater than 2 mw/cm^2.

	SIZE A	CODE IDENT NO.	DRAWING NO. SK1874-13
APPR./DATE	SCALE	52005	SHEET 1 OF 1

TEST SETUP FOR POWER MEASUREMENTS



TRANSMITTER POWER OUTPUT=DIRECTIONAL COUPLER+DUTY CYCLE CORRECTION FACTOR+METER READING

=50.0+33.0+1.7

=84.8 dBm

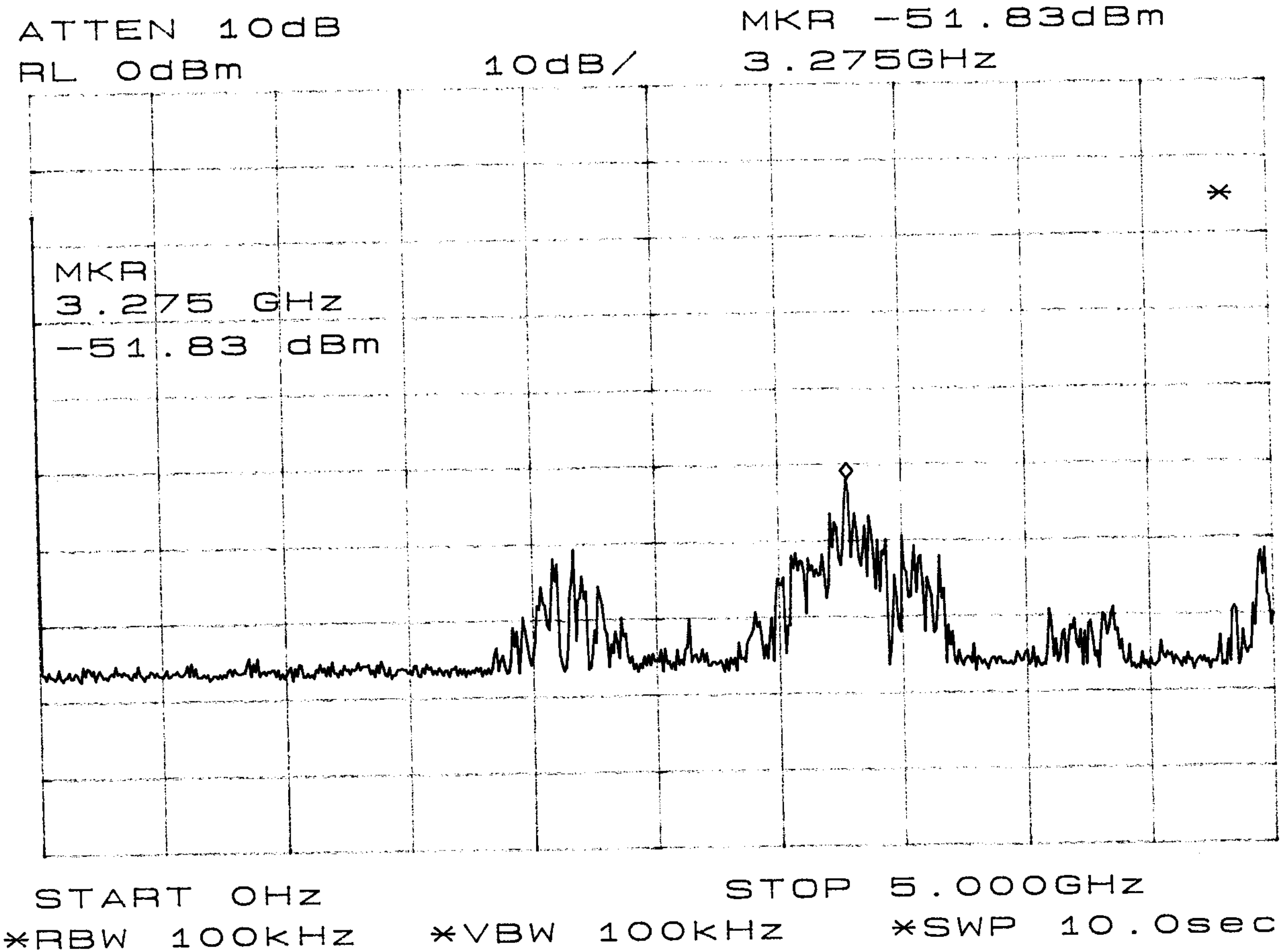
=295 kW

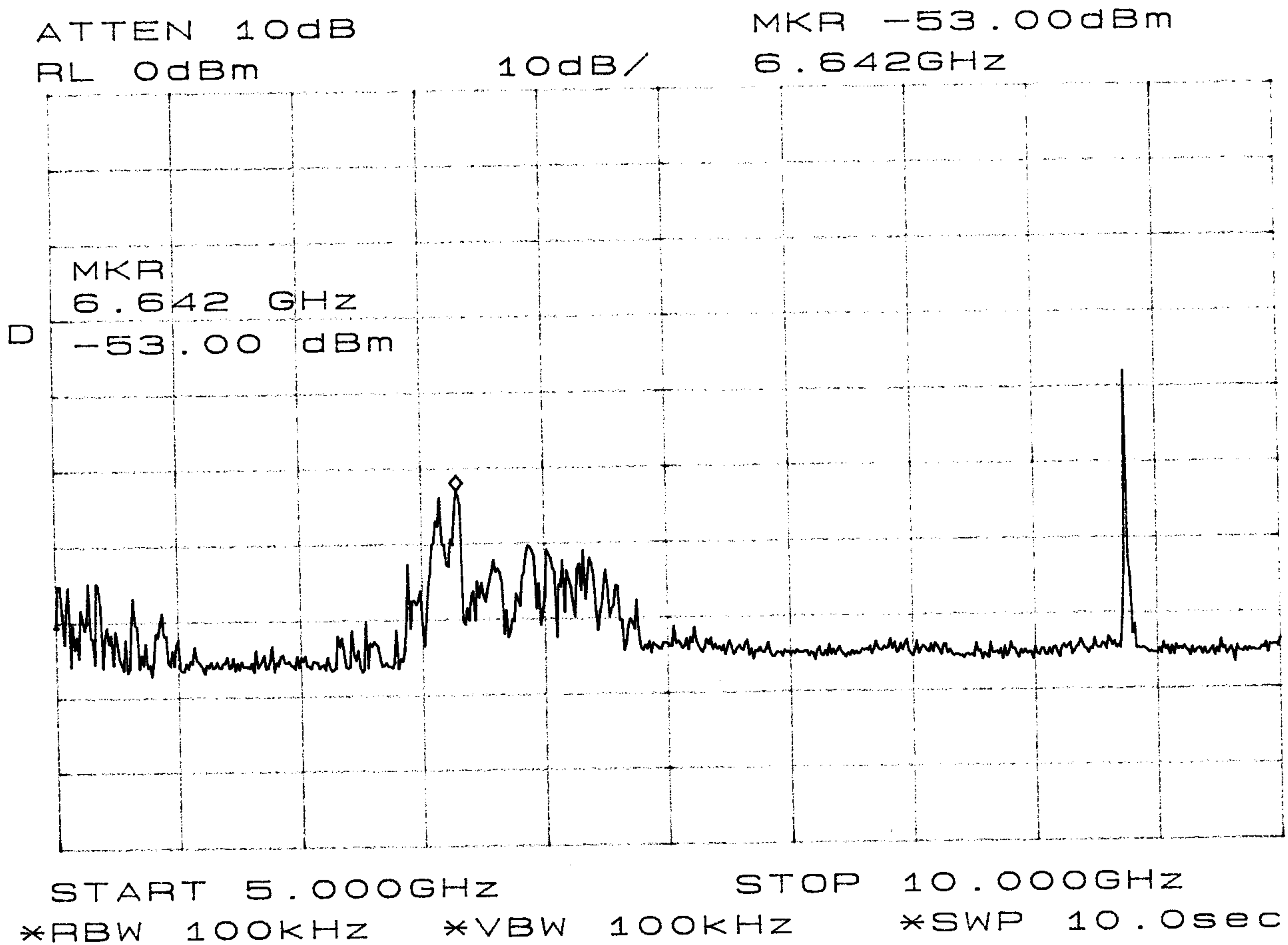
<u>DUTY CYCLE CORRECTION FACTOR</u>

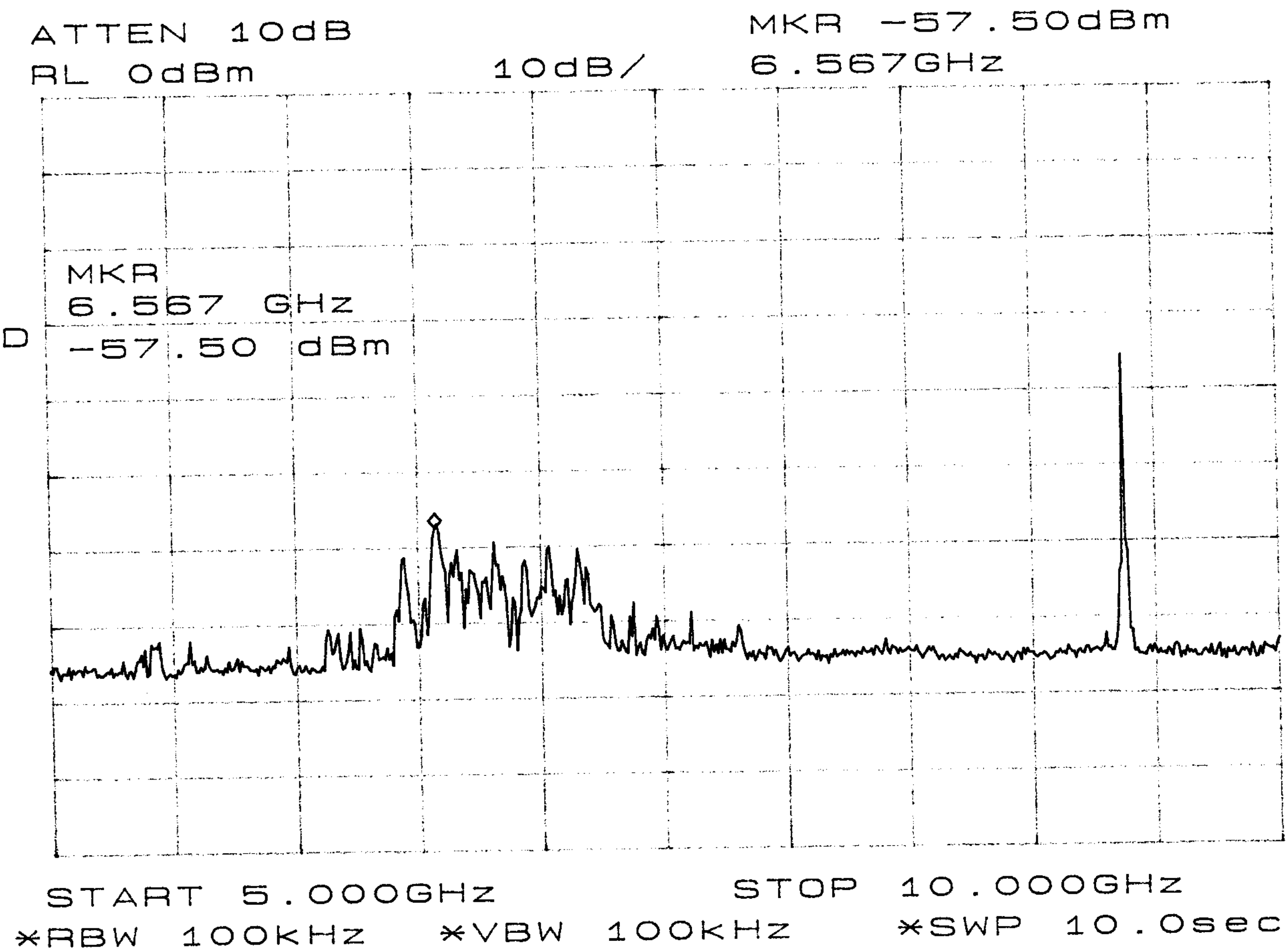
DC=10 LOG 1/PRF X PW
DC=10 LOG 1/250 X 2usec(10-6)
DC= 33.0

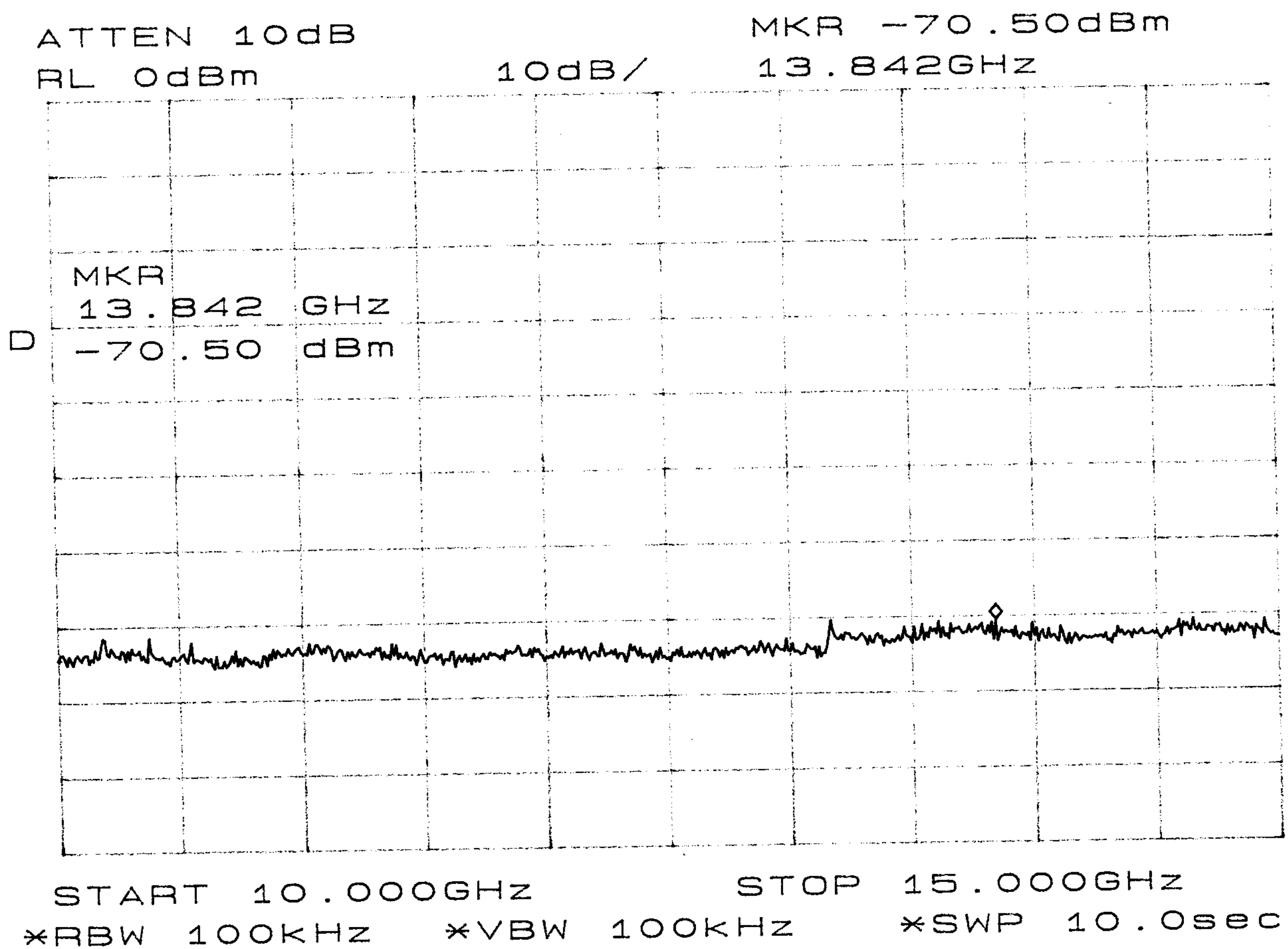
* WAVGUIDE FILTER INCLUDED IN TEST SETUP IS NORMALLY LOCATED IN THE WAVEGUIDE ASSEMBLY AT THE EQUIPMENT RACK. CENTER FREQUENCY IS 9375 MHz.

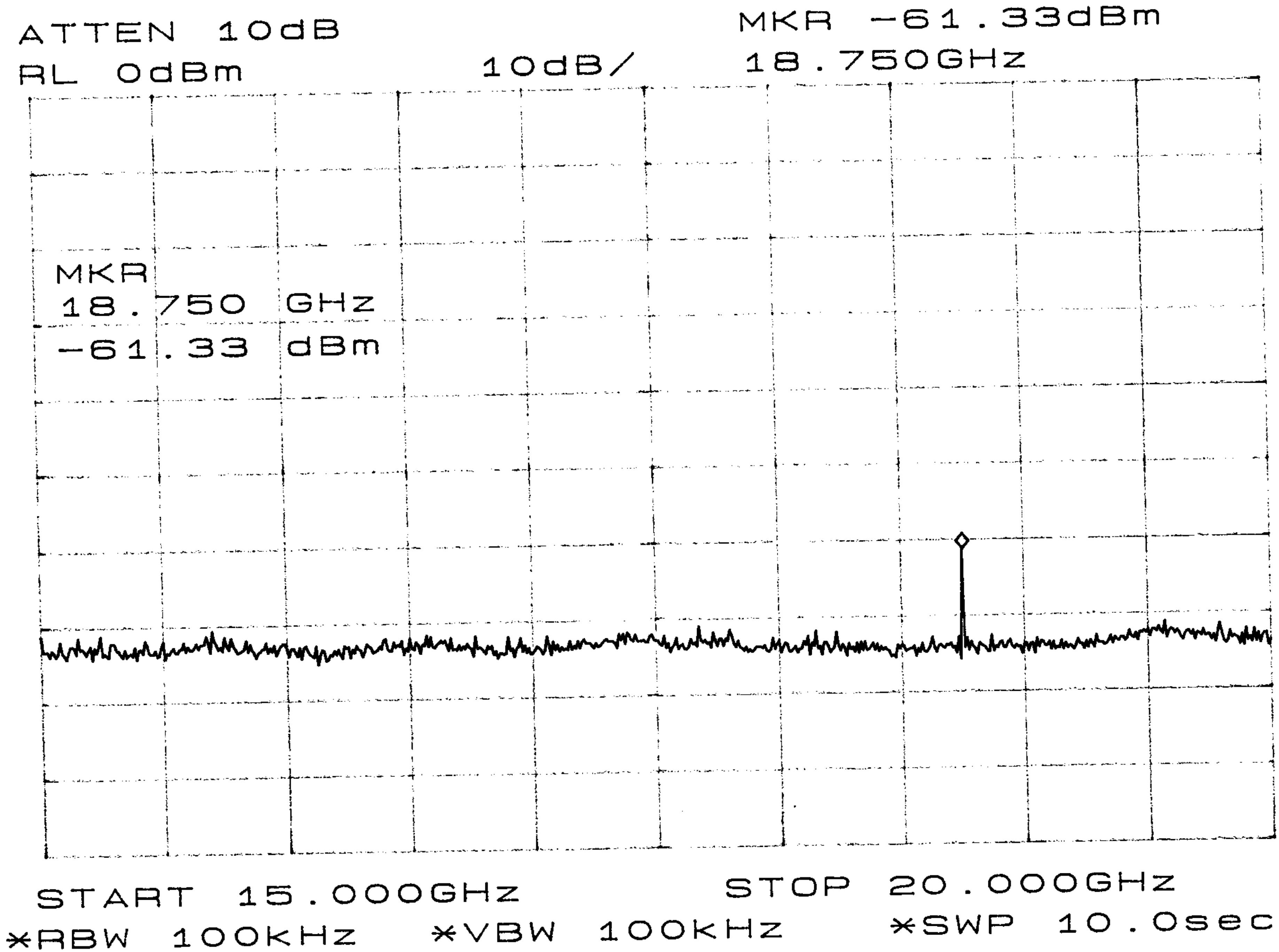
	SIZE A	CODE IDENT NO.	DRAWING NO. SK1874-10
APPR./DATE	SCALE	52005	SHEET 1 OF 1

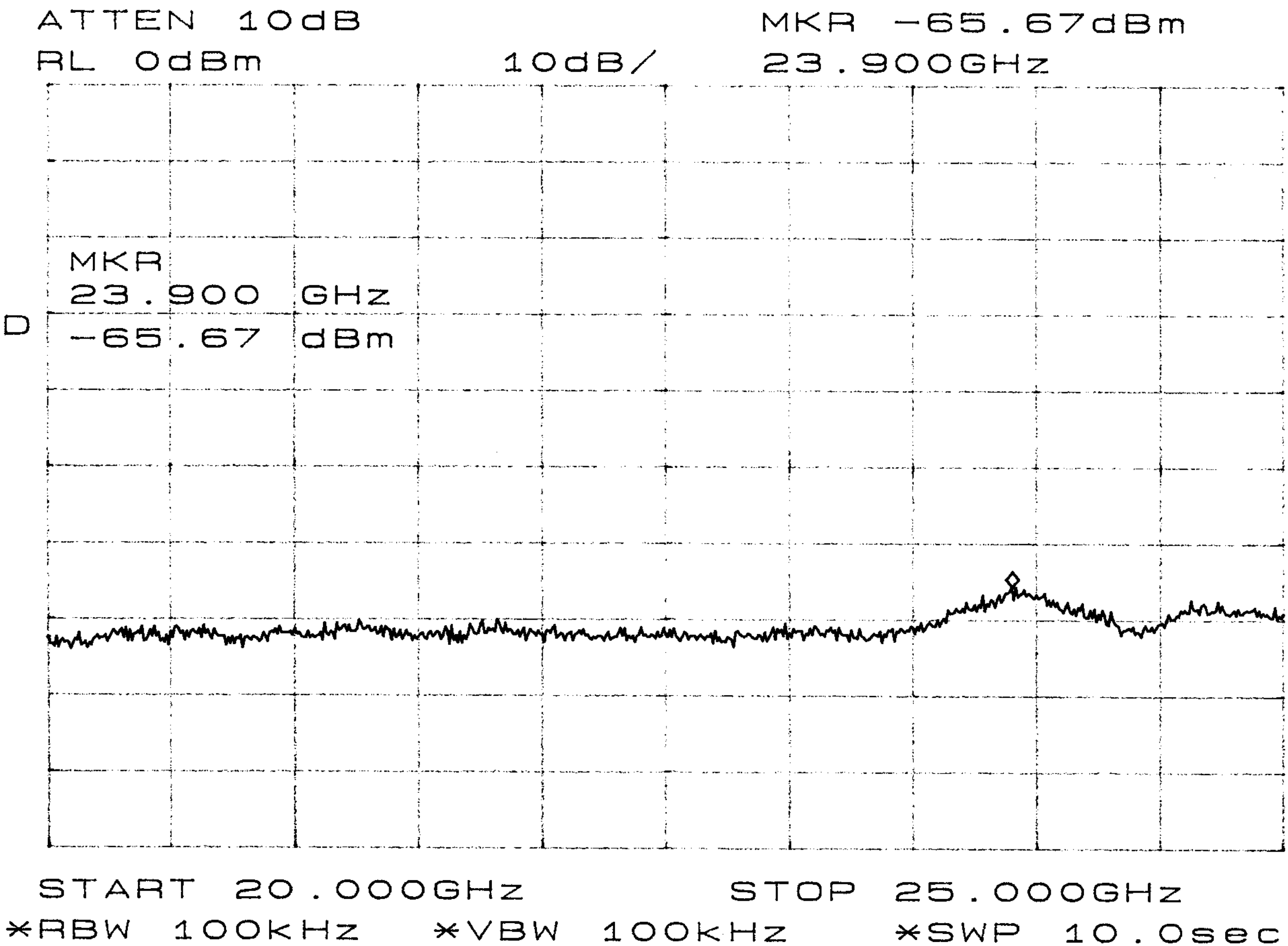

ATTEN 10dB
RL 0dBm
10dB/
MKR -51.83dBm
3.275GHz
MKR
3.275 GHz
-51.83 dBm
START 0Hz
STOP 5.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec

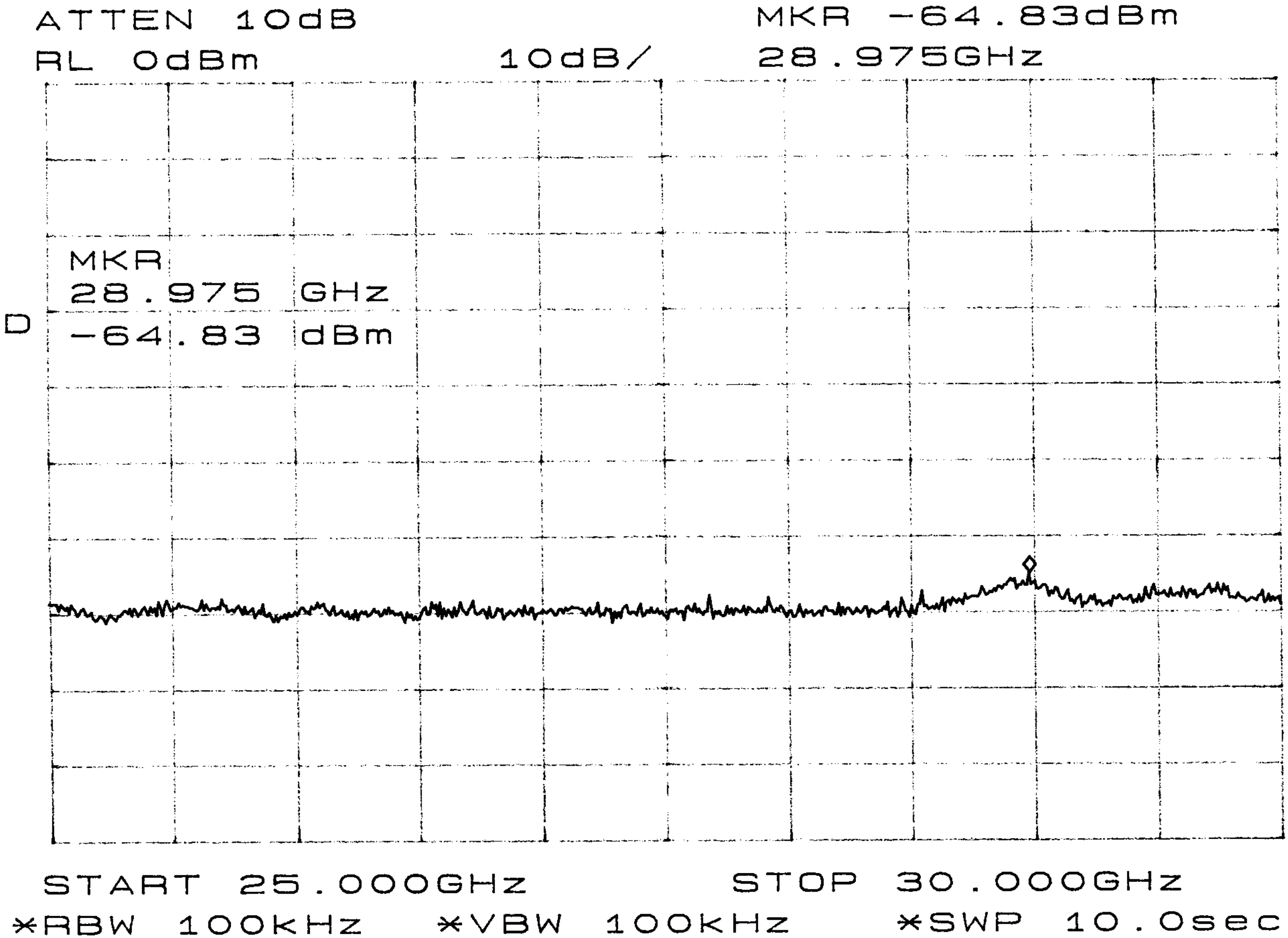

ATTEN 10dB
RL 0dBm
10dB/
MKR -53.00dBm
6.642GHz
MKR
6.642 GHz
-53.00 dBm
D
START 5.000GHz
STOP 10.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec

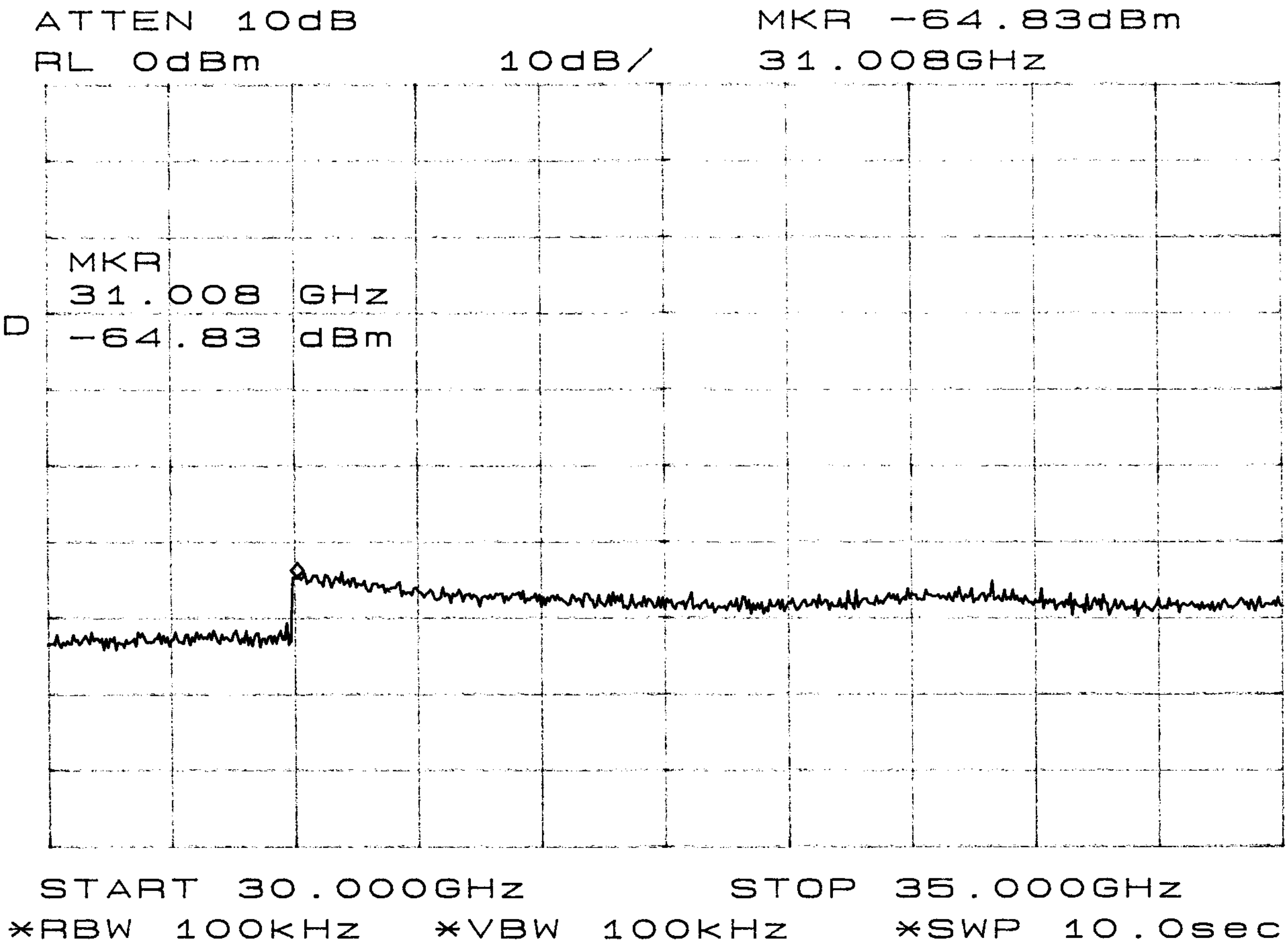

ATTEN 10dB
RL 0dBm
10dB/
MKR -57.50dBm
6.567GHz
MKR
6.567 GHz
-57.50 dBm
D
START 5.000GHz
STOP 10.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec

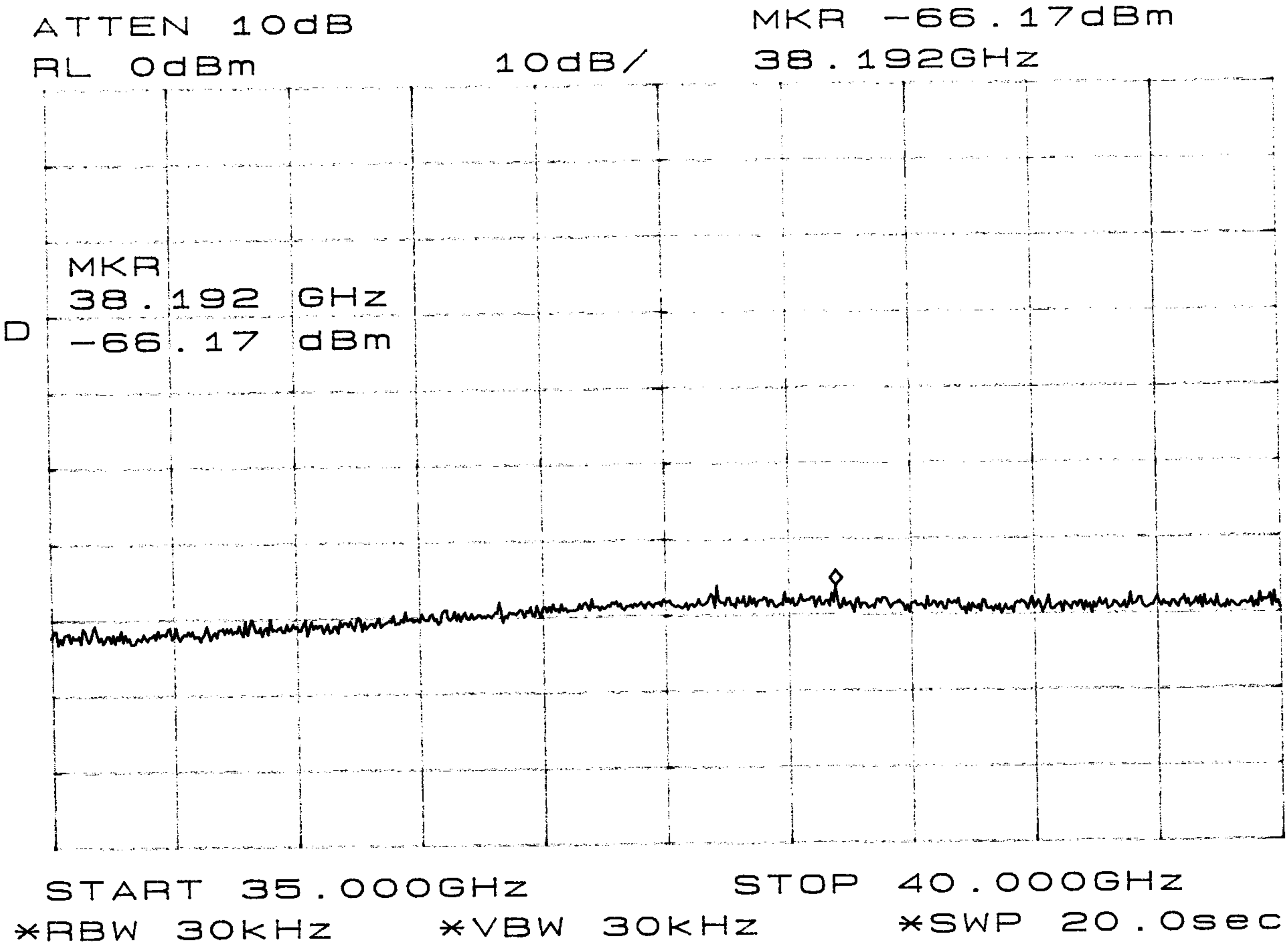

ATTEN 10dB
RL 0dBm
10dB/
MKR -70.50dBm
13.842GHz
MKR
13.842 GHz
-70.50 dBm
D
START 10.000GHz
STOP 15.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -61.33dBm
18.750GHz
MKR
18.750 GHz
-61.33 dBm
START 15.000GHz
STOP 20.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -65.67dBm
23.900GHz
MKR
23.900 GHz
-65.67 dBm
D
START 20.000GHz
STOP 25.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -64.83dBm
28.975GHz
MKR
28.975 GHz
-64.83 dBm
D
START 25.000GHz
STOP 30.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -64.83dBm
31.008GHz
MKR
31.008 GHz
-64.83 dBm
D
START 30.000GHz
STOP 35.000GHz
*RBW 100kHz
*VBW 100kHz
*SWP 10.0sec


ATTEN 10dB
RL 0dBm
10dB/
MKR -66.17dBm
38.192GHz
MKR
38.192 GHz
D
-66.17 dBm
START 35.000GHz
STOP 40.000GHz
*RBW 30kHz
*VBW 30kHz
*SWP 20.0sec