CSIRO DIVISION OF RADIOPHYSICS

SIDING SPRING A.T. INTERFERENCE SURVEY I

~~AT/15.77012~~ AT/15.5/012

CONTENTS

APPENDICES

1. INTRODUCTION

This report contains preliminary results and conclusions of interference measurements made at two sites around Siding Spring Mountain during the week 25 May to 2 June 1983. These sites correspond to the proposed alternative locations for an A.T. antenna. Test Site A′ is at higher elevation, being up the mountain hence is exposed to line-of-site transmitters etc. Test Site B′ is of lower priority but is located in a gulley behind the "quarry" giving better protection from interfering sources, however has a more restricted horizon. Sites A′ and B′ are only approximate locations to the exact preferred sites A1, A2 and B since access to these areas was restricted by weather and fencing. A third proposed location Site C approximately 2km away from the quarry towards Coonabarabran near the main road, was not tested.

Specifically the intention of the tests was to determine the suitability of the sites and to collect data on the statistics of the interfering signals.

2. DESCRIPTION OF TECHNIQUES AND EQUIPMENT

The test frequencies were:

(a) 327MHz
(b) 408MHz
(c) 1420MHz
(d) 2295MHz

The technique for carrying out the Interference measurements uses a Yagi, for the first two frequencies, and a horn, for the second two frequencies, feeding a low-noise radiometer. The required sensitivity is achieved by using a noise-adding radiometer system where the gain is stabilised by servoing on the added noise (gated). System stability depends on this noise source's stability. The system diagram and performance specifications may be found in Appendices A and B.

The survey consisted of azimuthal horizon scans, at each frequency, pausing 5-10 minutes on each 30° increment. To monitor each direction three types of data were taken:

(a) Average Total Power on the chart recorder
(b) Peak Detector on the chart recorder
(c) Photographs and Observation of the Spectrum Analyser

The observing bandwidth of the receiver was about 10MHz around the centre frequency.

Attention was paid to strong signals and their frequency structure was noted.

All four frequencies were tested at the preferred site A′ but only the worst case (in terms of interference) 408MHz was investigated at the lower, protected "quarry" site B′.

Calibration of the Noise-Adding Radiometer (NAR) system was via a wide-band, solid state, commercial noise source coupled to the input of the front-end. Application of a noise source calibrated the system in terms of the antenna temperature (knowing the temperature of the noise source and the attenuation).

3. RESULTS OBTAINED

(i) SUMMARY

(a) SITE A' (all figures are MHz unless otherwise stated)

* 327MHz Survey

  Vertical Polarization Scan (CF 327, BW 10)
  Horizontal Polarization Scan (CF 327, BW 10)

* 408MHz Survey

  Vertical Polarization Scan (CF 408, BW 10)
  Horizontal Polarization Scan (CF 408, BW 10)

* L-Band Survey

  45° Polarization Scan (CF 1420, BW 10)

* S-Band Survey

  Vertical Polarization Scan (CF 2295, BW 10)
  Horizontal Polarization Scan (CF 2295, BW 10)
  Balladoran Transmitter (CF 2251, BW 10) (1)
  Croxon Hill Transmitter (CF 2251, BW 10) (2)

(b) SITE B'

* 408MHz Survey

  45° Polarization Scan (CF 408, BW 10)

(c) PHOTOGRAPHIC LIST

Photograph #1	Balladoran Transmitter	2251	Site A'
Photograph #2	Croxon Hill Transmitter	2251	Site A'
Photograph #3	Typical + Swept Frequency Signal	408	Site A'
Photograph #4	Strong-short lived Signal	408	Site A'
Photograph #5	Typical at Quarry	408	Site B

Notes:

(1) Balladoran Transmitter data: Direction 201°azimuth, Range 77km, Receiver at Cen Cruaich, IF BW 36MHz, B/W ~ 3°. Vertical Polarization.

(2) Croxon Hill Transmtter data: Direction 92° azimuth, Range 24km, Receiver at Cen Cruaich, IF BW 36MHz, B/W ~ 3°. Horizontal Polarization.

(ii) DETAILS

(a) 327MHz Measurements

SITE A′ ONLY

Average Total Power

For a fixed direction, the Average Total Power (of the Noise-Adding Radiometer system) shows excursions of up to 160° K antenna temperature corresponding to a flux of 130000 Janskys. An average peak excursion of 50000 Jy was found in both polarizations (averaged over the azimuth scan). During quiet periods the fluctuation of the system temperature was approx. 2-3° K r.m.s.

Peak Detector

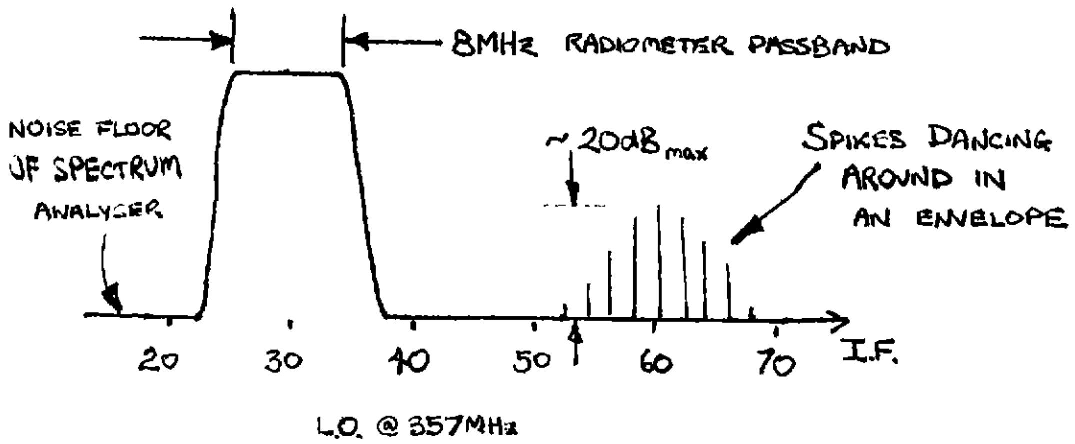
Active, corresponds with average total power.

Characteristic of the Interfering Signal

The main interference came on and off (mostly on) i.e. was of limited time duration. During 'on' times the signal varied (~ 30° K) 25000 Jys typically. The interference was to a certain extent polarization dependent, e.g. 120° SE direction, however all directions showed interference at both polarizations.

The Spectrum Analyser showed no constant CW signals within the observing passband. Very infrequently a signal would appear in the passband 5dB over system noise which caused an antenna temperature increase of 20° K. Its duration (1 observation) was < 30 seconds and appeared between 329-330MHz (direction south). Also a 10dB peak at a similar frequency was observed in a westerly direction which may be the same signal. N.B. Effect on total power by this signal is less than the other main interference of unkown origin.

An interesting signal however was observed outside the passband of the system and was above the noise floor of the spectrum analyser. The appearance was as follows.



This signal had some observable correlation with the average power variation hence may be the source of the interference. Clearly it must be a very strong signal before the attenuation. Otherwise the interference is probably broadband.

The system over the range of power levels measured had a non-linearity of ~ 20%. However this does not adversely affect the results (well within an order of magnitude) or the subsequent conclusions.

<u>Summary @ 327MHz</u>

There is definite but as yet undefined interference causing excursions in the test equipment's Average Total Power. The max flux estimate corresponding to this is 130000 Janskys. This interference is either broadband or well outside the bandwidth of the receiver. There was some intermittent CW interference however its effect was relatively minor.

As a whole it is recommended that a more detailed and definitive study be made at 327MHz to identify the signal and its characteristic statistics, at sites A' and B'.

AVERAGE TOTAL POWER DATA

Figures are based on peak excursion above quiet background.

Frequency 327MHz
Bandwidth 10MHz

TABLE 1 SITE A'

Azimuth Angle degrees	Vertical Polarization		Horizontal Polarization	
	Flux	Antenna Temp	Flux	Antenna Temp
0	41	50	74	90
30	48	58	60	73
60	129	156	69	84
90	43	52	55	67
120	62	75	26	32
150	26	31	22	27
180	22	27	41	50
210	35	42	17	21
240	17	21	36	44
270	108	131	117	142
300	40	49	52	63
330	40	49	40	49
Average	51	62	51	62
Standard dev	34	41	28	34

Units: Flux $\times 10^3$ (10^{26} W/m²/hz)
Temp ° K @ yagi antenna

Typical Calculation

Direction North (0° azimuth) with horizontal polarization:
Cal = 31.4° K
Signal = 2.9 x Cal = 90° K antenna temperature increase

A_e @ 327MHz = $\lambda^2 G/4\pi = 1.7m^2$ where G = 25 (14dB)

$$\therefore \text{Flux} = \frac{1.38 \times 10^{-23} \times 90}{1.7} \times 10^{26} \text{ Janskys}$$

$$= 74 \times 10^3 \text{ Janskys } (10^{26} \text{ W/m}^2/\text{hz})$$

(b) 408MHz Measurements

SITE A'

Average Total Power

There is extensive interference. The antenna temperature of the peak levels being considerably greater than 1000°K above ground radiation etc. The levels are polarization dependent. These levels correspond to 10^6 Janskys.

Peak Detector

Often saturating indicating impulsive type interference as well as the more slowly changing signal type captured on the Average Total Power.

Characteristics of the Interfering Signals

These may be classified as three types as seen and photographed on the spectrum analyser. All three contributed significantly to the average total power.

Class (i) Constant, fixed frequency, polarized and directional CW signals corresponding to "known" transmitters up to 20dB above system noise. There are about 12 transmitters total of this type visible in virtually every compass direction. Photograph #3 shows 5 such transmitters.

Class (ii) Very strong, short lived, fixed frequency, polarized and directional CW signals. Typically on 1-5 seconds and off 3 minutes, however these statistics are incomplete. Level was approximately 30dB above system noise. Probably 1 or 2 transmitters of this type noted. Photograph #4 shows the dominant signal direction (50° NE). The effect on system average total power was saturation. Unlisted transmissions.

Class (iii) Strong, swept frequency signal. It registered as in photographs #3 and #5 on the spectrum analyser as very narrow tall spikes. These spikes moved rapidly across the observing passband. The nature of its appearance on the photograph is due to the sampling characteristic of the spectrum analyser. The spike representing a single sample of the swept signal's modulation envelope. At max sweep rate on the spectrum analyser the complete modulating envelope was fleetingly visible. Level was approximately 25dB above system noise. This was an unlisted transmission.

AVERAGE TOTAL POWER DATA

Figures are based on peak excursion above quiet background

Frequency 408MHz
Bandwidth 10MHz

TABLE 2 SITE A'

Azimuth Angle degrees	Vertical Polarization		Horizontal Polarization	
	Flux	Antenna Temp	Flux	Antenna Temp
0	192	150	257	200
30	321	250	900+	700+
60	436	340	731	570
90	192	150	64	50
120	900+	700+	192	150
150	900+	700+	64	50
180	411	320	385	300
210	257	200	141	110
240	372	290	449	350
270	731	570	900+	700+
300	900+	700+	192	150
330	900+	700+	900+	700+

Key: 900+ means >900

N.B. since 900+ figures are indeterminate, azimuthal averages and standard deviations are not given.

Units: Flux $\times 10^3$ Jansky (10^{26} $W/m^2/hz$)
Temp ^oK @ yagi antenna

Typical Calculation

Direction East (90^o azimuth) with horizontal polarization: signal = 50^oK antenna temperature

A_e @ 408MHz = $\lambda G/4\pi = 1.08m^2$ where G = 25 (14dB)

$$\therefore \text{ Flux} = \frac{1.38 \times 10^{-23} \times 50}{1.08} \times 10^{26} = 64 \times 10^3 \text{ Janskys } (10^{26}\ W/m^2/hz)$$

SITE B'

Average Total Power

Average Total Power exceeded 500°K or 640 x 10^3 Janskys in many directions. The scaling was redefined to accommodate the peak levels involved. Levels of 1800°K or 2.3 x 10^6 Janskys were recorded. However over this range the system has dubious linearity, meaning that the intensities involved may be greater again.

Peak Detector

Often saturating indicating presence of strong impulsive interference.

Comment on Site B' Measurements

A data page summarizing the directional dependence of the interference is not given due to poor scaling chosen. Specifically the level saturated often. This coupled with the fact that data was taken with a 45° antenna polarization makes comparison with the site A' results difficult. As a general rough observation though, there didn't seem much directional correlation between the two sets of results in terms of intensity of interference activity. This implies perhaps interference has a transitory, temporal variation rather than a general spatial dependance.

Comparison of Sites A' and B' at 408MHz

Generally the quarry, with respect to site A', provided protection from the class (i) type signals however the class (iii) sweeping signal was still present and seemed to correspond in level with the observed fluctuations in the average total power. Class (ii)short, strong signals was also observed however this time outside the passband. The direction of the observed class (ii) signal corresponded with a depression in the horizon elevation, implying a different position in the quarry locale may also eradicate this signal.

The fact that both sites suffered from the sweeping signal interference at comparable levels seems to indicate that the source may have been airborne.

Summary and Reservations @ 408MHz

There seems to be heavy interference at 408MHz at both sites A' and B'. While the nature of the signals are known and categorized their exact identification is yet to be achieved. The transmitters visible in Photograph #3 don't seem to correspond in frequency and separation to known transmitters around 408MHz. This may indicate an error in the L.O. setting or measurement. Supportive of this conclusion is the comparison of the short-lived class (ii) signals shown in Photos #4 and #5 taken at the "Top" and in the "Quarry" respectively. Being in similar directions (azimuth) they may be the same signal hence one L.O. setting may be ~ 8MHz out.

Independent of the possible lack of calibration there still seems to be extensive interference around 408MHz. In particular the swept frequency signal seems just as strong in the Quarry as on top of the mountain (20-30dB).

As with 327MHz a more definitive survey at both sites is a necessary extension of the present investigation.

(c) 1420MHz Measurements

SITE A' ONLY

Average Total Power

Very quiet. The only discernible signal being that of the treeline (ground radiation). The ΔT fluctuation ($\sim 5^\circ K$) has its origins in the system instability rather than external interference.

Peak Detector

Short impulsive interference detected over a period of 30 seconds of unknown origin (direction NE). Corresponding to this the Average Total Power antenna temperature increase was $< 4^\circ K$. (This "interference" occurred during an azimuth increment hence may have been due to cable movement etc. rather than a real signal).

Summary @ L-Band

The top sites A1 and A2 would be suitable for an A.T. antenna at L-Band. This frequency band seems clear from CW and broadband interference.

AVERAGE TOTAL POWER DATA

Figures are based on estimated r.m.s. variation of system temperature.

Frequency 1420MHz
Bandwidth 10MHz

TABLE 3 SITE A'

Azimuth Angle degrees	45° Polarization	
	Flux (2)	Antenna Temp (1)
0	39	5.0
30	47	6.0
60	39	5.0
90	35	4.5
120	35	4.5
150	39	5.0
180	27	3.5
210	35	4.5
240	27	3.5
270	47	6.0
300	35	4.5
330	27	3.5
Average	36	4.6
Standard Deviation	7	0.9

Units: Flux $\times 10^3$ Jansky (10^{26} W/m^2/hz)
Temp °K @ horn antenna

Typical Calculation

Signal = 5°K

A_e @ 1420MHz = $\lambda^2 G/4\pi = 0.178 m^2$ where G = 50 (17dB)

$$\text{Flux} = 10^{26} \times \frac{1.38 \times 10^{-23}}{0.178} \times 5$$

$$= 39 \times 10^3 \text{ Janskys } (10^{26}\ W/m^2/hz)$$

Notes:

(1) This rms ΔT variation is due to system instability i.e. corresponds to the limit in sensitivity of the equipment.

(2) One may consider the flux as an upper bound on any interference that may have been present (but not detected).

(d) 2295MHz Measurements

SITE A' ONLY

Average Total Power

This was mainly quiet, any interfering signal being less than the level of trees and ground radiation in the horn antenna beamwidth. When directed towards the Siding Spring Observatory the system detected interference. for a few seconds, corresponding to an antenna temperature increase ~ 100°K.(1) Otherwise the power level corresponded with the tree coverage in the direction of the antenna.

Peak Detector

Quiet, a few minor insignificant peaks.

Balladoran Transmitter Monitoring

For this measurement the image rejecting filter was removed and the L.O. retuned for the system bandpass (~ 10MHz) to lie around 2251MHz. Average Total Power and Peak Detector were monitored yielding the following summarized results.

	Min.	Average	Max.
Antenna Temp (°K)	150	470	740
Flux (Jansky) (above system noise)	3.0×10^6	9.5×10^6	15×10^6

Photograph #1 shows the Balladoran transmitter spectrum. For this we may estimate the effective system temperature increase and compare with the above.

Assumptions:

Noise Bandwidth of System	10MHz
Signal Bandwidth estimation	300kHz (2)
System Temp..	500°K (3)

From photograph the peaks of the carrier above system noise is 17dB (≡ 50).

Hence

$$\text{Effective Antenna Temp. increase due to transmitter} = \frac{300 \times 10^3}{10 \times 10^6} \times 50 \times 500$$

$$= 750\ ^\circ K$$

Considering that the bandwidth of the signal is an estimate, as are most of the parameters, the order of magnitude correspondence with the Average Total Power record is quite good. Most of the transmitter power seems to be in the low modulation frequencies (< 500kHz) with another peak at 2MHz away from the carrier (double sideband).

Notes:

(1) This may not be a real signal at all. The NAR system servo loop was observed to 'drop out' momentarily causing an overshoot when it recovered. This overshoot might be interpreted incorrectly as a signal.

(2) Effective signal bandwidth estimate corresponds with the Spectrum Analyser setting since width of modulation appears out past 500kHz. This is only approximate.

(3) This is an estimate only. A more accurate figure is to be measured.

Estimated effect on 2295MHz Centred Survey

At 2251MHz the filter attenuation ≅ 30dB (min)

⇒ 0.5°K rise in average total power

Therefore the effect on this system would be less than its sensitivity hence unobservable.

Croxon Hill Monitoring

The same procedure as the Balladoran Transmitter was undertaken except the observation was at horizontal polarization rather than vertical polarization. The average total power results were as follows:

	Min.	Average	Max.
Antenna Temp. (°K)	150	180	300
Flux (Jansky) (above system noise)	3.0×10^6	3.7×10^6	6.1×10^6

Photograph #2 shows the Croxon Hill transmitter spectrum. Using similar assumptions as with the Balladoran case except now the signal is only 8dB (≡ 6.3) above system noise (rather than 17dB) we have:

$$\text{Effective Antenna Temp increase due to transmitter} = \frac{300 \times 10^3}{10 \times 10^6} \times 6.3 \times 500 = 95°K$$

Again this is a reasonable value and it is also clear that it would be impossible to detect this signal on the 2295MHz centred Average Total Power record due to system insensitivity.

Summary @ S-Band

No harmful interferring transmissions were observed at 2295MHz hence the top of the mountain (sites A1 and A2) may be considered suitable, as a preliminary judgement, for the location of an A.T. telescope at this frequency.

The two known transmitters at 2251MHz caused no adverse effects when observing in the narrow band 2295±5MHz.

AVERAGE TOTAL POWER DATA

Figures are based on estimated r.m.s. variation of system temperature.

Frequency 2295MHz
Bandwidth 10MHz

TABLE 4 SITE A'

Azimuth Angle (3) degrees	Vertical Polarization Flux (2)	Vertical Polarization Antenna Temp (1)	Horizontal Polarization Flux (2)	Horizontal Polarization Antenna Temp (1)
0	137	7	137	7
30	206	10	103	5
60	206	10	206	10
90	343	17	171	8
120	304	15	137	7
150	240	12	171	8
180	137	7	137	7
210	343	17	137	7
240	137	7	274	14
270	103	5	103	5
300	206	10	206	10
330	137	7	171	8
Average	208	10	162	8
Standard Deviation	84	4	48	2

Units: Flux $\times 10^3$ Jansky (10^{26} $W/m^2/hz$)

Temp °K @ horn antenna

Typical Calculation

Signal = 10°K

A_e @ 2295MHz = $\lambda^2 G/4\pi = 0.068m^2$ where G = 50 (17dB)

$$Flux = 10^{26} \times \frac{1.38 \times 10^{-23}}{0.068} \times 10$$

$$= 206 \times 10^3 \text{ Janskys } (10^{26}\ W/m^2/hz)$$

Notes:

(1) This rms ΔT variation is due mainly to system instability, i.e. corresponds to the limit in sensitivity of the equipment.

(2) One may consider the flux as an upper band in any interference that may have been present (but not detected).

(3) Directions of potential interference: Balladoran 201°, Croxon Hill 92°, SS Observatory 240°.

4. SITE CHARACTERISTICS

SITE A'

The equipment was placed on a raised part of the topology closer to the observatory road than originally planned. This was due to poor access to the desired site along the 4WD track, the heavy rains having restricted passage. The view around the horizon was treelined, with vertical clearance being impossible. The Cen Cruaich mountain TV tower and microwave dish towers were from the edge of the treeline. This site can be considered a worst case substitute for sites A1 and A2.

SITE B'

Complete access into the gully behind the quarry was restricted by fencing. The test site was adjacent to the main road having less protection than the real quarry site. The horizon elevation seemed greater than the measured 10-12° maximum. This site can be considered a worst case substitute for site B.

5. WEATHER CONDITIONS DURING OBSERVATIONS

* Fog during mornings
* Cold and damp during fogs
* Mostly cloudy with blue patches typically
* Winds were fairly constant and gusty
* Windier on Top than Quarry
* Temperature never above ~ 10°C
* Observations were not made during the rain periods

6. OBJECTIVES NOT ACHIEVED

Wet weather and time constraints restricted the original observing program. Types of measurement not performed (but which would have been desirable) were:

(i) 100MHz broadband observations of the spectrum (NB. This has associated problems of lack of image rejecting filter and aliasing due to 30MHz I.F.).

(ii) Identification and careful logging of the transmitters in the 408MHz band. Specifically correlating observed transmitters with the Department of Communications list (direction, polarization, frequency and strength, etc.)

(iii) Monitoring transmitters of limited time duration to determine the active times. However clearly this is a time-consuming procedure.

(iv) More complete statistics on transmitters and interference.

(v) Monitoring of broadband noise in the directions of large local towns particularly during wake-up times in the morning.

(vi) Observation of local TV stations, their possible harmonics (channels 5 and 6) and their effect on the astronomical bands.

(vii) Observation at frequencies 327, 1920 and 2295MHz at the Quarry site B'.

(viii) Site C was not tested.

7. EQUIPMENT RECOMMENDATIONS AND COMMENTS

(i) Spectrum Analyser

The HP 8558B spectrum analyser used lacked features which would be desirable namely:

* store facility or equivalent for short time duration signals
* max. level display available on newer spectrum analysers
* hard copy facility rather than photographs of CRO screen
* greater stability to enable more detailed spectral analysis
* preselector to avoid ambiguity with image spectrum.

(ii) Chart Recorder

The Rikadenki was not a field instrument and exhibited problems.

* damp atmosphere caused adverse effects
  - sprocket feed losing grip (paper became soggy)
  - pen ink washout
* probable increased power consumption over smaller units
* large physical size
* multipen facility (4) was useful however (necessarily) the different channels were displaced up to 1cm on paper, making correlation difficult.

(iii) Diesel Generator

Used for 250VAC power. This generator as distinct from a petrol generator caused no detectable interference at the four test frequencies. This would seem to imply that the observed interference from petrol generators comes from the ignition system used (spark plugs) rather than from the commutators and brushes etc.

(iv) Tower Extension for Tripod

At the location of the tests the tower gave insufficient elevation ($\sim$ 1.5m) for clearance of the tree-line. It is dubious that at other locations an advantage would be gained by this structure.

(v) Noise Adding Radiometer System

DC power supply instability is known to cause a significant proportion of the total systems instability manifesting itself as both drift and noise ripple on the total power record. The balancing network in the back-end uses this supply as a reference.

System linearity is also probably questionable over the large power range recorded, making calibration difficult.

(vi) General

RF cables were sensitive to movement.

Peak Detector circuit results lack reliability due to temperature instability and probably lack of calibration. Hence this report restricts itself to only qualitative references to peak detector results.

An original scheme to use inverters plus batteries would seem to be inconvenient and lack sufficient power to operate a number of instruments simultaneously especially in the light of the success of the Diesel Generator system.

As a whole if the information was logged digitally via a controlling computer this would be superior in many respects. Statistic analysis, which is the aim of the exercise, would be simple, direct and automatic rather than relying on eye-ball estimation of r.m.s. levels etc. Disc stored information would be more compact and processable.

8. GENERAL CONCLUSION

The results obtained at the four test frequencies lead to the following recommendations.

Further tests at L and S band are unnecessary, these frequencies being relatively interference free (at least during monitoring periods).

At 327MHz moderate levels of interference were recorded. As yet the source is to be identified. If it appears, as it might be, that the interference is due to a very strong signal outside the (astronomical) band then appropriate filtering should reduce its potential adverse effects on the AT. A further interference test excursion should seek to identify this source unambiguously.

The 408MHz band receives interference from three types of transmission. These are all potentially hazardous to AT operation. Further interference tests are probably necessary to give a more complete account of their statistics. Also complete correlation with known Department of Communications listed tranmitters would be desirable.

Comparison of sites showed the Quarry (Site B') to be marginally better in terms of interference rejection. Further tests will more completely define the relative merits of the different sites. The third site C could also be included in further tests.

Also a possible scenario is the testing of a further frequency around 610MHz, given that this would require minimal additional hardware. This may be particularly valuable if it is found either 408MHz or 327MHz is unacceptable as an AT frequency due to interference.

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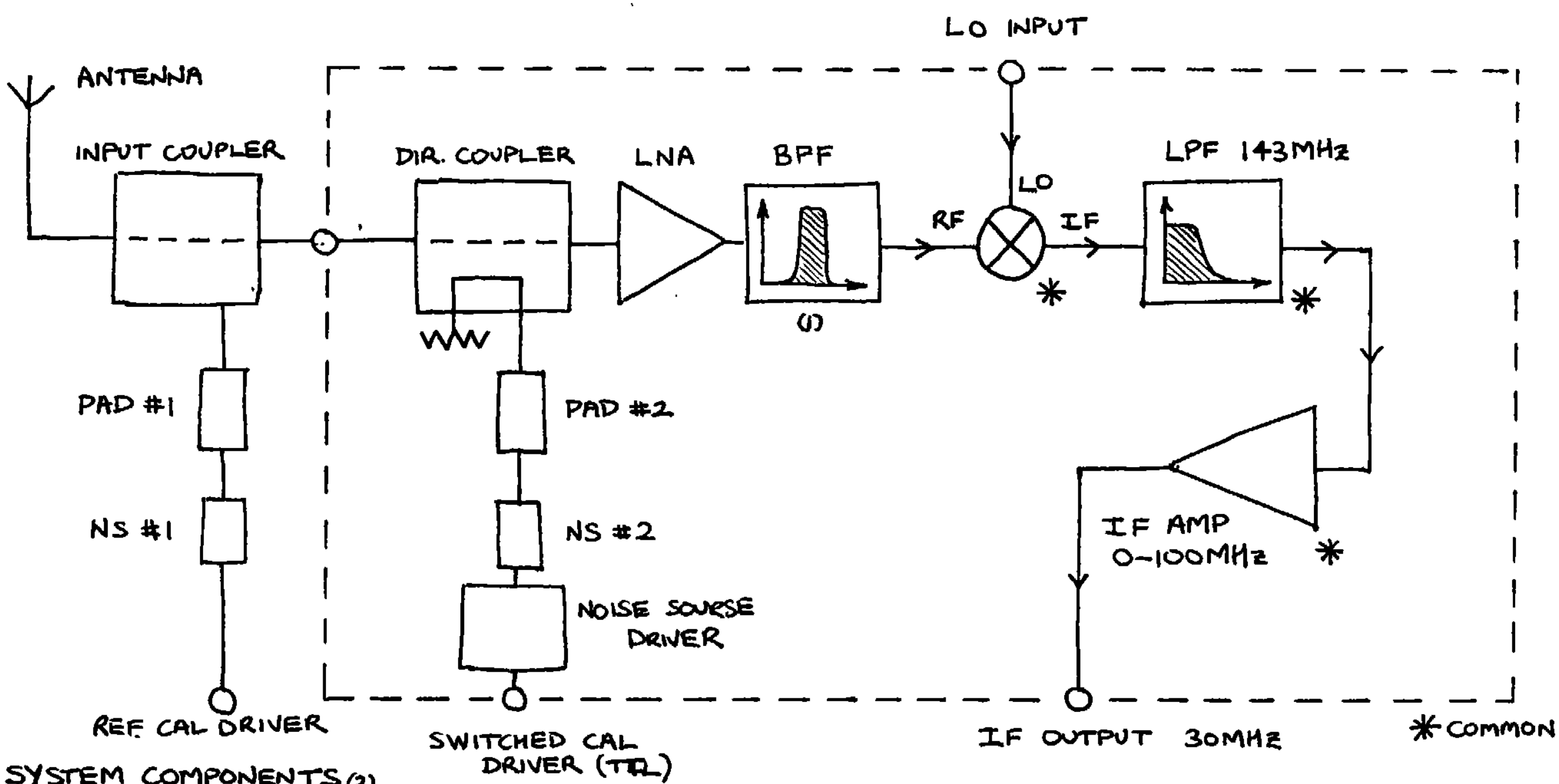
G.F. GERRARD

I. McCURLEY

APPENDIX A SYSTEM DIAGRAMS



SYSTEM COMPONENTS (2)

FREQUENCY	ANTENNA	INPUT COUPLER	PAD #1 (3)	NS #1	DIR. COUPLER	PAD #2	NS #2	LNA	BPF(BW)	LO
327	YAGI #1	20dB C22118	6dB	AIL 07615	20dB CUSTOM #1	20dB	CUSTOM #1	MITEQ	327 (18)	HP
408	YAGI #2	20dB C22118	0 dB	AIL 07615	20dB CUSTOM #1	20dB	CUSTOM #1	MITEQ	408 (20)	HP
1420	HORN #1	20dB 1257	6 dB	AIL 07615	20dB CUSTOM #1	10 dB	CUSTOM #1	MITEQ	1420 (36)	SANDERS 1
2295	HORN #2	20dB 1257	6 dB	AIL 07616	20dB CUSTOM #2	0 dB	CUSTOM #2	MICROMEGA	2295 (50)	SANDERS 2

NOTES:

(1) REMOVE FOR "BROADBAND"
(2) FIGURES ARE APPOXIMATE ONLY
(3) VARIED. ATTENUATION DEPENDED ON LEVEL OF INTERFERENCE

DIAGRAM 1. TEST FRONT END

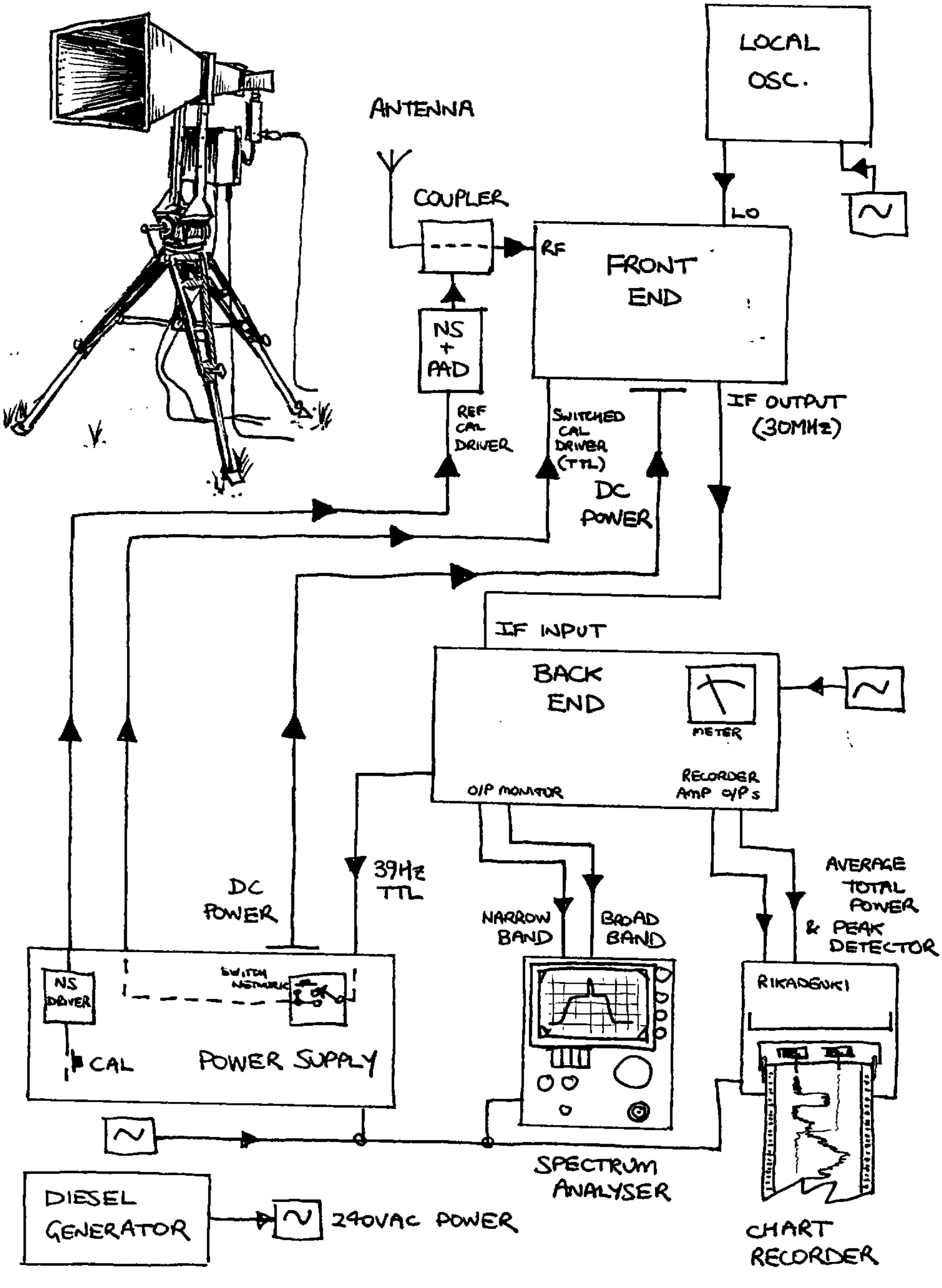
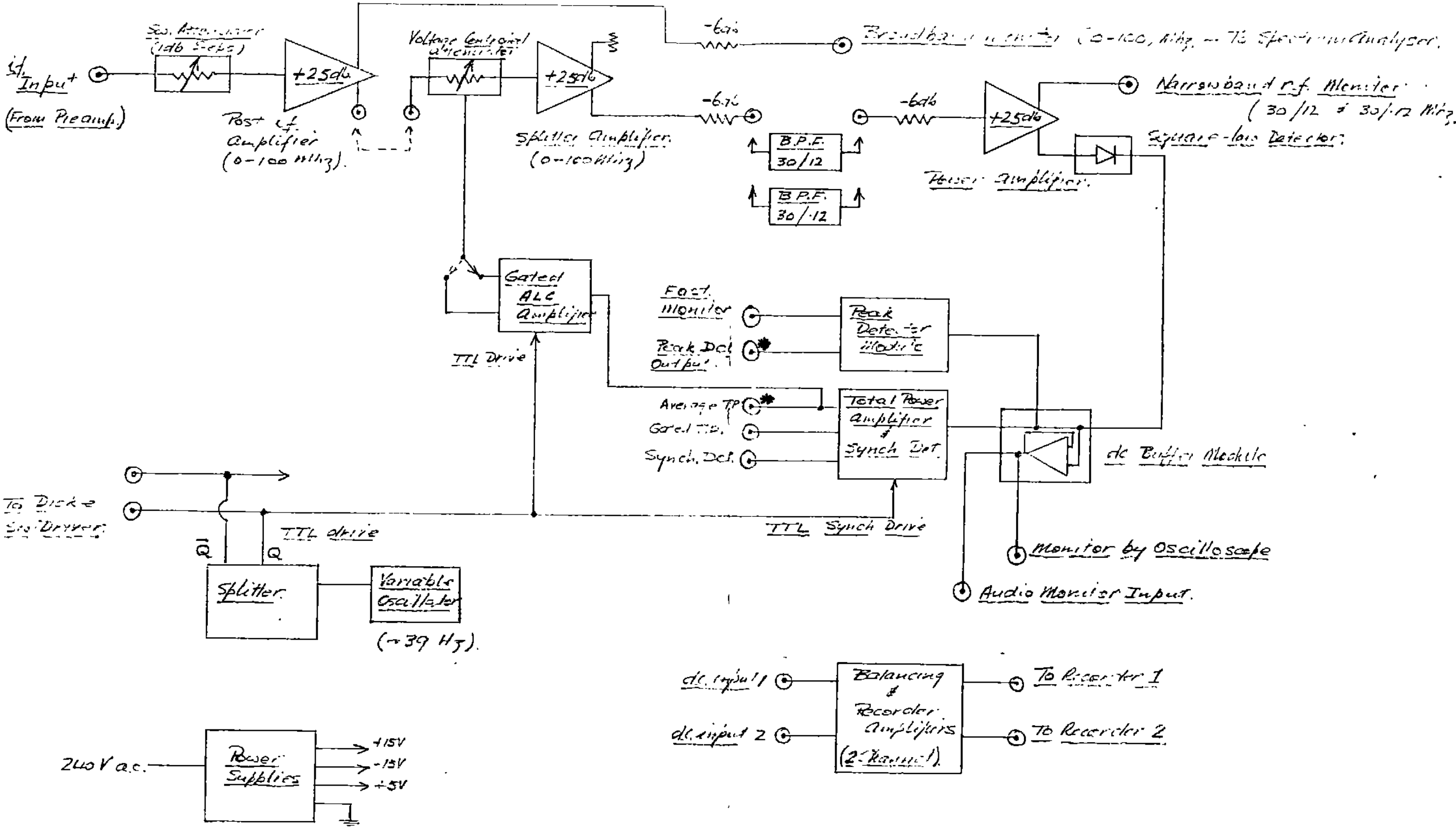


DIAGRAM 3. COMPLETE SYSTEM SCHEMATIC

DIAGRAM 2. i.f. Test Backend



APPENDIX B SYSTEM PARAMETERS

TEST ANTENNAS

			Gain	Beamwidth
@ 327MHz	13 element	Yagi	14dB	30°
@ 408MHz	13 element	Yagi	14dB	30°
@ 1420 MHz		Horn	17dB	24°
@ 2295 MHz		Horn	17dB	24°

SYSTEM TEMPERATURES (1)

327MHz	500°K
408MHz	500°K
1420MHz	500°K
2295MHz	500°K

POST LNA BAND PASS FILTERS (2)

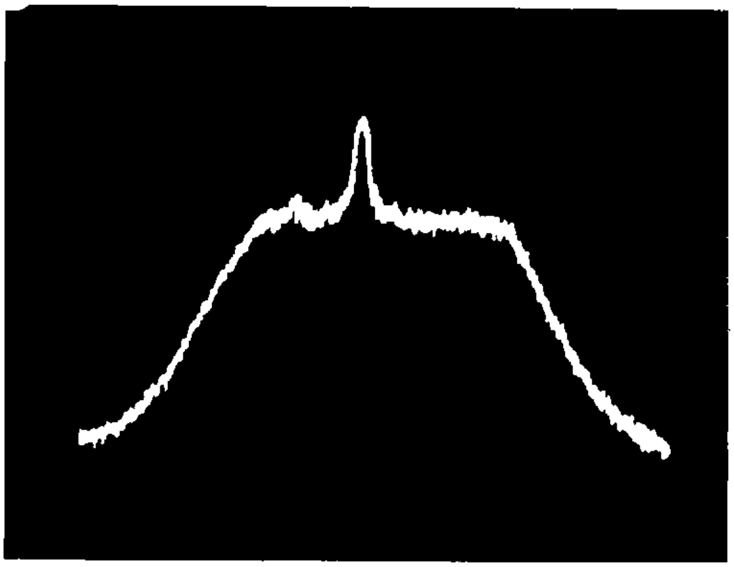
Centre Frequency	Bandwidth
327	18
408	20
1420	36
2295	50

Notes:

(1) Preliminary only

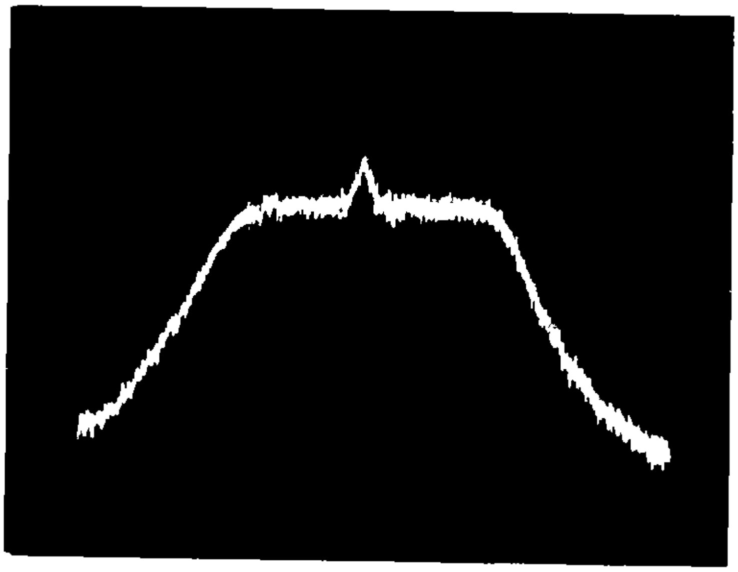
(2) System bandwidth determined by Back-End (10MHz)

APPENDIX C SPECTRUM ANALYSER PHOTOGRAPHS



PHOTOGRAPH #1 BALLADORAN TRANSMITTER 2251 SITE A'

Scales:	2MHz/div Horizontal	10dB/div Vertical
Data:	300kHz Bandwidth	2279.1MHz LO
	2251MHz Carrier	Vertical Polarization



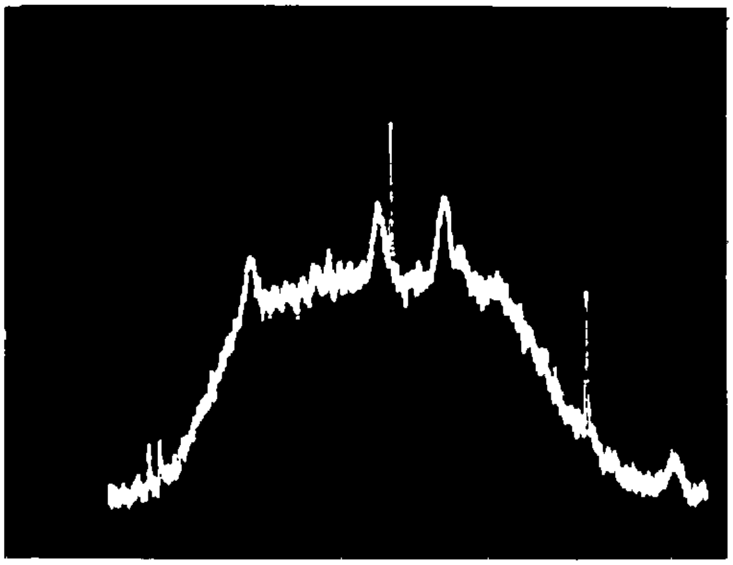
PHOTOGRAPH #2 CROXON HILL TRANSMITTER 2251 SITE A'

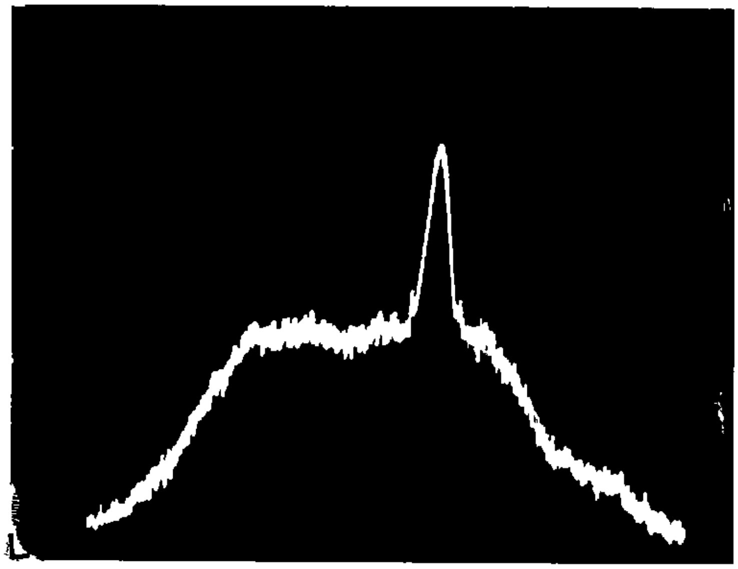
Scales:	2MHz/div Horizontal	10dB/div Vertical
Data:	300kHz Bandwidth	2279.1MHz LO
	2251 MHz Carrier	Horizontal Polarization

PHOTOGRAPH #3 TYPICAL + SWEPT FREQ. SIGNAL 408 SITE A'

Scales: 2MHz/div Horizontal
10dB/div Vertical

Data: 300kHz Bandwidth
437.99MHz LO
408MHz CF
Vertical Polarization





PHOTOGRAPH #4 STRONG SHORT-LIVED SIGNAL 408 SITE A'

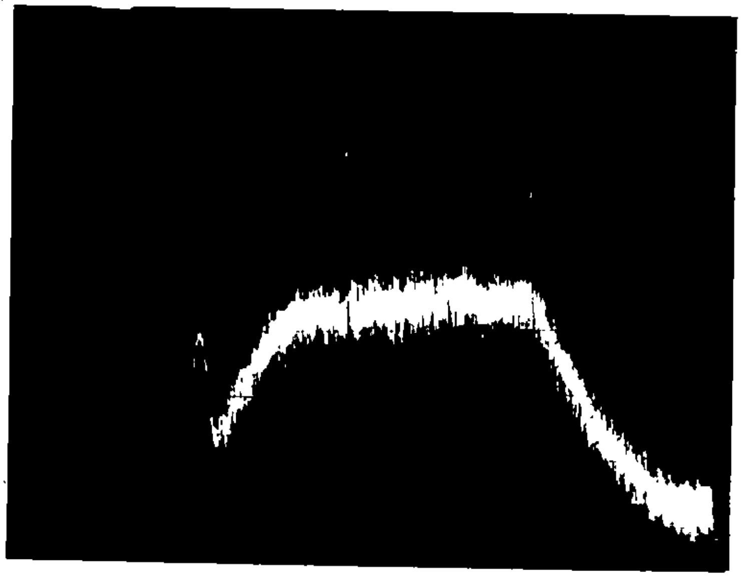
Scales: 2MHz/div Horizontal
10dB/div Vertical

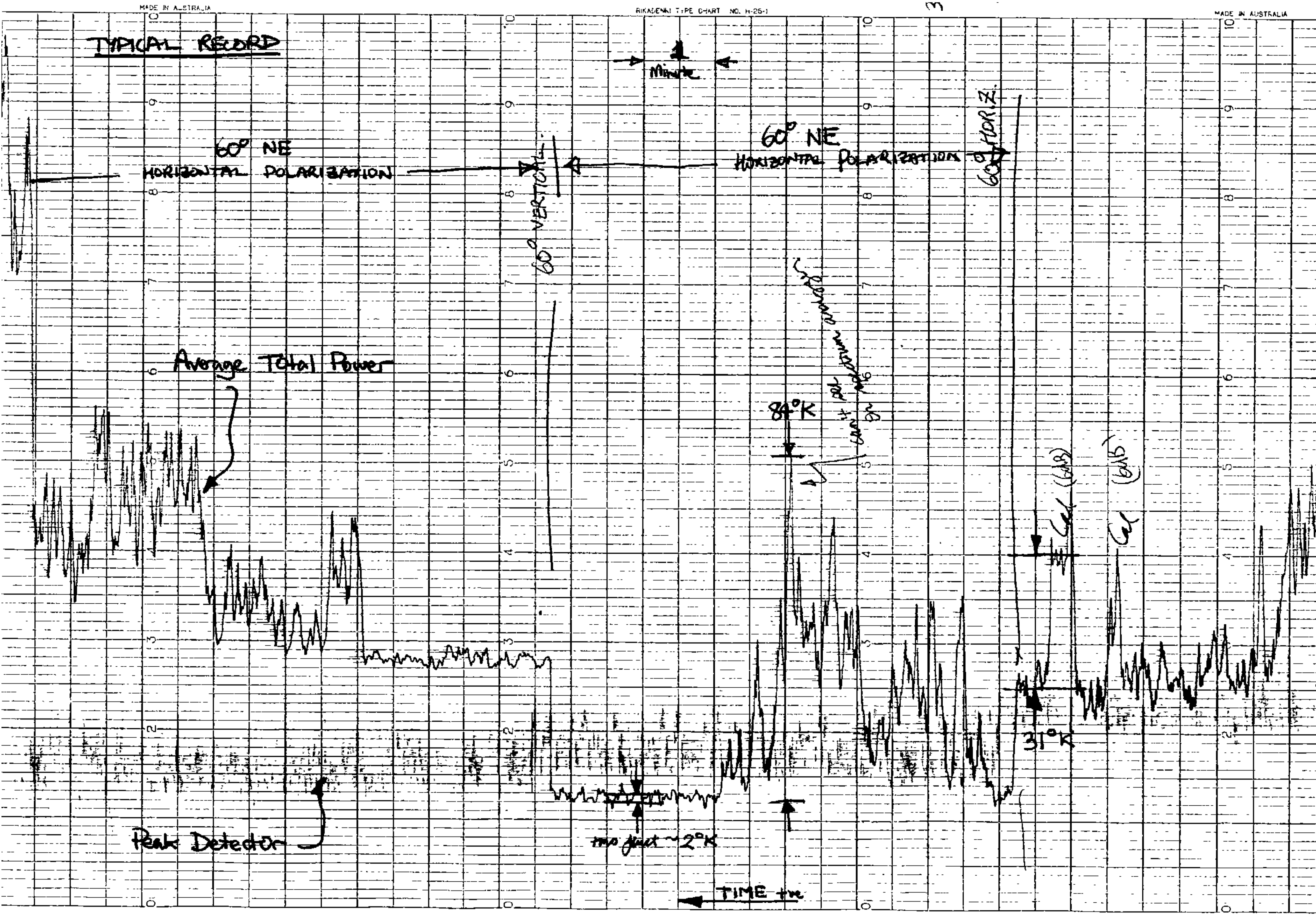
Data: 300kHz Bandwidth
437.99MHz LO
408MHz CF
Vertical Polarization

PHOTOGRAPH #5 TYPICAL AT QUARRY 408 SITE B'

Scales: 2MHz/div Horizontal
10dB/div Vertical

Data: 300kHz Bandwidth
438.02MHz LO
408MHz CF
45° Polarization





MADE IN AUSTRALIA
RIKADENKI TYPE CHART NO. H-25-1
MADE IN AUSTRALIA
TYPICAL RECORD
1 Minute
60° NE
HORIZONTAL POLARIZATION
60° VERTICAL
60° NE
HORIZONTAL POLARIZATION
60° HORZ.
Average Total Power
84°K
can't see on spectrum analyzer
Cal (6dB)
Cal (6dB)
31°K
Peak Detector
two fluct ~2°K
TIME +ve

INTERFERENCE TEST SITES