RADIOCOMMUNICATIONS AGENCY

Airborne Radar Interference into 32 GHz Fixed Links

An RTCG Project Report

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Radio Technology & Compatibility Group

Project No. 563

Airborne Radar Interference into 32 GHz Fixed Links

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Project Engineer: R. Drinkwater
Project Manager: J. Mellish
Checked by: J.Mellish

Approved by: B. Ottaway

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RADIOCOMMUNICATIONS AGENCY
Radio Technology & Compatibility Group,
Whyteleafe Hill,
WHYTELEAFE,
Surrey. CR3 0YY

Tel. Int. +44(0)20 8763 4000
Fax. Int. +44(0)20 8668 9856

ABSTRACT

The band 31.8-33.4 GHz is allocated to the fixed service and the radionavigation service on a co-primary basis. The band is also identified as being available for high-density applications in the fixed service. This project is a study of the potential to disrupt the operation of high-density applications in the fixed service due to interference from airborne radar systems in the radionavigation service.

KEYWORDS

RADAR, QPSK, QAM, FASS, Interference, telco, link, 32 GHz.

CONTENTS

LIST OF ABBREVIATIONS

BER	Bit Error Ratio
FASS	Frequency Agile Signal Simulator
RADAR	Radio Detection And Ranging
QPSK	Quadrature Phase Shift Keying
QAM	Quadrature Amplitude Modulation
S/A	Spectrum Analyser

1.0 INTRODUCTION

The band 31.8-33.4 GHz is allocated to the fixed service and the radionavigation service. In addition, the band is also identified as being available for high-density applications in the fixed service. In terms of fixed service use, the band could be used to support the infrastructure for 3G mobile telephony systems. Airborne radar systems in the radionavigation service use high power pulsed signals for ground mapping, weather avoidance and to calibrate aircraft on-board navigation systems for accurate aerial delivery in adverse weather conditions. These systems are used primarily to provide emergency relief during humanitarian disasters. The aim of this project will be to assess the impact of interference from these airborne radar systems into stations of the fixed service.

1.1 Equipment tested

Two fixed link equipments were loaned for test. These employed QPSK and 128 QAM modulation.

2.0 TEST METHOD

The aircraft RADAR signal was simulated on the FASS, according to Annex 1 of IFPG/F2(99)/54, System 1. As the FASS is unable to operate above 3 GHz, the RADAR signals were generated at 2500 MHz and up-converted to the band required.

2.1 QPSK link

The equipment was connected as shown in Fig. 1.

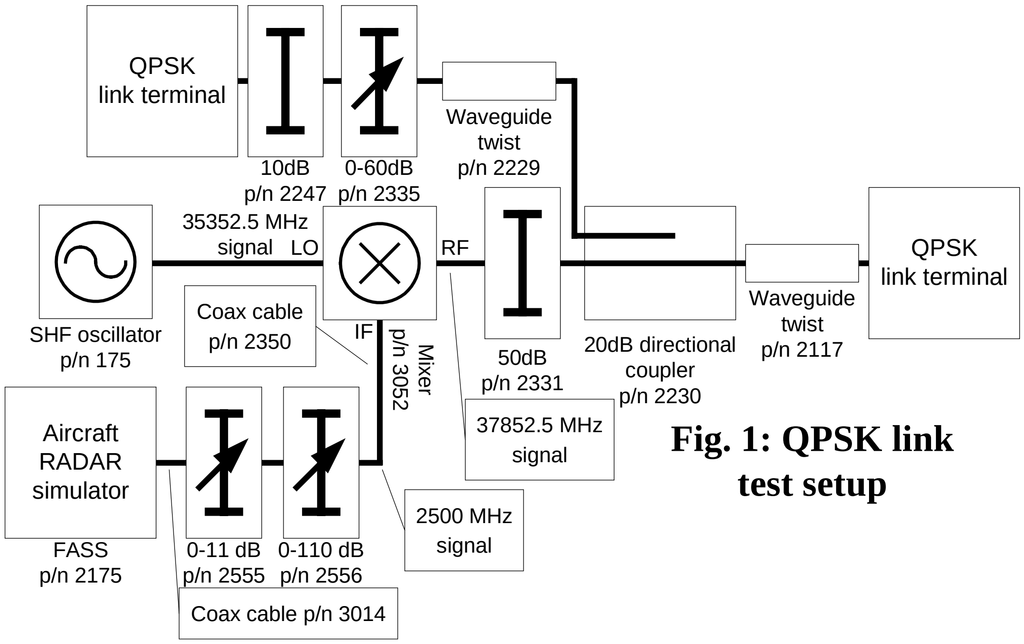

Fig. 1: QPSK link test setup

The QPSK link equipment was supplied as a 37 GHz version. The frequency difference between this and 32 GHz (a fraction of an octave) should not significantly affect the results of the tests.

The peak power of the wanted and unwanted signals present at the input port of the receiver were determined following measurement with the 50 GHz S/A, plant number 2747, and the application of a correction factor to correct for the bandwidth limitations of the S/A.

The correction factor for the unwanted signal was determined by measurements at 2500 MHz with the Boonton power meter equipment, plant numbers 2831/2973/2974, and the S/A. The correction factor for the wanted signal was determined in a similar manner following down-conversion and bandpass filtering. The application of correction factors to S/A measurements was necessary to overcome the frequency and sensitivity limitations of the power meter sensors that were available.

The wanted signal, in the absence of RADAR interference, was applied to the receiver input, and the BER was measured on transmission test set, plant number 2255, at various input levels. Results are shown in Fig. 3.

Having determined the wanted signal level for a BER of 1 part in 10^{-6}, the wanted signal level was increased by 1 dB. Co-channel interference from the RADAR simulator was then applied at various levels, and the effect on the BER noted. Results are shown in Fig. 4.

The recovery time, from any level of interference, back to a BER of 1 part in 10^{-6} or better, was less than 1 second, the period that the transmission measuring set took to indicate the initial value of the BER.

2.2 QAM 128 link

The equipment was connected as shown in Fig. 2.

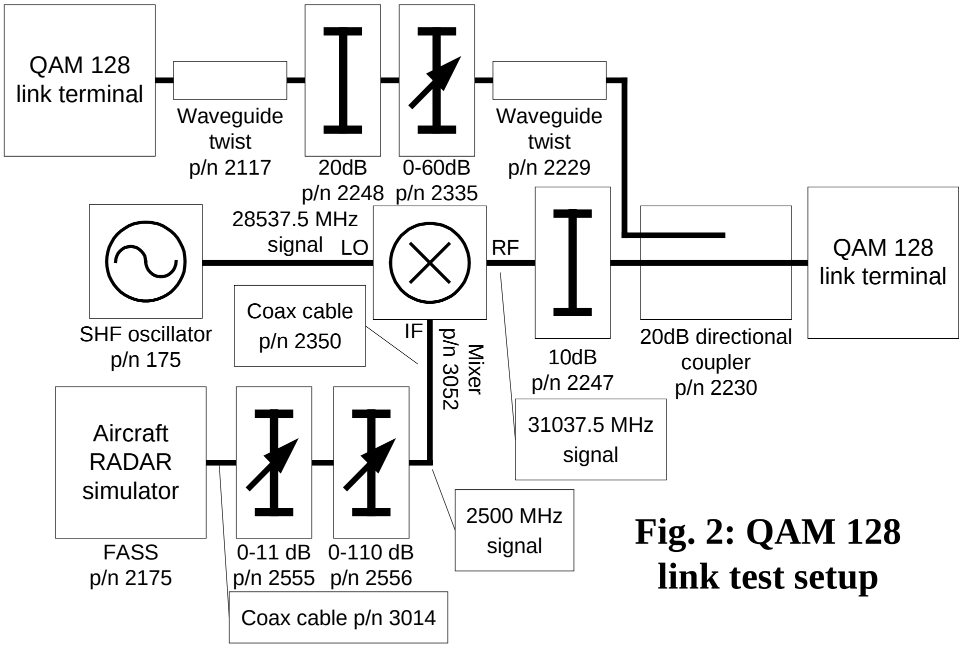

Fig. 2: QAM 128 link test setup

The peak power of the wanted and unwanted signals present at the input port of the receiver were determined following measurement with the 50 GHz S/A, plant number 2747, and the application of a correction factor to correct for the bandwidth limitations of the S/A.

The correction factor for the unwanted signal was determined by measurements at 2500 MHz with the Boonton power meter equipment, plant numbers 2831/2973/2974, and the S/A. The correction factor for the wanted signal was determined in a similar manner following down-conversion and bandpass filtering. The application of correction factors to S/A measurements was necessary to overcome the frequency and sensitivity limitations of the power meter sensors that were available.

The wanted signal was applied to the receiver input, at various input levels, in the absence of RADAR interference, and the BER was measured on a computer connected to the serial port of the link control unit. Results are shown in Fig. 5.

Having determined the wanted signal level for a BER of 1 part in 10^{-6}, the wanted signal level was increased by 1 dB. Co-channel interference from the RADAR simulator was then applied at various levels, and the effect on the BER noted. Results are shown in Fig. 6.

The recovery time, from any level of interference, back to a BER of 1 part in 10^{-6} or better, was about 11 seconds, the period that the equipment took to indicate the initial value of the BER.

3.0 TEST RESULTS

3.1 QPSK results

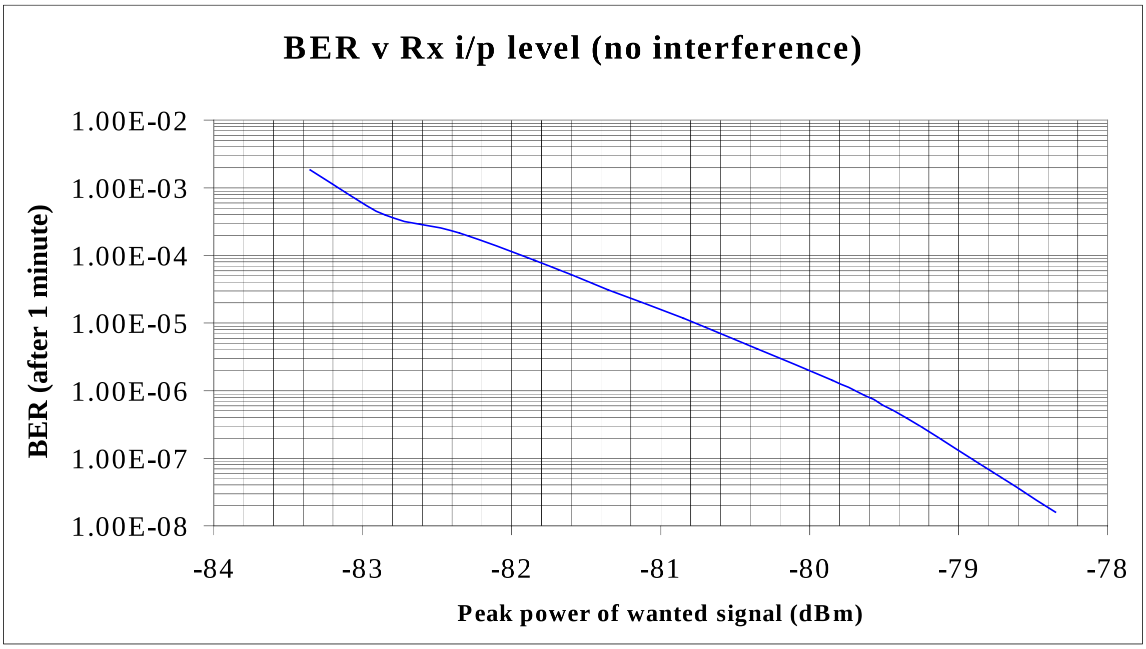

Fig. 3: QPSK link: BER v wanted signal level

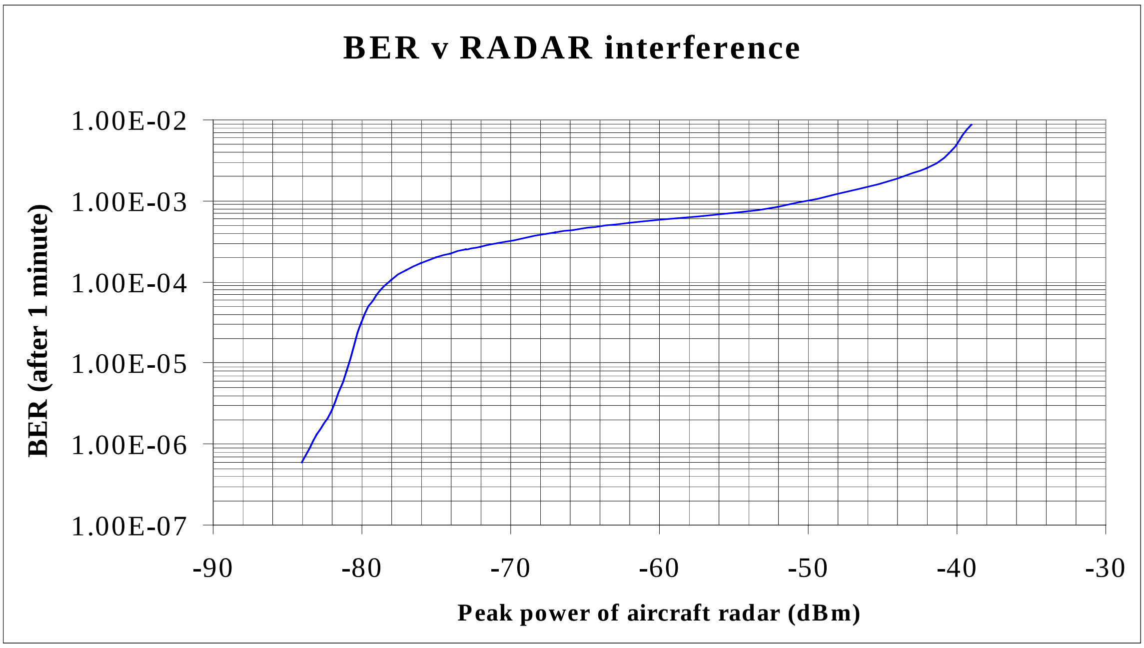

Fig. 4: QPSK link: BER v RADAR signal level

3.2 QAM 128 results

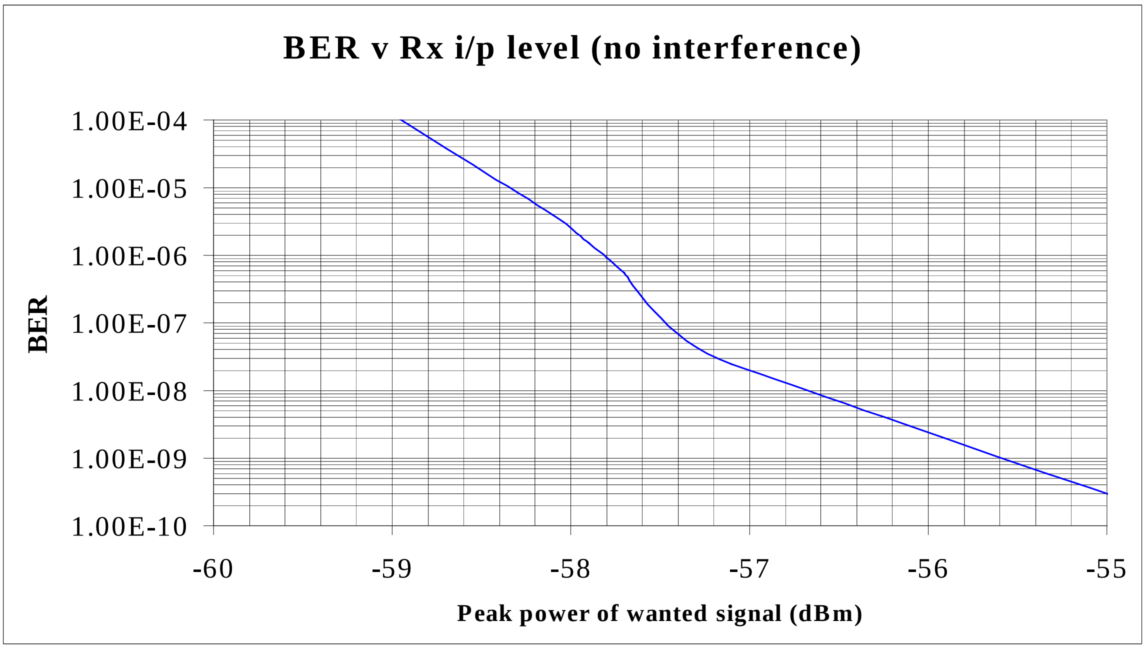

Fig. 5: QAM 128 link: BER v wanted signal level

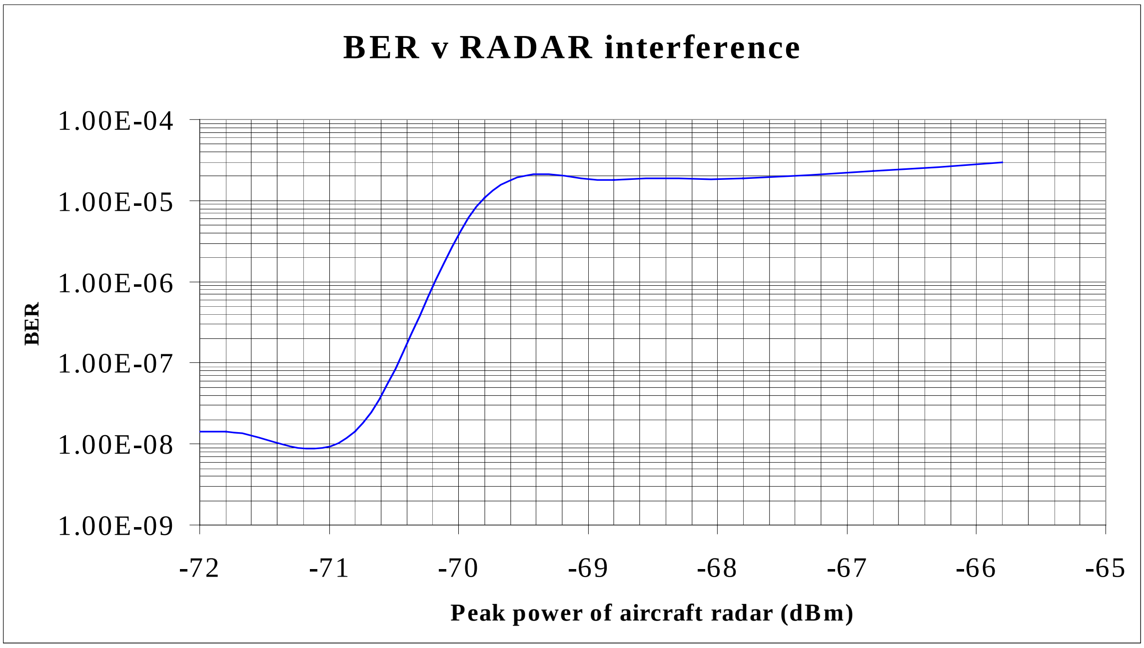

Fig. 6: QAM 128 link: BER v RADAR signal level

4.0 MEASUREMENT UNCERTAINTY

Measurement uncertainty is 5.1 dB, which is based on a standard uncertainty multiplied by a coverage factor k=2, providing a level of confidence of approximately 95%.

5.0 CONCLUSIONS

The results indicate that the BER of fixed service links will suffer as a result of airborne radar interference. However, the recovery time after BER degradation is rapid following removal of the interference. As the airborne radar systems generally move rapidly, careful orientation of the fixed links away from routes parallel to established airways should minimise loss of service (LOS), as the duration of the interference into the main lobe of fixed link antenna will be short. It may be pertinent that operators consider using antennas with a narrower beam-width than is traditional for this particular type of service in other fixed service bands, to minimise the LOS when it occurs. It should also be noted that it was not possible to subject the fixed link equipments to the maximum interference level that could potentially be experienced in reality. This maximum level[1] is about 30 dB above the highest interference level used in this study. Although it is considered unlikely that interference of this level would result in permanent damage or an extended recovery time, this cannot be confirmed.

6.0 KEY EQUIPMENT USED

Plant number	Manufacturer	Model number	Equipment type	Serial number
175	HEWLETT-PACKARD	83640A	Sweep Generator	3119A00489
1663	HEWLETT-PACKARD	Q8486A	Power Sensor	2503A00302
1664	HEWLETT-PACKARD	R8486A	Power Sensor	2503A00502
1665	HEWLETT-PACKARD	436A	RF Power Meter	2620U03905
2229	FLANN MICROWAVE.	22450-90	Waveguide Twist	NSN
2230	FLANN MICROWAVE.	22130-20	Waveguide Directional Coupler	431
2239	FLANN MICROWAVE.	22093-KF20	Waveguide to Coax	387
2247	FLANN MICROWAVE.	22081-10	Waveguide Attenuator	31
2248	FLANN MICROWAVE.	22081-20	Waveguide Attenuator	24
2255	HEWLETT-PACKARD	3784A	Analyser (Other)	3117U01309
2331	FLANN MICROWAVE.	22082-A1	Waveguide Attenuator	22
2335	FLANN MICROWAVE.	22110	WAVEGUIDE VARIABLE ATTENUATOR	570
2350	ROSENBERGER MICRO-COAX	UFA210A-0-0394	Coaxial Cable	6108
2351	ROSENBERGER MICRO-COAX	UFA210A-0-0394	Coaxial Cable	6114
2555	HEWLETT-PACKARD	8494B	Attenuator Switched	3308A33439
2556	HEWLETT-PACKARD	8496B	Attenuator Switched	3308A20864
3014	SEMFLEX INC	5151-DKF-0079	Coaxial Cable	380000438
3052	SPACER LABS INC	MKA20E	Mixer	0F14

7.0 REFERENCES

[1] IFPG/F2(99)54 contains a theoretical study assessing interference from the RNS into stations of the FS in the band 31.8→33.4 GHz.

An electronic version of this document can be found on the Agency's web site at http://www.radio.gov.uk.

END OF REPORT