Hardware Development
Feeds and Receivers
AT/44.2/020
AT/39.3/041

AUSTRALIA TELESCOPE NATIONAL FACILITY

SETI Circular Polarisation Requirements

Introduction

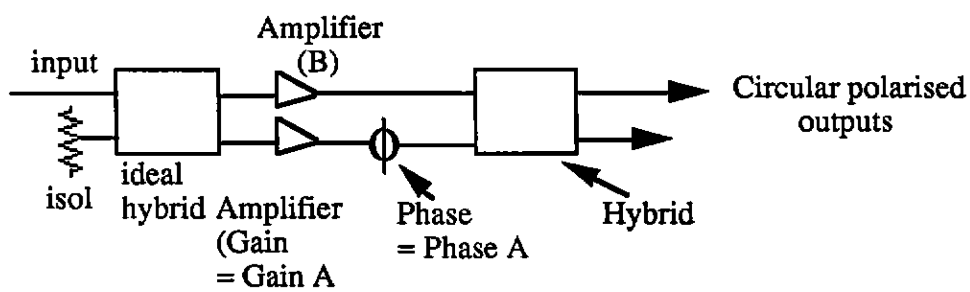
For the SETI (Phoenix) observations at Parkes and Mopra, we need to form circular polarisation. The purity of the polarisation does not need to be excessively high. For the Verification Site, the cross polarisation isolation needs to be 16 dB or greater (between the two circular polarisations at the IF output). For the Primary Observation Site, the isolation between the circular polarised outputs is also 16 dB. (There is the additional requirement of a prime focus feed polarisation isolation of at least 23 dB).

For both sites, it is proposed to form circular polarisation by use of a 90 degree hybrid, after the low noise amplifiers. As these amplifiers will have differences in their amplitude and phase characteristics, I was interested in estimating the maximum amount of amplitude and phase differences which would still allow the system to meet the requirements. Of course, I would not aim for just the minimum requirements: the higher the polarisation requirements, the better.

Procedure

I could simply use mathematics to determine the maximum allowed amplitude or phase errors. However, I decided to use our microwave analysis program (one of the EEsof programs). It is quick, easy and has good output plotting facilities.

The circuit consists of:



By varying the gain of the A channel, relative to that of the B channel, the isolation between the circular polarised outputs may be measured.

Similarly, the phase difference may be varied, or a combination of amplitude and phase offset used.

Note that I have assumed infinite isolation between the two channels. The OMT (ortho mode transducer) has high isolation and should not be a significant factor in the following results.

Results

The graphs obtained for various gain and phase offsets follow the conclusion. Briefly, for the 16 dB isolation requirement:

(a) If the phase offset is 0 degrees, the gain may vary by approximately ± 2.5 dB .

(b) If the gains of the amplifiers are identical, the phase error may be up to ± 20 degrees.

(c) For a gain error of ± 1 dB, the phase error may be up to about ± 15 degrees.

Conclusions

Providing the amplifiers are fairly well matched, it may not be particularly difficult to achieve an isolation of 16 dB between the circularly polarised outputs.

A phase shifter will be needed to provide a means of optimising the isolation across the band.

I have looked for a mechanical variable attenuator designed to work over the L (1.2 - 1.8 GHz) or S band (1.8 - 3.0 GHz), but have not found any suitable. We will need to set the amplitude with a fixed attenuator.

George Graves
5th September, 1994

GRG/gam:52/94

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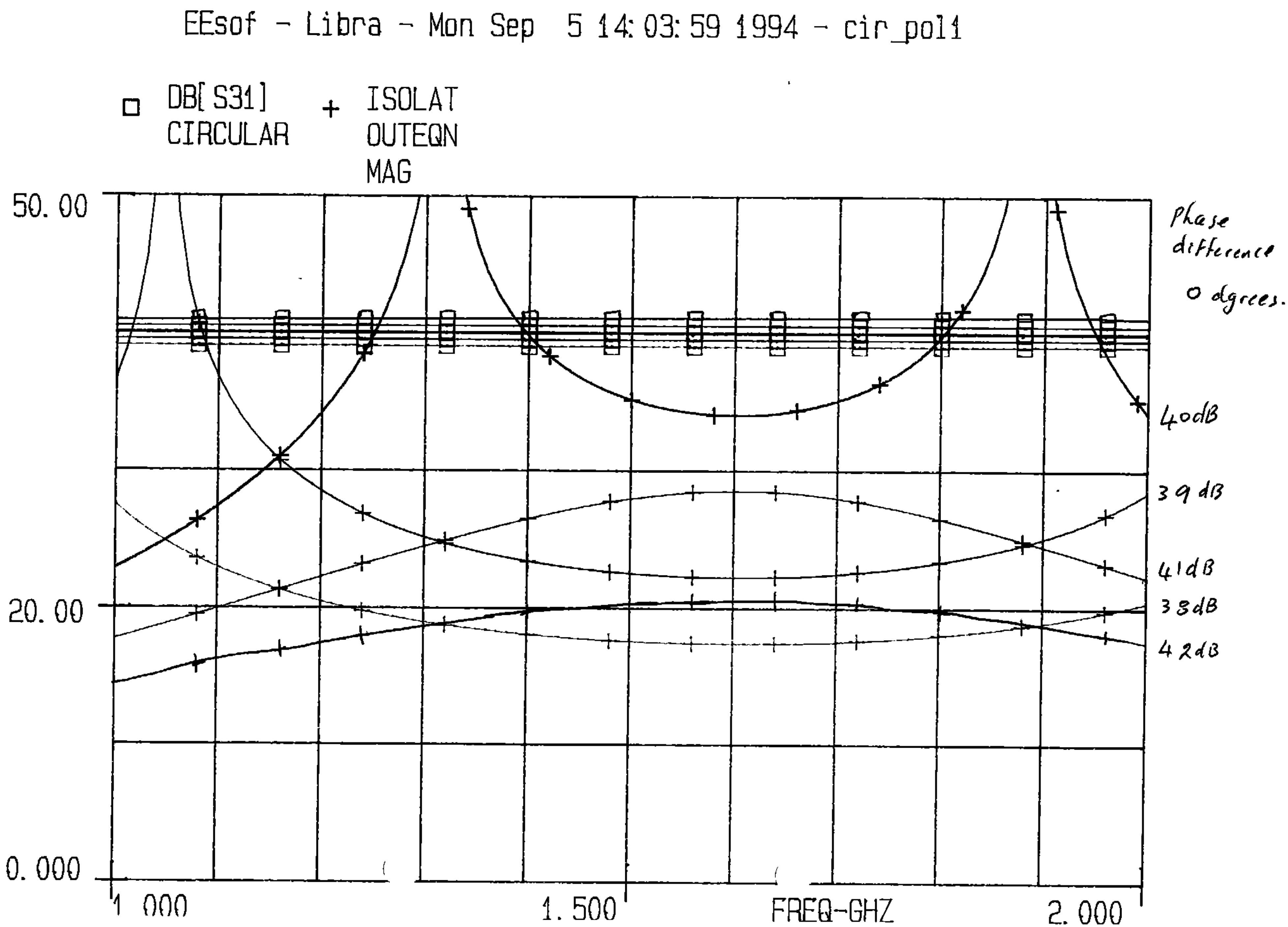
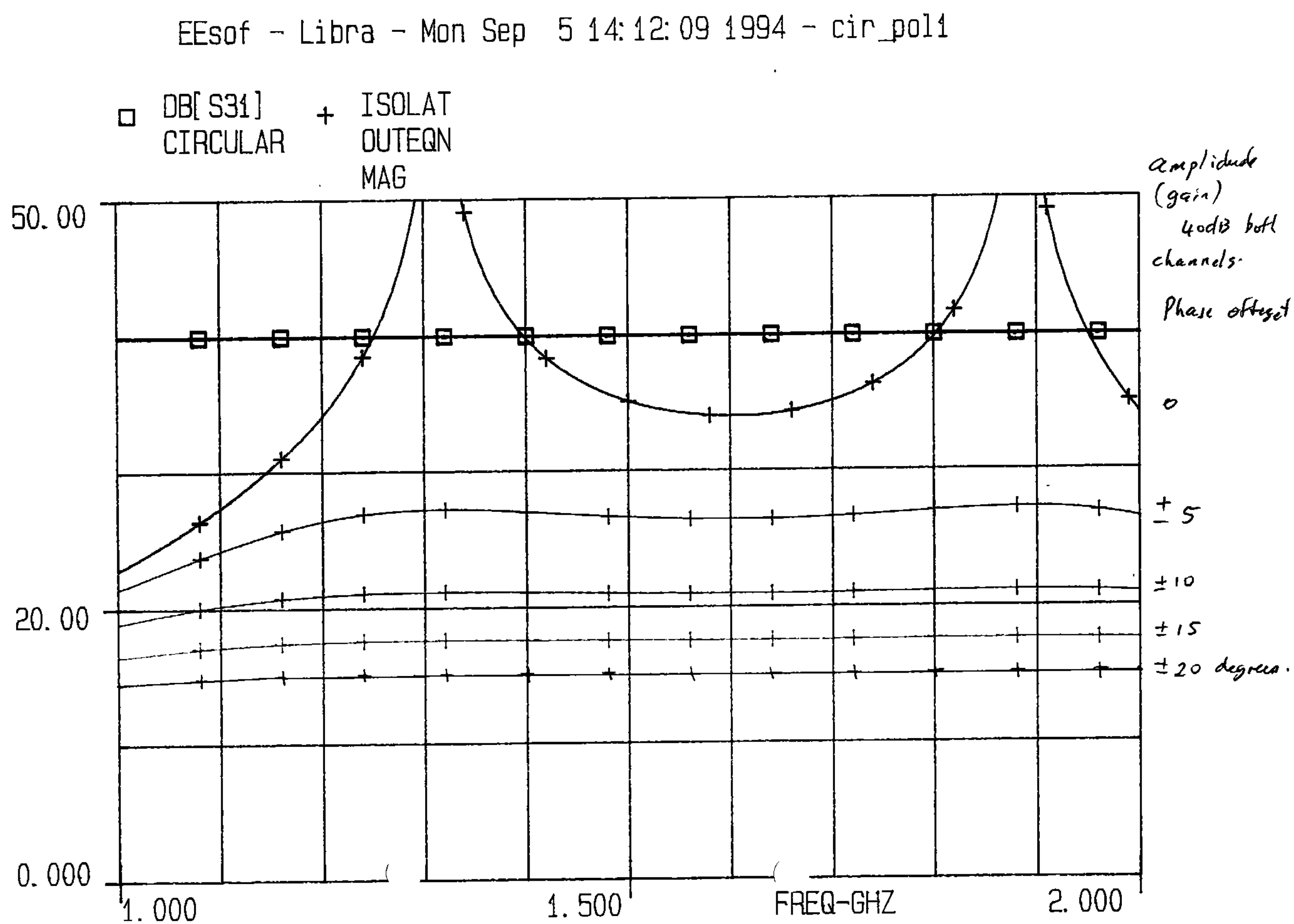
Libra (TM) Ver. 3.500.106.1  Cfg. (800 20608 5 53005B31 9138 0 0 11FC31DE)
           cir_pol1.ckt      Mon Sep  5 14:51:35 1994

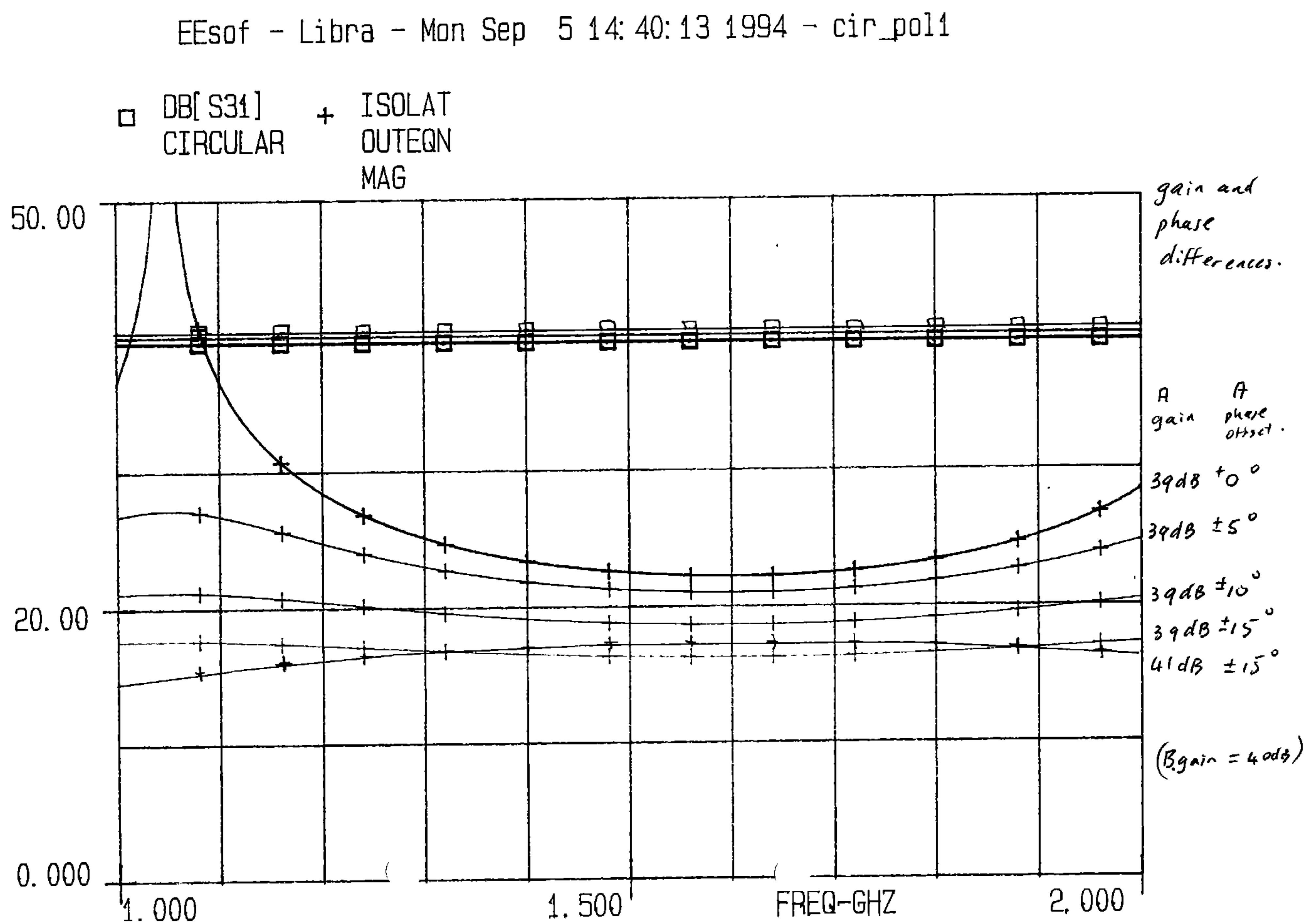
!       File  cir_plo1.ckt
!
!       This file is to derive the permitted errors in phase and gain for
!       a particular circular polarisation specificaton.
DIM
        FREQ    GHZ
        RES     OH
        IND     NH
        CAP     PF
        LNG     MM
VAR
        GainA   =       41      ! Pol B is set to 40 dB
!
        PhaseA  =       15      ! ideally, it would be zero
!
        CentreF =       1.6     ! centre frequency of the real hybrid
        CdB     =       2.85    ! coupling of hybrid at centre frequency
!
EQN
        c       =       10**(-0.1 * CdB)
        m       =       (1 + (c**0.5)) / (1 - (c**0.5))
        Zoo     =       (m**(-0.5)) * 50
        Zoe     =       (m**(0.5)) * 50
!
CKT
!       first use a hybrid to form an ideal circularly polarised signal.
!
        HYB90   1       2       3       4       C=3     L=0
        RES     3       0                       R=50
!
        GAIN    2       5                       A=40     S=0    F=0
        GAIN    4       6                       A^GainA  S=0    F=0
        PHASE   6       7                       A^PhaseA S=0    F=0
!
!       now, use an ideal coupled line section to model the hybrid.
        CLIN    8       5       9       7       ZE^Zoe  ZO^Zoo  E=90  F^CentreF
!
        DEF3P   1       8       9       Circular
!
OUTVAR
        circle1  =      Circular DB[S21]
        circle2  =      Circular DB[S31]
!
OUTEQN
        Isolat  =       circle1 - circle2
!
OUT
!       Circular    DB[S21]  GR1
        Circular    DB[S31]  GR1
        OUTEQN      MAG[Isolat]  GR1
FREQ
        SWEEP   1       2       0.01
GRID
        RANGE   1       2       0.1
        GR1     0       50      10
```



EEsof - Libra - Mon Sep 5 14:03:59 1994 - cir_pol1
DB[S31] CIRCULAR
+ ISOLAT OUTEQN MAG
50.00
20.00
0.000
1.000
1.500
FREQ-GHZ
2.000
Phase difference
0 dgrees.
40dB
39 dB
41dB
38dB
42dB



EEsof - Libra - Mon Sep 5 14:12:09 1994 - cir_pol1
DB[S31] CIRCULAR
ISOLAT OUTEQN MAG
50.00
20.00
0.000
1.000
1.500
FREQ-GHZ
2.000
amplitude (gain) 40dB both channels.
Phase offset
0
± 5
±10
±15
±20 degrees.


EEsof - Libra - Mon Sep 5 14:40:13 1994 - cir_pol1
DB[S31] CIRCULAR
ISOLAT OUTEQN MAG
50.00
20.00
0.000
1.000
1.500
FREQ-GHZ
2.000
gain and phase differences.
A gain
A phase offset.
39dB ±0°
39dB ±5°
39dB ±10°
39dB ±15°
41dB ±15°
(B gain = 40dB)