DESIGN PROJECT PROPOSAL

WIRELESS CDMA COMMUNICATION SUBSYTEM DESIGN

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ABSTRACT

The project involves design, fabrication, test and measurements of wireless CDMA communication subsystem. The goal is to use the HP-ESGD signal source as a transmitter with CDMA capability, and build a receiver to extract the data transmitted. Also, a duplexer would be designed and incorporated into the system at the transmitter as well as the receiver terminals.

I. INTRODUCTION

A block diagram of the system is given in Fig. 1. The HP-ESGD (Economy Signal Source with Digital I/Q modulation) signal source will be used as a transmitter to transmit QPSK modulated data. The signal will be modulated in the ESGD, in the PCS band, and transmitted through the duplexer and the antenna.

At the receiver end, the signal would be received through receiving antenna, and a duplexer. The receiver which would be designed and built includes an LNA, Mixer, IF Filter, VCO's, IF AGC, Demodulator and De-spreader with PN (Pseudo Noise Code) generator. All the receiver components will be integrated on a single Printed Circuit Board. Software tools (Microsim or Autocad) will be used for the design of the RF circuit board.

II. CDMA SIGNAL TRANSMITER

At the transmitter end, the ESGD generates the signal at 1.9GHz with QPSK modulated data. The transmitter can be viewed as a CDMA base station, which can be easily configured according to user specifications. The signal is passed through a duplexer. The duplex functionality is achieved by using a bi-directional distributed amplifier. The signal is transmitted through an antenna in the PCS band (1850-1990MHz).

A detailed study of the ESGD capabilities was done. The HP-ESGD transmitter has been ordered. The other components of the transmitter are the duplexer and antenna. The antenna will be ordered, and the design of the duplexer is in progress. The transistors needed in the design of duplexer have been ordered.

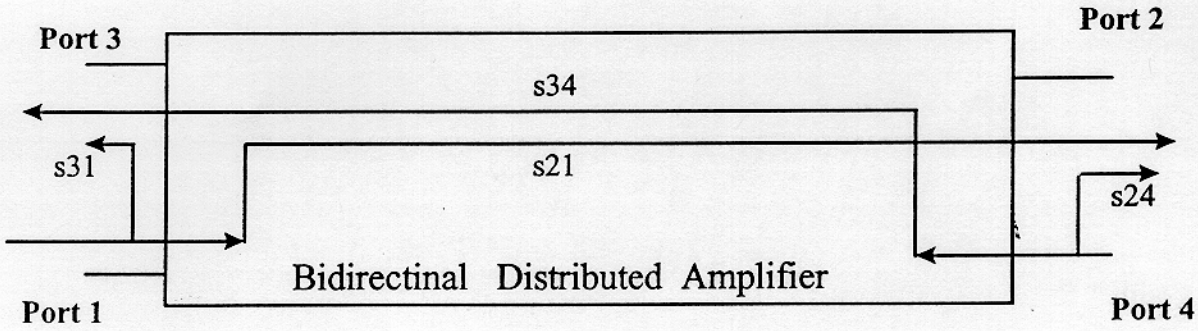

Fig. 2. Signal Paths in a Bidirectional Distributed Amplifier

Duplexer: Measurements were done on the existing duplexers available in the RF laboratory at 2.4 GHz and 1.9GHz bands respectively [1,2]. It has been observed that duplexer in the 2.4GHz band has better Noise figure results when the antenna was connected to the gate line. But it resulted in loss in the forward direction. An isolation of -16dB between isolated ports was observed and a gain of 3dB from the antenna to the receiver. When the duplexer in the 1.9GHz was tested it did not produce the desired gain. So it was decided to design the duplexer using the technique presented in [1] for 1.9GHz. The initial design was done analytically, based on the design guidelines presented in [1,3]. The duplexer circuit was then simulated using the HPEEsof linear simulator using the lumped element model for the gate and drain lines. The simulation was carried out using the NEC34018 transistor. The duplexer showed a gain of 13dB on the drain line. But the isolation between the transmitter/receiver ports was 0dB, not as desired in the 1850-1990MHz band. The duplexer circuit is shown in Fig. 3 and the results are shown in Fig. 4.

Design changes will be carried out to obtain the desired isolation. Then the lumped circuit model will be converted to the microstrip model. Further, characterization of each transistor used in the circuit will be done so as to have the measured S-parameters of each transistor for the design. Finally, the mask for the duplexer will be created and the board will be developed using photolithography, and tested using the Network Analyzer.

III. CDMA SIGNAL RECEIVER

The components used in the receiver are LNA, Mixer, VCOs, IF Filter, IF AGC, Demodulator and De-spreader with PN generator, and antennas. From the link budget calculations, appropriate components of desired gain, isolation, and noise figure and other specifications would be selected. Also care will be taken while integrating the different components for impedance match, and required matching networks will be designed. Individual components will be tested before integrating into the system .

The receiver board layout will be done using layout tools in MICROSIM or AUTOCAD depending on the ease of layout design and availability. The final layout of the receiver will be forwarded to 'Cunningham Graphics' Chicago, Illinois for manufacturing. The board used for receiver design is FR4.

Some of the components have been identified from the company "RF Micro devices", but a detailed search for other vendors is being done. Also, the extent of the receiver which can be built is looked into depending on the complexity of design on the board and time constraints.

IV. INSTRUMENTS NEEDED

1. HP-ESGD (Signal generator with Digital Modulation)
2. Spectrum Analyzer
3. Network Analyzer
4. Power meter and sensors
5. DC supplies and Multimeters

V. COMPONENTS NEEDED

The following components will be required for the project :

1. Transistor (NE 34018 - California Eastern Labs.) Ordered
2. Capacitors (Tunable) - To be ordered
3. Antenna (MACOM - 1800 to 2000 MHz) - To be ordered
4. Duplexer - Is being designed.
5. LNA
6. Mixer
7. IF/AGC
8. Demodulator
9. De-spreader circuit
10. PN code generator
11. Cables, connectors, adapters, Bias-Ts
12. Circuit board (Cunningham Graphics)

The receiver components are being considered and a decision will be made as soon as the receiver design is completed. The component that would be built in the RF PC Fab Lab is the Duplexer.

VI. COMPONENT SPECIFICATIONS

1. HP-ESGD - Frequency Range = 250KHz to 4GHz
   Power = +10 dBm (Max @ 1.9GHz)
   CDMA personality

2. Duplexer - Gain (Transmit) = -1dB
   Isolation (Tr/Rx) = -15dB

3. Antenna - Frequency band = 1850 to 1990MHz
Gain = +7dBi
VSWR= 1.5:1

4. LNA/Mixer- RF Micro Devices
RF Freq. = 1.5GHz to 2.5GHz
LO Freq. = 1.2 GHz to 2.5GHz
IF Freq. = DC to 500MHz
Cascaded Gain = 26dB
Cascaded Noise Figure = 2.5dB
D.C. Bias = 3.6V
Current = 52mA

LNA - Gain = 12dB
Noise figure = 1.4dB
Input VSWR = 2:1
Output VSWR = 1.5:1
Mixer - Gain = 15.5dB
Noise figure = 5.5dB
Input VSWR = 1.5:1

5. IF/AGC - RF Micro Devices
Frequency band = 12 to 285MHz
Gain = +48dBi
Noise figure = 5dB
Current = 16mA

6. Demodulator - RF Micro Devices
Frequency Range = 50 to 250MHz
LO frequency = 2 x IF
Noise figure = 5dB
Current=15mA

VI. SOFWARE TOOLS NEEDED

1. HP-EEsof (Series IV)
2. Microsim or Autocad

VII. FABRICATION FACILITES NEEDED

1. RF fabrication Laboratory.
2. Caterpillar Image Laboratory.
3. Cunningham Graphics.

VIII. SCHEDULE

The tasks and the schedule for the project is given below.

TASK / MONTH	APR 30	MAY 15	MAY 30	JUN15	JUN30	JUL15
RESEARCH PROJECT						
Procurement						
Modulators						
Demodulators						
Transceivers						
Other Components(Tr/Cap/Boards)						
Design of the receiver board						
Test board Layout and design						
Test board fabrication						
Test Individual component						
Receiver board design and Layout						
Board fabrication(Vendor)						
Circuit Assembly						
Receiver testing and measurements						
T/r Module						
Redesign Preliminary						
FET characterization						
Layout Design						
FET S parameter measurement						
Convert Lumped to Microstrip						
Tuning and optimization						
Board Fabrication and Testing						
Project Proposal						
Report						

IX. TESTS AND MEASUREMENTS

Duplexer: For the duplexer, the measurements to be carried out will be the forward gain on the drain line and the isolation between the transmit and the receive ports and noise figure measurements.

Receiver: The receiver board measurements is to obtain the desired data from the transmitter for a single user.

X. REPORT OUTLINE

1. Introduction.
2. CDMA system
3. Transmitter.
4. Receiver.
5. Duplexer.
5. Integrated Receiver.
6. Tests and Measurements
7. Summary and Conclusion
8. References
9. Appendices

REFERENCES

[1] Jalmi S.Abdul-Jalil , Tuan Tu , Senior Project Report, "A 2.4GHz Transmit/Receive Module for Wireless Communications ", Bradley University , May 1995.

[2] Thirendra Raymajhi , "Active antenna for full duplex operation ", M.S.E.E. Thesis, Bradley University, 1998.

[3] S.N.Prasad and J. B. Beyer , "MESFET Distributed Amplifier design Guidelines " IEEE Trans. Microwave Theory and Techniques ,1984 ,Vol. MTT -32 ,No. 3 ,pp 268-275.

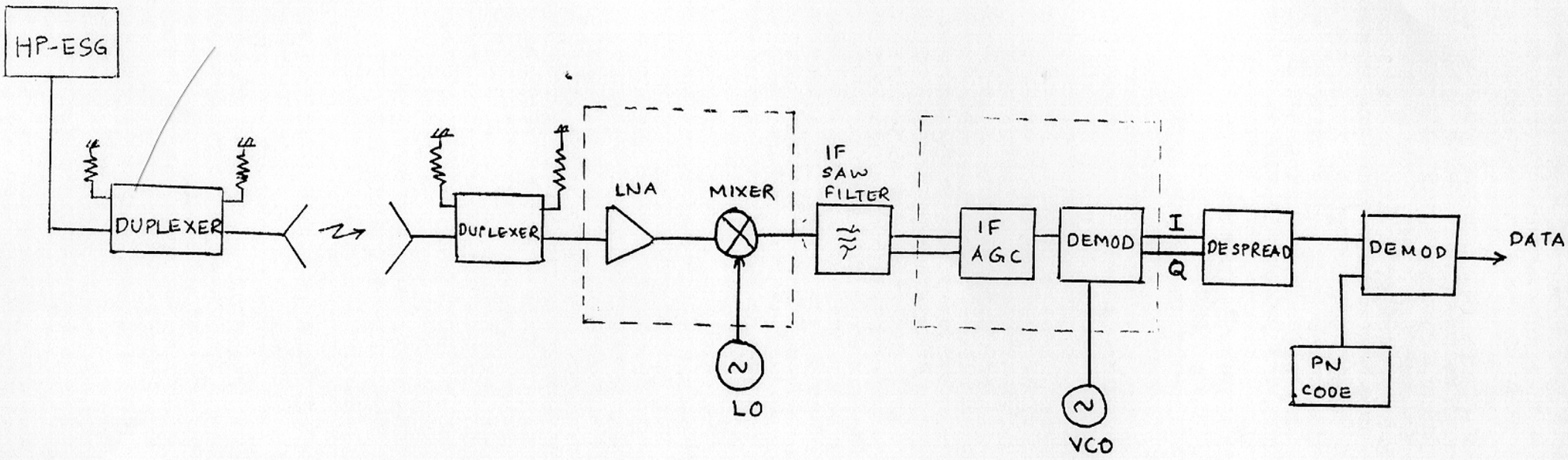

Fig. 1 BLOCK DIAGRAM OF TRANSMITTER / RECEIVER

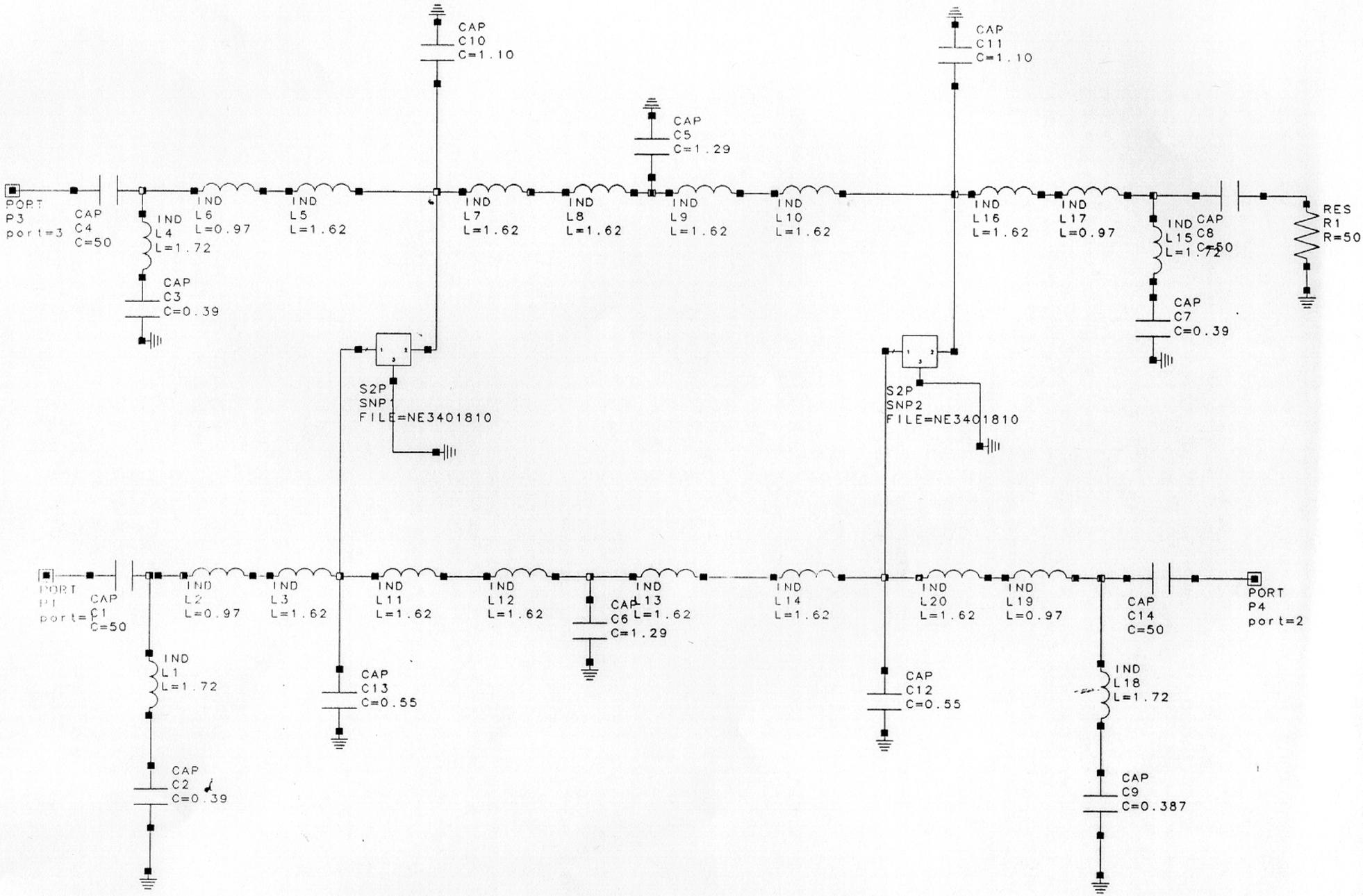

Fig. 3 Duplexer Lumped Element Model

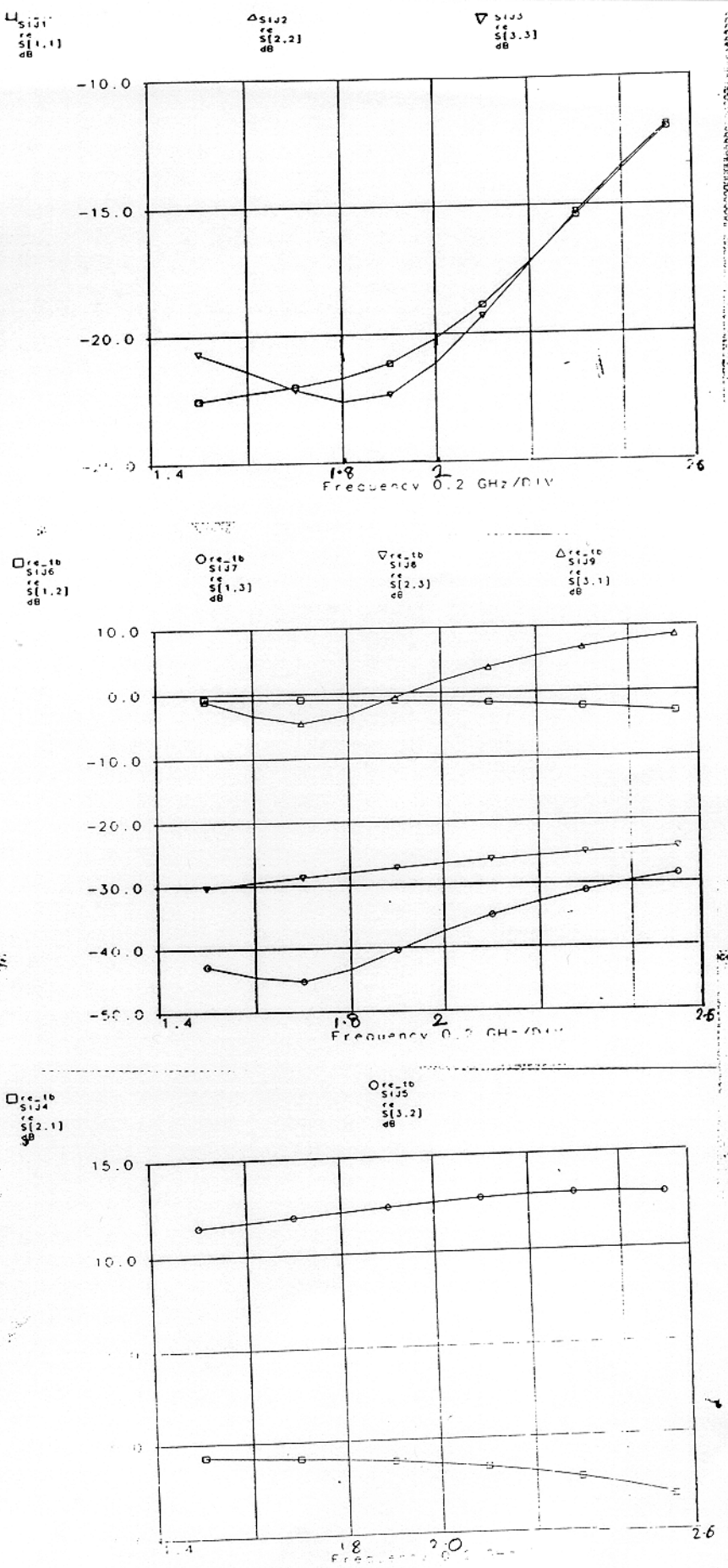

Fig. 4 Measured Results.