DESIGN OF HIGH FREQUENCY EQUIPMENT

INSTITUT PENYELIDIKAN, PEMBANGUNAN DAN PENGKOMERSILAN
UNIVERSITI TEKNOLOGI MARA
40450 SHAH ALAM, SELANGOR
MALAYSIA

BY :

AHMAD ASARI SULAIMAN
MEOR MOHD AZREEN MEOR HAMZAH

JANUARI 2006

Biro Penyelidikan dan Perundingan
Universiti Teknologi MARA
40450 Shah Alam, Malaysia
Tel : 03-55442094 / 5 / 3 / 2 Fax : 03-55442096
Website : www.uitm.edu.my/brc

UNIVERSITI TEKNOLOGI MARA

PENGURUSAN PENYELIDIKAN MENGGABUNGKAN KREATIVITI DENGAN PRODUKTIVITI, KECEKAPAN DAN AKAUNTABILITI

Penolong Naib Canselor
(Penyelidikan)
03-5544 2094/5
aznizl32@salam.itm.edu.my

Koordinator Penyelidikan
(Sains dan Teknologi)
03-5544 2091
izainonm@salam.itm.edu.my

Koordinator Penyelidikan
(Sains Kemasyarakatan &
Kemanusiaan)
03-5544 2097
rosmimah@salam.itm.edu.my

Koordinator Perundingan
(Kewangan)
03-5544 2090
shidah@salam.itm.edu.my

Koordinator Perundingan
03-5543 5120
aro@salam.itm.edu.my

Penolong Pendaftar
03-5544 2092
dapeah794@salam.itm.edu.my

Pegawai Eksekutif
03-5544 2098
rohani734@salam.itm.edu.my

Pentadbiran
03-5544 2093

Surat Kami : 600 – BRC/ST. 5/3/446
Tarikh : 13 Ogos 2002

Encik Mohd Halil Marsuki
Penolong Akauntan
Unit Kewangan Zon 17
Universiti Teknologi MARA, Shah Alam

Tuan

GERAN PENYELIDIKAN –

Merujuk kepada perkara di atas, bersama-sama ini dimajukan salinan surat kelulusan menjalankan penyelidikan untuk pensyarah dari Fakulti Kejuruteraan Elektrik.

1. **Design of High Frequency Equipment**
   Ketua Projek : Meor Mohd Azreen Meor Hamzah
   Kos Projek : RM 10,000.00

2. **Developing a New Technique to Determine the Optimal Location of Harmonic Filter in Electrical Distribution System**
   Ketua Projek : Norihan bt. Abdul Hamid
   Kos Projek : RM 10,000.00

Sekian untuk tindakan pihak tuan selanjutnya.
Terima kasih.

Yang benar

DAPEAH AHMAD
Penolong Pendaftar
b/p Penolong Naib Canselor (Penyelidikan)

s.k: 1. Encik Meor Mohd Azreen Meor Hamzah
Pensyarah/ Ketua Projek
Fakulti Kejuruteraan Elektrik
UiTM Shah Alam

2. Puan Norihan bt. Abdul Hamid
Pensyarah/ Ketua Projek
Fakulti Kejuruteraan Elektrik
UiTM Shah Alam

Tarikh : 10 Januari 2006
No. Fail Projek : 600-BRC/ST. 5/3/446

Penolong Naib Canselor (Penyelidikan)
Institut Penyelidikan, Pembangunan dan Pengkomersilan
Universiti Teknologi MARA
40450 Shah Alam

Ybhg. Prof.,

LAPORAN AKHIR PENYELIDIKAN "DESIGN OF HIGH FREQUENCY EQUIPMENT"

Merujuk kepada perkara di atas, bersama-sama ini disertakan 3 (tiga) naskah Laporan Akhir Penyelidikan bertajuk "DESIGN OF HIGH FREQUENCY EQUIPMENT".

Semoga dengan kejayaan ini akan menjadi perintis kepada penyelidikan seterusnya. Diharapkan agar pihak Prof. dapat menganjurkan kursus bagi memudahkan pensyarah mendapat pendedahan terhadap penyelidikan yang akan membangunkan Negara pada masa akan datang. Kami mengucapkan ribuan terima kasih di atas sokongan yang diberikan sepanjang projek ini.

Sekian, terima kasih.

Yang benar,

AHMAD ASARI SULAIMAN
Ahli Projek Penyelidikan

TABLE OF CONTENTS

ABSTRACT

This report is an explanation to the work that have been carried out to design monolithic microwave integrated circuit (MMIC) low pass filters using circuit and electromagnetic simulators. The filters were designed to be constructed on GaAs semiconductor wafer. The principal objectives were to reduce both circuit size and spurious content.

Two types of designs are proposed here. The first is a Butterworth filter made of the *m*-derived type which is realized using a single gold layer on the semiconductor substrate. The metal and substrate layers used in the design were optimized using the aid of the electromagnetic simulator to improve the steepness at the transition region. The filter demonstrated a maximally flat passband with a cut-off frequency of 10 GHz and passband and stopband insertion losses of 0.2 dB and greater than 20 dB respectively. The overall size of the circuit was 1.296×1.6 mm^2, smaller than filters constructed from transmission lines designed by other workers before. The filters used standard materials compatible with MMIC technology.

The second filter uses a novel metal/polyimide/metal multilayer structure consisting of buried coplanar waveguide and polyimide overlay. Two via holes were used to connect the coplanar waveguide to a transmission line at the top. The structure and the materials used are compatible with MMIC processing. Owing to the unique multilayer architecture, the filter operates well without spurious in the passband and stopband. The combination of several different materials in the structure also reduces the size. The proposed filter has a cut-off frequency of 3 GHz and an area of 1.0×0.7 mm^2 while the stopband insertion and return losses were 20 dB and 25 dB respectively. Optimum performance was obtained when the metal and polyimide thicknesses were 5 μm each. The filters have been simulated using electromagnetic simulator. Due to the fact that electromagnetic signals tend to radiate into space at microwave frequencies, more accurate designs were made possible using electromagnetic simulators in this work. A theoretical model to explain the new structure and design methodology are also discussed in detail in this report.