Graduation Project : Implementing an Automated Filter Measurement System

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Abstract

We chose an automated filter measurement system among many themes for graduation project. In this study, the system of automative filter quality test for the filter activeness during the process of the filter production was embodied with LabVIEW server. The LabVIEW server is LabVIEW's function as web server which can be remote controlled during filter quality test through on web. The system is constructed with Network Analyzer and PC Camera. The LabVIEW server controls Network Analyzer using GPIB card for measuring S parameter of filters. Moreover, PC camera is monitored the process of remote controlling during the filter test. It is possible to manage specific information of filters through the database connected results of Network Analyzer's measurement.

Key-Words: - LPF, LabVIEW, DAQ, GPIB, USB

1. Introduction

The senior students of Information Technical Division Engineering at Soonchunhyang University must submit a compulsory graduation thesis. Therefore many professors choose suitable themes, they teaches and guides teams composed of 3-4 students to implement and complete paper. Among the themes, many students were interested in an automated filter measurement, a data logger system and web-based remote equipments control system.

For them to accomplish the an automated filter measurement project, they must have integrative knowledge related microcontroller, C/LabVIEW programming skill, digial/analog circuit design, digital communication and so on.

In this study, we chose an automated filter measurement among many themes for graduation project. Today needs a production in the manufacturing processes of the subdivision and the automation because of a variety of developing manufacture and the complication of the manufacture on the basis of a machine, an electric, an electron and a computer technology.

The virtual instrumentation is breaking down the barriers of developing and maintaining instrumentation systems that challenge the world of test, measurement, and industrial automation. By leveraging off the latest computing technology, virtual instrumentation delivers innovative, scalable solutions that incorporate many different I/O options and maximizes code reuse-- saving you time and money.

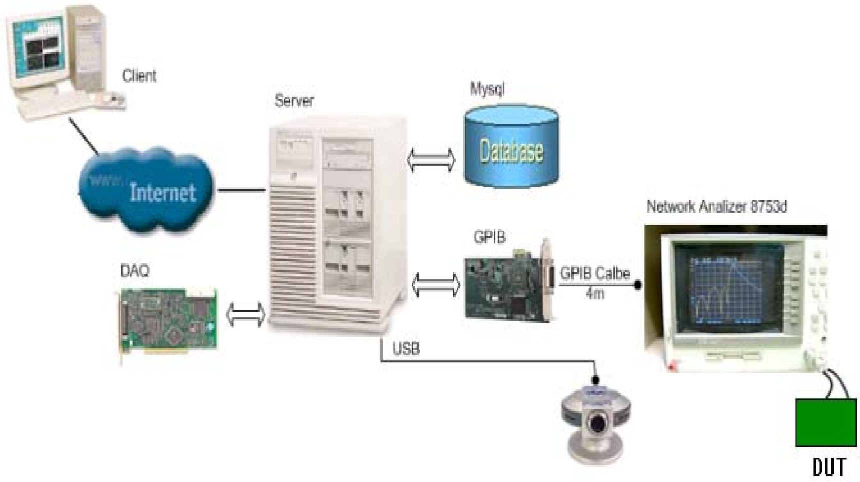
These days many companies have taken automatic operation by degrees instead of handwork mostly, but all of the works take handwork in that case development of the product for filter (RF manually operated circuit).

Our implementation system is used LabVIEW server. The LabVIEW server controls Network Analyzer using GPIB card for measuring S parameter of filters. Moreover, PC camera is used for monitoring the process of remote controlling during the filter test. The management of specific information of filters can be made of the database construction from results of Network Analyzer's measurement.

2. System configuration

The whole of the system in filter quality test is constructed client, LabVIEW server. The LabVIEW server is linked it to use the function of web server and network analyzer and PC camera. The LabVIEW can be used to control network analyzer using GPIB.

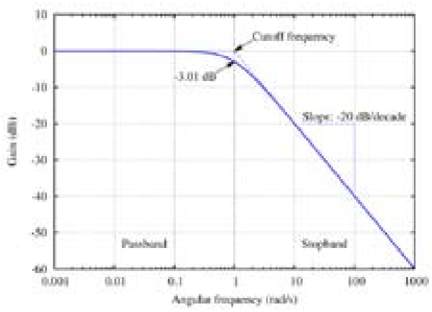
Fig. 1. System Layout



(1) filter used in the study

Filters may be specified by family and passband. The filter's family is specified by certain design criteria which give general rules for specifying the transfer function of the filter. Some common filter families and their particular design criteria are: Butterworth filter has no gain ripple in pass band and stop band, slow cutoff. Chebyshev filter(Type I) has no gain ripple in stop band, moderate cutoff. Chebyshev filter(Type II) has no gain ripple in pass band, moderate cutoff . Bessel filter has no group delay ripple, no gain ripple in both bands, slow gain cutoff. Elliptic filter has gain ripple in pass and stop band, fast cutoff. Generally, each family of filters can be specified to a particular order. The higher the order, the more the filter will approach the "perfect" filter of complete transmission in the pass band, and complete attenuation in the stop band. Each family can be used to specify a particular pass band in which frequencies are transmitted, while frequencies in the stop band (i.e. outside the pass band) are more or less attenuated. A low-pass filter has low frequencies are passed, high frequencies are attenuated. A high-pass filter has high frequencies are passed, low frequencies are attenuated. A band-pass filter has only frequencies in a frequency band are passed. A band-stop filter has only frequencies in a frequency band are attenuated. An all-pass filter has all frequencies are passed, but the phase of the output is modified.

Fig. 2 Frequency response of a LPF

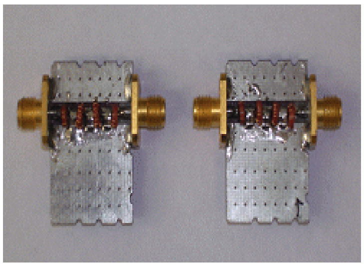


We experimented with our selecting LPF(Low Pass Filter) in the study. A LPF attenuates all signal components higher than the frequency cut-off. The filter will pass all signals from dc (0 Hz) up to the lowpass cut-off point. The filter type is useful in improving signal to noise ratio by also reducing system intrinsic noise. S-parameters are the reflection and transmission coefficients between the incident and reflected waves fully describing the behavior of a device under linear conditions at radio frequencies. S-parameters are complex (i.e. comprising both magnitude and angle) because both the magnitude and phase of the signal are changed by the network. S21 is the transmission loss. This shows the attenuation of various frequencies of the output signal with respect to the input signal. S11 is the return loss, which corresponds to the signal appearing at the input terminals. A Network Analyzer (HP8753C) is used to measure S11 magnitude and phase and S21 magnitude and phase.

Table 1 LPF Specification

Frequency	500MHz
Order	N=7
Response	Chebyshev
Ripple	0.01dB
Type	Chebyshev

Fig. 3 LPF filter implemented



(2) DAQ devices & GPIB

Traditionally, measurements are done on stand alone instruments of various types-oscilloscopes, multi meters, counters etc. However, the need to record the measurements and process the collected data for visualization has become increasingly important. There are several ways in which the data can be exchanged between instruments and a computer. Many instruments have a serial port which can exchange data to and from a computer or another instrument. Use of GPIB interface board allows instruments to transfer data in a parallel format and gives each instrument an identity among a network of instruments. Another way to measure signals and transfer the data into a computer is by using a Data Acquisition board. A typical commercial DAQ card contains ADC and DAC that allows input and output of analog and digital signals in addition to digital input/output channels. Since DAQ devices acquire electrical signals, a transducer or a sensor must convert some physical phenomenon into an electrical signal. A DAQ device can also simultaneously produce electrical signals. These signals can either intelligently control mechanical systems or provide a stimulus so that the DAQ system can measure a response. Most DAQ devices have four standard elements: analog input (AI), analog output (AO), digital I/O (DIO), and counter/timers. The General Purpose Interface Bus (GPIB), describes a standard interface for communication between instruments and controllers. It contains information about electrical, mechanical, and functional specifications. GPIB is a digital, 8-bit parallel communication interface with data transfer rates of 1 Mbyte/s and higher, using a three-wire handshake. The bus supports one System Controller, usually a computer, and up to 14 additional instruments. GPIB instruments have traditionally been used as stand-alone benchtop instruments where measurements are taken by hand. The GPIB is a 24-conductor parallel bus that consists of eight data lines, five bus management, three handshake lines, and eight ground lines. The GPIB uses a byte-serial, asynchronous data transfer scheme. To achieve the high data transfer rate that the GPIB was designed for, you must limit the number of devices on the bus and the physical distance between devices.

(3) Software Configuration

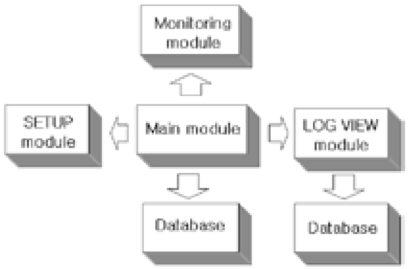
The proposed software is composed of five module section like in the figure 4.

- Main module

Filter Quality Test Auto System of main picture formation is the same as below figure 3. number(1) is to do output that receive an image from a PC camera so as to monitor the process of conveyor working system remotely. number(2) is to show us to measure a sort of filter, a frequency of limits and a intercepting frequency of filter. The lower of the setup button uses to input the sort of filter to measure, the frequency of limits and the intercepting frequency of filter. LOG VIEW button uses to check the measuring data of the filter in database and to make out the reports on the filter quality. number(3) shows the S parameter of the filter. number(6) shows the products of the measured filter with blue and red LED. number(4) shows the total number of article in the measured filter. number(5) shows two Horizontal

Progress Bar which measured filter's the state and the right of the button plays a role that start/stop the recording process of the S parameter on database.

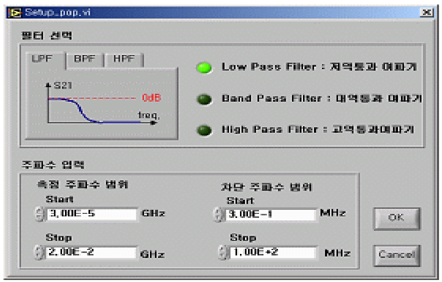
Fig. 4 Software Block Diagram



- SETUP module

We can have the SETUP module practiced, with using the SETUP button on the Main screen. The SETUP module is part of setting up the needed articles(a sort of measuring filter, a frequency of limits to measure filter, a cutoff frequency)from the process of the filter test.

Fig. 5 Setup Module Front Panel



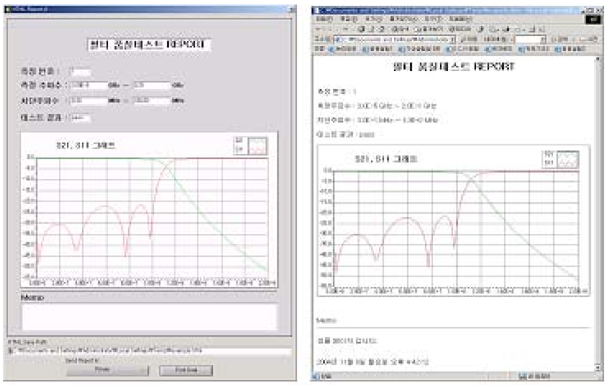
- Log View Module

Log View Module is practiced when we press a LOG VIEW button on the Main screen and shows the measuring information of the filter in a saved database till now. a director can confirm the pertinent measuring data and the results of the filter quality test as soon as change the measuring number of the filter.

- REPORT Module

REPORT Module is activated when we press a REPORT button on the lower right side of the LOG VIEW screen, and it has a function that this make the effects searched on LOG VIEW screen drawn up a report. we can print the results of the screen to make use of the lower button, indicate the report that we draw up with HTML form on internet browser and save the report written with the HTML form after we designated the storage site in the computer. the left of the figure 6 is the screen of the REPORT module. It is contained with Item number, measuring frequency, used frequency, result graph, memo and print button. On case of click the print button, the report appears in the right of the figure 6. It is a screen that the report written with HTML form is indicated on browser. After students print it, they submit it to professor.

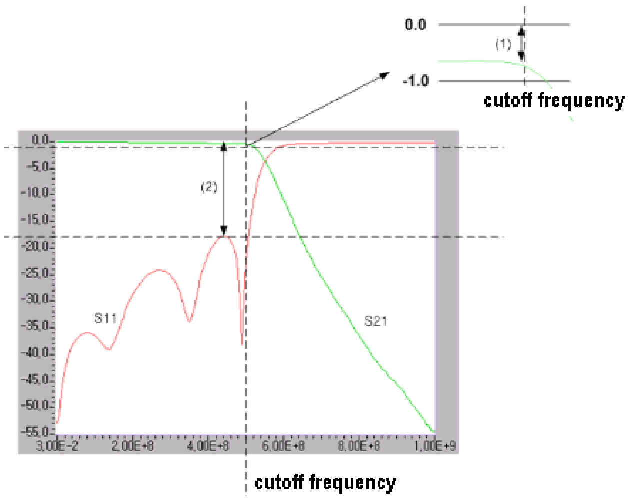
Fig. 6   Report Module



(4) Filter Quality Assessment

Below block diagram discriminate between filter moving and not moving with chosen spectrum, to receive S parameter data measured on network analyzer and use a intercepting frequency inputted on setup module. Scattering Parameters, or s-parameters, are the reflection and transmission coefficients between the incident and reflection waves. They describe completely the behavior of a device under linear conditions at microwave frequency range. Each parameter is typically characterized by magnitude, decibel and phase. The expression in decibel is 20log(Sij) because s-parameters are voltage ratios of the waves. S11 is the reflection coefficient of the input. S22 is the reflection coefficient of the output. S21 is the forward transmission gain. S12 is the reverse transmission gain (from output to input). The advantage of s-parameters does not only lie in the complete description of the device performance at microwave frequencies but also the ability to convert to other parameters such as hybrid (H) or admittance (Y) parameters. The figure 7 indicates the standard of the measuring filter qualities using s parameters. The number(1) check S11 value is below return loss: -15db or not, and the number(2) check S21 value is over return loss: -1db or not at the intercepting frequency.

Fig. 7 Desired criterion of LPF



trac

We developed an application to acquire s-parameter data from Agilent network analyzers via a National Instruments GPIB interface. The data is saved on the PC in touchstone format. We made six LPF(Low Pass Filter) to measure the capacity of the filter quality test auto-system embodied this study. We tested the capacity after setting each S parameter differently, and measured the network analyzer of frequency division. The figure 8 is the result of passing an exam and figure 9 is the result of disqualification. We confirm that S11 value show above -15db within the intercepting frequency.

Fig. 8 Success Result of Filter Quality Evaluation

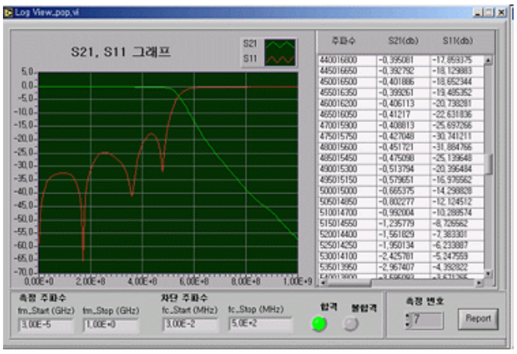


Fig. 9   Fail Result of Filter Quality Evaluation

4. Conclusion

We chose an automated filter measurement project among many themes for graduation thesis. As prerequisite for accomplishment of the system project, students must have integrative knowledge related with microcontroller, C programming skill, digial/analog circuit design, digital communication and so on. Because it is hard to implement, it is required for them to possess capabilities of hardware design, programming of microcontroller and GUI. The automated measurement system is made up of network analyzer and PC camera. The system is constructed with Network Analyzer and PC Camera. The LabVIEW server controls Network Analyzer using GPIB card for measuring S parameter of filters. Moreover, PC camera is for monitoring the process of remote controlling during the filter test. And the database construction from results of Network Analyzer's measurement made possible to manage specific information of filters.

Our designed schematic, circuit board layouts, parts list, parts purchase price, suppliers, microcontroller, step motor and LabVIEW application program, and other associated items will be published on a website of graduation thesis so that other students could study and download sufficient information to develop their own filter measurement system.

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