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MT2075 CONTROL OF A USER-DEFINED LO FOR MICROWAVE NOISE FIGURE MEASUREMENTS

Introduction

Noise figure meters, such as the Maury MT2075 series noise gain analyzers, are low frequency instruments. The maximum operating frequency of the MT2075C is 2047 MHz. Measurement of amplifiers at higher microwave frequencies require the assembly of a frequency converter to bring the noise output signal into the frequency range of the noise figure meter. Maury offers the MT755x series frequency extenders[1] for this purpose. These units are designed to operate in the swept LO (fixed IF) measurement configuration which requires a local oscillator (LO) synchronized to the MT2075 frequency[2].

Operation

Figure 1 is a block diagram of a microwave noise figure measurement setup using a Maury frequency extender. For meaningful results, it is necessary that the noise gain analyzer "know" the operating frequency of the signal source. This is accomplished by making the MT2075 a GPIB controller. The noise gain analyzer is equipped with a "private line", that is: a GPIB compatible captive interface bus (sometimes referred to as a system interface bus or SIB). After the setup entries have been made (start frequency, stop frequency, step size, etc.), and the MT2075 is given a sweep command either from the front panel or via the normal GPIB from a computer, the noise gain analyzer outputs a frequency and power level command to the GPIB port of the signal generator via the SIB. The MT2075 will then wait some predetermined time for the LO to settle, make the measurement, and repeat the sequence at the next frequency.

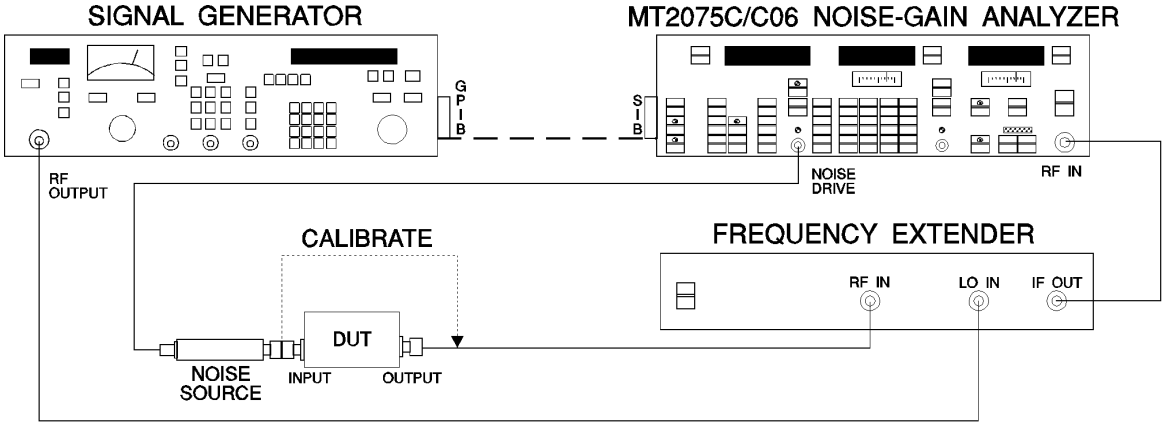

Figure 1: Typical microwave noise figure measurement setup using a MT7550 frequency extender.

LO Control

In order to control the LO, the GPIB commands appropriate for the particular signal source in use must be incorporated in the noise gain analyzer. The MT2075C and MT2075C06 include commands for four common signal sources generally considered suitable as local oscillators. These are:

HP8673	**HP8350**
HP8340/41	**Anritsu 6600**

These specific signal generators are not always easily available in some laboratories. A possible solution in such situations is the use of the "user-defined" local oscillator.

All Maury noise gain analyzers allow the user to enter the GPIB control codes for signal sources not supported by the instrument. This is accomplished by entering the decimal equivalents of the ASCII codes which control frequency and power output - the codes to disable modulation can also be entered to insure these functions are not active during the noise measurements. These are placed in nonvolatile RAM, and the user-defined source can be recalled via a special function.

Entering User-Defined LO Control Programs

Most modern signal sources, including those utilizing the SCPI language (Standard Commands for Programmable Instruments), can be controlled by means of the user-defined function in the noise gain analyzer. The only requirement being that the command syntax follow the generally accepted structure, **<Function><Data><Terminator>**, e.g.: the command string to send the HP8673 to a CW frequency of 3 GHz is **FR3000MZ** where **FR** specifies the CW frequency function and **MZ** is the terminator specifying that the data is in MHz.

It should be noted that the MT2075 series can send frequency commands in MHz only. In entering the program, the frequency and power output are variables; therefore, the data are replaced by the decimal equivalents of the ASCII CTRL-F (decimal 6) and ASCII CTRL-A (decimal 1) for frequency and power output data, respectively.

The general procedure for entering the codes for a user-defined LO is:

1. Enable entry of the codes for a user-defined LO by activating **SPEC FUNCT 48.1 ENTER**.

2. Determine the decimal equivalents of the ASCII mnemonics required to control frequency and power output of the source. Command codes to disable modulation and turn on the RF power can also be included; however, this is best done from the front panel of the source since including these would slow the tuning sequence between frequencies.

3. Enter these decimal values and depress **ENTER** after each input. At the point in the sequence where frequency and power output data would be entered, replace these with the decimal equivalents of CTRL-F and CTRL-A, respectively. The noise gain analyzer will accept up to 40 decimal entries.

4. After the last decimal entry, depress **ENTER** a second time to terminate the sequence.

5. Determine or set the bus address of the signal source, and set the MT2075 LO address to the same number using: **SHIFT LOCAL <address> ENTER**. Most signal sources are preset to address 19. The synthesizer in the Marconi 6200 is an exception (see next page).

6. When setting up the measurement from the front panel or from a computer, select the user-defined LO with **SPEC FUNCT 47.4 ENTER**.

Three sample programs which illustrate the entry process are shown on the following pages.

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Anritsu 6700 and 681xx series synthesizers

Both Anritsu model series will respond to the same set of commands. The initial commands disable modulation and insure the RF power is turned on. These are optional, and, in fact, it is recommended that these functions be controlled by the front panel keys to reduce the time required for interaction between the two instruments at each frequency step. Activate the user-defined LO control program entry with the following keystrokes:

SPEC FUNCT 48.1 ENTER

Enter the control code sequence

ASCII Symbol	Keystrokes	Function
A	65 ENTER	
M	77 ENTER	Disable AM
0	48 ENTER	
F	70 ENTER	
M	77 ENTER	Disable FM
0	48 ENTER	
P	80 ENTER	Disable pulse &
0	48 ENTER	square wave mod
R	82 ENTER	
F	70 ENTER	RF power
1	49 ENTER	on
F	70 ENTER	CW
1	49 ENTER	parameter
CTRL-F	6 ENTER	Frequency
M	77 ENTER	
H	72 ENTER	MHz
L	76 ENTER	Power out
1	49 ENTER	parameter
CTRL-A	1 ENTER	Power output
D	68 ENTER	
M	77 ENTER	dBm
	ENTER	Terminate

Marconi 6200 Microwave Test Set [3]

The following input allows the MT2075 noise gain analyzer to control the synthesizer in the Marconi 6200 microwave test set. When using this unit as the LO, avoid address 19. Activate the user-defined LO control program entry with the following keystrokes:

SPEC FUNCT 48.1 ENTER

Enter the control code sequence

ASCII Symbol	Keystrokes	Function
S	83 ENTER	
O	79 ENTER	
U	85 ENTER	
R	82 ENTER	
:	58 ENTER	Source
M	77 ENTER	mode
O	79 ENTER	
D	68 ENTER	
E	69 ENTER	
<space>	32 ENTER	
C	67 ENTER	
W	87 ENTER	CW
;	59 ENTER	
R	82 ENTER	
F	70 ENTER	
<space>	32 ENTER	RF power
O	79 ENTER	on
N	78 ENTER	
;	59 ENTER	
F	70 ENTER	
R	82 ENTER	Set
E	69 ENTER	frequency
Q	81 ENTER	
<space>	32 ENTER	
CTRL-F	6 ENTER	Frequency
E	69 ENTER	
6	54 ENTER	MHz
;	59 ENTER	
P	80 ENTER	
O	79 ENTER	
W	87 ENTER	
:	58 ENTER	Set
L	76 ENTER	power
E	69 ENTER	
V	86 ENTER	
<space>	32 ENTER	
CTRL-A	1 ENTER	Power output
<end>	0 ENTER	End program
	ENTER	Terminate

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Sources Using the SCPI Language

The following sequence will program all signal sources utilizing the Standard Commands for Programmable Instruments (SCPI) language. Among these are the HP8360 and 83700 series synthesizers. It should be noted that the HP8360 has an "analyzer" control mode which, when set, causes the instrument to respond to GPIB commands designed to drive the HP8340 and 8341. These command codes are already stored in the MT2075; therefore, the user-defined entry can be avoided when using this signal source. Activate the user-defined LO control program entry with the following keystrokes:

SPEC FUNCT 48.1 ENTER

Enter the control code sequence

ASCII Symbol	Keystrokes	Function
F	70 ENTER	
R	82 ENTER	
E	69 ENTER	
Q	81 ENTER	CW mode
:	58 ENTER	
C	67 ENTER	
W	87 ENTER	
<space>	32 ENTER	
CTRL-F	6 ENTER	Frequency
<space>	32 ENTER	
M	77 ENTER	
H	72 ENTER	MHz
Z	90 ENTER	
CR	13 ENTER	Carriage return
LF	10 ENTER	Line feed
P	80 ENTER	
O	79 ENTER	
W	87 ENTER	Set
:	58 ENTER	power
L	76 ENTER	level
E	69 ENTER	
V	86 ENTER	
<space>	32 ENTER	
CTRL-A	1 ENTER	Power output
<space>	32 ENTER	
D	68 ENTER	
B	66 ENTER	dBm
M	77 ENTER	
	ENTER	Terminate

Frequency Extenders

Maury uses the term "frequency extender" to describe a line of low noise microwave frequency converters. The purpose of such instruments is to convert microwave noise signals to frequencies within the range of a noise figure meter in such a way that the measurement accuracy is minimally affected. The frequency extenders consist of a low noise, broadband amplifier followed by a mixer. Local oscillator power is provided by an external signal source controlled as illustrated earlier. Maury offers a selection of three such units to meet a variety of industry applications. These are shown in the chart below.

MODEL		MT7550A	MT7551B	MT7552B
Frequency Range		1.6 to 4.2 GHz	1.8 to 18 GHz	1.8 to 26.5 GHz
Noise Figure	(Typical)	4.5 dB	4.0 dB	6.0 dB
	(Maximum)	6.0 dB	5.0 dB	7.0 dB
Conversion Gain	(Nominal)	6.0 dB	9.0 dB	10.5 dB
Gain Flatness	(Typical)	±2.0 dB	±2.5 dB	±3.0 dB
Input Power	1 dB Compression	-20 dBm	-25 dBm	-25 dBm
	Maximum	-15 dBm	-10 dBm	-10 dBm
Local Oscillator Input Power		0 dBm		+10 dBm
Output Frequency	Specified	30 MHz		
	Usable	30 MHz	10 to 500 MHz	10 to 500 MHz
Conversion Mode		Single Sideband	Double Sideband	
Connectors	RF Input	Type N female		3.5mm male (NMD)
	LO Input			3.5mm female
	IF Output			Type N female

Notes

1 See Maury Data Sheet 4N-020 for detail on the frequency extenders.

2 See the operating manual for the MT2075C for specific information on measurement configurations.

3 This sequence is reproduced here courtesy of Dr. George Hjipieris and Marconi Instruments, Ltd., Stevenage, UK. Additional detail on the use of the Marconi 6200 microwave test set with the Maury MT2075 can be found in Marconi Publication No. 46889-474, April 1994.

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