



NoiseTech Microwaves Ltd.

Product Manual for Impedance Generators for “Cold” Noise-Parameter
Measurements
Rev. 0 – May 3, 2017

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2. Introduction

NoiseTech Microwave Ltd. (NoiseTech) has developed impedance generators (IGs) for “cold” noise-parameter measurements.

Together with a proprietary impedance generation and a data processing algorithm [1], these compact impedance generators allow for fast and accurate measurement of noise parameters [1] for a large number of frequencies.

The small size and fully electronic design permit noise-parameter measurements of packaged and on-wafer devices extending to low frequencies. On-board memory stores calibration data. A temperature sensor is included for monitoring IG temperature for improved measurement accuracy.



Fig. 1: Photograph of an IG0160C Impedance Generator.

This document describes the procedure for using impedance generators developed for the “cold” noise parameter extraction method.

3. Impedance generator installation, functionality, and control

3.1 Installation

When first connected to a host computer via a USB 2.0, IG0160C is a composite device and appears as a mass storage device and as a COM device. For the COM device to work properly, appropriate drivers must be installed. Windows 10 is capable of installing these drivers automatically. For Windows 8 and Windows 7 computers, driver installation is performed with the following steps:

- Navigate to: Control Panel -> Device Manager
- Locate “NoiseTech Microwaves Ltd” device under “Other devices” and right click on it to select “Update Driver Software”
- Select “Browse my computer for driver software”

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- Browse to as USB device labelled "IG0160C" and select an appropriate subdirector in directory "COM Drivers" and click "Next"
- A "Windows Security" window might pop-up, click on "Install this driver software anyway"
- The following window should inform of successful driver installation. Close this window.
- NoiseTech Microwave's IG0160C should now appear as one of COM devices under "Ports (COM & LPT)" in the "Device Manager". Record the COM port number for future use.
- Close "Device Manager" and "Control Panel".
- Installation is complete.

3.2 Functionality

The impedance generator is powered and controlled via a USB connection to a host computer. When connected to the computer and the drivers are installed, IG0160C appears as a COM port in the windows Device Manager. SCPI commands can be sent to control and configure the device. The following is a list of commands, which control the device:

setStateA: sets the IG into the thru state "A"

setStateB: set IG to impedance state "B".

setStateC: set IG to impedance state "C".

setStateD: set IG to impedance state "D".

getIGtemperature: read IG temperature and output result in degrees Centigrade and a hexadecimal ADC code for troubleshooting.

getNSTemperature: read noise source temperature and output result in degrees Centigrade and a hexadecimal ADC code for troubleshooting. If a noise source is not connected, the resultant temperature will be a large negative value, typically -61.45°C.

noiseSourceOn: Enables USB noise source (NoiseTech Microwave Devices only)

noiseSourceOff: Disabled USB noise source (NoiseTech Microwave Devices only)

setUpdateMode: Sets device in update mode. Requires hard reset by power cycling unit.

3.3 Control

This section shows examples of using IG0160C device.

3.3.1 Putty

The quickest way to communicate with the device is by using Putty, which can be downloaded from <http://www.chiark.greenend.org.uk/~sgtatham/putty/latest.html>.

After Putty is downloaded and installed, it should be configured as follows:

- Click on "Serial" for Connection type
- Set "Serial line" to the COM port number (e.g., COM16) associated with IG0160C in "Device Manager"
- Baud rate: 115200
- An example of the Putty configuration is shown in Fig. 2.

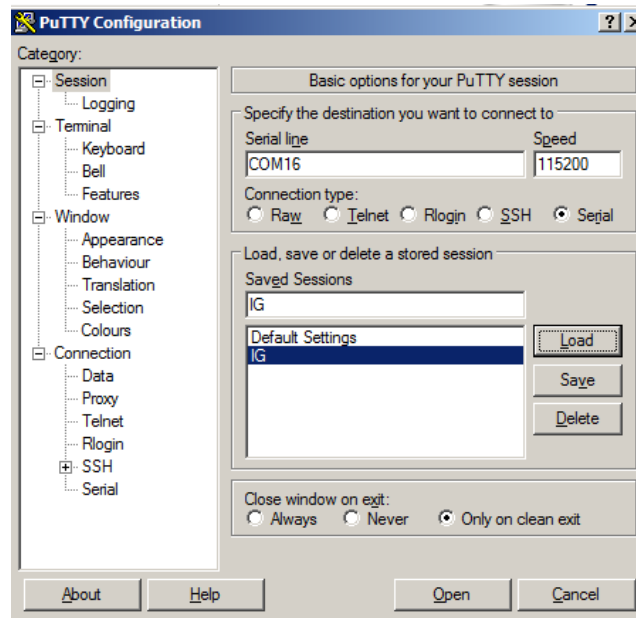


Fig. 2. Putty serial connection configuration.

- Navigate to "Terminal" category.
- Select: "auto wrap mode initially on", "implicit CR in every LF", "implicit LF in every CR", and "Local echo: Force On". See Fig. 3 for example.

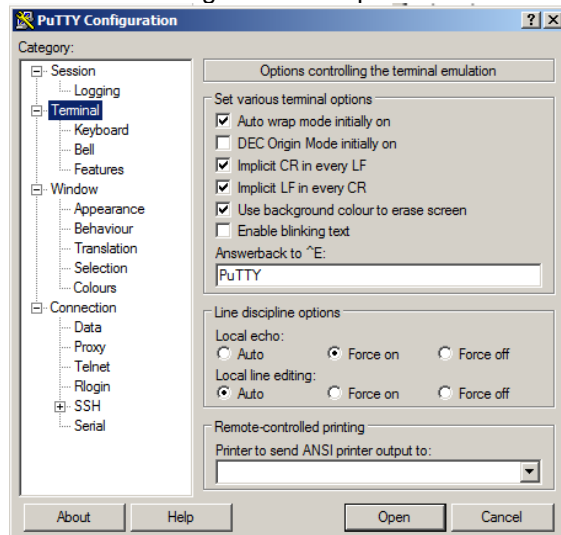


Fig. 3. Putty "Terminal" category configuration.

- Click "Open" to open the IG0160C port in Putty.
- This opens a terminal window.
- Typing IG0160C commands (case sensitive) in the terminal window controls the device.

3.3.2 Matlab

Matlab can be used for communicating with IG0160C. Since other instruments can be also controlled through Matlab, an automated measurement system can be developed to perform noise parameter measurements. Contact NoiseTech Microwave for advice and assistance with developing such a system.

The following shows an example code for controlling IG0160C.

```
% Replace this COM port number in windows "Device Manager"
COM_port = 'COM16';
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```

```

% Set Impedance Generator to State A (THRU)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'setStateA');
fgets(s1) % Optional command to check on IG0160C status.
fclose(s1);

% Set Impedance Generator to State B (THRU)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'setStateB');
fgets(s1) % Optional command to check on IG0160C status.
fclose(s1);

% Set Impedance Generator to State C (THRU)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'setStateC');
fgets(s1) % Optional command to check on IG0160C status.
fclose(s1);

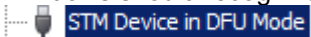
% Set Impedance Generator to State D (THRU)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'setStateD');
fgets(s1) % Optional command to check on IG0160C status.
fclose(s1);

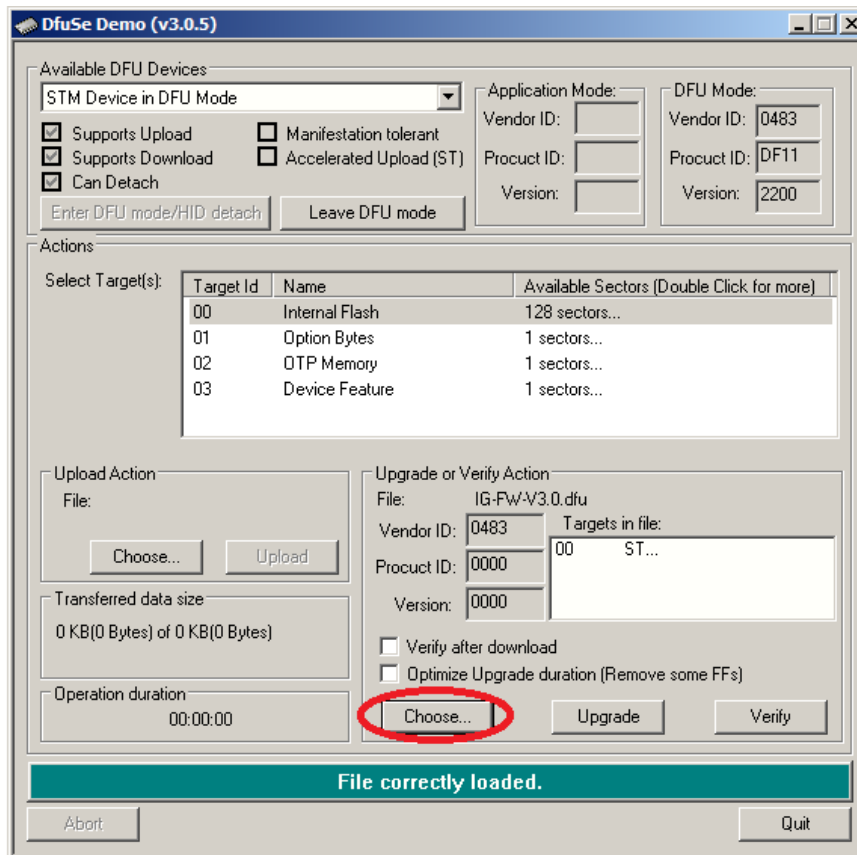
% Get Impedance generator Temperature (Celsius)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'getIGtemperature');
IGtemperatureString = fgets(s1);
IGtemperatureString_value = strsplit(IGtemperatureString,',');
IGtemperature = str2num(IGtemperatureString_value{2});
fclose(s1);
disp(['IG0160C temperature is: ',num2str(IGtemperature),'C'])

% Get Noise Source generator Temperature (Celsius)(if attached)
s1 = serial(COM_port,'BaudRate',115200);
fopen(s1);
fprintf(s1,'getNSTemperature');
NSTemperatureString = fgets(s1);
NSTemperatureString_value = strsplit(NSTemperatureString,',');
NSTemperature = str2num(NSTemperatureString_value{2});
fclose(s1);
disp(['Noise source temperature is: ',num2str(NSTemperature),'C'])

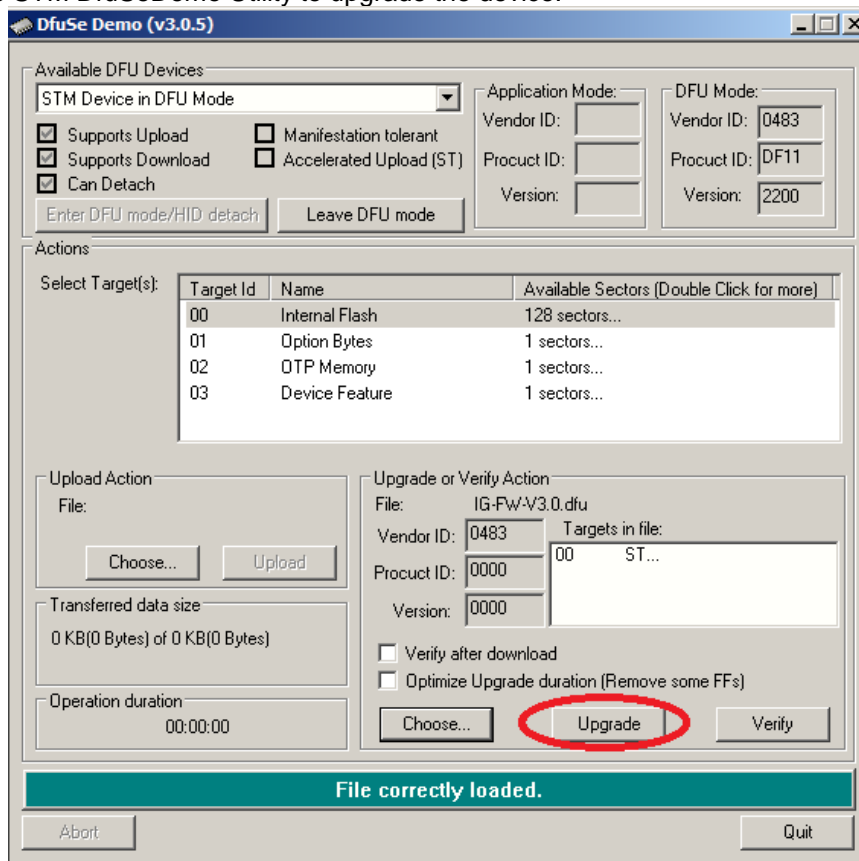
```

3.4 Firmware Update

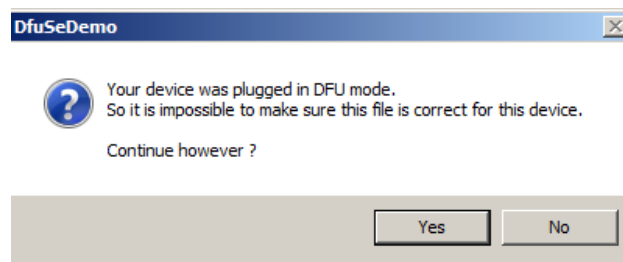
1. Connect to receiver through Putty (3.3.1).
2. Issue command “setUpdateMode”.
3. Power cycle the unit (disconnect power and reconnect)
4. Windows should recognize the USB device as an STM device in bootloader mode

5. Use the STM DfuSeDemo Utility to upload the desired firmware (only .dfu files supported):



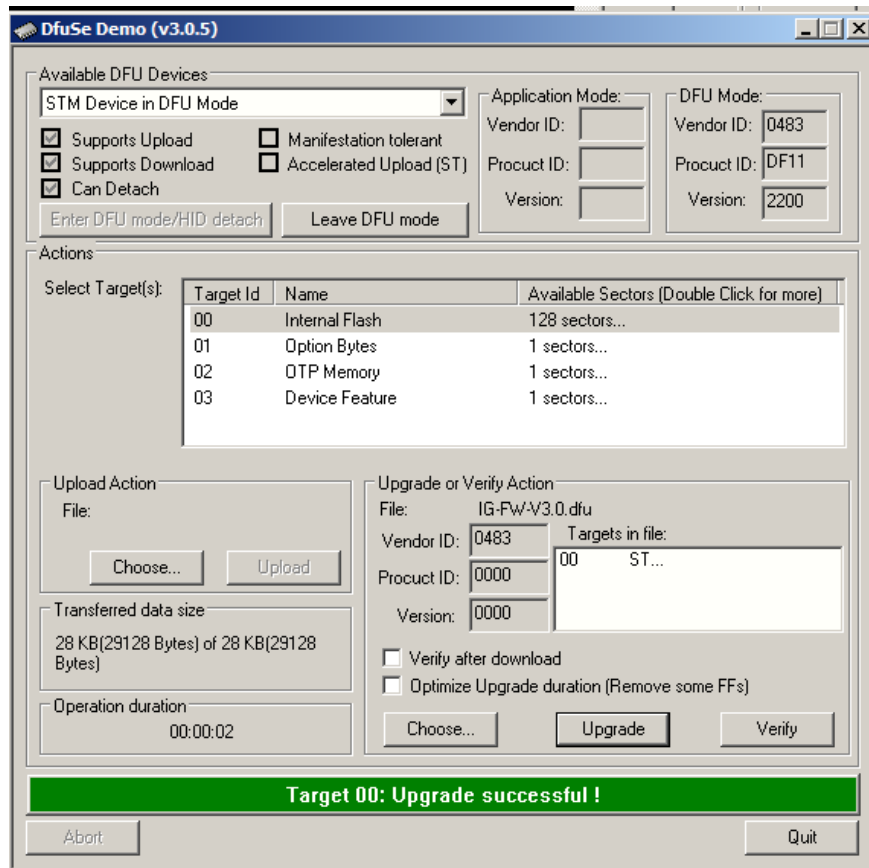
6. Use the STM DfuSeDemo Utility to upgrade the device:



7. Select Yes in the pop-up window:



8. If successful you should see the follow screen:



4. Noise parameter measurement procedure

The following procedure talks most about a calibration method. It should be understood that a device-under-test (DUT) measurement follows exactly the same procedure during which the DUT is placed at the calibration plane and the DUT noise parameters are corrected using the calibration data.

4.1 Required equipment

Noise parameters fully describe noise performance of a linear two-port device. To conduct noise parameter measurements the following equipment is required:

- NoiseTech’s IG0160C impedance generator (IG)
- Vector network analyzer (VNA) with an appropriate calibration kit
- Noise power meter (aka “receiver”). This can include a Noise Figure Analyzer (NFA) or a spectrum analyzer (SA) or a VNA, which is able to measure noise power, such as Keysight’s PNA-X or Rohde and Schwarz ZVA, both with the noise figure measurement

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option. *Note: ZVA does not need a noise source and therefore the procedure described below is slightly different. Contact NoiseTech for a ZVA-specific measurement procedure.*

- Noise source (NS). An NS is used to measure the gain of the receiver. In case of a ZVA, NS is not required but an external power meter is used instead to calibrate the ZVA gain.
- Low noise amplifier (LNA) may be used at the input to the receiver to reduce receiver noise and improve measurement uncertainty.
- Appropriate RF cables
- A computer connected to the IG via a USB port and running software that controls the IG.

4.2 Measurement process

A block diagram of the measurement setup is shown in Fig. 4.

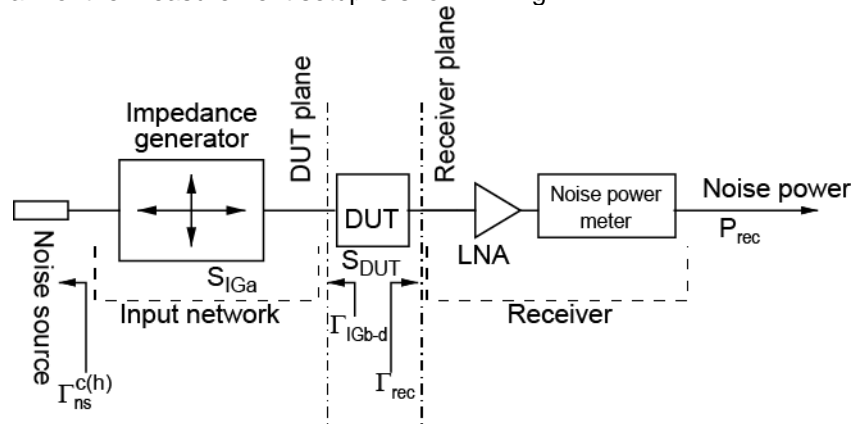


Fig. 4. Block diagram of the noise-parameter measurement system.

The following is a general procedure for calibrating the receiver by measuring its noise parameter. All steps are performed over the required frequency range. It is suggested to perform of large number measurements for adequate averaging, especially for noise-power measurements. (*If a VNA is used as a receiver, please contact NoiseTech for updated procedure.*)

- Step 1 Calibrate VNA for S-parameter measurement.
- Step 2 Measure the DUT S-parameters (S_{DUT}) and save in a touchstone-format file.
- Step 3 Measure the reflection coefficient of the receiver (Γ_{rec}) and save in a touchstone-format file.
- Step 4 Measure reflection coefficients ($\Gamma_{ns}^{c(h)}$ and Γ_{bs}^h) of the NS in its ON state (a.k.a. Hot state) and OFF state (a.k.a. Cold state) and save in touchstone-format files.
- Step 5 Measure two port S-parameters (S_{IGa}) of the IG in state “A”, and the output reflection coefficients (Γ_{IGb} , Γ_{IGc} , and Γ_{IGd}) of the IG in its states “B”, “C”, and “D”. Save S-parameters in touchstone-format files.
- Step 6 Connect the output of IG to the input of the receiver (i.e. as in Fig. 4 but with the DUT replaced by a thru). Set the IG to its state “A”. For both the ON state and the OFF state of the NS, measure noise powers with the receiver ($P_{rec,cal}$), the IG temperature (T_{IG}), and, if available, the NS temperature (T_{NS}). Save measurements in appropriate files.
- Step 7 Repeat Step 6 for states “B”, “C”, and “D”, while keeping the NS OFF. Save measurements in appropriate files.
- Step 8 Insert the DUT between the output of IG and the receiver.
- Step 9 With NS set to OFF, set IG to its four states and measure noise power ($P_{rec,meas}$) with the receiver. Save results in appropriate files.
- Step 10 Extract noise parameters using measured data. An example Matlab code for performing such extraction is included on IG0160C for user reference.

5. References

- [1] “System and method for measuring wideband noise parameters using an impedance generator,” U.S. Patent Application No. 62/364,458

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- [2] M. Himmelfarb and L. Belostotski, "On Impedance-Pattern Selection for Noise Parameter Measurement," *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 1, pp. 258-270, January, 2016.

6. Revision notes