



Gowin Beamforming IP

User Guide

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Revision History

Date	Version	Description
03/03/2021	1.0E	Initial version published.

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1 About This Guide

1.1 Purpose

Gowin Beamforming IP User Guide mainly provides the descriptions of the features, functions, ports, timing, GUI, and reference design. It mainly helps you quickly learn the characteristics and usage of Gowin Beamforming IP.

1.2 Related Documents

The latest user guides are available on the GOWINSEMI Website. You can find the related documents at www.gowinsemi.com:

- [DS102](#), GW2A series of FPGA Products Data Sheet
- [DS226](#), GW2AR series of FPGA Products Data Sheet
- [DS961](#), GW2ANR series of FPGA Products Data Sheet
- [SUG100](#), Gowin Software User Guide

1.3 Terminology and Abbreviations

The terminology and abbreviations used in this manual are as shown in Table 1-1.

Table 1-1 Terminology and Abbreviations

Terminology and Abbreviations	Meaning
IP	Intellectual Property
BSRAM	Block Static Random Access Memory
DSP	Digital Signal Processing

1.4 Support and Feedback

Gowin Semiconductor provides customers with comprehensive technical support. If you have any questions, comments, or suggestions, please feel free to contact us directly by the following ways.

Website: www.gowinsemi.com

E-mail: support@gowinsemi.com

2 Overview

2.1 Introduction to Gowin Beamforming IP

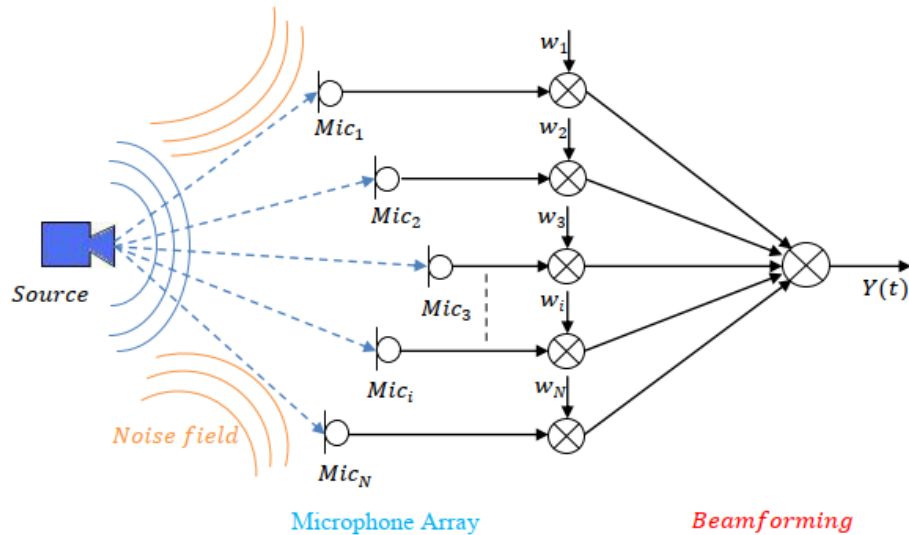
Gowin Beamforming IP is used to process microphone array data, locate acoustic source, and extract speech information from ambient noise.

Table 2-1 Gowin Beamforming IP Overview

Gowin Beamforming IP	
IP Core Application	
Logic Resource	See Table 3-1
Delivered Doc.	
Design Files	Verilog (encrypted)
Test and Design Flow	
Synthesis Software	Synplify Pro/GowinSynthesis
Application Software	Gowin Software

2.2 Introduction to Beamforming Algorithm

Figure 2-1 Gowin Beamforming Diagram



Beamforming is used to locate the acoustic source through the microphone array acquiring the source from different distances, and to obtain the signal of required direction by weighting the microphones of different directions to attenuate the signals of other directions. As shown in the figure below, its mathematical expression is

$$y(f) = \sum_{i=1}^N w_i^H(f) x_i(f)$$

3 Feature and Performance

3.1 Features

- Direction Identification
- Beamforming

3.2 Max. Frequency

The maximum frequency of Gowin Beamforming IP is primarily determined by the device used and the speed grade of the devices. Taking GW2A-55 series of FPGA for an instance, it can be up to 80M.

3.3 Resource Utilization

Gowin Beamforming IP can be implemented by Verilog language. Its performance and resource utilization may vary when the design is employed in different devices, or at different density, speed, grade or the different modes of IP configuration.

Gowin Beamforming IP takes GW2A-55 series of FPGA with default configuration for an instance to introduce resource utilization. The resource utilization is shown in Table 3-1. For application verification on other Gowin FPGA, please pay attention to the post-released information.

Table 3-1 Gowin Beamforming IP Resource Utilization

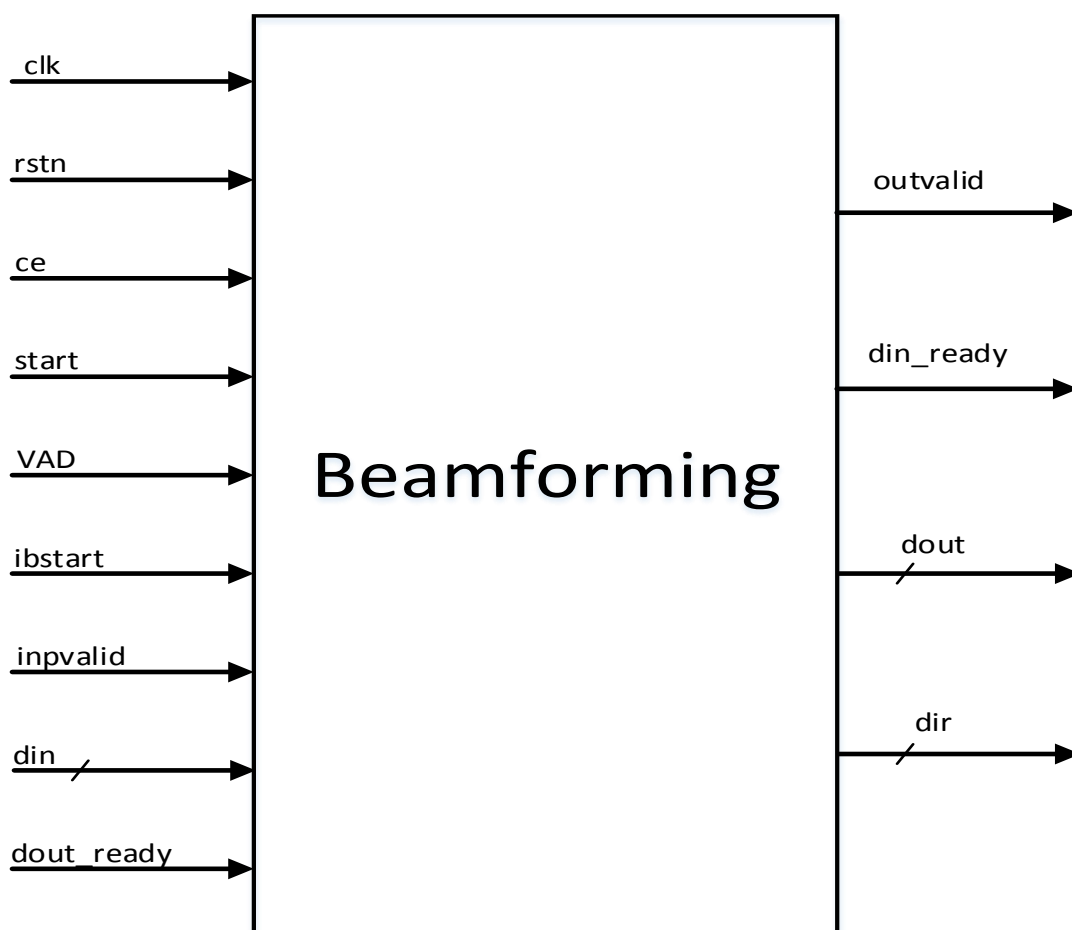
Device Series	Speed Grade	Resource Utilization		Remarks
GW2A-55	C8/I7	Logic		6044
		Register		8104
		BSRAM		7
		DSP	MULT18X18	4
			MULTADDALU18X18	4
				-

4 Functional Description

Port Description

The IO ports of Gowin Beamforming IP are shown in Figure 4-1 below.

Figure 4-1 Ports Diagram of Gowin Beamforming IP



For the detailed IO ports description of Gowin Beamforming IP, please refer to Table 4-1.

Table 4-1 Gowin Beamforming IO Description

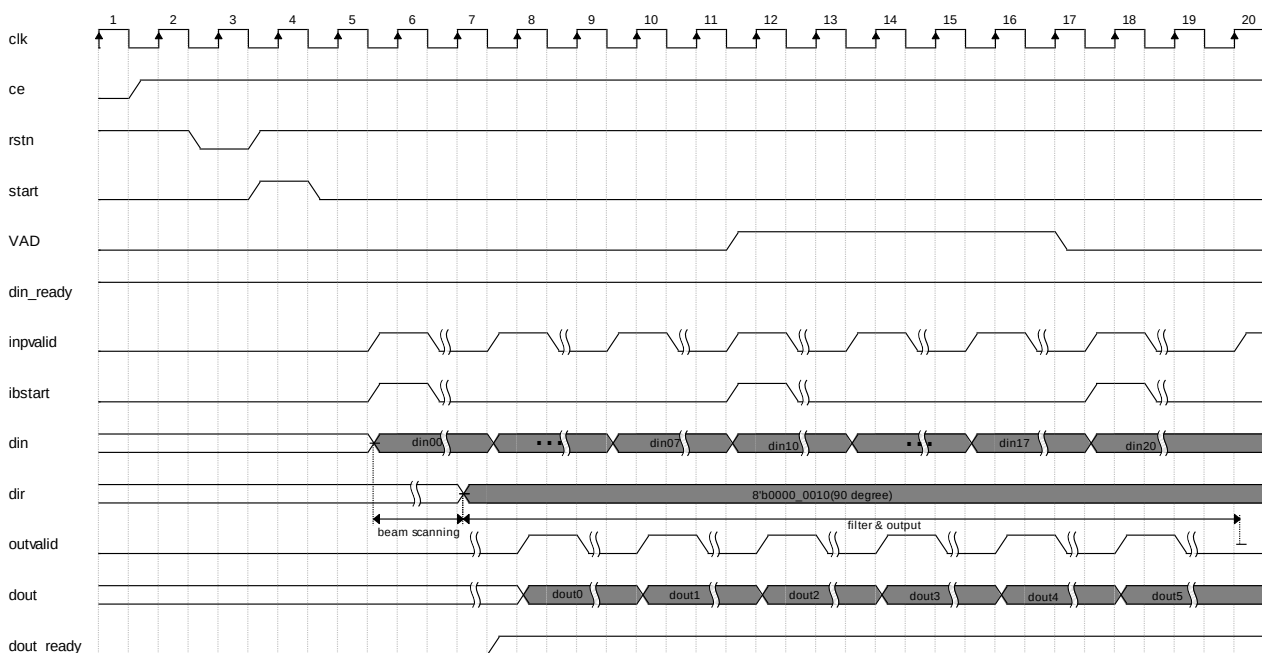
Signal	I/O	Description
clk	input	Clock
rstn	input	Reset, active-low.
ce	input	Enable Signal
start	input	Start signal of direction detection
VAD	input	Valid speech signal
ibstart	input	Channel start signal (or sync signal)
inpvalid	input	Input data valid signal
din	input	Input data with 18 bit width.
dout_ready	input	Ready to output data
outvalid	output	Output data valid signal
dout	output	Output data with 18 bit width.
dir	output	Direction signal with 8 bit width, pointing to 8 directions. 8'B0000_0000: processing 8'b0000_0001: 0° 8'b0000_0010: 45° 8'b0000_0100: 90° 8'b0000_1000: 135° 8'b0001_0000: 180° 8'b0010_0000: 225° 8'b0100_0000: 270° 8'b1000_0000: 315° 8'b1111_1111: No direction detected
din_ready	output	Ready to input data

5 Timing Description

Gowin Beamforming IP Timing

The timing of Gowin Beamforming IP is shown in Figure 5-1.

Figure 5-1 Beamforming Timing Diagram



When direction detection is carried out, VAD is high to indicate that the speech signal is valid; after identification, the detected acoustic source direction can be obtained. Detecting of a start cycle of high level pulse signal, IP will re-start the identification of direction.

Data are input in order from channel 1 to channel 8, invalid means the input data is valid, and ibstart is the start channel for each input; after a period of delay, when dout_ready is high, that is, the module is ready to receive data, and this module will output data.

din_ready (output) and dout_ready (input) are handshake signals. din_ready=1 means the IP is ready to receive the output data from the IP's high-level module; usually it is connected to the dout_ready of the high-level module. dout_ready=1 means the next-level module of the IP is ready to receive the output data from the IP; usually it is connected to din_ready of the next-level module.

Note!

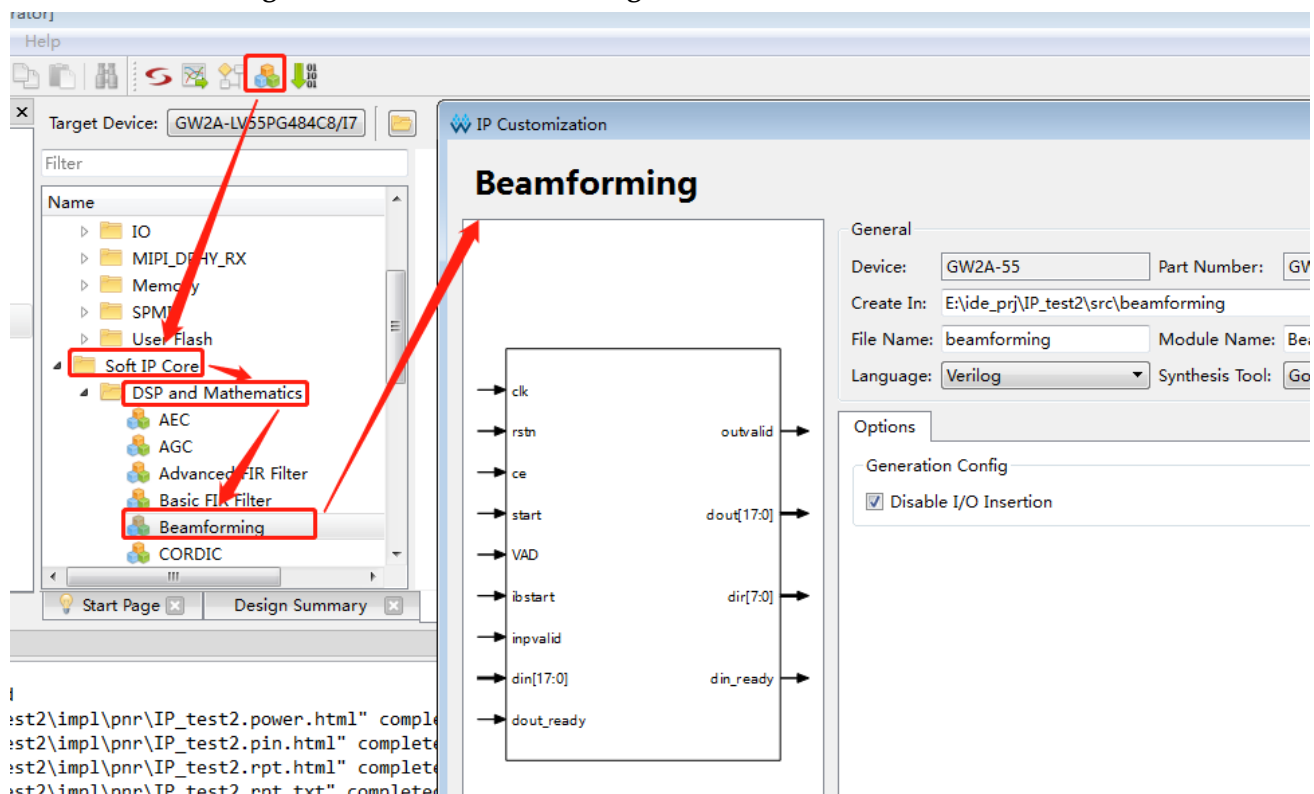
din00 in the timing diagram indicates the first number of channel 1; din10 indicates the second number of channel 1; din17 indicates the second number of channel 8.

6 Call and Configuration

6.1 IP Call

Start "IP Core Generator" from the "Tools" menu in the Gowin Software and to call and configure Gowin Beamforming IP. Or you can start via the icons as Figure 6-1.

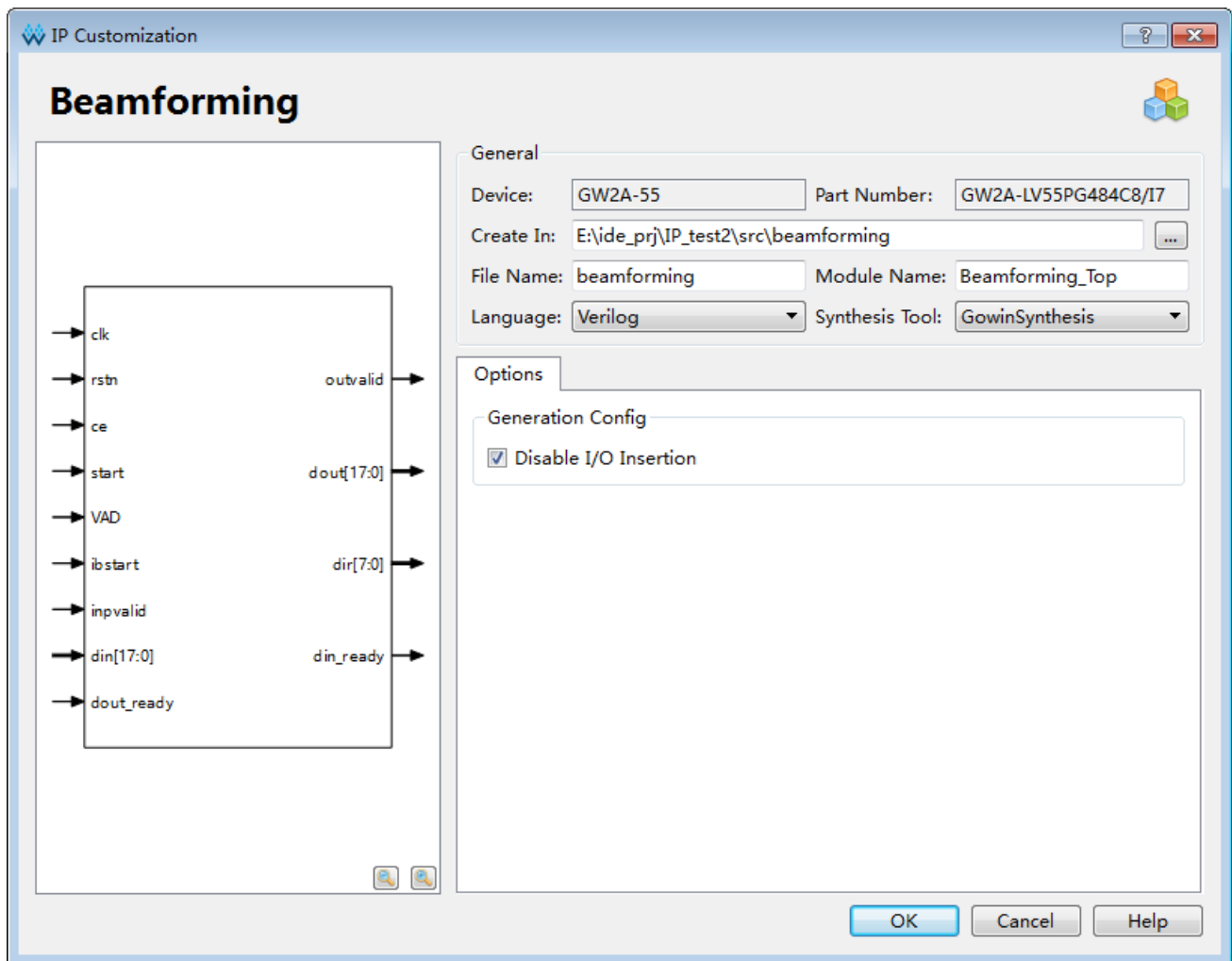
Figure 6-1 Gowin Beamforming IP Call Via Tool Bar



6.2 Configuration Interface

The Gowin Beamforming IP configuration interface is shown in Figure 6-2.

Figure 6-2 Gowin Beamforming IP Configuration Interface



This manual selects GW2A-55 chip and GW2A-LV55PG484C8/I7 part number as an example.

- Create In" displays the path of generated IP core folder, and you can modify the path.
- File Name displays the file name of the generated IP, and you can modify the name.
- Module Name displays the module name of the generated IP, and you can modify the name.

7 Reference Design

Please refer to the related test cases in [RefDesign](#).

